

2020 Census Detailed Operational Plan for: Post-Enumeration Survey (PES) Operations – Including: 27. CMDE, 28. CMM, and 29. CMFO

A New Design for the 21st Century

Issued: April 16, 2020

Version: 1.0

Prepared by: Decennial Census Management Division



[Page intentionally left blank.]

Approvals

This PES Detailed Operational Plan has been reviewed and approved for use.

Electronically Signed Judy G. Belton ADC for Special Enumerations, Decennial Census Management Division (DCMD)	03/24/2020 Date Signed
---	---------------------------

Electronically Signed Timothy Kennel ADC for Statistical Methods, Decennial Statistical Studies Division (DSSD)	03/24/2020 Date Signed
--	---------------------------

Electronically Signed T. Trang Nguyen ADC for Matching and Coverage Measurement, DSSD	03/24/2020 Date Signed
---	---------------------------

Electronically Signed Jennifer Reichert Acting Division Chief, DCMD	4/16/2020 Date Signed
---	--------------------------

Electronically Signed Patrick Cantwell Division Chief, DSSD	4/16/2020 Date Signed
---	--------------------------

Document Change History

Revision #	Version	Date	Description
1-4	v0.01c – v0.01d	April 11 – September 16, 2019	Initial shells for various chapters created as pieces (CMDE, CMFO, CMM, Section 2, etc.).
5	v0.01d	December 13, 2019	Draft created that combined CMM, CMFO, CMDE in the main shell.
6	v0.02e	February 21, 2020	DPMO review complete, all sections in a single document, annotated BPM set version 5.4 reflected, added PES I/O tables between PES operations.
7	v0.02e EDITS	March 18, 2020	Back from DPMO with PES Team edits included.
8	v0.02f	March 24, 2020	Back to DPMO with MITRE review updates.
9	v0.02g	April 8, 2020	DCCO edits and final BPM 5.4 figure updates.

Document Footer Information Control Table

Field Name	Version, Date and Status
DocVersion:	V1.0
DocDate:	April 16, 2020
DocStatus:	Final

Table of Contents

1. Document Purpose	1
2. Operational Overview	2
2.1 Operation Purpose.....	2
2.2 About This Document	2
2.3 Background	3
2.3.1 Census 2000 A.C.E. Program	5
2.3.2 2010 Census Coverage Measurement	6
2.3.3 2020 Post-Enumeration Survey.....	6
2.4 Design Overview.....	15
2.4.1 High-Level Operational Design.....	15
2.4.2 PES Operational Context.....	19
2.4.2.1 PES Operational Inputs	21
2.4.2.2 PES Operational Controls.....	25
2.4.2.3 PES Operational Outputs	27
2.4.2.4 PES Operational Mechanisms.....	29
2.5 PES Operations Data Flow and Operational Influences.....	34
3. CMDE Design Overview and Detailed Process Description [27].....	81
3.1 CMDE Design Overview.....	81
3.1.1 High-Level Operational Design	81
3.1.2 Operational Context for CMDE Activities.....	83
3.1.2.1 CMDE Operational Inputs	84
3.1.2.2 CMDE Operational Outputs.....	85
3.2 CMDE Detailed Process Description.....	88
3.2.1 CMDE Survey Design and Sampling [CMDE 27-1]	89
3.2.1.1 Design Post-Enumeration Survey [CMDE 27-1.1]	90
3.2.1.2 Select Initial Sample of PES Basic Collection Units (BCUs) [CMDE 27-1.2]	91

3.2.1.3	Subsample PES Small Basic Collection Units [CMDE 27-1.3].....	93
3.2.1.4	Select PES PI Housing Unit (HU) Sample [CMDE 27-1.4]	94
3.2.1.5	Select E Sample Housing Units [CMDE 27-1.5]	95
3.2.2	CMDE Estimation and Reporting [CMDE 27-2]	97
3.2.2.1	Produce PES Person Estimates [CMDE 27-2.1]	98
3.2.2.2	Produce PES Housing Unit (HU) Estimates [CMDE 27-2.2]	105
3.2.2.3	Produce PES Estimation Reports and Release Findings [CMDE 27-2.3].....	112
4.	CMM Design Overview and Detailed Process Description [28].....	113
4.1	CMM Design Overview.....	113
4.1.1	High-Level Operational Design.....	113
4.1.2	Operational Context for CMM Activities.....	115
4.1.2.1	CMM Operational Inputs	117
4.1.2.2	CMM Operational Outputs.....	120
4.2	CMM Detailed Process Description.....	123
4.2.1	CMM Initial Housing Unit (IHU) Matching [CMM 28-1]	124
4.2.1.1	Conduct PES Initial Housing Unit (IHU) Computer Matching [CMM 28-1.1].....	125
4.2.1.2	Conduct PES IHU Before Followup (BFU) Clerical Matching [CMM 28-1.2]	127
4.2.1.3	Conduct PES IHU After Followup (AFU) Clerical Matching [CMM 28-1.3]	130
4.2.2	CMM Person Data Preparation and Matching [CMM 28-2]	133
4.2.2.1	Conduct Clerical Geocoding (CGC) [CMM 28-2.1].....	135
4.2.2.2	Conduct PES Person Computer Matching [CMM 28-2.2]	138
4.2.2.3	Conduct Clerical Residence Status Coding (RSC) [CMM 28-2.3]	142
4.2.2.4	Conduct PES Person Before Followup (BFU) Clerical Matching [CMM 28-2.4] ..	145
4.2.2.5	Conduct PES Person After Followup (AFU) Clerical Matching [CMM 28-2.5] ...	148
4.2.3	CMM Final Housing Unit (FHU) Matching [CMM 28-3]	151
4.2.3.1	Conduct PES Final Housing Unit (FHU) Computer Matching/Processing [CMM 28-3.1]	153
4.2.3.2	Conduct PES FHU Before Followup (BFU) Clerical Matching [CMM 28-3.2]	154

4.2.3.3	Conduct PES FHU After Followup (AFU) Clerical Matching [CMM 28-3.3].....	157
5.	CMFO Design Overview and Detailed Process Description [29].....	161
5.1	CMFO Design Overview.....	161
5.1.1	High-Level Operational Design.....	161
5.1.2	Operational Context for CMFO Activities.....	163
5.1.2.1	CMFO Operational Inputs	164
5.1.2.2	CMFO Operational Outputs.....	166
5.2	CMFO Detailed Process Description.....	169
5.2.1	CMFO Planning and Preparation [CMFO 29-1]	170
5.2.2	PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2]	171
5.2.2.1	Provide IL Training and Perform Admin Activities [CMFO 29-2.1]	173
5.2.2.2	Conduct IL Production Fieldwork [CMFO 29-2.2]	173
5.2.2.3	Manage Workload for IL Quality Control (QC) [CMFO 29-2.3].....	174
5.2.2.4	Conduct IL QC Fieldwork [CMFO 29-2.4].....	174
5.2.2.5	Manage Outputs from PES IL and QC [CMFO 29-2.5]	175
5.2.3	PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3]	175
5.2.3.1	Provide IHUFU Training and Perform Admin Activities [CMFO 29-3.1]	177
5.2.3.2	Conduct IHUFU Production Fieldwork [CMFO 29-3.2]	178
5.2.3.3	Manage Workload for IHUFU Quality Control (QC) [CMFO 29-3.3]	178
5.2.3.4	Conduct IHUFU QC Fieldwork [CMFO 29-3.4]	179
5.2.3.5	Manage Outputs from PES IHUFU and QC [CMFO 29-3.5]	179
5.2.4	PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4]	180
5.2.4.1	Provide PI Training and Perform Admin Activities [CMFO 29-4.1]	182
5.2.4.2	Conduct PI Production Fieldwork [CMFO 29-4.2]	182
5.2.4.3	Perform PES Person Interview (PI) Reinterview (RI) [CMFO 29-4.3]	183
5.2.4.4	Manage Outputs from PES PI and Reinterview [CMFO 29-4.4]	185
5.2.5	PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5]	186

5.2.5.1	Provide PFU Training and Perform Admin Activities [CMFO 29-5.1]	188
5.2.5.2	Conduct PES PFU Production Fieldwork [CMFO 29-5.2].....	189
5.2.5.3	Perform PES Person Followup Reinterview (PFU RI) [CMFO 29-5.3]	190
5.2.5.4	Manage Outputs from PES PFU and Reinterview [CMFO 29-5.4]	191
5.2.6	PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6]	191
5.2.6.1	Provide FHUFU Training and Perform Admin Activities [CMFO 29-6.1]	193
5.2.6.2	Conduct FHUFU Production Fieldwork [CMFO 29-6.2]	194
5.2.6.3	Manage Workload for FHUFU Quality Control (QC) [CMFO 29-6.3]	194
5.2.6.4	Conduct FHUFU QC Fieldwork [CMFO 29-6.4].....	195
5.2.6.5	Manage Outputs from PES FHUFU and QC [CMFO 29-6.5]	195
5.2.7	CMFO Closeout [CMFO 29-7]	196
6.	Cost Factors	198
7.	Measures of Success	200
	Appendix A – Acronyms and Terminology.....	201
	Appendix B – References.....	206
	Appendix C – Activity Tree for Post-Enumeration Survey (PES) Operations – Including: 27. CMDE, 28. CMM, and 29. CMFO.....	208

List of Figures

Figure 1: PES Operation Context Model (incl. 27. CMDE, 28. CMM, and 29. CMFO)	3
Figure 2: Post-Enumeration Survey (PES) Operations Context Diagram	20
Figure 3: 2020 Post-Enumeration Survey (PES) Integrated Operations Diagram (IOD)	35
Figure 4: PES Operation Context Model Showing CMDE Operational Context.....	88
Figure 5: CMDE Survey Design and Sampling [CMDE 27-1] Activities.....	89
Figure 6: Design Post-Enumeration Survey	91
Figure 7: Select Initial Sample of PES Basic Collection Units (BCUs).....	92

Figure 8: Subsample PES Small Basic Collection Units.....	93
Figure 9: Select PES PI Housing Unit (HU) Sample	94
Figure 10: Select E Sample Housing Units	96
Figure 11: CMDE Estimation and Reporting [CMDE 27-2] Activities	97
Figure 12: Produce PES Person Estimates	99
Figure 13: Process Inputs for PES Person Estimates	100
Figure 14: Perform Imputation and Weighting for PES Person Estimates	102
Figure 15: Perform Estimation and Tabulation for PES Person Estimates.....	104
Figure 16: Produce PES Housing Unit (HU) Estimates	106
Figure 17: Process Inputs for PES Housing Unit Estimates	107
Figure 18: Perform Imputation and Weighting for PES Housing Unit Estimates.....	109
Figure 19: Perform Estimation and Tabulation for PES Housing Unit Estimates	111
Figure 20: Produce PES Estimation Reports and Release Findings.....	112
Figure 21: PES Operations Context Model Showing CMM Operational Context	123
Figure 22: CMM Initial Housing Unit (IHU) Matching [CMM 28-1] Activities.....	124
Figure 23: Conduct PES Initial Housing Unit (IHU) Computer Matching	126
Figure 24: Conduct PES IHU Before Followup (BFU) Clerical Matching	127
Figure 25: Receive and Process Inputs for IHU BFU Clerical Matching	128
Figure 26: Perform IHU BFU Clerical Matching, Review, and QC	129
Figure 27: Manage Outputs from IHU BFU Clerical Matching	130
Figure 28: Conduct PES IHU After Followup (AFU) Clerical Matching	131
Figure 29: Receive and Process Inputs for IHU AFU Clerical Matching	132
Figure 30: Perform IHU AFU Clerical Matching, Review, and QC.....	132
Figure 31: Manage Outputs from IHU AFU Clerical Matching	133
Figure 32: CMM Person Data Preparation and Matching [CMM 28-2] Activities.....	134
Figure 33: Conduct Clerical Geocoding (CGC).....	136
Figure 34: Receive and Process Inputs for CGC	137

Figure 35: Perform Clerical Geocoding, Review, and QC.....	137
Figure 36: Manage Outputs from CGC	138
Figure 37: Conduct PES Person Computer Matching	139
Figure 38: Receive and Process Inputs for Person Computer Matching	140
Figure 39: Perform Person Computer Matching.....	141
Figure 40: Manage Outputs from Person Computer Matching	142
Figure 41: Conduct Clerical Residence Status Coding (RSC)	143
Figure 42: Receive Inputs for Clerical RSC.....	144
Figure 43: Perform Clerical Residence Status Coding, Review, and QC	144
Figure 44: Manage Outputs from Clerical RSC.....	145
Figure 45: Conduct PES Person Before Followup (BFU) Clerical Matching	146
Figure 46: Receive and Process Inputs for Person BFU Clerical Matching.....	147
Figure 47: Perform Person BFU Clerical Matching, Review, and QC	147
Figure 48: Manage Outputs from Person BFU Clerical Matching.....	148
Figure 49: Conduct PES Person After Followup (AFU) Clerical Matching.....	149
Figure 50: Receive and Process Inputs for Person AFU Clerical Matching	150
Figure 51: Perform Person AFU Clerical Matching, Review, and QC	150
Figure 52: Manage Outputs from Person AFU Clerical Matching	151
Figure 53: CMM Final Housing Unit (FHU) Matching [CMM 28-3] Activities	152
Figure 54: Conduct PES Final Housing Unit (FHU) Computer Matching/Processing.....	153
Figure 55: Conduct PES FHU Before Followup (BFU) Clerical Matching	155
Figure 56: Receive and Process Inputs for FHU BFU Clerical Matching	156
Figure 57: Perform FHU BFU Clerical Matching, Review, and QC	156
Figure 58: Manage Outputs from FHU BFU Clerical Matching.....	157
Figure 59: Conduct PES FHU After Followup (AFU) Clerical Matching.....	158
Figure 60: Receive and Process Inputs for FHU AFU Clerical Matching.....	159
Figure 61: Perform FHU AFU Clerical Matching, Review, and QC	159

Figure 62: Manage Outputs from FHU AFU Clerical Matching.....	160
Figure 63: PES Operation Context Model Showing CMFO Operational Context.....	169
Figure 64: CMFO Planning and Preparation [CMFO 29-1] Activity.....	170
Figure 65: PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2] Activity	171
Figure 66: PES Independent Listing (IL) and Quality Control (QC) Subactivities.....	172
Figure 67: Conduct IL Production Fieldwork.....	173
Figure 68: Manage Workload for IL Quality Control (QC).....	174
Figure 69: Conduct IL QC Fieldwork.....	174
Figure 70: Manage Outputs from PES IL and QC.....	175
Figure 71: PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3] Activity.....	176
Figure 72: PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) Subactivities...	177
Figure 73: Conduct IHUFU Production Fieldwork	178
Figure 74: Manage Workload for IHUFU Quality Control (QC)	179
Figure 75: Conduct IHUFU QC Fieldwork.....	179
Figure 76: Manage Outputs from PES IHUFU and QC	180
Figure 77: PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4] Activity.....	180
Figure 78: PES Person Interview (PI) and Reinterview (RI) Subactivities	181
Figure 79: Conduct PI Production Fieldwork	182
Figure 80: Perform PES Person Interview (PI) Reinterview (RI)	184
Figure 81: Manage Outputs from PES PI and Reinterview (General Process).....	185
Figure 82: Manage Outputs from PES PI and Reinterview (Detail for PI Post-Data Collection Processing).....	186
Figure 83: PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5] Activity.....	187
Figure 84: PES Person Followup (PFU) and Reinterview (RI) Subactivities	188
Figure 85: Conduct PFU Production Fieldwork.....	189
Figure 86 Perform Person Followup (PFU) Reinterview (RI).....	190
Figure 87: Manage Outputs from PES PFU and Reinterview	191

Figure 88: PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6] Activity..... 192

Figure 89: PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) Subactivities ... 193

Figure 90: Conduct FHUFU Production Fieldwork..... 194

Figure 91: Manage Workload for FHUFU Quality Control (QC)..... 195

Figure 92: Conduct FHUFU QC Fieldwork..... 195

Figure 93: Manage Outputs from PES FHUFU and QC..... 196

Figure 94: CMFO Closeout [CMFO 29-7] Activity..... 196

List of Tables

Table 1: PES Operational Inputs 21

Table 2: PES Operational Controls 26

Table 3: PES Operational Outputs..... 27

Table 4: Staff Resources Used Within PES Operational Activities 30

Table 5: Infrastructure Sites for PES Operational Activities..... 30

Table 6: Systems Used Within PES Operational Activities 31

Table 7: Strata for Selecting the BCU Sample for PES Independent Listing 37

Table 8: CMDE Operational Inputs 84

Table 9: CMDE Operational Outputs..... 86

Table 10: CMM Operational Inputs 117

Table 11: CMM Operational Outputs..... 120

Table 12: CMFO Operational Inputs 164

Table 13: CMFO Operational Outputs..... 166

Table 14: Acronyms and Abbreviations List..... 201

Table 15: Terminology 205

1. Document Purpose

The 2020 Census Detailed Operational Plan for the Post-Enumeration Survey (PES) Operations (including 27. CMDE, 28. CMM, and 29. CMFO¹) is intended for use by U.S. Census Bureau managers, staff, contractors, and other internal and external stakeholders working on the 2020 Census. The document presents the detailed operational design for each of the operations comprising the PES, including a summary of the operational processes involved, their inputs, outputs and controls, and the basic mechanisms employed to conduct the operational work.

Anticipated uses of this document include the following:

- Communication – Documents operational design details for internal and external stakeholders.
- Planning – Documents planning assumptions and key milestones.
- Staffing – Documents staffing needs and strategies.
- Design – Describes operations and flows, which inform design of Information Technology (IT) systems, manual processes, and training.
- Development – Identifies business rules and required capabilities to be developed.
- Testing – Provides a basis for developing integrated test plans for IT systems and processes.

This document complements the 2020 Census Operational Plan, which presents the 2020 Census operational design and covers all operations required to execute the 2020 Census, starting with pre-census address and geographic feature updates and ending once census data products are disseminated and coverage and quality are measured.

¹ 27. Coverage Measurement Design and Estimation operation (CMDE), 28. Coverage Measurement Matching operation (CMM), and 29. Coverage Measurement Field Operations (CMFO).

2. Operational Overview

2.1 Operation Purpose

The Post-Enumeration Survey (PES) includes three operations with the following responsibilities:

- **Coverage Measurement Design and Estimation operation (CMDE):** Designs the PES, including sampling and estimation.
- **Coverage Measurement Matching operation (CMM):** Identifies matches and nonmatches between the 2020 Census and the PES for the enumerated housing units (HUs) and people.
- **Coverage Measurement Field Operations (CMFO):** Collects person and HU information (independent from the 2020 Census operations) for the sample of HUs in the PES.

2.2 About This Document

This document provides the detailed operational planning information for the Post-Enumeration Survey (PES). The PES is an interrelated set of operational activities intended to allow the Census Bureau to evaluate coverage of the 2020 Census and provide data to improve future censuses. The Census Bureau conducts the PES to measure the coverage of housing units and people residing in housing units in the 2020 Census.

Specifically, this plan describes an overview of the PES and the three operations that make up the PES:

- The Coverage Measurement Design and Estimation operation (CMDE)
- The Coverage Measurement Matching operation (CMM)
- The Coverage Measurement Field Operations (CMFO)

The structure of these activities is given in [Figure 1](#), the 2020 Census PES Operations Context Model. Activities 27-1 and 27-2 in this model constitute the CMDE operational activities for the 2020 Census PES. Activities 28-1 through 28-3 in this model constitute the CMM operational activities for the 2020 Census PES. Activities 29-1 through 29-7 in this model constitute the CMFO operational activities for the 2020 Census PES.

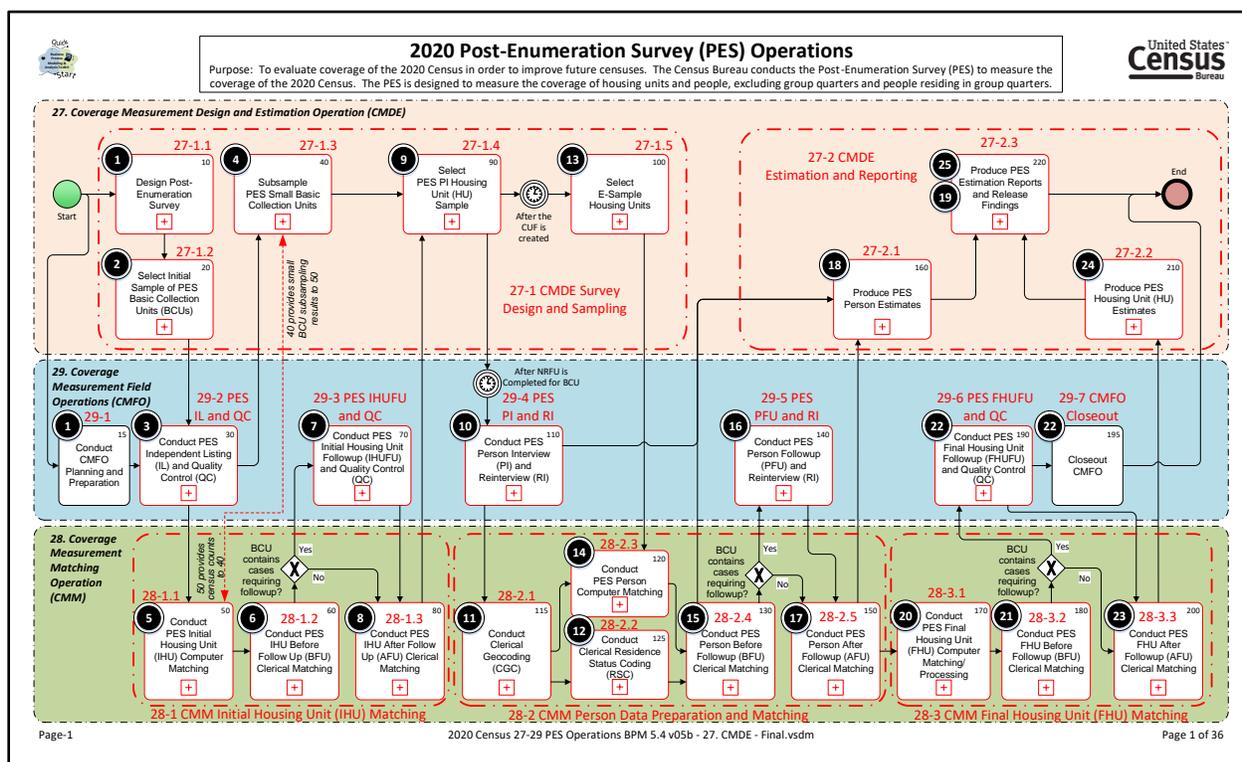


Figure 1: PES Operation Context Model (incl. 27. CMDE, 28. CMM, and 29. CMFO)

Additional background on the PES is provided in the remainder of Section 2 of this document. The detailed plans for CMDE, CMM, and CMFO are then discussed in Sections 3, 4, and 5 of this document, respectively.

2.3 Background

The undercount has been a significant issue in census-taking since the first census in 1790. Both President Washington and Secretary of State Jefferson thought that the 1790 Census total population—reported as 3.9 million—should have been over 4 million. Crude historical estimates of percentage net undercount date back as far as 1880. Beginning in the 1940s, the Census Bureau produced demographic-based estimates of census net undercount, focusing on specific demographic subgroups. By the 1960s, the Census Bureau had increasing evidence that African Americans and other minorities were undercounted at higher-than-average rates. Evaluations of the census since that time have indicated that this “differential undercount” also affects young adult males and renters. By the late 1970s, the Census Bureau had done significant work in developing survey-based tools for estimating net coverage in the census, and during the 1980s, it significantly refined these tools for measuring the number of people missed by the census for relatively large areas and groups. For the 1990 Census, the Census Bureau employed the first true “coverage measurement survey” to measure net overcounts and

undercounts in the census; it was referred to as the 1990 Post-Enumeration Survey. For more information on the 1990 Census and PES, see U.S. Census Bureau (1996).

For Census 2000, the coverage measurement survey was called the Accuracy and Coverage Evaluation (A.C.E.). In the 2010 Census, the survey was called the Census Coverage Measurement (CCM) Survey. The coverage measurement survey for the 2020 Census will be called the Post-Enumeration Survey (PES).

Today, the Census Bureau employs two principal methods—both of which have been vastly improved since their earliest uses—to evaluate coverage in the census. That is, the agency compares the census counts with two sets of estimates of net undercount: (1) estimates produced by the methodology known as demographic analysis and (2) estimates produced through dual system estimation in conjunction with a coverage measurement survey. Demographic Analysis is described as part of the Experiments and Evaluations operation and not discussed in this Detailed Operational Plan.

The PES activities planned for the 2020 Census will provide estimates of net coverage error and components of census coverage for housing units (HUs) and people in HUs. The PES goals are to:

- Provide measures of net coverage error.
- Produce measures of components of census coverage, including correct enumerations, erroneous enumerations, imputations, and omissions.
- Produce these measures of coverage for demographic groups and key census operations.

As was the case for the 2010 CCM Program and the 2000 A.C.E. Program, group quarters facilities and people residing in those facilities are not within the scope of the 2020 PES. Group quarters (such as college/university student housing, nursing/skilled nursing facilities and correctional facilities for adults) are out-of-scope because populations can change significantly between census enumeration and PES enumeration operations. Remote areas of Alaska are also out-of-scope for the PES because the seasonal nature of addresses and the population throughout the year make it infeasible to accurately conduct the matching and follow-up activities necessary for dual-system estimation. For this reason, the Census Bureau's past post-enumeration surveys have never included remote Alaska.

The 2020 PES estimation process will continue to use the dual system methodology for net coverage error estimation. This methodology was used in the coverage measurement programs for the 1980, 1990, 2000, and the 2010 censuses (Fay et al. 1988; Hogan 1993; U.S. Census Bureau 2004; Viehdorfer 2011).

The Census 2000 A.C.E. program involved comparing survey results with the census itself, using a methodology known as dual system estimation (DSE), to measure net overcounts and undercounts in the census—and was similar to both the 1990 Census Post-Enumeration Survey and the 1980 Census Post-Enumeration Program in that regard (U.S. Census Bureau [1989] and U.S. Census Bureau [1996]). This methodology required two independent systems of measurement: the population sample (P sample) and the enumeration sample (E sample). The P sample measured the housing unit population, as did the census, but was conducted independently of the census. This was done by selecting a sample of block clusters (geographically contiguous groups of blocks), canvassing each block cluster to find all housing units, and interviewing the people in the listed housing units. Results of the P sample were matched to census enumerations to determine the nonmatch rate in the P sample and to indicate potential omissions (people who were missed) in the census. The E sample, which consisted of the census enumerations in the same sample block clusters as the P sample, was used to measure the erroneous enumeration rate in the census. Erroneous enumerations included duplicate enumerations, people who were counted at the wrong address, and fictitious people. Thus, the E sample was the basis for measuring the correct enumeration rate, and the P sample was the basis for measuring the match rate. The two samples produced an estimate of the true population that was used to estimate net coverage. For more information on Census 2000 and the 2000 A.C.E, see Maury and Pemberton (2009).

2.3.1 Census 2000 A.C.E. Program

The Census Bureau designed the A.C.E. program to measure net coverage in Census 2000 and to potentially carry out a statistical adjustment of Census 2000 data for nonapportionment purposes, based on the results of the A.C.E. sample survey. Earlier legal challenges to the Census Bureau’s planned uses of sampling in Census 2000 resulted in a 1999 Supreme Court decision (*Department of Commerce v. U.S. House of Representatives*); this ruling states that Section 195 of Title 13, U.S. Code (Title 13 provides the statutory authority for conducting the census) precludes the use of statistical sampling (including statistical adjustment based on sampling) to produce congressional apportionment numbers. As a result of the Supreme Court ruling that sampling could not be used for apportionment purposes and the Clinton administration’s interpretation of the decision as affirming the legality of using statistical sampling for purposes other than apportionment, including redistricting, if doing so were determined to be “feasible,” the Census Bureau proceeded with plans to produce a statistically adjusted census count for redistricting and other nonapportionment purposes. However, after much discussion and consideration, the unadjusted census count was used for these and other purposes (Maury and Pemberton, 2009).

2.3.2 2010 Census Coverage Measurement

For 2010, the scope of coverage measurement was to be broader and the emphasis would be different from what it had been in the past. In general, the Census Bureau wanted to expand the role of coverage measurement to provide information that could be used to improve future censuses. As such, the initial 2010 CCM goals were as follows:

- Begin producing measures of gross coverage error, including its components.
- Produce these measures of coverage error not only for demographic groups and geographic areas, but also for key census operations.
- Continue to provide measures of net coverage.
- Expand the program that evaluates the coverage estimates.

Obtaining estimates of the components of coverage was the Census Bureau's highest priority. CCM anticipated the need to derive estimates of census omissions from the estimates of net coverage and of erroneous census inclusions.

The 2010 CCM estimation process continued to use dual system estimation (DSE) methodology for net coverage error estimation. This methodology had been used in the coverage measurement programs for the 1980, 1990, and the 2000 censuses. However, for 2010, statistical (logistic regression) models were used to predict the correct enumeration and match rates for all people and housing units. In 2000 and previously, averages of correct enumerations and matches for groups of similar units (poststratification) were used to predict the correct enumeration and match rates. In addition, the Census Bureau applied a correlation bias adjustment to improve the estimates of net coverage error for certain population subgroups. For more details of the CCM estimation process, methods, and results see Griffin (2008).

Since estimation of coverage components was new for the 2010 CCM, CCM used a straightforward estimator for correct and erroneous enumerations—a basic summation of ratio-adjusted survey weights. The ratio adjustments served to reduce the variance of the estimates and also ensured that the estimates of correct and erroneous enumerations summed to the total number of data-defined census enumerations overall and for various subpopulations. Estimates of omissions were obtained by subtracting the estimate of correct enumerations from the dual system population estimate.

2.3.3 2020 Post-Enumeration Survey

The 2020 Post-Enumeration Survey (PES) design includes the following key activities, which are described in more detail in the rest of this document:

- Survey Design.
- Sample Design.
- Independent Listing.
- Initial Housing Unit Matching and Initial Housing Unit Followup.
- Person Interview.
- Person Matching and Person Followup.
- Final Housing Unit Matching and Final Housing Unit Followup.
- Estimation.

Survey Design

During the survey design phase, key features of the PES are determined, high-level requirements are written, business process models are created, and detailed operational plans are written to provide the framework for the PES operations.

The high-level design of the PES will be similar to the design of the 2010 CCM. PES will make synthetic estimates of net coverage using dual system estimation (DSE) and direct estimates of correct enumerations and erroneous enumerations.

The PES will be conducted in a probability sample of basic collection units (BCUs) in each state, the District of Columbia (DC), and Puerto Rico. The BCU is the smallest unit of geography, roughly the size of a block, used to collect data for the 2020 Census. In 2010, the primary sampling unit and basic work unit was a block cluster. As in the 2000 A.C.E. and the 2010 CCM, any area designated as a Remote Alaska enumeration area will be out of scope for the 2020 PES.

Dual system estimation requires two independent listing efforts. The Population sample (P sample) and Enumeration sample (E sample) are the two lists used for dual system estimation. The P sample is created by listing housing units and rostering people in those housing units within the PES sample BCUs. The P sample data collection efforts are conducted independently of the decennial census data collection. The source of the E sample is the census HUs and census person enumerations in HUs geocoded to the sample of BCUs selected for the P sample.

The PES design in Puerto Rico is the same as the PES design in the 50 states and DC. All automated instruments, paper forms, and paper materials will be translated into Spanish for use in Puerto Rico. Paper and automated instruments for Independent Listing (IL), Person Interview (PI), and Person Followup (PFU) will be available in English and Spanish for the 50 states, DC, and Puerto Rico. Paper forms for the Initial HU Followup and the Final HU Followup will only be available in English for the 50 states and DC, and only available in Spanish in Puerto

Rico. The instruments and forms developed for use in Puerto Rico will account for the special features of addresses there.

Sample Design

The PES sample design is a general-purpose sample to support the various objectives of the Post-Enumeration Survey program, which includes estimating omissions and erroneous enumerations in addition to net coverage for the 2020 Census. The sample design for 2020 is essentially the same as that used for the 2010 CCM, except there are no plans for the sample reduction of medium and large BCUs. Additional differences include changing the initial primary sampling units from block clusters to BCUs and lowering the size threshold for defining the large stratum.

The PES sample design includes a number of distinct processes, from creating the sampling frame and selecting the sample of BCUs, to selecting addresses for the P and E samples. After the PES BCUs are selected, an address list is created independent of the census for each BCU (this is the Independent Listing [IL] operation described later).

The 2020 Post-Enumeration Survey sample will be a probability sample of approximately 180,000 housing units in 10,500 BCUs across the U.S. (excluding remote Alaska), including Puerto Rico. In 2010, a similar sample size of housing units was obtained in 8,365 collection block clusters.

In 2010, block clusters were created by combining adjacent collection blocks. Collection blocks with few housing units were combined with adjacent units to form blocks clusters with an average size of 30 housing units. Furthermore, enclave collection blocks (blocks entirely contained within another block) were combined with their surrounding block to form one block cluster. For 2020, PES does not plan to combine BCUs.

As a result of sampling operations, there are six subsets of the population to identify:

- BCU sample – A set of BCUs that will be independently listed. The census housing unit (HU) enumerations in these BCUs form the frame for the HU E sample. Likewise, the census person enumerations in these BCUs form the frame for the person E sample. The independently listed HUs in these BCUs form the frame for the HU P sample, and the people in the listed HUs in these BCUs form the frame for the person P sample.
- HU P sample – This is a sample of listed HUs in the BCU sample.
- HU E sample – This is a sample of census HU enumerations in the BCU sample.
- Person P sample – This is all people in the HU P sample.
- Person E sample – This is all people in the HU E sample.

- Person Interview (PI) sample – This is combination of the person P sample and some unresolved and new cases in the person E sample.

The source of the person E sample is the Census Unedited File (CUF). An initial draft of the HU E sample will be selected from the Master Address File after it has been updated with results from the Address Canvassing operation. The final HU E sample will contain housing units from the CUF.

Independent Listing

All sample BCUs will be listed. Enumerators will canvass the entire sample BCU and construct a list of housing units. Similar to the 2010 CCM, group quarters and nonresidential units are out of scope and do not need to be listed, but housing units in transitory locations will be listed. Listers will identify the location of all housing units by assigning Global Positioning System (GPS) coordinates using the Census Listing and Mapping Instrument (LiMA). Independent listing is subject to quality control. A sample of housing units within every BCU will be checked and all BCUs that fail will be reworked.

Initial Housing Unit Matching and Initial Housing Followup

Initial Housing Unit Matching (Before Followup)

During Initial Housing Unit Computer Matching, the independent listings are computer matched against the census records file within each sample BCU and one ring of surrounding BCUs. Addresses in the sample BCUs are assigned one of three possible outcome codes during computer matching:

- Matched.
- Possibly matched.
- Not matched.

During this process, potential duplicates will also be identified.

In general, the possibly matched addresses, not matched address, and potential duplicates are sent to clerical matching to resolve any unresolved cases and confirm the nonmatches. During Initial Housing Unit Before Followup Clerical Matching, the National Processing Center (NPC) matching staff uses computer-assisted clerical matching techniques, along with maps, to review and to resolve the match status of the possibly matched and not matched addresses from the Initial Housing Unit Computer Matching. In addition, the NPC matching staff also searches for duplicate census addresses. Cases in the search areas that remain unresolved following this

operation are eligible for Initial Housing Unit Followup fieldwork. Some examples of unresolved cases include the following:

- PES IL units not linked to a census unit in the PES sample BCU or in the BCUs touching the sample BCU.
- Addresses identified as possibly matched or possibly duplicated.
- Matched addresses with unresolved housing unit status.
- Addresses that match to a group quarters or that match to units outside the sample BCU.

Initial Housing Unit Followup Fieldwork

During Initial Housing Unit Followup fieldwork, interviewers collect additional information for addresses unresolved after the Initial Housing Unit Computer and Before Followup Clerical Matching activities. The Initial Housing Unit Followup operation attempts to perform the following actions:

- To collect additional information that might allow a resolution of match codes for any differences between the Independent Listing results and the census file .
- To resolve potential duplicates.

The Initial Housing Followup data collection will be paper-based. The questions included for each follow-up case will vary depending upon the reason the case is being sent to follow-up. This field operation includes a quality control mechanism.

Initial Housing Unit Matching (After Followup)

The NPC matching staff will use the results of the Initial Housing Unit Followup fieldwork to attempt to match unresolved addresses. The result of this activity is a file containing match codes for listed and census units in the BCU sample.

Person Interview

For each sample BCU, PES will interview people in selected housing units. During Person Interview (PI), interviewers use an automated instrument to obtain information about the following:

- Current residents of the sample housing unit.
- People living at the housing unit at the time of interview who may or may not have been there on Census Day (nonmovers and inmovers).

- Certain people who moved out of the sample housing unit between Census Day and the time of the PI (outmovers).

The information collected for each person includes name, sex, age, date of birth, race, relationship, and Hispanic origin. The interviewer also collects information about alternate addresses to establish where people lived on Census Day, according to census residence rules. The PI will include some census cases not in the P sample. These census-only cases will be included in the PI sample to obtain information about them that may be useful in person matching.

The processing of alternate addresses and inmovers' Census Day addresses requires geocoding functionality prior to matching. Since addresses are collected during both the PI and the Person Followup (PFU) interviews, 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 BCUs 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 by the PFU interview will be clerically geocoded, but not computer geocoded.

The PI field operation includes a reinterview for quality control purposes. A sample of all interviews in every sample BCU will be checked. BCUs that fail quality control will be reworked.

Person Matching and Person Followup

Person Matching (Before Followup)

During Person Computer Matching, the person data collected during PI is computer matched against all census enumerations. The person dataset from the PI is also computer matched against itself within a sample BCU to identify duplicate people 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, people are identified as one of the following:

- Matched.
- Possibly matched.
- Not matched.

In general, the possibly matched people and not matched people are sent to clerical matching to resolve any unresolved cases and confirm the nonmatches. During the Person Before

Followup Clerical Matching activity, the NPC matching staff uses computer-assisted clerical matching techniques, along with 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 people. 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. Cases that remain unresolved following this operation are sent to Person Followup (PFU). Some examples of unresolved PFU cases include the following:

- Nonmatched P sample person records with a proxy response.
- Nonmatched E sample person records.
- Possibly matched or possibly duplicated records.
- Matching housing units with differing rosters between the E sample and P sample households.
- P sample people with unclassified residence status.
- Inmovers with ungeocoded inmover addresses.
- Possible matches.
- Possible duplicates at nationwide potential long-distance duplicate addresses (follow-up at both the in-cluster and long-distance addresses).

Person Followup Fieldwork

During PFU fieldwork, interviewers contact people identified in the Person Matching activities as requiring additional information to resolve the following:

- Census Day residence status.
- Enumeration status.
- Match status.
- Person duplication.

The universe for potential follow-up includes the E sample, the P sample, and suspected census duplicates. The PFU operation collects data that are later used in the Person After Followup Clerical Matching activities to resolve any differences between the PES and the census enumeration results. The PFU data collection forms will be collected through paper-based personal interview. The questions printed on each follow-up form will depend on the reason the case is being sent to follow-up. This field operation includes a quality control mechanism.

Person Matching (After Followup)

The NPC matching staff use information obtained during PFU fieldwork from the completed questionnaires to resolve match, residence, enumeration, and duplication status for remaining people in the P and E samples.

Final Housing Unit Matching and Final Housing Unit Followup

Final Housing Unit Matching (Before Followup)

During Final Housing Unit Computer Processing, housing unit information is prepared for the Final Housing Unit Clerical Matching. A determination is made as to which housing units will go to the Final Housing Unit Clerical Matching activity. These are generally one of the following:

- Housing units added to the census after the preliminary list was created.
- Listed units matched to a census unit that was deleted from the preliminary census list used in Initial Housing Unit Matching.

During the Final Housing Unit Before Followup Clerical Matching operation, the NPC matching staff use computer-assisted clerical matching techniques, along with PES and census maps, 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. Cases that remain unresolved following this operation are eligible for Final Housing Unit Followup fieldwork. Some examples of unresolved cases include the following:

- Nonmatched PES or census addresses.
- Addresses identified as possibly matched or possibly duplicated.
- Matched addresses with unresolved housing unit status.
- Addresses that match to group quarters or that match to surrounding BCUs.

Final Housing Unit Followup Fieldwork

During Final Housing Unit Followup fieldwork, interviewers collect additional information for addresses with an unresolved match status from the Final Housing Unit Before Followup Clerical Matching activity. The Final Housing Unit Followup attempts to collect information needed to resolve any residual differences between the Independent Listing results and the census. The Final Housing Unit Followup is conducted using paper forms and maps. The questions included for each follow-up case will vary depending upon the reason the case is being set to follow-up. This field operation includes a quality control mechanism.

Final Housing Unit Matching (After Followup)

The NPC matching staff will use the results of the Final Housing Unit Followup fieldwork from the completed paper questionnaires to match remaining nonmatched addresses. This is the final operational step before estimation.

Estimation

The estimation process consists of several major activities, which will ultimately lead to the production of estimates of coverage for both housing units and people in housing units. This includes estimates of net coverage error as well as components of coverage. As part of this estimation, PES will implement operations to account for missing data and reduce the sampling and nonsampling errors in our estimates.

Like the 1990 Post-Enumeration Survey, the 2000 Accuracy and Coverage Evaluation Survey, and the 2010 CCM, PES will measure net coverage error by using dual system estimation to generate population estimates of housing units and people in housing units. Like the 2010 CCM, PES will use logistic regression modeling instead of poststratification.

For both person and housing unit net error estimation, the major estimation activities are as follows:

- Imputations for missing characteristics of the P sample.
- Imputations for unresolved enumeration status in the E sample and unresolved match status in the P sample.
- Imputations for unresolved Interview Day residence status for person estimation and unresolved Census Day housing unit status for housing unit estimation.
- Weight trimming for influential BCUs.
- Logistic regression models and generation of the necessary predictions for estimation.

For person net error estimation, PES will implement the following additional activities:

- A noninterview adjustment for the P sample.
- A correlation bias adjustment using Demographic Analysis to reduce effects of violating dual system estimation model assumptions.

For the measurement of components of census coverage (correct enumerations, omissions, whole-person imputations, and erroneous enumerations), an enumeration is correct if it is included once and only once anywhere in the census housing unit universe. The implementation of dual system estimation uses a strict definition for correct enumeration that includes correct location as defined by the BCU and one ring of surrounding BCUs. Therefore,

for the components, PES needs additional processing activities to assign correct and erroneous enumeration statuses to the sample cases.

For both person and housing unit coverage component estimation, PES will implement these activities:

- Imputations for unresolved enumeration statuses.
- A two-stage ratio adjustment estimator to reduce the standard errors for the erroneous enumeration estimate.
- Estimate omissions by adding the estimates of erroneous enumerations and net error together. For people, PES will also estimate the number of person omissions by whether their housing unit was included in the census or not.

The last estimation activity will be to generate standard errors of the net error and component estimates. This activity will use replication methods to generate the standard errors and reflect the sampling and possibly imputation variance.

2.4 Design Overview

The following section presents the high-level design for the PES operations. Please refer to the 2020 Census Operational Plan for a complete inventory of design decisions for all 2020 Census operations.

2.4.1 High-Level Operational Design

The PES operations include three 2020 Census operations and their respective operational activity areas:

- Coverage Measurement Design and Estimation operation (CMDE) [27].
- Coverage Measurement Matching operation (CMM) [28].
- Coverage Measurement Field Operations (CMFO) [29].

Each of these operations and their major activity areas is summarized below. Together, these operations and activities represent the complete set of work that needs to be performed to conduct PES.

Coverage Measurement Design and Estimation Operation (CMDE) [27]

CMDE is responsible for the statistical design of the 2020 Census coverage measurement survey. Specifically, the work of this Integrated Project Team (IPT) will revolve around the high-level design of the PES, the sample design of the PES, statistical postprocessing of the PES, dual-

system estimation of net coverage, and estimation of components of coverage. Primary areas of research and production for this IPT include the sampling of BCUs for independent listing, imputation of characteristics, inclusion status, and match status, as well as estimation of net coverage and components of coverage.

The major activities comprising CMDE are as follows:

- **CMDE Survey Design and Sampling [27-1]** – This activity area is responsible for selecting the initial sample of basic collection units, subsampling small basic collection units, selecting the Person Interview Housing Unit Sample, and identifying the E sample Housing Unit sample.
- **CMDE Estimation and Reporting [27-2]** – This activity area is responsible for producing estimates of net and components of coverage for people, producing estimates of net and components of coverage for housing units, and writing and disseminating reports.

Coverage Measurement Matching operation (CMM) [28]

CMM is responsible for planning, overseeing, managing and coordinating the design, development, testing, implementation and assessment of all 2020 PES operational and software requirements needed for PES matching activities. This includes ensuring all operations and data processing applications, and all automated and clerical record linkage software and operations work together to provide the PES data and results necessary to produce the 2020 PES estimates.

The purpose of this operation is to identify matches and nonmatches between the 2020 Census and the PES, for both the enumerated housing units and people, including computer and clerical components.

The major activities comprising CMM are as follows:

- **CMM Initial Housing Unit (IHU) Matching [28-1]** – This activity area is responsible for linking the PES housing unit addresses in the sample and the initial census addresses in the MAF using automated computer matching and clerical matching techniques.
- **CMM Person Data Preparation and Matching [28-2]** – This activity area is responsible for linking the people in the sample and the census using automated computer and clerical matching techniques.
- **CMM Final Housing Unit (FHU) Matching [28-3]** – This activity area is responsible for linking the housing unit addresses in the sample and the final census addresses using automated computer matching and clerical matching techniques.

The Housing Unit, Person, and Final Housing Unit Matching operations use two different methods:

- **Computer Matching – Method 1**
 - Computer matching of addresses or people is conducted using software that assigns a probability that the addresses or people match. A threshold is identified to indicate cases that are definite matches, another to indicate cases that are definite nonmatches, and the cases in between these points are considered possible matches.
 - When the intent is to identify duplicates, a similar process is used, resulting in a set of duplicate cases, nonduplicate cases, and possible duplicate cases.
- **Clerical Matching – Method 2**
 - There are two phases of clerical matching, called “Before” and “After Followup” clerical matching.
 - Clerical matching is conducted by clerical matchers utilizing matching and coding software. The software displays the results of computer matching and allows the matchers to review and correct any results.
 - Matchers must review and code all the possible matches or duplicates and can also correct cases coded by computer matching. Unresolved cases are sent to the field follow-up operations (HU or person follow-up).
 - In addition, clerical matchers must geocode new addresses collected that are not computer geocoded and assign residence status codes and housing unit status codes.
 - The clerical matchers are provided the actual respondent information from follow-up activities, so they can review a whole household composition and any interviewer notes about the cases to help on their analysis and case resolution.

Coverage Measurement Field Operations (CMFO) [29]

CMFO is responsible for planning, overseeing, managing, and coordinating the design, development, testing, implementation and assessment of all PES operational and software requirements for PES field data collection activities. This includes ensuring all data collection instruments, operations, and data processing applications work together to provide the PES data and results necessary to produce the 2020 PES estimates.

The purpose of this operation is to collect person and housing unit information (independent from the 2020 Census operations) for the sample of housing units in the PES. The PES collects the same data as the 2020 Census for both housing units and people. Additional information is collected by the PES to help us understand coverage and to detect erroneous enumerations.

The major activities comprising CMFO are as follows:

- **CMFO Planning and Preparation [29-1]** – This activity area is responsible for planning the five PES field operations, hiring the workforce, training the workforce, and obtaining the instruments and materials needed to conduct the five PES field operations.
- **PES Independent Listing (IL) and Quality Control (QC) [29-2]** – This activity area is responsible for collecting addresses for housing units and potential housing units in sample BCUs. The collection of these addresses is independent from census address sources including the Delivery Sequence File, the Master Address File, and Address Canvassing updates.
In this activity, listers walk all areas of the sample basic collection units (BCUs) and list all the housing units in the sample area from scratch, that is, no Master Address File (MAF) information is used in this operation. This is an independent listing. Listers knock on all housing units to inquire if there are more than one housing unit at the addresses listed (like a basement or garage apartment) and these are listed separately.
- **PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [29-3]** – This activity area is responsible for obtaining information that will help resolve the final match status and enumeration status of housing units in the PES. Before this follow-up, the list of PES housing unit addresses in the sample are matched to the initial census MAF list of addresses in the same sample areas to identify matches and possible matches between the two lists, duplicates and possible duplicates in either list, and nonmatches in either list. The cases (addresses) that are in one list and not the other (nonmatches) and those identified as possible matches or possible duplicates are sent back to the field for an Initial Housing Unit Followup interview. Out of this activity an additional matching using the follow-up results is conducted. The results identify the list of housing units in the PES sample to be included in the PES person operations.
- **PES Person Interview (PI) and Reinterview (RI) [29-4]** – This activity area is responsible for collecting information about people living in PES sample housing units. The collection of this person information is independent from census data collections.
The PES Person Interview collects person information for the PES sample housing units by performing in-person interviews using a computer-assisted data collection instrument. The enumerators collect data similar to those collected in the 2020 Census as well as additional data about people in the household to determine if any of these people may have been counted at other addresses on Census Day.
- **PES Person Followup (PFU) and Reinterview (RI) [29-5]** – This activity area is responsible for collecting additional information when lacking sufficient information for estimation. The list of PES housing unit people in the sample are matched to the people listed in the census in the same sample areas to identify matches and possible matches

between the two lists, duplicates and possible duplicates in either list, and nonmatches in either list. The nonmatched people (that are in only one list and not the other) and those identified as possible matches or possible duplicates are sent back to the field for the Person Followup interview to obtain additional information. The collected information is used in after follow-up person matching to resolve the cases and the results are used in the estimation of person coverage.

- **PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [29-6]** – This activity area is responsible for obtaining information that will help resolve the final match status and enumeration status of housing units in the PES. After completion of census operations, the updated MAF list of addresses is matched to the PES list of addresses to identify additional matches, nonmatches, or duplicates, many resulting from housing units added to the census after Initial HU Matching and Followup operations. Cases unresolved are sent back to the field to conduct the Final Housing Unit Followup activity. The resulting data are sent to the Final Housing Unit after follow-up matching and then used in the housing unit coverage estimation.
- **CMFO Closeout [29-7]** – This activity area is responsible for decommissioning the PES field data collection workforce, instruments, systems, and materials, as well as assessing the field operations.

The full hierarchy of activities for the PES operations is provided in Appendix C in the form of an Activity Tree. In the Activity Tree, each major operational activity area listed above is numbered and then decomposed into a numbered set of subactivities, some of which are further decomposed into more detailed numbered subactivities or steps.

For a full description of the operational subactivities that comprise the PES operations, see the Detailed Process Description discussions in Sections 3, 4, and 5 below.

2.4.2 PES Operational Context

The PES operational activities described above are conducted within the context of other 2020 Census operations and other programs or data sources that are external to the 2020 Census Program. One way to depict an operational context is by using a “Context Diagram,” which shows the boundary of the operational process, the operational activities it contains, and the information exchanged with its neighbor operations (or other entities) as well as the resources (mechanisms) needed to conduct the operational work.

Figure 2 is a top-level context diagram for the combined set of PES operations represented as an Integrated Definition, Level 0 (IDEF0) model. An IDEF0 model of a process (or operation)

shows the inputs, controls, outputs, and mechanisms of the process. These IDEF0 model elements are summarized below and described further in the sections that follow.

The yellow box in the center of the IDEF0 model lists the major operational activity areas for the operation, numbered as given in the Activity Tree for PES operations in Appendix C. Specific information exchanges (IEs) are shown in different colored boxes to represent the inputs (green boxes on left side), outputs (orange boxes on right side), controls (purple boxes on top), and mechanisms (blue boxes on the bottom). Boxes to the left of the inputs indicate the *provider* of the inputs to the operation (typically another 2020 Census operation or an external source). The provider of the existing controls is noted in the box itself. Boxes to the right of the outputs indicate the *receiver* of the outputs (typically another 2020 Census operation or external entity). Each information exchange has a name and a unique number for identification purposes.

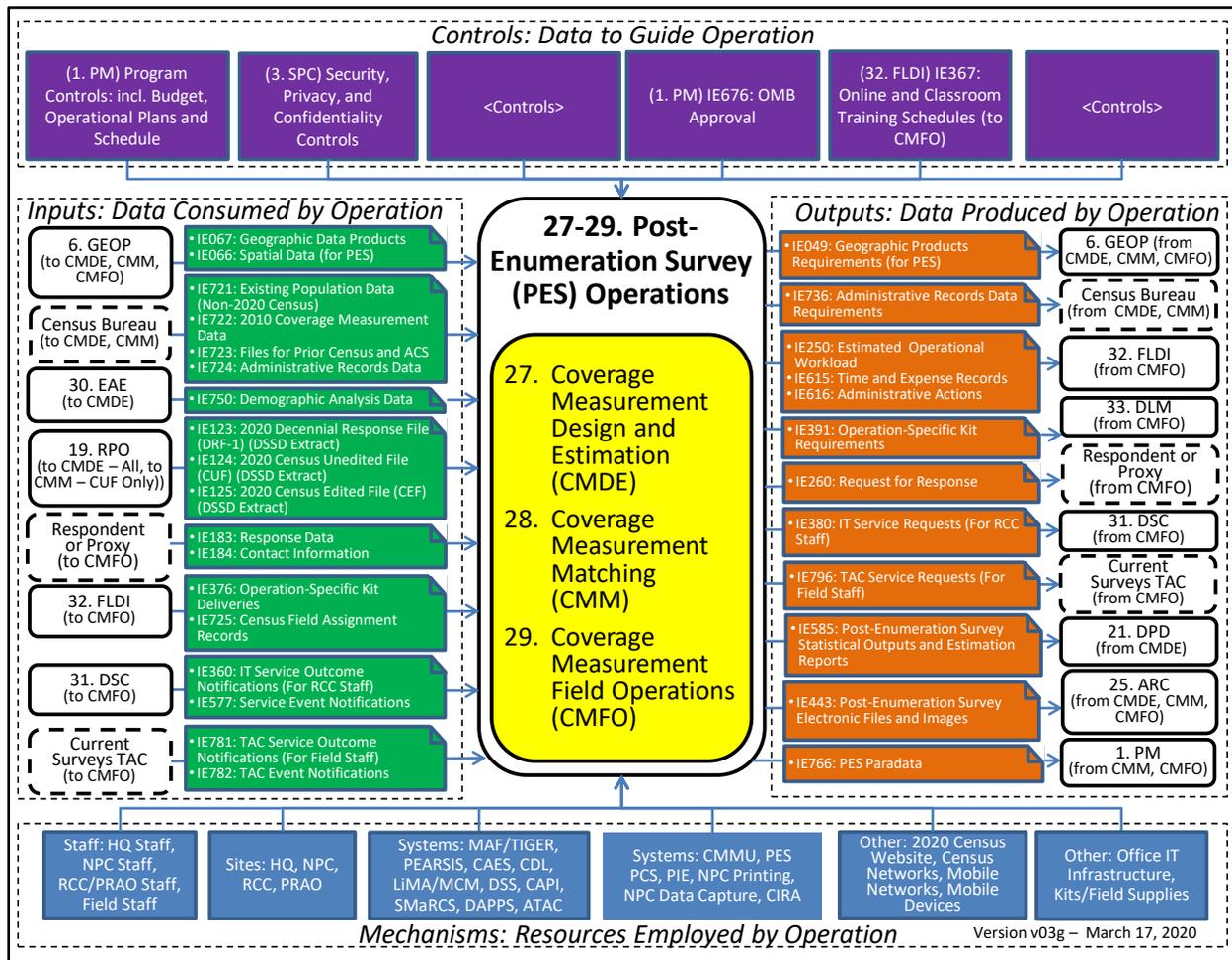


Figure 2: Post-Enumeration Survey (PES) Operations Context Diagram

For detailed descriptions of the inputs, controls, outputs, and mechanisms used by the PES operations, see the sections that follow.

2.4.2.1 PES Operational Inputs

Inputs are the data that are consumed by the operation. The inputs define the amount of operational work that needs to be performed.

Table 1 lists the inputs to the PES operations.

Table 1: PES Operational Inputs

Provider	Information Exchange	Description
6. Geographic Programs operation (GEOP)	IE066: Spatial Data (for PES)	Spatial data from MAF/TIGER ² . For PES, spatial data include: <ul style="list-style-type: none"> • Map data. • Collection Geography Delineations for BCUs.
6. Geographic Programs operation (GEOP)	IE067: Geographic Data Products	The Geographic data products that will be needed to conduct the specific 2020 Census operations work. For PES, this includes information about the 2020 Census addresses in BCUs. These are used during the matching process to determine which census addresses are also in PES IL address list.

² Master Address File/Topologically Integrated Geographic Encoding and Referencing system

Provider	Information Exchange	Description
Census Bureau	IE721: Existing Population Data (Non-2020 Census)	Population data collected by Census Bureau in prior censuses and/or prior surveys. These include population estimates from the Population Estimates Program to determine sampling parameters and allocate the PES sample. Data also might include tabulations at various geographic levels from surveys such as the Longitudinal Employer-Household Dynamics (LEHD) to improve models for dual-system estimation.
Census Bureau	IE722: 2010 Coverage Measurement Data	Data collected by Census Bureau in 2010 Decennial Coverage Measurement Matching operation. The 2010 Census Coverage Measurement Person File is needed to stratify and sort BCUs prior to the initial sample of BCUs for Independent Listing.
Census Bureau	IE723: Files for Prior Census and American Community Survey (ACS)	Data collected by Census Bureau in prior decennial censuses and/or prior American Community Surveys. These include replicate factors from the American Community Survey to assign codes to the PES sample BCUs. Data also include counts and percents of American Indians living on reservations from the 2010 Census. Data might also include American Community Survey geographic tabulations to improve models for dual-system estimation.

Provider	Information Exchange	Description
Census Bureau	IE724: Administrative Records Data	<p>Administrative records (ADREC) and administrative record data refer to microdata records contained in files collected and maintained by administrative or program agencies and commercial entities. Government and commercial entities maintain these files for the purpose of administering programs and providing services. Administrative records are distinct from systems of information collected exclusively for statistical purposes, such as data from censuses and surveys that are produced under the authority of Titles 13 or 15 of the United States Code (U.S.C.).</p> <p>For the most part, the Census Bureau draws upon administrative records developed by federal agencies. To a lesser degree, it may use information from state, local, and tribal governments, as well as commercial entities.</p> <p>The primary sources of ADREC data used by the Census Bureau are the Internal Revenue Service (IRS), Social Security Administration (SSA), Bureau of Labor Statistics (BLS), Centers for Medicare and Medicaid Services (CMS), United States Postal Service (USPS), and Bureau of Economic Analysis (BEA). To obtain these data, the Census Bureau must adhere to a number of regulatory requirements.</p>

Provider	Information Exchange	Description
Evaluations and Experiments operation (EAE)	IE750: Demographic Analysis Data	Demographic analysis data including Demographic Analysis (DA) sex ratios for the Black/non-Black population for all ages. These data will be used by the PES for correlation bias adjustment.
19. Response Processing Operation (RPO)	IE123: 2020 Census Decennial Response File (DRF-1) (DSSD Extract)	The computer file containing all 2020 Census responses for the enumeration universe before additional data processing.
19. Response Processing Operation (RPO)	IE124: 2020 Census Unedited File (CUF) (DSSD Extract)	The computer file resulting from application of Count and Status Imputation to the DRF to complete the determination of the address and person count data to be used in the census. It is used to generate apportionment data, as well as used in the Coverage Measurement activities.
19. Response Processing Operation (RPO)	IE125: 2020 Census Edited File (CEF) (DSSD Extract)	The computer file resulting from the application of Data Consistency Editing and Characteristic Imputation to the CUF.
Respondent or Proxy	IE183: Response Data	Data provided by the respondent or proxy directly to a PES interviewer in response to Post-Enumeration Survey questions.
Respondent or Proxy	IE184: Contact Information	Contact information (e.g., telephone numbers and best time to contact) provided by respondents/proxy for follow-up/reinterview.
32. Field Infrastructure operation (FLDI)	IE376: Operation-Specific Kit Deliveries	Deliveries of operational training kits for use by field staff.

Provider	Information Exchange	Description
32. Field Infrastructure operation (FLDI)	IE725: Census Field Assignment Records	Census Field Assignment Records provide the historic field staff assignment information from prior census field operations work that is needed to enforce PES Assignment Independence rules.
31. Decennial Service Center operation (DSC)	IE360: IT Service Outcome Notifications (For RCC Staff)	Notifications and status updates of IT service results provided to the users (requesters).
31. Decennial Service Center operation	IE577: Service Event Notifications	Notifications to all users of a service event such as routine operations updates/changes, system problem/incident status, or privacy/security incident status.
Current Surveys Technical Assistance Center (TAC) (to CMFO)	IE781: Technical Assistance Center (TAC) Service Outcome Notifications (For Field Staff)	Data regarding the outcome of service requests submitted by field staff to Technical Assistance Center.
Current Surveys Technical Assistance Center (TAC) (to CMFO)	IE782: Technical Assistance Center TAC Event Notifications	Notifications from Technical Assistance Center to field staff, typically regarding system maintenance events.

2.4.2.2 PES Operational Controls

Controls are the data that guide the behavior of the operation. They are not consumed by the operation, but rather they provide guidance, models, limits, criteria, cutoff dates, or other information that controls the way in which the operational work is performed.

Table 2 lists the controls for the PES operations.

Table 2: PES Operational Controls

Provider	Information Exchange	Description
1. Program Management operation (PM)	Program Controls	Program control information including: <ul style="list-style-type: none"> • Budget. • Operational plans and schedule.
3. Security, Privacy, and Confidentiality operation (SPC)	Security, Privacy, and Confidentiality Controls	Laws, policies, regulations, and guidelines related to physical security, IT security, data security, and privacy and confidentiality impacts, analyses, and processes. These include but are not limited to Title 13, Title 26, and other laws and policies related to protection of personally identifiable information.
1. Program Management operation (PM)	IE676: OMB Approval	To avoid overburdening the public with federally sponsored data collections, the Paperwork Reduction Act (PRA) of 1995 requires that U.S. federal government agencies obtain Office of Management and Budget (OMB) approval before requesting or collecting most types of information from the public. OMB approval must be obtained before collecting federally sponsored data, whether the request is delivered in-person, on the phone, or online.
32. Field Infrastructure operation (FLDI)	IE367: Online and Classroom Training Schedules (to CMFO)	Schedules for PES-specific online and classroom training classes.

2.4.2.3 PES Operational Outputs

Outputs are the data produced by the operation. The outputs constitute the results of operational work that has been performed. Outputs produced may be used as inputs or controls to other operations.

Table 3 lists the outputs from the PES operations.

Table 3: PES Operational Outputs

Consumer	Information Exchange	Description
6. Geographic Programs operation (GEOP)	IE049: Geographic Products Requirements (for PES)	Requirements and specifications for the Geographic Products that will be needed to support PES activities, including MAF extracts, maps, and geographic reference files.
Census Bureau	IE736: Administrative Records Data Requirements	Requirements and specifications detailing which administrative data sources for use by PES operations and how they should be processed.
32. Field Infrastructure operation (FLDI)	IE250: Estimated Operational Workload	Estimate of number of PES attempts by geographic area. This information is used by FLDI along with the PES contact strategies to create a model for estimating the staffing needs by location.
32. Field Infrastructure operation (FLDI)	IE615: Time and Expense Records	Information regarding staff time and reimbursable expenses. Used by FLDI to pay employees.

Consumer	Information Exchange	Description
32. Field Infrastructure operation (FLDI)	IE616: Administrative Actions	Decisions regarding administrative changes for field and office staff made by field operation management. For example, field operations may decide to transfer an employee to another location. FLDI is responsible for documenting these actions in the appropriate systems.
33. Decennial Logistics Management operation (DLM)	IE391: Operation-Specific Kit Requirements	A list of the contents that should be included in the operation-specific kits provided to the field staff in support of PES field operations. This includes the number of kits required and the count of each item in the kits.
Respondent or Proxy	IE260: Request for Response	Request for respondent or proxy to respond or provide follow-up information to the CMFO interviewers during the 2020 Post-Enumeration Survey.
31. Decennial Service Center operation (DSC)	IE380: IT Service Requests (for RCC Staff)	Requests for information or advice, or for a standard change (a preapproved change that is low risk, relatively common and follows a procedure) or for access to an IT service.
Current Surveys Technical Assistance Center (TAC) (from CMFO)	IE796: Technical Assistance Center (TAC) Service Requests (For Field Staff)	Service requests initiated by field staff for technical assistance.
21. Data Processing and Dissemination (DPD)	IE585: Post-Enumeration Survey Estimation Reports and Tables	Reports and statistical outputs from Post-Enumeration Survey (PES) activities. Statistical outputs include estimation microdata and replicate weights.

Consumer	Information Exchange	Description
25. Archiving operation (ARC)	IE443: Post-Enumeration Survey Electronic Files and Images	Includes multiple files collected during Post-Enumeration Survey. Examples include: <ul style="list-style-type: none"> • Survey sample and estimation files. • Coverage reports.
1. Program Management operation (PM)	IE766: PES Paradata	Paradata collected during field operations that are specific to PES.

2.4.2.4 PES Operational Mechanisms

Mechanisms are the resources (people, places, and things) that are used to perform the operational processes. They include staff resources, infrastructure sites, systems, and other technology infrastructure.

Staff Resources

Table 4 identifies the staff resources employed for the PES operations.

Table 4: Staff Resources Used Within PES Operational Activities

Staff Resources	Description/Role
Headquarters (HQ) Staff	Census HQ staff to manage the PES operation.
National Processing Center (NPC) Staff	PES uses the NPC’s staff to process paper questionnaires and map products collected in PES field operations. NPC staff also conduct clerical matching operations for the PES.
Regional Census Center (RCC)/Puerto Rico Area Office (PRAO) Staff	Staff who manage all PES activities within their regional census center or Puerto Rico.
Field Staff	Enumerators and supervisors who perform PES operational activities in the field.

Infrastructure Sites

Table 5 identifies the infrastructure sites employed for the PES operations.

Table 5: Infrastructure Sites for PES Operational Activities

Infrastructure Site	Description/Role
Headquarters (HQ)	HQ site for office work conducted in support of the Post-Enumeration Survey (PES). This permanent site in Suitland, Maryland, houses the PES headquarters operations staff.
National Processing Center (NPC)	NPC is located in Jeffersonville, Indiana. PES uses the NPC site for the following actions: <ul style="list-style-type: none"> • Printing PES questionnaires and assembling packets. • Receiving and scanning PES questionnaire returns. • Conducting clerical geocoding and matching activities. • Keying PES paper questionnaire data. • Disposition of PES paper materials after PES work is complete.

Infrastructure Site	Description/Role
Regional Census Centers (RCC)	Regional census offices used to coordinate PES regional fieldwork.
Puerto Rico Area Office (PRAO)	Census regional office located in Puerto Rico used to coordinate PES regional fieldwork.

Systems and other Technology Infrastructure

Table 6 identifies the systems employed for the PES operations.

Table 6: Systems Used Within PES Operational Activities

System	Description
Master Address File/Topologically Integrated Geographic Encoding and Referencing System (MAF/TIGER)	MAF/TIGER is a system with a central database and many utilities and tools that contains, manages, and controls an extensive repository of spatial and nonspatial data used to provide extracts to define Census Bureau operations, provide maps, and support web applications.
Production Environment for Administrative Record Staging, Integration, and Storage (PEARSIS)	A system to manage administrative records and provide services associated with those records.
Concurrent Analysis and Estimation System (CAES)	An enterprise modeling platform that stores data and uses them to execute statistical models in support of survey flow processing, analysis, and control.
Census Data Lake (CDL)	The Census Data Lake serves as the repository for paradata and response data. It is built on a distributed, scalable platform to support data ingest, storage, and to provide data access to reporting and analytics applications.

System	Description
Listing and Mapping / Mobile Case Management (LiMA/MCM)	LiMA provides listing and mapping support for PES field listers. MCM provides the lister their case assignment for the day in the order that they should work the cases.
Demographic Survey System (DSS)	DSS is a suite of legacy systems historically used for demographic and current surveys. These systems provide laptop management, operations control, field operations control, data collection, IT support, and image scanning and retrieval services for the PES.
Computer Assisted Personal Interview (CAPI)	Computer-Assisted Personal Interviews (CAPI) is an in-person data collection method in which the interviewer uses a portable computing device to record answers given during the interview by the respondent.
Sampling, Matching, Review, and Coding System (SMaRCS)	An application supporting quality control (QC). SMaRCS specifically supports QC activities designed to determine whether field listers and enumerators are using validated procedures and collecting accurate data. SMaRCS facilitates QC activities by providing a mechanism for selecting quality control samples, validating production interview data against administrative records sources, and by providing a tool for clerical matching to compare the production interview data against Reinterview (RI) data. SMaRCS also serves as a major control component for QC activities by managing the selection of quality control samples for field follow-up related to Post-Enumeration Survey operations and tracking the progress of the RI work through the matching, field, and resolution processes.
Decennial Applicant Personnel and Payroll System (DAPPS)	System that supports payroll for field staff including clerks, enumerators, and census field supervisors (CFSs).

System	Description
Automated Tracking and Control (ATAC)	ATAC provides customer, employee, and workflow management by automating the business and support. It provides support for material tracking and check-in/ check-out.
Clerical Matching and Map Update (CMMU)	The CMMU is designed to allow clerical matchers to compare PES data to decennial census data, along with PES and Census maps, to review and attempt to match, possibly match, or assign nonmatch codes to housing units or people.
Post-Enumeration Survey Processing and Control System (PES PCS)	PES PCS performs the following work: <ul style="list-style-type: none"> • Computer Matching for PES (CM). • PES Workload Control. • PES Sampling.
PES Imputation and Estimation (PIE)	PIE supports imputation and estimation activities for Post-Enumeration Survey data.
National Processing Center (NPC) Printing	The NPC system that is used to print and assemble mailing materials needed for PES.
National Processing Center (NPC) Data Capture	The NPC system that is used to capture and key in materials needed for PES.
Census Image Retrieval Application (CIRA)	CIRA displays decennial census images of paper questionnaires as well as geographic and response data. It provides a user interface for reviewing the images and data and is used to provide an Age Search service to the public at National Processing Center (NPC).

Other technology infrastructure employed for the PES operations includes:

- 2020 Census website.
- Census networks – Census Bureau network connectivity for data transmission between operational systems and operational sites. This connectivity is provided by the IT Infrastructure operation (ITIN).

- Mobile networks and mobile devices – Laptop computers for use with Listing and Mapping Application (LiMA) and Computer Assisted Personal Interview (CAPI). Devices and network are provided by ITIN.
- Office IT infrastructure at headquarters, regional census centers, Puerto Rico Area Office, and NPC for conducting PES operational work. This infrastructure is provided by ITIN.
- Kits/field supplies – Kits and field supplies are created by DLM for field staff to use for data collection activities.

2.5 PES Operations Data Flow and Operational Influences

Figure 3 is an Integrated Operations Diagram (IOD), which depicts the major interactions among the operations and external entities involved in the 2020 Post-Enumeration Survey operations (PES). This diagram shows the three major operational components of PES as the principal activities (Coverage Measurement Design and Estimation operation [CMDE], Coverage Measurement Field Operations [CMFO], and Coverage Measurement Matching operation [CMM]), with collaborations among other decennial operations.

PES includes interactions with Geographic Programs operation (GEOP), Response Processing Operation (RPO), Field Infrastructure operation (FLDI), Decennial Logistics Management operation (DLM), Decennial Service Center operation (DSC), Data Products and Dissemination operation (DPD), and Archiving operation (ARC).

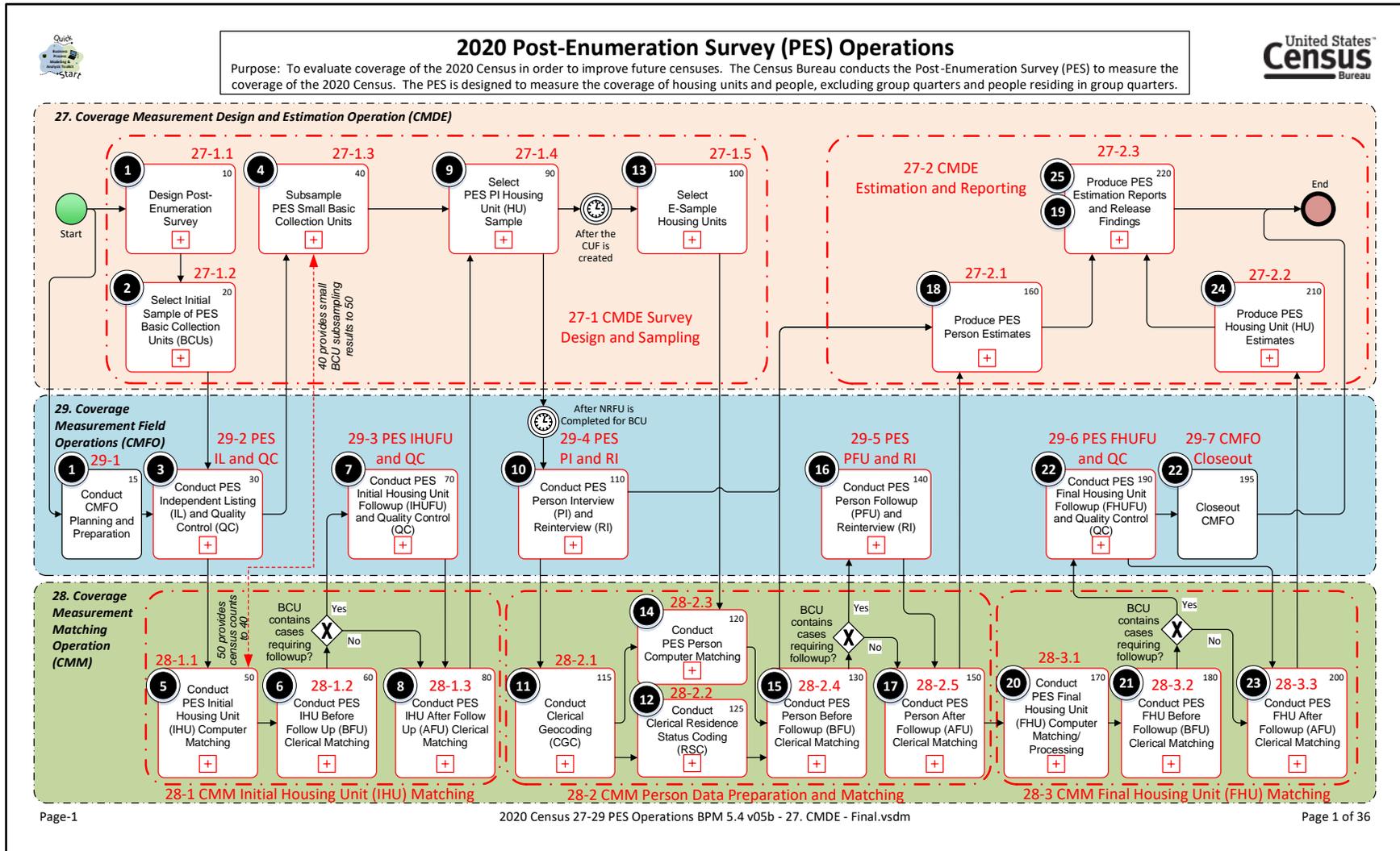


Figure 3: 2020 Post-Enumeration Survey (PES) Integrated Operations Diagram (IOD)

1 CMDE performs the design activities for the Post-Enumeration Survey (PES).

At this time, CMFO also performs its planning and preparation work, including activities required to plan for the PES field data collection activities.

2 CMDE selects the initial sample of PES basic collection units (BCUs).

CMDE selects an area sample of basic collection units in the 50 states, the District of Columbia, and Puerto Rico for use during the PES Independent Listing (IL) field data collection activity.

As a result of these initial sampling activities, the following PES sample is identified:

- PES BCU Sample – A set of BCUs that will be independently listed during PES data collection work.

Note: The census housing unit (HU) enumerations in these BCUs form the frame for the HU E sample. Likewise, the census person enumerations in these BCUs form the frame for the person E sample. The independently listed HUs in these BCUs form the frame for the HU P sample, and the people in the listed HUs form the frame for the Person P sample.

Within each state, the District of Columbia, and Puerto Rico, BCUs are stratified based on the cross-classification of size, tenure (owner/nonowner³), and American Indian Reservation (AIR) status. First, BCUs are classified by size into three mutually exclusive groups based on the expected number of HUs within the BCU. The expected number of HUs within the BCU is derived by counting addresses on the Master Address File. The three groups are as follows:

- Small BCUs – 0 to 2 HUs.
- Medium BCUs – 3 to 57 HUs.
- Large BCUs – 58 or more HUs.

The second classification categorizes medium and large BCUs based on tenure, i.e., for the entire BCU, the proportion of households that are either rented or owned based on 2010

³ Technically, the nonowner category includes renters and people occupying HUs without payment of cash rent. However, renters make up the vast majority of people in the nonowner category, this category appears as “renters” throughout the document, unless the reference is to a specific sampling stratum.

Census data. BCUs where more than 40 percent of the households do not own their home are placed into the nonowner stratum.

For 26 states, an AIR stratum is defined. This stratum contains BCUs with three or more HUs located on an AIR or associated trustland, regardless of the tenure status of the BCU. To adequately control sample sizes for American Indians, inclusion in the AIR stratum takes precedence over the other stratification variables. Table 7 summarizes the six mutually exclusive sampling strata.

Table 7: Strata for Selecting the BCU Sample for PES Independent Listing

First-Phase Stratum	Size Definition	Tenure Definition
(1) Small	0-2 HUs	Not applicable (NA)
(2) Medium Owner	3-57 HUs	BCUs with less than 40 percent of nonowner households
(3) Medium Nonowner	3-57 HUs	BCUs with 40 percent or more of nonowner households
(4) Large Owner	58+ HUs	BCUs with less than 40 percent of nonowner households
(5) Large Nonowner	58+ HUs	BCUs with 40 percent or more of nonowner households
(6) AIR (26 states only) ¹	3+ HUs	NA

¹ These are the states with sufficient American Indian population living on AIRs in 2010.

Note: There may be AIR in other states, but with insufficient American Indian population to support a separate AIR stratum.

Allocating the Sample

The IL BCU sample in the U.S. is a national sample of about 10,100 BCUs: 8,000 medium and large BCUs and 2,100 small BCUs. Included in the 8,000 BCUs is a separate sample of BCUs for AIRs. The number of medium and large BCUs is based on an expected average of P sample HUs per BCU in each state from preliminary housing unit counts by BCU for each state.

The 8,000 medium and large BCUs are allocated to the 50 states and DC. This allocation is proportional to the population in each state with three exceptions. First, Hawaii is allocated enough BCUs to support an expected HU sample size of 4,500 to help the reliability of the

Native Hawaiian or Pacific Islander estimates. Second, each state is allocated a minimum sample size to get an expected 1,050 HUs, not including housing units in the small and AIR strata. Third, the states with AIR stratum are allocated enough BCUs to support an expected 10,500 HUs in the AIR stratum. The allocation of BCUs to the 26 states with AIR is proportional to the 2010 Census population of American Indians living on reservations on each state. The allocation of the 2,100 small BCUs to the states is proportional to the number of small BCUs in each state.⁴

For Puerto Rico, the expected number of sample BCUs for IL is 400: 280 medium and large BCUs and 120 small BCUs.

Probabilities of Selection

To help support the reliability of minority and renter estimates, the sampling activity oversamples BCUs in the nonowner strata. This oversampling will help increase the sample size of minorities and renters. Also, the large BCUs are selected with higher probability than medium BCUs to allow for the subsampling of HUs within these BCUs later on. This brings the overall probability of selection for HUs in large BCUs more in line with the overall probability of selection for HUs in medium BCUs. Oversampling of large BCUs increases the number of unique BCUs in sample to provide a more geographically diverse HU sample.



CMFO conducts the PES Independent Listing (IL) and Quality Control (QC) field data collection activity.

All sample BCUs will be listed. Enumerators will canvass the entire sample BCU and construct a list of housing units. Group quarters and nonresidential units are out of scope and do not need to be listed, but housing units in transitory locations will be listed. Listers will identify the location of all housing units (except those on military bases) by assigning GPS coordinates using an automated listing and mapping instrument. Independent Listing is subject to quality control; a sample of housing units within every BCU will be checked, and all BCUs that fail will be reworked.

⁴ See Davis, Nguyen, and Hill (2018) for sample allocation details.

The listers make a complete canvass of their assigned BCUs to collect the following information for each HU and potential HU:

- Address (information to identify the HU and structure, street name, city, and ZIP code) for units with city-style⁵ addresses and for non-city-style when available.
- Rural route and box number (for both non-city-style and city-style addresses).
- Respondent name and physical location description for units with non-city-style addresses.
- Number of HUs in any multiunit structure.
- Description of each building that contains HUs.⁶
- Status of each unit listed such as occupied, vacant and intended for occupancy, under construction, future construction, unfit for habitation, boarded up, empty trailer lot or site, structure used for storage of household goods, or structure used for another purpose.
- Special features of addresses in Puerto Rico.

To get information about extra and hidden units, listers will attempt to contact a respondent at each address. Listers will make two attempts at the unit before contacting a proxy and use observation only when necessary. In multiunit structures, the lister will canvass by observation and then attempt to gather and reconcile the information from a manager who may be able to provide information on all HUs more efficiently than questioning residents of each unit directly. Also, efforts will be made to acquire maps of apartment complexes, mobile home parks, and recreational vehicle (RV) parks from the managers of these facilities.

Units in RV parks, campgrounds, marinas, and other similar locations will be listed only if someone with no other usual residence occupies them at the time of listing. In addition, vacant lots in mobile home parks will be listed since they could contain an HU when the PES Person Interview is conducted. If the listers are unsure about whether or not a unit is an HU, they will be instructed to list the addresses. The assignment of listers to BCUs adheres to strict rules for independence between census and PES operations (U.S. Census Bureau, 2019).

⁵ City-style is a form of address where house number and street name are given (e.g., 123 Blue Jay Road). Non-city-style addresses pertain to all addresses other than city-style.

⁶ Description of a building includes identifying the building as a single-family house; building with two or more apartments; mobile home or trailer (inside or outside of a mobile home park); camper, tent, boat, van; or other.

Listers will place a spot on the electronic map to indicate the location of each structure listed.

The quality assurance plan for Independent Listing has four components:

- All listers undergo online and classroom training.
- Listers who struggled in training are observed by their field supervisor.
- Automated instrument edits to detect and correct common data-entry errors. Some edits prevent the lister from moving forward until a correction is made, while other edits warn the lister of a possible error but allow them to move on without a correction.
- Some BCUs are sent for in-field quality control (QC), as described below.

After a BCU is listed, it is run through a series of checks to place the BCU into one of three sampling strata for a possible quality reinterview; these strata are high, medium, and low. If a BCU is selected for in-field QC, another lister specifically hired for QC will check a sample of addresses in that BCU to verify addresses or make corrections, as needed. After the sample is complete, the automated instrument calculates a pass or fail decision. If the production lister made fewer than the number of allowable errors, the BCU passes QC. Otherwise, the BCU fails QC and the QC lister reworks all remaining addresses in the BCU.



CMDE does the subsampling of PES small basic collection units.

CMDE performs a subsampling of the PES small BCUs. The BCUs that were classified as small before the independent listing are restratified within each state and a subsample of the small BCUs will be included in the CMM Initial Housing Unit Computer Matching activity.

Using results from the IL as well as preliminary census address data⁷, BCUs from the original small sampling stratum (0-2 HUs) are stratified into four groups based on the updated number of HUs per BCU. The updated HU count for each BCU is the larger of the number of HUs from the PES IL operation and the number of HUs from the preliminary census address list. The subsampling is designed to minimize the impact on the variance of the coverage estimates and to increase the efficiency of the PES field operations.

⁷ Same preliminary census address data used in the Initial HU Matching discussed in Section 5.1.

The strata are formed so that small BCUs with more than the expected number of HUs will be sampled at a higher rate to keep their weights lower. This will reduce the potential contribution from these BCUs to the sampling variance of the coverage estimates.

Approximately 10 percent of the original small BCUs with 0 to 2 HUs found is retained in the final BCU sample and 30 percent of the small BCUs with 3 to 9 HUs found is retained in sample. The target national BCU sample size is allocated to the 50 states and DC proportional to the HUs in each state.

Small BCUs with 10 or more HUs are not subsampled. Also, BCUs that are part of an American Indian Reservation, associated trustland, or Tribal Jurisdiction Statistical Area/Tribal Designated Statistical Area/Alaska Native Village Statistical Area are not subsampled. Within each of the other two strata, BCUs are sorted and a systematic sample of BCUs are selected with equal probability within each subsampling stratum within each state, DC, and Puerto Rico.



CMM conducts the PES Initial Housing Unit (IHU) Computer Matching activity.

During Initial HU Computer Matching, all addresses listed in the PES sample BCUs during IL are computer matched to preliminary census addresses (of HUs and group quarters [GQs]) within the sample BCUs and one ring of surrounding BCUs. This matching activity will identify the following:

- Matches and possible matches between the IL addresses and census addresses.
- Potential PES IL duplicates within the sample BCU.
- Potential census duplicates.

The data from the IL and the preliminary census addresses go through a series of data preparation steps before matching, including address standardization. Addresses from either file that are blank or could not be standardized are not subject to computer matching, but will be included in the clerical matching activity.

Potential duplicates are identified through a one-to-many matching process. Links between a single census address and multiple IL addresses identify a potential PES duplicate; links between a single PES IL address and multiple census addresses identify a potential census duplicate.

The results of the computer matching and additional information are loaded into an HU clerical matching system, which is subsequently used by clerical matchers. All of the results from computer matching will be checked clerically.



CMM conducts PES Initial Housing Unit Before Follow up (IHU BFU) Clerical Matching activity.

In general, the possibly matched addresses, “not matched” addresses, and potential duplicates are sent to clerical matching to resolve any unresolved cases and confirm the nonmatches. During Initial Housing Unit Before Followup Clerical Matching, the National Processing Center (NPC) matching staff uses computer-assisted clerical matching techniques, along with maps, to review and to resolve the match status of the possibly matched and “not matched” addresses from the IHU Computer Matching. In addition, the NPC matching staff also searches for duplicate census addresses. The clerical matching uses a computer-assisted software called the clerical matching and map update system. Cases in the search areas that remain unresolved following this activity are eligible for Initial Housing Unit Followup fieldwork.

There are two stages of Initial HU BFU Clerical Matching: BFU Technician and BFU Analyst.

In the BFU Technician stage, technicians use clerical matching software for the following work:

- Review the results from the Initial HU Computer Matching activity to determine the correct match status and to unlink addresses as necessary.
- Attempt to match IL units and census units that were not matched in the Initial HU Computer Matching activity.
- Search for duplicates:
 - Between IL units within the PES sample BCUs.
 - Between units on the preliminary census list in the PES sample BCU and the surrounding BCU.
- Assign match codes to indicate the results of their review.

The supplemental materials used in the clerical matching include electronic maps with the PES map-spotted units and electronic census maps. Given the number of non-city-style addresses in rural areas, map spots and descriptions are very important for the clerical matching procedure in these areas.

In the IHU BFU Analyst stage, analysts perform the QC of the technicians' work and review cases referred by the technician. The referred cases are IL or census units where the match or duplicate status is not clear. The QC process for clerical matching consists of analysts performing a full review of BCUs selected for the matching QC sample. For the IHU BFU Clerical Matching activity, approximately 33 percent of all BCUs going through the CMM operation will be checked. The target Average Outgoing Quality Limit (AOQL) is 3.5 percent.

After training, technicians will start production work in 100 percent QC status. If a technician is performing poorly, the technician may be required to undergo retraining. Technicians who perform poorly even after retraining will be removed from the CMM operation.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.

Some BCUs meeting specific criteria will be allowed to skip the BFU Clerical Matching and go directly to IHUFU. Other BCUs will be allowed to skip both BFU Clerical Matching and the IHUFU. All BCUs skipping BFU Clerical Matching will be subject to a clerical duplicate search in Initial HU AFU Clerical Matching.

The result of the BFU Clerical Matching process will be a file containing the Initial HU match codes for all addresses (both IL and census), and flags indicating which census or IL units will go to the next operation, the CMFO IHUFU operation.



For cases identified from IHU BFU Clerical Matching that require follow-up, CMFO conducts the PES Initial Housing Unit Followup (IHUFU) and QC field data collection activity.

During Initial Housing Unit Followup, CMFO interviewers collect additional information for addresses unresolved after the IHU Computer Matching and IHU BFU Clerical Matching activities.

IHUFU attempts to do the following work:

- Collect additional information that might allow a resolution of match codes for any differences between the Independent Listing results and the census file.
- Resolve potential duplicates.

The following are the conditions that will render a unit eligible for follow-up:

- Census unit not linked to an IL unit in the same PES sample BCU.

- IL unit not linked to a census unit in the PES sample BCU or surrounding BCUs.
- IL or census unit with a link assigned a possible match status.
- IL unit with unresolved HU status (under construction, future construction, unfit for habitation, vacant trailer pad, or other), regardless of match status.
- IL unit with a duplicate link, regardless of match status.
- IL unit with a link to a census unit in a surrounding BCU, regardless of match status.
- Census unit with a duplicate link, regardless of match status.
- IL unit with a link to a census GQ.

To maintain the independence between the PES and census, previous census and PES work assignments are taken into account when making assignments to PES staff. As with all other PES follow-up activities, staff will use a paper form seeking to acquire the necessary information. Also, PES field representatives will have access to both PES and census maps. Further, they will be able to update paper maps in limited situations.

The follow-up forms are customized for each individual situation. Efforts will be made to collect the following information:

- BCU number (for a unit that could be a duplicate in a surrounding BCU).
- Evidence to determine if there was an HU at the address on the date of the follow-up visit.⁸ If the case in question is not an HU, a statement should be provided as to the reason for this determination.
- Whether or not two units identified as possible matches are the same unit.
- Whether or not two or more units identified as possible duplicates are the same unit.
- HU status updates for certain situations.
- Response to case-specific questions provided by the clerical matchers.

Also, field representatives will use the reference list⁹ provided to determine if any units sent for follow-up match other units on the reference list. This is done to reduce the number of

⁸ It is possible that some of the follow-up cases were not HUs at the time of listing. In this situation, the interviewer will need to determine if an HU does actually exist at the address.

⁹ The reference list is a list of all of the PES HUs and census HUs and GQs in the PES sample BCU. It also includes census units in surrounding BCUs that contain a unit linked to a unit in the sample BCU.

potential E sample nonmatches. Cases lacking sufficient information to locate the unit in the field and conduct the follow-up interview will not go to IHUFU.

The IHUFU quality assurance plan has the following components:

- All listers undergo online and classroom training.
- Listers who struggled in training are observed by their field supervisor.
- Field supervisors review and edit completed forms for accuracy and completeness.
- A separate staff of listers, called QC listers, perform a check of data accuracy for randomly selected IHUFU forms in each BCU. Approximately 15 percent of all cases sent to IHUFU will be checked in the field, with a target AOQL of 4.0 percent.
- A field supervisor edits the QC forms for accuracy and completeness.

Each BCU undergoes an office edit.



CMM conducts PES Initial Housing Unit After Follow up (IHU AFU) Clerical Matching activity.

The NPC matching staff will use the results of the IHUFU data collection to attempt to match unresolved addresses. The result of this activity is a file containing match codes for PES listed and census units in the BCU sample. The output of this matching is sent to CMDE for use in selecting the PES Person Interview (PI) HU Sample.

Once the IHUFU is completed, the IHUFU paper forms, along with Initial HU BFU Clerical Matching results file and updated PES maps, are made available for the next PES activity, the Initial HU AFU Clerical Matching. There are three stages in the Initial HU AFU Clerical Matching: AFU Technician, AFU Analyst, and AFU Outlier Review.

A main objective of the AFU Technician stage is to have the technicians assign match status and HU status codes to cases that were sent to IHUFU. A clerical search is performed to attempt to find duplicates for BCUs that have skipped Initial HU BFU Clerical Matching.

In addition, clerical matchers will correct addresses and update PES maps by adding or deleting map spots, based on information collected in IHUFU. Clerical matchers may add map spots to the PES maps for census addresses that belong within the sample BCU or a surrounding BCU and were listed in the sample BCU by census, but were not listed there in IL. Clerical matchers may also delete map spots for IL addresses that do not belong in the sample BCU or do not represent a unit that has the potential to be an HU by the time of the PI, such as businesses. These address corrections and map spot numbers are recorded and are used for future PES

field operations and matching activities, but are not fed back into any actual census operation (e.g. GEOP).

The IHU AFU Analyst stage for IHU AFU Clerical Matching is very similar to that for IHU BFU Clerical Matching. In this stage, the analyst conducts a quality check on a sample of technicians' work and reviews any cases referred by the technician. The expected QC workload and target AOQL for this activity are the same as for IHU BFU Clerical Matching.

After training, technicians will start production work in 100 percent QC status. If a technician is performing poorly, the technician may be required to undergo retraining. Technicians who perform poorly even after retraining will be removed from the CMM operation.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.

In the AFU Outlier Review stage, analysts review BCUs identified for review by headquarters staff and BCUs that exceed a prespecified threshold of weighted nonmatch and erroneous enumeration counts. The analysts review the BCUs for systematic errors or issues. They document their findings in journals that can later be used during estimation processes if questions arise.

The output for the Initial HU AFU Clerical Matching activity consists of the results file, containing the match status codes and HU status codes of all census and IL units included in the initial HU activities.



CMDE selects the PES Person Interview (PI) HU Sample using inputs from IHU AFU.

Identifying the P sample and E sample HUs are separate sampling activities done at different times. Along with identifying the P sample HUs, an additional sample of census-only HUs is identified to receive the PI. Since these census-only units were not listed in the PES IL they cannot be part of the P sample, but a sample of them is selected to be included in the PI, along with the P sample HUs. Identifying the PI sample involves selecting a subsample of HUs within large BCUs.

In large BCUs (58 or more HUs), the HUs within the BCU are subsampled. This feature of the sample design is intended to increase the number of BCUs in sample while still attaining the targeted number of HUs for the P sample. The objective is to reduce costs and yield manageable fieldwork loads for PES PI and PFU without seriously affecting the precision of the

PES coverage estimates. Also, by taking advantage of the homogeneity of units within the large BCUs, interviewing a manageable fraction of several different large BCUs provides a more geographically diverse sample. This approach is expected to have lower sampling variance than a design with more sample housing units within BCUs and fewer BCUs.

When selecting the initial sample of PES BCUs for IL, large BCUs have a higher selection probability than medium BCUs to take into account the anticipated subsequent HU subsampling. After the subsampling of HUs in large BCUs, the HU selection probabilities in medium and large BCUs in the original BCU sampling strata are similar.

Another important goal of the HU subsampling is to geographically overlap the P and E samples to reduce the E sample PFU workload. An overlapping P and E sample is not necessary but improves the precision of coverage estimates, the cost-effectiveness of the succeeding field operations, and the data processing efficiency.

Identifying the P Sample HUs

The PES independently listed units that are determined to be HUs or potential HUs and that are located in the final PES sample BCUs after the IHU Matching and Followup activities are the source of the P sample. For BCUs containing 57 or fewer IL HUs, all the PES HUs are included in the P sample. For BCUs with 58 or more IL HUs, a subsample of PES HUs is selected. All HUs in BCUs in the AIR stratum are included in the P sample.

A subsample of HUs within the large BCUs are formed by grouping adjacent HUs, called segments, and selecting one or more segments per BCU for the P sample. The segments are constructed by sorting housing units by map spot number within a BCU. The map spot numbers are reviewed during the Initial Housing Unit matching activities to assure they are sequential numbered around the BCU. The segments have roughly equal numbers of HUs within a BCU. Segments of HUs are used as the sampling unit to obtain compact interviewing workloads and to facilitate the identification of an overlapping E sample. A systematic sample of segments is selected across the BCUs within a stratum. The resulting sample will yield at least one segment selected per BCU. The PES IL units in BCUs where no subsampling occurs and the PES IL units that are retained after the subsampling compose the P sample.

As was done in the 2000 A.C.E., the PI sample will be selected on a flow basis for the 2020 PES. As BCUs complete Initial HU Clerical Matching, the addresses that are eligible for the PI shall be input to PI sample selection. Overall, PES expects to sample addresses for PI in five waves spread across the P sample selection period.

Identifying the PI sample of HUs

The PI sample is the set of HUs where the PES PI is conducted. It consists of the HUs selected for the P sample (described in the previous section) and a sample of census-only units. Census-only HUs are eligible for the PES PI to obtain Census Day residence status of people in these HUs prior to identifying E sample HUs. There are four categories of census-only HUs eligible for the PI:

- Nonmatched census unit that is confirmed to exist in the sample BCU, but was missed by the PES IL.
- Nonmatched census unit that is geocoded to the PES sample BCU, but confirmed to exist in one of the BCUs surrounding the sample BCU.
- Nonmatched census unit geocoded to the PES sample BCU, with an unresolved HU status code.
- Matched census unit that is geocoded to the sample BCU, but confirmed to exist in one of the BCUs surrounding the sample BCU. (The corresponding IL unit is not eligible for the P sample, since it is not located in the sample BCU.)

Census-only HUs are eligible for the E sample if they are on the final census address list for the final sample BCU.

For PI sample identification, the eligible census-only HUs are assigned to the same segments as the P sample by sorting all PES IL HUs and eligible census-only HUs together geographically by their expected location on the ground (i.e., map spot numbers). Sometimes there is a large number of these census-only cases within a sample segment(s) in a BCU. If there is a large number (58 or more) of these census-only HUs in all the sample segments in the BCU, they are subsampled. Within sample segment(s) in a BCU, the census-only units are selected at a constant rate of 1-in-3.

If there are fewer than 58 eligible census-only HUs within all sample segments or there are fewer than 58 of these units within a BCU that was not subsampled during the P sample selection, all of these eligible census-only HUs are included in the PES PI sample. PES expects the number of census-only HUs in sample P sample segments to be about 6 percent of the number of PI-sample HUs.

10 After the decennial census Nonresponse Followup operation (NRFU) is completed for the BCU, CMFO conducts the PES Person Interview (PI) and Reinterview field data collection activity.

For each sample BCU, CMFO will interview people in selected housing units. During PI, interviewers use a computer-assisted person interview (CAPI) to obtain information about the following:

- The current residents of the sample housing unit.
- The people living at the housing unit at the time of interview who may or may not have been there on Census Day (nonmovers and inmovers).
- Certain people who moved out of the sample housing unit between Census Day and the time of the PI (outmovers).

The information collected for each person includes name, sex, age, date of birth, race, relationship, and Hispanic origin. The interviewer also collects information about alternate addresses to establish where people lived on Census Day, according to census residence rules. The PI will include some census cases not in the person P sample. These Census Adds and census-only cases from the person E sample will be included in the PI sample to obtain information about them that may be useful in person matching.

The PES PI will be conducted at the selected HUs to build an independent roster of people currently living at each HU. Emphasis will be placed on collecting information on the Census Day and Interview Day residence of people associated with the HUs (nonmovers and inmovers) based on residence rules. This method, by which all people who live at the sample address at the time of the PI are included in the P sample, is known as PES Procedure B. Information on the Census Day residence of these people is collected to facilitate matching. The 2020 PES will use Procedure B.

The 2010 CCM used Procedure B+. When the P sample also includes people who lived at the sample address on Census Day but who died after Census Day or whose Interview Day residence is out of scope for the coverage measurement universe (that is, has no probability of selection for the P sample), this is known as PES Procedure B+. An example of how the 2010 CCM employed the B+ methodology was collecting Census Day information on a person who was a Census Day resident of the sample address, but who moved into a college dorm between Census Day and Interview Day. The college dorm represents a residence that is out of scope for PES since it is a GQ.

To maintain the independence needed to preserve the validity of the DSE methodology, the PI field operation should not overlap with the NRFU operation within a BCU.

In the PI, the interviewers' primary focus is establishing the Census Day and Interview Day residence for people at the sample address at the time of interview, both nonmovers and inmovers since Census Day. Data will be collected for people (either individuals or entire households) about whom the respondent is knowledgeable and who have moved out since Census Day. Outmover data are collected to reduce the PFU workload and to obtain an interview closer to Census Day for these possible E sample cases. This information also helps to identify people who may have been enumerated at more than one location in the census. Situations where all Census Day residents of an HU have moved out before Interview Day present a challenge for data collection and in resolving Census Day residence status.

For each household in the PI, the data collection process will include questions to establish where each person should have been counted in the census (their Census Day address) and information on where each person could have been counted, such as inmover and alternate addresses. These inmover and alternate addresses will be used to assist in determining the Census Day residence status of each person. They will also be used to identify possible erroneous enumerations (including possible duplicates).

The PI will be conducted using a computer-assisted person interview (CAPI) instrument on a laptop computer. Having an automated instrument allows the interview to be tailored to the specific living situation and demographic characteristics of all people, as determined by their responses. A series of roster probes will be asked to capture information about any other person who has stayed at the residence that the respondent did not previously mention. These questions ask about babies, foster children, relatives, friends, or someone else who may have stayed temporarily at the sample address.

After rostering, questions are asked to gather demographic information and additional addresses where a person could have been counted in the census. The questions are geared toward collecting addresses for any of the following places where a person might have resided:

- Census Day address other than the sample address.
- College address.
- Military service address.
- Residence for a job.
- Relative's address where the person may stay, including joint custody situations.

- Seasonal home address.
- Other GQ (nursing home, correctional facility, group home, etc.).
- Any other place stayed often.

Questions are then asked as to how often a person “cycles” (goes back and forth) between the sample address and any alternate address. This method is similar to the one employed in the 2010 CCM PI and the 2000 A.C.E. person follow-up and evaluation follow-up interviews. Responses to these questions are needed so the clerical matching staff can apply the census residence criteria to determine where the person should be counted.

The PI quality assurance plan has the following components:

- All interviewers undergo online and classroom training.
- Interviewers who struggled in training are observed by field supervisors.
- Automated instrument edits to detect and correct common data-entry errors. Some edits prevent the interviewer from moving forward until a correction is made, while other edits warn the interviewer of a possible error but allow them to move on without a correction.
- A reinterview of selected cases.

There are four ways a case can be selected for reinterview:

- Analytic, which selects cases that appear to be unusual. For example, a case that is completed very quickly is suspicious.
- Random, which selects cases using a systematic sampling approach.
- Supplemental, which is used when clerical resolution staff suspect an interviewer may not be following proper procedures and are looking for more information.
- Hard Fail, which is used when an interviewer is confirmed to have falsified work. In this situation, all of the interviewer’s cases that have not already been selected for reinterview are added to the reinterview workload.

The reinterview is conducted by a separate staff of interviewers. As completed reinterview cases are transmitted from the field, the PI and PI reinterview data are matched. Reinterview cases that are not assigned a “Pass” or “reinterview noninterview” match code during computer matching go on to a clerical matching stage to determine a final match code. The reinterview program is designed to sample 15 percent of the PI cases.



CMM performs the Clerical Geocoding activity.

The processing of alternate addresses and inmovers' Census Day addresses requires geocoding functionality prior to matching. Since addresses are collected during both the PI and the PFU interviews, geocoding will be required for addresses obtained from each of these two CMFO activities at two different times.

Inmover and alternate addresses identified during the PI will be geocoded to census BCUs using automated software during the Clerical Geocoding activity. An attempt to clerically geocode those PI respondent-provided addresses that cannot be computer geocoded will also be made.

Automated Geocoding

The inmovers' Census Day addresses, and the alternate addresses provided by the respondents in PI, are geocoded. The geocodes are used during person matching to create search areas for person matching that encompass the BCU of the inmover or alternate address and its surrounding BCUs.

The results of automated geocoding for addresses collected in the PI will be input to the Clerical Geocoding activity. Clerical Geocoding will attempt to geocode the addresses that could not be given a geocode during automated geocoding. The results from these two geocoding activities will be used to conduct Person Computer Matching and Person Clerical Matching, as well as Clerical Residence Status Coding. The inclusion of clerical geocoding results prior to computer matching is a change from 2010.

The Census Bureau's MAF/TIGER database is the primary source of the geocodes. Geocoding can occur at various levels of geography. The most detailed geocoding occurs when the respondent-provided address matches to a specific record on the MAF. If the address matches to the MAF, PES receives the matching MAF Identifier (MAFID) as well as the geocode. The least detailed geocode is assigning only a state. Several county codes can be assigned if only a city or town is provided and that city or town lies in more than one county. In general, geocoding is successful for matching purposes if the address can be assigned to a specific county and census BCU or a small group of census BCUs.

If the automated geocoding is not successful in determining the MAFID or the BCU of the respondent-provided address, then the address is provided to Clerical Geocoding for the clerical matchers to attempt to geocode using additional information collected during PI.

Clerical Geocoding

After automated geocoding, all cases with ungeocoded inmover or ungeocoded alternate addresses will be reviewed during the Clerical Geocoding Technician stage.

Any inmover or alternate address that is not geocoded to a BCU by automated geocoding will be reviewed by the technicians. They will have access to census maps for the entire country, the MAF browser, the online ZIP+4 directory, and the internet to attempt to geocode the address. They will also have access to other information collected in the PI such as landmarks, cross streets, names of other household members, and names of nearby neighbors.

Clerical matchers also review the PI data and geocode(s) for each inmover addresses to determine how confident they are that the census person would be found in the inmover address search area, given that the person was correctly enumerated in the census. Clerical matchers assign an inmover address code to each inmover address, based on this review.



CMM performs the Residence Status Coding activity.

Automated Residence Status Coding

Each person rostered in a PI HU that is coded as a complete or partial interview is assigned a residence status code. This includes people in census-only HUs selected to receive the PI. These codes ultimately are used to indicate whether a person should be included in the P sample or not. A person rostered in a census-only HU is assigned a residence status code but is not eligible for the P sample. The residence status codes are assigned by computer following the PI and can be reviewed and reassigned during Clerical Residence Status Coding or any part of person clerical matching based on information provided in PI or PFU.

The residence status codes for P sample people are as follows:

- Nonmover (N).
- Inmover (I).
- Unclassified (U).

The PI is designed to roster all people at the sampled HU on Interview Day. If the respondent can provide information on people who lived at the sample HU on Census Day but no longer do, then this information is collected. As such, some of the people rostered may not turn out to be

residents of the sample address on Interview Day and would therefore not be included in the P sample. The residence status codes for these non-P sample people are as follows:

- Outmover (O).
- Out of scope (X).

If the computer determines that a clerical review is needed to determine the residence status, the person is given a residence status code of “R,” which will flag the record for clerical review.

Clerical Residence Status Coding

After automated residence status coding, PI cases with a “review” residence status code from automated residence status coding will be reviewed during the Clerical Residence Status Technician stage. In some cases, the computer cannot assign a residence status code to a person rostered in the PI, but notes collected during the PI may help resolve the status. In these cases, a technician will review the data collected in the PI and will assign a residence status code. The Clerical Residence Status Technician stage within a BCU occurs after the BCU completes Clerical Geocoding, since some cases may require geocodes to determine the correct residence status code.



After the CUF is created, CMDE selects the E sample HUs.

The E sample is identified after the PES PI is conducted but before the Person Matching activities begin.

The E sample contains HUs enumerated in the census in the same sample areas as the P sample. The source of the final set of census HUs is the Census Unedited File (CUF).

One primary goal of E sample identification is to geographically overlap the P and E samples to the extent possible. Having overlapping P and E samples reduces the E sample PFU workload. Overlapping the P and E samples also improves the precision of the dual system estimates and the cost effectiveness of succeeding field operations.

The identification of E sample HUs is done by mapping the final set of census HUs onto the previously identified PES segments. The final census HUs are divided into two categories; those that are on the PI frame and those that are not. If a unit maps to a unit on the PI frame and is selected for PI, then it is in the E sample. Those units that did not map to the PI frame are Census Adds.

In addition, the census inventory of HUs may change between the IHU Matching activity and the IHUFU field operation and the identification of the E sample. For example, a unit may be added to the census address list through a census operation. The added unit could also have been on the census list at the time of IHU matching and IHU follow-up, but declared erroneous for some reason such as duplication. These erroneous units that are still in the census would also be treated as Census Adds for E sample identification. These Census Adds are assigned to the already-formed segments geographically. For the 2020 PES, Census Adds in sample segments will not be subsampled. The E sample is expected to contain about the same number of HUs as the P sample.



CMM conducts PES Person Computer Matching.

During Person Computer Matching, the person data collected during PI are computer matched against all census enumerations. The person dataset from the PI is also computer matched against itself within a sample BCU to identify duplicate people in the PI. The person computer matching also searches for census duplicates within the U.S. or within 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, people are identified as one of the following codes:

- Matched.
- Possibly matched.
- Not matched.

The Person Computer Matching involves three different searches:

- PI to census – PI people are matched to the entire census to find matches both within the sample BCU search area and throughout the census.
- E sample to census – E sample people are matched to the entire census to find duplicates both within the sample BCU search area and throughout the census.
- PI to PI within-BCU – PI people within the BCU are matched to find within-BCU PI duplicates only.

For each search outlined above, Person Computer Matching involves several steps:

1. Preparing the Data – Census and PI data fields used in the computer matching algorithm need to be consistent. They include data items such as gender and computed age. In

addition, the phone number—a key component in the matching system—is edited. Finally, names are prepared by removing punctuation, titles (Mr., Mrs., Dr., etc.), and special characters (including Spanish characters). A name variant list is used to standardize first names (for instance, “Cathy” and “Catherine” are considered the same).

2. Computer Matching – Person records are compared across all living quarters outside of their own (i.e., a person cannot match within their own HU or GQ). A person can link to multiple people but to only one person per living quarter. Matching is accomplished in two steps. The first step matches all people across the universe. The second step builds on the links established in the first step but allows additional flexibility for finding matches within other households.
3. Geographic Assignment – Each linked pair is assigned a geographic code indicating the relationship of the link. The codes are:
 - Within the sample BCU.
 - In a surrounding BCU.
 - In county but outside the sample BCU and surrounding BCUs.
 - In a different county in the same state.
 - In a different state.
4. Computer Modeling – Modeling is used to establish which links should be considered matches, possible matches, or not a match. Rules are applied based on geographic proximity (see Geographic Assignment above), household patterns, phone numbers, person characteristics, and type of living quarters (HU or GQ). There are two types of modeling. The first is within-household modeling, which takes the household structure into consideration. The second type is residual modeling, which matches individuals without the benefit of the household structure.
5. Creating the Output – The output from computer matching contains identifying information for each person record in a linked pair and the match code for that pair (either match or possible match).

Each of the three searches uses the same software and the same steps in matching. For the PI to census search, the data are matched only once but there are three separate modeling processes. Links in the sample address search area or in the nationwide search area are modeled with respect to the sample address. Links in the in-mover address search area are modeled with respect to the in-mover address. Links in the alternate address search areas are modeled with respect to the alternate address. For each of the modeling steps, the geographic distance category is reassigned based on the distance of the address being modeled. This

adjustment can make it more likely to call a link a match when modeling with respect to a different address. In general, links with closer geographic proximity are more likely to be called matches.



CMM conducts PES Person Before Followup (Person BFU) Clerical Matching.

In general, the possibly matched people and not matched people are sent to clerical matching to resolve any unresolved cases and confirm the nonmatches. During the Person Before Followup Clerical Matching activity, the NPC matching staff uses computer-assisted clerical matching techniques, along with 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 people. 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. Cases that remain unresolved following this activity are sent to PFU. Some examples of unresolved PFU cases include the following:

- Nonmatched P sample person records with a proxy response.
- Nonmatched E sample person records.
- Possibly matched or possibly duplicated records.
- Matching housing units with differing rosters between the E sample and P sample households.
- P sample people with unclassified residence status.
- Inmovers with ungeocoded inmover addresses.
- Possible matches.
- Possible duplicates at nationwide potential long-distance duplicate addresses (follow-up needed at both the in-cluster and long-distance addresses).

During the BFU Technician stage, technicians will review the results of Person Computer Matching. In particular, technicians attempt to match PI records to the census, find duplicates in the PI, and find E sample duplicates.

The technicians will review each E sample case with insufficient information for follow-up to attempt to update the record with information from other census data (including electronic images of census forms). An example would be adding the last name of a parent listed on a census form to children on the form whose last names are missing. PI cases with incomplete names or characteristics will be updated using other PI data.

As part of the Person Before Followup Analyst (BFA) stage, analysts review every technicians' work and resolve any cases that the technicians could not resolve. The analysts will perform a full review of BCUs selected for the person matching QC sample. They will also review specific person records sent by the technicians in the Person BFU Technician stage. It is expected that about 25 percent of all BCUs requiring person matching will be subject to this QC activity, with an expected average outgoing quality level (AOQL) of 3.5 percent.

After training, technicians will start production work in a 100 percent QC status. If a technician is performing poorly, the technician may be required to undergo retraining. Technicians who perform poorly even after retraining will be removed from the CMM operation.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.

After this initial matching activity, all E sample nonmatches, selected PI nonmatches, and all possible matches and duplicates are followed up in the field through the PFU operation.



For cases from Person BFU Clerical Matching that remain unresolved, CMFO conducts the PES Person Followup (PFU) and Reinterview field data collection activity.

During PFU, interviewers contact cases identified in the CMM Person Matching activities as requiring additional information to resolve the following:

- Census Day residence status.
- Enumeration status.
- Match status.
- Person duplication.

The universe for potential follow-up includes the E sample, the P sample, or suspected census duplicates. PFU collects data that is later used in the Person After Followup Clerical Matching activity to resolve any differences between the Post-Enumeration Survey and the census enumeration results. The PFU data collection forms will be collected through paper-based data collection. The questions included for each follow-up case will vary depending upon the reason the case is being sent to follow-up. This field operation includes a reinterview for quality control purposes.

Person Followup cases are identified after the Person BFU Clerical Matching activity is completed. The PFU interview attempts to collect additional information needed to establish

Census Day residence for P sample cases. It also attempts to resolve enumeration status for nonmatched E sample cases. People coded as having insufficient information for follow-up are not sent to PFU. The types of cases sent to PFU are as follows:

- Possible matches (P or E sample), not including possible matches identified during nationwide computer matching.
- P sample partial-household nonmatches.
- P sample whole-household nonmatches with a proxy respondent in the PI and either no people in the matching census unit or no matching census unit.
- P sample whole-household nonmatches in BCUs with a high rate of P sample nonmatches (more than 45 percent).
- P sample whole-household nonmatches where the PI interviewer changed the sample address.
- Inmovers with ungeocoded inmover addresses (regardless of match status).
- Conflicting households, which occur when addresses that matched during IHU activities have completely different rosters in the census and PI (nonmovers).
- Unclassified P or E sample people with sufficient information for follow-up, who are not duplicates, regardless of match status.
- P sample people who are identified as a match or possible match in the nationwide computer matching (follow-up at sample address).
- People identified in the nationwide search who match or possibly match to P sample people (follow-up at the nationwide address) by personal visits.
- E sample nonmatches.
- E sample whole-household nonmatches whose addresses were flagged for a geocoding check and not included in Initial HU Matching.
- E sample people who are duplicates or possible duplicates to a nationwide person (follow-up at the sample address).
- People identified in the nationwide search who are duplicates or possible duplicates to other E sample people (follow-up at the nationwide address by personal visit).
- Any case sent to PFU by an analyst.
- P sample possible duplicates within the sample BCU.
- E sample possible duplicates within the sample BCU or the surrounding BCUs (at least one of the pair is an E sample person).

- PI in-movers who are not found at their respondent-provided Census Day address (i.e., not matched at their in-mover address), where the PI data was collected from a proxy respondent.
- Non-movers at addresses where the IHU activities determined that no HU existed at the time of follow-up, but the potential existed for an HU at the time of PI.
- E sample matches to out-movers at addresses where the IHU activities determined that no HU existed at the time of follow-up.

Note that a case can be sent to PFU for multiple reasons. The PFU data collection methods will include establishing where the person should have been counted in the census (their Census Day residence) and collecting information on alternate locations and addresses where the person could have been counted on Census Day.

The PFU interview will be conducted using a Docuprinted paper questionnaire. This method allows the PFU form to be tailored to collect only the information needed for each person. The paper questionnaire will be used for final coding of the Person Matching results.

The PFU questions are geared toward collecting addresses at any of the following places where a person might have resided:

- Census Day address other than the sample address.
- College address.
- Military service address.
- Residence for a job.
- Relative's address where the person may stay, including joint custody.
- Seasonal home address.
- Any other place stayed often.
- Other GQs (nursing home, correctional facility, group home, etc.).

To assign a residence status code, the PFU interview then asks for dates spent at each residence and includes some semiscripted probes to help matching staff determine at which address the person should be counted in the census according to census residence criteria.

In addition, a follow-up on matches, duplicates, possible matches, and possible duplicates identified in the nationwide computer match will be performed. The part of the link that is located outside PES sample and surrounding BCUs (referred to as the "nationwide" address) will be followed up by personal visits as part of the nationwide PFU operation. The part of the

link located inside the search area will be followed up in the field as part of the regular PFU operation.

The PFU quality assurance plan has the following components:

- All interviewers undergo online and classroom training.
- Interviewers who struggled in training are observed by field supervisors.
- Field supervisors review and edit completed PFU forms for accuracy and completeness.
- Each PFU questionnaire undergoes an office edit.
- Reinterview, described below.
- Following reinterview, each case is edited by a field supervisor and then office staff.

The purpose of the reinterview is to ensure that the original interviewer contacted the PFU case. Reinterviews are chosen by random or supplemental sampling. Once a case is selected for reinterview, a reinterviewer will visit the follow-up address or make contact by telephone and conduct the reinterview with the same person who responded to the PFU interview to confirm that the PFU interview respondent was contacted by the interviewer. About 15 percent of each interviewer's completed eligible cases are randomly selected for reinterview.



CMM conducts PES Person After Followup (Person AFU) Clerical Matching.

The NPC matching staff use information obtained during PFU from the completed questionnaires to resolve match, residence, enumeration, and duplication status for remaining people in the coverage measurement P sample and E sample.

Following the PFU interview, Person AFU Clerical Matching activities are performed. The Person AFU Clerical Matching consists of four stages:

- AFU Technician.
- AFU Analyst.
- AFU BCU Review.
- AFU Outlier Review.

As PFU forms are returned from interviewing, they are assembled into batches to be reviewed by the clerical matching staff. First, these batches are reviewed by technicians in the Person AFU stage. Then, during Person AFU Analyst, analysts perform a review of the technicians' work selected for QC purposes. The analysts also resolve any cases that the technicians could not

resolve. This process is similar to the process for all other PES clerical matching activities. About 20 percent of all PFU forms will be reviewed for QC purposes. The target AOQL is 6.13 percent.

After training, technicians will start production work in a 100 percent QC status. If a technician is performing poorly, the technician may be required to undergo retraining. Technicians who perform poorly even after retraining will be removed from the CMM operation.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.

During the AFU Technician and AFU Analyst stages, the PFU interview results are clerically reviewed and the people are coded according to a predetermined set of matching codes. Technicians and analysts are allowed to make corrections to previous coding assignments if errors are discovered from the Person BFU Clerical Matching activities, even if the people were not included in PFU. These match codes provide the basic information needed for measuring both net coverage error and the components of census coverage. This clerical review also includes assignment of residence status codes and the clerical geocoding of any additional respondent-provided addresses (inmover and alternate addresses) collected in the PFU interview.

All PES sample BCUs are eligible for AFU BCU Review and AFU Outlier Review stages. BCUs are flagged for AFU BCU Review by technicians or analysts in the AFU Technician or AFU Analyst stage when certain conditions make it necessary to review the BCU as a whole instead of the batched forms. AFU Outlier Review stage is an analyst-only stage that targets the BCUs that may need further review. Analysts will review the BCU and write journals to explain any problems with the BCU. Analysts will also recode any cases that may be incorrectly coded. The journals are useful during analysis when particular BCUs stand out. BCUs are flagged for outlier review by headquarters staff or by having a high outlier priority score. The outlier priority score is computed as the weighted sum of cases that do not match in the net error context in the P sample and cases in the E sample that do not link back to the P sample or are considered erroneous enumerations for net error.

Person AFU Clerical Matching is the final PES person activity. Output files with the results from the PI and person matching activities will be made available for the PES Estimation activities (see Section 9). People records that remain unresolved will be handled through statistical techniques for missing data.



CMDE produces the PES Person Estimates.

The Person Estimation process consists of several activities, which will ultimately lead to the production of estimates of person coverage for the decennial census.

To produce PES Person Estimates, CMDE performs the following activities:

- Perform imputation and weighting for P sample people, which includes:
 - Imputing missing demographic characteristics.
 - Adjusting person-level weights for PES household noninterviews.
 - Imputing the probability of P sample inclusion.
 - Imputing the probability of match status.
- Perform Imputation and Weighting for E sample People, which includes:
 - Imputing missing demographic characteristics.
 - Imputing missing enumeration status for net coverage.
 - Imputing missing enumeration status for components of coverage.
- Perform estimation of net coverage.
- Perform estimation of components of coverage, which includes:
 - Calibration of E sample weights.
 - Estimation of erroneous and correct enumerations.
 - Estimation of omissions.

Missing Data for P Sample People

There are four adjustments designed to account for missing data for people in the P sample:

- Imputing missing demographic characteristics.
- Applying a household-level noninterview adjustment for the PES Person Interview.
- Imputing the probability that a person should be included in the P sample.
- Imputing a match status.

Imputing Missing Demographic Characteristics for People

Production of PES coverage estimates requires data on the following characteristics:

- Age.
- Sex.

- Tenure (owner versus renter).
- Relationship to the householder.
- Race.
- Hispanic origin.

Because these characteristics are important classifiers used to report coverage rates and reduce bias in the dual-system estimates, they will be imputed whenever the data was not collected. PES will impute these characteristics using the 2020 Census edit and imputation programs.

Person-Level Noninterview Adjustment for PES Household Noninterviews

The PES accounts for a potential bias introduced because of households that were not interviewed in the PI. The units with “missing” interviews have sample weights associated with them. The noninterview adjustment procedure accounts for these cases by assigning a weight of zero to noninterviews and distributing their weight uniformly among interviewed cases with similar characteristics and response propensities. Weights from noninterviewed American Indian Country (AIC) HUs will be distributed only to other AIC HUs, and weights from noninterviewed non-AIC HUs will be distributed only to other non-AIC HUs. The noninterview adjustment is applied to people in interviewed HUs, for the purposes of dual-system estimation for people. Weights used in HU estimation are unaffected because all household responses are obtained by observation if a respondent does not provide them.

A weight-trimming procedure is applied after the missing-data activities have been performed, but before the final coverage estimates are created. Trimming the weights reduces the likelihood that a small number of BCUs will have a large influence on the coverage estimates and their standard errors.

Imputing the Probability of P Sample Inclusion for People

The PES interview needs to determine if a person should be included in the P sample. The P sample of people includes residents of the P sample HU on Interview Day.

PES will assign a probability of P sample inclusion status for all sample cases. Resolved cases that should be included in the P sample will receive a probability of 1. Resolved cases that should not be included will receive a probability of 0. For the unresolved cases, the PES uses an imputation procedure with logistic regression. Since the overstatement of the P sample total was an error for the A.C.E., the PES Estimation Team will closely examine and review how the imputation handles these cases.

Imputing the Probability of Match Status for People

The PES needs to determine if the P sample person matched to a census enumeration in the net error search area.¹⁰ This involves accounting for P sample cases that may have an unresolved match status or an unresolved mover status. A record may have either or both of these statuses unresolved. This section lays out the methodology to account for both statuses and how the final match probability for net error estimation is assigned.

PES will assign a match probability for all sample cases. Resolved matches will receive a probability of 1. Resolved nonmatches will receive a probability of 0. Cases with unresolved status need to have a match probability assigned to them.

Since both the match status and mover status can be unresolved, PES will assign an overall match probability for unresolved cases based on the following conditional probability of mover status.

PES first needs to account for unresolved in-mover status. The cases used for this imputation will be the resolved nonmovers and resolved in-movers. Using the resolved cases, PES will determine the weighted proportion of cases that were nonmovers or in-movers. This will be done by forming cells using some of the covariates in the logistic regression models, such as Before Followup (BFU) groupings. This will allow the two mover probabilities—of being a nonmover and of being an in-mover—to be assigned to each case within each grouping. (The probability of being a nonmover and the probability of being an in-mover sum to one.) The weighted proportions will be assigned as these probabilities for the unresolved mover status cases.

PES will then assign the probabilities of a case being a match given that it is either a nonmover or an in-mover. When these conditional probabilities are unresolved, PES will use logistic regression methods to impute them. These models and the general prediction equation will be used to determine the conditional probability of cases matching.

The conditionally predicted match rate for each unresolved match status case is then obtained. If the case is a nonmover, then the correct search area is the BCU and ring of surrounding BCUs. PES first uses the clerical matching information to see if matching staff were able to match the case in the BCU search area. If so, PES will assign this conditional probability of a match for this

¹⁰ The net error search area is typically the PES sample BCU and one ring of surrounding BCUs.

case equal to 1. The clerical matching information may indicate that the case was a nonmatch in the BCU search area. If so, PES will assign this conditional probability of a match equal to 0. If the matching results are unresolved, then PES will assign the conditional probability of a match by using logistic regression.

The predicted match rate for each unresolved P sample case given that it is an inmover is obtained next. One difference from the conditional match probability given that the case is a nonmover is that the correct search area for inmovers needs to be identified based on the PES interview information. The clerical results may indicate that a case links to a census enumeration outside the BCU search area, but PES cannot assume that it is the correct search area. For these cases the conditional match prediction will be assigned using logistic regression. Recall that when assigning the predicted match rate for each unresolved P sample case given that it is a nonmover, PES treated cases with an unresolved mover status as nonmovers.

After a) the probabilities of the case being either a nonmover or inmover, and b) the conditional match probabilities of nonmovers and inmovers are estimated, PES can estimate the probability of the unresolved case being a match.

Missing Data for E Sample People

There are two missing-data procedures needed for people in the E sample: a procedure for imputing missing demographic characteristics and one for imputing enumeration status (correct or erroneous). However, imputation of enumeration status needs to be considered separately depending on whether net error or components of census coverage is being estimated. Each of these processes will be discussed in more detail in the following sections.

Missing Demographic Characteristics for E Sample People

For people in the E sample with missing demographic characteristics, PES will not develop any special imputation procedures. PES will match those records to the Census Edited File and obtain the imputed characteristics from that file based on the 2020 Census edit and imputation methodology.

Imputing Missing Enumeration Status for People in the E Sample (Net Error)

The PES needs to determine if the census enumeration in the E sample was correctly enumerated in the net error search area. The probability of correct enumeration will be assigned for all E sample cases. The cases with unresolved status will have a probability imputed for them.

As was done in the 2010 CCM, a logistic regression model will be used to generate the predicted probability of unresolved cases being correct enumerations. The independent variables in the logistic regression imputation models for correct and erroneous enumeration probabilities will include matching and PES interview information identified as good discriminators. This might include PES covariates that are not available for the entire census. The models will include, at a minimum, the main effects of the independent variables used in the regression models to determine the predicted probabilities of being data-defined, a correct enumeration, or a match in the overall dual-system estimation formula.

Imputing Missing Enumeration Status for People in the E Sample (Components of Coverage)

The definition of correct enumeration used for net coverage estimation attempts to minimize matching error. This definition is not appropriate for estimating coverage components, since it results in inflated estimates of erroneous enumerations. Therefore, some cases treated as erroneous enumerations for net error estimation are considered to be correct enumerations for component estimation. One example is that an enumeration may be treated as erroneous for net error because it was enumerated in the wrong location. But if the person was enumerated once and only once, then that enumeration would be correct for national estimates of components.

Another example is the treatment of cases with insufficient information. If they are data-defined but do not have adequate information for PES follow-up, they are treated as resolved erroneous enumerations for net coverage. However, for component estimation, the PES will expand its matching activities to determine the enumeration status of these cases. If this matching effort is successful, some of the cases treated as erroneous enumerations for net error will be correct enumerations for estimating components. The ones that cannot be matched are unresolved for estimating components of coverage and require imputation.

As was done in the 2010 CCM, PES will use a cell mean imputation methodology to assign the enumeration status for the unresolved cases. The A.C.E. used this methodology for the missing-data adjustments of unresolved enumeration status for net error estimation in 2000. The enumeration statuses are as follows:

- Correct enumerations.
 - In the BCU search area.
 - Same county, same place.
 - Same county, different place.
 - Different county, same state; same place.

- Different county, same state; different place.
- Different state.
- Erroneous enumerations.
 - Duplicate.
 - Other reasons.

The weighted averages of each type of enumeration listed will be estimated using the resolved cases, and those weighted averages will be assigned to the unresolved E sample cases.

Person Net Coverage Error

There is a long history of using DSE in measuring census coverage. The DSE for people is calculated using the following equation:

$$DSE = \sum_{j \in C} \pi_{dd(j)} \times \frac{\pi_{ce(j)}}{\pi_{m(j)}} \times CB_j$$

where j indexes person records in the census. The predicted data-defined, correct enumeration, and match probabilities (π_{dd} , π_{ce} , π_m , respectively) will be obtained through logistic regression modeling. In 2010, the correlation bias adjustment factor (CB_j) was computed using sex ratios by race from the Census Bureau's Demographic Analysis program. This adjustment accounted for differences between the PES target population and the census universe, namely removing people in group quarters and in remote Alaska.

PES will then estimate net coverage by comparing the estimate of the true population (from the DSE) to the census count.

Person Components of Census Coverage

For people in HUs, estimates of correct and erroneous enumerations will be formed at the national level and for various subpopulations (or estimation domains) using data from the E sample. The requirements for an enumeration to be considered correct for component estimation are less stringent than those treated as correct for net coverage. PES will tally and report the total number of census whole-person imputations and omissions overall and for various subcategories. Census whole-person imputations are tallied from census files, and omissions are calculated by deduction.

Calibration Adjustment for E Sample People

Estimates of correct and erroneous enumerations will be formed by inflating ratio-adjusted survey weights attached to person records from the PES E sample in the particular estimation domain.

A set of predefined cells is formed, and the sampling weights for the E sample cases in each cell are ratio-adjusted so that the sum of the weights equals the census totals for those cells. These cells may be based on race/ethnicity, tenure, age/gender groupings or other demographic variables. Geographic variables, such as region and state, can also be used, and the census totals are the number of data-defined census person records in each cell. Depending on sample sizes and the size of the adjustment factors, some collapsing of the original cells may be necessary.

Erroneous and Correct Enumerations for People

For component estimation, the PES will estimate the total number of erroneous enumerations.

The PES will use the following definition of being a correct enumeration at the national level when evaluating the components of census coverage of people in the 2020 Census:

The person enumeration is considered to be correct if the record corresponds to a person that should have been included anywhere in the coverage universe¹¹. If such a person was included multiple times, one of the enumerations will be considered correct and the other enumeration(s) will be erroneous.

As stated previously, there are stricter requirements to be a correct enumeration for net coverage than for the estimation of the components of census coverage.

For the estimation of correct enumerations as a component of census coverage at the state level, an enumeration is correct if the person should have been counted in the state.

¹¹ The PES coverage universe includes HUs and people in HUs. It does not include GQs or remote Alaska enumeration areas.

Person Omissions

An overall estimate of the number of people omitted by the census will be obtained by subtracting the total estimated number of correct enumerations from the dual system estimate:

$$\text{Omissions} = \text{DSE} - \text{CE}$$



CMDE produces PES Estimation Reports from the Person Estimation work.

When the estimation and tabulation data for the PES Person Estimates are ready, the initial work on the PES estimation reports can begin.



CMM conducts PES Final Housing Unit (FHU) Computer Matching and Processing.

In the FHU Computer Matching and Processing, information from all previous stages of computer and clerical matching from both HU and person procedures, coupled with final census data, is used to update HU records. Using the person-matching results, the Computer Processing assigns geocoding error codes to P sample and E sample units where the people are coded as such and assigns Census Day HU status to unresolved HUs based upon specific PI results. These PI results include vacant HUs and records that were not HUs on Census Day.

During FHU Computer Matching, some addresses listed in the PES sample BCUs during IL are computer matched to the CUF addresses (of HUs and GQs) within the sample BCUs and one ring of surrounding BCUs. This matching activity may identify the following:

- Matches and possible matches between the IL addresses and census addresses.
- Potential PES IL duplicates within the sample BCU.
- Potential census duplicates.

In addition, FHU Computer Processing identifies units that will go to FHU BFU Clerical Matching. Computer Processing will assign a work flag to the following types of units:

- P sample links to Census Deletes.¹²
- Census Adds¹³ that are in the sample BCU (including subsampled out).
- Census Adds that are in the surrounding BCUs to the PES sample BCU.
- E sample units that were duplicates where the primary¹⁴ was deleted from the census address canvassing results file and is not on the CUF.
- E sample units that linked to a unit that is no longer in the P sample.
- Any P or E sample unit (not covered above) for which HU Computer or Clerical Matching has not yet been conducted.¹⁵

Lastly, Computer Processing identifies PES and census units, including census GQs, with links to census units not on the CUF, and then unlinks those units. Once the data files have been updated and the units flagged, the next process can begin—FHU BFU Clerical Matching.



CMM conducts PES Final Housing Unit Before Followup (FHU BFU) Clerical Matching.

During the FHU BFU Clerical Matching activity, the NPC matching staff use computer-assisted clerical matching techniques, along with PES and census maps, to match, possibly match, or assign “not matched” codes to addresses sent from the Final Housing Unit Computer Matching/Processing. Cases that remain unresolved following this activity are eligible for Final Housing Unit Followup. Some examples of unresolved cases include the following:

- Nonmatched PES or census addresses.
- Addresses identified as possibly matched or possibly duplicated.
- Matched addresses with unresolved housing unit status.

¹² A Census Delete is an HU on the preliminary census address list used for Initial HU Matching, but *not* on the CUF.

¹³ A Census Add is an HU *not* on the preliminary census address list, but is on the CUF.

¹⁴ If two or more records within the same system (PES or census) represent the same person or living quarters, one record is designated as the primary and given an appropriate nonduplicate match code; the other record(s) is (are) designated as the duplicate(s) and given an appropriate duplicate match code.

¹⁵ All P sample HUs should have been processed through Initial HU Computer or Clerical Matching by this point. They are included here to handle unexpected problems that might prevent a BCU from going through the Initial HU Matching system.

- Addresses that match to group quarters or that match to surrounding BCUs.

In the FHU BFU Clerical Matching activity, files containing the entire BCUs including the flagged HUs from Computer Processing and Matching are made available for matchers to view. Matching staff will attempt to match by address, HU description, or map spot location, all P sample units and census units that were flagged earlier. Clerical matchers will have access to data from all previous PES operations activities, including maps. Clerical matches will also have access to map-spotted maps from the census corresponding to the CUF data. Those units that remain unresolved will be flagged for FHUFU, unless previous attempts were made to follow up on the units during IHUFU. The FHU BFU Clerical Matching activity will have multiple sources of information including the following:

- The data prepared for FHU BFU Clerical Matching in FHU Computer Processing and Matching.
- Completed IHUFU forms.
- Completed PFU forms.
- PES Person AFU Clerical Matching results.
- Census maps with map spots for HUs and GQs of the same vintage as the CUF.
- PES maps with map spots and updates from IL and IHU Matching and Followup.

In addition to identifying matches between PES and census units, matching staff will attempt to identify duplicate units:

- Between PES P sample units within the PES sample BCUs.
- Between E sample units and other census units in the PES sample BCU and in its surrounding BCUs.

Clerical matchers will search all the census addresses added in the sample BCU and surrounding BCUs to identify duplicates to the E sample addresses.

Also, analysts are allowed to change match codes previously assigned if errors are uncovered, and they may attempt to resolve the case.

The FHU BFU activities will include BFU Technician, BFU Analyst, and quality control components, similar to IHU BFU.

In the Final Housing Unit Before Followup Analyst (FHU BFA) stage, analysts perform the QC of the technicians' work and review cases referred by the technician. The QC process for clerical

matching consists of analysts performing a full review of block clusters selected for the matching QC sample. For the FHU BFU Clerical Matching activity, approximately 33 percent of all block clusters going through the CMM operation will be checked. The target AOQL is 3.5 percent.

After training, technicians will start production work in a 100 percent QC status. If a technician is performing poorly, the technician may be required to undergo retraining. Technicians who perform poorly even after retraining will be removed from the CMM operation.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.



For cases identified from FHU BFU Clerical Matching that require follow-up, CMFO conducts the PES Final HU Followup (FHUFU) and QC field data collection activity.

During Final Housing Unit Followup, interviewers collect additional information for addresses that are unresolved during the FHU BFU Clerical Matching activity.

FHUFU attempts to collect information needed to resolve any residual differences between the Independent Listing results and the census. FHUFU data collection is conducted in a paper-based personal interview. The questions included for each followup case will vary depending upon the reason the case is being sent to follow-up. This field operation includes a quality control mechanism.

The FHUFU is a field operation performed by PES field representatives to resolve questions, discrepancies, and missing data from the FHU BFU activity. In making assignments, care is taken to observe the independence rules followed for all PES operations. Field representatives will use a preprinted paper form along with PES maps updated with the results from the PES IL and IHU operational activities with map spots and the census maps to locate flagged HUs.

The questions on the FHUFU forms will be tailored for each specific case given its situation. The following information will be collected:

- BCU number (for a unit that could be a duplicate in a surrounding BCU).
- Evidence to determine if there was an HU at the address on the date of the follow-up visit. If the case in question is not an HU, a statement should be provided as to the reason for this determination.
- Whether or not two or more units identified as possible matches are the same unit.

- Whether or not two or more units identified as possible duplicates are the same unit.
- HU status updates for certain situations.
- Response to case-specific questions provided by the clerical matchers.

The questions will be the same as those on the PES IHUFU form for similar types of follow-up situations, except for changes needed because of the different reference dates for the initial and final follow-up interviews.¹⁶

Interviewers will use the reference list¹⁷ provided during the FHUFU to determine if any units sent to follow-up match other units on the reference list. All of the information collected during follow-up will be used to assist in determining the status of followed-up HUs as of Census Day.

The FHUFU quality assurance plan has the following components:

- All listers undergo online and classroom training.
- Listers who struggled in training are observed by their field supervisor.
- Field supervisors review and edit completed forms for accuracy and completeness.
- A separate staff of listers, called QC listers, perform a check of data accuracy for randomly selected FHUFU forms in each BCU. Approximately 15 percent of all cases sent to FHUFU will be checked in the field, with a target AOQL of 4.0 percent.
- A field supervisor edits the QC forms for accuracy and completeness.
- Each BCU undergoes an office edit.

Note, the FHUFU quality assurance plan is identical to the IHUFU quality assurance plan.

Once FHUFU and QC is completed, CMFO conducts the closeout activities to needed conclude the field operations work.

¹⁶ If any serious problems are encountered with the IHUFU form, the FHUFU form may be changed.

¹⁷ The FHU reference list is intended to be a list of all PES and census HUs in the PES sample BCU and its surrounding BCUs.



CMM conducts PES Final Housing Unit After Followup (FHU AFU) Clerical Matching.

The NPC matching staff use the results of the Final Housing Unit Followup from the completed paper questionnaires to match remaining nonmatched addresses. This is the final operational step before Housing Unit Estimation.

Like the IHU AFU Clerical Matching, the FHU AFU Clerical Matching activities contain FHU AFU Technician, FHU AFU Analyst, and FHU AFU Outlier Review components.

The FHU AFU Clerical Matching activity will have multiple sources of information to help resolve HU status, match status, or enumeration status such as the following:

- Data used for PES FHU BFU Clerical Matching.
- Completed FHUFU and IHUFU forms.
- Completed PFU forms.
- PES FHU BFU Clerical Matching results.
- PES Person AFU Clerical Matching results.
- PES maps with any updates from FHUFU.

Using this wealth of data, matching staff will attempt to determine unit status, match status, or enumeration status and assign appropriate codes to each case sent to FHUFU. An output file with the results from the PES HU operational activities will be made available for the PES Estimation activities. HUs that remain unresolved will be handled using statistical techniques for missing data.

In the FHU AFU Analyst stage, analysts perform both production and QC; unlike the other clerical activities, there are no technicians. The QC process for clerical matching consists of analysts performing a full review of block clusters selected for the matching QC sample. For the FHU BFU Clerical Matching activity, approximately 33 percent of all block clusters going through the CMM operation will be checked. The target AOQL is 3.5 percent.

To help ensure the quality of the matching and ensure the newer analysts understand procedures, the experienced analysts will informally review the work of the newer analysts.



CMDE produces PES Housing Unit Estimates.

The Housing Unit Estimation process consists of several activities, which will ultimately lead to the production of estimates of housing unit coverage for the decennial census.

To produce PES Housing Unit Estimates, CMDE performs the following activities:

- Impute data for P sample housing units, which includes:
 - Imputing missing characteristics.
 - Imputing missing HU status.
 - Imputing missing match status.
- Impute missing data for E sample housing units, which includes:
 - Imputing missing characteristics.
 - Imputing missing enumeration status for net coverage.
 - Imputing missing enumeration status for components of coverage.
 - Calibrate housing unit weights.
- Estimate net coverage.
- Estimate components of coverage.
- Estimate uncertainty of estimates.

Missing Data for P Sample HUs

There are three missing-data activities for HUs in the P sample: imputing HU characteristics, imputing HU status, and imputing HU match status. Each of these will be discussed in more detail in the sections that follow.

Imputing Missing Characteristics for P Sample HUs

Production of PES HU coverage estimates requires data on occupancy status, tenure (owner versus renter), and race/ethnicity domain of the householder to classify HUs by these important characteristics. They will be imputed whenever the data were not collected. The census edit and imputation system will be used to impute the missing characteristics. In general, if the HU is occupied and interviewed in the PES PI, the values used for HU estimation will be the same as those used for person estimation. If the HU was not interviewed in the PES PI, PES will assume it is occupied.

Imputing Missing HU Status for P Sample HUs

The PES HU matching activities must determine if a P sample HU was an HU on Census Day. For some units, this cannot be determined, and the HU status will be unresolved. PES will assign a probability of being an HU status for all sample cases. Cases determined to be an HU will receive a probability of 1. Cases determined not to be HUs will receive a probability of 0. The cases with unresolved status will have a probability assigned to them.

The PES fits one or more logistic regression models to the resolved cases. Using these models and the characteristics of the unresolved cases, the PES can then impute a probability of being an HU for these unresolved cases.

Imputing Missing Match Status for P Sample HUs

The PES HU Matching activities must determine if the HU matched a census enumeration in the net error search area. This process is simpler for HUs than for people because mover status is not a consideration. PES will assign a probability of match for all sample cases. Matches will receive a probability of 1. Nonmatches will receive a probability of 0. The cases with unresolved match status will have a match probability assigned to them.

The PES will fit one or more logistic regression model to the resolved cases. Using these models and the characteristics of the unresolved cases, the PES then imputes a probability of match for the unresolved cases.

Missing Data for E Sample HUs

There are three missing-data procedures needed for HUs in the E sample: a procedure for dealing with missing HU characteristics, a procedure for imputing enumeration status (correct or erroneous) for DSE, and a procedure for estimating components of coverage. Each of these processes will be discussed in more detail in the following sections.

Missing Characteristics for E Sample HUs

Production of PES HU coverage estimates requires data on occupancy status, tenure (owner versus renter), and race/ethnicity domain of the householder to classify HUs by these important characteristics. So, they will be imputed whenever the data was not collected. For cases in the E sample with missing HU characteristics, the PES will not do any special imputation procedures. Instead, analogous to the procedure for missing data for E sample people, the PES will use the CEF and obtain the imputed characteristics from there.

Imputing Missing Enumeration Status for E Sample HUs (Net Error)

The probability of being a correct enumeration for net coverage will be determined using logistic regression. Cases with insufficient information for matching and follow-up will not be used in the modeling.

Imputing Missing Enumeration Status for E Sample HUs (Components)

When an HU's enumeration status is unresolved, it is unresolved for both net coverage and components of coverage. In this way, the HU estimation is unlike the person estimation, where person enumerations can be resolved for net error but unresolved for components of coverage. The imputation for components of coverage is conducted separately from the imputation for net error. There are five components of coverage:

- Correctly enumerated in the sample BCU.
- Correctly enumerated in the surrounding ring of BCUs.
- Correctly enumerated outside the ring of surrounding BCUs.
- Erroneously enumerated because of duplication.
- Erroneously enumerated because of reasons other than duplication.

To satisfy the assumptions of the DSE and to properly estimate net coverage, HUs correctly enumerated outside the surrounding ring of BCUs are classified as erroneous enumerations for net coverage, even though they are classified as correct enumerations for components of coverage.

Estimating Net Coverage

Demographic Analysis data is not created for housing units. Thus, the dual system estimate for HUs does not include the correlation bias adjustment. Furthermore, the data-defined concept does not apply to HUs, so the associated predicted probability of being data-defined is also excluded from the DSE formula. The DSE for HUs can be expressed as

$$DSE = \sum_{j \in C} \frac{\pi_{ce(j)}}{\pi_{m(j)}}$$

where j indexes housing units enumerated in the Census. The predicted correct enumeration and match probabilities (π_{ce} , π_m , respectively) will be obtained through logistic regression modeling.

The PES will then estimate net coverage by comparing the estimate of the true population (from the dual system estimator) to the census HU count.

Estimating Components of Census Coverage

The process for computing component estimates for HUs is very similar to the one used for people, including a ratio adjustment. The ratio adjustment cells can be based on region, occupancy status or other variables, and the cell totals are the corresponding census HU counts. Depending on sample sizes and the size of the adjustment factors, some collapsing of the original cells may be necessary.

For HUs, separate estimates of correct enumerations, erroneous enumerations, and omissions will be computed. The correct enumerations will be of two kinds: correctly enumerated in the BCU and correctly enumerated in the surrounding BCUs. The erroneous enumeration estimate will be broken down into the following three parts:

- Structures enumerated in the census as HUs that did not exist or were not HUs.
- HUs enumerated more than once (duplicates).
- Geocoding errors.

As with person omissions, the estimated number of HUs omitted from the census will be obtained by subtracting the estimate of correct enumerations from the DSE:

$$\text{Omissions} = \text{DSE} - \text{CE}$$

Uncertainty Estimation

For all estimates of correct and erroneous enumerations, the PES will publish standard errors based on successive difference replicates using 80 replicates assigned during the BCU sample selection.

For national-level estimates of net coverage, the PES will repeat all estimation activities using survey weights for each successive difference replicate. For example, the PES will fit a survey-weighted logistic regression model for the match rate within each replicate and use each of the 80 models to predict 80 match rates for each census record.

For biased synthetic estimates of net coverage, the PES will calculate mean squared errors. As was done for the 2010 CCM, the PES plans to use the smoothed group method to estimate the mean squared error of biased synthetic estimates. However, the PES does not plan to

disseminate substate estimates. Also, the current plan is to produce unbiased estimates of net coverage for states. Thus, there are no plans to disseminate any biased synthetic estimates.



CMDE produces PES Estimation Reports from the Housing Unit Estimation work and releases PES findings for dissemination.

When the estimation and tabulation data for the PES Housing Estimates are ready and approved for dissemination, the work on the PES estimation reports can be completed. Once the reports are approved, the PES findings can be released for dissemination.

3. CMDE Design Overview and Detailed Process Description [27]

3.1 CMDE Design Overview

The sections below present the high-level design for the Coverage Measurement Design and Estimation operation (CMDE).

3.1.1 High-Level Operational Design

The design of the CMDE operation for the 2020 Census includes two major operational activity areas shown below:

- **CMDE Survey Design and Sampling.**
- **CMDE Estimation and Reporting.**

Each of these major activity areas is summarized below. Together, these activity areas represent the complete set of work that needs to be performed to conduct this operation.

CMDE Survey Design and Sampling

Design

The 2020 (PES) sample design has been developed to support the various objectives of the program, which includes estimating correct enumerations, erroneous enumerations, and omissions in addition to net coverage for the 2020 Census. The PES is designed to measure the coverage of housing units (HUs) and people, excluding group quarters and people residing in group quarters. The PES will be conducted in the U.S. and in Puerto Rico in selected PES sampled areas. Group quarters (such as college dormitories and correctional facilities) are out of scope because populations can change significantly between census enumeration and PES enumeration operations. Remote areas of Alaska are also out of scope for PES because the seasonal nature of addresses and the population throughout the year make it infeasible to accurately conduct the matching and follow-up operations necessary for dual-system estimation. For this reason, the Census Bureau's past post-enumeration surveys have never included remote Alaska.

The high-level design of the PES will be similar to the design of the 2010 CCM. During the design phase, high-level decisions are made about the PES sample design, data collection methods, matching methods, and estimation methods.

Sampling

The PES sampling activities identify the areas and HUs to conduct PES survey operations. The PES sample design is a general-purpose sample to support the various objectives of the PES. The sample design for 2020 is similar to the 2010 CCM sample design, except there are no plans for the sample reduction of medium and large BCUs. Additional differences include changing the initial primary sampling units from block clusters to BCUs and lowering the thresholds for the large stratum.

The PES sample design comprises a number of distinct processes, from forming basic collection units (BCUs), creating the sampling frame, selecting sample BCUs, to eventually selecting addresses for the P sample and E sample. The primary sampling unit for the first stage sample is the BCU, the smallest collection geography for the census. After a sample of BCUs is selected, an address list is created independent of the census in each sample BCU. The approximate PES listing workload is 10,100 BCUs for the United States and 400 for Puerto Rico. Overall, approximately 565,000 HUs are listed (541,000 in the nation and 24,000 in Puerto Rico). Finally, after subsampling the PES HUs listed during Independent Listing, the final expected P sample size is approximately 171,500 HUs for the nation and 8,000 for Puerto Rico. The national sample is distributed among the 50 states and the District of Columbia roughly proportional to population size, although there are slight increases in the sample for small states and for American Indian Reservations.

Enumeration (E) and Population (P) Samples

The 2020 PES will use the dual-system estimation procedure, which depends on two independent systems of measurement. The PES will comprise two independent enumerations of housing units and the household population within the same sample areas. These two enumerations are called the enumeration sample (E sample) and the population sample (P sample). The E sample contains the list of housing units and people enumerated in the 2020 Census within the PES sample BCUs. The P sample contains housing units and people in the sample set of sample BCUs, but obtained independently from the census. The independent roster of housing units is obtained during the PES Independent Listing, while the independent roster of people is obtained during the PES Person Interview. The P sample housing units and people will be matched to all census housing units in the sample BCUs and surrounding BCUs.

CMDE Estimation and Reporting

The PES Estimation process consists of several operational activities, which will ultimately lead to the production of estimates of census coverage for both HUs and people in HUs. This includes estimates of net coverage and measures of the components of census coverage, including correct enumerations, erroneous enumerations, whole-person census imputations, and omissions. As part of this estimation, CMDE will implement procedures to account for missing data and reduce the sampling and nonsampling errors in the coverage estimates. The estimation programs are specified separately for people and HUs, although much of the work is similar between the person and HU estimation activities.

The full hierarchy of activities for the CMDE operation is provided in Appendix C in the form of an Activity Tree. In the Activity Tree, each major operational activity area listed above is numbered and then decomposed into a numbered set of subactivities, some of which are further decomposed into more detailed numbered subactivities or steps.

For a full description of the operational subactivities that comprise the CMDE operation, see the Detailed Process Description as outlined in Section 3.2 below.

3.1.2 Operational Context for CMDE Activities

The CMDE operational activities are conducted within the context of other 2020 Census operations and other programs or data sources that are external to the 2020 Census Program. Section 2 covers the overall operational context for the PES operations, i.e., the inputs, outputs, controls, and mechanisms that apply for the set of PES operations and elements external to PES. The specific inputs and outputs related to the CMDE operational interaction with the other two PES operations (CMM and CMFO) are given in the next two sections below.

The input and output tables within PES are based on several concepts. A source operation is the PES operation that provides the data exchange while the destination operation receives the data exchange. The Business Process Models (BPMs) that accompany this document use ID numbers (e.g., CMDE BPM 40) that are the references for where the data exchanges appear. The source activity and destination activity for the data exchange provide a quick context for the data. The name of an activity in the table references BPM annotation and also matches an operation's activity tree, which provides organization for this document's detailed process descriptions should a reader wish to consult more detail for descriptions of related pairs of BPMs for a data exchange.

3.1.2.1 CMDE Operational Inputs

Inputs are the data that are consumed by the operation. [Table 8](#) below lists the inputs to the CMDE operation from the other PES operations (i.e., CMFO and CMM).

Table 8: CMDE Operational Inputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Inputs from CMFO:		
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>Independent Listing (IL) HU Counts</i>	CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Person Data</i>	CMDE BPM 160	27-2.1 Produce PES Person Estimates
		Inputs from CMM:		
CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching	<i>Census HU Counts</i>	CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units
CMM BPM 60, CMM BPM 80	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching, 28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching	<i>Preliminary Enhanced List (PEL) Records</i>	CMDE BPM 90	27-1.4 Select PES PI Housing Unit (HU) Sample

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Person BFU Clerical Matching Data</i>	CMDE BPM 160	27-2.1 Produce PES Person Estimates
CMM BPM 150	28-2.5 Conduct PES Person After Followup (AFU) Clerical Matching	<i>Person AFU Clerical Matching Data</i>	CMDE BPM 160, CMDE BPM 210	27-2.1 Produce PES Person Estimates, 27-2.2 Produce PES Housing Unit (HU) Estimates
CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching	<i>FHU AFU Clerical Matching Data</i>	CMDE BPM 210	27-2.2 Produce PES Housing Unit (HU) Estimates

3.1.2.2 CMDE Operational Outputs

Outputs are the data produced by the operation. [Table 9](#) below lists the outputs from the CMDE operation to the other PES operations (i.e., CMFO and CMM).

Table 9: CMDE Operational Outputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Outputs to CMFO:		
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>PES BCU Sample File (Excel)</i>	CMFO BPM 15	29-1 CMFO Planning and Preparation
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>Listing Sample Control Input File (SCIF)</i>	CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>PSU File</i>	CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)
CMDE BPM 90	27-1.4 Select PES PI Housing Unit (HU) Sample	<i>Updated Preliminary Enhanced List (PEL)</i>	CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)
		Outputs to CMM:		
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>Sample Design File Vs. 1</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units	<i>Sample Design File Vs. 2</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMDE BPM 100	27-1.5 Select E Sample Housing Units	<i>Sample Design File Vs. 4</i>	CMM BPM 120	28-2.2 Conduct PES Person Computer Matching

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMDE BPM 100	27-1.5 Select E Sample Housing Units	<i>E Sample Control File</i>	CMM BPM 120, CMM BPM 130	28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching

3.2 CMDE Detailed Process Description

Figure 4 is a top-level Business Process Model (BPM) showing the Level 1 activity areas within the PES operations. BPMs for the 2020 Census follow industry-standard Business Process Model and Notation (BPMN). An explanation of how to read the BPMN notations and a full-sized copy of all of the BPMN diagrams for the CMDE operation are provided under separate cover.

This top-level BPM serves as the Context Model for the PES operations. A BPMN Context Model displays the high-level activities within the operation and relationships between them, whereas the IDEF0 Context Diagram shown earlier depicts the boundaries of the operation or activity and the interfaces between the operation or activity and other operations and activities with which it is associated.

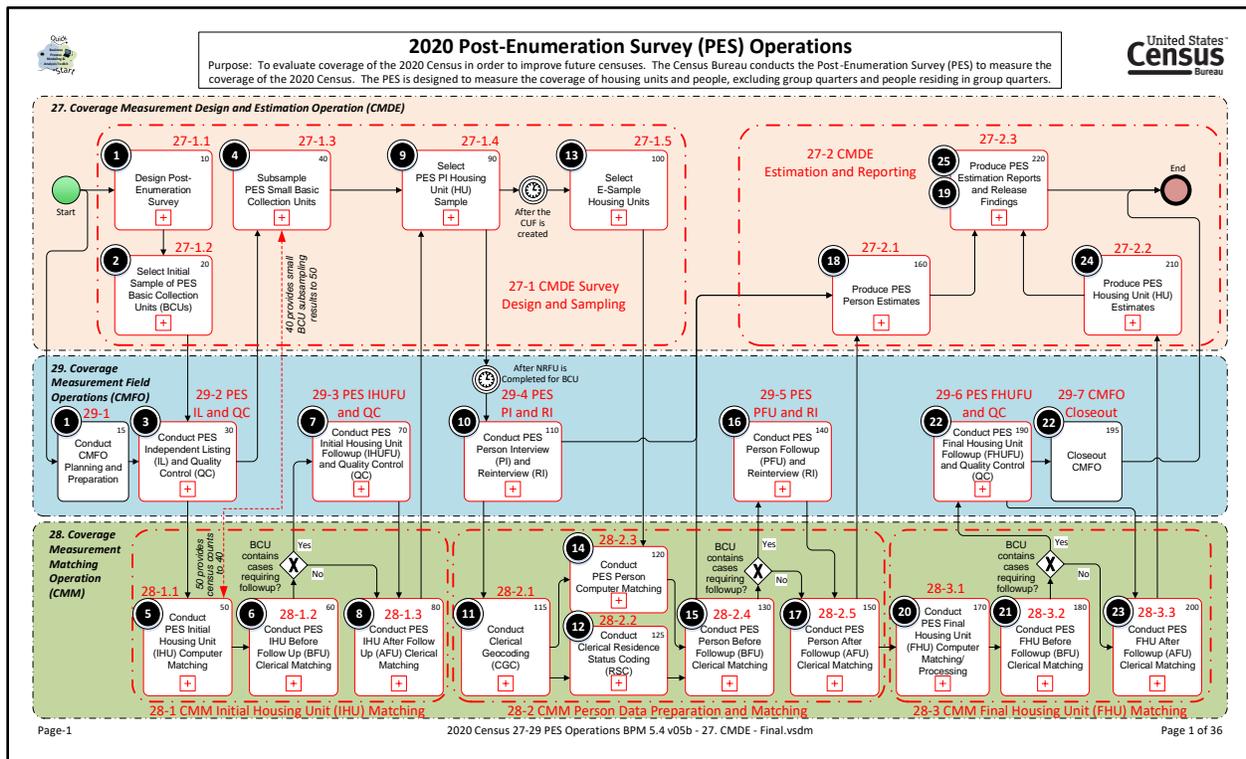


Figure 4: PES Operation Context Model Showing CMDE Operational Context

The CMDE operation is subdivided into the following activity areas:

- CMDE Survey Design and Sampling [CMDE 27-1].
- CMDE Estimation and Reporting [CMDE 27-2].

The business processes for each of these Level 1 activities are discussed along with their inputs and outputs in the following subsections.

3.2.1 CMDE Survey Design and Sampling [CMDE 27-1]

The first CMDE activity is CMDE Survey Design and Sampling.

Figure 5 shows the BPM for the CMDE Survey Design and Sampling [CMDE 27-1] activity (area within the gray rounded rectangle) and its constituent activities within the overall context of the PES operations.

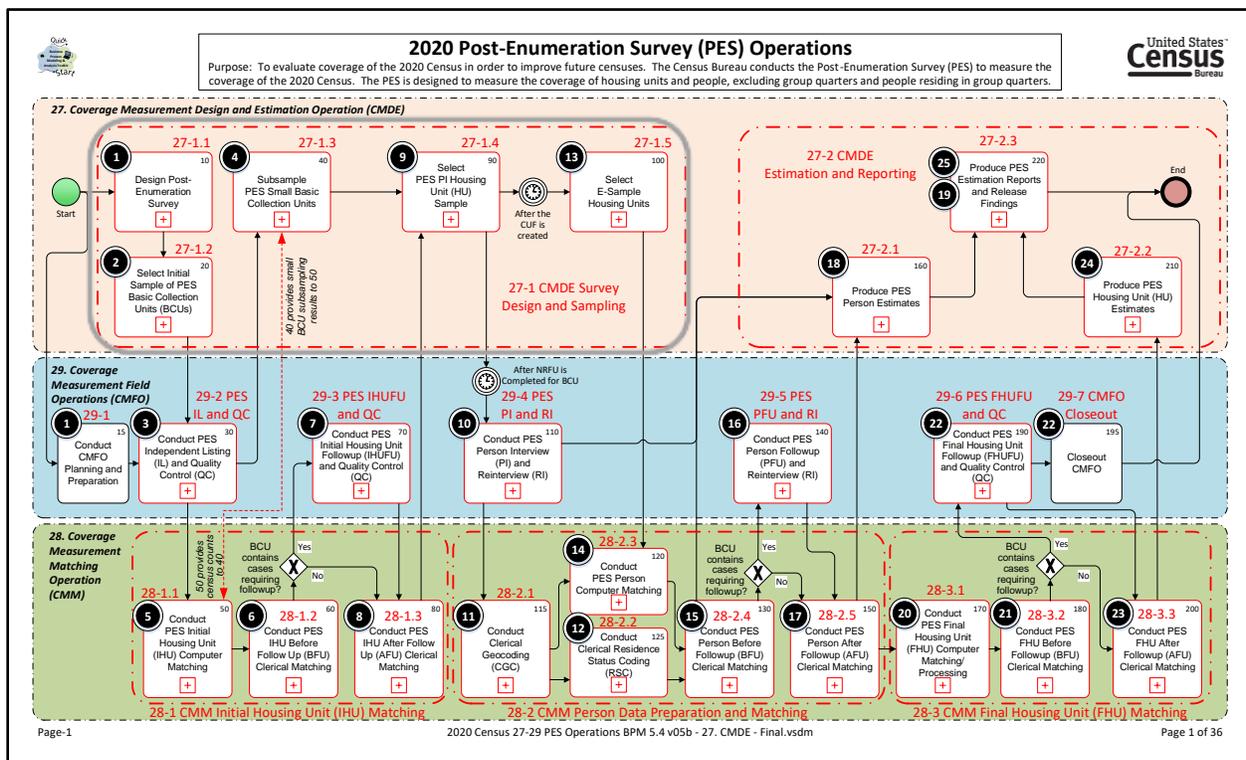


Figure 5: CMDE Survey Design and Sampling [CMDE 27-1] Activities

The “CMDE Survey Design and Sampling” operational activity is subdivided into the following activity areas:

- CMDE Survey Design and Sampling [CMDE 27-1].
 - Design Post-Enumeration Survey [CMDE 27-1.1].
 - Select Initial Sample of PES Basic Collection Units (BCUs) [CMDE 27-1.2].
 - Subsample PES Small Basic Collection Units [CMDE 27-1.3].

- Select PES PI Housing Unit (HU) Sample [CMDE 27-1.4].
- Select E Sample Housing Units [CMDE 27-1.5].

There are five components to the CMDE Survey Design and Sampling activities. First, key features of the PES are determined in the design phase. High-level requirements are written, business process models are created, and detailed operational plans are written to provide the framework for the PES operations. The remaining four components involve probability sampling and subsampling activities.

At the beginning of the first sampling activity, a frame of BCUs in the 50 states, DC, and Puerto Rico is created. A stratified systematic sample of BCUs is selected. All further PES activities are generally limited to these sample areas. For example, in the Independent Listing operation (a CMFO operation), HUs are listed from scratch in these sample BCUs. As the cost per HU is rather expensive in BCUs with few HUs, small BCUs are subsampled in the second sampling activity. In the third sampling activity, a sample of HUs is selected in BCUs with 58 or more housing units. This subsampling of HUs in large BCUs allows the PES to initially sample more BCUs across the nation rather than focusing on a large number of housing units in a small number of BCUs. So, the design of oversampling large BCUs then subsampling HUs within them yields a more heterogeneous sample than not oversampling and subsampling. This is expected to decrease the design effect and increase the precision of the estimates. Because households in the same neighborhood tend to be homogenous, it is statistically more efficient to conduct the PES in a lot of neighborhoods and then subsample HUs within the neighborhoods than it is to conduct the PES in a small number of neighborhoods but not subsample the HUs. In the final sampling activity, PES identifies HUs included in the final 2020 Census that are in PES sample areas but not included in the preliminary census results.

Subsequent sections describe the “CMDE Survey Design and Sampling” operational subactivities in detail.

3.2.1.1 Design Post-Enumeration Survey [CMDE 27-1.1]

The “Design Post-Enumeration Survey” operational subactivity consists of a single activity area shown in [Figure 6](#) below.

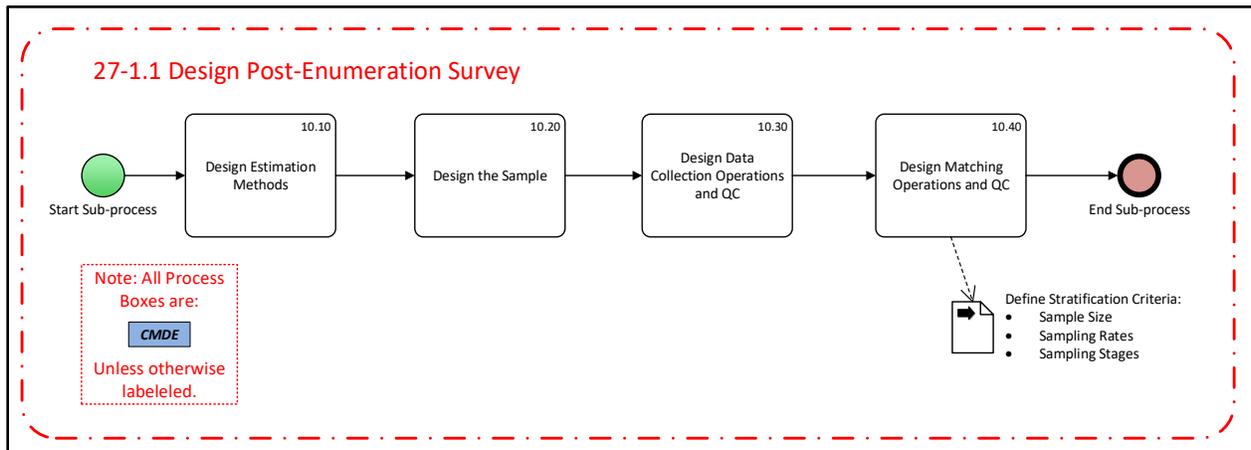


Figure 6: Design Post-Enumeration Survey

During the survey design phase, key features of the PES are determined, high-level requirements are written, business process models are created, and detailed operational plans are written to provide the framework for the PES operations. The general estimation methods, sample design, data collection framework, and matching methods are researched and determined during this activity.

3.2.1.2 Select Initial Sample of PES Basic Collection Units (BCUs) [CMDE 27-1.2]

A detailed view of the activities that make up this subactivity is given in [Figure 7](#) below.

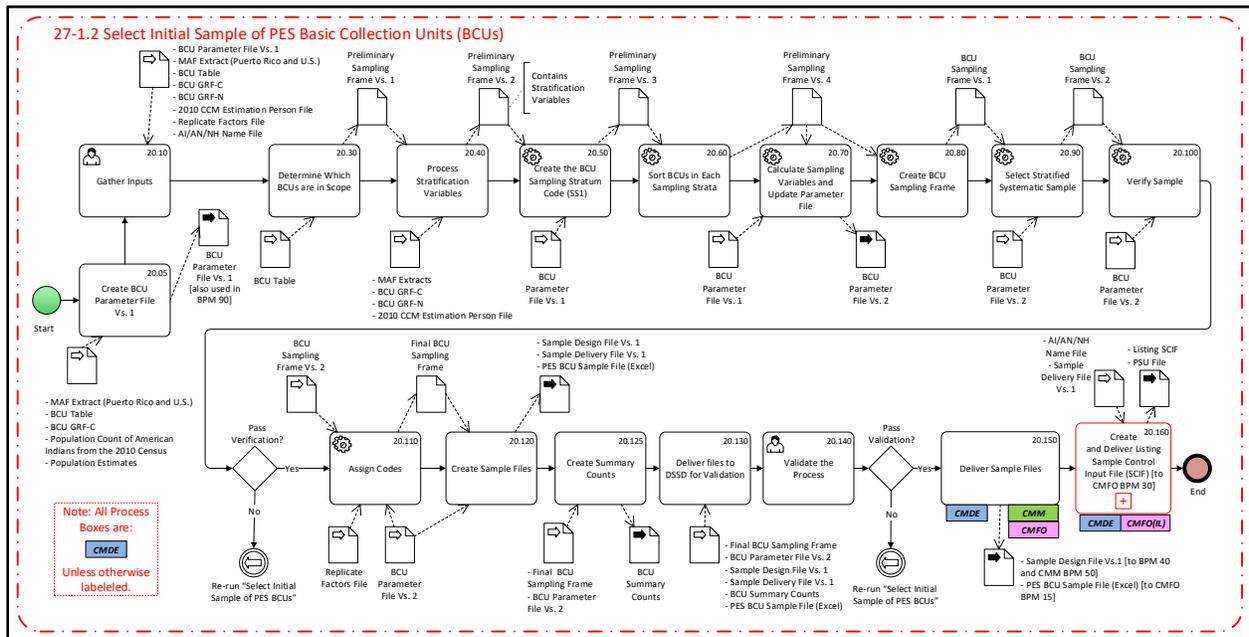


Figure 7: Select Initial Sample of PES Basic Collection Units (BCUs)

The initial sampling of BCUs is the first operational activity of the 2020 PES and the first phase of the 2020 PES sample design. This activity selects an initial sample of BCUs within each state, DC, and Puerto Rico. The sample BCUs are sent to field listing to create a list of addresses for the 2020 PES that is independent of the census preliminary address list.

BCUs in each state are classified into mutually exclusive and relatively homogeneous groups known as sampling strata. These strata are based on the BCU size and whether the BCU is located on an American Indian Reservation. The four major strata are as follows:

- BCUs with 0 to 2 HUs (small stratum).
- BCUs with 3 to 57 HUs (medium stratum).
- BCUs with 58 or more HUs (large stratum).
- BCUs on American Indian Reservations with three or more HUs (American Indian Reservation stratum).

Using 2010 Census data for the determination, the medium and large strata are further split into primarily renter or primarily owner BCUs, resulting in up to six sampling strata being formed in each state and Puerto Rico. The definition of the large and medium groups for the 2020 PES is different from that of the 2010 Census Coverage Measurement (CCM). For 2010 CCM, the medium group contained block clusters with 3 to 79 HUs and the large group

contained block clusters with 80 or more HUs. Since the size of the BCUs is smaller than the block clusters on average, this change preserves the same proportion of frame HUs in the medium and large strata between the two designs (2010 and 2020). This yields a similar HU Independent Listing (IL) workload.

After strata are formed within each state, the BCUs are sorted within each stratum by size indicator, minority status, and geography. A stratified systematic sample of BCUs is selected and sampling codes are assigned to sample records for use during data collection, data processing, subsampling, and estimation.

3.2.1.3 Subsample PES Small Basic Collection Units [CMDE 27-1.3]

A detailed view of the activities that make up this subactivity is given in Figure 8 below.

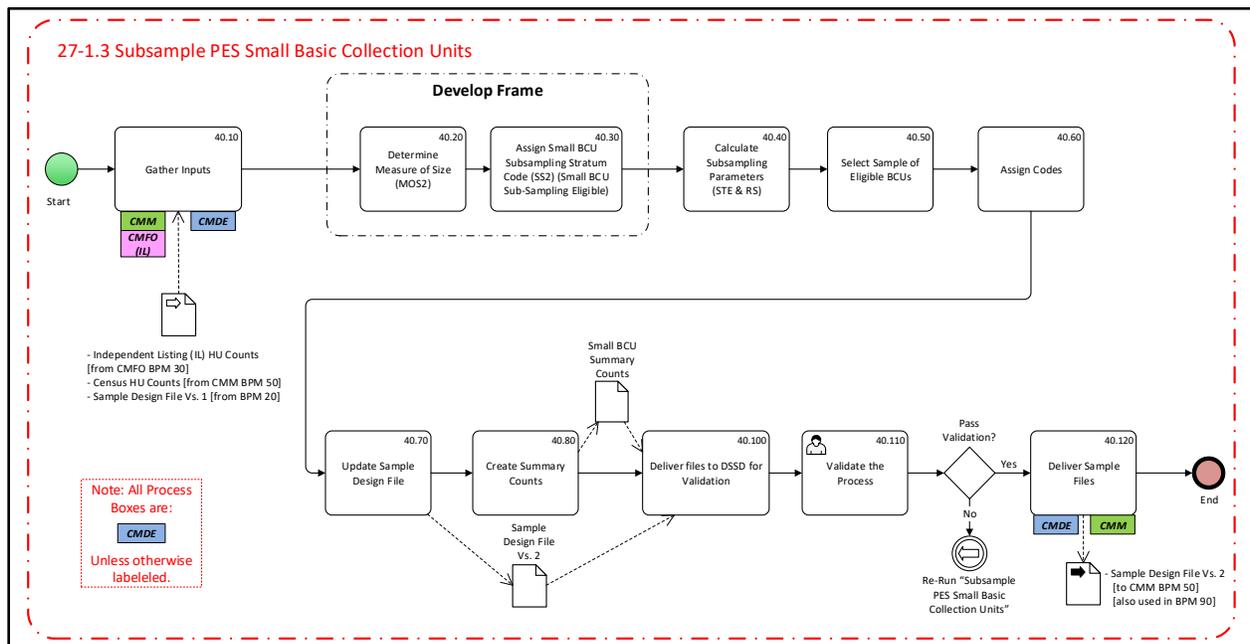


Figure 8: Subsample PES Small Basic Collection Units

The second phase of the 2020 PES selects a subsample of BCUs from the first-phase small sampling stratum using a similar method as in the 2010 CCM design. The PES will use a double-sampling technique by selecting a slightly larger sample of small BCUs in the first phase then selecting a subsample of small BCUs using an updated measure of size. This is done to reduce a BCU’s influence on the estimates when more HUs are found than expected. Additionally, small BCU subsampling reduces costs, since conducting interview and follow-up field operations in small BCUs is more expensive per HU than in medium or large BCUs.

Using HU counts from both the Independent Listing and the preliminary census address list, the small BCUs selected in the first phase are restratified by these counts within each state. A systematic sample of BCUs is selected within each stratum with equal probability. All BCUs from the small sampling stratum with ten or more HUs based on the updated counts are retained in sample. All BCUs from the small sampling stratum that are on American Indian Country are also retained in sample. (American Indian Country includes American Indian Reservations and associated trust lands, as well as the American Indian statistical areas.) The small BCU subsampling activity starts after the IL field operation ends and before the IHU Computer Matching activity finishes.

All sample BCUs that finish IL are processed in this subsampling activity; however, only small BCUs are sampled with probabilities of selection less than 1. All remaining BCUs are retained in sample with certainty (i.e., with probability of selection equal to 1).

3.2.1.4 Select PES PI Housing Unit (HU) Sample [CMDE 27-1.4]

A detailed view of the activities that make up this subactivity is given in [Figure 9](#) below.

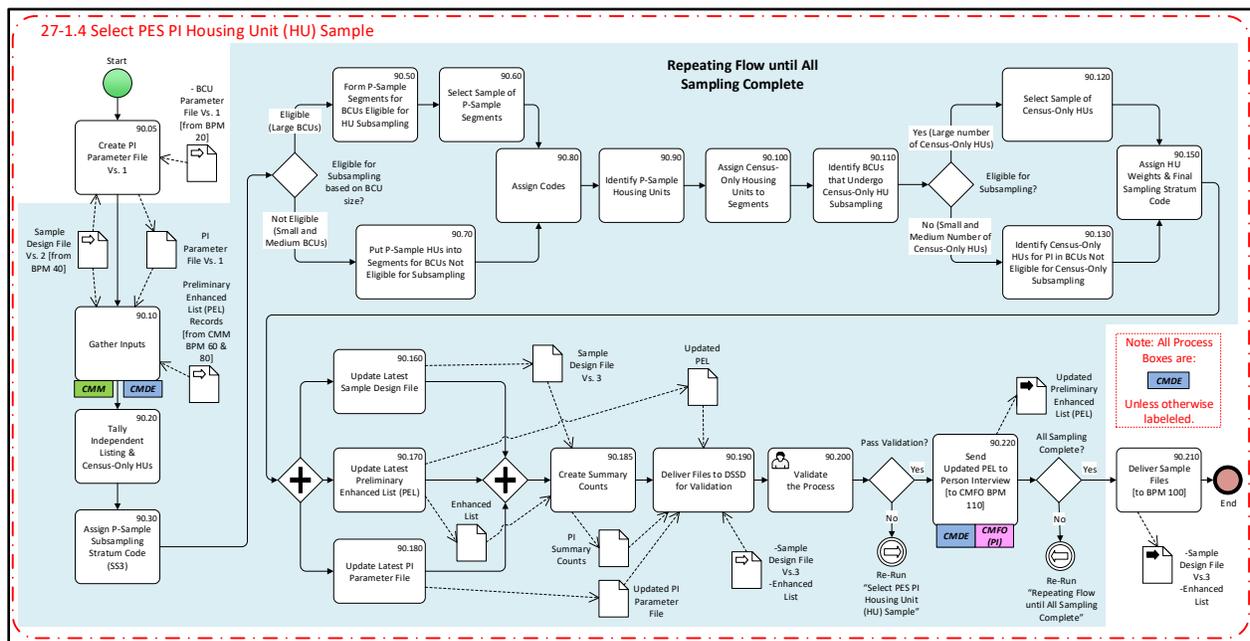


Figure 9: Select PES PI Housing Unit (HU) Sample

The PI housing unit sampling activity occurs before the PES PI and Reinterview field operation work. The PI workload includes P sample and census-only HUs in the final sample of BCUs from

the second sampling phase. The selection of the PI sample is the third phase of the PES sample design.

The first and second phases of the 2020 PES select the BCU sample. In the third phase of PES sampling, a subsample of HUs within large BCUs is selected. For a BCU with 57 or fewer HUs observed, all the HUs are included in the sample. For a BCU with 58 or more HUs observed in IL or the preliminary census list, a subsample of segments of contiguous HUs is selected to facilitate data collection in the field and to reduce sampling error. This phase of sampling results in more similar overall selection probabilities for HUs because the large BCUs will have a higher probability of selection during the first phase.

The Preliminary Enhanced List (PEL) of addresses is used to determine which sample BCUs are large and eligible for HU subsampling. The PEL provides the frame from which this sample is selected. There are multiple nonoverlapping PELs created, one for each of the seven sampling waves. The subsampling of HUs occurs in waves so that the PI does not have to wait to begin until all the IHU matching activities end.

Once a PEL is received, segments of HUs are formed by grouping geographically adjacent HUs within each large BCU. Then a subsample of segments is selected.

PI HU sampling includes the following activities:

- Selecting segments of IL HUs in BCUs with 58 or more HUs listed.
- Selecting a subsample of census-only HUs when there are 58 or more census-only HUs in sampled P sample segment(s).

No HU subsampling occurs in BCUs:

- That are categorized as American Indian Reservation (AIR) in the first sampling phase regardless of the number of HUs listed.
- That are categorized as small in the first sampling phase and in American Indian Country (AIC). (On AIC includes both on AIR and in Indian Country but off AIR.)
- That have fewer than 58 IL HUs and fewer than 58 census-only HUs.

3.2.1.5 Select E Sample Housing Units [CMDE 27-1.5]

A detailed view of the activities that make up this subactivity is given in [Figure 10](#) below.

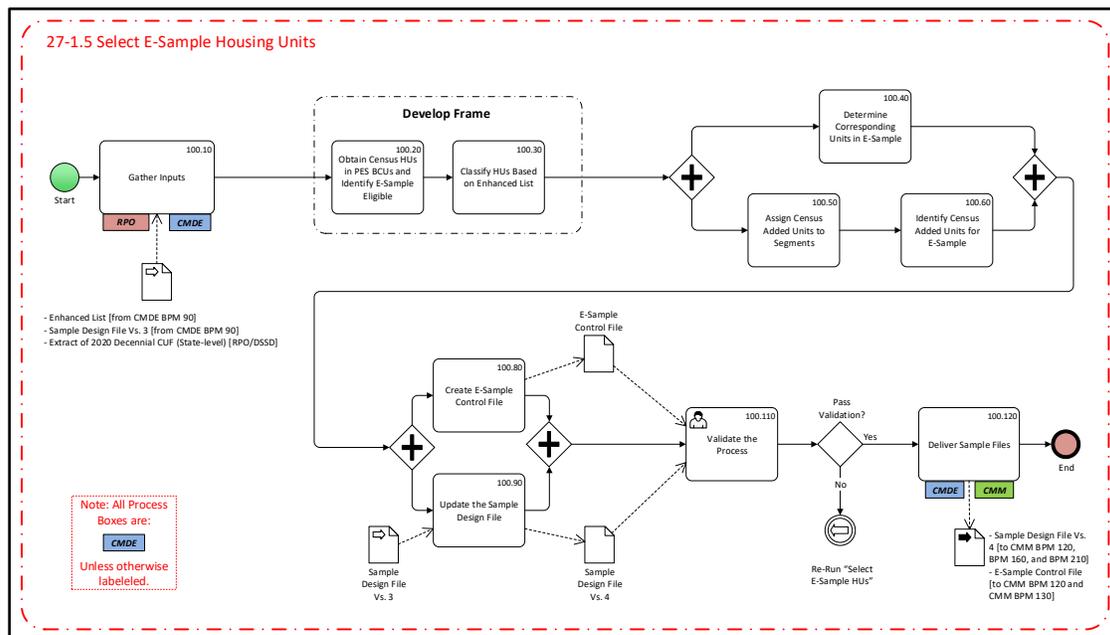


Figure 10: Select E Sample Housing Units

The E sample HU identification activity in CMDE occurs before the person computer matching activity in CMM. The identification of the E sample housing units is part of the third sampling phase of the PES sample design.

This process identifies changes (primarily adds and deletes) to the census housing units in sample BCUs between the preliminary census HU universe created after address canvassing and the final census HU universe. The E sample is the set of person enumerations and housing unit enumerations in the census within PES sample BCUs. The E sample is necessary to estimate the correct and erroneous enumerations in the census. Census adds are housing units that were added to the final census universe but were not included as valid housing units in the preliminary census universe. Census adds are identified so they can be given a chance to match to P sample housing units and other census HUs. In the E sample identification, census HUs that fall in PI sample segments are identified in a way to assure that the E sample and P sample HUs are in common areas. This reduces the number of E sample cases requiring follow-up, which is cost-effective.

The identification of E sample housing units is done by mapping the final set of census housing units from the Census Unedited File (CUF) onto the PES sample BCU segments from the P sample. Housing units that are eligible for the E sample include those records on the CUF geocoded to BCUs in sample that fit into one of the following categories:

- Match to IL HUs during the initial housing unit matching and follow-up activities.
- Exist but do not match to IL HUs during the initial HU matching and follow-up activities (these are census-only HUs).
- Are added after the initial HU matching and follow-up activities through various census address list updating procedures or moved from nonsample BCUs to sample BCUs (these are added census HUs).

Census HUs in the first two bullets are referred to as corresponding HUs while the last bullet refers to the added HUs.

3.2.2 CMDE Estimation and Reporting [CMDE 27-2]

The second CMDE activity is CMDE Estimation and Reporting.

Figure 11 shows the BPM for the CMDE Estimation and Reporting [CMM 27-2] activity (area within the gray rounded rectangle) and its constituent activities within the overall context of the PES operations.

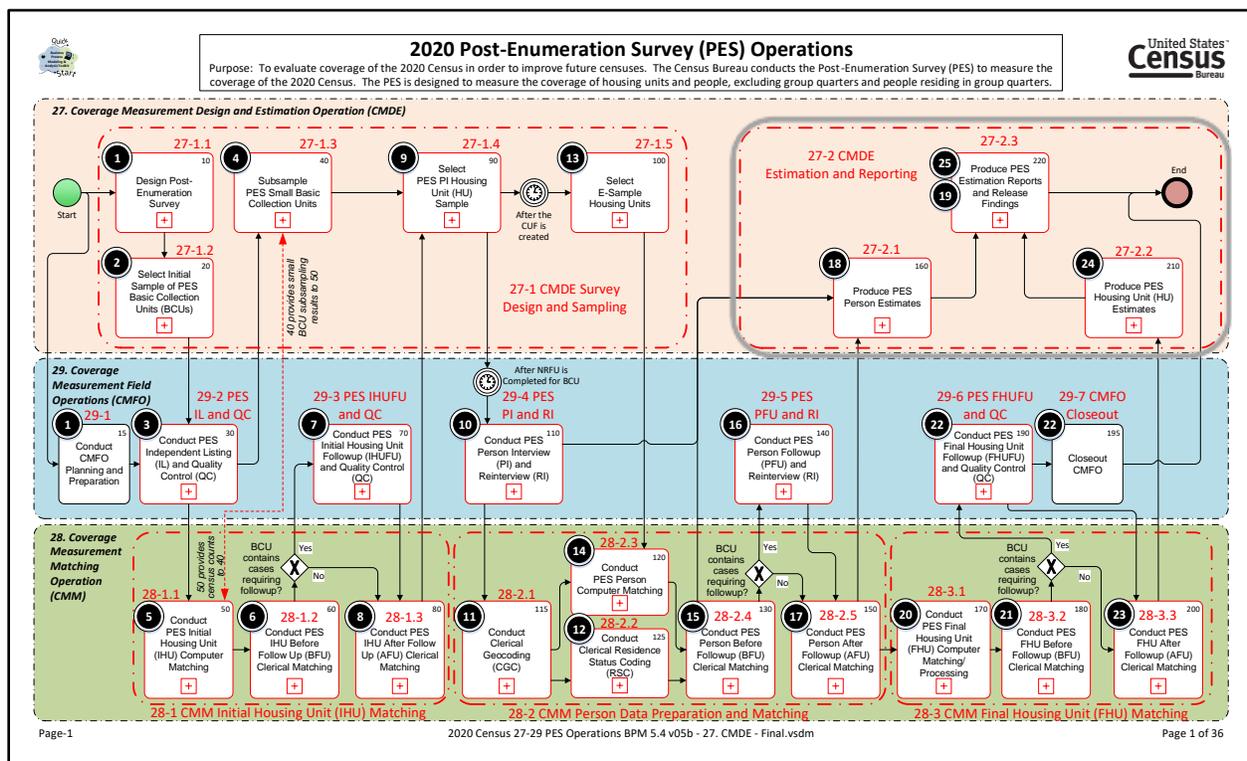


Figure 11: CMDE Estimation and Reporting [CMDE 27-2] Activities

The “CMDE Estimation and Reporting” operational activity is subdivided into the following activity areas:

- CMDE Estimation and Reporting [CMDE 27-2].
 - Produce PES Person Estimates [CMDE 27-2.1].
 - Produce PES Housing Unit (HU) Estimates [CMDE 27-2.2].
 - Produce PES Estimation Reports and Release Findings [CMDE 27-2.3].

The PES Estimation process consists of several operational activities, which will ultimately lead to the production of estimates of census coverage rates for both HUs and people in HUs. This includes estimates of net coverage and measures of the components of census coverage (correct enumerations, erroneous enumerations, whole-person census imputations, and omissions). As part of this estimation, CMDE will implement procedures to account for missing data and reduce the sampling and nonsampling errors in the coverage estimates. Person and housing unit estimates are produced in separate subactivities. The final reports and tables will be released on the 2020 Census website. Estimates will be disseminated at the national or state levels.

Subsequent sections describe the “CMDE Estimation and Reporting” operational subactivities in detail.

3.2.2.1 Produce PES Person Estimates [CMDE 27-2.1]

The “Produce PES Person Estimates” operational subactivity is subdivided into the following activity areas:

- Produce PES Person Estimates [CMDE 27-2.1].
 - Process Inputs for PES Person Estimates [CMDE 27-2.1.1].
 - Perform Imputation and Weighting for PES Person Estimates [CMDE 27-2.1.2].
 - Perform Estimation and Tabulation for PES Person Estimates [CMDE 27-2.1.3].

A detailed view of the activities that make up the “Produce PES Person Estimates” operational subactivity is given in [Figure 12](#) below.

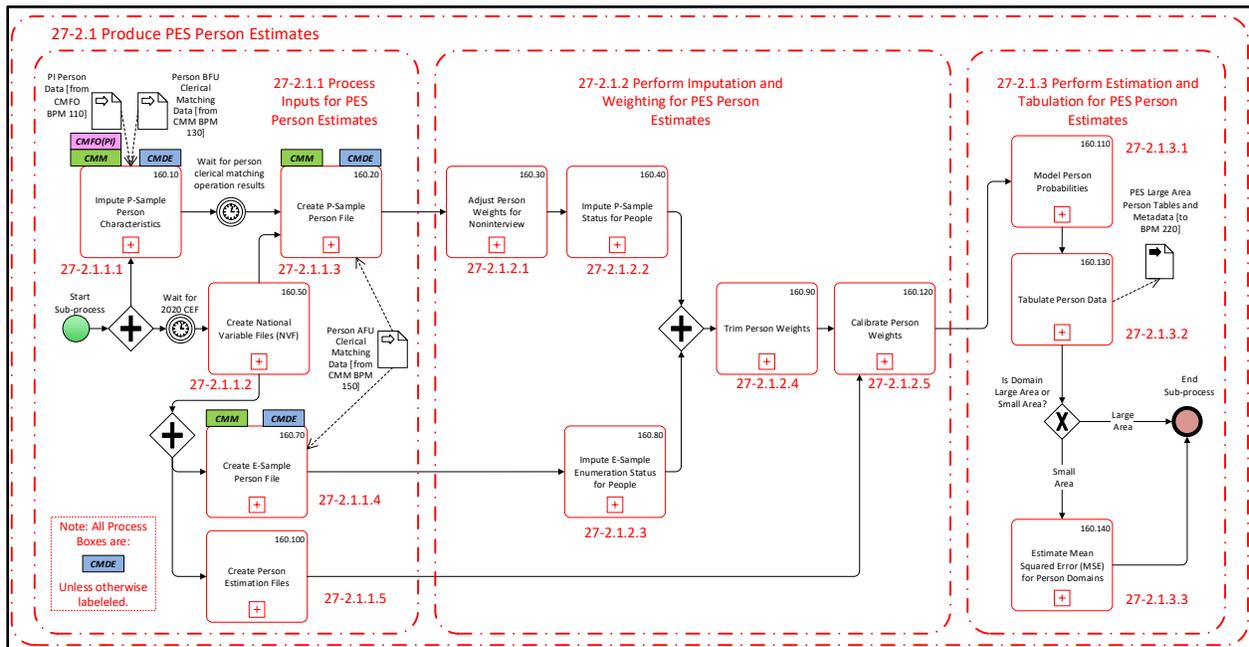


Figure 12: Produce PES Person Estimates

This subactivity will produce estimates of coverage for the household population *i* in the 50 states, DC, and Puerto Rico. This CMDE activity will combine the results from person matching activities with other files, impute characteristics and status variables, perform weighting adjustments, and produce estimates of net coverage and components of coverage for people living in housing units in the 50 states, DC, and Puerto Rico.

First, results from the Person Interview field operation and results from the person matching activities are combined with the final list of enumerated people and housing units from the 2020 Census to create files for use in the estimation process. Next, imputation and weighting adjustments are used to account for missing data, outliers, and correlation bias. Statistical modeling is used to generate estimates of net coverage. Finally, estimates of net coverage and components of coverage are tabulated and estimates of uncertainty are calculated for various subpopulations (domains).

Process Inputs for PES Person Estimates [CMDE 27-2.1.1]

The “Process Inputs for PES Person Estimates” operational subactivity is subdivided into the following activity areas:

- Process Inputs for PES Person Estimates [CMDE 27-2.1.1].
 - Impute P Sample Person Characteristics [CMDE 27-2.1.1.1].
 - Create National Variable Files (NVF) [CMDE 27-2.1.1.2].
 - Create P Sample Person File [CMDE 27-2.1.1.3].
 - Create E Sample Person File [CMDE 27-2.1.1.4].
 - Create Person Estimation Files [CMDE 27-2.1.1.5].

A detailed view of the activities that make up the “Process Inputs for PES Person Estimates” operational subactivity is given in [Figure 13](#) below.

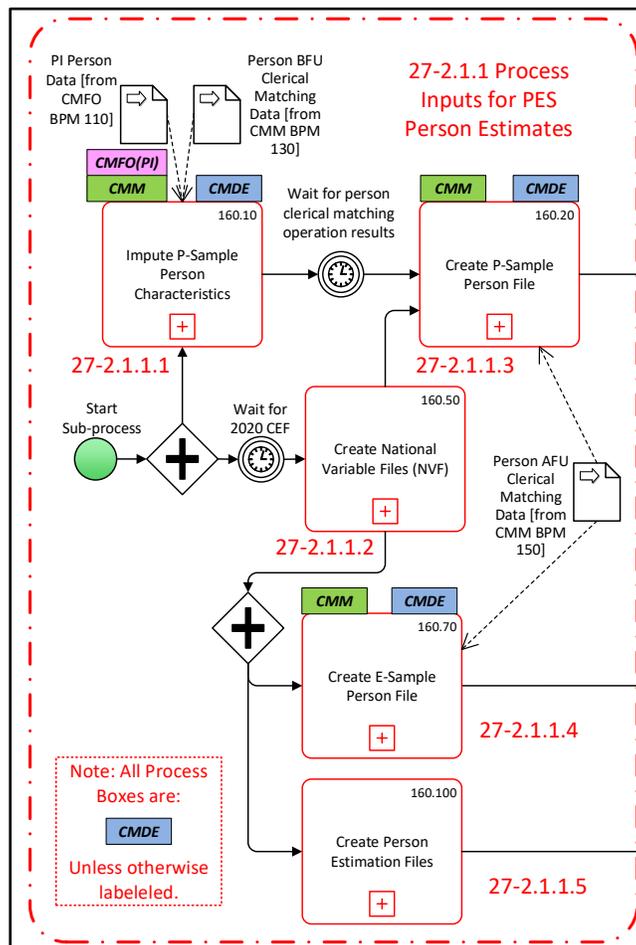


Figure 13: Process Inputs for PES Person Estimates

Multiple input files are gathered and processed to generate three sets of files necessary for the calculation of person coverage estimates including the following:

- P Sample Person File.
- E Sample Person File.
- Person Estimation Files.

First, missing characteristics for people and housing units will be imputed using the same process specified for the 2020 Census Edit and Characteristic Imputation system. Write-in responses for race and Hispanic Origin will be assigned numerical codes in a process referred to as autocoding.

Meanwhile, the National Variable Files are created. They contain variables from 2020 Census operations that are aggregated at various levels of geography for use as covariates in statistical models.

Then, person records from the person AFU Clerical Matching activity are merged with the National Variable Files to create the P and E sample person files. Each file contains person records in PES sample BCUs, covering the 50 states, DC, and Puerto Rico.

Variables from the Census Edited File, Census Unedited File, and the National Variable Files are used to create the Person Estimation File. The Person Estimation File contains every census person enumeration that is in scope for PES (people living in group quarters and remote Alaska are excluded).

Perform Imputation and Weighting for PES Person Estimates [CMDE 27-2.1.2]

The “Perform Imputation and Weighting for PES Person Estimates” operational subactivity is subdivided into the following activity areas:

- Perform Imputation and Weighting for PES Person Estimates [CMDE 27-2.1.2].
 - Adjust Person Weights for Noninterview [CMDE 27-2.1.2.1].
 - Impute P Sample Status for People [CMDE 27-2.1.2.2].
 - Impute E Sample Enumeration Status for People [CMDE 27-2.1.2.3].
 - Trim Person Weights [CMDE 27-2.1.2.4].
 - Calibrate Person Weights [CMDE 27-2.1.2.5].

A detailed view of the activities that make up the “Perform Imputation and Weighting for PES Person Estimates” operational subactivity is given in [Figure 14](#) below.

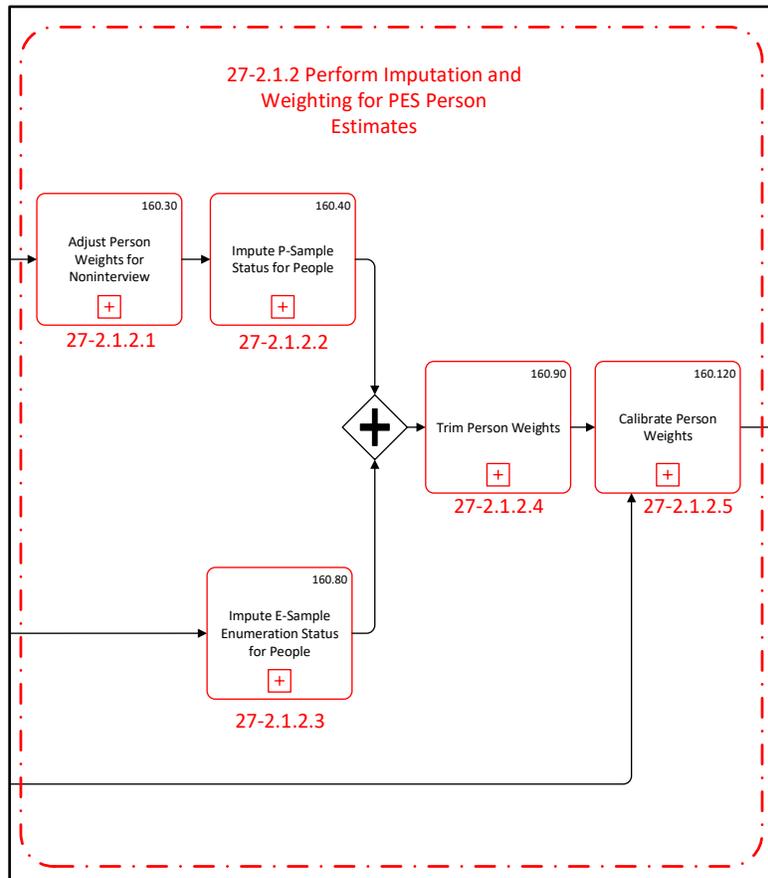


Figure 14: Perform Imputation and Weighting for PES Person Estimates

Imputation and weighting adjustments are applied to the P and E Sample Person Files before final estimates of coverage can be calculated.

For the P sample, person weights are adjusted to account for HUs that were sampled but were not interviewed. Then, match status variables that remain unresolved after follow-up and clerical matching activities are imputed with a probability for P sample person records.

For the E sample, unresolved enumeration status variables are imputed. After follow-up and clerical matching activities, some enumerations lack information to definitively assign an enumeration status. For these cases, a correct and erroneous enumeration probability is imputed.

Then, once the P and E sample imputation activities end, person weights are trimmed on both files for BCUs that potentially have an undue influence on the net coverage estimates. Lastly, person weights are calibrated so that weighted estimates of correct and erroneous enumerations will sum to the total number of census enumerations (excluding whole person imputations) on the Person Estimation File for selected estimation domains.

Perform Estimation and Tabulation for PES Person Estimates [CMDE 27-2.1.3]

The “Perform Estimation and Tabulation for PES Person Estimates” operational subactivity is subdivided into the following activity areas:

- Perform Estimation and Tabulation for PES Person Estimates [CMDE 27-2.1.3].
 - Model Person Probabilities [CMDE 27-2.1.3.1].
 - Tabulate Person Data [CMDE 27-2.1.3.2].
 - Estimate Mean Squared Error (MSE) for Person Domains [CMDE 27-2.1.3.3].

A detailed view of the activities that make up the “Perform Estimation and Tabulation for PES Person Estimates” operational subactivity is given in [Figure 15](#) below.

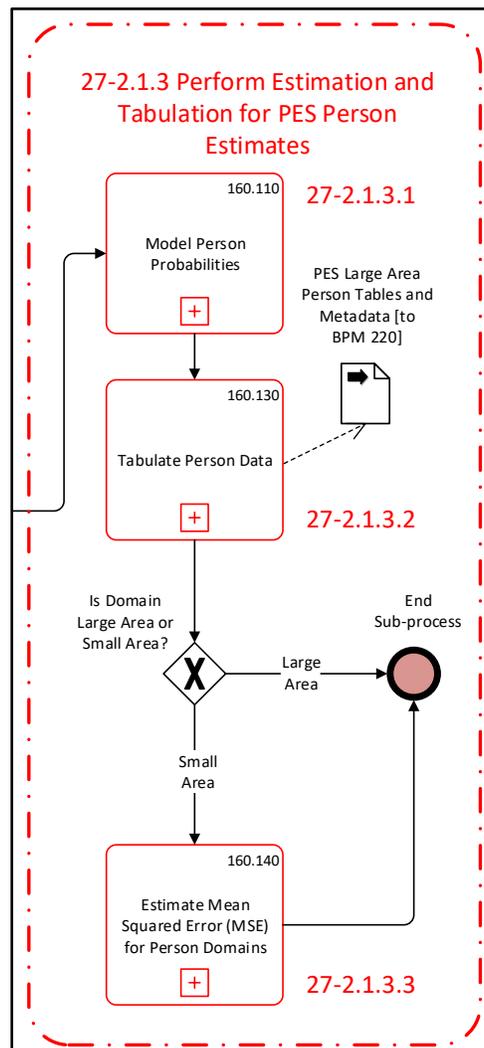


Figure 15: Perform Estimation and Tabulation for PES Person Estimates

After imputation and weight adjustments are applied, estimates of net coverage and components of coverage are produced.

In the first activity, statistical models will be used to predict three probabilities for each person on the Estimation File. The first is the probability of a match between the PES and the 2020 Census; it is modeled using the P sample Person File. The second is the probability that the enumeration is correct; it is modeled using the E sample Person File. The third is the probability that the enumeration is data-defined; it is modeled using the Person Estimation File. The probabilities are used to calculate a coverage correction factor (CCF) for each person record on the Person Estimation File.

In the second activity, the CCFs are then tabulated to produce dual-system estimates (DSEs) for various demographic, geographic, and operational domains. The census counts are compared to the DSEs to produce estimates of net coverage. Rates of correct and erroneous enumerations (and their corresponding standard errors) are calculated using the E sample Person File. Estimates of omission rates are derived from the DSEs and whole person imputation rates are calculated from on the Person Estimation File.

3.2.2.2 Produce PES Housing Unit (HU) Estimates [CMDE 27-2.2]

The “Produce PES Housing Unit (HU) Estimates” operational subactivity is subdivided into the following activity areas:

- Produce PES Housing Unit (HU) Estimates [CMDE 27-2.2].
 - Process Inputs for PES Housing Unit Estimates [CMDE 27-2.2.1].
 - Perform Imputation and Weighting for PES Housing Unit Estimates [CMDE 27-2.2.2].
 - Perform Estimation and Tabulation for PES Housing Unit Estimates [CMDE 27-2.2.3].

A detailed view of the activities that make up the “Produce PES Housing Unit (HU) Estimates” operational subactivity is given in [Figure 16](#) below.

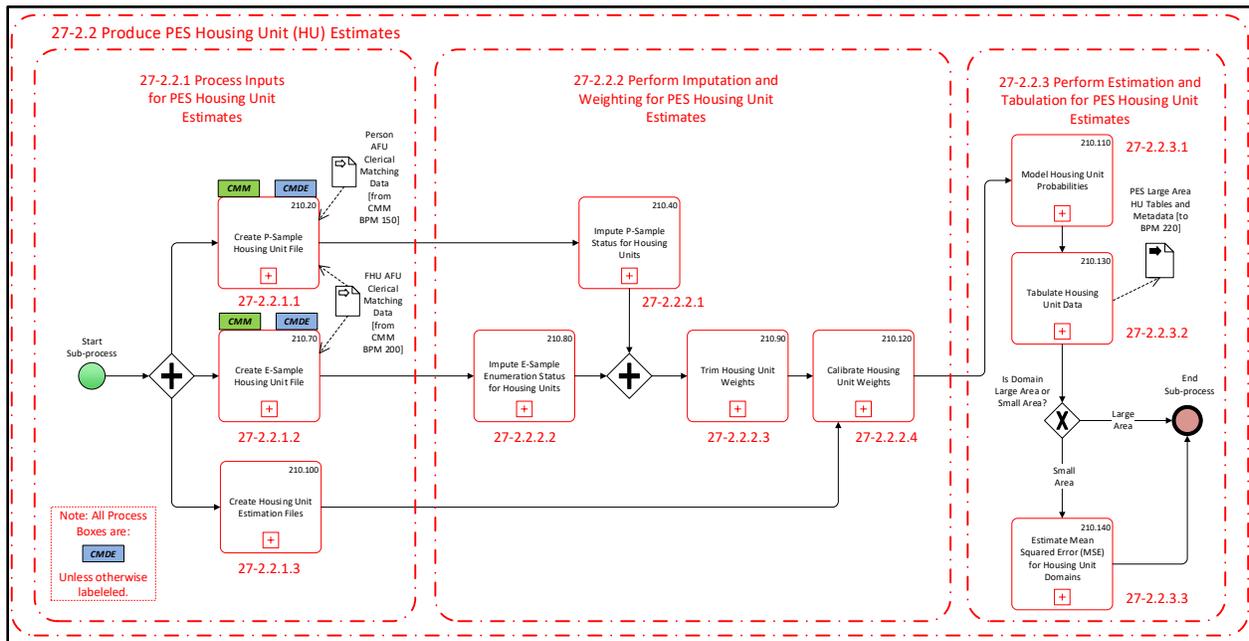


Figure 16: Produce PES Housing Unit (HU) Estimates

This subactivity will produce estimates of coverage for the HUs in the 50 states, DC, and Puerto Rico. The high-level process is similar to the process for producing person estimates. Inputs from PES field and matching activities and the 2020 Census operations are combined to create HU files that are used in the estimation process. Imputation and weighting adjustments are used to account for missing data, outliers, and other data issues. Estimates of net coverage are produced using statistical models. Finally, estimates of net coverage and components of coverage are tabulated, and estimates of uncertainty are calculated for housing unit domains.

Process Inputs for PES Housing Unit Estimates [CMDE 27-2.2.1]

The “Process Inputs for PES Housing Unit Estimates” operational subactivity is subdivided into the following activity areas:

- Process Inputs for PES Housing Unit Estimates [CMDE 27-2.2.1].
 - Create P Sample Housing Unit File [CMDE 27-2.2.1.1].
 - Create E Sample Housing Unit File [CMDE 27-2.2.1.2].
 - Create Housing Unit Estimation Files [CMDE 27-2.2.1.3].

A detailed view of the activities that make up the “Process Inputs for PES Housing Unit Estimates” operational subactivity is given in [Figure 17](#) below.

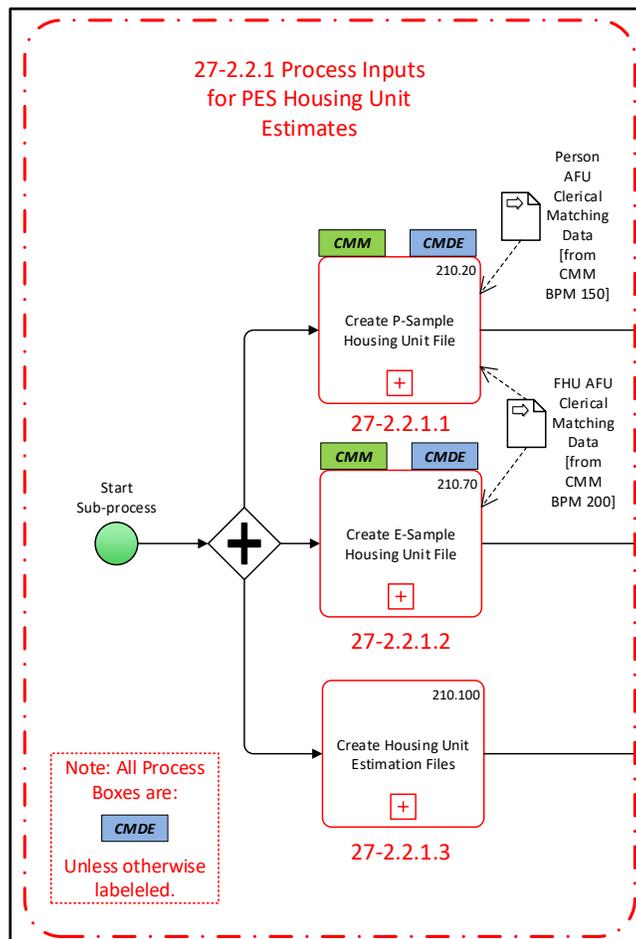


Figure 17: Process Inputs for PES Housing Unit Estimates

Various input files are gathered and processed to generate HU sample and estimation files.

Housing unit records from the Final HU AFU Clerical Matching activities are merged with the National Variable Files to create the P and E sample HU Files. As with the person sample files, each housing unit sample file contains HU records in PES sample BCUs, covering the 50 states, DC, and Puerto Rico.

The Census Edited File, Census Unedited File, and the National Variable Files are used to create the HU Estimation File. The HU Estimation File contains every HU that is in scope for PES (HUs in remote Alaska are excluded).

Perform Imputation and Weighting for PES Housing Unit Estimates [CMDE 27-2.2.2]

The “Perform Imputation and Weighting for PES Housing Unit Estimates” operational subactivity is subdivided into the following activity areas:

- Perform Imputation and Weighting for PES Housing Unit Estimates [CMDE 27-2.2.2].
 - Impute P Sample Status for Housing Units [CMDE 27-2.2.2.1].
 - Impute E Sample Enumeration Status for Housing Units [CMDE 27-2.2.2.2].
 - Trim Housing Unit Weights [CMDE 27-2.2.2.3].
 - Calibrate Housing Unit Weights [CMDE 27-2.2.2.4].

A detailed view of the activities that make up the “Perform Imputation and Weighting for PES Housing Unit Estimates” operational subactivity is given in [Figure 18](#) below.

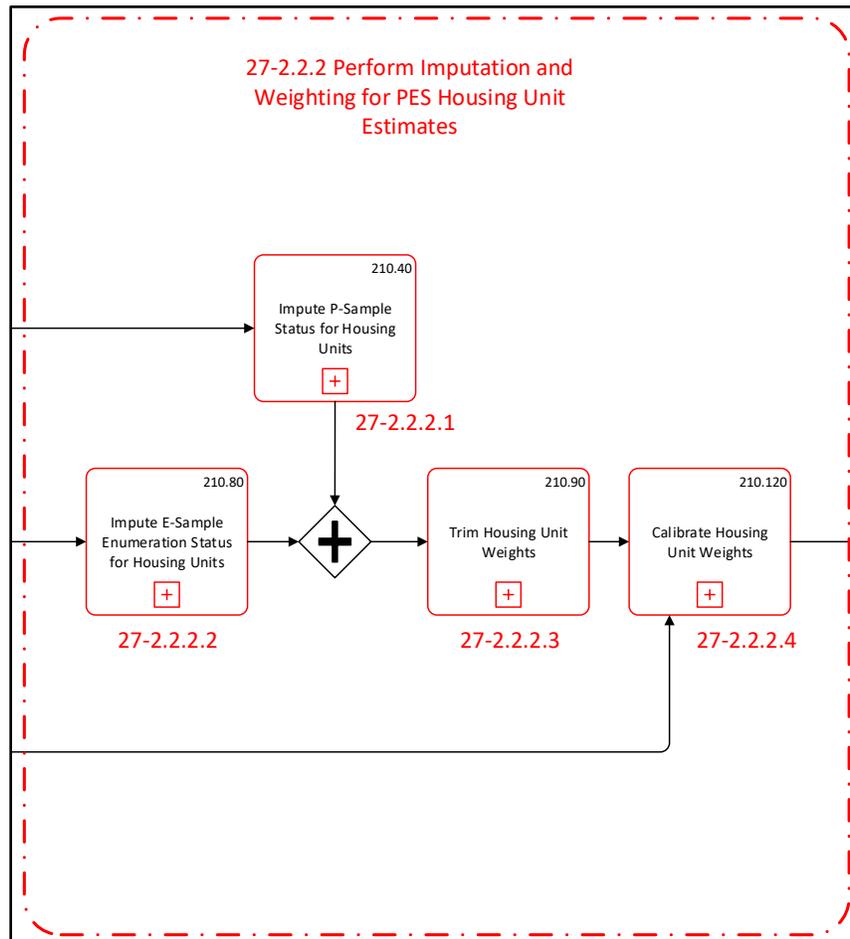


Figure 18: Perform Imputation and Weighting for PES Housing Unit Estimates

After the P and E sample HU Files are created, imputation and weighting adjustments are applied before final estimates of coverage can be calculated.

For the P sample, match status is imputed for housing units with an unresolved match status after follow-up and clerical matching. In this imputation, the match status is imputed with the probability that the housing unit is a match.

Similarly, for the E sample, enumeration status variables that were not resolved during the follow-up and clerical matching activities are imputed with probabilities for E sample HU records.

Housing unit weights are trimmed on both files for BCUs that potentially have an undue influence on the net coverage estimates.

Housing unit weights are calibrated so that weighted estimates of correct and erroneous enumerations will sum to the total number of census enumerations on the HU Estimation File for selected estimation domains.

Perform Estimation and Tabulation for PES Housing Unit Estimates [CMDE 27-2.2.3]

The “Perform Estimation and Tabulation for PES Housing Unit Estimates” operational subactivity is subdivided into the following activity areas:

- Perform Estimation and Tabulation for PES Housing Unit Estimates [CMDE 27-2.2.3].
 - Model Housing Unit Probabilities [CMDE 27-2.2.3.1].
 - Tabulate Housing Unit Data [CMDE 27-2.2.3.2].
 - Estimate Mean Squared Error (MSE) for Housing Unit Domains [CMDE 27-2.2.3.3].

A detailed view of the activities that make up the “Perform Estimation and Tabulation for PES Housing Unit Estimates” operational subactivity is given in [Figure 19](#) below.

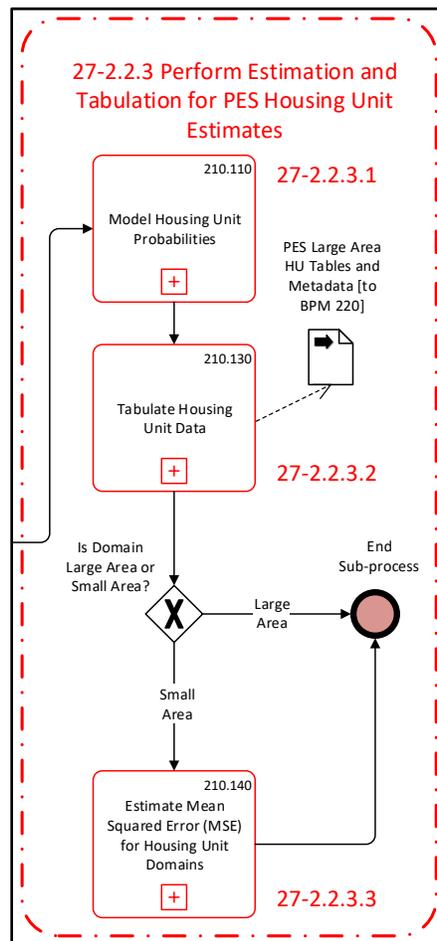


Figure 19: Perform Estimation and Tabulation for PES Housing Unit Estimates

Estimates of net coverage and components of coverage for HUs are produced using the sample files after imputation and weight adjustments.

First, two statistical models will be used to predict match status and correct enumeration status probabilities for each housing unit on the HU Estimation File. These models will be developed using the P sample to model match status and the E sample to model correct enumeration status. The two probabilities will then be combined and tabulated to form dual system estimates of the HU population.

As with person estimation, the DSEs will be compared to the census counts, yielding undercount rates by demographic, geographic, and operational domains. Estimates of components of coverage are tabulated using the weighted data from the E sample HU File and the HU Estimation File.

3.2.2.3 Produce PES Estimation Reports and Release Findings [CMDE 27-2.3]

A detailed view of the activities that make up this subactivity is given in [Figure 20](#) below.

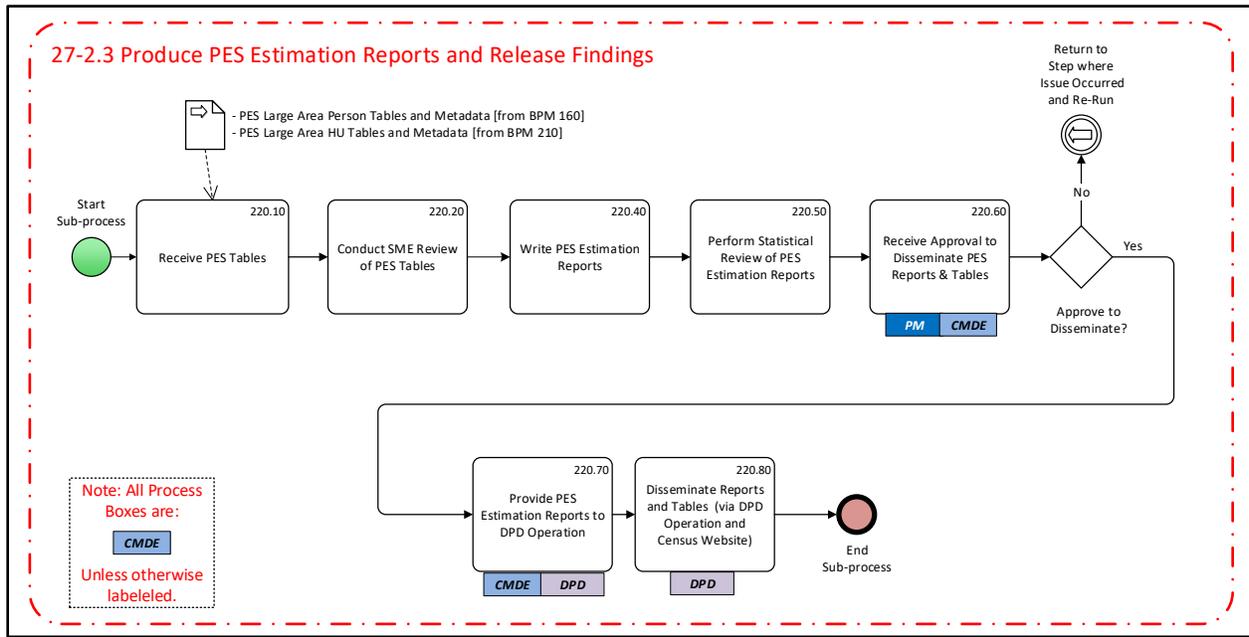


Figure 20: Produce PES Estimation Reports and Release Findings

After tables of coverage estimates are produced for the household population and for HUs, subject-matter experts will review these tables. Decennial Statistical Studies Division (DSSD) staff will write reports containing the results of net coverage and components of coverage estimation.

The reports will go through statistical review to ensure that Census Bureau statistical quality standards are met. Disclosure avoidance techniques will be applied to PES tables and reports to prevent unauthorized release of protected information.

After appropriate approvals are received, the Data Products and Dissemination (DPD) operation will disseminate the PES estimation reports and tables on the 2020 Census website.

4. CMM Design Overview and Detailed Process Description [28]

4.1 CMM Design Overview

The sections below present the high-level design for the Coverage Measurement Matching (CMM) operation. Please refer to the 2020 Census Operational Plan for a complete inventory of design decisions for all 2020 Census operations.

4.1.1 High-Level Operational Design

The design of the CMM operation for the 2020 Census includes three major operational activity areas:

- **CMM Initial Housing Unit (IHU) Matching.**
- **CMM Person Data Preparation and Matching.**
- **CMM Final Housing Unit (FHU) Matching.**

Each of these major activity areas is summarized below. Together, these activity areas represent the complete set of work that needs to be performed to conduct this operation.

CMM Initial Housing Unit (IHU) Matching

The IHU Computer Matching activity follows Independent Listing (IL). The listing results from the PES IL are matched against a preliminary listing of census housing units (HU) and group quarters addresses within each sample basic collection unit (BCU) and one ring of surrounding BCUs. Duplicate addresses within the PES IL and within the preliminary census address listing are also identified.

The next activity after IHU Computer Matching is the IHU Before Followup (BFU) Clerical Matching, which attempts to resolve possible matches, nonmatches, and duplicates from the IHU computer matching. For this activity, the clerical matchers use a computer application that facilitates and records the clerical review and coding of address records. Clerical matchers also search for duplicate addresses within the PES IL and preliminary census address lists, in addition to those duplicates identified during IHU computer matching.

Once these initial matching activities are completed, the CMFO IHU Followup (IHUFU) field operation is conducted to obtain more information for use during the IHU After Followup (AFU) clerical matching activity. In the IHU AFU, results from the IHUFU are used to assign the match status, duplicate status, or HU status for unresolved addresses. This process produces files that

contain match codes for PES and census addresses in the sample BCUs and in the surrounding BCUs. None of the results from any of the IHU activities are used to update any census information.

CMM Person Data Preparation and Matching

After the CMFO PI field operation work is done, but before the person matching activities begin, an automated activity is conducted to assign a residence status code to all people listed in the PI. Also, an automated activity to assign geocodes to alternate and inmover addresses collected in the PI is conducted. This is followed by clerical activities conducted to 1) assign geocodes to respondent-provided addresses and 2) assign residence status codes to people when these codes could not be assigned during the automated coding activities.

The PES Person Computer Matching activity will attempt to search for matches between people rostered at the sample addresses during the PI and people enumerated in the census in the PES sample BCUs and surrounding BCUs. Alternate and inmover addresses collected during the PI and geocoded during automated or clerical geocoding are also used to identify other places to search for matches between PI and census enumerations.

The Person Before Followup (BFU) Clerical Matching activity follows the Person Computer Matching, where the matching staff assign the status of match, possible match, or nonmatch to PI and census person records. For Person BFU Clerical Matching, the clerical matchers use a computer application that facilitates and records the clerical review, matching, and coding of the person data. A clerical search for duplicates is also performed. Cases remaining unresolved in terms of match status, enumeration status, or residence status become eligible for the next PES operation, the CMFO Person Followup (PFU) field operation.

The PFU interview is designed to collect additional information to be used in the Person After Followup (AFU) Clerical Matching. During Person AFU Clerical Matching, clerical matchers attempt to resolve match, residence, or enumeration status for people sent to PFU. Once Person AFU Clerical Matching has concluded, the CMDE Person Estimation process begins.

CMM Final Housing Unit (FHU) Matching

Once all of the person-based PES activities have been performed, Final HU (FHU) activities are conducted to determine the final match codes assigned to addresses. These results will be used to estimate census coverage of HUs. The first of these tasks is the FHU Computer Processing. In this activity, a determination is made as to which HUs will proceed to the FHU Before Followup

(BFU) Clerical Matching activity, based on changes to the lists of PES or census units since the IHU Matching activities and the IHUFU field operation were conducted.

During FHU BFU Clerical Matching, the staff review and assign the status of match, possible match, or nonmatch to addresses sent from the FHU Computer Processing. During FHU Clerical Matching, the matchers attempt to determine whether or not an address should have been counted as a valid HU on Census Day. The FHU Clerical Matching activity is similar to the IHU Clerical Matching activity described previously, except that it uses the final list of census addresses rather than data from the preliminary list of census addresses. Also, only those PES IL addresses that were selected for PI are included in the FHU activities. Results from the Person Matching activities and PFU field operation are available to assist the matching staff, as well as results and data from the IHU matching and follow-up activities.

Those cases that need additional information are candidates for the paper-based FHU Followup (FHUFU) field operation. Additional information is collected to resolve any remaining differences between HUs. This information then flows into the concluding step in the FHU matching activities, which is the FHU After Followup (AFU) Clerical Matching. When conducting this activity, results from the FHUFU field operation (and any previous PES Person and HU Matching activities) are used to resolve any outstanding issues regarding coding status. Once FHU AFU has concluded, the CMDE HU Estimation process begins

The full hierarchy of activities for the CMM operation is provided in Appendix C in the form of an Activity Tree. In the Activity Tree, each major operational activity area listed above is numbered and then decomposed into a numbered set of subactivities, some of which are further decomposed into more detailed numbered subactivities or steps.

For a full description of the operational subactivities that comprise the CMM Operation, see the Detailed Process Description as outlined in Section 4.2 below.

4.1.2 Operational Context for CMM Activities

The CMM operational activities are conducted within the context of other 2020 Census operations and other programs or data sources that are external to the 2020 Census Program. Section 2 covers the overall operational context for the PES operations, i.e., the inputs, outputs, controls, and mechanisms that apply for the set of PES operations and elements external to PES. The specific inputs and outputs related to the CMM operational interaction with the other two PES operations (CMDE and CMFO) are given in the next two sections below.

The input and output tables within PES are based on several concepts. A source operation is the PES operation that provides the data exchange while the destination operation receives the data exchange. The Business Process Models (BPMs) that accompany this document use ID numbers (e.g., CMM BPM 50) that are the references for where the data exchanges appear. The source activity and destination activity for the data exchange provide a quick context for the data. The name of an activity in the table references BPM annotation and also matches an operation's activity tree, which provides organization for this document's detailed process descriptions should a reader wish to consult more detail for descriptions of related pairs of BPMs for a specific data exchange.

4.1.2.1 CMM Operational Inputs

Inputs are the data that are consumed by the operation. [Table 10](#) below lists the inputs to the CMM Operation from the other PES operations (i.e., CMFO and CMDE).

Table 10: CMM Operational Inputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Inputs from CMFO:		
CMFO BPM 15	29-1 CMFO Planning and Preparation	<i>Field Priority Codes</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>IL Address List</i>	CMM BPM 50, CMM BPM 60	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching, 28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>PES Maps (with Map Spots)</i>	CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>Auxiliary Maps from IL</i>	CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)	<i>Completed IHUFU Paper Questionnaire Packets and Maps</i>	CMM BPM 80	28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>Automated Geocoding Results for PI Inmover and Alternate Addresses</i>	CMM BPM 115	28-2.1 Conduct Clerical Geocoding (CGC)
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Post Processing Data</i>	CMM BPM 115, CMM BPM 120, CMM BPM 130	28-2.1 Conduct Clerical Geocoding (CGC), 28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Form Selection Results</i>	CMM BPM 120, CMM BPM 130	28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching
CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)	<i>Completed PFU Paper Questionnaire Packets</i>	CMM BPM 150	28-2.5 Conduct PES Person After Followup (AFU) Clerical Matching

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMDE BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)	<i>Completed FHUFU Paper Questionnaire Packets and Maps</i>	CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching
CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)	<i>Auxiliary Maps from FHUFU</i>	CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching
		Inputs from CMDE:		
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>Sample Design File Vs. 1</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units	<i>Sample Design File Vs. 2</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMDE BPM 100	27-1.5 Select E Sample Housing Units	<i>Sample Design File Vs. 4</i>	CMM BPM 120	28-2.2 Conduct PES Person Computer Matching
CMDE BPM 100	27-1.5 Select E Sample Housing Units	<i>E Sample Control File</i>	CMM BPM 120, CMM BPM 130	28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching

4.1.2.2 CMM Operational Outputs

Outputs are the data produced by the operation. [Table 11](#) below lists the outputs from the CMM Operation to the other PES operations (i.e., CMFO and CMDE).

Table 11: CMM Operational Outputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMM BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Outputs to CMFO:		
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>IHUFU Workload</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>IHU BCU Control File</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets and Maps for IHUFU</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)
CMM BPM 80	28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching	<i>Updated PES Maps (if Any)</i>	CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>PFU Workload</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMM BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Person BCU Control File</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets for PFU</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>PES Maps and Census Maps (including Map Spots)</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>FHUFU Workload</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>FHU BCU Control File</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets and Maps for FHUFU</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)
		Outputs to CMDE:		

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMM BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching	<i>Census HU Counts</i>	CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units
CMM BPM 60, CMM BPM 80	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching, 28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching	<i>Preliminary Enhanced List (PEL) Records</i>	CMDE BPM 90	27-1.4 Select PES PI Housing Unit (HU) Sample
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Person BFU Clerical Matching Data</i>	CMDE BPM 160	27-2.1 Produce PES Person Estimates
CMM BPM 150	28-2.5 Conduct PES Person After Followup (AFU) Clerical Matching	<i>Person AFU Clerical Matching Data</i>	CMDE BPM 160, CMDE BPM 210	27-2.1 Produce PES Person Estimates, 27-2.2 Produce PES Housing Unit (HU) Estimates
CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching	<i>FHU AFU Clerical Matching Data</i>	CMDE BPM 210	27-2.2 Produce PES Housing Unit (HU) Estimates

4.2 CMM Detailed Process Description

Figure 21 is a top-level Business Process Model (BPM) showing the Level 1 activity areas within the PES operations. BPMs for the 2020 Census follow industry-standard Business Process Model and Notation (BPMN). An explanation of how to read the BPMN notations and a full-sized copy of all of the BPMN diagrams for the CMM operation are provided under separate cover.

This top-level BPM serves as the Context Model for the PES operations. A BPMN Context Model displays the high-level activities within the operation and relationships between them, whereas the IDEF0 Context Diagram shown earlier depicts the boundaries of the operation or activity and the interfaces between the operation or activity and other operations and activities with which it is associated.

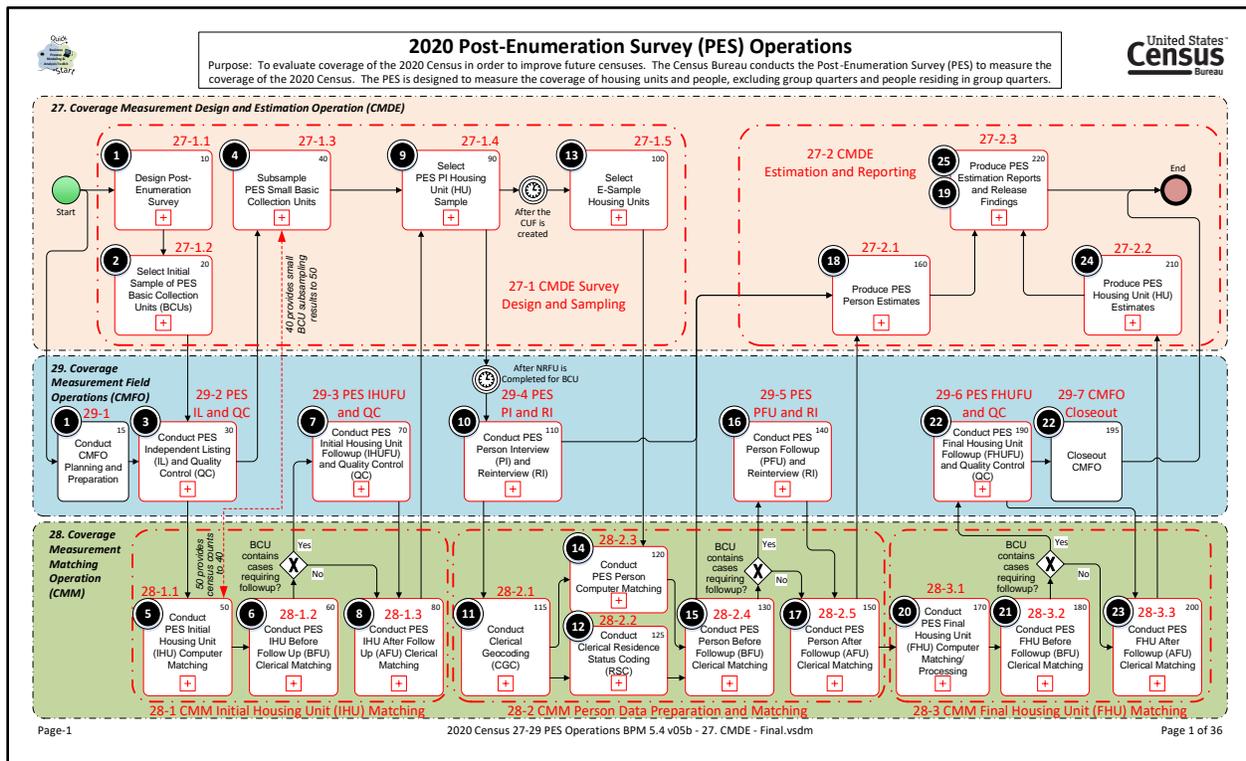


Figure 21: PES Operations Context Model Showing CMM Operational Context

The CMM Operation is subdivided into the following activity areas:

- CMM Initial Housing Unit (IHU) Matching [CMM 28-1].
- CMM Person Data Preparation and Matching [CMM 28-2].

- CMM Final Housing Unit (FHU) Matching [CMM 28-3].

The business processes for each of these Level 1 activities are discussed along with their inputs and outputs in the following subsections.

4.2.1 CMM Initial Housing Unit (IHU) Matching [CMM 28-1]

The first CMM activity is CMM Initial Housing Unit (IHU) Matching.

Figure 22 shows the BPM for the CMM Initial Housing Unit (IHU) Matching [CMM 28-1] activity (area within the gray rounded rectangle) and its constituent activities within the overall context of the PES operations.

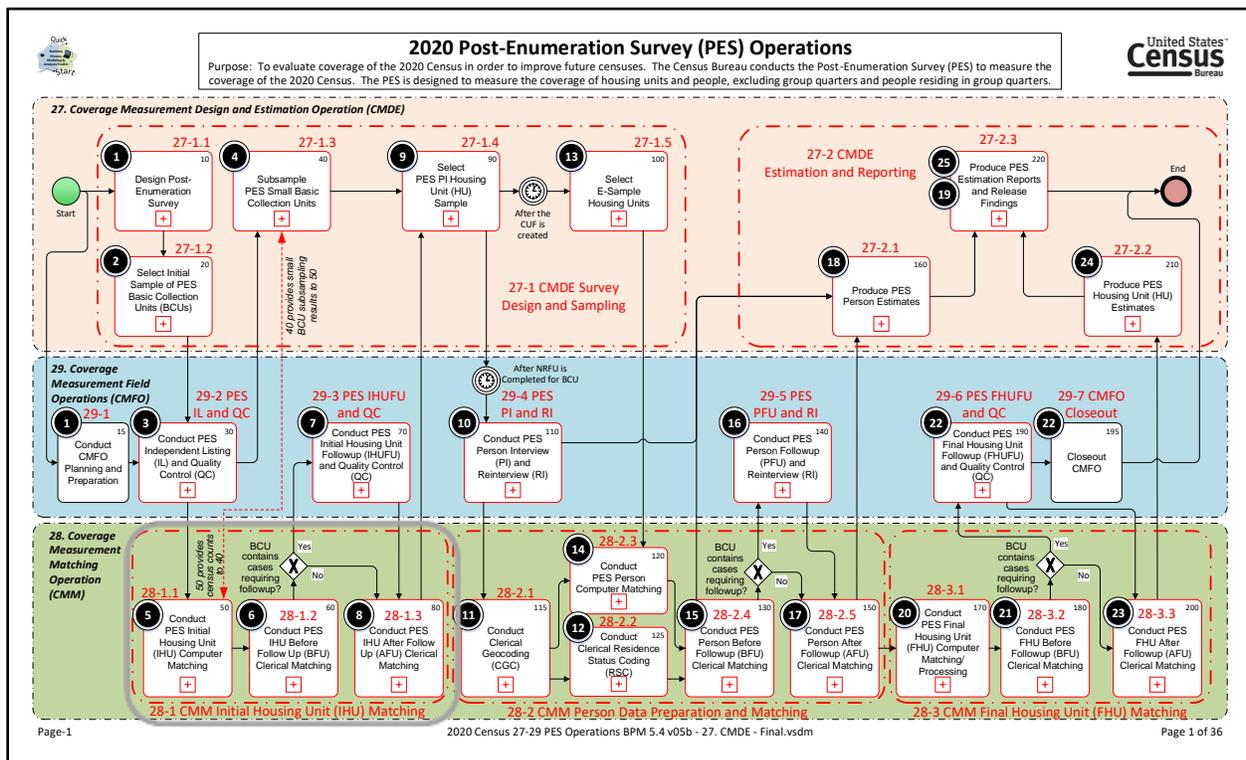


Figure 22: CMM Initial Housing Unit (IHU) Matching [CMM 28-1] Activities

The “CMM Initial Housing Unit (IHU) Matching” operational activity is subdivided into the following activity areas:

- CMM Initial Housing Unit (IHU) Matching [CMM 28-1].
 - Conduct PES Initial Housing Unit (IHU) Computer Matching [CMM 28-1.1].

- Conduct PES IHU Before Followup (BFU) Clerical Matching [CMM 28-1.2].
- Conduct PES IHU After Followup (AFU) Clerical Matching [CMM 28-1.3].

The IHU Matching activity contains several subactivities, all of which are designed to assign HU status and match status. The Initial HU Computer Matching activity and Initial HU Before Followup (BFU) Clerical Matching activity attempt to match units from the CMFO Independent Listing (IL) field operation to preliminary census addresses. The results of these two matching processes are recorded so that units from the IL fieldwork and census units that remain unresolved can be sent to the next operation, the CMFO Initial HU Followup (IHUFU) field operation. In IHUFU, additional information is collected and used during the Initial HU After Followup (AFU) Clerical Matching activity to assign final match codes.

Subsequent sections describe the “CMM Initial Housing Unit (IHU) Matching” operational subactivities in detail.

4.2.1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching [CMM 28-1.1]

The “Conduct PES Initial Housing Unit (IHU) Computer Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES Initial Housing Unit (IHU) Computer Matching [CMM 28-1.1].
 - Receive and Process Inputs for IHU Computer Matching [CMM 28-1.1.1].
 - Perform IHU Computer Matching [CMM 28-1.1.2].

A detailed view of the activities that make up the “Conduct PES Initial Housing Unit (IHU) Computer Matching” operational subactivity is given in [Figure 23](#) below.

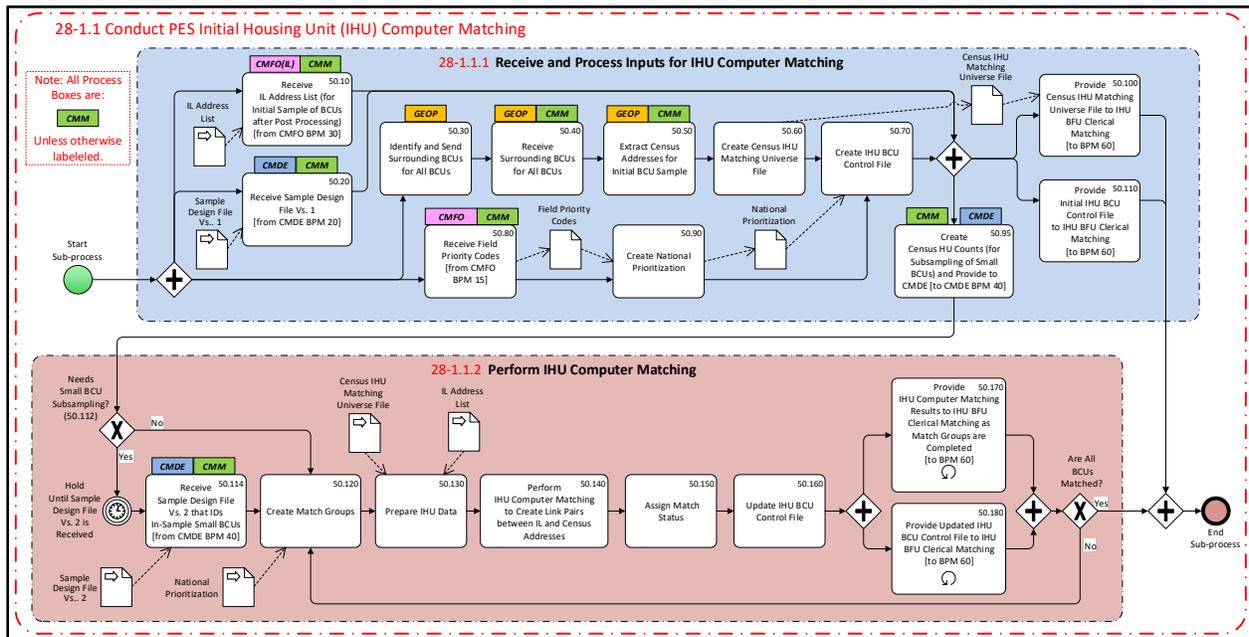


Figure 23: Conduct PES Initial Housing Unit (IHU) Computer Matching

During Initial HU Computer Matching, all addresses listed from IL are computer matched to preliminary census addresses. The results of the computer matching are loaded into a clerical matching system, which is subsequently used by clerical matchers. All of the results from computer matching will be checked clerically.

Receive and Process Inputs for IHU Computer Matching [CMM 28-1.1.1]

The details of this operational subactivity are shown in Figure 23 above.

Input data is received from multiple sources and will go through a series of data preparation steps before computer matching. The results are then used for computer matching.

Perform IHU Computer Matching [CMM 28-1.1.2]

During IHU Computer Matching, all addresses listed in the PES sample BCUs are computer matched to preliminary census addresses (of HUs and GQs) within the sample BCUs and one ring of surrounding BCUs. Match codes are assigned, and these data are then passed to the clerical matching system for use by the clerical matchers.

The details of this operational subactivity are shown in Figure 23 above.

4.2.1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching [CMM 28-1.2]

The “Conduct PES IHU Before Followup (BFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES IHU Before Followup (BFU) Clerical Matching [CMM 28-1.2].
 - Conduct IHU BFU Clerical Matching Training [CMM 28-1.2.1].
 - Receive and Process Inputs for IHU BFU Clerical Matching [CMM 28-1.2.2].
 - Perform IHU BFU Clerical Matching, Review, and QC [CMM 28-1.2.3].
 - Manage Outputs from IHU BFU Clerical Matching [CMM 28-1.2.4].

A detailed view of the activities that make up the “Conduct PES IHU Before Followup (BFU) Clerical Matching” operational subactivity is given in [Figure 24](#), [Figure 25](#), [Figure 26](#), and [Figure 27](#) below.

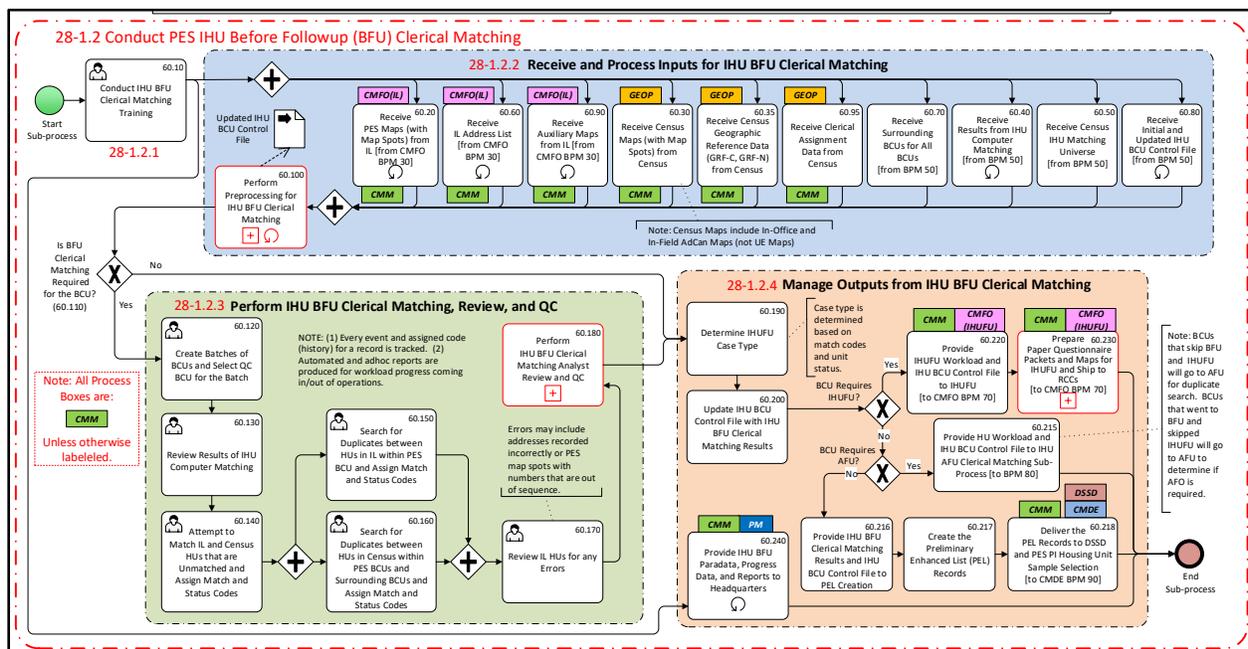


Figure 24: Conduct PES IHU Before Followup (BFU) Clerical Matching

The IHU BFU Clerical Matching activity uses the results of the computer matching stage in an attempt to further match and review HUs. Before clerical matching begins, technicians and analysts are trained on the clerical matching system. Data are received from multiple sources and will go through a series of data preparation steps. These files are then used for clerical

matching, review, and QC. In IHU BFU, results of computer matching are reviewed and match codes are assigned to indicate the results of the review by technicians. Analysts conduct a quality check on a sample of technicians’ work and review any cases referred by the technicians. The output of the IHU BFU Clerical Matching process will be a file containing the IHU match codes for all addresses (both IL and census), and flags indicating which census or IL units will go to the next operation, the CMFO IHUFU field operation. Some BCUs meeting specific criteria will be allowed to skip BFU Clerical Matching and go directly to IHUFU.

Conduct IHU BFU Clerical Matching Training [CMM 28-1.2.1]

This operational subactivity consists of a single activity (see Figure 24 above).

Once training materials are created, clerical matchers are trained on the IHU BFU clerical matching system. This is done through on-site instructor-led training. Clerical matchers will attend operation-specific training throughout the PES cycle.

Receive and Process Inputs for IHU BFU Clerical Matching [CMM 28-1.2.2]

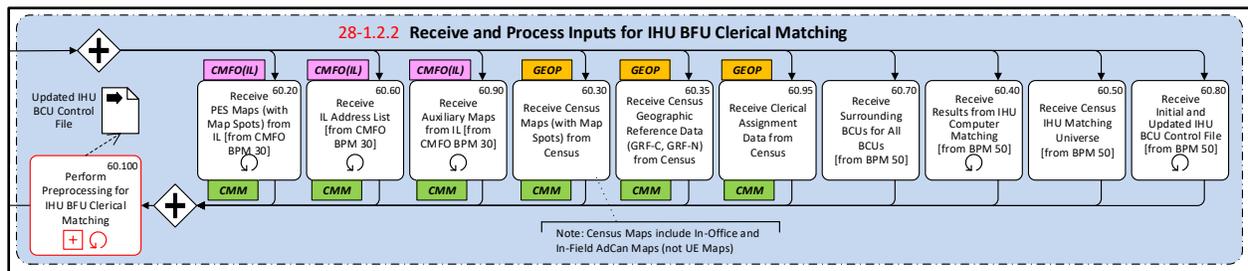


Figure 25: Receive and Process Inputs for IHU BFU Clerical Matching

Inputs are received from multiple sources including IHU Computer Matching and will go through a series of data preparation steps. During preprocessing, standardization of the data occurs and these files are used for IHU BFU Clerical Matching.

Perform IHU BFU Clerical Matching, Review, and QC [CMM 28-1.2.3]

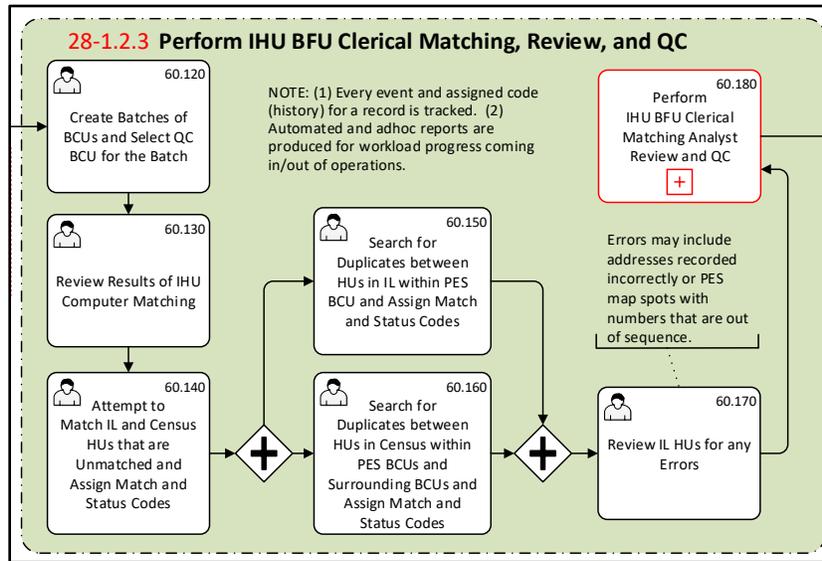


Figure 26: Perform IHU BFU Clerical Matching, Review, and QC

In the IHU BFU Clerical Matching, Review, and QC, the results from the IHU Computer Matching activity are reviewed to determine the correct match status. Technicians perform a cursory review of all the cases from IHU Computer Matching. Analysts perform the QC of the technicians’ work and review cases referred by the technicians. The QC process for clerical matching consists of analysts performing a full review of BCUs selected for the matching QC sample.

Manage Outputs from IHU BFU Clerical Matching [CMM 28-1.2.4]

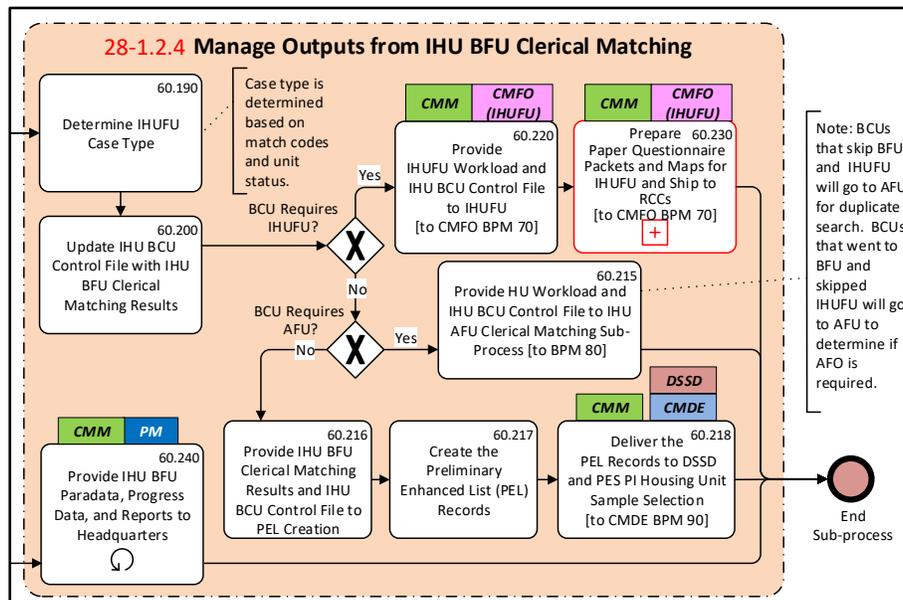


Figure 27: Manage Outputs from IHU BFU Clerical Matching

The output of the BFU Clerical Matching process will be a file containing the IHU match codes for all addresses (both IL and census), and flags indicating which census or IL units will go to the next operation, the CMFO IHUFU field operation.

4.2.1.3 Conduct PES IHU After Followup (AFU) Clerical Matching [CMM 28-1.3]

The “Conduct PES IHU After Followup (AFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES IHU After Followup (AFU) Clerical Matching [CMM 28-1.3].
 - Conduct IHU AFU Clerical Matching Training [CMM 28-1.3.1].
 - Receive and Process Inputs for IHU AFU Clerical Matching [CMM 28-1.3.2].
 - Perform IHU AFU Clerical Matching, Review, and QC [CMM 28-1.3.3].
 - Manage Outputs from IHU AFU Clerical Matching [CMM 28-1.3.4].

A detailed view of the activities that make up the “Conduct PES IHU After Followup (AFU) Clerical Matching” operational subactivity is given in [Figure 28](#), [Figure 29](#), [Figure 30](#), and [Figure 31](#) below.

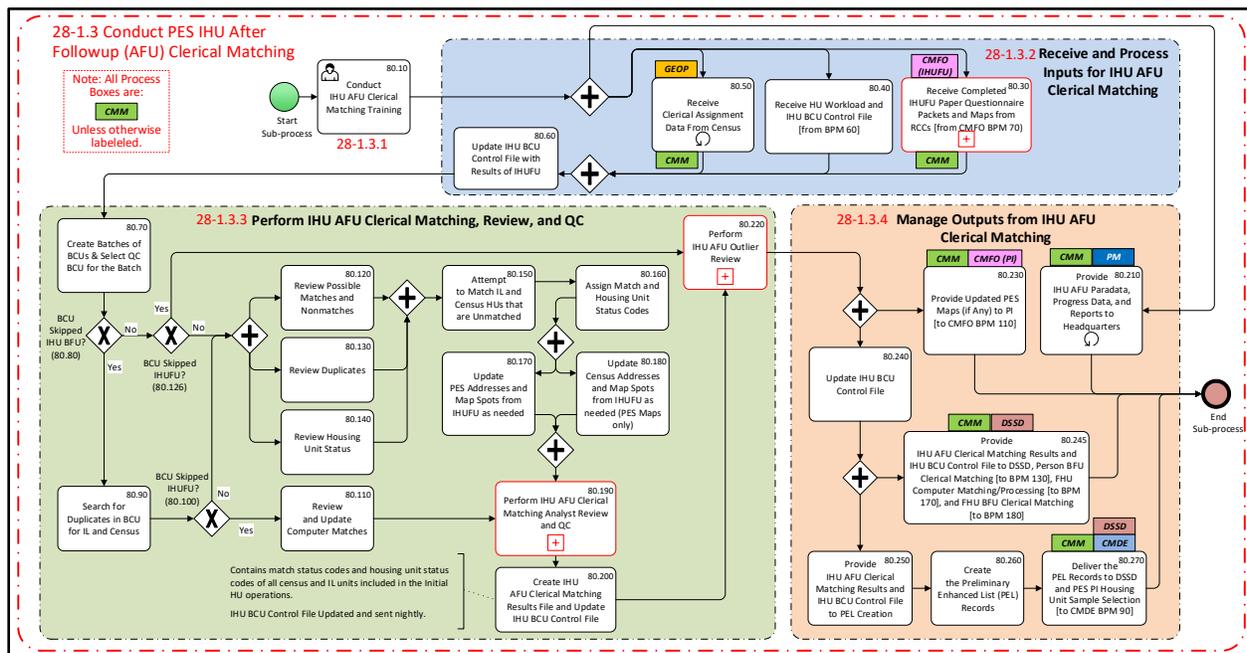


Figure 28: Conduct PES IHU After Followup (AFU) Clerical Matching

The main objective of the IHU AFU is to have the technicians assign match status and HU status codes to cases that were sent to IHUFU as well as cases that skipped IHU BFU. Before clerical matching begins, technicians and analysts are trained on the clerical matching system. Data are received from multiple sources and will go through a series of data preparation steps. These files are then used for Clerical Matching, Review, and QC. In IHU AFU, analysts conduct a quality check on a sample of technicians’ work and review any cases referred by the technician. In the AFU Outlier Review stage of the IHU AFU Clerical Matching, Review, and QC, analysts review BCUs that are flagged for review for systematic errors or issues. They document their findings in journals that can later be used during estimation processes if questions arise. The output for the IHU AFU Clerical Matching activity consists of the results file, containing the match status codes and HU status codes of all census and IL units included in the IHU activities.

Conduct IHU AFU Clerical Matching Training [CMM 28-1.3.1]

This operational subactivity consists of a single activity (see Figure 28 above).

Once training materials are created, the clerical matchers are trained on the IHU AFU clerical matching system. This is done through on-site instructor led training. Clerical matchers will attend operation specific training throughout the PES cycle.

Receive and Process Inputs for IHU AFU Clerical Matching [CMM 28-1.3.2]

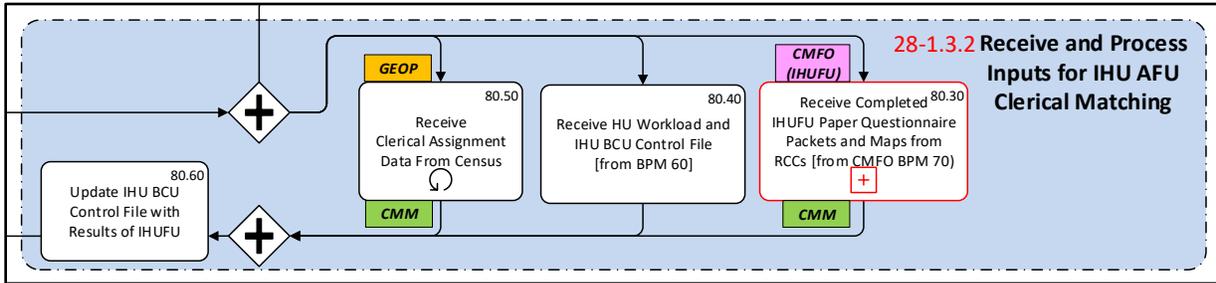


Figure 29: Receive and Process Inputs for IHU AFU Clerical Matching

Once the IHUFU is completed, the IHUFU paper forms with data collected in IHUFU, along with IHU BFU Clerical Matching result files are delivered for use in IHU AFU Clerical Matching.

Perform IHU AFU Clerical Matching, Review, and QC [CMM 28-1.3.3]

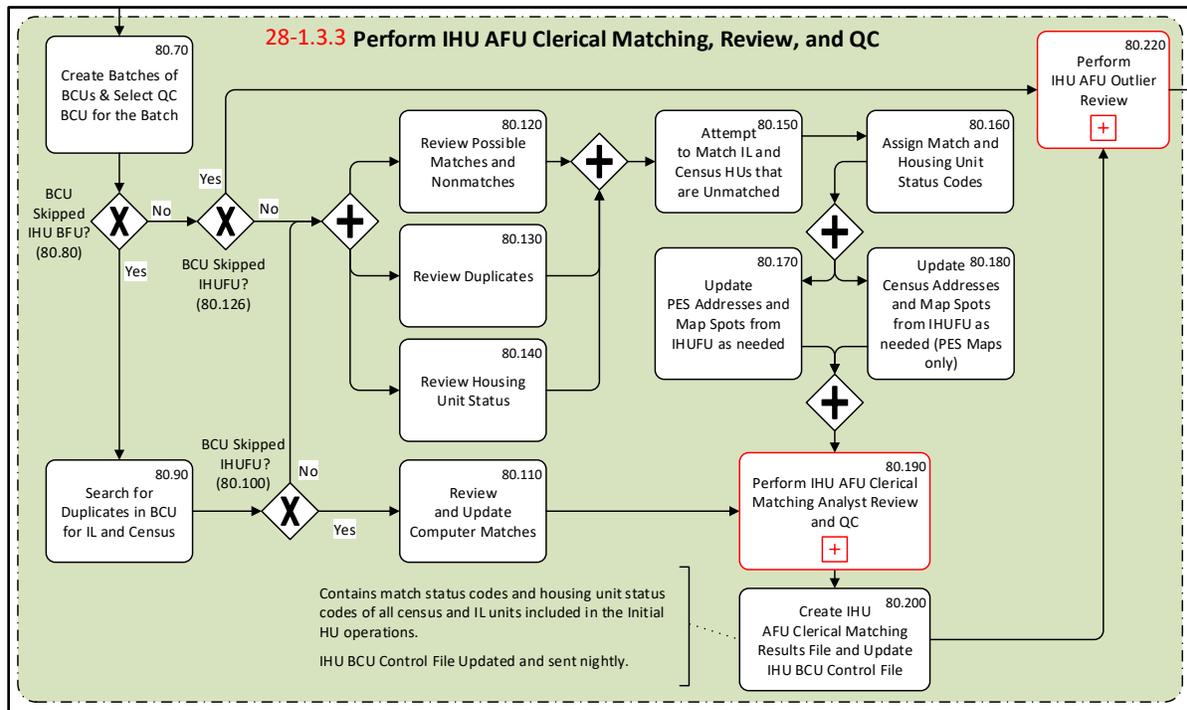


Figure 30: Perform IHU AFU Clerical Matching, Review, and QC

In the IHU AFU Clerical Matching, Review, and QC, the technicians assign match status and HU status codes to cases that were sent to IHUFU. The analysts perform the QC of the technicians' work and review cases referred by the technicians. The QC process for IHU Clerical Matching

consists of analysts performing a full review of BCUs selected for the matching QC sample. In the AFU Outlier Review Stage, analysts review preidentified BCUs for systematic errors or issues and document their findings.

Manage Outputs from IHU AFU Clerical Matching [CMM 28-1.3.4]

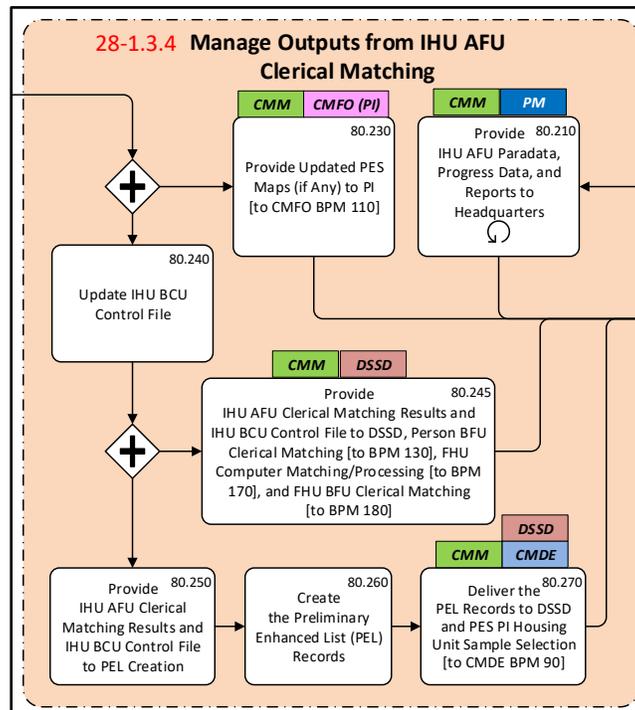


Figure 31: Manage Outputs from IHU AFU Clerical Matching

The output for the IHU AFU Clerical Matching activity consists of the results file, containing the match status codes and HU status codes of all census and IL units included in the IHU activities.

4.2.2 CMM Person Data Preparation and Matching [CMM 28-2]

The second CMM activity is CMM Person Data Preparation and Matching.

Figure 32 shows the BPM for the CMM Person Data Preparation and Matching [CMM 28-2] activity (area within the gray rounded rectangle) and its constituent activities within the overall context of the PES operations.

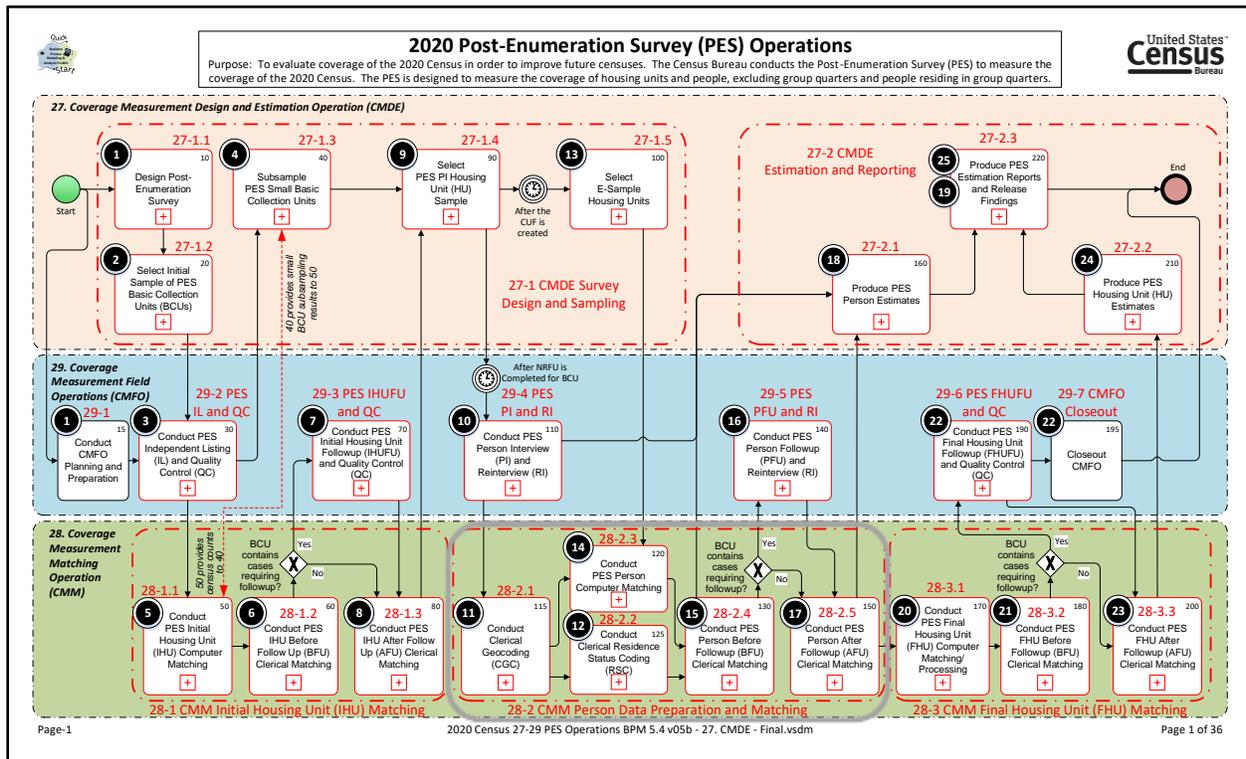


Figure 32: CMM Person Data Preparation and Matching [CMM 28-2] Activities

The “CMM Person Data Preparation and Matching” operational activity is subdivided into the following activity areas:

- CMM Person Data Preparation and Matching [CMM 28-2].
 - Conduct Clerical Geocoding (CGC) [CMM 28-2.1].
 - Conduct PES Person Computer Matching [CMM 28-2.2].
 - Conduct Clerical Residence Status Coding (RSC) [CMM 28-2.3].
 - Conduct PES Person Before Followup (BFU) Clerical Matching [CMM 28-2.4].
 - Conduct PES Person After Followup (AFU) Clerical Matching [CMM 28-2.5].

After the CMFO Person Interview (PI) is the CMM Person Data Preparation and Matching activity. The Person Data Preparation and Matching activity contain several subactivities, all of which are designed to assign match status between people rostered at the sample addresses during the PI and people enumerated in the census in the PES sample BCUs and surrounding BCUs. The Person Computer Matching activity establishes matches when straightforward relationships between records exist. The Clerical Geocoding (CGC) activity will attempt to assign

geocodes to the alternate and in-mover addresses collected during PI that could not be given a geocode during automated geocoding. The Residence Status Codes (RSC) are assigned by computer (in automated RSC) following the PI and can be reviewed and reassigned during Clerical RSC or any part of person clerical matching based on information provided in PI or Person Followup (PFU).

CGC occurs after the Automated Geocoding and before the Person Computer Matching. The Clerical RSC occurs after the CGC and Automated RSC. The Clerical RSC may occur parallel to Person Computer Matching. The Person BFU Clerical Matching occurs after the Clerical RSC and after the Person Computer Matching. Person AFU Clerical Matching is conducted after PFU.

Subsequent sections describe the “CMM Person Data Preparation and Matching” operational subactivities in detail.

4.2.2.1 Conduct Clerical Geocoding (CGC) [CMM 28-2.1]

The “Conduct Clerical Geocoding (CGC)” operational subactivity is subdivided into the following activity areas:

- Conduct Clerical Geocoding (CGC) [CMM 28-2.1].
 - Conduct Clerical Geocoding Training [CMM 28-2.1.1].
 - Receive and Process Inputs for CGC [CMM 28-2.1.2].
 - Perform Clerical Geocoding, Review, and QC [CMM 28-2.1.3].
 - Manage Outputs from CGC [CMM 28-2.1.4].

A detailed view of the activities that make up the “Conduct Clerical Geocoding (CGC)” operational subactivity is given in [Figure 33](#), [Figure 34](#), [Figure 35](#), and [Figure 36](#) below.

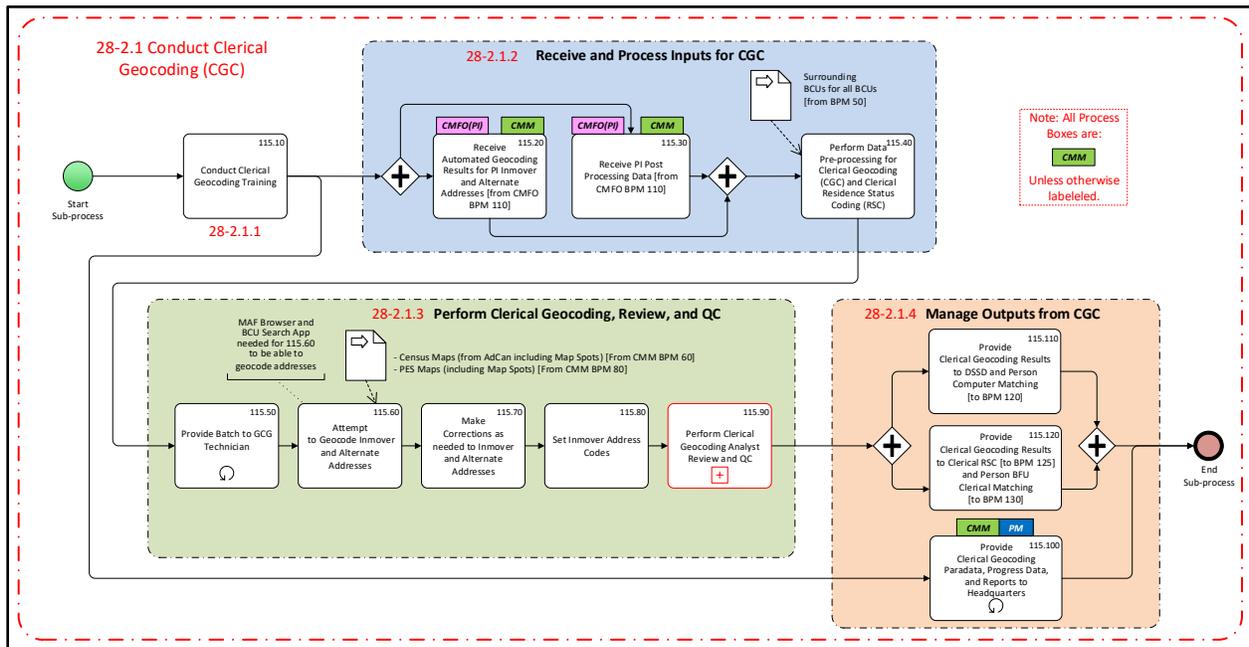


Figure 33: Conduct Clerical Geocoding (CGC)

The main objective of CGC is to review the automated geocodes and to assign geocodes to cases with ungeocoded addresses. Before CGC begins, technicians and analysts are trained on the clerical matching system. Data are received from multiple sources and will go through a series of data preparation steps. These files are then used for CGC, Review, and QC. Analysts conduct a quality check of technicians’ work. The results of CGC will be used in Person Clerical Matching.

Conduct Clerical Geocoding Training [CMM 28-2.1.1]

This operational subactivity consists of a single activity (see Figure 33 above).

Once training materials are created, clerical matchers are trained to assign geocodes using the clerical matching batch system. This is done through on-site instructor led training.

Receive and Process Inputs for CGC [CMM 28-2.1.2]

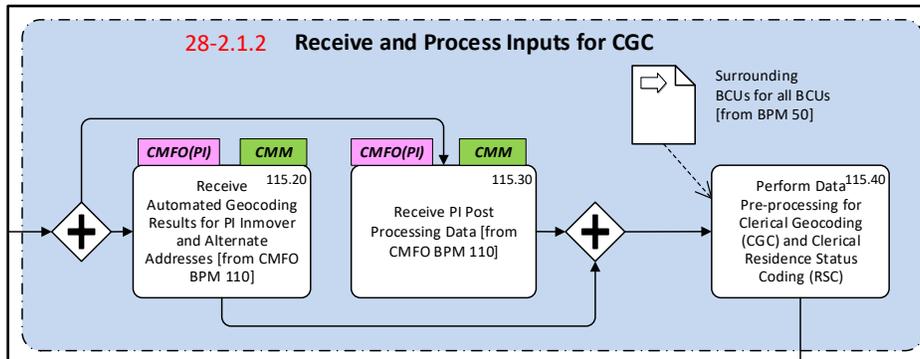


Figure 34: Receive and Process Inputs for CGC

The results of automated geocoding and PI are received. These inputs are used to prepare the data for CGC.

Perform Clerical Geocoding, Review, and QC [CMM 28-2.1.3]

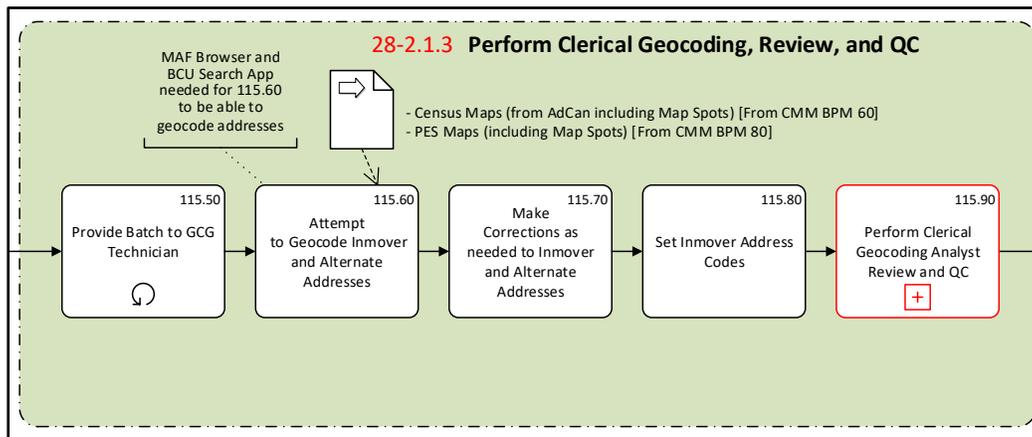


Figure 35: Perform Clerical Geocoding, Review, and QC

After automated geocoding, during CGC, technicians review the automated geocodes and assign geocodes to remaining addresses with missing geocodes. Analysts perform the QC of the technicians' work and review cases referred by the technician. The QC process for CGC consists of analysts performing a full review of BCUs selected for the matching QC sample.

Manage Outputs from CGC [CMM 28-2.1.4]

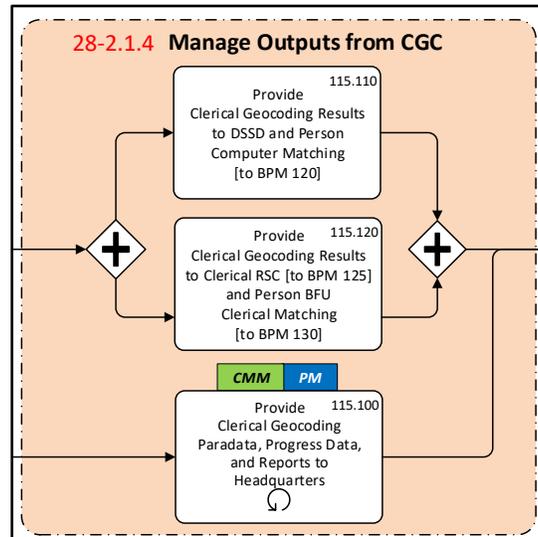


Figure 36: Manage Outputs from CGC

Results from CGC will be provided to Person Computer Matching, Clerical RSC, and Person BFU Clerical Matching for use in those activities.

4.2.2.2 Conduct PES Person Computer Matching [CMM 28-2.2]

The “Conduct PES Person Computer Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES Person Computer Matching [CMM 28-2.2].
 - Receive and Process Inputs for Person Computer Matching [CMM 28-2.2.1].
 - Perform Person Computer Matching [CMM 28-2.2.2].
 - Manage Outputs from Person Computer Matching [CMM 28-2.2.3].

A detailed view of the activities that make up the “Conduct PES Person Computer Matching” operational subactivity is given in [Figure 37](#), [Figure 38](#), [Figure 39](#), and [Figure 40](#) below.

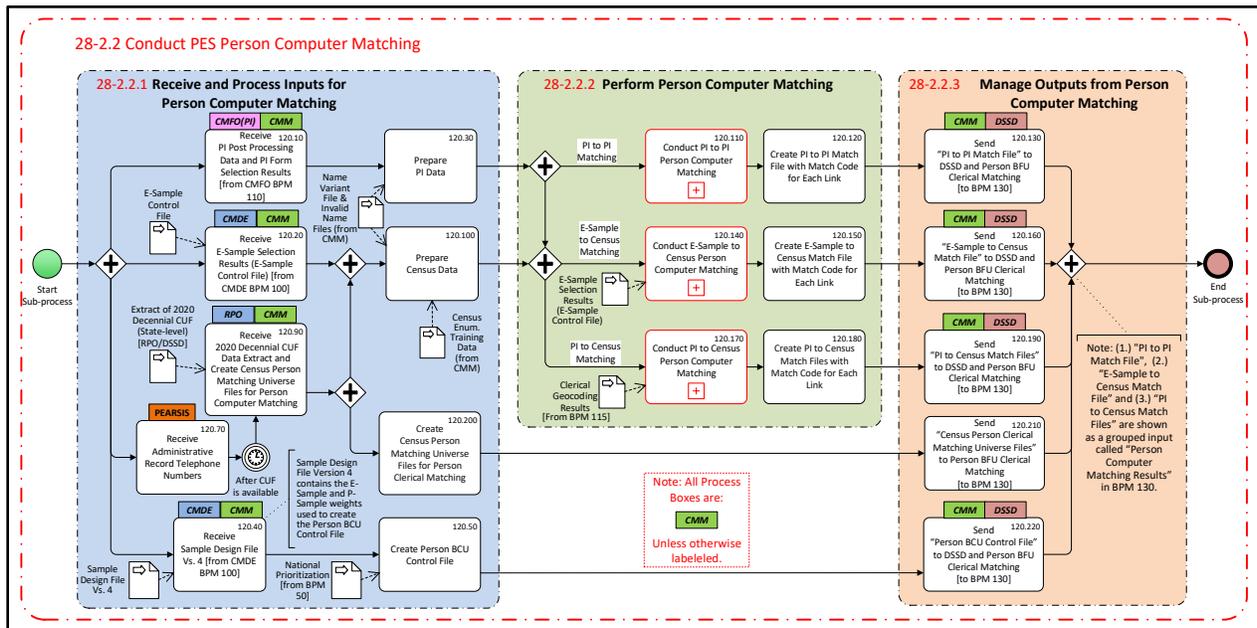


Figure 37: Conduct PES Person Computer Matching

The Person Computer Matching activity establishes matches when straightforward relationships between records exist. Census and PI data are prepared for use in Computer Matching. The output from Person Computer Matching contains identifying information for each person record in a linked pair and the match code for that pair. The output is used in Person BFU Clerical Matching.

Receive and Process Inputs for Person Computer Matching [CMM 28-2.2.1]

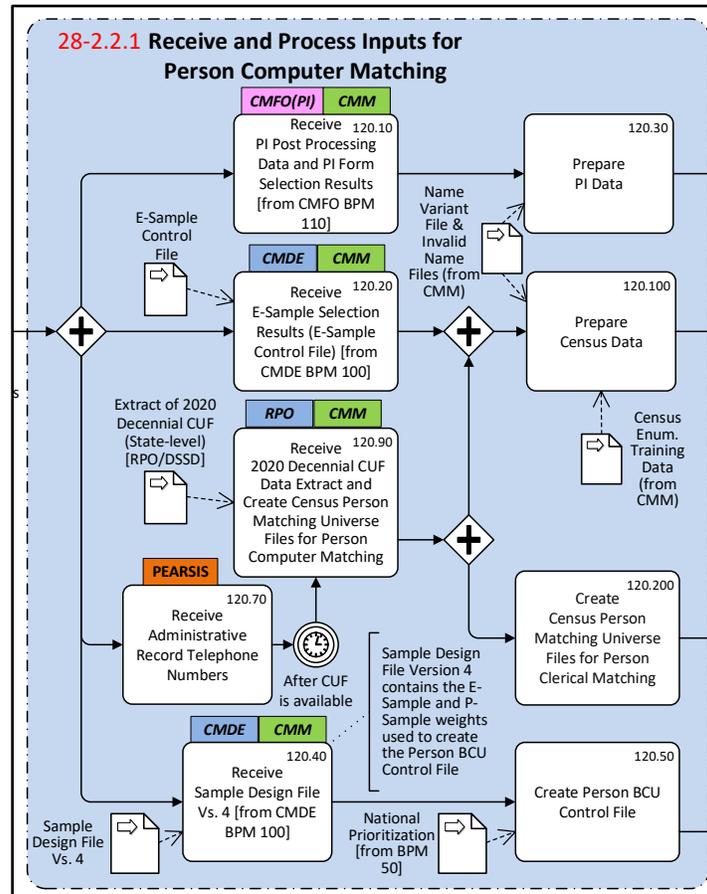


Figure 38: Receive and Process Inputs for Person Computer Matching

Input data are received from multiple sources and will go through a series of data preparation steps. These files are then used for Person Computer Matching.

Perform Person Computer Matching [CMM 28-2.2.2]

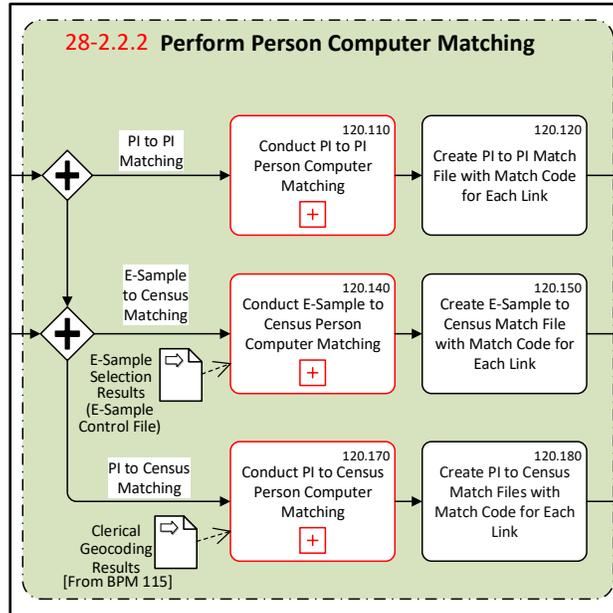


Figure 39: Perform Person Computer Matching

During Person Computer Matching, there are three different searches that generate matches. There is a PI to PI match within BCU to search for duplicates within the BCU. There is an E sample to Census match where E sample people are matched to the entire census to find duplicates. Lastly, there is a PI to census is where PI people are matched to the entire census to find matches. These three searches occur based on a predetermined algorithm. Results files with match codes are created for use in Person BFU Clerical Matching.

Manage Outputs from Person Computer Matching [CMM 28-2.2.3]

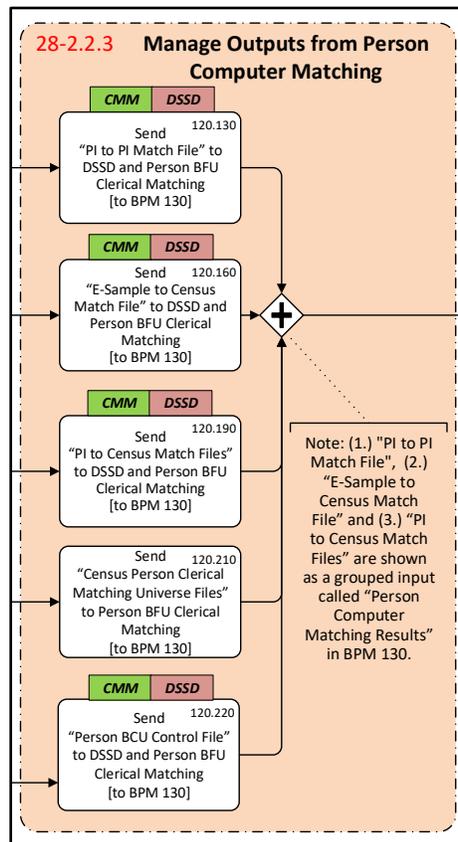


Figure 40: Manage Outputs from Person Computer Matching

The results of the Person Computer Matching are loaded into a person clerical matching system for use in the Person BFU Clerical Matching activity.

4.2.2.3 Conduct Clerical Residence Status Coding (RSC) [CMM 28-2.3]

The "Conduct Clerical Residence Status Coding" operational subactivity is subdivided into the following activity areas:

- Conduct Clerical Residence Status Coding (RSC) [CMM 28-2.3].
 - Conduct Clerical Residence Status Coding Training [CMM 28-2.3.1].
 - Receive Inputs for Clerical RSC [CMM 28-2.3.2].
 - Perform Clerical Residence Status Coding, Review, and QC [CMM 28-2.3.3].
 - Manage Outputs from Clerical RSC [CMM 28-2.3.4].

A detailed view of the activities that make up the “Conduct Clerical Residence Status Coding” operational subactivity is given in [Figure 41](#), [Figure 42](#), [Figure 43](#), and [Figure 44](#) below.

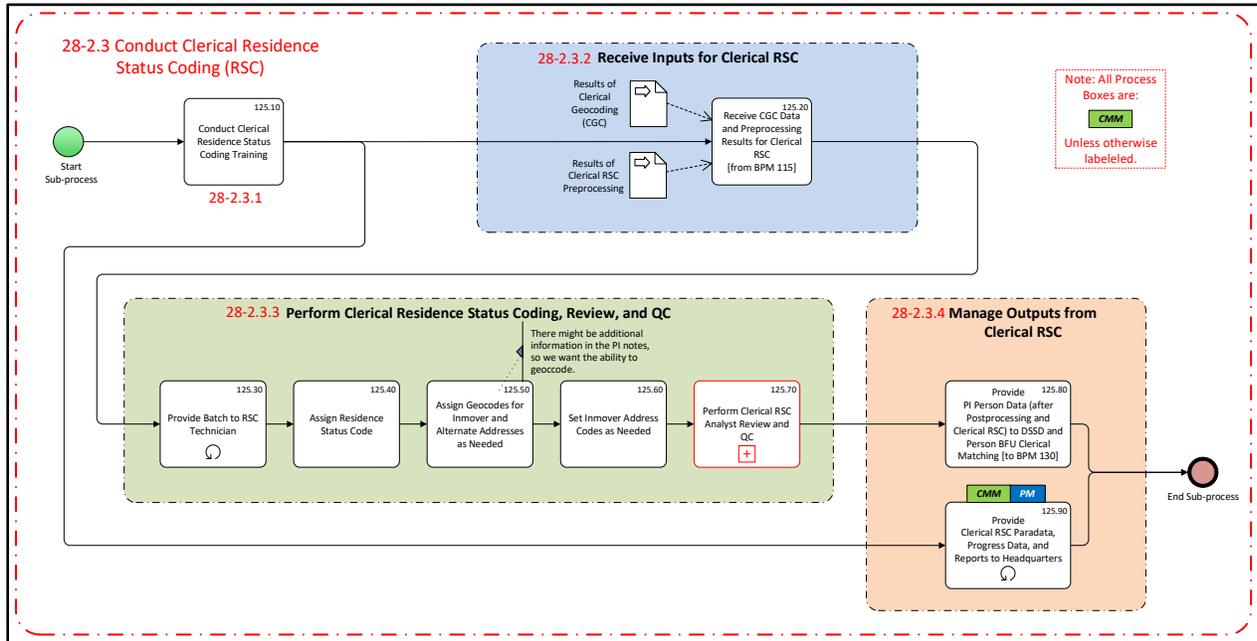


Figure 41: Conduct Clerical Residence Status Coding (RSC)

The main objective of Clerical RSC is to have the technicians review a PI case that is flagged for residence status code review or assign a residence status code, using notes collected during PI, to a rostered person. Before Clerical RSC begins, technicians and analysts are trained on assigning residence status codes using the clerical matching system. Data are received from multiple sources and will go through a series of data preparation steps. Some inmover and alternate addresses from PI may require geocodes to determine the correct residence status code, so after the BCU completes Clerical Geocoding, then Clerical Residence Status coding can be completed. These data files are used for Clerical RSC, Review, and QC. Analysts conduct a QC on a sample of technicians’ work and review any cases referred by the technician. The output from the Clerical RSC consists of a results file, which is then used during Person BFU Clerical Matching.

Conduct Clerical Residence Status Coding Training [CMM 28-2.3.1]

This operational subactivity consists of a single activity (see [Figure 41](#) above).

Once training materials are created, clerical matchers are trained on the clerical matching system to review and assign residence status codes. This is done through on-site instructor-led training.

Receive Inputs for Clerical RSC [CMM 28-2.3.2]

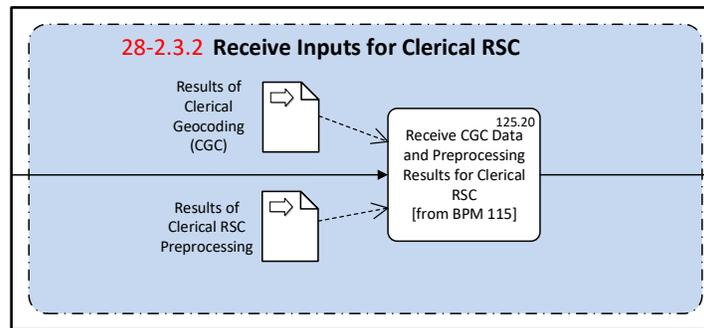


Figure 42: Receive Inputs for Clerical RSC

The results of CGC and Clerical RSC preprocessing are received to prepare for Clerical RSC.

Perform Clerical Residence Status Coding, Review, and QC [CMM 28-2.3.3]

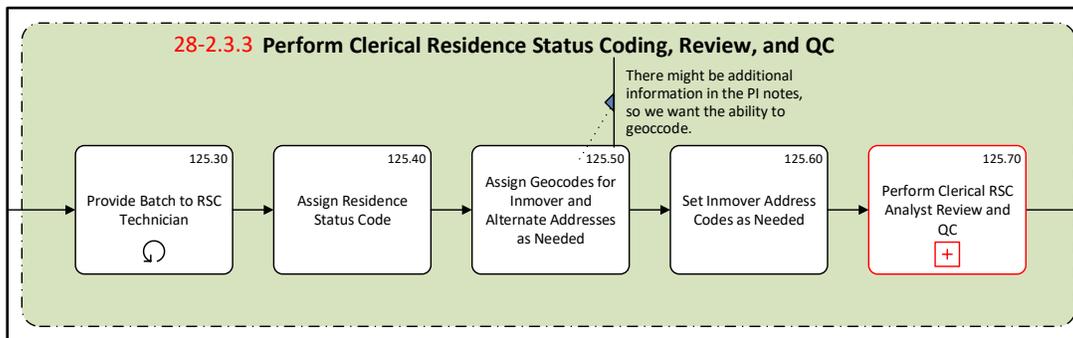


Figure 43: Perform Clerical Residence Status Coding, Review, and QC

PI cases that have been identified as needing a review are sent to Clerical RSC. Technicians will review cases with a missing residence status code and use the data collected in the PI to assign a residence status code. Analysts perform the QC of the technicians' work. The QC process for Clerical RSC consists of analysts performing a full review of BCUs selected for the matching QC sample.

Manage Outputs from Clerical RSC [CMM 28-2.3.4]

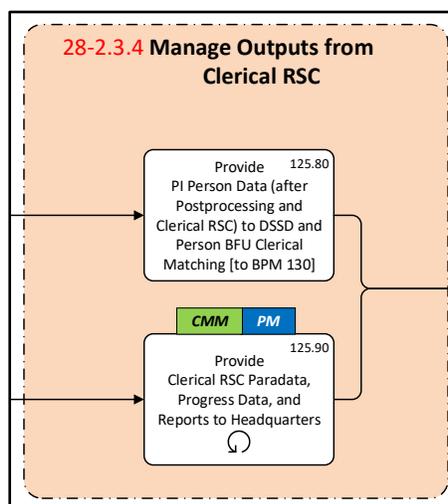


Figure 44: Manage Outputs from Clerical RSC

The results of Clerical RSC are loaded into a person clerical matching system to begin Person BFU Clerical Matching.

4.2.2.4 Conduct PES Person Before Followup (BFU) Clerical Matching [CMM 28-2.4]

The “Conduct PES Person Before Followup (BFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES Person Before Followup (BFU) Clerical Matching [CMM 28-2.4].
 - Conduct Person BFU Clerical Matching Training [CMM 28-2.4.1].
 - Receive and Process Inputs for Person BFU Clerical Matching [CMM 28-2.4.2].
 - Perform Person BFU Clerical Matching, Review, and QC [CMM 28-2.4.3].
 - Manage Outputs from Person BFU Clerical Matching [CMM 28-2.4.4].

A detailed view of the activities that make up the “Conduct PES Person Before Followup (BFU) Clerical Matching” operational subactivity is given in [Figure 45](#), [Figure 46](#), [Figure 47](#), and [Figure 48](#) below.

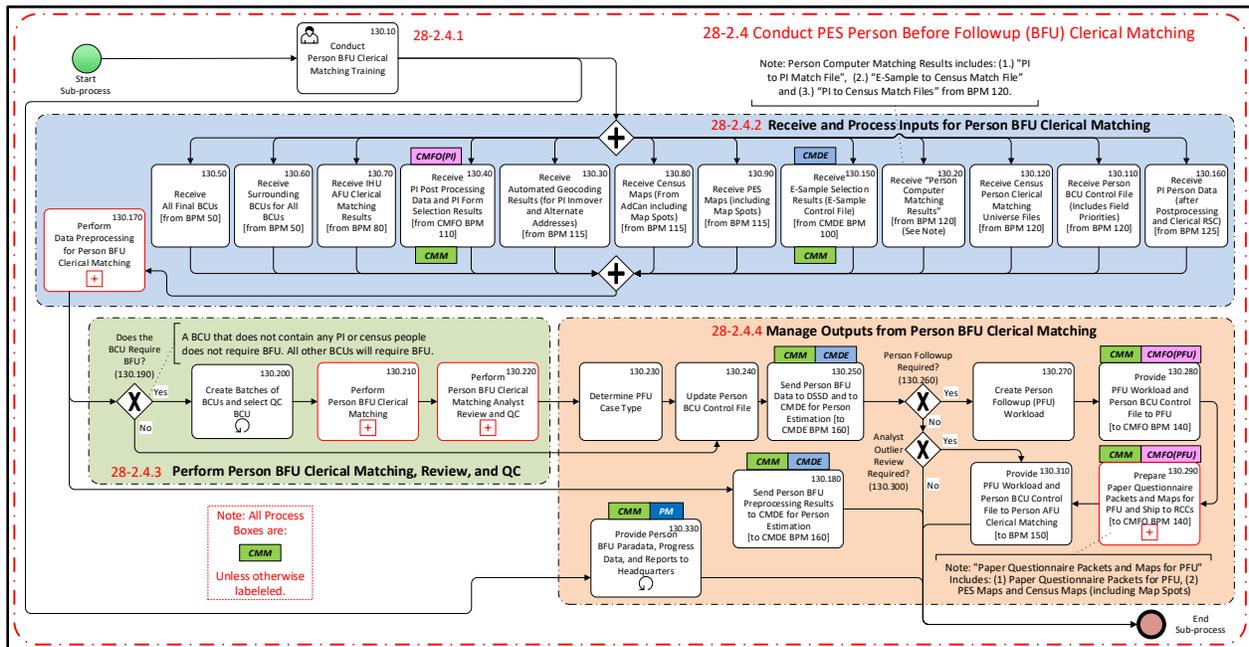


Figure 45: Conduct PES Person Before Followup (BFU) Clerical Matching

The Person BFU Clerical Matching occurs after the Clerical RSC and after the Person Computer Matching. The main objective of Person BFU Clerical Matching is to have the technicians review a match code assigned by automated computer matching or assign a match code. Before clerical matching begins, technicians and analysts are trained on the clerical matching system to perform person matching. Data are received from multiple sources and will go through a series of data preparation steps. These data are then used for Person BFU Clerical Matching, Review, and QC. Analysts conduct a quality check on a sample of technicians’ work and review any cases referred by the technicians. The output of the Person BFU Clerical Matching process will be a file containing the match codes for all person (both PI and Census) and flags indicating which Census or PI people will go to the next operation, the CMFO Person Followup (PFU) field operation.

Conduct Person BFU Clerical Matching Training [CMM 28-2.4.1]

This operational subactivity consists of a single activity (see in Figure 45 above).

Once training materials are created, clerical matchers are trained on the clerical matching system to perform person BFU Clerical Matching. This is done through on-site instructor-led training.

Receive and Process Inputs for Person BFU Clerical Matching [CMM 28-2.4.2]

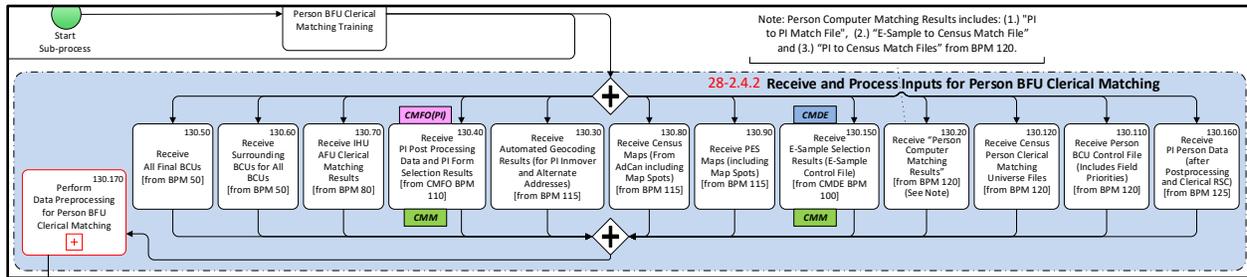


Figure 46: Receive and Process Inputs for Person BFU Clerical Matching

Input data are received from several preceding CMM activities such as IHU AFU Clerical Matching, CGC, Person Computer Matching, and Clerical RSC. Preprocessing of these data files is performed to prepare the data for Person BFU Clerical Matching.

Perform Person BFU Clerical Matching, Review, and QC [CMM 28-2.4.3]

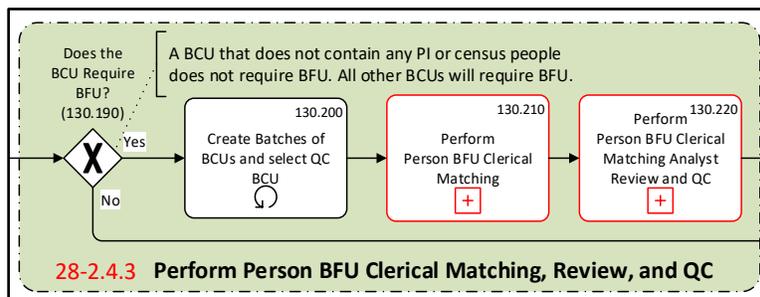


Figure 47: Perform Person BFU Clerical Matching, Review, and QC

During the Person BFU Clerical Matching, the technicians will review the results of Person Computer Matching. In particular, matchers attempt to match PI records to the census, find duplicates in the PI, and find E sample duplicates. Analysts perform the QC of the technicians' work. The QC process for Person BFU Clerical Matching consists of analysts performing a full review of BCUs selected for the matching QC sample.

Manage Outputs from Person BFU Clerical Matching [CMM 28-2.4.4]

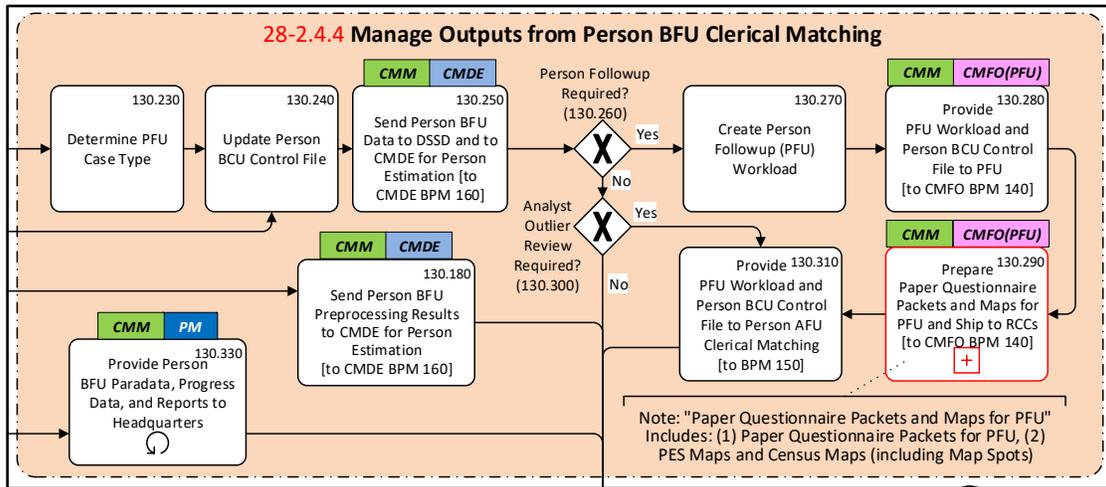


Figure 48: Manage Outputs from Person BFU Clerical Matching

The output from Person BFU Clerical Matching determines the PFU workload. The workload is then provided to PFU, and the paper questionnaire packets are prepared and shipped to the field for use in data collection.

4.2.2.5 Conduct PES Person After Followup (AFU) Clerical Matching [CMM 28-2.5]

The “Conduct PES Person After Followup (AFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES Person After Followup (AFU) Clerical Matching [CMM 28-2.5].
 - Conduct Person AFU Clerical Matching Training [CMM 28-2.5.1].
 - Receive and Process Inputs for Person AFU Clerical Matching [CMM 28-2.5.2].
 - Perform Person AFU Clerical Matching, Review, and QC [CMM 28-2.5.3].
 - Manage Outputs from Person AFU Clerical Matching [CMM 28-2.5.4].

A detailed view of the activities that make up the “Conduct PES Person After Followup (AFU) Clerical Matching” operational subactivity is given in [Figure 49](#), [Figure 50](#), [Figure 51](#), and [Figure 52](#) below.

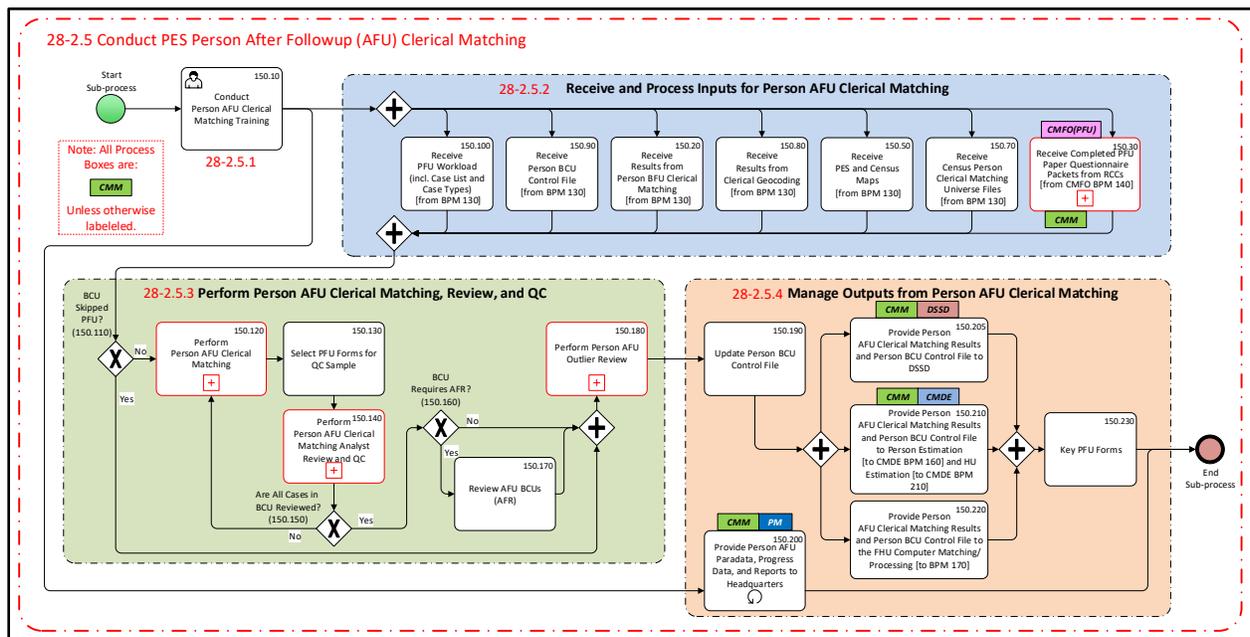


Figure 49: Conduct PES Person After Followup (AFU) Clerical Matching

Following the PFU interview, Person AFU Clerical Matching activities are performed. As PFU forms are returned from interviewing, they are assembled into batches to be reviewed by the clerical matching staff. The PFU interview results are clerically reviewed and the people are coded according to a predetermined set of match codes. Technicians and analysts are allowed to make corrections to previous coding assignments if errors are discovered from the Person BFU Clerical Matching activities, even if the people were not included in the PFU. This clerical review also includes assignment of residence status codes and geocodes if any additional respondent-provided addresses are collected in the PFU. Analysts perform a review of the technicians’ work selected for QC purposes. The analysts also resolve cases that the technicians could not resolve. This process is similar to the process for all other PES clerical matching activities. Person AFU Clerical Matching is the final PES person activity. The results of this activity are sent to PES Estimation to produce person estimates.

Conduct Person AFU Clerical Matching Training [CMM 28-2.5.1]

This operational subactivity consists of a single activity (see Figure 49 above).

Once training materials are created, clerical matchers are trained on the clerical matching system to perform Person AFU clerical matching.

Receive and Process Inputs for Person AFU Clerical Matching [CMM 28-2.5.2]

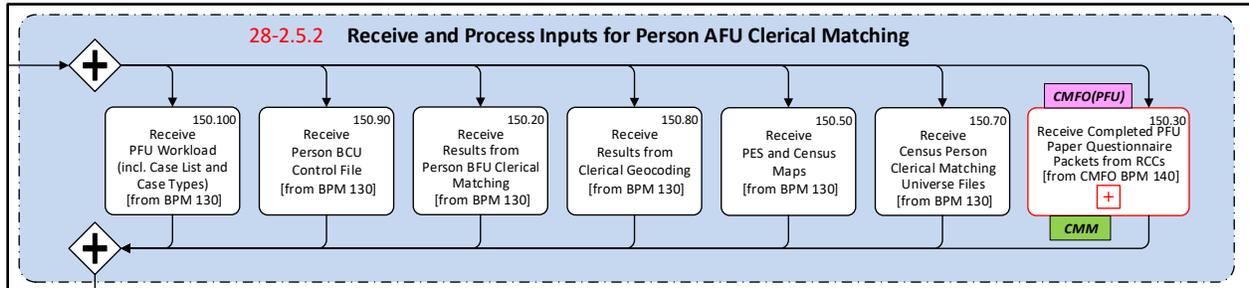


Figure 50: Receive and Process Inputs for Person AFU Clerical Matching

Input data are received from Person BFU Clerical Matching and PFU (including workload and PFU questionnaire packets from the field). These inputs are prepared and used in Person AFU Clerical Matching.

Perform Person AFU Clerical Matching, Review, and QC [CMM 28-2.5.3]

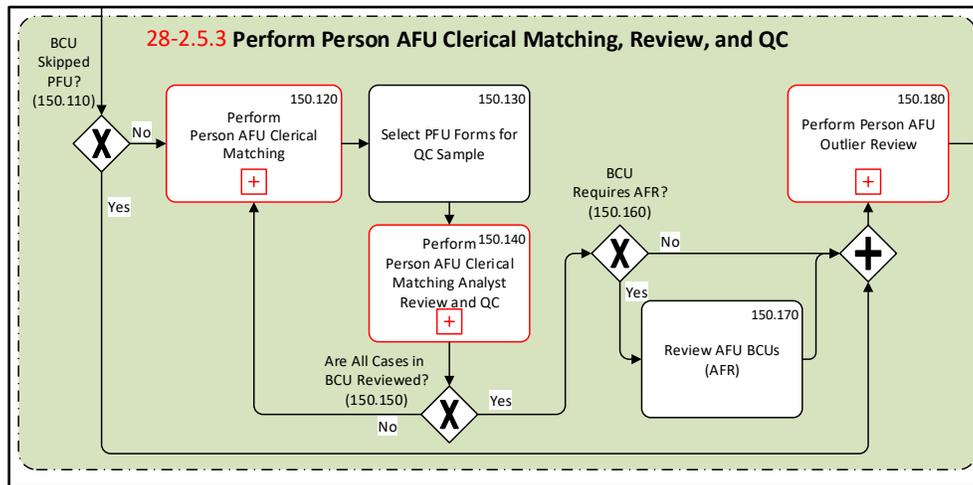


Figure 51: Perform Person AFU Clerical Matching, Review, and QC

Technicians perform Person AFU Clerical Matching work. Then analysts perform a review of the technicians’ work selected for QC purposes. The analysts also resolve any cases that the technicians could not resolve and conduct AFU Outlier Review, which targets BCUs that may need further review.

Manage Outputs from Person AFU Clerical Matching [CMM 28-2.5.4]

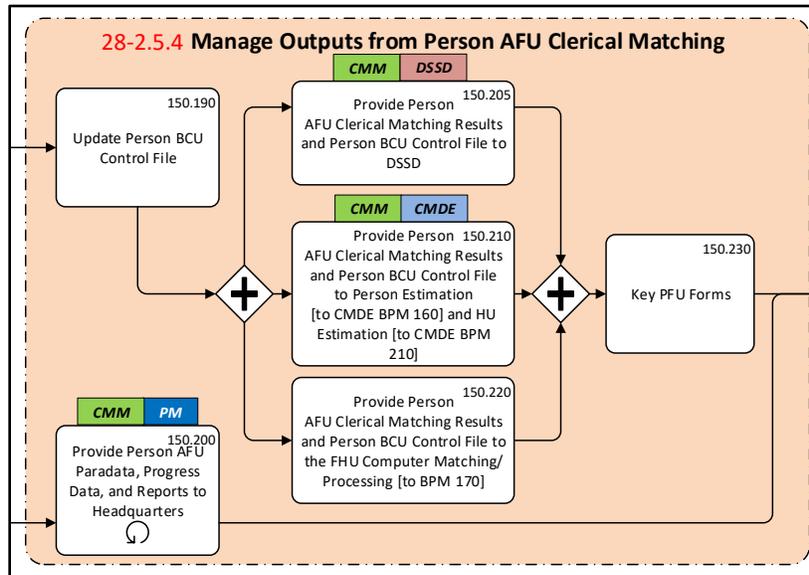


Figure 52: Manage Outputs from Person AFU Clerical Matching

Person AFU Clerical Matching is the final PES person activity. Output files with the results from the PI operation and the person matching activities will be made available for the PES Estimation activities as well as FHU computer matching and processing.

4.2.3 CMM Final Housing Unit (FHU) Matching [CMM 28-3]

The third CMM activity is CMM Final Housing Unit (FHU) Matching.

Figure 53 shows the BPM for the CMM Final Housing Unit (FHU) Matching [CMM 28-3] activity (area within the gray rounded rectangle) and its constituent activities within the overall context of the PES operations.

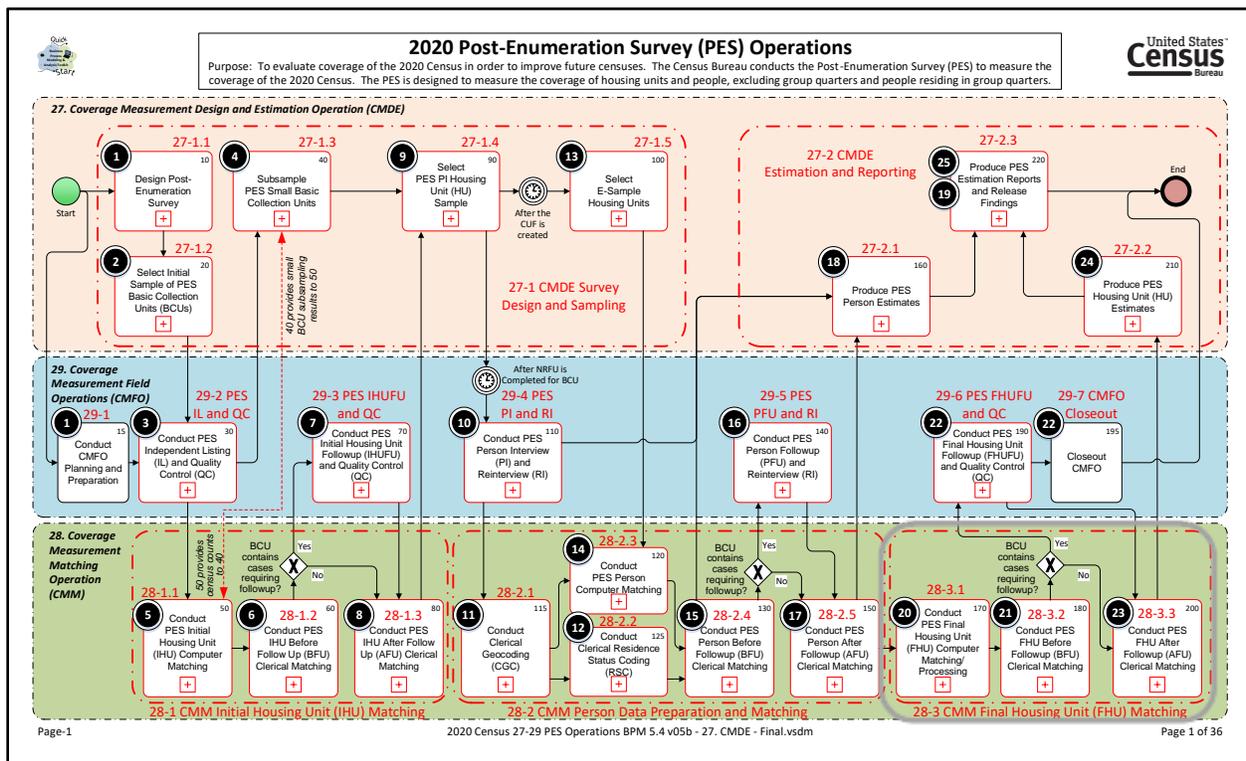


Figure 53: CMM Final Housing Unit (FHU) Matching [CMM 28-3] Activities

The “CMM Final Housing Unit (FHU) Matching” operational activity is subdivided into the following activity areas:

- CMM Final Housing Unit (FHU) Matching [CMM 28-3].
 - Conduct PES Final Housing Unit (FHU) Computer Matching/Processing [CMM 28-3.1].
 - Conduct PES FHU Before Followup (BFU) Clerical Matching [CMM 28-3.2].
 - Conduct PES FHU After Followup (AFU) Clerical Matching [CMM 28-3.3].

The FHU Matching activity contains several subactivities. The primary objective of the FHU Matching activities is to process changes to the HU inventory that occurred between the preliminary census address list used in the IHU matching and the final census address list. More importantly, the FHU processes the final set of HU data, allowing proper evaluation of the final census results.

Subsequent sections describe the “Conduct PES Final Housing Unit (FHU) Computer Matching” operational subactivities in detail.

4.2.3.1 Conduct PES Final Housing Unit (FHU) Computer Matching/Processing [CMM 28-3.1]

The “Conduct PES Final Housing Unit (FHU) Computer Matching/Processing” operational subactivity is subdivided into the following activity areas:

- Conduct PES Final Housing Unit (FHU) Computer Matching/Processing [CMM 28-3.1]
 - Receive and Process Inputs for FHU Computer Matching/Processing [CMM 28-3.1.1].
 - Perform FHU Computer Matching/Processing [CMM 28-3.1.2].

A detailed view of the activities that make up the “Conduct PES Final Housing Unit (FHU) Computer Matching/Processing” operational subactivity is given in [Figure 54](#) below.

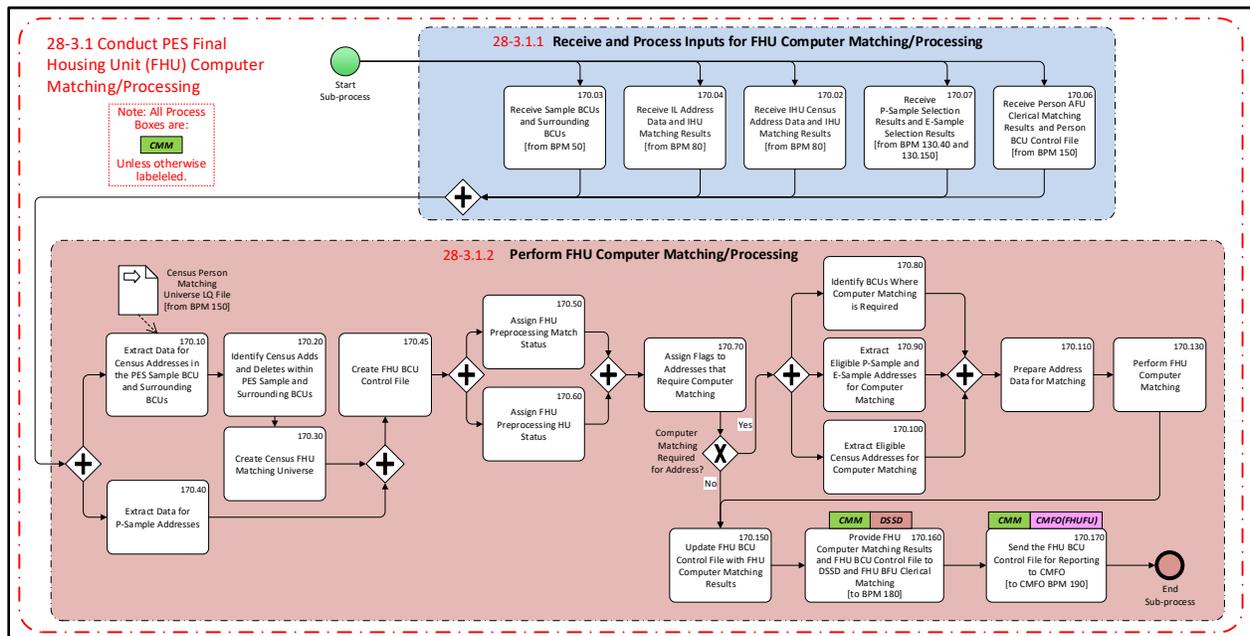


Figure 54: Conduct PES Final Housing Unit (FHU) Computer Matching/Processing

In the FHU Computer Matching and Processing, information from all previous stages of computer and clerical matching from both the HU and person activities, coupled with final Census data, is used to update HU records. This process updates data files and identifies units that will go to the FHU BFU Clerical Matching activity. These results are loaded into the clerical matching system, which is subsequently used by clerical matchers.

Receive and Process Inputs for FHU Computer Matching/Processing [CMM 28-3.1.1]

Input data are received from multiple sources and will go through a series of data preparation steps. These files are then used for FHU Computer Matching.

The details of this operational subactivity are shown in [Figure 54](#) above.

Perform FHU Computer Matching/Processing [CMM 28-3.1.2]

The details of this operational subactivity are shown in [Figure 54](#) above.

The FHU Computer Matching/Processing determine which HUs will proceed to the FHU BFU Clerical Matching activity, based on changes to the IL or Census units since the IHU Matching activities and the IHUFU operation were conducted.

4.2.3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching [CMM 28-3.2]

The “Conduct PES FHU Before Followup (BFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES FHU Before Followup (BFU) Clerical Matching [CMM 28-3.2].
 - Conduct FHU BFU Clerical Matching Training [CMM 28-3.2.1].
 - Receive and Process Inputs for FHU BFU Clerical Matching [CMM 28-3.2.2].
 - Perform FHU BFU Clerical Matching, Review, and QC [CMM 28-3.2.3].
 - Manage Outputs from FHU BFU Clerical Matching [CMM 28-3.2.4].

A detailed view of the activities that make up the “Conduct PES FHU Before Followup (BFU) Clerical Matching” operational subactivity is given in [Figure 55](#), [Figure 56](#), [Figure 57](#), and [Figure 58](#) below.

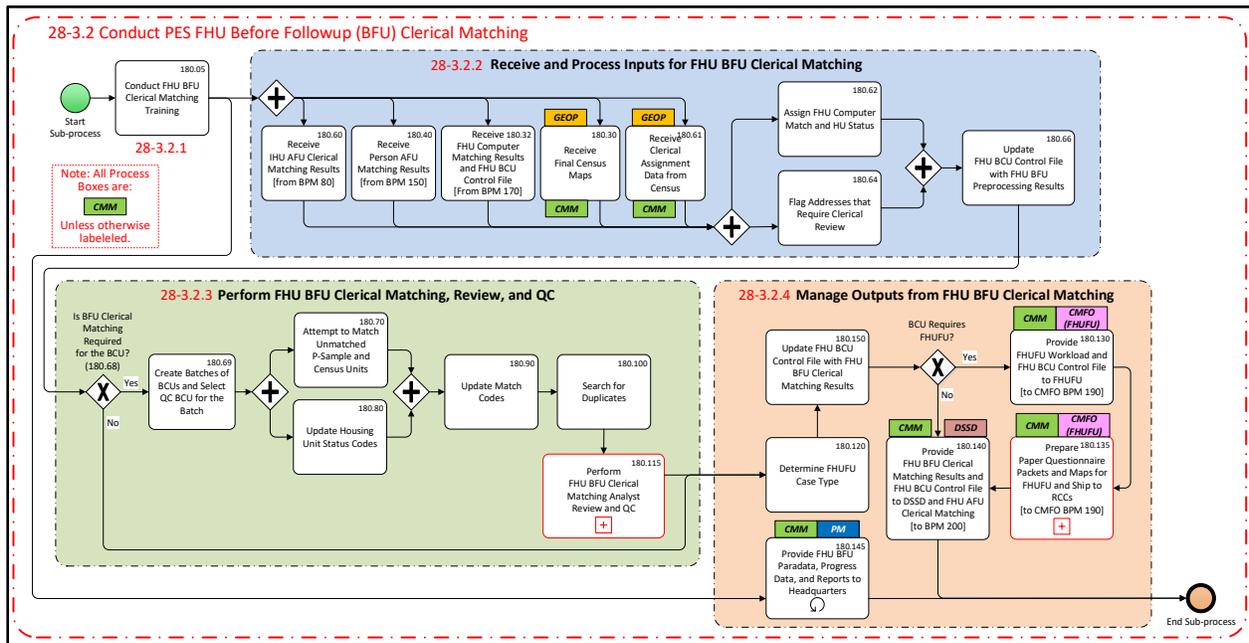


Figure 55: Conduct PES FHU Before Followup (BFU) Clerical Matching

The FHU BFU Clerical Matching activity uses the results of the computer matching/processing stage. Before FHU BFU Clerical Matching begins, technicians and analysts are trained on the clerical matching system. Data are received from multiple sources and go through a series of data preparation steps. These files are then used for FHU BFU Clerical Matching, Review, and QC. In FHU BFU, results of FHU Computer Matching are reviewed and final match codes are assigned to indicate the results of the review. Analysts conduct FHU BFU Clerical Matching. The product of the FHU BFU Clerical Matching process will be a file containing the FHU match codes for all addresses and flags indicating which census or IL units will go to the next operation, the CMFO Final Housing Unit Followup (FHUFU) field operation.

Conduct FHU BFU Clerical Matching Training [CMM 28-3.2.1]

This operational subactivity consists of a single activity (see Figure 55 above).

Once training materials are created, clerical matchers are trained on the clerical matching system. This is done through on-site instructor-led training.

Receive and Process Inputs for FHU BFU Clerical Matching [CMM 28-3.2.2]

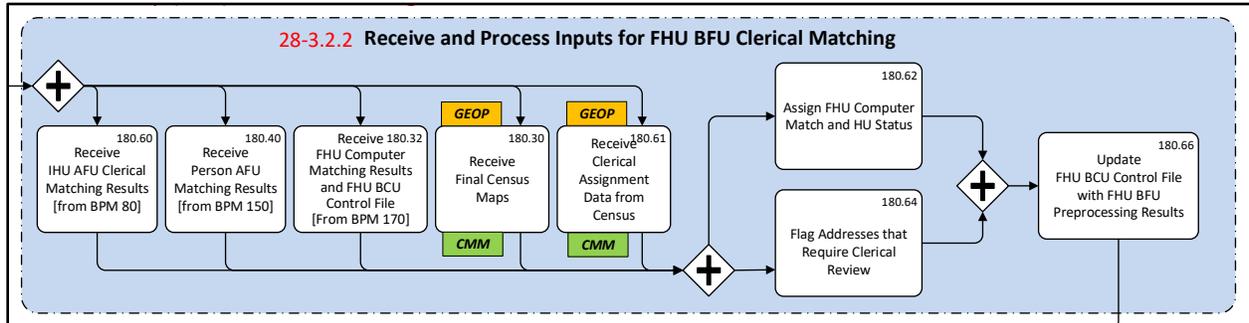


Figure 56: Receive and Process Inputs for FHU BFU Clerical Matching

This activity receives and processes inputs from multiple sources to prepare for FHU BFU Clerical Matching.

Perform FHU BFU Clerical Matching, Review, and QC [CMM 28-3.2.3]

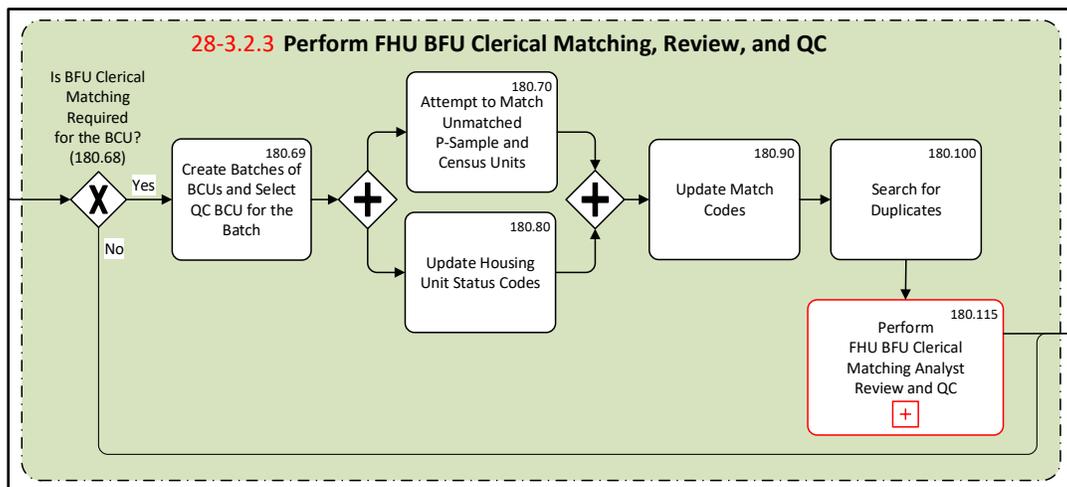


Figure 57: Perform FHU BFU Clerical Matching, Review, and QC

During FHU BFU Clerical Matching, the analysts use computer-assisted clerical matching techniques to review and assign the status of match, possible match, or nonmatch to addresses from the FHU Computer Matching. QC is conducted the same as all other clerical matching activities, with analysts QCing technicians’ work. Those cases that need additional information such as unresolved housing unit status or potential duplicates are candidates for the CMFO FHUFU field operation.

Manage Outputs from FHU BFU Clerical Matching [CMM 28-3.2.4]

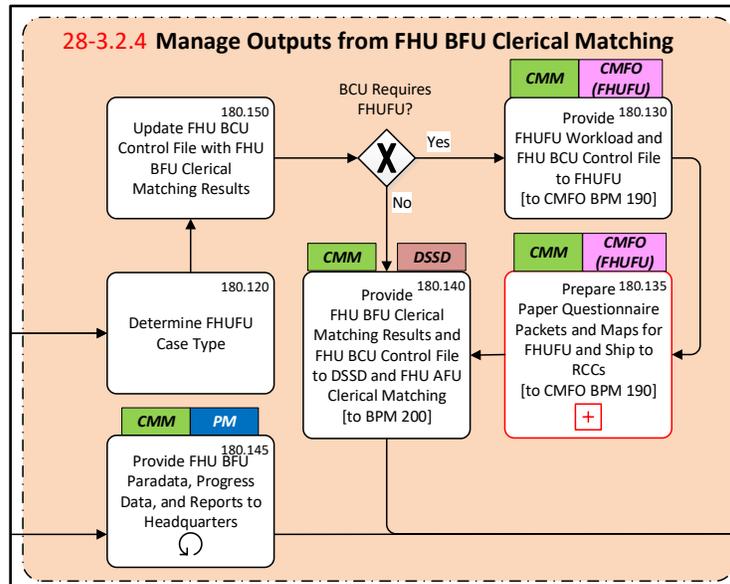


Figure 58: Manage Outputs from FHU BFU Clerical Matching

The output from FHU BFU Clerical Matching determines the FHUFU workload. The workload is then provided to FHUFU, and the paper questionnaire packets are prepared and shipped to the field to use to collect data.

4.2.3.3 Conduct PES FHU After Followup (AFU) Clerical Matching [CMM 28-3.3]

The “Conduct PES FHU After Followup (AFU) Clerical Matching” operational subactivity is subdivided into the following activity areas:

- Conduct PES FHU After Followup (AFU) Clerical Matching [CMM 28-3.3].
 - Conduct FHU AFU Clerical Matching Training [CMM 28-3.3.1].
 - Receive and Process Inputs for FHU AFU Clerical Matching [CMM 28-3.3.2].
 - Perform FHU AFU Clerical Matching, Review, and QC [CMM 28-3.3.3].
 - Manage Outputs from FHU AFU Clerical Matching [CMM 28-3.3.4].

A detailed view of the activities that make up the “Conduct PES FHU After Followup (AFU) Clerical Matching” operational subactivity is given in [Figure 59](#), [Figure 60](#), [Figure 61](#), and [Figure 62](#) below.

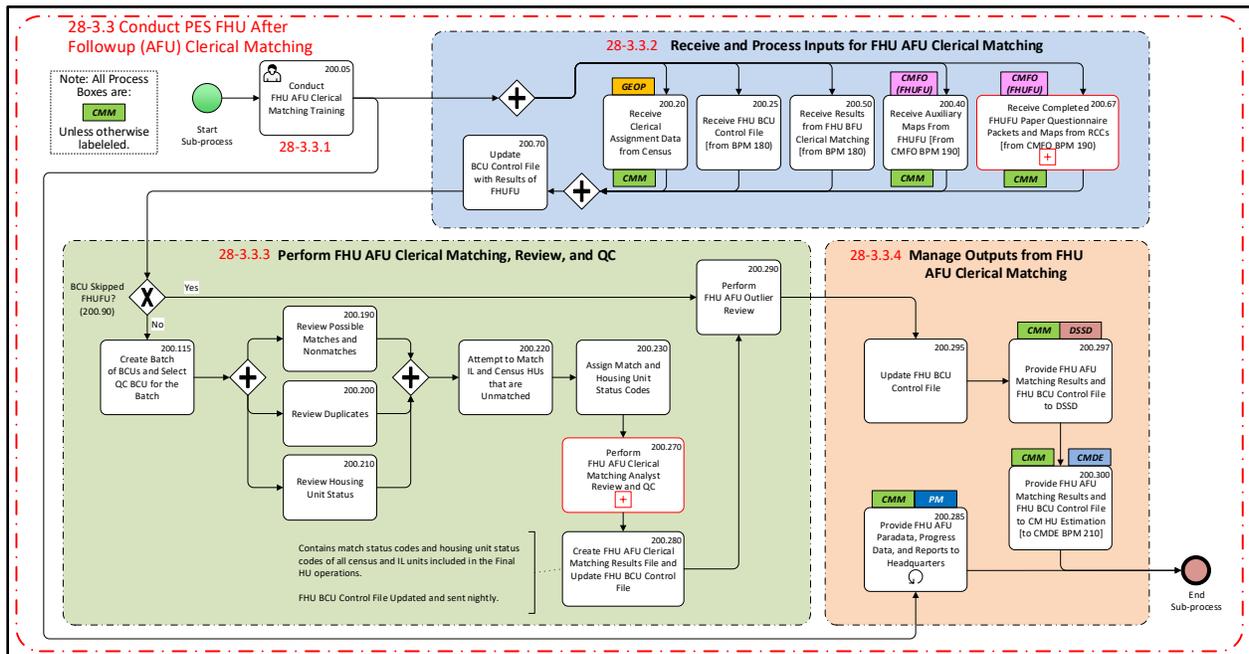


Figure 59: Conduct PES FHU After Followup (AFU) Clerical Matching

The last step in the FHU matching activities is the FHU AFU Clerical Matching. FHU AFU matching staff will attempt to determine unit status, match status, or enumeration status and assign appropriate codes to each case sent to FHUFU. Before clerical matching begins, technicians and analysts are trained on the clerical matching system. Data are received from multiple sources and will go through a series of data preparation steps. The data are from FHUFU and previous person or HU matching activities. These data files are then used for FHU AFU Clerical Matching, Review, and QC. Analysts perform QC, and an output file with the results from the FHU AFU Clerical Matching activities will be made available for the PES Estimation activities to produce HU estimates.

Conduct FHU AFU Clerical Matching Training [CMM 28-3.3.1]

This operational subactivity consists of a single activity (see Figure 59 above).

Once training materials are created, technicians and analysts are trained on the clerical matching system to conduct FHU AFU clerical matching activities. This is done through on-site instructor-led training.

Receive and Process Inputs for FHU AFU Clerical Matching [CMM 28-3.3.2]

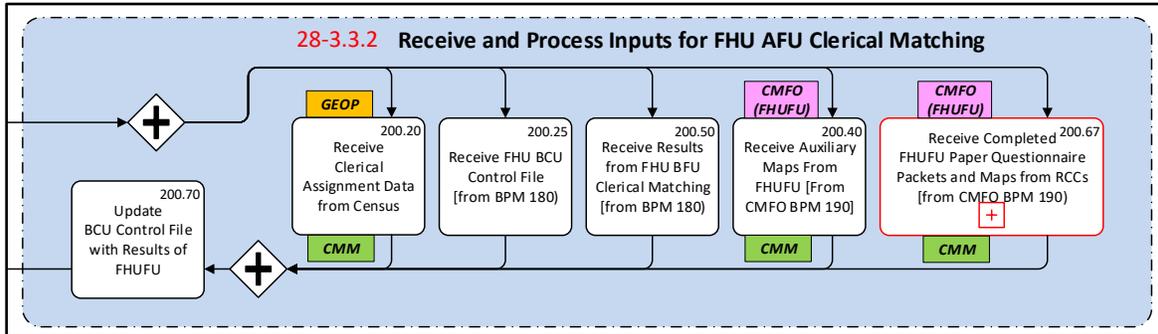


Figure 60: Receive and Process Inputs for FHU AFU Clerical Matching

This activity receives and processes results from FHU BFU clerical matching and FHUFU paper questionnaire packets from field.

Perform FHU AFU Clerical Matching, Review, and QC [CMM 28-3.3.3]

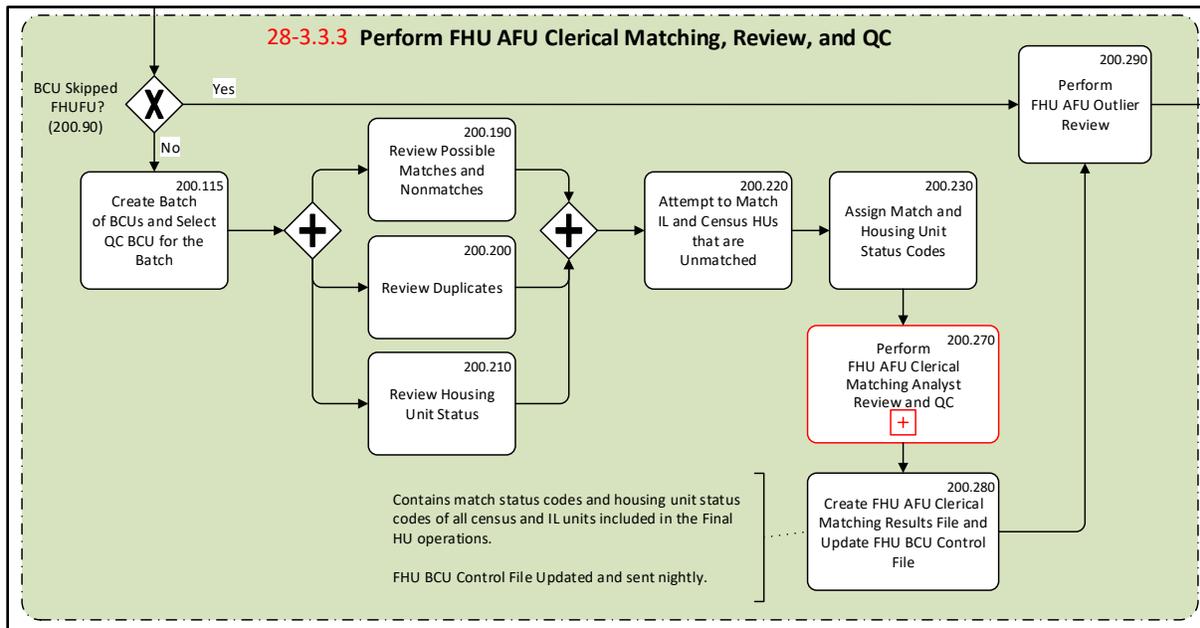


Figure 61: Perform FHU AFU Clerical Matching, Review, and QC

The FHU AFU Clerical Matching activity will have results from the IHU matching and Person matching activities, and the CMFO FHUFU field operation. Using this information, technicians and analysts will attempt to determine unit status, match status, or enumeration status and

assign appropriate codes to each case sent to FHUFU. QC is performed in the same way as other clerical matching activities, where the analysts are QCing the technicians' work.

Manage Outputs from FHU AFU Clerical Matching [CMM 28-3.3.4]

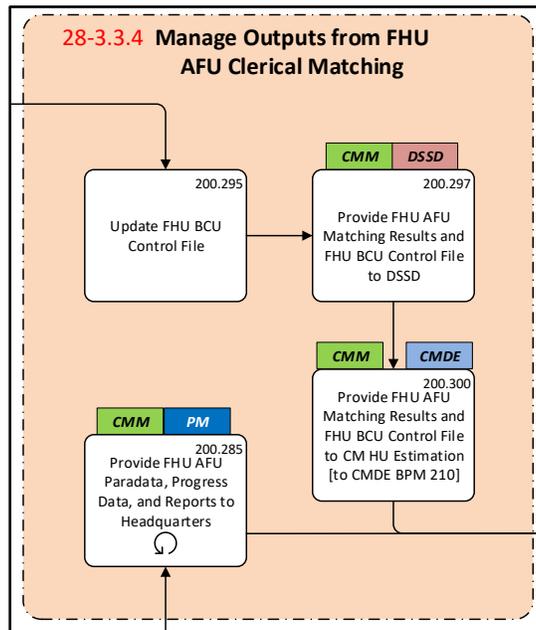


Figure 62: Manage Outputs from FHU AFU Clerical Matching

An output file with the results from the FHU AFU Clerical Matching activities will be made available for the PES Estimation activities.

5. CMFO Design Overview and Detailed Process Description [29]

5.1 CMFO Design Overview

The sections below present the high-level design for the Coverage Measurement Field Operations (CMFO). Please refer to the 2020 Census Operational Plan for a complete inventory of design decisions for all 2020 Census operations.

5.1.1 High-Level Operational Design

The design of the CMFO operation for the 2020 Census includes seven major operational activity areas:

- **CMFO Planning and Preparation.**
- **PES Independent Listing (IL) and Quality Control (QC).**
- **PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC).**
- **PES Person Interview (PI) and Reinterview (RI).**
- **PES Person Followup (PFU) and Reinterview (RI).**
- **PES Final Housing Unit Followup (FHUFU) and Quality Control (QC).**
- **CMFO Closeout.**

Each of these major activity areas is summarized below. Together, these activity areas represent the complete set of work that needs to be performed to conduct this operation.

CMFO Planning and Preparation

CMFO will perform planning and preparation activities in advance of the 2020 Census operations. This will include the development of questionnaires, contact strategies, business rules, and detailed systems requirements. CMFO will also hire field staff and prepare for the training of field staff.

PES Independent Listing (IL) and Quality Control (QC)

The IL operation lists all housing units and potential housing units in each PES sample BCU. It is conducted by personal visit using the Listing and Mapping Application (LiMA). Information regarding the number of housing units belonging to a particular structure is also collected. A

subsample of the listed BCUs is selected and relisted to confirm the correctness of the information collected by the field staff as the listing QC part of this operation.

PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)

The IHUFU operation follows the initial housing unit matching of the PES IL addresses to the preliminary 2020 Census housing unit and group quarters addresses. This operation is conducted using paper questionnaires and attempts to resolve differences between the IL information and census information. It also attempts to resolve potential duplicates and housing unit status, if needed. The QC part of this operation checks the BCUs that completed the IHUFU for completeness and accuracy of the information collected during follow-up.

PES Person Interview (PI) and Reinterview (RI)

The PI operation is conducted at selected housing units to build an independent roster of people currently living at each housing unit. PI interviewers will use a computer-assisted data collection instrument on laptops to obtain information about the residents of the sample HU on Interview Day (the day the PI is conducted) and people who moved out of the sample housing unit between Census Day (April 1, 2020) and Interview Day. The RI part of this operation checks the quality of the work done by interviewers in PI to detect and deter interviewer errors and data falsification.

PES Person Followup (PFU) and Reinterview (RI)

The PFU operation follows the matching of the people rostered at the sample addresses during PI and the people enumerated in the 2020 Census in the PES sample BCUs and surrounding BCUs. PFU interviewers will use paper questionnaires to follow up on possible matches or possible duplicates where one of the records in the linked pair is located outside the PES sample BCU or ring of surrounding BCUs. The RI part of this operation checks for completeness and accuracy of the information collected during follow-up.

PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)

The FHUFU operation is conducted following the final housing matching of the IL addresses to the final 2020 Census addresses. Similar to IHUFU, this operation is conducted using paper questionnaires and attempts to resolve differences between the IL information and Census information. It also attempts to resolve potential duplicates and housing unit status, if needed. The QC part of this operation checks the BCUs that completed the FHUFU for completeness and accuracy of the information collected during follow-up.

CMFO Closeout

After the FHUFU data collection operation is completed, CMFO will perform closeout activities. These activities include reducing field staff as workloads are reduced. It also includes conducting operational assessments of each PES data collection operation.

The full hierarchy of activities for the CMFO operation is provided in Appendix C in the form of an Activity Tree. In the Activity Tree, each major operational activity area listed above is numbered and then decomposed into subactivities, some of which are further decomposed into more detailed subactivities or steps.

For a full description of the operational subactivities that comprise the CMFO operation, see the Detailed Process Description as outlined in Section 5.2 below.

5.1.2 Operational Context for CMFO Activities

The CMFO operational activities are conducted within the context of other 2020 Census operations and other programs or data sources that are external to the 2020 Census Program. Section 2 covers the overall operational context for the PES operations, i.e., the inputs, outputs, controls, and mechanisms that apply for the set of PES operations and elements external to PES. The specific inputs and outputs related to the CMFO operational interaction with the other two PES operations (CMM and CMDE) are given in the next two sections below.

The input and output tables within PES are based on several concepts. A source operation is the PES operation that provides the data exchange while the destination operation receives the data exchange. The Business Process Models (BPMs) that accompany this document use ID numbers (e.g., CMFO BPM 15) that are the references for where the data exchanges appear. The source activity and destination activity for the data exchange provide a quick context for the data. The name of an activity in the table references BPM annotation and also matches an operation's activity tree, which provides organization for this document's detailed process descriptions should a reader wish to consult more detail for descriptions of related pairs of BPMs for a data exchange.

5.1.2.1 CMFO Operational Inputs

Inputs are the data that are consumed by the operation. [Table 12](#) below lists the inputs to CMFO from the other PES operations (i.e., CMDE and CMM).

Table 12: CMFO Operational Inputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Inputs from CMDE:		
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>PES BCU Sample File (Excel)</i>	CMFO BPM 15	29-1 CMFO Planning and Preparation
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>Listing Sample Control Input File (SCIF)</i>	CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)
CMDE BPM 20	27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)	<i>PSU File</i>	CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)
CMDE BPM 90	27-1.4 Select PES PI Housing Unit (HU) Sample	<i>Updated Preliminary Enhanced List (PEL)</i>	CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)
		Inputs from CMM:		
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>IHUFU Workload</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>IHU BCU Control File</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets and Maps for IHUFU</i>	CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)
CMM BPM 80	28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching	<i>Updated PES Maps (if Any)</i>	CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>PFU Workload</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Person BCU Control File</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets for PFU</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 130	28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching	<i>PES Maps and Census Maps (including Map Spots)</i>	CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>FHUFU Workload</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>FHU BCU Control File</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)
CMM BPM 180	28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching	<i>Paper Questionnaire Packets and Maps for FHUFU</i>	CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)

5.1.2.2 CMFO Operational Outputs

Outputs are the data produced by CMFO. [Table 13](#) below lists the outputs from CMFO to other PES operations (i.e., CMDE and CMM).

Table 13: CMFO Operational Outputs

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Outputs to CMDE:		
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>Independent Listing (IL) HU Counts</i>	CMDE BPM 40	27-1.3 Subsample PES Small Basic Collection Units
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Person Data</i>	CMDE BPM 160	27-2.1 Produce PES Person Estimates

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
		Outputs to CMM:		
CMFO BPM 15	29-1 CMFO Planning and Preparation	<i>Field Priority Codes</i>	CMM BPM 50	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>IL Address List</i>	CMM BPM 50, CMM BPM 60	28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching, 28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>PES Maps (with Map Spots)</i>	CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
CMFO BPM 30	29-2 PES Independent Listing (IL) and Quality Control (QC)	<i>Auxiliary Maps from IL</i>	CMM BPM 60	28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
CMFO BPM 70	29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)	<i>Completed IHUFU Paper Questionnaire Packets and Maps</i>	CMM BPM 80	28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>Automated Geocoding Results for PI Inmover and Alternate Addresses</i>	CMM BPM 115	28-2.1 Conduct Clerical Geocoding (CGC)

Source (Operation BPM Sheet)	Source Activity Name	Data Exchange Name (From CMFO BPM Set)	Destination (Operation BPM Sheet)	Destination Activity Name
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Post Processing Data</i>	CMM BPM 115, CMM BPM 120, CMM BPM 130	28-2.1 Conduct Clerical Geocoding (CGC), 28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching
CMFO BPM 110	29-4 PES Person Interview (PI) and Reinterview (RI)	<i>PI Form Selection Results</i>	CMM BPM 120, CMM BPM 130	28-2.2 Conduct PES Person Computer Matching, 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching
CMFO BPM 140	29-5 PES Person Followup (PFU) and Reinterview (RI)	<i>Completed PFU Paper Questionnaire Packets</i>	CMM BPM 150	28-2.5 Conduct PES Person After Followup (AFU) Clerical Matching
CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)	<i>Completed FHUFU Paper Questionnaire Packets and Maps</i>	CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching
CMFO BPM 190	29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)	<i>Auxiliary Maps from FHUFU</i>	CMM BPM 200	28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching

5.2 CMFO Detailed Process Description

Figure 63 is a top-level Business Process Model (BPM) showing the Level 1 activity areas within the PES operations. BPMs for the 2020 Census follow industry-standard Business Process Model and Notation (BPMN). An explanation of how to read the BPMN notations and a full-sized copy of all of the BPMN diagrams for the CMFO are provided under separate cover.

This top-level BPM serves as the Context Model for the PES operations. A BPMN Context Model displays the high-level activities within the operation and relationships between them, whereas the IDEF0 Context Diagram shown earlier depicts the boundaries of the operation or activity and the interfaces between the operation or activity and other operations and activities with which it is associated.

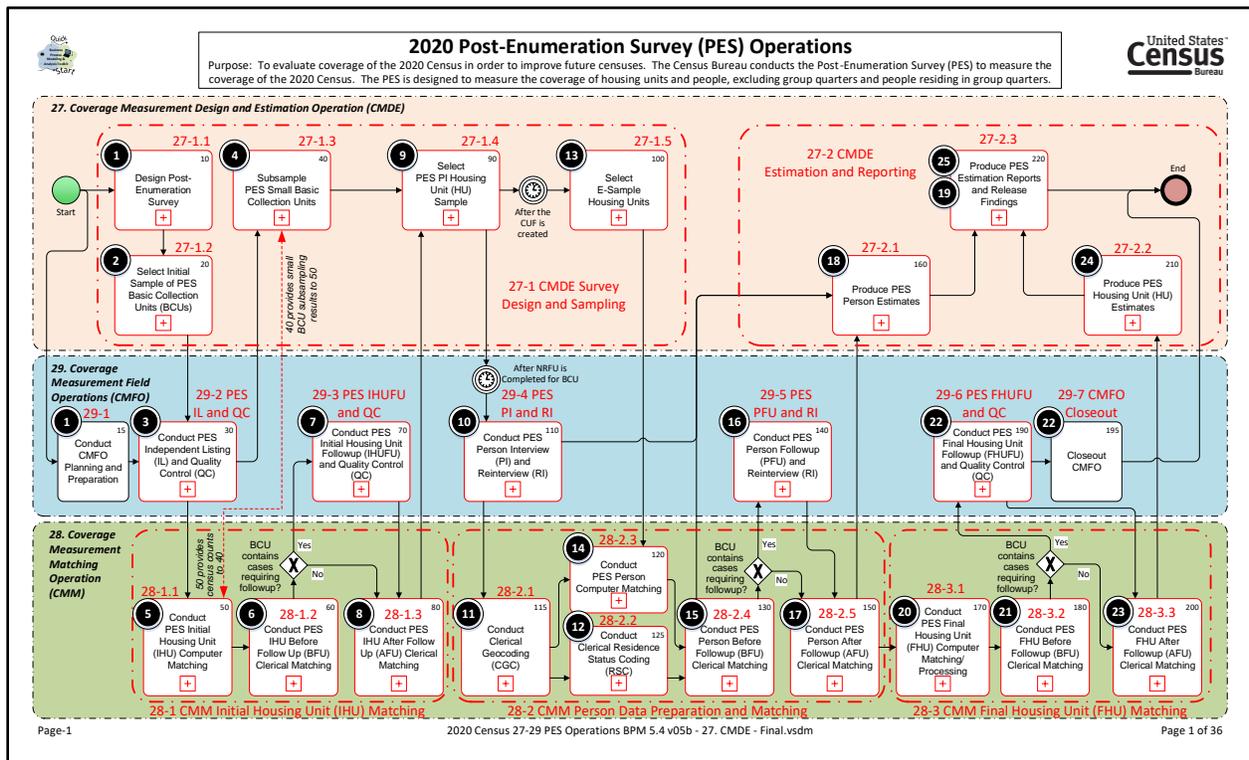


Figure 63: PES Operation Context Model Showing CMFO Operational Context

The CMFO Operation is subdivided into the following activity areas:

- CMFO Planning and Preparation [CMFO 29-1].
- PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2].

- PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3].
- PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4].
- PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5].
- PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6].
- CMFO Closeout [CMFO 29-7].

The business processes for each of these Level 1 activities are discussed along with their inputs and outputs in the following subsections.

5.2.1 CMFO Planning and Preparation [CMFO 29-1]

The first CMFO activity is CMFO Planning and Preparation.

Figure 64 shows the BPM for the CMFO Planning and Preparation [CMDE 29-1] activity (area within the gray box) within the overall context of the PES operations.

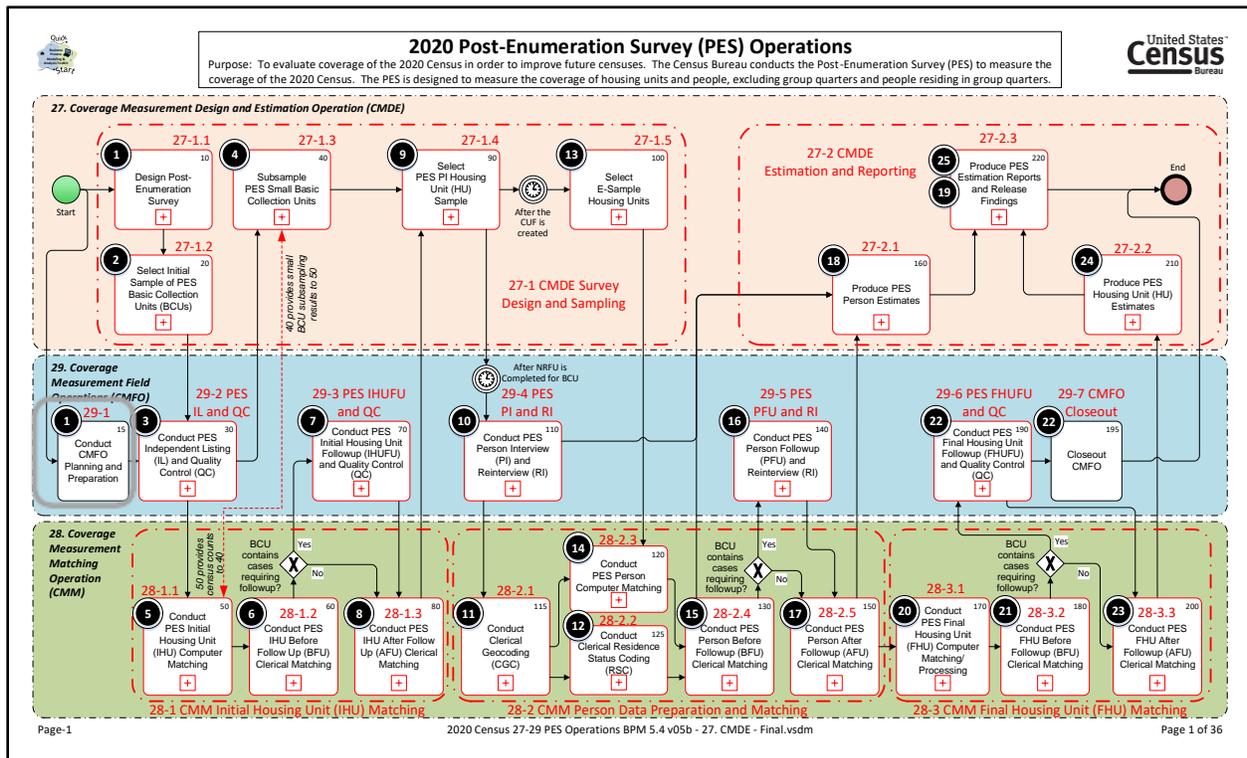


Figure 64: CMFO Planning and Preparation [CMFO 29-1] Activity

The “CMFO Planning and Preparation” operational activity consists of a single activity area, which is described below.

CMFO will perform planning and preparation activities in advance of the 2020 Census operations. This will include the development of questionnaires, contact strategies, business rules, and detailed systems requirements. CMFO will also hire field staff and prepare for the training of that staff.

5.2.2 PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2]

The second CMFO activity is PES Independent Listing (IL) and Quality Control (QC).

Figure 65 shows the BPM for the PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2] activity (area within the gray box) within the overall context of the PES operations.

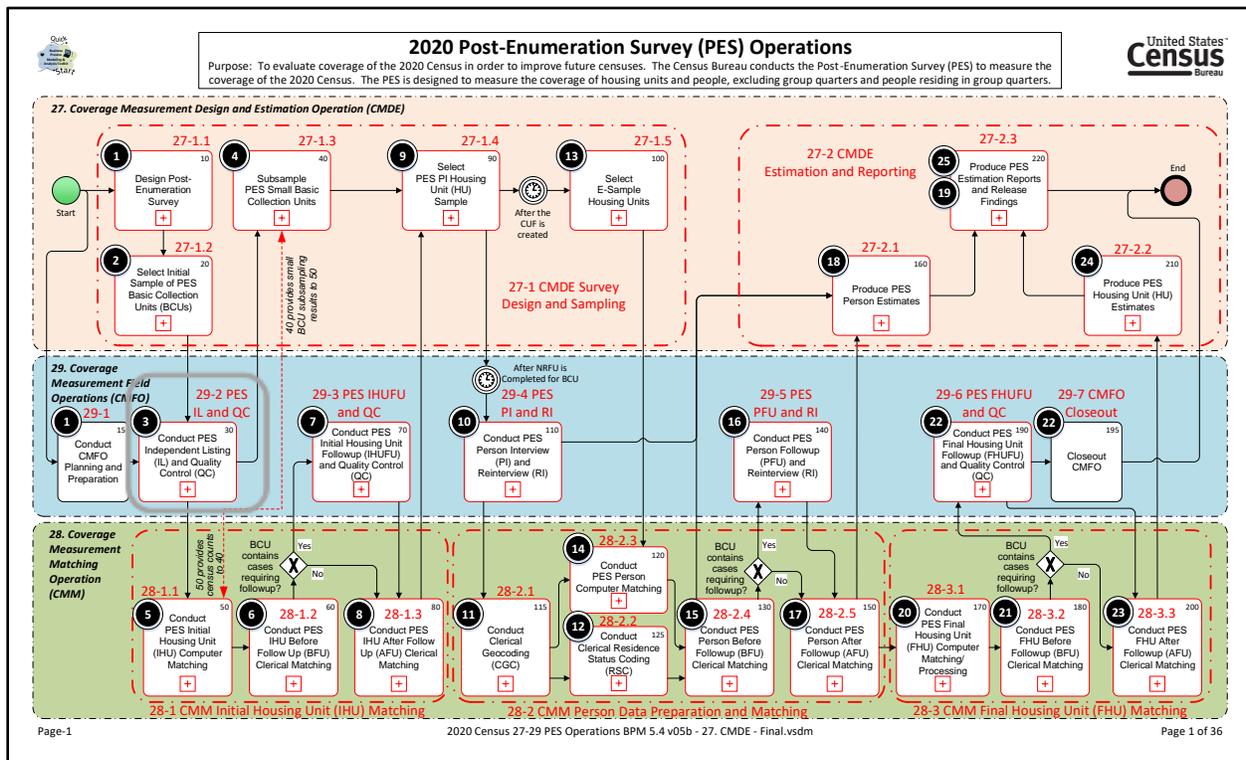


Figure 65: PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2] Activity

The “PES Independent Listing (IL) and Quality Control (QC)” operational activity is subdivided into the following activity areas:

- PES Independent Listing (IL) and Quality Control (QC) [CMFO 29-2].
 - Provide IL Training and Perform Admin Activities [CMFO 29-2.1].
 - Conduct IL Production Fieldwork [CMFO 29-2.2].
 - Manage Workload for IL Quality Control (QC) [CMFO 29-2.3].
 - Conduct IL QC Fieldwork [CMFO 29-2.4].
 - Manage Outputs from PES IL and QC [CMFO 29-2.5].

A detailed view of the subactivities that make up the “PES Independent Listing (IL) and Quality Control (QC)” operational activity is given in [Figure 66](#) below.

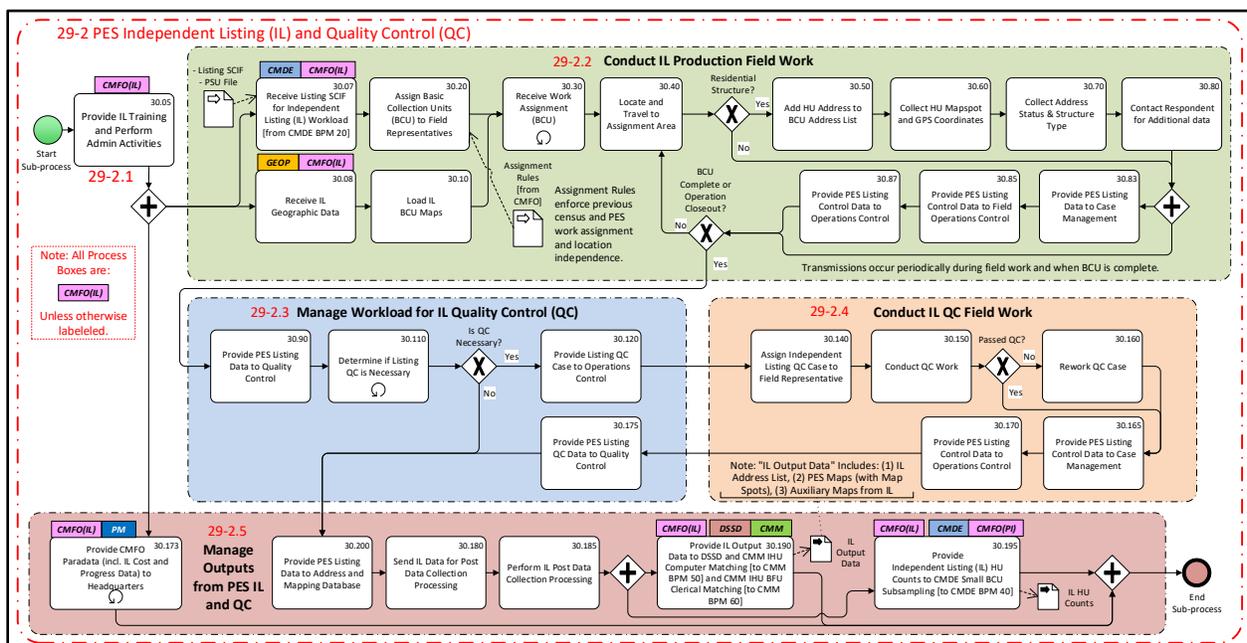


Figure 66: PES Independent Listing (IL) and Quality Control (QC) Subactivities

The IL operation is conducted in advance of Census Day, April 1, 2020. IL listers canvass the PES sample BCUs, collecting address information for housing units and potential housing units. This listing is conducted using the LIMA instrument on a laptop. To obtain information about hidden units, listers will attempt to contact a respondent at each address. Listers will make up to three attempts at the unit before contacting a proxy, and then list by observation only when necessary. A sample of the BCUs listed in production will be selected for QC.

Subsequent sections describe the “PES Independent Listing (IL) and Quality Control (QC)” operational subactivities in detail.

5.2.2.1 Provide IL Training and Perform Admin Activities [CMFO 29-2.1]

This operational subactivity consists of a single activity area shown in [Figure 66](#) above.

Training and administrative activities precede IL data collection. The administrative activities include the onboarding of field staff and distribution of laptops. The training for IL listers will include classroom-style training and an online training course. Listers will also be provided a manual for their reference.

5.2.2.2 Conduct IL Production Fieldwork [CMFO 29-2.2]

A detailed view of the activities that make up this operational subactivity is given in [Figure 67](#) below.

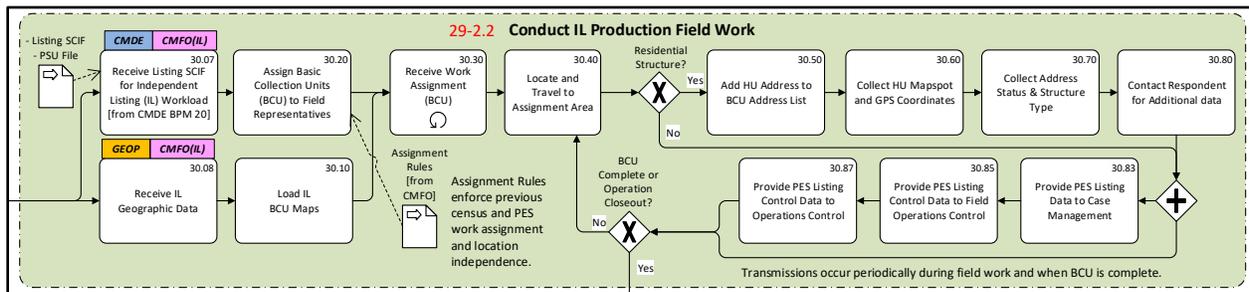


Figure 67: Conduct IL Production Fieldwork

The CMFO IL operation receives the Sample Control Input File (SCIF) from the CMDE. The SCIF, which includes the IL workload, is ingested by the Master Control System (MCS) and the Regional Office Survey Control (ROSCO) system. ROSCO delivers BCUs for listers to work through Mobile Case Management (MCM). Meanwhile, the CMFO IL operation also receives spatial data from Geographic programs. The geographic data is loaded in the LiMA. It is a requirement for CMFO IL that listers cannot have worked in similar 2020 Census operations in the BCU.

Once the lister has received his or her assignment, they will locate and travel to the assignment area. The lister will list the BCU, collect data from respondents when possible, and enter the data into the LiMA instrument. Listing data from the LiMA and control data from the MCM are provided to ROSCO and MCS.

5.2.2.3 Manage Workload for IL Quality Control (QC) [CMFO 29-2.3]

A detailed view of the activities that make up this operational subactivity is given in [Figure 68](#) below.

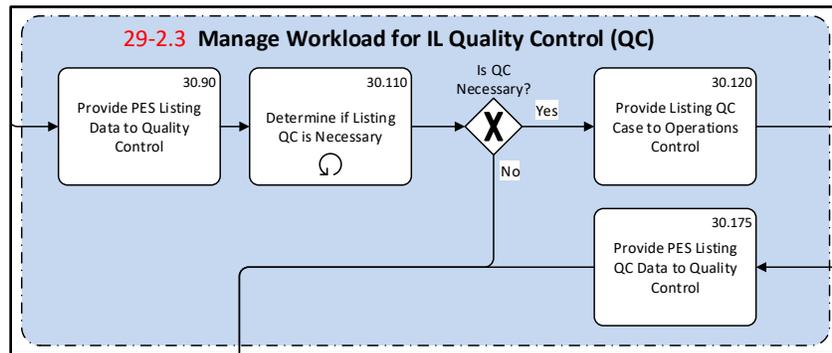


Figure 68: Manage Workload for IL Quality Control (QC)

Once a PES sample BCU has been completed by the lister, the MCS provides the data to the Sampling Matching, Reviewing, and Coding System (SMaRCS) for QC processing. The SMaRCS selects a subsample of the PES sample BCUs in CMFO IL. BCUs that are included in the QC sample are determined to be necessary to be worked by QC listers.

5.2.2.4 Conduct IL QC Fieldwork [CMFO 29-2.4]

A detailed view of the activities that make up this operational subactivity is given in [Figure 69](#) below.

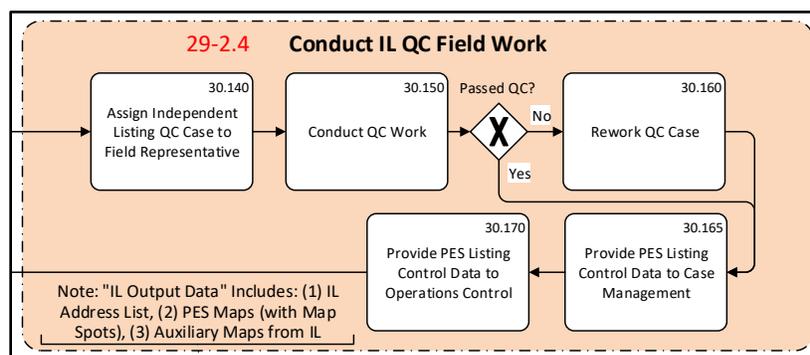


Figure 69: Conduct IL QC Fieldwork

When a BCU is assigned to a QC lister, it is received through MCM. QC listers will check a sample of the addresses in that BCU. Once that sample is complete the instrument determines

if the BCU has passed or failed QC. If the BCU fails QC, the QC lister will rework the remaining addresses in that BCU.

5.2.2.5 Manage Outputs from PES IL and QC [CMFO 29-2.5]

A detailed view of the activities that make up this operational subactivity is given in [Figure 70](#) below.

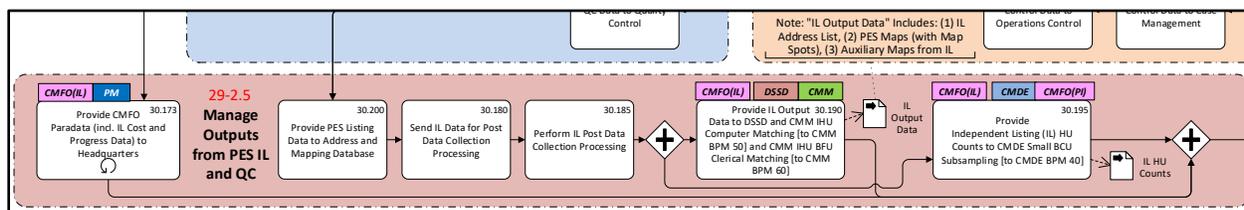


Figure 70: Manage Outputs from PES IL and QC

During the duration of the CMFO IL and QC operation, paradata, including cost and progress data, will be delivered from ROSCO to the Unified Tracking System (UTS). As BCUs are completed by listers and QC listers, address data are delivered from the LiMA to the Master Address File/Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) System. The MAF/TIGER processes the IL address data and creates a PES MAF that is independent of the data from the 2020 Census operations. The PES MAF is delivered to the PES Processing and Control System (PES PCS), which conducts the post-data collection processing. Once the address data have been processed, the data are provided to the CMM operation for IHU computer and clerical matching (including notes files), as well as the CMDE operation for Small BCU Subsampling.

5.2.3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3]

The third CMFO activity is PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC).

[Figure 71](#) shows the BPM for the PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMDE 29-3] activity (area within the gray box) within the overall context of the PES operations.

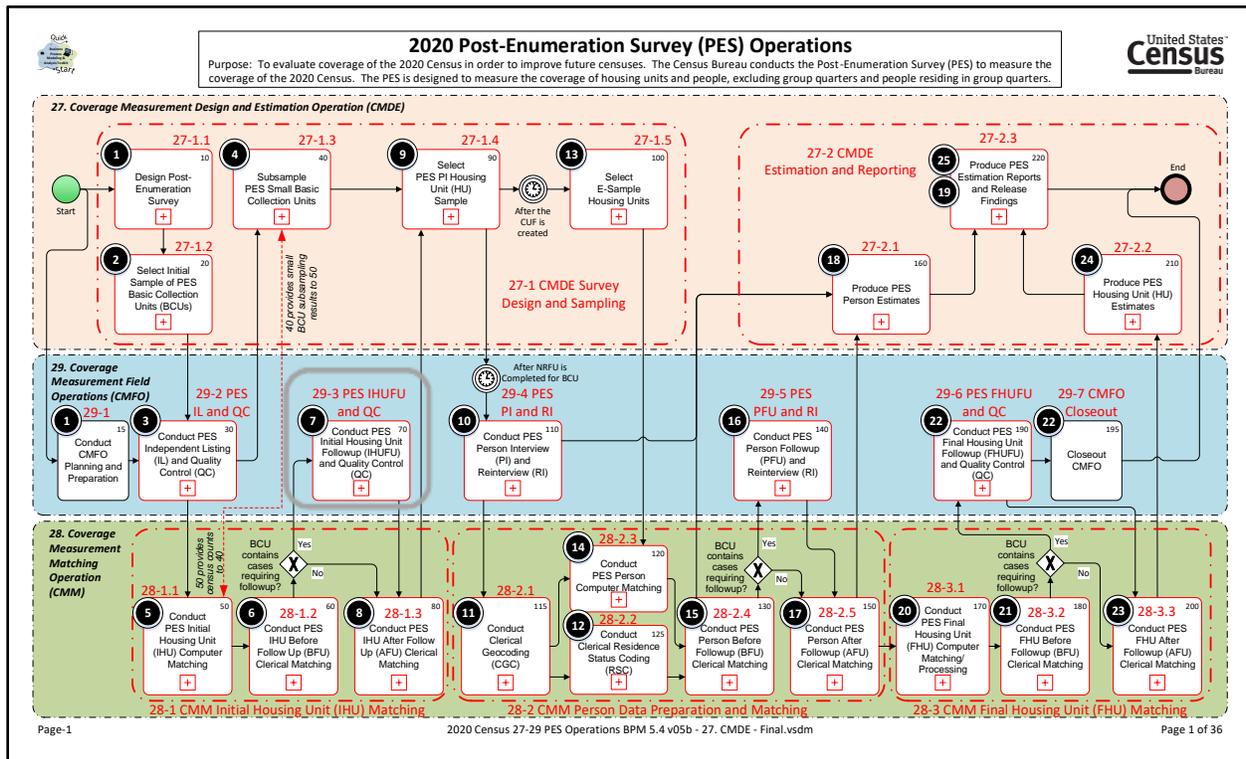


Figure 71: PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3] Activity

The “PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)” operational activity is subdivided into the following activity areas:

- PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) [CMFO 29-3].
 - Provide IHUFU Training and Perform Admin Activities [CMFO 29-3.1].
 - Conduct IHUFU Production Fieldwork [CMFO 29-3.2].
 - Manage Workload for IHUFU Quality Preparation (QC) [CMFO 29-3.3].
 - Conduct IHUFU QC Fieldwork [CMFO 29-3.4].
 - Manage Outputs from PES IHUFU and QC [CMFO 29-3.5].

A detailed view of the subactivities that make up the “PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)” operational activity is given in [Figure 72](#) below.

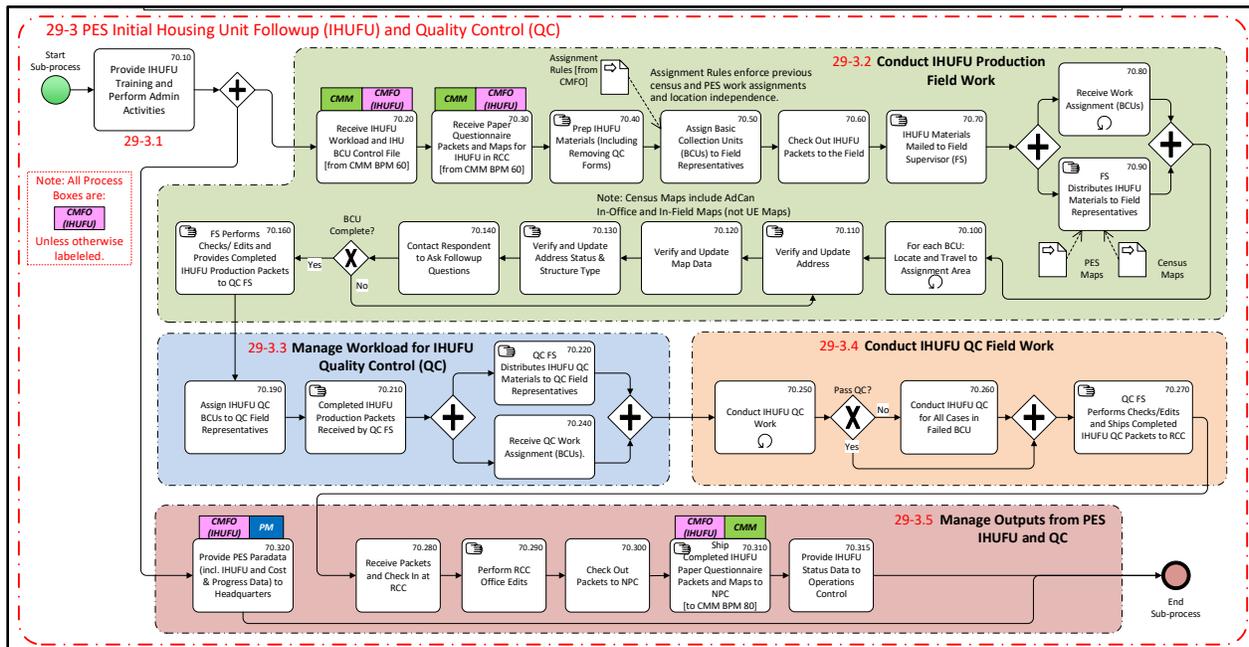


Figure 72: PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC) Subactivities

The IHUFU operation will work with CMM to follow up on any housing units that require more information. These are housing units that identified as nonmatches, possible matches, or duplicates by CMM during initial housing unit computer matching and clerical matching. IHUFU listers will try to resolve differences between the PES address list from IL and the preliminary 2020 Census address list. IHUFU listers will also collect information for housing units whose statuses changed since they were first listed.

Subsequent sections describe the “PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)” operational subactivities in detail.

5.2.3.1 Provide IHUFU Training and Perform Admin Activities [CMFO 29-3.1]

This operational subactivity consists of a single activity area shown in Figure 72 above.

Training and administrative activities precede IHUFU data collection. The administrative activities include the onboarding of field staff and distribution of laptops. The training for IHUFU listers will include classroom-style training and an online training class. IHUFU listers will also be provided a manual for their reference.

5.2.3.2 Conduct IHUFU Production Fieldwork [CMFO 29-3.2]

A detailed view of the activities that make up this operational subactivity is given in [Figure 73](#) below.

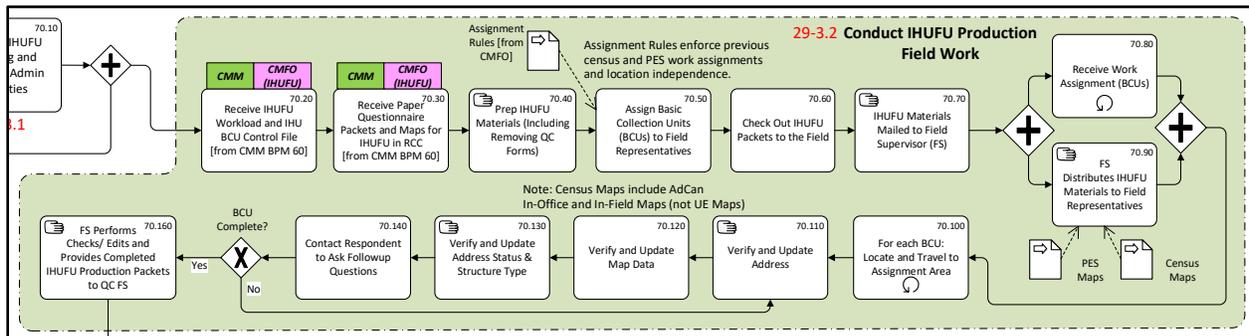


Figure 73: Conduct IHUFU Production Fieldwork

Once the IHUFU workload is received from CMM and the IHUFU questionnaires are received at the regional census center (RCC), RCC staff prepare the IHUFU materials, including the removal of QC forms from the packets.

BCUs are then assigned to IHUFU listers following the assignment rules to enforce the independence of the PES and census address lists. IHUFU listers receive their assignments through the MCM on their laptops. IHUFU packets including maps (IL and Census Address Canvassing) are checked out and mailed to field supervisors. Once the work assignment is received, the field supervisors will then distribute the mailed materials to the IHUFU listers. For each case in a BCU that needs follow-up, an IHUFU lister will locate and travel to the BCU assignment area and verify and update the address, map data, address status, and structure type. The respondent for each address is then interviewed for any follow-up questions. Once the BCU is completed, the field supervisors check and edit the IHUFU questionnaires before providing the IHUFU packets to QC field supervisors for IHUFU QC work.

5.2.3.3 Manage Workload for IHUFU Quality Control (QC) [CMFO 29-3.3]

A detailed view of the activities that make up this operational subactivity is given in [Figure 74](#) below.

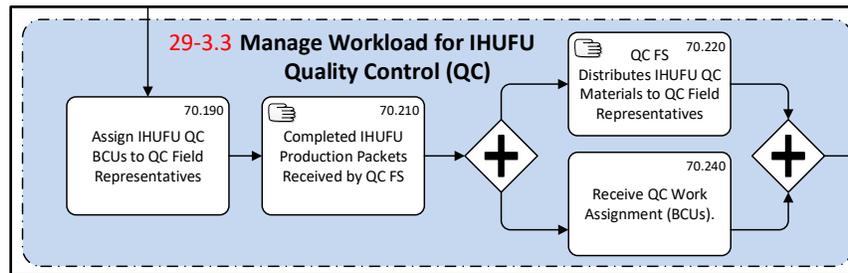


Figure 74: Manage Workload for IHUFU Quality Control (QC)

BCUs for IHUFU QC are assigned to QC listers and the IHUFU packets are received by the QC field supervisors. The QC listers receive the IHUFU QC materials from their supervisors and their BCU assignments are sent to their laptops.

5.2.3.4 Conduct IHUFU QC Fieldwork [CMFO 29-3.4]

A detailed view of the activities that make up this operational subactivity is given in [Figure 75](#) below.

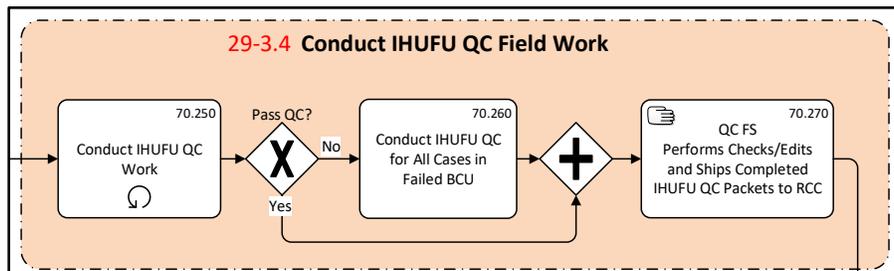


Figure 75: Conduct IHUFU QC Fieldwork

The IHUFU BCUs are checked for completeness and accuracy. A portion of each IHUFU lister’s work is checked to ensure that it was done correctly. If the BCU fails the quality check, all cases in the BCU will be reviewed and corrections will be made as needed. When the QC work is complete, the QC field supervisors perform checks and edits of the forms before shipping the IHUFU QC packets back to the RCC.

5.2.3.5 Manage Outputs from PES IHUFU and QC [CMFO 29-3.5]

A detailed view of the activities that make up this operational subactivity is given in [Figure 76](#) below.

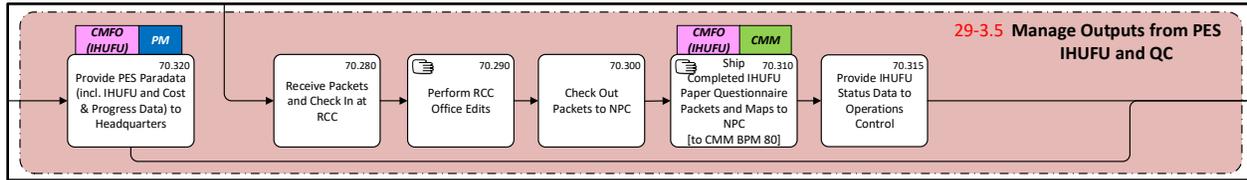


Figure 76: Manage Outputs from PES IHUFU and QC

Once the RCC receives packets from the field, staff perform office edits. Once complete, the packets are checked out and shipped to the National Processing Center (NPC). During the entire IHUFU and QC operation, status data are sent by MCM to ROSCO. PES paradata, such as cost and progress, are sent to the Census Data Lake (CDL) for reporting purposes.

5.2.4 PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4]

The fourth CMFO activity is PES Person Interview (PI) and Reinterview (RI).

Figure 77 shows the BPM for the PES Person Interview (PI) and Reinterview (RI) [CMDE 29-4] activity (area within the gray box) within the overall context of the PES operations.

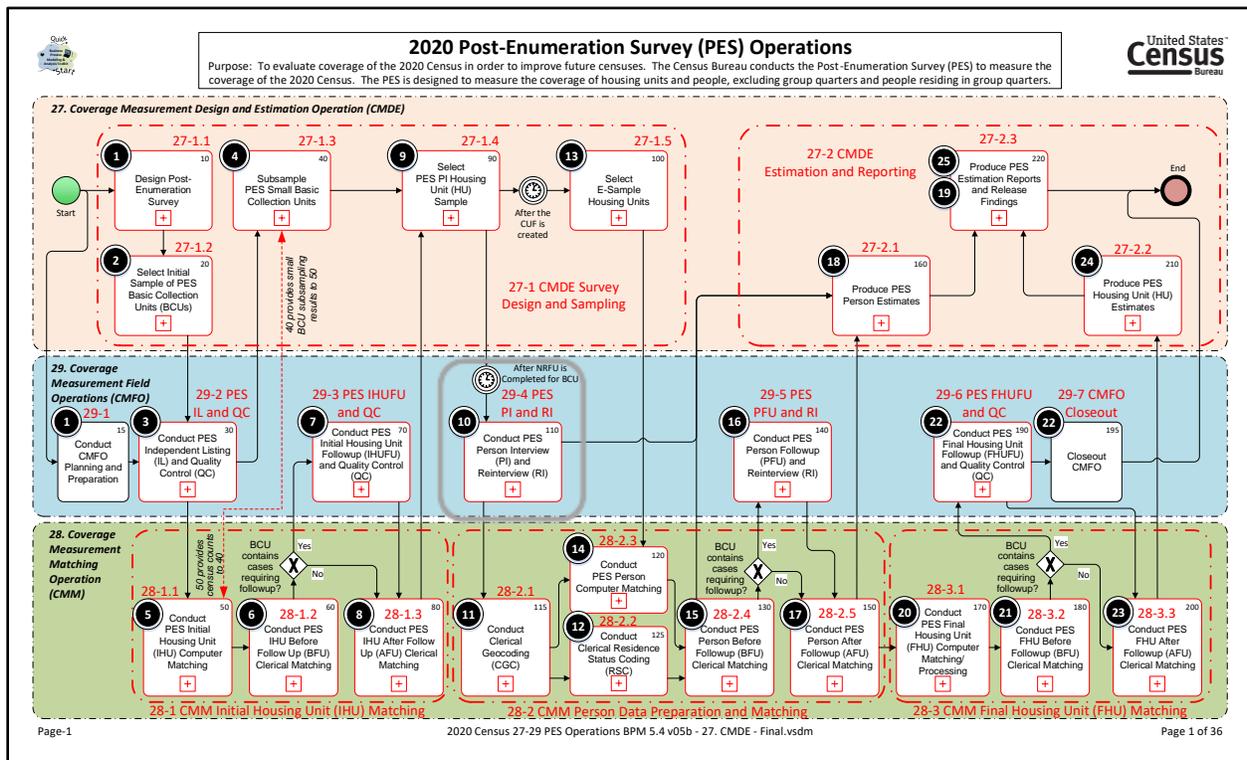


Figure 77: PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4] Activity

The “PES Person Interview (PI) and Reinterview (RI)” operational activity is subdivided into the following activity areas:

- PES Person Interview (PI) and Reinterview (RI) [CMFO 29-4].
 - Provide PI Training and Perform Admin Activities [CMFO 29-4.1].
 - Conduct PES PI Production Fieldwork [CMFO 29-4.2].
 - Perform PES Person Interview (PI) Reinterview (RI) [CMFO 29-4.3].
 - Manage Outputs from PES PI and Reinterview [CMFO 29-4.4].

A detailed view of the subactivities that make up the “PES Person Interview (PI) and Reinterview (RI)” operational activity is given in [Figure 78](#) below.

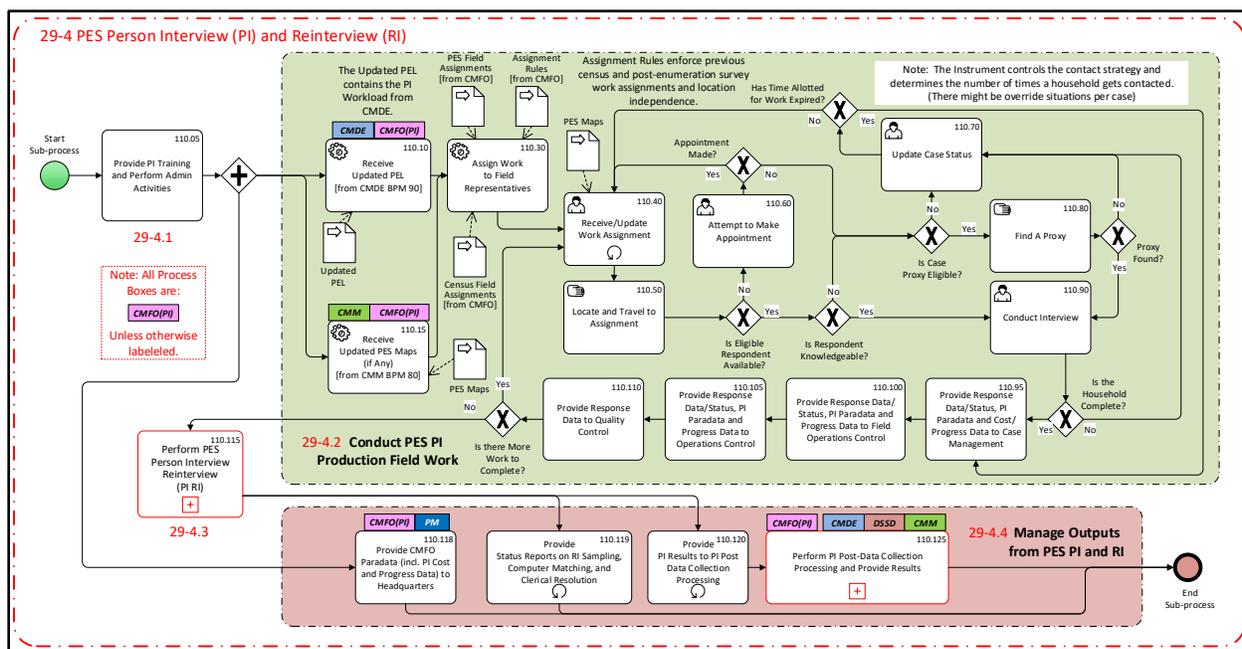


Figure 78: PES Person Interview (PI) and Reinterview (RI) Subactivities

For each in sample BCU, CMFO will conduct a PES PI for selected housing units. The purpose of the PI operation is to obtain information about the current residents of the sample housing unit. This includes those who may have moved into the selected housing unit since Census Day (April 1, 2020). The interview also collects data for those who moved out of the sample housing unit between Census Day and the time of the PES interview.

Subsequent sections describe the “PES Person Interview (PI) and Reinterview (RI)” operational subactivities in detail.

5.2.4.1 Provide PI Training and Perform Admin Activities [CMFO 29-4.1]

This operational subactivity consists of a single activity area shown in [Figure 78](#) above.

Training and administrative activities precede PI data collection. The administrative activities include the onboarding of field staff and distribution of laptops. The training for PI in interviewers will include classroom-style training and an online training course. Interviewers will also be provided a manual for their reference.

5.2.4.2 Conduct PI Production Fieldwork [CMFO 29-4.2]

A detailed view of the activities that make up this operational subactivity is given in [Figure 79](#) below.

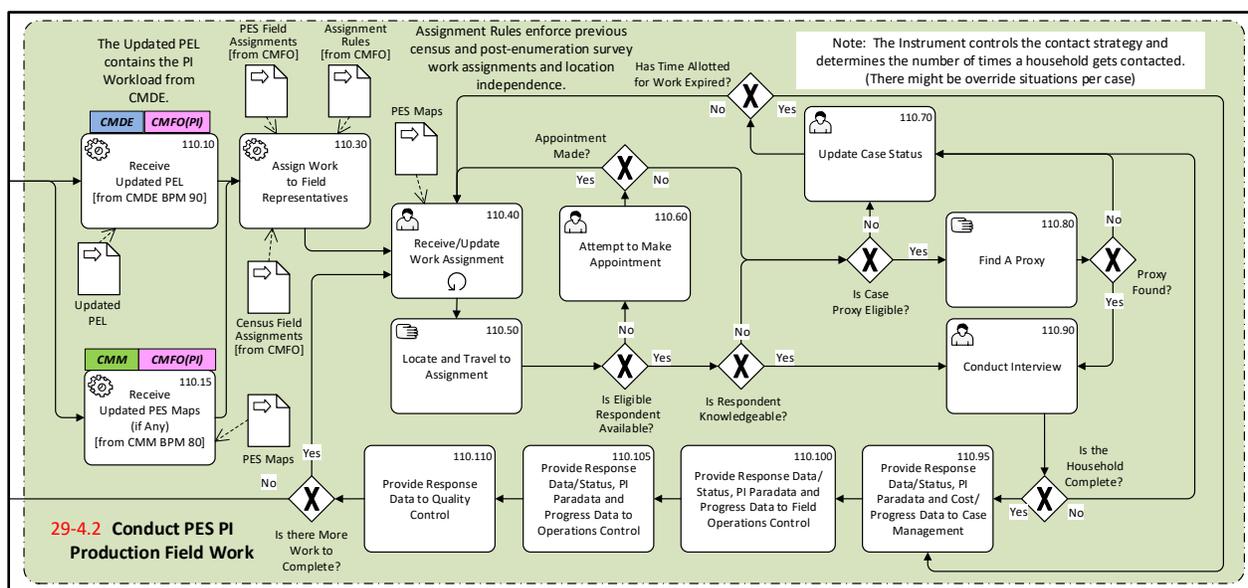


Figure 79: Conduct PI Production Fieldwork

The PI workload is received from CMDE and includes IL housing units that remain after the subsampling of some small BCUs and the subsampling of some housing units from large BCUs. The PI workload also includes census-only units from the initial housing unit matching operation that required followup. The workload is then assigned to PI interviewers based on assignment rules.

The PES PI is conducted by personal visit using a computer-assisted data collection instrument on a laptop. Interviewers will be able to view their assignments in MCM and conduct the interview using Blaise (a survey processing tool). An interviewer attempts to locate the address for the assigned case and contact a household member at the address. If the address is occupied and an eligible, willing, and able respondent is identified, the interviewer conducts the interview. If a household member contact attempt is unsuccessful, based on business rules, the interviewer may attempt to interview a proxy for the household. A proxy would be someone such as a neighbor or a caregiver who may have sufficient knowledge about the original household. The respondent may also refuse because it is an inconvenient time. In this situation, the interviewer will attempt to make an appointment for a subsequent attempt. The instrument also contains wording for a telephone interview used when a respondent requests an interview by telephone.

After each attempt, status data, response data, paradata and cost and progress data are sent to MCM, ROSCO, MCS, and SMarCS. For completed and sufficient partial cases, the response data are sent to MCS through ROSCO for processing. MCS passes on paradata for analysis. Response data are sent to SMarCS to determine the reinterview workload.

5.2.4.3 Perform PES Person Interview (PI) Reinterview (RI) [CMFO 29-4.3]

A detailed view of the activities that make up this operational subactivity is given in [Figure 80](#) below.

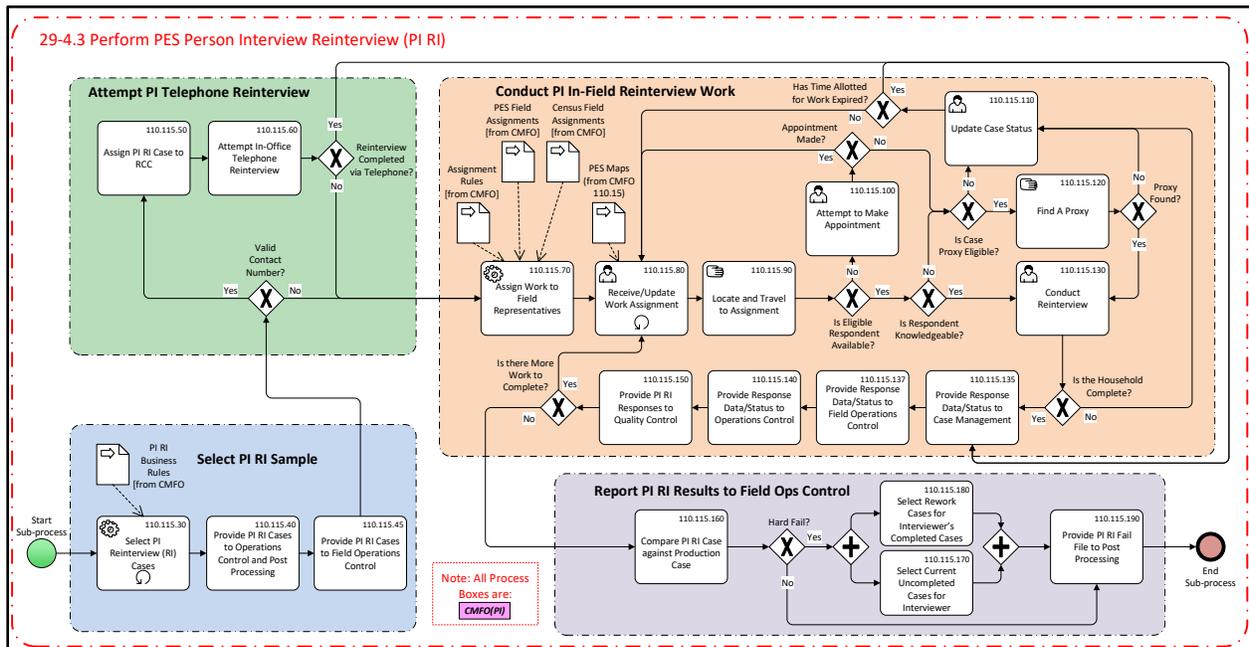


Figure 80: Perform PES Person Interview (PI) Reinterview (RI)

The work for PES PI RI is divided into four stages:

- Select PI RI Sample.
- Attempt PI Telephone Reinterview.
- Conduct PI In-Field Reinterview Work.
- Report PI RI Results to Field Ops Control.

The PI RI operation checks the quality of the work done by interviewers in PI. It is designed to detect and deter interviewer errors and data falsification. The PI RI involves conducting an independent RI with selected sample households to verify that the interviewer conducted the PI interview correctly and followed procedures.

The SMARCS will select the sample of PI cases and deliver to the ROSCO through the MCS for assignment to the reinterviewers. There is a check in place to ensure that a PI interviewer is not assigned a reinterview of a case that he or she completed. The reinterviewers will complete the RI cases using the PI RI instrument. RCC staff in the office will make up to three telephone attempts if telephone number is collected from PI. If the case is not able to be completed via telephone, then it will be sent to the reinterviewer for personal visit attempts. Up to six

attempts are allowed per PI RI case. As with PI cases, the SMarCS will receive all data on the RI cases daily. This includes response data and paradata.

After a reinterviewer completes a case, PI and RI data are compared through computer and clerical matching, as well as an RCC review, to determine if the interviewer conducted the interview, followed proper procedures, and collected valid roster data. The comparison of the original interview and RI data is facilitated by the use of the SMarCS, which provides computer matching, clerical matching, final coding, and supplemental RI selection. The SMarCS will pair the data from the original interview and RI cases and assign a computer matching outcome code.

The RCC will review the RI cases that were given a “hard fail” recommendation by the NPC clerks. Based on the training guidelines, the RCC staff will assign an outcome code to the case. All codes assigned during this stage are considered final. If the RCC confirms the “hard fail” status, field staff will prevent further cases from being assigned to the interviewer. The SMarCS will also send all of the “hard fail” interviewer’s eligible cases to be reworked by a different interviewer.

5.2.4.4 Manage Outputs from PES PI and Reinterview [CMFO 29-4.4]

A detailed view of the activities that make up this operational subactivity is given in [Figure 81](#) and [Figure 82](#) below.

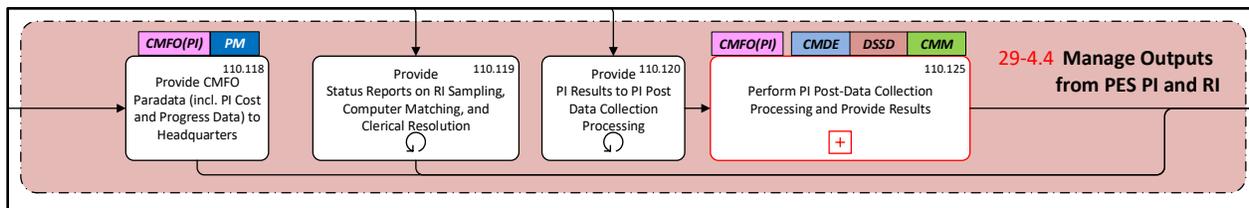


Figure 81: Manage Outputs from PES PI and Reinterview (General Process)

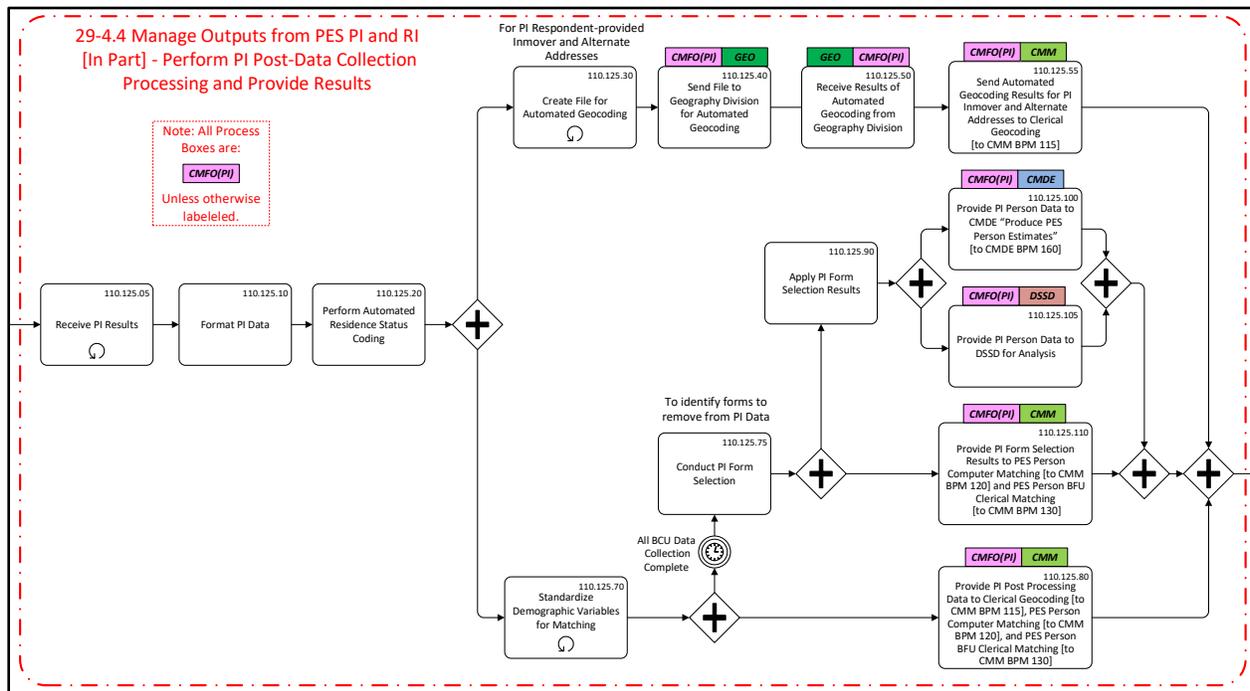


Figure 82: Manage Outputs from PES PI and Reinterview (Detail for PI Post-Data Collection Processing)

Throughout the PI operation, the SMARCS will provide NPC, RCC, and headquarters (HQ) staff with reports to assist in managing the PI RI workload. These reports provide valuable information about the processing status of the RI cases and progress of PI RI data collection.

PI Post-Data Collection Processing begins once PES PI and PI RI results are received and formatted. It includes automated residence status coding and geocoding to prepare for matching activities. It also conducts PI Form Selection to select the final version of interview data (either collected in PI or RI) to use. Then it provides results to the CMM and CMDE operations. Notes files from PI and PI RI are also sent to CMM clerical matching.

5.2.5 PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5]

The fifth CMFO activity is PES Person Followup (PFU) and Reinterview (RI).

Figure 83 shows the BPM for the PES Person Followup (PFU) and Reinterview (RI) [CMDE 29-5] activity (area within the gray box) within the overall context of the PES operations.

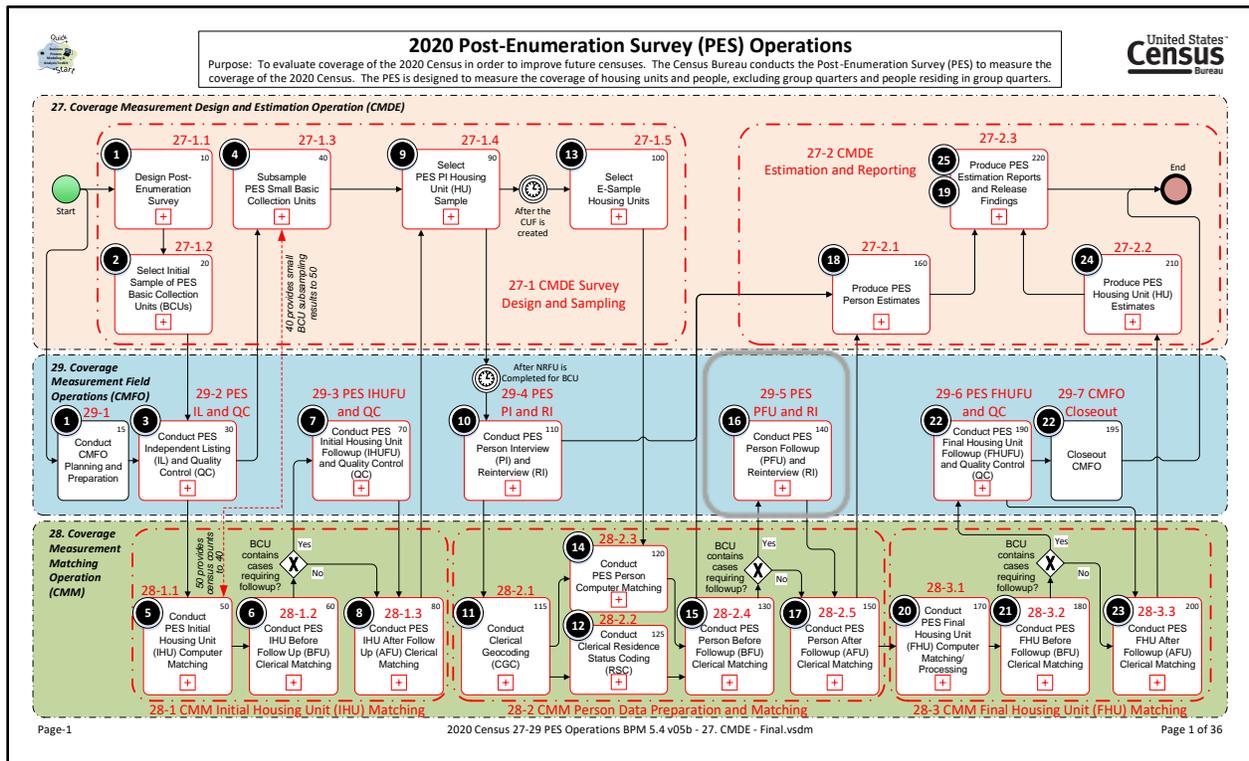


Figure 83: PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5] Activity

The “PES Person Followup (PFU) and Reinterview (RI)” operational activity is subdivided into the following activity areas:

- PES Person Followup (PFU) and Reinterview (RI) [CMFO 29-5].
 - Provide PFU Training and Perform Admin Activities [CMFO 29-5.1].
 - Conduct PES PFU Production Fieldwork [CMFO 29-5.2].
 - Perform PES PFU Reinterview (PFU RI) [CMFO 29-5.3].
 - Manage Outputs from PES PFU and Reinterview [CMFO 29-5.4].

A detailed view of the subactivities that make up the “PES Person Followup (PFU) and Reinterview (RI)” operational activity is given in [Figure 84](#) below.

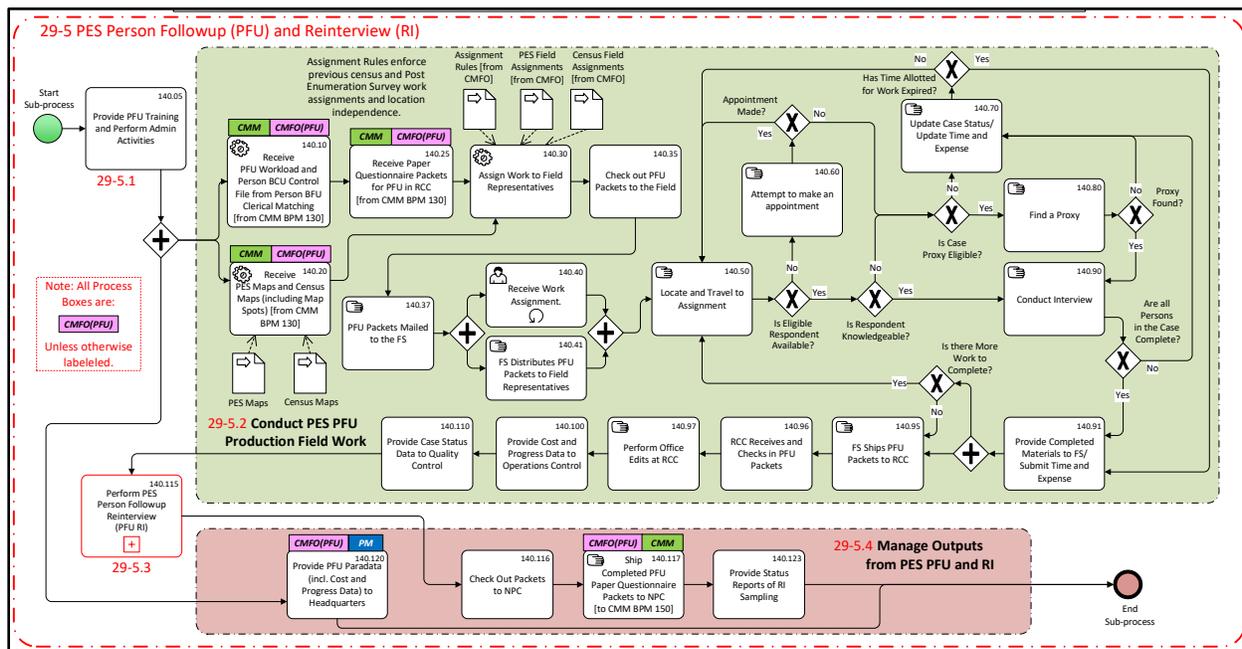


Figure 84: PES Person Followup (PFU) and Reinterview (RI) Subactivities

Person Followup cases are identified after the Person BFU Clerical Matching operation is completed. The PFU interview attempts to collect additional information needed to establish Census Day residence for P sample cases. It also attempts to resolve enumeration status for nonmatched E sample cases. The PFU operation uses a paper questionnaire and primarily personal visit interviews. There are four different types of PFU questionnaires : stateside nonnationwide, stateside nationwide, Puerto Rico nonnationwide, and Puerto Rico nationwide. Nationwide questionnaires are used to follow-up on people outside of the PES sample BCUs who are linked to in-sample people found during person computer matching. The linked in-sample people will be followed up separately using the nonnationwide questionnaires.

Subsequent sections describe the “PES Person Followup (PFU) and Reinterview (RI)” operational subactivities in detail.

5.2.5.1 Provide PFU Training and Perform Admin Activities [CMFO 29-5.1]

This operational subactivity consists of a single activity area shown in Figure 84 above.

Training and administrative activities precede PFU production fieldwork. The administrative activities include the onboarding of field staff. Interviewers will be given a manual as well as classroom style training. There will also be an online training class.

5.2.5.2 Conduct PES PFU Production Fieldwork [CMFO 29-5.2]

A detailed view of the activities that make up this operational subactivity is given in [Figure 85](#) below.

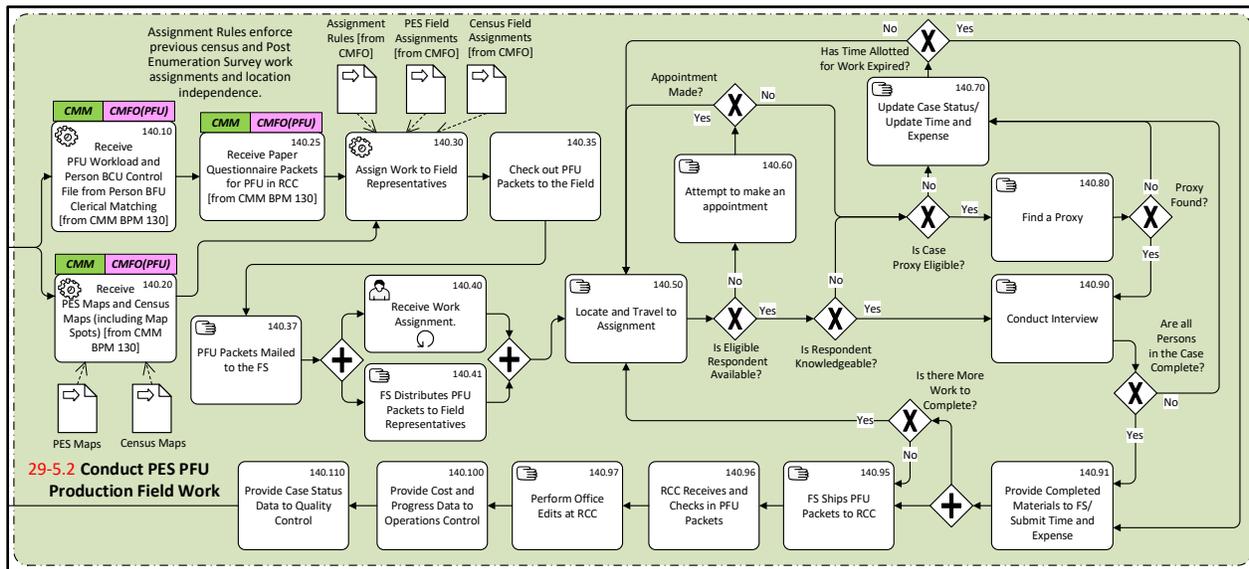


Figure 85: Conduct PFU Production Fieldwork

The PFU workload is received in MCS from the CMM operation and sent to ROSCO. Meanwhile, the paper PFU packets are received in the RCC from NPC. Once ROSCO has the workload and the RCCs have the packets, assignments can be made to the interviewers. Paper PFU packets, including paper questionnaires and paper maps, will be shipped to the supervisors and then distributed to the interviewers. Interviewers will be able to view their assignments in MCM.

Interviewers will conduct personal visit interviews using the paper questionnaires. Proxy respondents will be allowed when a household respondent cannot be located or when the household respondent is not knowledgeable about the follow-up people. After the interview is complete, interviewers will update the status of the case in MCM.

Interviewers will return completed packets to the supervisor, who will check and edit the questionnaires before returning the packets to the RCC. Once at the RCC, the questionnaires will undergo an office edit and be checked into ROSCO. ROSCO will send the status of the case to SMarCS to be included in sampling for PFU RI.

5.2.5.3 Perform PES Person Followup Reinterview (PFU RI) [CMFO 29-5.3]

A detailed view of the activities that make up this operational subactivity is given in [Figure 86](#) below.

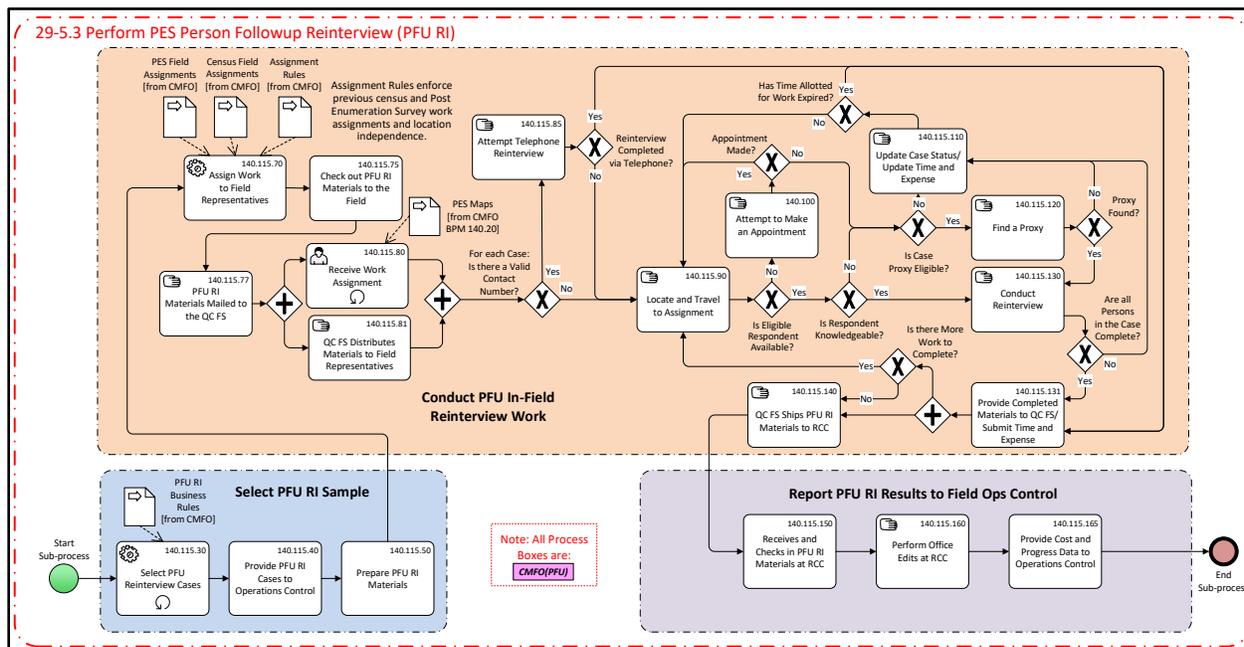


Figure 86 Perform Person Followup (PFU) Reinterview (RI)

The work for PES PFU RI is divided into three stages:

- Select PFU RI Sample.
- Conduct PFU In-Field Reinterview Work.
- Report PFU RI Results to Field Ops Control.

After the PFU case is completed, SMaRCS selects a sample of eligible cases for PFU RI. To be eligible, a PFU case must be complete or partially complete and must have been completed with a single respondent. SMaRCS sends the PFU RI sample to MCS to pass along to ROSCO. PFU RI assignments are made in ROSCO and sent to MCM. RCC staff in the office will make up to three telephone attempts if a telephone number is collected from PFU. If the case is not able to be completed by telephone, then it will be sent to the reinterviewer for personal visit attempts. Up to six attempts are allowed per PFU RI case. Paper packets including the PFU questionnaire, PFU RI form, and maps are mailed to the supervisors to distribute to the reinterviewers. Once the RI is complete, the PFU RI status data are sent to ROSCO.

5.2.5.4 Manage Outputs from PES PFU and Reinterview [CMFO 29-5.4]

A detailed view of the activities that make up this operational subactivity is given in [Figure 87](#) below.

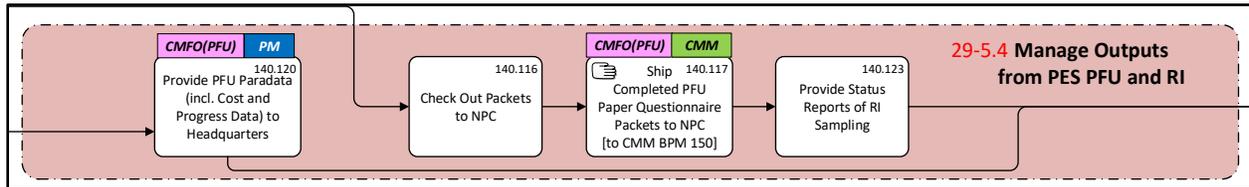


Figure 87: Manage Outputs from PES PFU and Reinterview

After the completion of PFU RI, RCC staff will check out the PFU packets (includes PFU questionnaire and PFU RI form) and ship them to NPC for additional processing and matching by the CMM operation. SMarCS will provide sampling reports to HQ staff for analysis.

5.2.6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6]

The sixth CMFO activity is PES Final Housing Unit Followup (FHUFU) and Quality Control (QC).

[Figure 88](#) shows the BPM for the PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMDE 29-6] activity (area within the gray box) within the overall context of the PES operations.

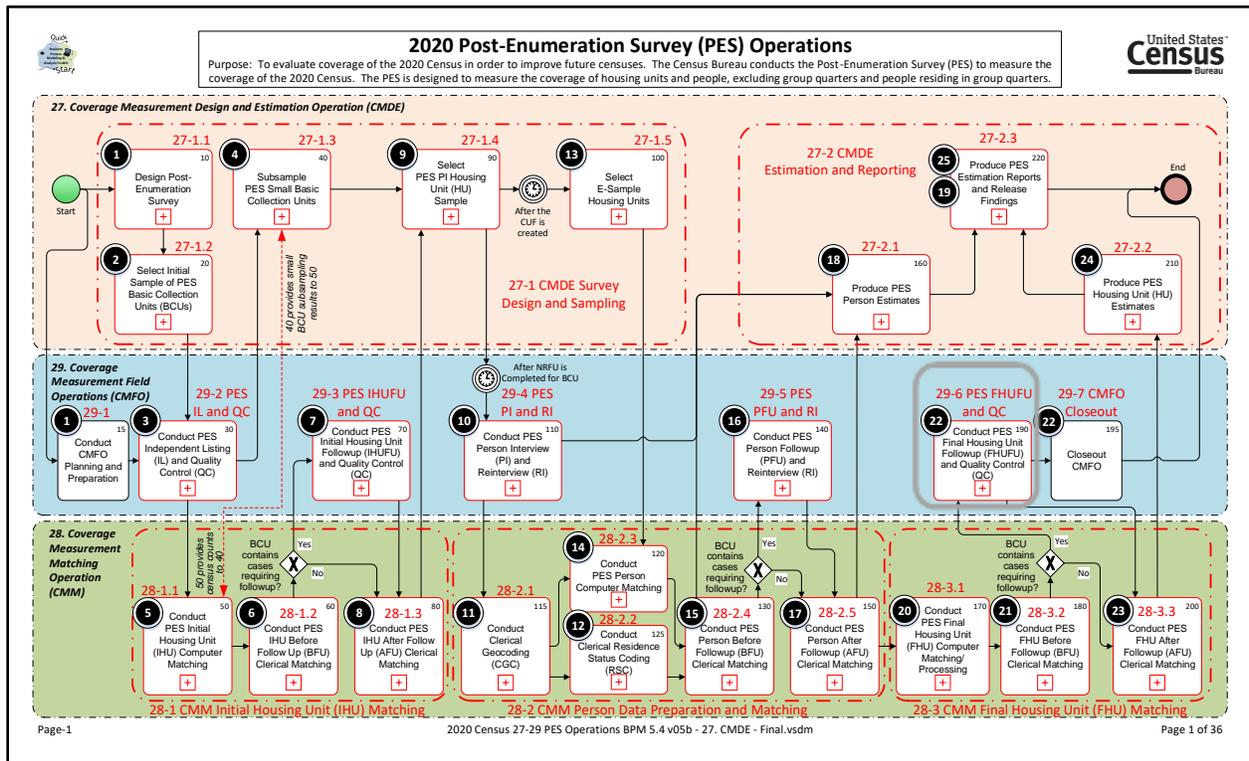


Figure 88: PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6] Activity

The “PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)” operational activity is subdivided into the following activity areas:

- PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) [CMFO 29-6].
 - Provide FHUFU Training and Perform Admin Activities [CMFO 29-6.1].
 - Conduct FHUFU Production Fieldwork [CMFO 29-6.2].
 - Manage Workload for FHUFU Quality Control (QC) [CMFO 29-6.3].
 - Conduct FHUFU QC Fieldwork [CMFO 29-6.4].
 - Manage Outputs from PES FHUFU and QC [CMFO 29-6.5].

A detailed view of the subactivities that make up the “PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)” operational activity is given in [Figure 89](#) below.

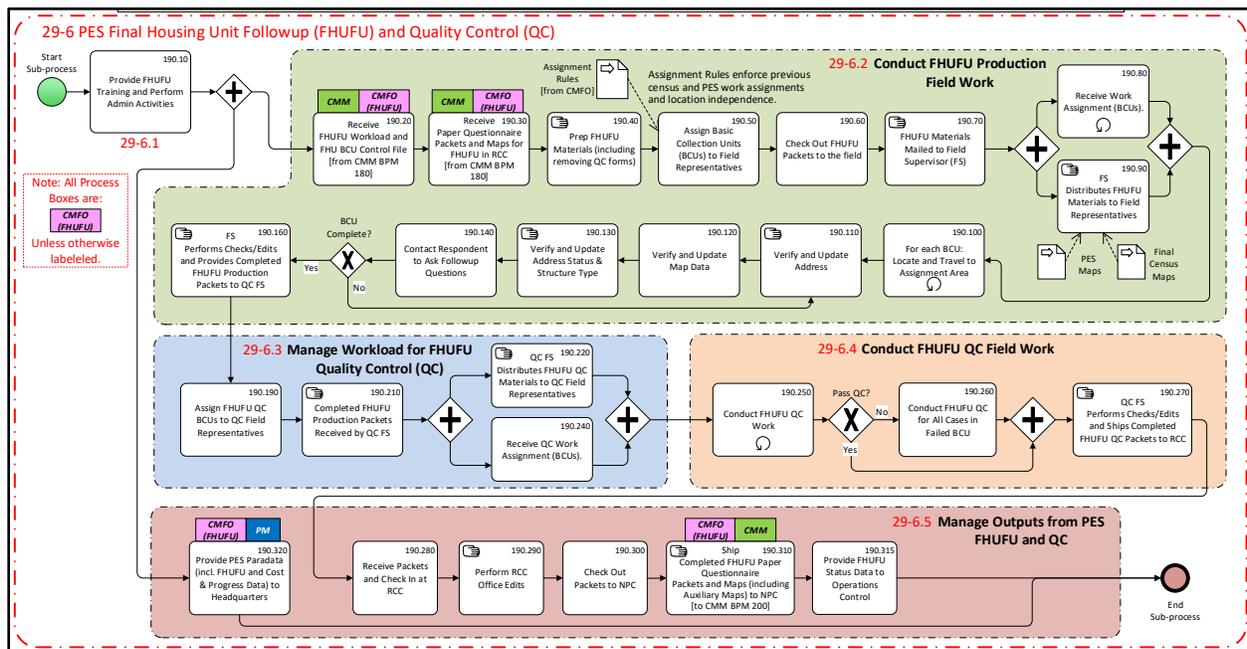


Figure 89: PES Final Housing Unit Followup (FHUFU) and Quality Control (QC) Subactivities

The procedures for the FHUFU operation are very similar to the IHUFU operation. The FHUFU operation will work with CMM to follow up on any housing units that require more information. These housing units will be identified as nonmatches, possible matches, or duplicates by CMM in final housing unit computer matching and clerical matching. FHUFU listers will try to resolve any differences between the PES housing units list from IL and the final 2020 Census address list. Listers will also collect information for any housing units whose statuses changed since they were first listed.

Subsequent sections describe the “PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)” operational subactivities in detail.

5.2.6.1 Provide FHUFU Training and Perform Admin Activities [CMFO 29-6.1]

This operational subactivity consists of a single activity area shown in [Figure 89](#) above.

Training and administrative activities precede FHUFU data collection. The administrative activities include the onboarding of field staff and distribution of laptops. The training for FHUFU listers will include classroom-style training and an online training class. Listers will also be provided a manual for their reference.

5.2.6.2 Conduct FHUFU Production Fieldwork [CMFO 29-6.2]

A detailed view of the activities that make up this operational subactivity is given in [Figure 90](#) below.

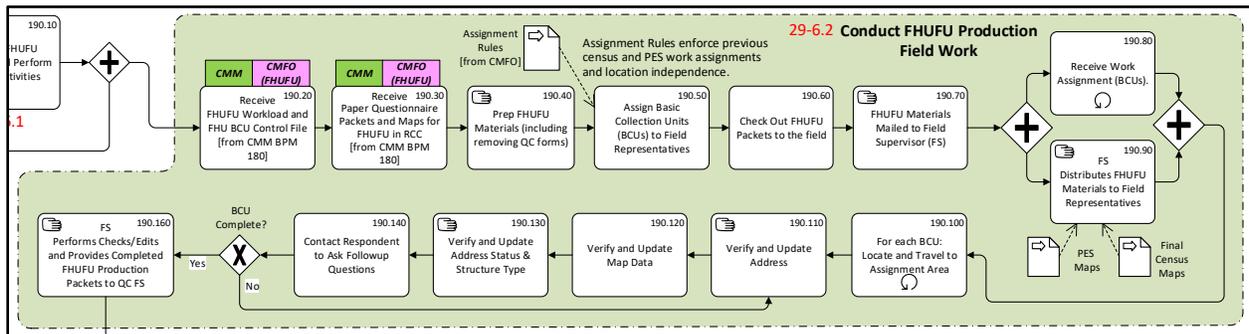


Figure 90: Conduct FHUFU Production Fieldwork

Once the FHUFU workload is received from CMM and FHUFU questionnaires are received at the regional census center (RCC), RCC staff prepare the FHUFU materials, including the removal of QC forms from the packets.

BCUs are then assigned to FHUFU listers following the assignment rules to enforce the independence of the PES and Census address lists. FHUFU listers receive their assignments through the MCM on their laptops. FHUFU packets including maps (IL and Census Address Canvassing) are checked out and mailed to field supervisors. Once the work assignment is received, the field supervisors will then distribute the mailed materials to the FHUFU listers. For each case in a BCU that needs follow up, an FHUFU lister will locate and travel to the BCU assignment area and verify and update the address, map data, address status, and structure type. The respondent for each address is then interviewed for any follow-up questions. Once the BCU is completed, the field supervisors check and edit the FHUFU questionnaires before providing the FHUFU packets to QC field supervisors for FHUFU QC work.

5.2.6.3 Manage Workload for FHUFU Quality Control (QC) [CMFO 29-6.3]

A detailed view of the activities that make up this operational subactivity is given in [Figure 91](#) below.

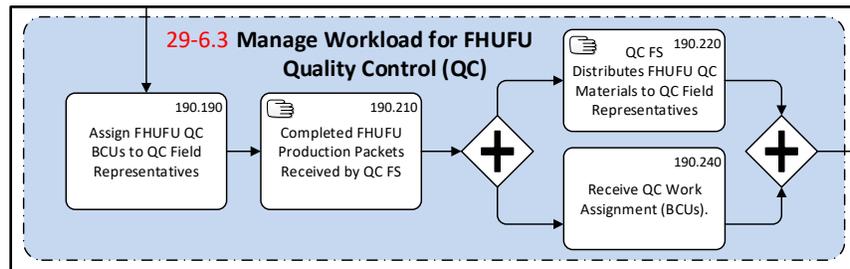


Figure 91: Manage Workload for FHUFU Quality Control (QC)

BCUs for FHUFU QC are assigned to QC listers, and the FHUFU QC packets are received by the QC field supervisors. The QC listers receive the FHUFU QC materials from their supervisors and their assigned BCUs on their laptops.

5.2.6.4 Conduct FHUFU QC Fieldwork [CMFO 29-6.4]

A detailed view of the activities that make up this operational subactivity is given in [Figure 92](#) below.

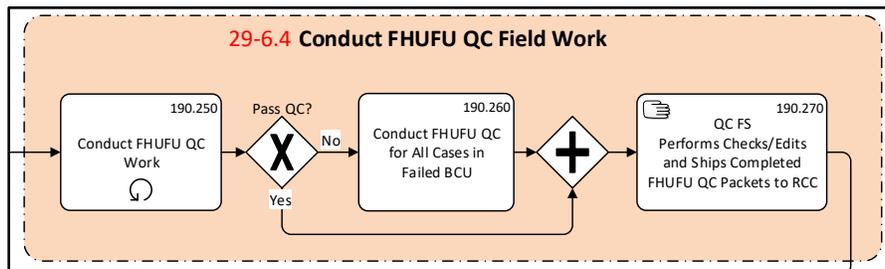


Figure 92: Conduct FHUFU QC Fieldwork

The BCUs are checked for completeness and accuracy. A portion of each interviewer’s work will be checked to ensure the work is done correctly. If the BCU fails the quality check, all cases in the BCU will be reviewed and corrections will be made as needed. When the QC work is complete, the QC field supervisors perform checks and edits of the forms before shipping the FHUFU QC packets back to the RCC.

5.2.6.5 Manage Outputs from PES FHUFU and QC [CMFO 29-6.5]

A detailed view of the activities that make up this operational subactivity is given in [Figure 93](#) below.

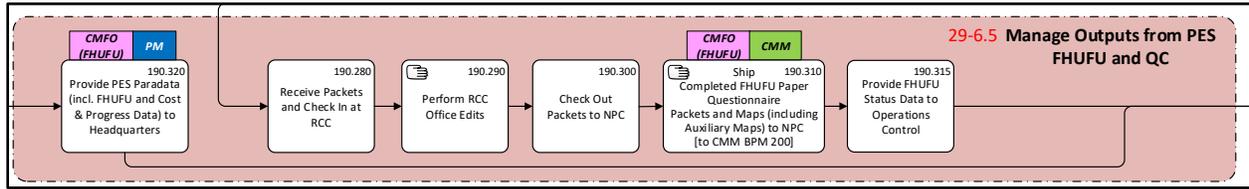


Figure 93: Manage Outputs from PES FHUFU and QC

Once the RCC receives packets from the field, staff will perform office edits. Once complete, the packets are checked out and shipped to NPC. During the entire FHUFU and QC operation, status data is sent by MCM to ROSCO and PES paradata such as cost and progress are sent to CDL for reporting purposes.

5.2.7 CMFO Closeout [CMFO 29-7]

The final CMFO activity is CMFO Closeout.

Figure 94 shows the BPM for the CMFO Closeout [CMDE 29-7] activity (area within the gray box) within the overall context of the PES operations.

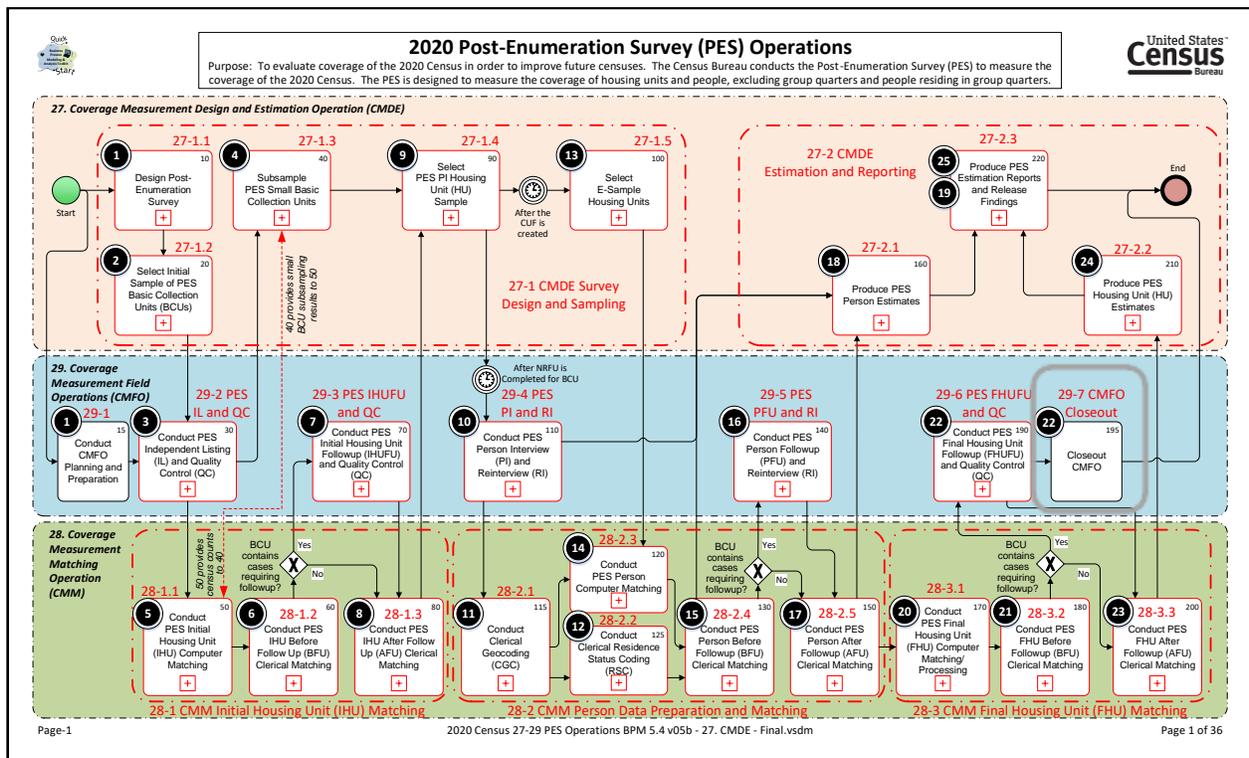


Figure 94: CMFO Closeout [CMFO 29-7] Activity

The “CMFO Closeout” operational activity consists of a single activity area, which is described below.

After the FHUFU and QC operation has completed, CMFO will perform closeout activities. These activities include reducing field staff as workloads are reduced and collecting equipment used by field staff. Closeout also includes conducting operational assessments of each PES data collection operation. The results of these assessments may be used to plan future census and PES operations.

6. Cost Factors

The investment in Post-Enumeration Survey operations (PES) is projected to have minimal influence on the 2020 Census overall costs and quality. While the PES operations are not a major cost driver for the 2020 Census, the following mechanisms from the IDEF0 Context Diagram represent the resources used to support these operations and comprise part of the 2020 Census cost elements:

Staff

- Headquarters (HQ) staff.
- National Processing Center (NPC) staff.
- Regional census centers (RCC) staff.
- Puerto Rico Area Office (PRAO) staff.
- Field staff.

Sites

- HQ.
- NPC.
- RCC.
- PRAO.

Systems

- Automated Tracking and Control system (ATAC).
- Concurrent Analysis and Estimation System (CAES).
- Computer Assisted Personal Interview (CAPI).
- Census Data Lake (CDL).
- Census Imaging and Retrieval Application (CIRA).
- Clerical Matching and Map Update (CMMU).
- Decennial Applicant Personnel and Payroll System (DAPPS).
- Demographic Survey System (DSS).
- Listing and Mapping Application/Mobile Case Management (LiMA/MCM).
- Master Address File/Topologically Integrated Geographic Encoding and Referencing System (MAF/TIGER).
- NPC Data Capture.

- NPC Printing.
- PES Processing and Control System (PES PCS).
- Production Environment for Administrative Record Staging, Integration, and Storage (PEARSIS).
- PES Imputation and Estimation (PIE).
- Sampling, Matching, Review, and Coding System (SMaRCS).

Other

- 2020 Census website.
- Census networks.
- Mobile networks.
- Mobile devices.
- Office information technology (IT) infrastructure.
- Kits and field supplies.

7. Measures of Success

For the 2020 Census operations, the corresponding Measures of Success will be documented in the operational assessment study plans and final reports. The operational assessment study plan documents the criteria that will be used to define successful completion of the operation. The operational assessment report will provide results on whether the criteria were met.

In general, operational assessments report on planned to actual variances in budget, schedules, and production and training workloads. The corresponding Measures of Success (as documented in the operational assessment study plan) include variances that exceed established thresholds. See *Preparing for the 2020 Census Operational Assessment Study Plan* for the potential scope of assessment.

Types of success measures include:

- **Process Measures** that indicate how well the process works, typically including measures related to completion dates, rates, and productivity rates.
- **Cost Measures** that drive the cost of the operation and comparisons of actual costs to planned budgets. Costs can include workload as well as different types of resource costs.
- **Measures of the Quality** of the results of the operation, typically including things such as rework rates, error rates, and coverage rates.

See the corresponding operational assessment study plan and report for the Post-Enumeration Survey (PES) operations for details on the measures of success.

Appendix A – Acronyms and Terminology

Table 14 lists the acronyms and abbreviations used within this Detailed Operational Plan document.

Table 14: Acronyms and Abbreviations List

Acronym	Meaning
ACS	American Community Survey
ADREC	Administrative Records
AFU	After Followup
AIC	American Indian Country
AIR	American Indian Reservation
AOQL	Average Outgoing Quality Limit
ARC	Archiving operation
ATAC	Automated Tracking and Control
BCU	Basic Collection Unit
BEA	Bureau of Economic Analysis
BFA	Before Followup Analyst
BFU	Before Followup
BLS	Bureau of Labor Statistics
BPM	Business Process Model
BPMN	Business Process Model Notation
CAES	Concurrent Analysis and Estimation System
CAPI	Computer Assisted Person Interview
CCF	Coverage Correction Factor
CCM	Census Coverage Measurement operation
CDL	Census Data Lake
CE	Correct Enumerations
CEF	Census Edited File

Acronym	Meaning
CGC	Clerical Geocoding
CIRA	Census Imaging and Retrieval Application
CM	Coverage Measurement
CMDE	Coverage Measurement Design Estimation operation
CMFO	Coverage Measurement Field Operations
CMM	Coverage Measurement and Matching operation
CMMU	Clerical Matching and Map Update
CMS	Centers for Medicare and Medicaid Services
CUF	Census Unedited File
DA	Demographic Analysis
DAPPS	Decennial Applicant Personnel and Payroll System
DC	District of Columbia
DLM	Decennial Logistics Management operation
DOP	Detailed Operational Plan
DPD	Data Processing and Dissemination operation
DRF	Decennial Response File
DSC	Decennial Service Center operation
DSE	Dual System Estimation
DSS	Demographic Survey System
DSSD	Decennial Statistical Studies Division
E	Enumeration
EAE	Evaluations and Experiments operation
FHU	Final Housing Unit
FHUFU	Final Housing Unit Followup
FLDI	Field Infrastructure operation
GEOP	Geographic Programs operation
GPS	Global Positioning System

Acronym	Meaning
GQ	Group Quarters
HQ	Headquarters
HU	Housing unit
IDEF	Integrated DEFinition Methods
IDEFO	Integrated DEFinition Methods Zero (diagram)
IE	Information Exchange
IHU	Initial Housing Unit
IHUFU	Initial Housing Unit Followup
IL	Independent Listing
IOD	Integrated Operations Diagram
IPT	Integrated Project Team
IRS	Internal Revenue Service
IT	Information Technology
ITIN	IT Infrastructure operation
KFP	Key from Paper
LEHD	Longitudinal Employer-Household Dynamics
LiMA	Listing and Mapping Application
MAF	Master Address File
MAF/TIGER	Master Address File / Topologically Integrated Geographic Encoding and Referencing
MAFID	Master Address File Identifier
MCM	Mobile Case Management
MCS	Master Control System
MSE	Mean Squared Error
NA	Not Applicable
NPC	National Processing Center
NRFU	Nonresponse Followup operation

Acronym	Meaning
NVF	National Variable Files
OMB	Office of Management and Budget
P	Population
PES PCS	Post-Enumeration Survey Processing and Control System
PDC	Paper Data Capture operation
PEARSIS	Production Environment for Administrative Record Staging, Integration, and Storage
PEL	Preliminary Enhanced List
PES	Post-Enumeration Survey
PFU	Person Followup
PI	Person Interview
PIE	PES Imputation and Estimation
PRA	Paperwork Reduction Act
PRAO	Puerto Rico Area Office
QC	Quality Control
RCC	Regional Census Center
RI	Reinterview
ROSCO	Regional Office Survey Control
RPO	Response Processing Operation
RSC	Residence Status Coding
RV	Recreational Vehicle
SCIF	Sample Control Input File
SMaRCS	Sampling, Matching, Review, and Coding System
SPC	Security, Privacy, and Confidentiality operation
SSA	Social Security Administration
TAC	Technical Assistance Center
USPS	United States Postal Service

Acronym	Meaning
UTS	Unified Tracking System
ZIP	Zone Improvement Plan

Table 15 lists terminology used in this Detailed Operational Plan document.

Table 15: Terminology

Term	Meaning
BCU Sample	A set of BCUs that will be independently listed.
HU Population (P) Sample	Sample of listed HUs in the BCU sample.
HU Enumeration (E) Sample	Sample of census HU enumerations in the BCU sample.
Person P Sample	All people in the HU P sample.
Person E Sample	All census enumerations in the HU E sample.
Person Interview (PI) Sample	Combination of the person P sample and some unresolved and new cases in the person E sample.

Appendix B – References

Appendix B lists the documents or other resources used during the development of this Detailed Operational Plan document.

U.S. Census Bureau (2019), “Independence Rules for the 2020 Post-Enumeration Survey Field Data Collection Operations,” March 14, 2019.

Fay, R.E., Passel, J.S., and Robinson, J.G. with assistance from C.D. Cowan (1988). The Coverage of Population in the 1980 Census, 1980 Census of Population and Housing, Evaluation and Research Reports PHC80-E4. Washington, D.C.: U.S. Department of Commerce. 1988.

Griffin, R. (2008). 2010 Census Coverage Measurement Estimation Methodology. 2008.

Davis, L., Nguyen, T., and Hill, C. (2018). Considerations in Designing the 2020 Post-Enumeration Survey Sample. *Proceedings of the Joint Statistical Meetings 2018 Survey Research Methods Section*. Vancouver, British Columbia, Canada, July 28 - August 2, 2018.

Hogan, H. (1993). The 1990 post-enumeration survey: Operations and results. *Journal of the American Statistical Association*, 88(423), 1047-1060. 1993.

Maury, W., & Pemberton, D. M. (2009). History, 2000 Census of Population and Housing (Vol. 2). US Department of Commerce, Economics and Statistics Administration, US Census Bureau.

U.S. Census Bureau (2004). “Accuracy and Coverage Evaluation of Census 2000: Design and Methodology.”

U.S. Census Bureau (2018), “[2020 Census Operational Plan](#),” Version 4.0, December 31, 2018.

U.S. Census Bureau (2018), “Preparing for the 2020 Census Operational Assessment Study Plan,” Draft, May 10, 2018.

U.S. Census Bureau, Census and You, Volume 25, No. 8, August 1990, p. 2.

U.S. Census Bureau (1989), 1980 Census of Population and Housing, History, Part E, PHC80-R-2E (Washington, DC: U.S. Government Printing Office).

U.S. Census Bureau (1996), “1990 Census of Population and Housing, History,” 1990 CPH-R-2D (Washington, DC: U.S. Government Printing Office, March 1996).

Viehdorfer, M. (2011). The Design of the Coverage Measurement Program for the 2010 Census—REVISION #1.

Appendix C – Activity Tree for Post-Enumeration Survey (PES) Operations – Including: 27. CMDE, 28. CMM, and 29. CMFO

This appendix presents the Activity Tree for the Post-Enumeration Survey (PES) operations, which are Coverage Measurement Design Estimation operation (CMDE), Coverage Measurement and Matching operation (CMM) and Coverage Measurement Field Operations (CMFO). An Activity Tree uses an outline structure to reflect the decomposition of the major operational activities in the operation. Each activity is numbered according to its position in the outline. For example, for the CMDE operation numbered “27,” the first activity would be numbered 27-1. Subactivities under this activity would be numbered sequentially, starting again with the number one. For example, the first subactivity under the first activity would be numbered 27-1.1 the second subactivity as 27-1.2. The second activity would be numbered 27-2, and so on. CMM activities begin with 28 and CMFO activities begin with 29 using the same rules as described for CMDE.

Post-Enumeration Survey Activity Tree:

27 CMDE Activity Tree

27-1 CMDE Survey Design and Sampling

- 27-1.1 Design Post-Enumeration Survey
- 27-1.2 Select Initial Sample of PES Basic Collection Units (BCUs)
- 27-1.3 Subsample PES Small Basic Collection Units
- 27-1.4 Select PES PI Housing Unit (HU) Sample
- 27-1.5 Select E Sample Housing Units

27-2 CMDE Estimation and Reporting

- 27-2.1 Produce PES Person Estimates
 - 27-2.1.1 Process Inputs for PES Person Estimates
 - 27-2.1.1.1 Impute P Sample Person Characteristics
 - 27-2.1.1.2 Create National Variable Files (NVF)
 - 27-2.1.1.3 Create P Sample Person File
 - 27-2.1.1.4 Create E Sample Person File
 - 27-2.1.1.5 Create Person Estimation Files
 - 27-2.1.2 Perform Imputation and Weighting for PES Person Estimates
 - 27-2.1.2.1 Adjust Person Weights for Noninterview
 - 27-2.1.2.2 Impute P Sample Status for People
 - 27-2.1.2.3 Impute E Sample Enumeration Status for People
 - 27-2.1.2.4 Trim Person Weights

- 27-2.1.2.5 Calibrate Person Weights
- 27-2.1.3 Perform Estimation and Tabulation for PES Person Estimates
 - 27-2.1.3.1 Model Person Probabilities
 - 27-2.1.3.2 Tabulate Person Data
 - 27-2.1.3.3 Estimate Mean Squared Error (MSE) for Person Domains
- 27-2.2 Produce PES Housing Unit (HU) Estimates
 - 27-2.2.1 Process Inputs for PES Housing Unit Estimates
 - 27-2.2.1.1 Create P Sample Housing Unit File
 - 27-2.2.1.2 Create E Sample Housing Unit File
 - 27-2.2.1.3 Create Housing Unit Estimation Files
 - 27-2.2.2 Perform Imputation and Weighting for PES Housing Unit Estimates
 - 27-2.2.2.1 Impute P Sample Status for Housing Units
 - 27-2.2.2.2 Impute E Sample Enumeration Status for Housing Units
 - 27-2.2.2.3 Trim Housing Unit Weights
 - 27-2.2.2.4 Calibrate Housing Unit Weights
 - 27-2.2.3 Perform Estimation and Tabulation for PES Housing Unit Estimates
 - 27-2.2.3.1 Model Housing Unit Probabilities
 - 27-2.2.3.2 Tabulate Housing Unit Data
 - 27-2.2.3.3 Estimate Mean Squared Error (MSE) for Housing Unit Domains
- 27-2.3 Produce PES Estimation Reports and Release Findings

28 CMM Activity Tree

28-1 CMM Initial Housing Unit (IHU) Matching

- 28-1.1 Conduct PES Initial Housing Unit (IHU) Computer Matching
 - 28-1.1.1 Receive and Process Inputs for IHU Computer Matching
 - 28-1.1.2 Perform IHU Computer Matching
- 28-1.2 Conduct PES IHU Before Followup (BFU) Clerical Matching
 - 28-1.2.1 Conduct IHU BFU Clerical Matching Training
 - 28-1.2.2 Receive and Process Inputs for IHU BFU Clerical Matching
 - 28-1.2.3 Perform IHU BFU Clerical Matching, Review, and QC
 - 28-1.2.4 Manage Outputs from IHU BFU Clerical Matching
- 28-1.3 Conduct PES IHU After Followup (AFU) Clerical Matching
 - 28-1.3.1 Conduct IHU AFU Clerical Matching Training
 - 28-1.3.2 Receive and Process Inputs for IHU AFU Clerical Matching
 - 28-1.3.3 Perform IHU AFU Clerical Matching, Review, and QC
 - 28-1.3.4 Manage Outputs from IHU AFU Clerical Matching

28-2 CMM Person Data Preparation and Matching

- 28-2.1 Conduct Clerical Geocoding (CGC)
 - 28-2.1.1 Conduct Clerical Geocoding Training
 - 28-2.1.2 Receive and Process Inputs for CGC
 - 28-2.1.3 Perform Clerical Geocoding, Review, and QC
 - 28-2.1.4 Manage Outputs from CGC
- 28-2.2 Conduct PES Person Computer Matching
 - 28-2.2.1 Receive and Process Inputs for Person Computer Matching
 - 28-2.2.2 Perform Person Computer Matching
 - 28-2.2.3 Manage Outputs from Person Computer Matching
- 28-2.3 Conduct Clerical Residence Status Coding (RSC)
 - 28-2.3.1 Conduct Clerical Residence Status Coding Training
 - 28-2.3.2 Receive Inputs for Clerical RSC
 - 28-2.3.3 Perform Clerical Residence Status Coding, Review, and QC
 - 28-2.3.4 Manage Outputs from Clerical RSC
- 28-2.4 Conduct PES Person Before Followup (BFU) Clerical Matching
 - 28-2.4.1 Conduct Person BFU Clerical Matching Training
 - 28-2.4.2 Receive and Process Inputs for Person BFU Clerical Matching
 - 28-2.4.3 Perform Person BFU Clerical Matching, Review, and QC
 - 28-2.4.4 Manage Outputs from Person BFU Clerical Matching
- 28-2.5 Conduct PES Person After Followup (AFU) Clerical Matching
 - 28-2.5.1 Conduct Person AFU Clerical Matching Training
 - 28-2.5.2 Receive and Process Inputs for Person AFU Clerical Matching
 - 28-2.5.3 Perform Person AFU Clerical Matching, Review, and QC
 - 28-2.5.4 Manage Outputs from Person AFU Clerical Matching

28-3 CMM Final Housing Unit (FHU) Matching

- 28-3.1 Conduct PES Final Housing Unit (FHU) Computer Matching/Processing
 - 28-3.1.1 Receive and Process Inputs for FHU Computer Matching/Processing
 - 28-3.1.2 Perform FHU Computer Matching/Processing
- 28-3.2 Conduct PES FHU Before Followup (BFU) Clerical Matching
 - 28-3.2.1 Conduct FHU BFU Clerical Matching Training
 - 28-3.2.2 Receive and Process Inputs for FHU BFU Clerical Matching
 - 28-3.2.3 Perform FHU BFU Clerical Matching, Review, and QC
 - 28-3.2.4 Manage Outputs from FHU BFU Clerical Matching
- 28-3.3 Conduct PES FHU After Followup (AFU) Clerical Matching
 - 28-3.3.1 Conduct FHU AFU Clerical Matching Training
 - 28-3.3.2 Receive and Process Inputs for FHU AFU Clerical Matching

- 28-3.3.3 Perform FHU AFU Clerical Matching, Review, and QC
- 28-3.3.4 Manage Outputs from FHU AFU Clerical Matching

29 CMFO Activity Tree

29-1 CMFO Planning and Preparation

29-2 PES Independent Listing (IL) and Quality Control (QC)

- 29-2.1 Provide IL Training and Perform Admin Activities
- 29-2.2 Conduct IL Production Fieldwork
- 29-2.3 Manage Workload for IL Quality Control (QC)
- 29-2.4 Conduct IL QC Fieldwork
- 29-2.5 Manage Outputs from PES IL and QC

29-3 PES Initial Housing Unit Followup (IHUFU) and Quality Control (QC)

- 29-3.1 Provide IHUFU Training and Perform Admin Activities
- 29-3.2 Conduct IHUFU Production Fieldwork
- 29-3.3 Manage Workload for IHUFU Quality Control (QC)
- 29-3.4 Conduct IHUFU QC Fieldwork
- 29-3.5 Manage Outputs from PES IHUFU and QC

29-4 PES Person Interview (PI) and Reinterview (RI)

- 29-4.1 Provide PI Training and Perform Admin Activities
- 29-4.2 Conduct PES PI Production Fieldwork
- 29-4.3 Perform PES Person Interview Reinterview (PI RI)
- 29-4.4 Manage Outputs from PES PI and RI

29-5 PES Person Followup (PFU) and Reinterview (RI)

- 29-5.1 Provide PFU Training and Perform Admin Activities
- 29-5.2 Conduct PES PFU Production Fieldwork
- 29-5.3 Perform PES Person Followup Reinterview (PFU RI)
- 29-5.4 Manage Outputs from PES PFU and RI

29-6 PES Final Housing Unit Followup (FHUFU) and Quality Control (QC)

- 29-6.1 Provide FHUFU Training and Perform Admin Activities
- 29-6.2 Conduct FHUFU Production Fieldwork
- 29-6.3 Manage Workload for FHUFU Quality Control (QC)
- 29-6.4 Conduct FHUFU QC Fieldwork
- 29-6.5 Manage Outputs from PES FHUFU and QC

29-7 CMFO Closeout