

2020 Census Detailed Operational Plan for: 10. Paper Data Capture (PDC) Operation

A New Design for the 21st Century

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1. Document Purpose

The 2020 Census Detailed Operational Plan (DOP) for the Paper Data Capture (PDC) operation is intended for distribution to and use by U.S. Census Bureau managers, staff, contractors, internal and external stakeholders, and others having a stake in the 2020 Census. The document presents the planned operations for PDC and includes details of the operational processes involved, their inputs, outputs, controls, and the basic mechanisms necessary to conduct the work.

Anticipated use of this document includes to:

- Communicate – Provides details for internal and external stakeholders.
- Plan – Documents assumptions and key milestones.
- Staff – Highlights staffing needs.
- Inform – Defines planned operations and flows to aid in the design and development of systems, processes, training, and tests.

This document complements the 2020 Census Operational Plan, which presents the 2020 Census operational design and covers the operations required to execute the 2020 Census. Operations begin with precensus address and geographic feature updates and conclude with data product dissemination and coverage and quality measurement.

This is a living document that will be updated periodically to reflect modifications based on lessons learned and changes in strategies resulting from continued refinement of the approach to successfully conduct the 2020 Census.

2. Operational Overview

2.1 Operation Purpose

The Paper Data Capture (PDC) operation captures and converts data from paper questionnaires. This operation includes:

- PDC Universe Management
- Paper Questionnaire Preparation
- Paper Questionnaire Data Capture
- PDC Quality Assurance Check
- Data Distribution (includes sending Response Data to Response Processing, Case Status Data to Response Processing, and Paradata to Program Management)
- Final Data Disposition (includes Checkout, Receipt Confirmation and Disposition)

2.2 Background

Paper Response was the primary mode for self-response (formerly known as mailout/mailback) and Nonresponse Followup (NRFU) for previous censuses, including Census 2000 and the 2010 Census. The PDC operation was responsible for capturing almost all of the response data. The remaining response data, which was a small amount, was captured on the internet using a portable document format file in 2000 and by telephone assistance in 2010.

The following paragraphs describe how paper data capture was done for Census 2000 and the 2010 Census. A brief discussion of the key innovations planned for the 2020 Census is also provided.

Census 2000

The Data Capture System 2000 (DCS2000) provided the hardware and software to capture questionnaire data for Census 2000. The DCS2000 captured data through a scanning process to create a digital image that was passed through Optical Mark Recognition (OMR) and Optical Character Recognition (OCR) devices. Manual keying was used to enter data not captured electronically. The data were then aggregated to support detailed tabulations.

For Census 2000, four data capture centers were used. Three were contracted sites and were located in Baltimore, Maryland; Phoenix, Arizona; and Pomona, California. The fourth site was the Census Bureau's National Processing Center (NPC) in Jeffersonville, Indiana.

The DCS2000 efficiently and effectively processed approximately 162 million forms. The Baltimore site processed approximately 39 million; the Phoenix site processed approximately 46

million; and the Pomona site processed approximately 44 million. The NPC in Jeffersonville processed approximately 32 million forms.

2010 Census

For the 2010 Census, the Decennial Response Integration System (DRIS) was responsible for the Paper Data Capture (PDC) operation.

The PDC operation consisted of three data capture centers. Two were contracted facilities located in Phoenix, Arizona, and Baltimore, Maryland. The third was the NPC in Jeffersonville, Indiana. The Phoenix and Baltimore locations each completed approximately 40 percent of the paper capture workload and the NPC completed the remaining 20 percent.

In 2010, the data capture centers processed and captured data from over 164 million paper questionnaires, which contained over 3 billion individual checkbox fields. The DRIS had more than 50 different interfaces (system data exchanges) with various systems at Census Bureau headquarters (HQ) during peak production and captured and converted over 65 form types. In addition to the 164 million questionnaires processed in calendar year 2010, the DRIS also processed more than 2 million forms at the NPC for GQ validation operations in 2009.

2020 Census

For the 2020 Census, we expect the majority of self-response to be provided on the Internet using an Internet Self-Response (ISR) instrument. The plan for the 2020 Census promotes the Internet as the preferred mode of enumeration and provides Census Questionnaire Assistance (CQA). Maximizing the use of an ISR instrument offers opportunities such as reducing the paper processing footprint of PDC processing facilities. The plan also reduces the number of processing sites from three to two and uses the Integrated Computer Assisted Data Entry (iCADE) system currently in operation capturing data for other on-going censuses and surveys.

Most respondents will be sent Internet invitation letters containing a census ID encouraging them to respond on the Internet. Paper questionnaires will be sent to an estimated 20 percent of the self-response area universe and to the Update Enumerate (UE) universe. Households in self-response and UE areas will also be sent reminder cards or letters, or both, asking them to respond. All nonresponders in self-response areas will receive a paper questionnaire. Special populations, such as those residing in Group Quarters (GQ), will be enumerated using a variety of methods, including by paper data collection.

The anticipated workload for PDC for the 2020 Census is 20.5 million forms. This number includes the anticipated workload from NRFU and UE. Paper questionnaires will be booklet style with dimensions of 9 inches by 11 inches. Bilingual English/Spanish questionnaires will be flip style. Exact page counts will be determined by the final results of content research.

The PDC Integrated Project Team (IPT) is using 20.5 million forms as the 2020 Census workload estimate. At this time, 30 million forms is being used for capacity planning. This number allows for contingency against the potential receipt of a larger than expected volume of paper questionnaires being returned based on a lower than expected response rate from the Internet and CQA.

For the 2020 Census, we will rely on the United States Postal Service (USPS) to provide postal tracing data for questionnaires returning to the processing office. We are also investigating the use of extractors to automate the removal of questionnaires from envelopes, possibly reducing the steps in the document preparation process. In addition, we plan to use automated document imaging to conduct data capture and to perform paper checkout operations.

2.3 Design Overview

The sections below present the high-level design for the PDC operation. Please refer to the 2020 Census Operational Plan for a complete inventory of design decisions for all 2020 Census operations. Many details of the design of the PDC operation are still under development. This document reflects the known design as of March 31, 2017. A later release of this document will show the full design of this operation as planned for the 2020 Census.

2.3.1 High-Level Operational Design

The design of the PDC operation for the 2020 Census includes six major operational activity areas:

PDC Universe Management – The Response Processing Operation (RPO) provides the enumeration universe to the paper capture system prior to the start of the mailout (contact) operation. RPO provides updates to the universe as work completes in all modes.

Paper Questionnaire Preparation – The PDC operation will receive mailed questionnaires from the USPS and will stage and sort them. The questionnaire envelopes will be opened using either a sorter or an extractor. Forms will be separated from envelopes by hand or extractor. Forms will then be stacked in trays. (Note: these steps are being tested prior to the 2018 End-to-End [E2E] Census Test [CT]; the details will be refined as final processes are determined.)

Paper Questionnaire Data Capture – Paper questionnaires will be converted to digital images through the scanner; image processing will be conducted; and write-in responses will be captured and recognized via OCR, OMR and Key From Image (KFI), as necessary.

PDC Quality Assurance (QA) Check – Data capture quality output verification will be performed on automated and manually produced results. Data quality levels taken from a sample of fields identified on the questionnaire will be verified they meet QA requirements.

Data Distribution – The image retention process will be performed. Paradata will be sent to Program Management Operation (PM). Response data and case status will be sent to the Response Processing Operation (RPO).

Final Data Disposition – At the completion of paper capture operations, images of the paper questionnaires will be made available to the Archiving operation. Archiving discussions related to the images and response data for the 2020 Census are underway.

The full hierarchy of activities for the PDC 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 and numbered subactivities or steps.

For a full description of the operational subactivities that comprise the PDC operation, see the Detailed Process Description discussions in Section 3 below.

2.3.2 PDC Operational Context

The PDC 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 1 is a top-level context diagram for the PDC operation 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 PDC operation Activity Tree in Appendix C. Specific Information Exchanges (IE) 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 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.

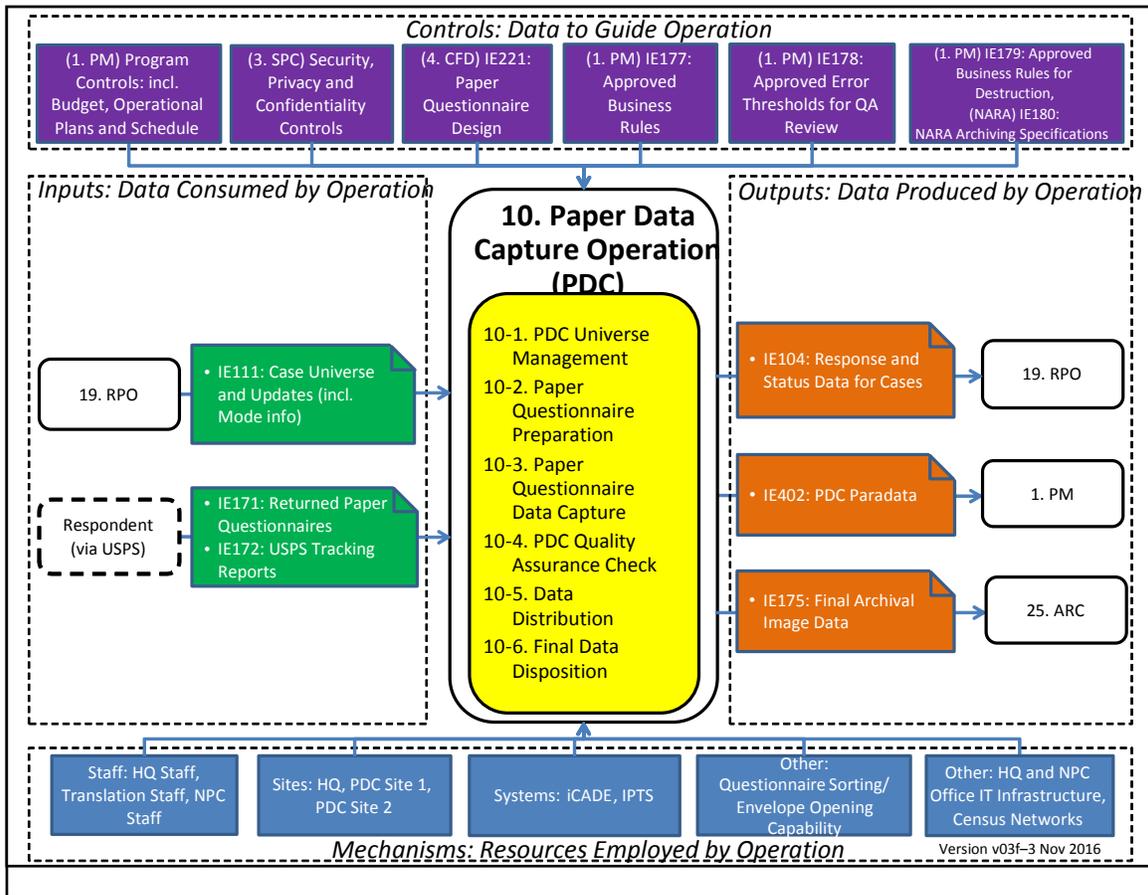


Figure 1: Paper Data Capture (PDC) Operation Context Diagram

For detailed descriptions of the Inputs, Controls, Outputs, and Mechanisms used by the PDC operation, see the sections that follow.

2.3.2.1 PDC Operational Inputs

Inputs are the data and paradata that are consumed by the operation. The inputs, in conjunction with business rules provided by Subject Matter Experts (SMEs), define the amount of operational work that needs to be performed.

Table 1 lists the inputs to the PDC operation.

Table 1: PDC Operational Inputs

Provider	Information Exchange (IE)	Description
19. Response Processing Operation (RPO)	IE111: Case Universe and Updates (including Mode info)	The set of cases, i.e., living quarters, to be enumerated and the expected response mode (Internet, paper, update/enumerate) for each case. An initial case universe is sent at the beginning of the PDC operation by RPO. Universe updates are reflected as work completes in all modes.
Respondent (via USPS)	IE171: Returned Paper Questionnaires	Paper questionnaires that were mailed back to the Census Bureau by respondents.
	IE172: USPS Tracing Reports	Data provided by USPS related to mail delivery and undeliverable status of paper questionnaires. Delivery status data would include the number of paper questionnaires en route to the Census Bureau and their expected arrival date.

2.3.2.2 PDC 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 PDC operation.

Table 2: PDC 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

Provider	Information Exchange	Description
	IE177: Approved Business Rules	Including approved business rules for keying specific fields and write-in responses while capturing data from the paper questionnaires. There will also be capture rules for automated and key entry.
	IE178: Approved Error Thresholds for QA Review	Approved percentage of allowed errors detected during quality review of a batch of sample fields. If the percentage of errors exceeds the threshold, the batch fails quality assurance and the remainder of the fields in the batch is rekeyed.
	IE179: Approved Business Rules for Destruction	Approved business rules that dictate when and how paper questionnaires can be destroyed after imaging.
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 (PII).
4. Content and Forms Design Operation (CFD)	IE221: Paper Questionnaire Design	Design of the paper questionnaires. Includes templates for each questionnaire form type to be used for setting up the scanners and software for OMR, OCR, KFI and Barcode Recognition (BCR).
External: National Archives and Records Administration (NARA)	IE180: NARA Archiving Specifications	Specifications that dictate what, how, and when images should be archived. Images of census questionnaires for NARA must be of a certain quality. We ensure that all scanned images meet the requirements.

2.3.2.3 PDC 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 PDC operation.

Table 3: PDC Operational Outputs

Consumer	Information Exchange	Description
19. Response Processing Operation (RPO)	IE104: Response and Status Data for Cases	Responses from the questionnaires and the associated production status information. The data sources for status are the IPTS and iCADE systems. The following are examples of kinds of information in PDC reports: Forms with Return Tracking Forms checked in through iCADE Data delivered
1. Program Management Operation (PM)	IE402: PDC Paradata	May include counts on checkout or where a response is in the system.
25. Archiving Operation (ARC)	IE175: Final Archival Image Data	Image data to be indexed and archived based on NARA requirements.

2.3.2.4 PDC 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 to be employed for the PDC operation.

Table 4: Staff Resources used within PDC Operational Activities

Staff Resources (Includes FTEs and Contractor personnel)	Description/Role
HQ Staff	All staff members located at Census Bureau HQ who support this operation. This includes Integrated Computer Assisted Data Entry (iCADE) system staff at HQ who coordinate systems at the paper data capture centers as well as Decennial staff who support and report status of PDC activities. It may also include staff located at the Census Bureau’s Bowie Computer Center (BCC).
NPC Staff	NPC staff who manage and operate the two PDC sites. These include the iCADE and Operations Management staff, as well as people overseeing the receipt, scanning preparation, imaging, and KFI processing, as well as questionnaire checkout and paper questionnaire destruction. This also includes staff responsible for quality assurance and support services activities associated with the PDC operation.
Translation Staff	Staff who translate and key selected non-English/Spanish response fields for paper operations. For 2020, this staff may be on-site at the paper data capture sites or provided as a service from another location.

Infrastructure Sites

Table 5 identifies the Infrastructure Sites planned for the PDC operation.

Table 5: Infrastructure Sites for PDC Operational Activities

Infrastructure Sites	Description/Role
HQ	The site for iCADE systems/testing work and location of HQ staff supporting the PDC operation. May also include the Census Bureau’s BCC facility and/or a dedicated 2020 Census Cloud.
PDC Site 1	The first of two sites at which paper data capture processing will be performed. This site will be in the Jeffersonville, Indiana, area.
PDC Site 2	The second of two sites at which paper data capture processing will be performed. This site will be in the Tucson, Arizona, area.

Systems and other Technology Infrastructure

Table 6 identifies the Systems employed for the PDC operation.

Table 6: Systems used within PDC Operational Activities

System	Description
Integrated Computer Assisted Data Entry (iCADE)	iCADE is a data capture solution for paper based data collection operations. For PDC, iCADE receives paper questionnaires and produces document images and form control information, provides OCR, text recognition, mark/sense and other image processing functions and uses these to extract respondent data, as well as to control KFI and QA.
Intelligent Mail Barcode (IMb) Tracing Service	A tracing service offered by the USPS for domestic mail delivery using a 65-bar “Intelligent Mail” barcode.

System	Description
Intelligent Mail Barcode Postal Tracking System (IPTS)	IPTS is a Census Bureau system housed at NPC and used to ingest data from the USPS IMb Tracing Service. The system generates records for each mail piece when it is processed through an automated sort. These events can be correlated to an expected delivery date of outbound mail or business reply mail entering or making its way to a data capture facility and can be used to inform PDC of workload spikes. Specific technology to support this capability is being tested.
Questionnaire Sorting /Opening Capability	A capability to support questionnaire sorting based on predefined criteria. Some equipment can also open envelopes. NPC requirements include using sorters to count mail receipts for postal reconciliation.
Extracting Capability	A capability to open the envelope, extract the questionnaire and remove the spine on a booklet style questionnaire. Currently, sorters open envelopes (but do not extract) and spines are removed using guillotines. Note: If spine removal via extractor proves viable it has the potential to reduce use of guillotines in the questionnaire preparation process. The specific technology to support this capability is being tested.

Other Technology Infrastructure that will be deployed for the PDC operation includes:

- HQ and NPC office IT infrastructure for conducting PDC operational work.
- Census network connectivity for data transmission between operational systems and operational sites.

2.4 PDC Data Flow and Operational Influences

Note to Reader: An Integrated Operations Diagram (IOD) for the data collection operations is being developed and will not be completed until later in fiscal year 2017. This diagram, which will show the flow of information among all of the data collection operations, is intended to help

the reader understand how this operation fits into the bigger picture. The Data Collection IOD will be added as Figure 2 in the next release of this document

t.

<Data Collection IOD to be inserted here at a later date>

Figure 2: 2020 Census Data Collection Integrated Operations Diagram (IOD)

2.5 PDC Design Assumptions

Workloads

- The PDC operation will process both self-response paper questionnaires and field-collected paper questionnaires for those operations that are not enumerated electronically.
- The majority of the PDC workload will be self-response, however, it will also include GQs.
- The PDC workload is approximately 20 million forms with a capacity of 30 million 16-page forms.

Forms

- All paper questionnaires will have a unique Census Identifier.
- Mailed questionnaires will be booklets requiring separation before scanning.
- All paper questionnaire booklets will be serialized, i.e., each page number within a booklet will have an associated ID.

Operations

- Field data collection operations (Nonresponse Followup, Update Enumerate, and Enumeration at Transitory Locations) will be conducted using automated instruments.
- Experimental paper questionnaires are expected.
- GQ operations will use single person paper questionnaires.
- GQ linking will occur within the GQ operation.
- PDC will not be responsible for the linking of GQ forms to the GQ.
- A GQ linking file will be sent to the main data repository outside of and separate from the PDC operation.

Other

- An independent quality program for PDC will be established to ensure the planned quality levels for OMR, OCR, and KFI for the 2020 Census remain the same as those used for the 2010 Census: 99.8 percent for OMR, 99 percent for OCR, and 97 percent for KFI.
- NPC will maintain the requirement to use sorters to count mail receipts for postal reconciliation.
- After a paper questionnaire is captured and the questionnaire is deemed a valid response, the questionnaire will be destroyed.

- Questionnaire images and associated data will be provided to the archiving system.

3. Paper Data Capture (PDC) Operation Detailed Process Description

Figure 3 is a top-level Business Process Model (BPM) showing the Level 1 activity areas within the PDC operation. BPMs for the 2020 Census follow industry-standard Business Process Model and Notation (BPMN) best practices Refer to Appendix D for an explanation of how to read the BPMN notations and a copy of all of the BPMN diagrams for this operation.

This top-level BPM serves as the Context Model for the PDC operation. 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 them and other operations and activities with which they are associated.

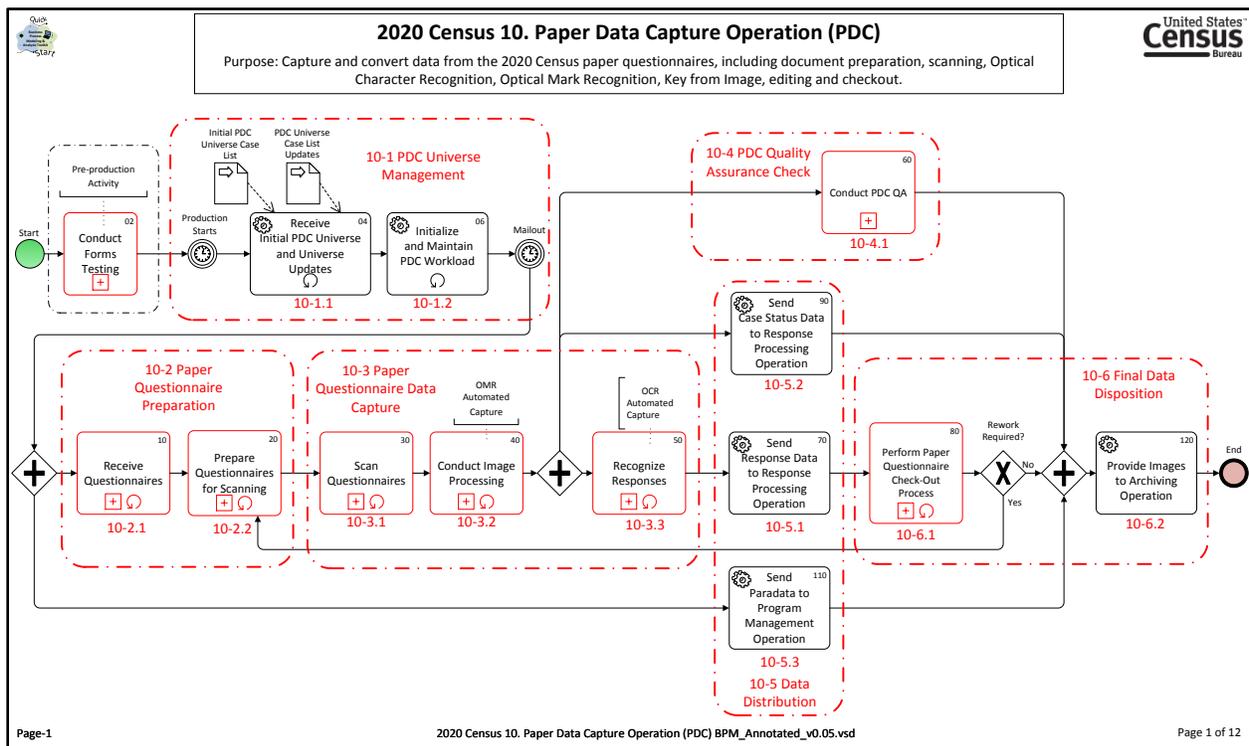


Figure 3: PDC Operation Context Model

The PDC operation is subdivided into the following Activity Areas.

- PDC Universe Management [PDC 10-1]
- Paper Questionnaire Preparation [PDC 10-2]
- Paper Questionnaire Data Capture [PDC 10-3]

- PDC Quality Assurance Check [PDC 10-4]
- Data Distribution [PDC 10-5]
- Final Data Disposition [PDC 10-6]

The business processes for each of these Level 1 activity areas are discussed along with their inputs and outputs in the following sub-sections.

3.1 PDC Universe Management [PDC 10-1]

Figure 4 shows the BPM for the PDC Universe Management [PDC 10-1] activity area (area within the shaded gray rounded rectangle) and its constituent activities within the overall context of the PDC operation.

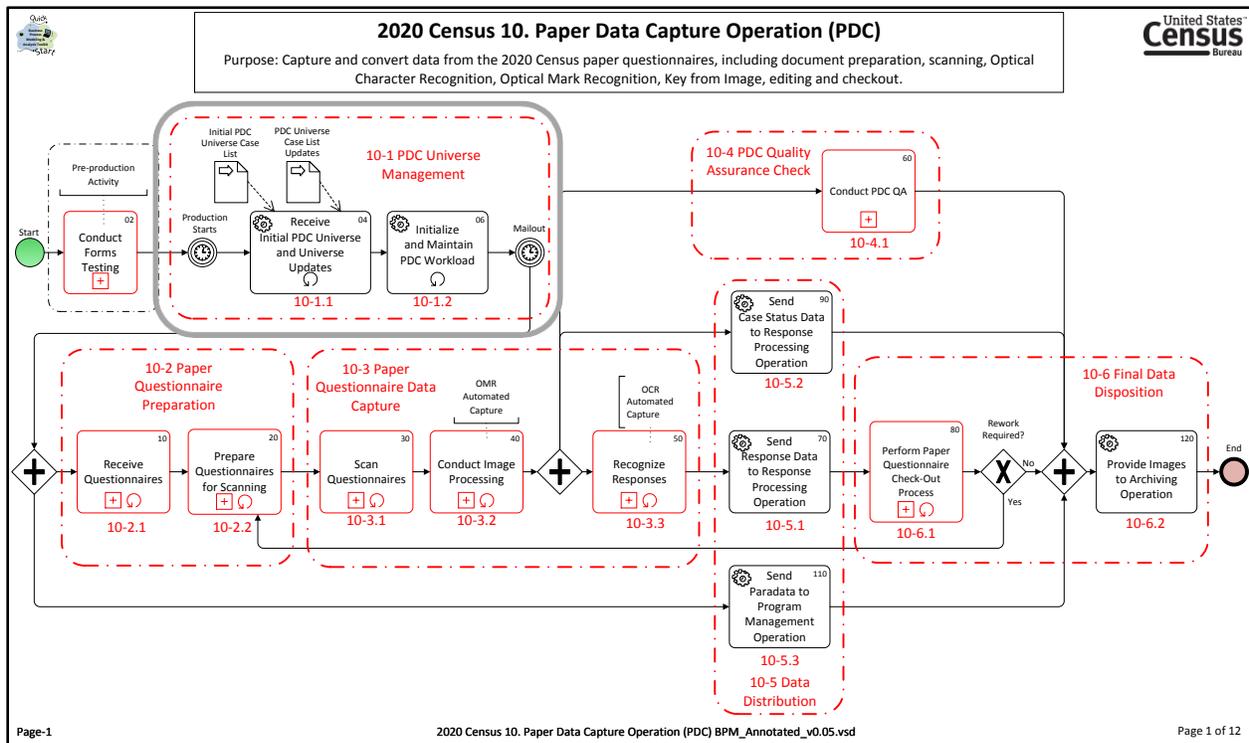


Figure 4: PDC Universe Management [PDC 10-1] Constituent Activities

The PDC Universe Management activity area is subdivided into the following operational subactivities.

- PDC Universe Management [PDC 10-1]
 - Receive Initial PDC Universe and Universe Updates [PDC 10-1.1]
 - Initialize and Maintain PDC Workload [PDC 10-1.2]

Subsequent sections describe the PDC Universe Management operational subactivities in detail.

3.1.1 Receive Initial PDC Universe and Universe Updates [PDC 10-1.1]

The PDC operation receives the entire universe of cases for which paper forms could be captured from RPO before the questionnaire mailouts and other paper enumeration operations.

3.1.2 Initialize and Maintain PDC Workload [PDC 10-1.2]

Upon receiving the initial PDC Universe, the PDC operation creates a PDC Workload that represents all of the cases that could potentially require paper data capture. As questionnaires are processed, PDC sends status updates to RPO so RPO can inform field data collection operations which cases have cleared the paper data capture mode.

3.2 Paper Questionnaire Preparation [PDC 10-2]

Figure 5 shows the BPM for the Paper Questionnaire Preparation [10-2] activity area (area within the shaded gray rounded rectangle) within the context of the overall PDC operation.

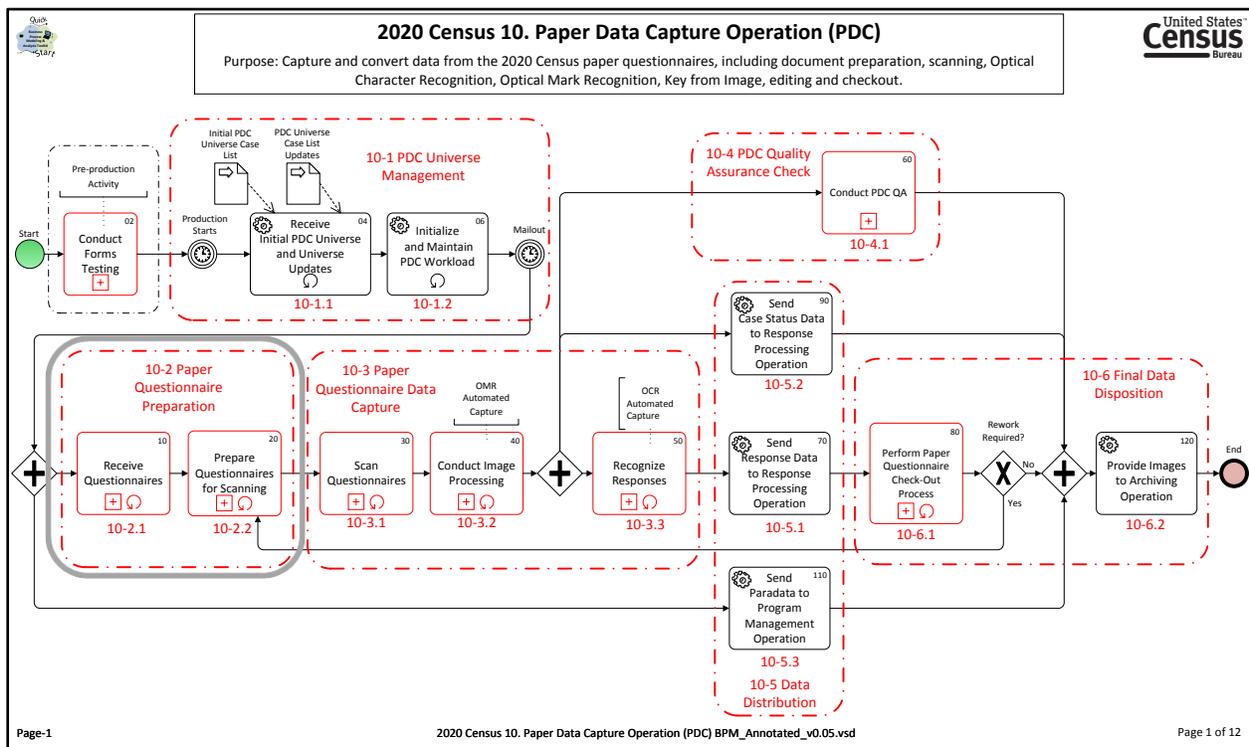


Figure 5: Paper Questionnaire Preparation [PDC 10-2] Constituent Activities

The Paper Questionnaire Preparation activity area is subdivided into the following operational subactivities.

- Paper Questionnaire Preparation [PDC 10-2]
 - Receive Questionnaires [PDC 10-2.1]
 - Prepare Questionnaires for Scanning [PDC 10-2.2]

Subsequent sections describe the Paper Questionnaire Preparation operational subactivities in detail.

3.2.1 Receive Questionnaires [PDC 10-2.1]

Figure 6 provides a detailed view of the constituent activities that make up the “Receive Questionnaires” operational subactivity.

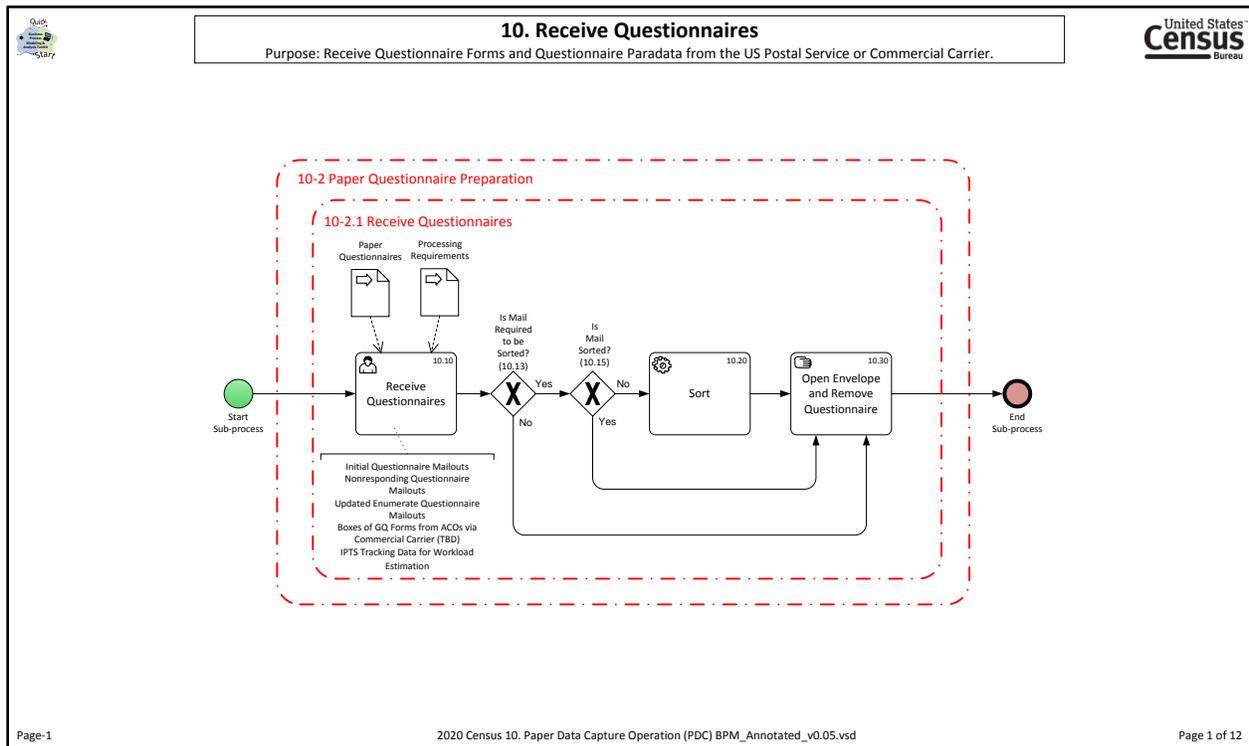


Figure 6: Receive Questionnaires

PDC is responsible for capturing the following groups of questionnaires:

Paper forms arriving via USPS as individual receipts

- A portion of the U.S and Puerto Rico (at least 20 percent) will receive a questionnaire in the mail as part of the first contact attempt.

- 2020 Census plans include 100 percent of the nonresponders in self-response areas will receive a questionnaire in the fourth week after initial mailout.
- The UE plans include mailing or dropping off paper questionnaires to a portion of the population.

Forms returned by paper-based field operations – sent in bulk from field offices

- Group Quarters forms, planned as single sheet person-based forms, will arrive at a PDC site (and will be linked to their associated GQ by an ID). They may be delivered by a carrier other than USPS.
- Forms that are handed to enumerators, as well as UE forms, may also be returned in bulk.

The PDC operation uses address status data provided by USPS postal tracing to track questionnaire delivery and returns. The information informs PDC operations about expected receipts from the USPS. This information is used for estimating the data capture workload timing and can be used to determine peaks in mail returns. It is maintained within the IPTS and is provided by management reports.

It is expected that the USPS will use tractor-trailers to transport and deliver forms coming from their local distribution centers to the PDC facilities. (In some cases, smaller trucks may deliver mail from secondary sites.) Each tractor-trailer holds 36 USPS All Purpose Containers (APCs). Containers are unloaded from the truck into the processing area. APCs are unloaded onto mail trays that are then placed on bins and labeled with a date. APCs are then returned to USPS. Misdirected mail is identified and is set aside for return to the USPS.

Bins are staged in First-In-First-Out (FIFO) order or as required by the business rules received from the operations. The plan is to test having the USPS presort questionnaires before delivering them to the PDC facilities. It also includes maximizing the use of presorting work in order to reduce the number of sorters that may be required at the PDCs.

3.2.2 Prepare Questionnaires for Scanning [PDC 10-2.2]

Figure 7 provides a detailed view of the constituent activities that make up the “Prepare Questionnaires for Scanning” operational subactivity.

Extractor technology is being researched as a mail opening activity. The extractor opens three sides of the envelope and separates the booklet into individual pages (removes the binding edge during envelope opening), exposing the contents of the envelope, disposing of the envelope, and stacking the contents for further processing. Because the spines can be removed during this stage, forms need to be unfolded, inspected, and batched, eliminating the guillotine step for booklets as was implemented in previous censuses.

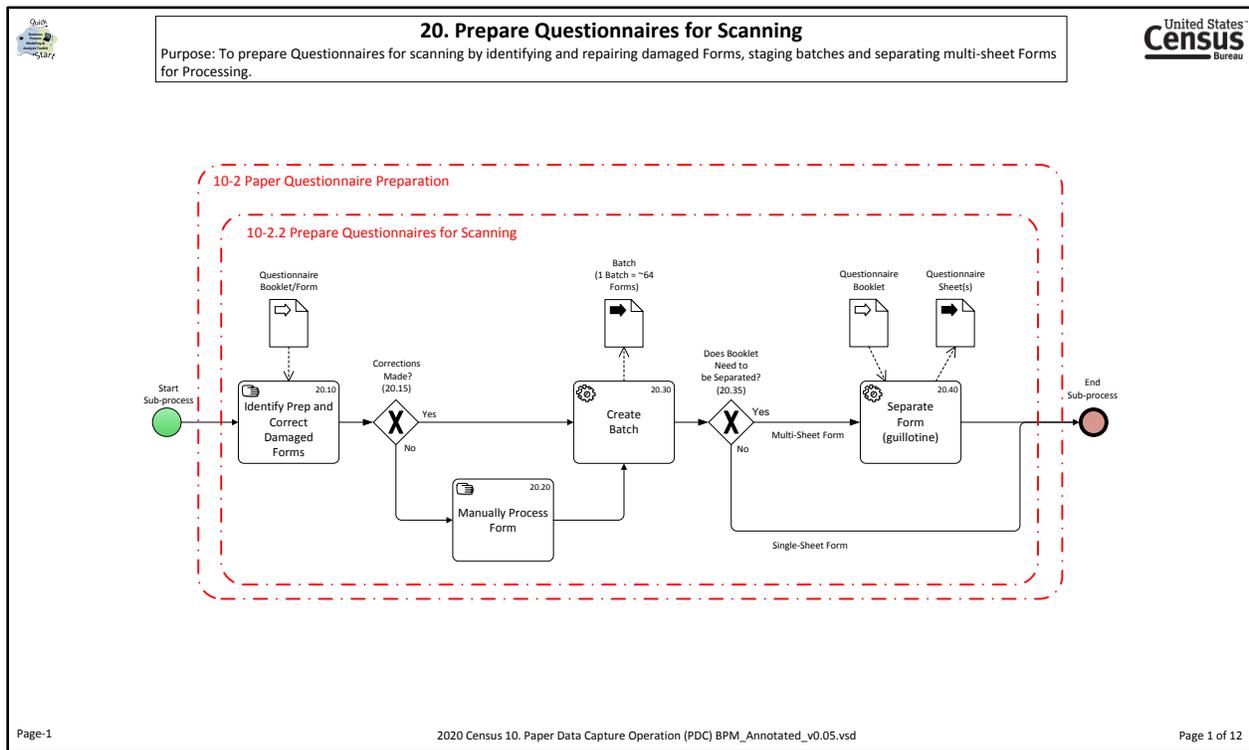


Figure 7: Prepare Questionnaires for Scanning

Prepare Receipts for Extraction - Form Separation

Staff will begin by inspecting trays of forms and ensuring they are all oriented in the same direction.

Staff will pull out problem forms and place them in the resolution tray. The extractor separates the booklet into individual pages (by removing the binding edge during opening), exposes the contents, disposes of the envelope, and stacks the forms for further processing. Extracted documents are removed from the automated stacker and placed in a batch tray.

- The final step in preparing the questionnaire for scanning is creating a batch of questionnaires.

Unscannable documents are placed into problem trays. Scannable documents are placed into batch trays. The number of forms in a batch is determined by the number of pages per form. All pages that comprise a single form must be in a single batch.

- Resolve Problems - identify and correct damaged forms.

If there is a problem such as a form cannot be extracted normally, that form is placed in the problem resolution tray. Often these forms arrive in nonstandard envelopes. They may have

correspondence, may be a partial form, or may be damaged in some way. Sometimes the questionnaire is inserted in the return envelope backward so the address cannot be seen.

- Transcription Operations - Forms that cannot be scanned are sent to a transcription area where data are transcribed from partial booklets or forms that may be torn, mangled, or damaged.

Once transcribed, these new forms are inserted into the normal production flow. Transcription is verified, and the ID and address are transcribed from the old form to the new form. The damaged forms are stored in the warehouse for future disposition. There are checks during the document preparation to ensure all forms are processed and that no forms are discarded by mistake.

3.3 Paper Questionnaire Data Capture [PDC 10-3]

Figure 8 shows the BPM for the Paper Questionnaire Data Capture [PDC 10-3] activity area (area within the shaded gray rounded rectangle) and its constituent activities within the overall context of the PDC operation.

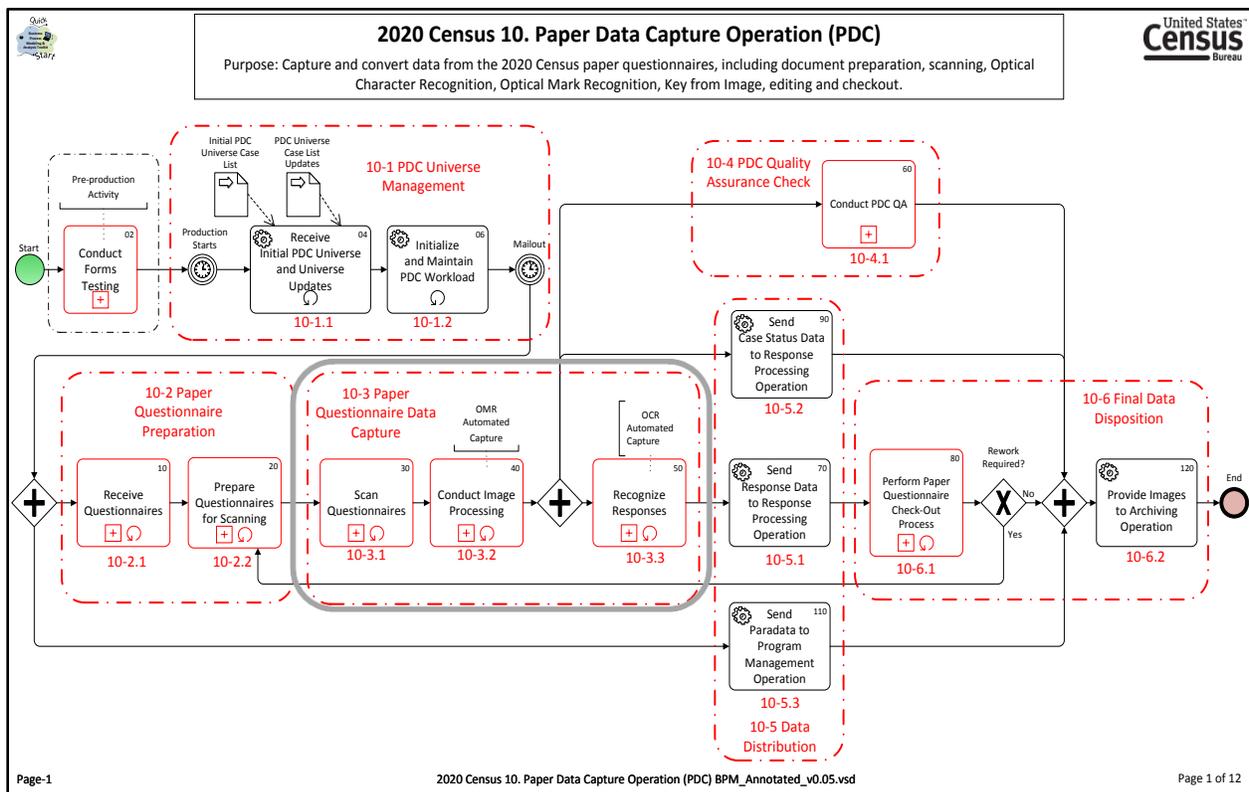


Figure 8: Paper Questionnaire Data Capture [10-3] Constituent Activities

The Paper Questionnaire Data Capture activity area is subdivided into the following subactivities.

- Paper Questionnaire Data Capture [PDC 10-3]
 - Scan Questionnaires [PDC 10-3.1]
 - Conduct Image Processing [PDC 10-3.2]
 - Recognize Responses [PDC 10-3.3]

Subsequent sections describe the Paper Questionnaire Data Capture operational subactivities in detail.

3.3.1 Scan Questionnaires [PDC 10-3.1]

A detailed view of the constituent activities that make up the “Scan Questionnaires” operational subactivity is given in [Figure 9](#) below.

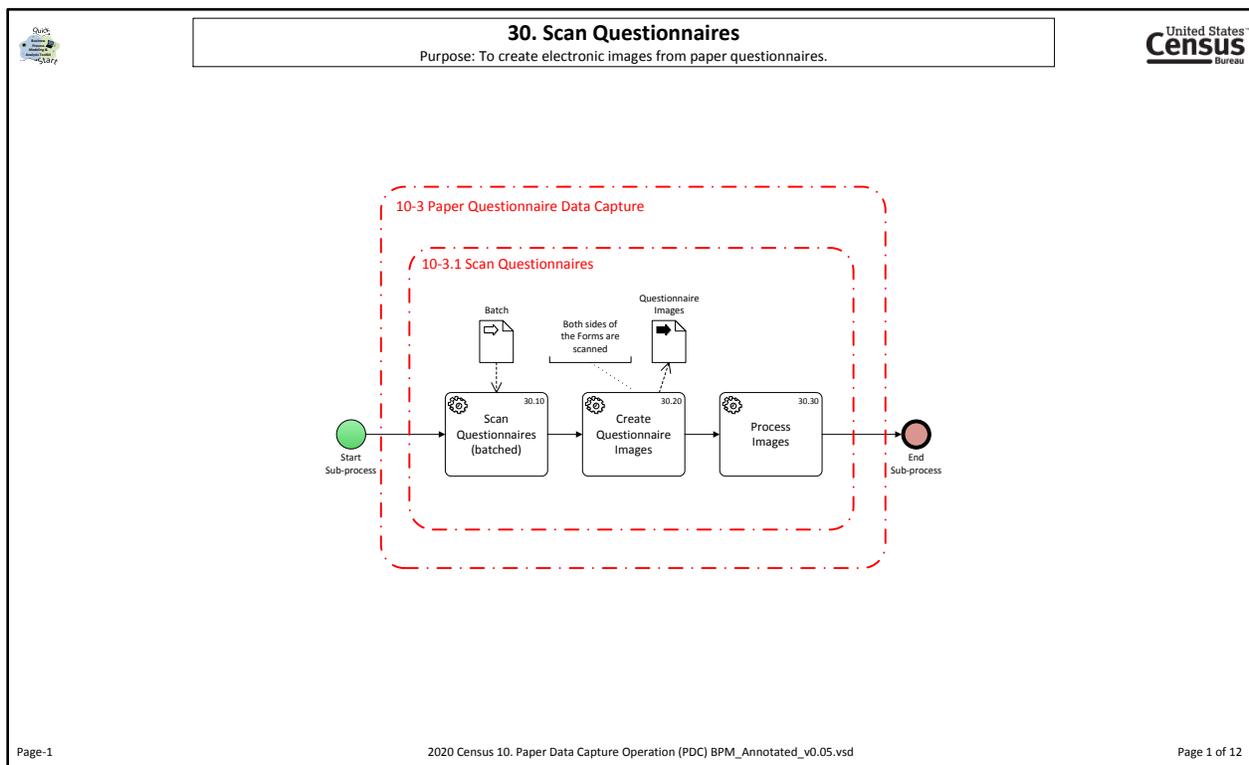


Figure 9: Scan Questionnaires

There are a number of steps in the iCADE process of ensuring the data on the form is captured accurately on the image.

Scanning personnel are responsible for scanning every page of every form within the batch. Batches of forms are scanned, and an electronic form image is created for each form. This is where the form is officially checked into the system. Double feeds or problem forms are rescanned as needed. After all forms are scanned, they are sent to checkout staging. They remain there in the event they are needed for exception review. When a form has cleared output and is ready for image processing, the paper is moved to the warehouse to await checkout.

Scanned form images that pass certain quality criteria are sent on to the data capture process.

Scanner jams or multiple document feeds are corrected. Forms that cannot be scanned because the paper is physically damaged are sent to transcription. Routine scanner cleaning and calibration are performed regularly.

3.3.2 Conduct Image Processing [PDC 10-3.2]

Figure 10 provides a detailed view of the constituent activities that make up the “Conduct Image Processing” operational subactivity.

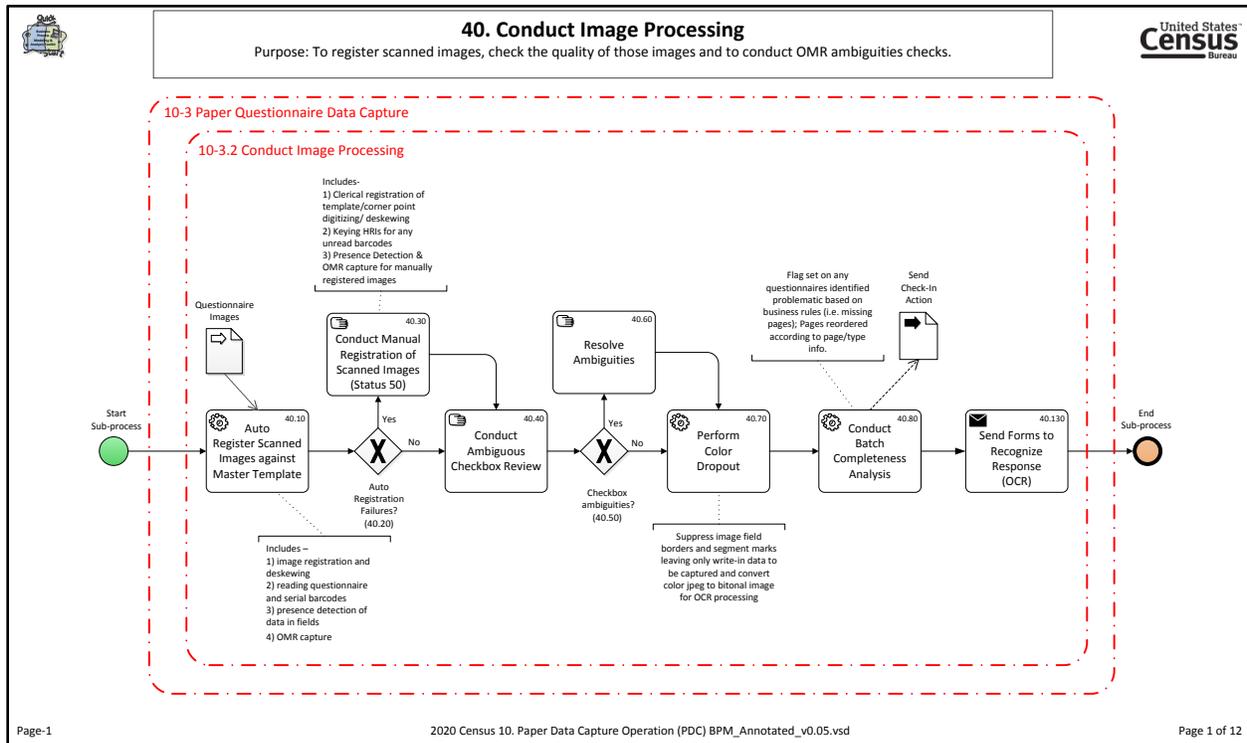


Figure 10: Conduct Image Processing

Auto Registration – After scanning, images are created and matched against the master template for the form type and page identification. This allows the system to find duplicate pages, missing pages, and unexpected forms. It aligns the corner points of the image and can adjust slightly

skewed images. Problems are sent to manual registration for resolution. Next, the OMR checkboxes are read, evaluated, and captured, and the OCR software attempts to recognize alphanumeric data fields. Finally, the software detects handwritten entries in the write-in zones. A file is written that contains OMR and OCR fields that were flagged for review and fields that were flagged for presentation during KFI. The file includes all the pages that could not be registered automatically and must be sent to be fixed.

Manual Registration (MR) – Manual review clerks will review registration and OMR issues that were flagged by the software during autoregistration. During this step, a clerk can key page barcodes as well as Census ID and document integrity barcodes readable to the eye for pages that were unreadable in automatic processing. They can also manually repair corner points for images of forms that had torn, or badly scanned images so that data capture fields can be read. OMR fields that were flagged in the previous step (autoregistration) are reevaluated in MR. These check boxes are not presented to a keyer.

Batch Completeness – This step ensures that all form IDs that were expected to be seen are present and accounted for, that all pages within a form are present and in sequence, and that there are no issues such as missing pages, extra pages, duplicate pages, missing form IDs, extra form IDs, page count issues, or duplicate form IDs. Any issues identified during the processing step are flagged for manual examination at Exception Review (ER).

Check-out – This step is critical to ensuring the completeness of the scanning step. It ensures that all data is accounted for. A report produced automatically lists all issues that were identified during the batch completeness step. The exception review clerk pulls the paper batch from temporary storage and attempts to resolve the issues identified in the report. The clerk then determines which forms should be pulled and may require rescanning. If a form is not resolved, it is deleted from the batch. If it is resolved, the questionnaire remains and is then sent on to KFI. If no problems are detected in a batch, ER is skipped.

3.3.3 Recognize Responses [PDC 10-3.3]

A detailed view of the constituent activities that make up the “Recognize Responses” operational subactivity is given in [Figure 11](#) below.

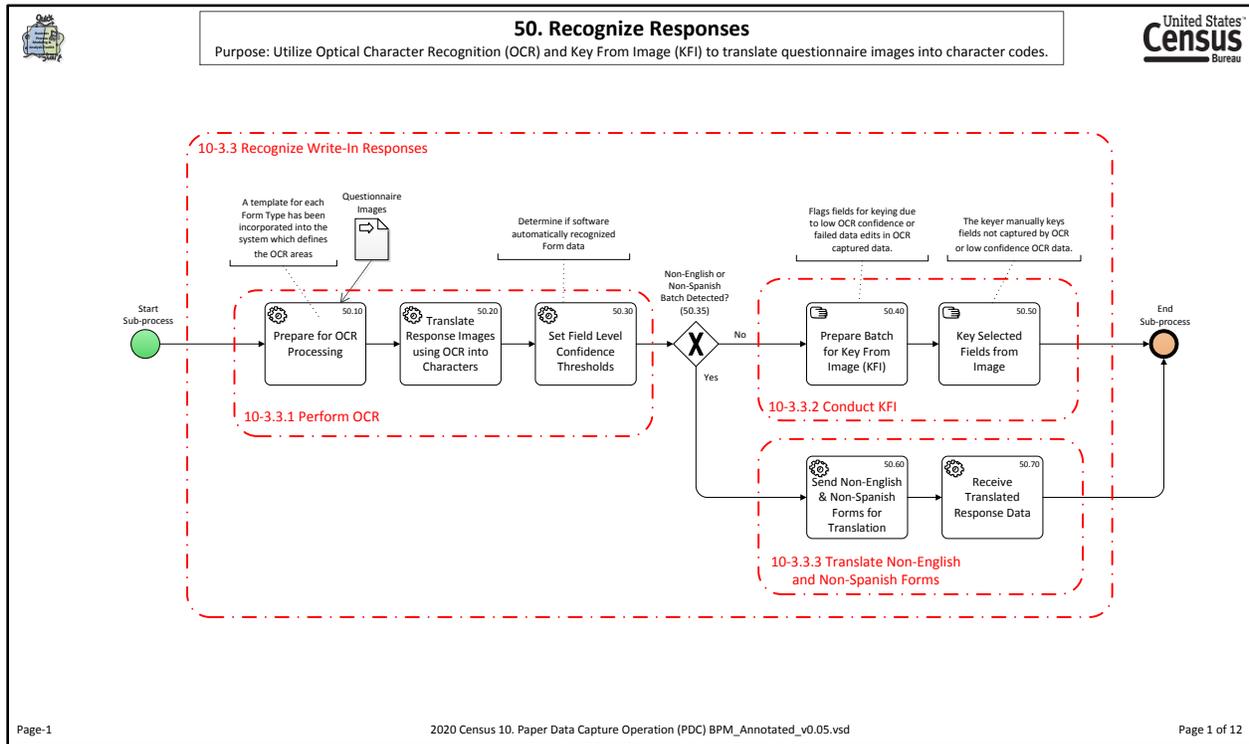


Figure 11: Recognize Responses

The Recognize Responses activity area is subdivided into the following operational subactivities.

- Recognize Responses [PDC 10-3.3]
 - Perform OCR [PDC 10-3.3.1]
 - Conduct KFI [PDC 10-3.3.2]
 - Translate Non-English and Non-Spanish responses [PDC 10-3.3.3]

Subsequent sections describe the Recognize Responses operational subactivities in detail.

3.3.3.1 Perform OCR [PDC 10-3.3.1]

Figure 12 provides a detailed view of the constituent activities that make up the “Perform OCR” operational subactivity.

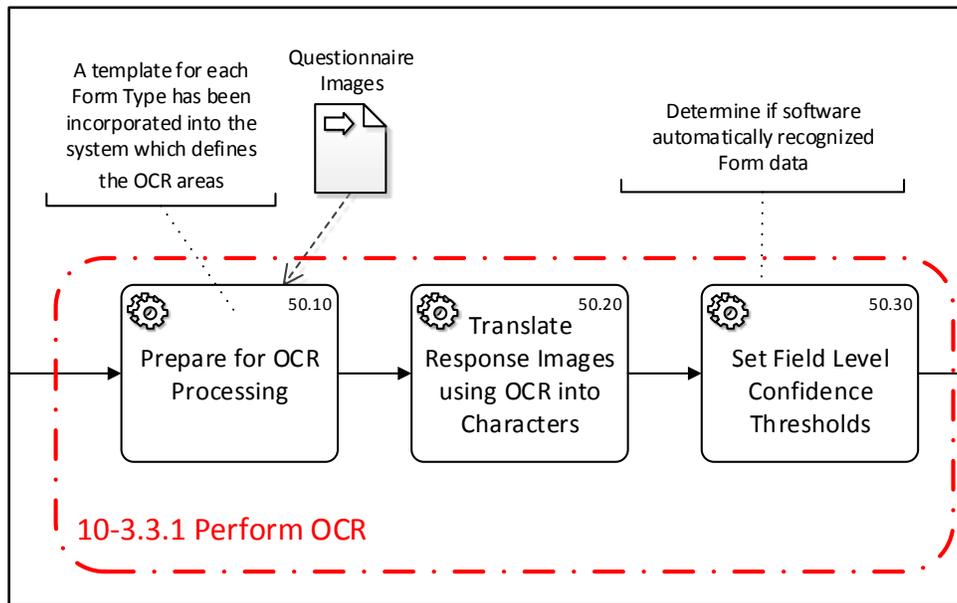


Figure 12: Perform OCR

A template for each form type has been incorporated into the system. The software allows the definition of all the OCR (and OMR) zone areas that are used to recognize data contained on the form. An input image is registered, and the OCR (and OMR) zones are adjusted to maximize the optical recognition processing accuracy. OMR is used to read responses that are in check boxes; OCR is used to read alphabetic and numeric characters. Data is captured in English and Spanish only.

The system uses field-level confidence thresholds to accept or reject characters written in the field. In cases where the recognition software cannot automatically recognize data from the form image, the image is sent to manual capture where a keyer performs Key from Image (KFI).

3.3.3.2 Conduct KFI [PDC 10-3.3.2]

Figure 13 provides a detailed view of the constituent activities that make up the “Conduct KFI” operational subactivity.

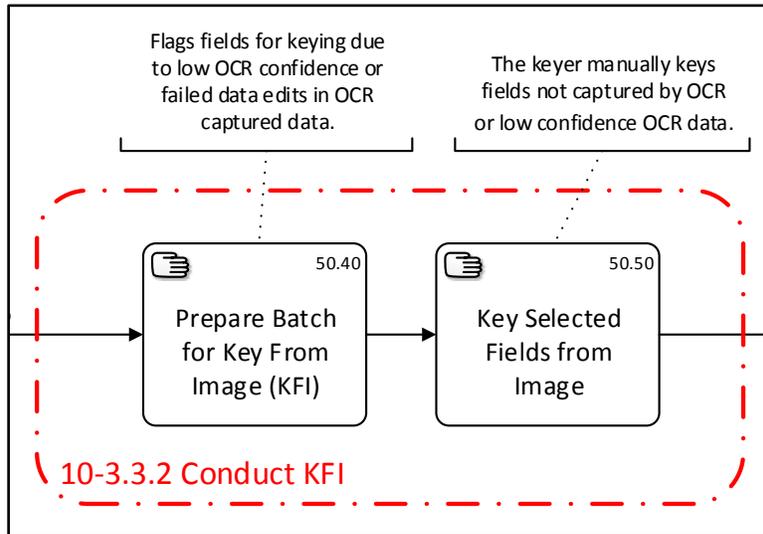


Figure 13: Conduct KFI

KFI - The purposes of KFI are to capture field level data manually that could not be captured automatically at the required quality level and to process QA samples. The KFI step is done after scanning and character recognition has been performed.

The keyer uses a computer workstation to view the field of a questionnaire that has been presented for review, analysis, and correctional keying. The information keyed into the system should be identical to what is on the form or as per capture and business rules. For example, the KFI specification contains keying rules that instruct keyers to ignore some characters such as special characters and alphabetic characters found in the Date of Birth write-in field.

3.3.3.3 Translate Non-English and Non-Spanish Forms [PDC 10-3.3.3]

Figure 14 provides a detailed view of the constituent activities that make up the “Translate Non-English and Non-Spanish Forms” operational subactivity.

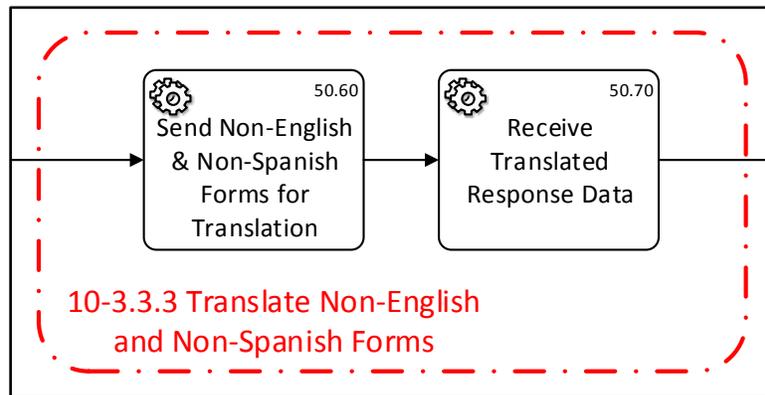


Figure 14: Translate Non-English and Non-Spanish Forms

For the 2020 Census, PDC is required to translate certain fields on questionnaires that are written in a language other than English or Spanish. This plan is preliminary and will be tested in the 2018 End-to-End CT.

As paper forms are scanned, questionnaires completed in another language fail OCR. Failures are directed to a manual KFI operation. Keyers then view an image and determine if the handwriting is in another language. The keyer will flag fields that are filled out in a language other than English or Spanish. Certain fields will be held for translation by Decennial Translation Office (DTO) staff. The current plan is for DTO staff to access iCADE, locate the bookmarked forms, then cases, then translate and key responses in English into the iCADE system. At this time, the details around the actual DTO translation and keying are tentative, and the assumption is that they will be only translating a predetermined set of languages.

Any forms completed in English or Spanish can continue on the high volume production path. At this writing, no other foreign language forms are planned for the 2020 Census.

3.4 PDC Quality Assurance Check [PDC 10-4]

Figure 15 shows the BPM for the PDC Quality Assurance Check [PDC 10-4] activity area (area within the shaded gray rounded rectangle) within the context of the overall PDC operation.

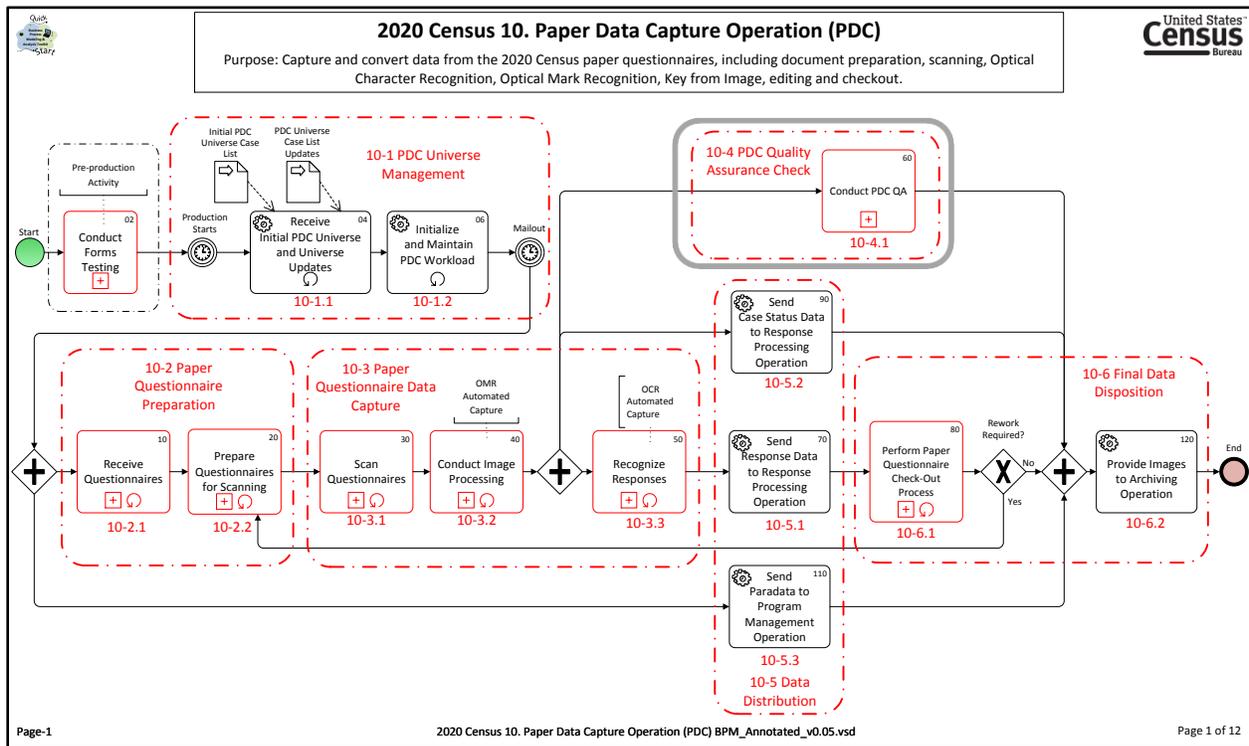


Figure 15: PDC Quality Assurance Check [10-4] Constituent Activities

The PDC Quality Assurance Check activity area has one subactivity as shown below.

- PDC Quality Assurance Check [PDC 10-4]
 - Conduct PDC QA [PDC 10-4.1]

The subsequent section describes the PDC Quality Assurance Check operational activity in detail.

3.4.1 Conduct PDC QA [PDC 10-4.1]

Figure 16 provides a detailed view of the constituent activities that make up the “Conduct PDC QA” operational subactivity.

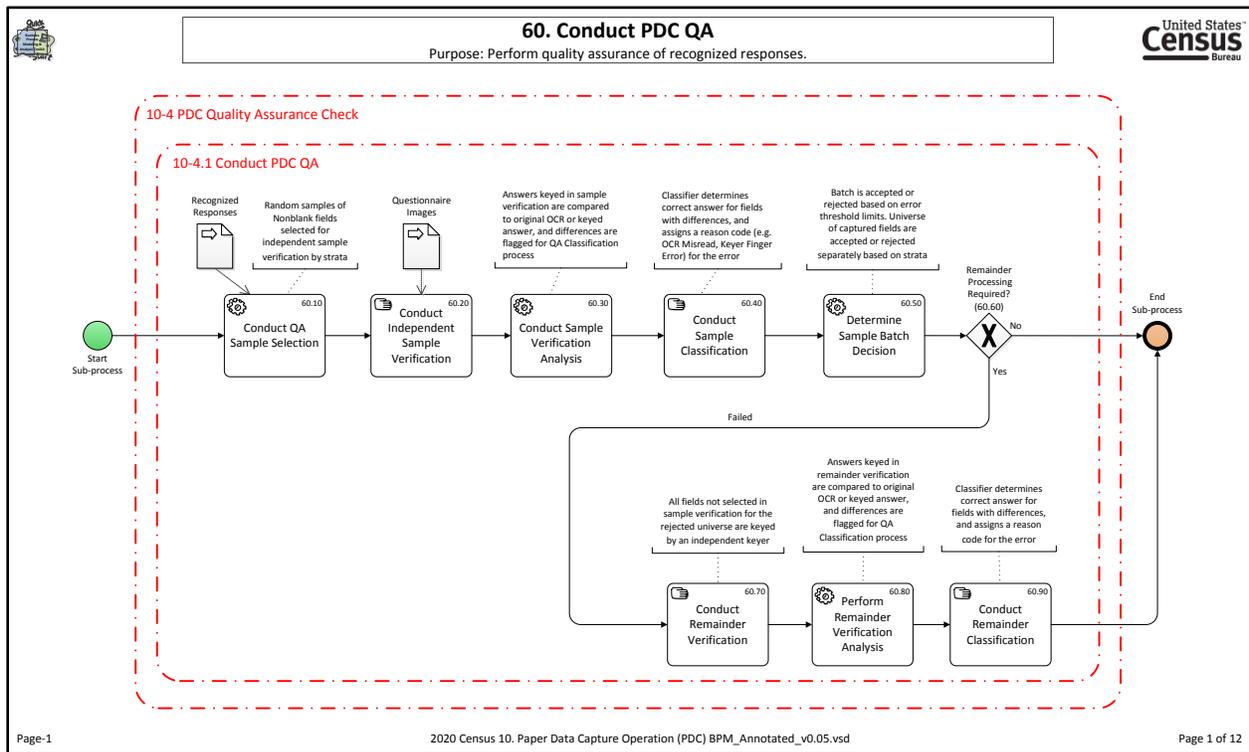


Figure 16: Conduct PDC QA

A random sample of OCR Nonblank and KFI Nonblank fields is selected for sample verification. Answers keyed in the sample verification are compared with OCR or keyed responses, and differences are flagged for QA classification process. The classifier determines the correct answer fields with differences and assigns reason codes for the error. The batch is accepted or rejected based on error threshold limits. The universes of OCR captured fields and KFI captured fields are accepted or rejected separately. If the batch passes both OCR and KFI, it is sent to Output. Batches that are rejected will have all nonsampled fields sent back for rekeying, an action that is called Remainder Processing. If it is determined that the batch requires Remainder Processing, all fields not selected in the original verification sample will be presented to a keyer different from the original keyer for Remainder processing. The keyer for KFI Remainder Verification will not be able to see what the original keyer entered. The answers keyed for the selected fields will be keyed and then compared against the original keyer’s data.

The remainder batches are tracked by keyer on a daily basis through a series of iCADE reports and based on survey sponsor criteria. A keyer’s qualification can be impacted, and the keyer may ultimately be removed from the data capture process. The system will compute differences in all of the fields, the types of differences, and the error rates.

3.5 Data Distribution [PDC 10-5]

Figure 17 shows the BPM for the Data Distribution [PDC 10-5] activity area (area within the shaded gray rounded rectangle) and its constituent activities within the overall context of the PDC operation.

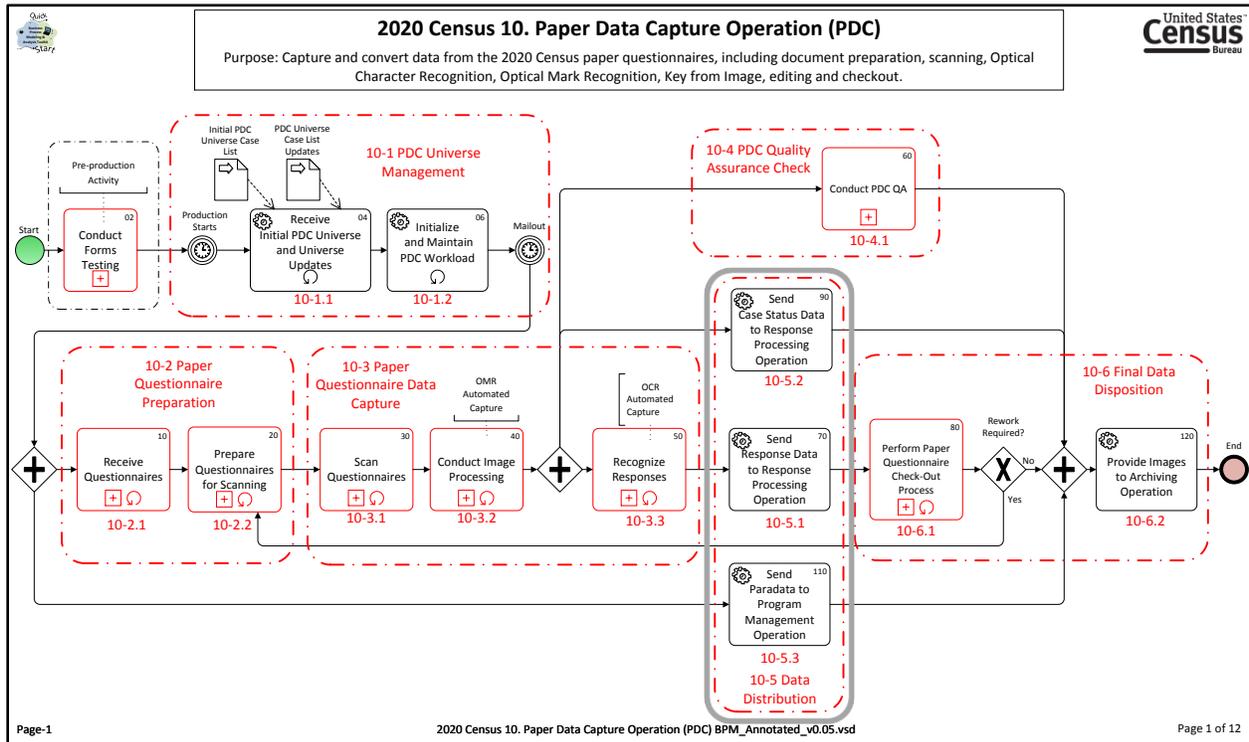


Figure 17: Data Distribution [10-5] Constituent Activities

The Data Distribution activity area is subdivided into the following subactivities.

- Data Distribution [PDC 10-5]
 - Send Response Data to Response Processing [PDC 10-5.1]
 - Send Case Status Data to Response Processing [PDC 10-5.2]
 - Send Paradata to Program Management [PDC 10-5.3]

Subsequent sections describe the Data Distribution operational subactivities in detail.

3.5.1 Send Response Data to Response Processing [PDC 10-5.1]

Once completed, PDC will deliver completed response data in multiple intervals during the process to the Decennial data delivery interface. The file delivery process will provide the PDC operation confirmation that the file was received. The accepted file delivery is just one criteria in the approval to destroy the paper form.

3.5.2 Send Case Status Data to Response Processing [PDC 10-5.2]

The iCADE system sends status data to various areas several times per day. The information provided includes processing status scanning, keying, and response data that is sent to areas such as ECaSE, Multimode Operational Control System (MOCS), etc. The within-system iCADE reports show work moving through stages in their capture process.

3.5.3 Send Paradata to Program Management [PDC 10-5.3]

Unified Tracking System (UTS) reports are made available to management.

3.6 Final Data Disposition [PDC 10-6]

Figure 18 shows the BPM for the Final Data Disposition [PDC 10-6] activity area (area within the shaded gray rounded rectangle) and its constituent activities within the overall context of the PDC operation.

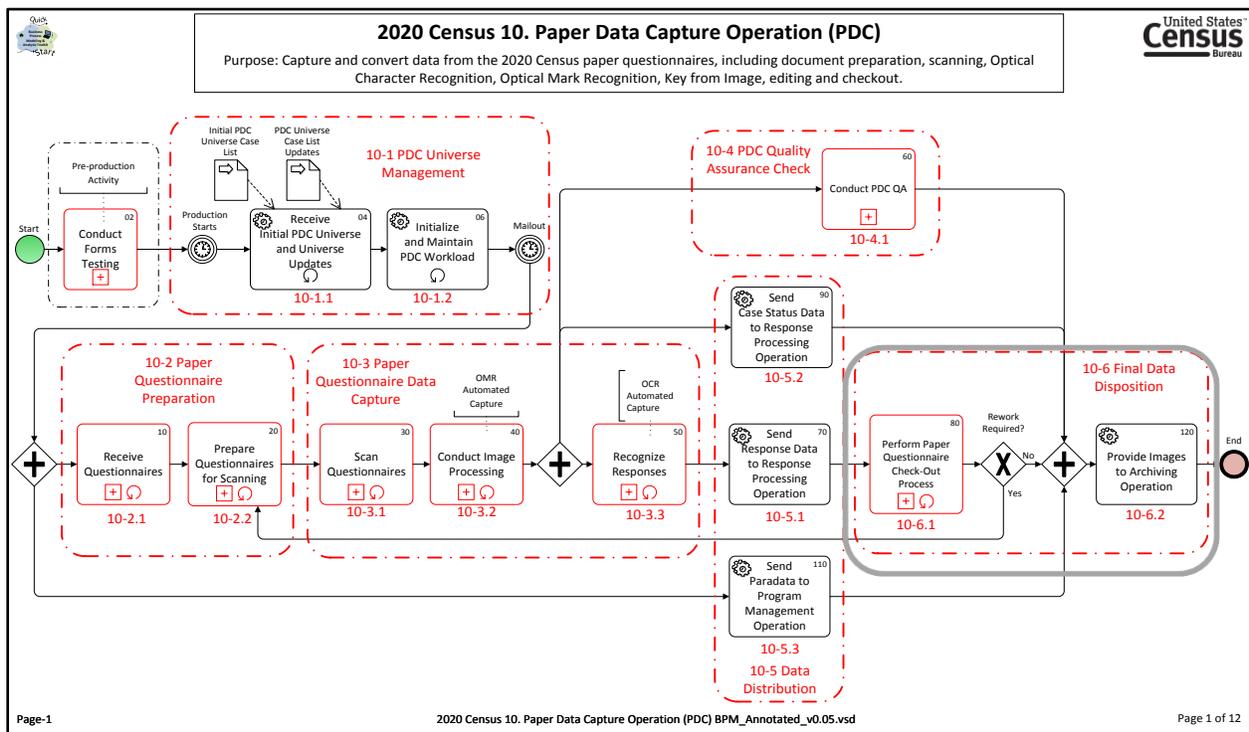


Figure 18: Final Data Disposition [10-6] Constituent Activities

The Final Data Disposition activity area is subdivided into the following subactivities.

- Final Data Disposition [PDC 10-6]
 - Perform Paper Questionnaire Checkout Process [PDC 10-6.1]

- Provide Images to Archiving Operation [PDC 10-6.2]

Subsequent sections describe the Final Data Disposition operational subactivities in detail.

3.6.1 Perform Paper Questionnaire Checkout Process [PDC 10-6.1]

Figure 19 provides a detailed view of the constituent activities that make up the “Perform Paper Questionnaire Checkout Process” operational subactivity.

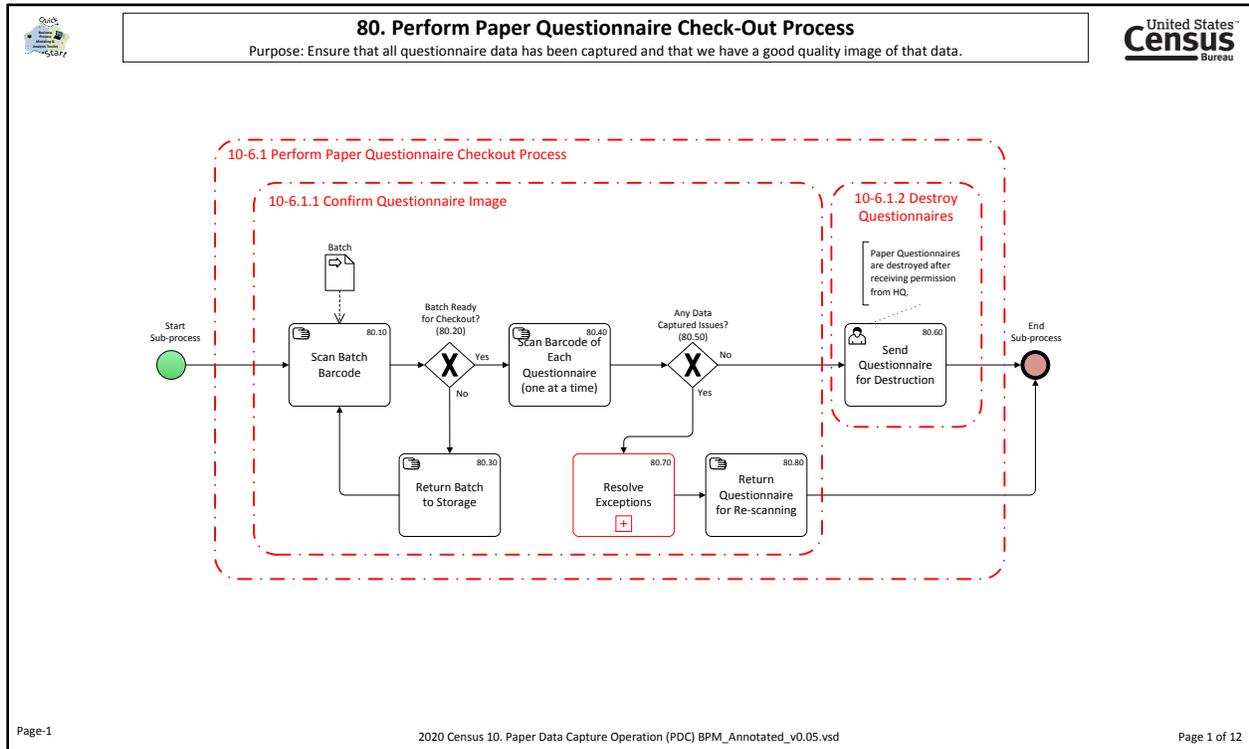


Figure 19: Perform Paper Questionnaire Checkout Process

The Perform Paper Questionnaire Checkout Process activity area is subdivided into the following subactivities.

- Perform Paper Questionnaire Checkout Process [PDC 10-6.1]
 - Confirm Questionnaire Image [PDC 10-6.1.1]
 - Destroy Questionnaires [PDC 10-6.1.2]

Subsequent sections describe the Perform Paper Questionnaire Checkout Process operational subactivities in detail.

3.6.1.1 Confirm Questionnaire Image [PDC 10-6.1.1]

A detailed view of the constituent activities that make up the “Confirm Questionnaire Image” operational subactivity is given in [Figure 20](#) and [Figure 21](#) below.

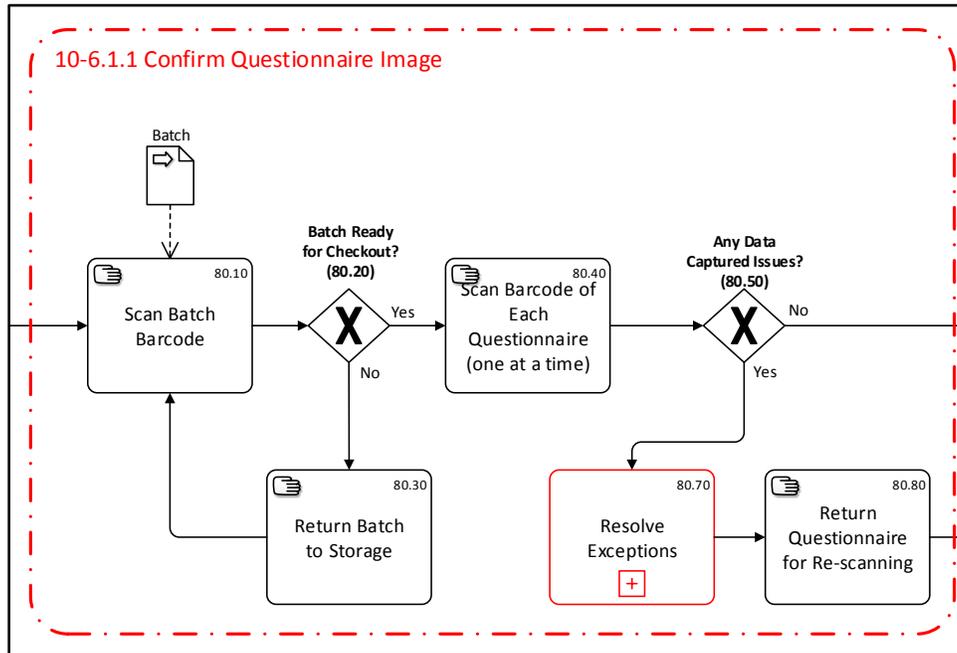


Figure 20: Confirm Questionnaire Image

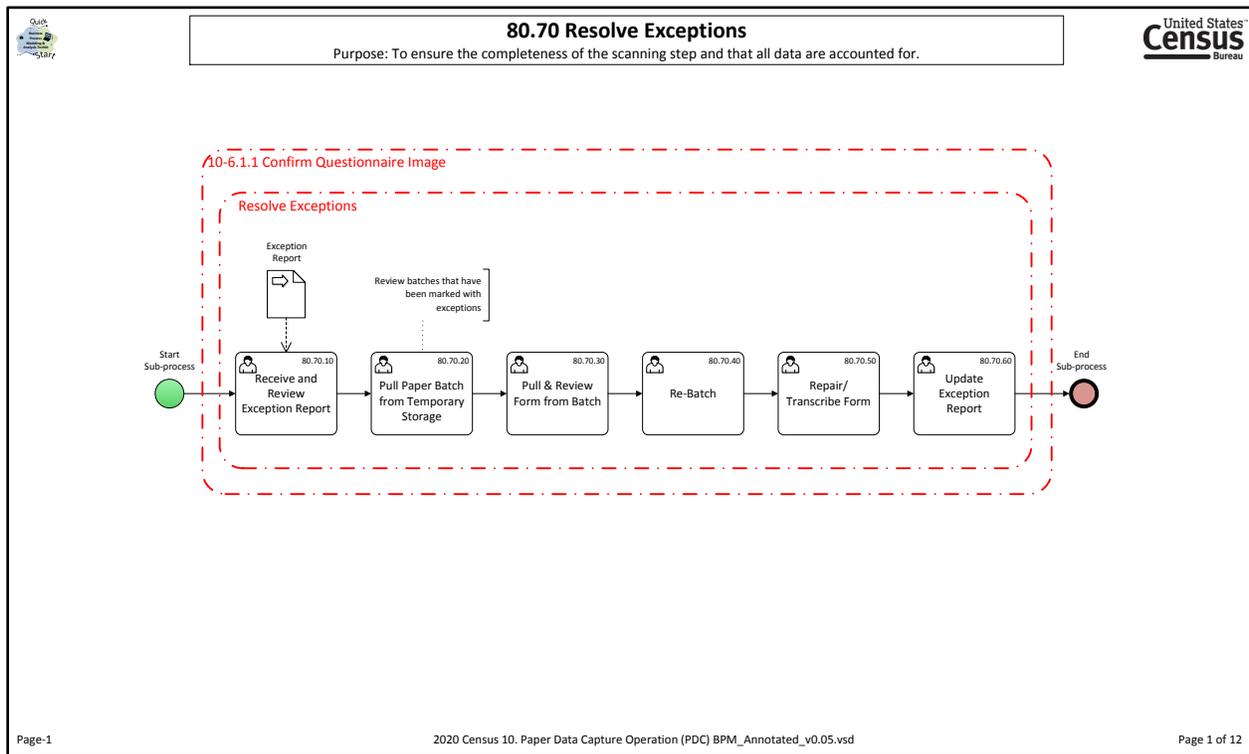


Figure 21: Resolve Exceptions (Subactivity of “Confirm Questionnaire Image”)

Forms Checkout – The forms checkout function is the last operation in the data process flow. It occurs before moving the forms to final storage and before destroying them. This function confirms that all forms have been processed through the applicable processes, that response data has been successfully captured, and that a good digital image was captured.

All (100 percent) of the forms are checked after data capture processing is completed to confirm the data was captured and to redirect any suspect forms (either data or the image is discrepant) back into the process flow to capture the data. Any data problems identified at this time are resolved before forms are moved to storage, resulting in the failing forms either being rescanned and a new barcode applied or being transcribed and then rescanned.

The Checkout operation has two very distinct functions – Checkout and Checkout Analysis. The first part (Checkout) automatically sorts 100 percent of the forms, separating batches containing all good forms and batches containing forms that need to be reprocessed. Automated checkout will occur by running forms through the scanner a second time after data is captured and delivered. Forms requiring reprocessing (Checkout Analysis) will be reviewed, corrected, and reprocessed in new batches allowing the accepted forms/data to continue to the next phase. Ultimately, all forms will have to clear the Checkout before final storage or disposal.

3.6.1.2 Destroy Questionnaires [PDC 10-6.1.2]

Figure 22 provides a detailed view of the constituent activities that make up the “Destroy Questionnaires” operational subactivity.

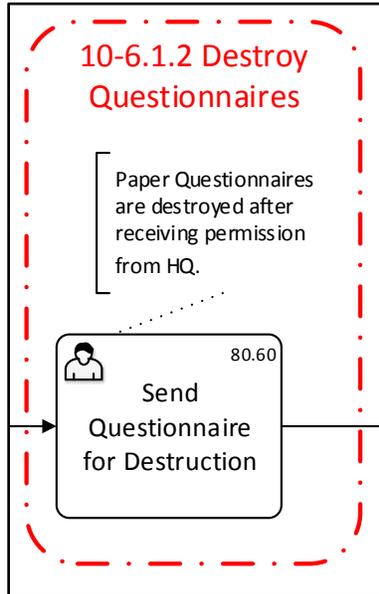


Figure 22: Destroy Questionnaires

3.6.2 Provide Images to Archiving Operation [PDC 10-6.2]

TBD – NARA requirements are not known at this writing.

4. Cost Factors

4.1 Background

Investment in Paper Data Capture is projected to influence (reduce ↓ or increase ↑) the 2020 Census overall costs in the following ways. Reductions are anticipated from:

- ↓ Using an enterprise solution, iCADE, for paper data capture.
- ↓ Provisioning a low-cost self response mode (other than the Internet) to increase self-response rate.
- ↓ Using postal tracing data for followup universe creation to allow for a reduced equipment footprint in the PDC facilities.

4.2 Cost Factors

A list of cost factors related to the Paper Data Capture program includes, but may not be limited to, the following:

- Workload
- Number of different types of paper questionnaires to capture
- Size of questionnaires
- Number of pages of questionnaires
- Number of PDC sites
- Size of PDC sites
- Deadlines for processing
- Service Level Agreements (SLAs)
- Staffing requirements
- Contingency plans

This information is preliminary and will be updated as operations continue to mature.

4.3 Relevant IDEF0 Mechanisms

The following mechanisms from the IDEF0 Context Diagram represent the resources used to support this operation and comprise part of the 2020 Census cost elements:

Staff (FTEs and Contract personnel)

- HQ Decennial & iCADE Staff
- Translation Staff
- NPC Staff – including iCADE and Operations Management as well as positions in receipt, scanning preparation, imaging, and KFI processing, as well as questionnaire

checkout and paper questionnaire destruction. This also includes staff responsible for quality assurance and support services activities associated with the PDC operation.

Sites

- HQ
- PDC Site 1
- PDC Site 2

Systems

- Integrated Computer Assisted Data Entry (iCADE)
- Intelligent Mail Barcode Postal Tracking System (IPTS)
- Other systems, as necessary

Other

- Envelope Opening Capability
- HQ and NPC Office IT Infrastructure
- Census Networks

5. Measures of Success

For the 2020 Census operations, the corresponding Measures of Success will be documented in 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 *Content Guidelines for the 2020 Census Operational Assessments* 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.

Details on the measures of success for the PDC operation will be included in the operational assessment study plans and final reports.

Appendix A – Acronyms and Terminology

Table 7 lists the acronyms and abbreviations used within this document.

Table 8 lists a Glossary of Terms used within this document.

Table 7: Acronyms and Abbreviations List

Acronym	Meaning
APC	All Purpose Containers
ARC	Archiving Operation
BCC	Bowie Computer Center
BCR	Barcode Recognition
BPM	Business Process Model
BPMN	Business Process Model and Notation
CFD	Content and Forms Design Operation
CQA	Census Questionnaire Assistance Operation
CT	Census Test
DCSC	Data Capture Services Contract
DOP	Detailed Operational Plan
DRIS	Decennial Response Integration System
E2E	End-to-End
ECaSE	Enterprise Censuses and Surveys Enabling platform
ER	Exception Review
GQ	Group Quarters Operation

HQ	Headquarters
iCADE	Integrated Computer Assisted Data Entry System
IDEF0	Integrated Definition Level 0 Model
IE	Information Exchange
IMB	Intelligent Mail Barcode
IOD	Integrated Operations Diagram
IPTS	IMS Postal Tracking System
ISR	Internet Self Response Operationa
KFI	Key From Image
LCO	Local Census Offices
MOCS	Multi-mode Operational Control System
MR	Manual Registration
NARA	National Archives and Records Administration
NPC	National Processing Center
NRFU	Nonresponse Followup Operation
OCR	Optical Character Recognition
OMR	Optical Mark Recognition
PDC	Paper Data Capture Operation
PII	Personally Identifiable Information
PM	Program Management Operation
QA	Quality Assurance
RPO	Response Processing Operation

SLA	Service Level Agreement
SME	Subject Matter Expert
SPC	Security, Privacy, and Confidentiality Operation
UE	Update Enumerate
UTS	Unified Tracking System

Table 8: Glossary of Terms

Term	Meaning
Intelligent Mail	The term “Intelligent Mail” refers to services offered by the United States Postal Service for domestic mail delivery.

Appendix B – References

Appendix B lists the documents or other resources referenced within this Detailed Operational Plan document.

U.S. Census Bureau (2016), “2020 Census Operational Plan,” Version 2.0, October 28, 2016.

U.S. Census Bureau (2016), “Operational Assessment Content Guidelines for the 2018 End-to-End Census Test and the 2020 Census,” Draft, May 10, 2016.

Appendix C – Activity Tree for Paper Data Capture (PDC) Operation

This appendix presents the Activity Tree for the PDC operation. 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 current operation numbered “10,” the first activity would be numbered 10-1. 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 10-1.1 the second subactivity as 10-1.2. The second activity would be numbered 10-2, and so on.

PDC Activity Tree:

- 10-1 PDC Universe Management
 - 10-1.1 Receive Initial PDC Universe and Universe Updates
 - 10-1.2 Initialize and Maintain PDC Workload
- 10-2 Paper Questionnaire Preparation
 - 10-2.1 Receive Questionnaires
 - 10-2.2 Prepare Questionnaires for Scanning
- 10-3 Paper Questionnaire Data Capture
 - 10-3.1 Scan Questionnaires
 - 10-3.2 Conduct Image Processing
 - 10-3.3 Recognize Responses
 - 10-3.3.1 Perform OCR
 - 10-3.3.2 Conduct KFI
 - 10-3.3.3 Translate Non-English and Non-Spanish Forms
- 10-4 PDC Quality Assurance Check
 - 10-4.1 Conduct PDC QA
- 10-5 Data Distribution
 - 10-5.1 Send Response Data to Response Processing
 - 10-5.2 Send Case Status Data to Response Processing
 - 10-5.3 Send Paradata to Program Management
- 10-6 Final Data Disposition
 - 10-6.1 Perform Paper Questionnaire Checkout Process
 - 10-6.1.1 Confirm Questionnaire Image
 - 10-6.1.2 Destroy Questionnaires
 - 10-6.2 Provide Images to Archiving Operation

Appendix D – Business Process Models

The Annotated 2020 Census PDC Business Process Models (BPMs) for the Paper Data Capture Operation are provided under separate cover.