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BEFORE THE
POSTAL RATE COMMISSION
WASHINGTON, D.C. 20268-0001

SERVICE PERFORMANCE MEASUREMENT SYSTEMS FOR MARKET DOMINANT PRODUCTS

Docket No. PI2015-1

NOTICE OF THE UNITED STATES POSTAL SERVICE CONCERNING THE FILING OF THE STATISTICAL DESIGN PLAN FOR INTERNAL SERVICE PERFORMANCE MEASUREMENT
(August 25, 2015)

The United States Postal Service is today filing the above-referenced document in support of the USPS Service Performance Measurement Plan, its proposal to replace certain external or hybrid components of its current market-dominant product service performance measurement system with internal components, within the meaning of 39 U.S.C. § 3691(b)(2).

The USPS Service Performance Measurement (SPM) Plan was published by the Commission as PRC Library Reference PI2015-1/1 on January 29, 2015[1] and was revised most recently by the Postal Service on March 24, 2015.[2]

The new supporting document -- USPS Informed Visibility: Statistical Design Plan for Internal Service Performance Measurement (August 25, 2015), reflects the proposed statistical design methodology for measuring transit-time performance for various market-dominant product letters and flats and explains both the sampling methodology and the estimation methodology for calculating service performance scores and their margins of error. For shorthand purposes,

[1] In conjunction with PRC Order No. 2336, Notice of Request for Comments and Scheduling of Technical Conference Concerning Service Performance Measurement Systems For Market Dominant Products.

[2] http://www.prc.gov/docs/91/91822/2015-03-24-Revised-SPM-Plan.pdf.

parties may find it convenient to refer to this document as the "USPS Statistical Design Plan."

In PRC Order No. 2544,[3] the Commission signaled its intent to consider scheduling one or more off-the-record technical conferences at which Postal Service experts would be requested to appear and provide informal responses to questions seeking clarification of documents filed in support of the USPS Service Performance Measurement Plan. The Postal Service hereby gives notice that it has conferred with its technical experts and their support staffs regarding availability to participate in such meetings. On the assumption that the technical conferences relating to the USPS Statistical Design Plan will be scheduled during the month of September, the Postal Service requests that they **not** be scheduled on the following dates: September 1, 4, 8, 11, 14-15, 18, 22-23 and 25.

Respectfully submitted,

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[3] PRC Docket No. PI2015-1, Interim Order Concerning Service Performance Measurement Systems For Market Dominant Products, at 3 (June 17, 2015).

UNITED STATES POSTAL SERVICE™

Informed Visibility (IV)

Statistical Design Plan for Internal Service Performance Measurement

August 19, 2015

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2 Introduction

The United States Postal Service (Postal Service) is required to establish modern service standards for its market-dominant mail products and to design these standards to provide a system of objective performance measurements for each market-dominant product. This serves as a basis for measurement of Postal Service delivery performance.

After consultations with the Postal Regulatory Commission (PRC) and as a result of PRC Docket No. PI2008-1, the Postal Service established a variety of external, internal and hybrid systems[1] for market-dominant product service measurement in 2008. Moving forward, the Postal Service is implementing changes in the application of mailpiece and operational scanning technology. These changes are expected to allow for the efficient generation of data that the Postal Service can utilize to measure the transit of mail -- from acceptance to processing, during processing, and from processing to delivery -- with sufficient reliability to justify replacing some existing external and hybrid service performance measurement (SPM) systems and components with internal systems and components. Accordingly, in January 2015, the Postal Service submitted the initial draft of a plan for internal service performance measurement to the PRC for review.[2] In turn, the PRC initiated Docket No. P12015-1 for that purpose. Using the statistical design plan described in greater detail below, the Postal Service expects to demonstrate that the internal data collection methods described in its revised Service Performance Measurement Plan can be relied upon to conduct service performance measurement and report service performance scores for many market-dominant products.

The purpose of this document is to describe the proposed statistical design methodology for measuring transit-time performance for various market-dominant product letters and flats. The methodology combines data taken from samples made by Postal personnel with the very large volumes of data available from mail processing to estimate the overall transit-time for mail, and when combined with service standard information allows for the development of estimates of the percent of mail delivered on time and the percent of mail delivered within one day, two days, and three days after the service standard.

[1] For example, the EXFC measurement system is operated externally by an independent third party that employs droppers (unknown to the Postal Service) who seed the mailstream with letters and flats addressed to reporters. That system generates service performance data based on the transit times for those mailpieces. In contrast, the Postal Service measures Package Services service performance internally on the basis of data generated by its scanning of those mailpieces during acceptance, processing and delivery. For other products such as First-Class Mail Presort, Standard Mail, Periodicals, and Bound Printed Matter Flats, hybrid systems measure service performance by combining internal methods for capturing Intelligent Mail barcode scan data and externally generated delivery data provided by reporters.

3 Overview of Service Performance Measurement Approach

The market-dominant letter and flat mail products for which transit-time measurement is required and for which the statistical designs described in this document apply include the following[3]:

- First-Class Mail Single-Piece Letters and Cards
- First-Class Mail Presort Letters and Cards
- First-Class Mail Flats
- Periodicals Mail
- Standard Mail High Density and Saturation Letters
- Standard Mail High Density Flats
- Standard Mail Carrier Route
- Standard Mail Letters
- Standard Mail Flats
- Package Services Bound Printed Matter Flats

Single-Piece First-Class Mail letters, cards, and flats are typically inducted into the mail stream through outdoor postal collection boxes, office building lobby mail chutes, at retail postal units, and through postal letter carrier pickup.[4] This mail is then transported to the postal plant for processing, transportation to the destination plant, and then to destination delivery units for delivery. Bulk commercial mail products are inducted into the mail stream in a variety of locations, including business mail entry units, detached mail units, and through destination entry. After induction, commercial mail receives processing and transportation between plants, where required, and is transported to destination delivery units for delivery.

The methodology for measuring mail transit-time is designed to leverage the increased visibility of mail during many aspects of its processing and delivery. The approach breaks the transit time into three phases for which estimates will be made and combined to form overall estimates of transit-time. The three phases are as follows:

- **First Mile** represents the time between deposit of mail into a collection box or at a retail unit, for instance, and the first processing on postal equipment. It applies to Single-Piece letters, cards and flats.

[3] Other market-dominant mail products will continue to be measured through existing service measurement approaches, as outlined in the USPS *Service Measurement Plan*. Those products include Outbound First-Class Mail International, Inbound International Letter-Post Single-Piece Mail, the non-automation portion of Standard Mail Saturation Flats and Every Door Direct Mail-Retail, Media and Library Mail, Bound Printed Matter Parcels, Standard Mail Parcels, and Special Services.

[4] For simplicity, this document uses “Single-Piece” to refer to Single-Piece First-Class Mail Letters and Cards and the portion of First-Class Mail Flats which are not presorted. The term “commercial mail” refers to the remaining products listed above.

- **Processing Duration** represents the time between initial processing and final processing for single-piece mail, and the time from the start-the-clock event, e.g. acceptance at a business mail entry unit, through final processing for commercial mail.
- **Last Mile** represents the time between final processing and delivery for both single-piece and commercial mail.

While performance of the Processing Duration will be based on the processing data for all uniquely identifiable and measurable mailpieces, First Mile and Last Mile performance estimations each contain sampling components. For instance, Postal Service personnel will scan a subset of mailpieces at randomly selected collection points at the time of collection and at randomly selected delivery points at the time of delivery, which will be used to generate First Mile and Last Mile performance estimates when coupled with first and last processing operations from the Processing Duration.

Two sampling groups have been defined for estimation of First Mile performance for single-piece mail: single-piece letters/cards and single-piece flats. These sampling groups were defined based on observed First Mile performance for single-piece Intelligent Mail® (IM) barcoded test mail measured by the External First-Class (EXFC) system. EXFC data from Fiscal Years 2014 and 2015 were analyzed and the fiscal quarters with the lowest recent performance in First Mile were selected to establish a conservative baseline for First Mile performance expectations. These time periods were FY14 Quarter 1 for single-piece flats and FY15 Quarter 2 for single-piece letters/cards. While overall the great majority of test pieces receive initial processing on postal equipment on the same day as induction, greater differences were noted between the letters/cards and flats groups, with flats having a slightly lower rate of initial processing on the induction day.

Two additional components will be combined with Carrier Sampling to create the overall First Mile estimates. Collectors' daily scanning activities at managed USPS collection points, which indicate the times at which boxes are collected as compared to their scheduled collections will be used to create estimates of days in collection. When combined with Carrier Sampling performance data, this will allow the measurement to account for delays due to missed and/or partial collections in addition to the performance of the sampled mailpieces once collected. First Mile performance data for the retail channel will be represented by non-sample single-piece mail inducted over the counter at retail locations with Special Services such as Certified Mail. These data will be combined with the Carrier Sampling and collection data to formulate the overall First Mile performance estimates.

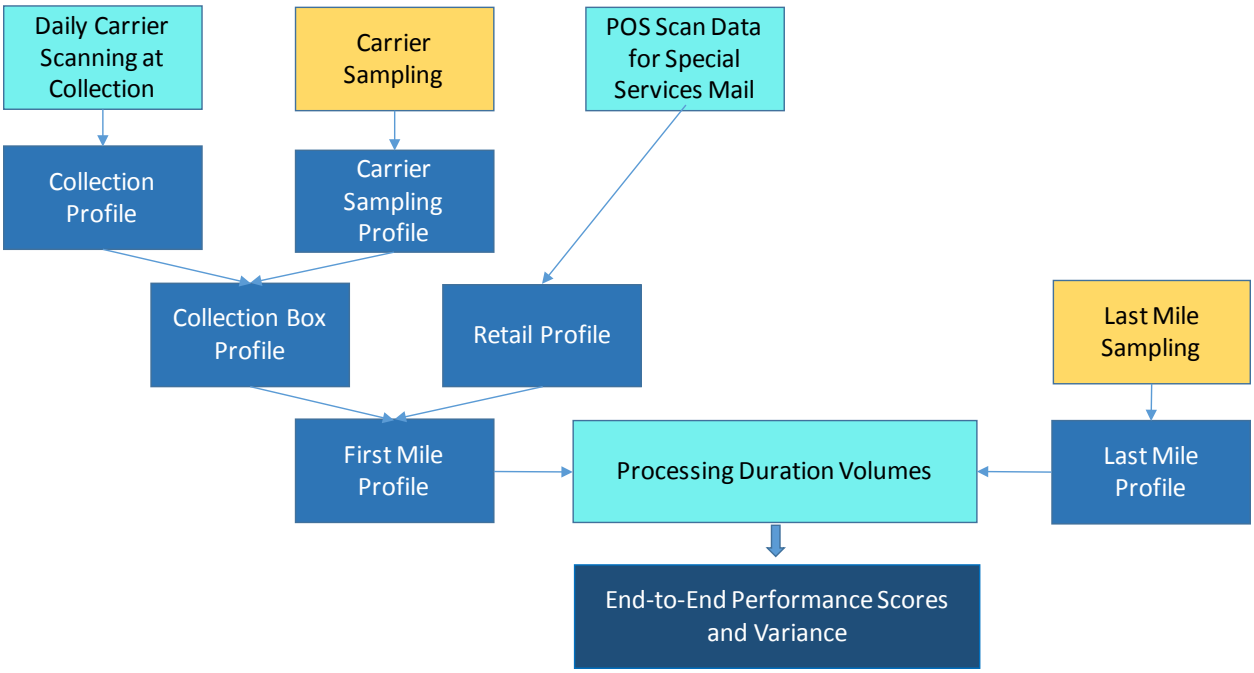
Seven sampling groups have been defined for estimation of Last Mile performance for commercial and single-piece mail, based on observed performance in Last Mile from legacy external third-party reporter data from the Intelligent Mail Accuracy and Performance System (IMAPS) system. These data from FY15 Quarter 2 were used to develop the sampling group definitions and simulate sampled results. The use of FY15 Quarter 2 data serves as a conservative performance baseline, as they reflect processing under the

service standards and processing operating window changes in place since January 2015. The seven sampling groups defined for Last Mile estimation are:

- First-Class Mail Flats
- Periodicals
- Presort First-Class Mail Letters/Cards
- Single-Piece First Class Mail Remittance/Reply Letters/Cards
- Single-Piece First Class Mail Non-Remittance Letters/Cards
- Standard Mail and Bound Printed Matter Flats
- Standard Mail Letters/Cards

Estimation of end-to-end performance requires the combination of First Mile, Processing Duration, and Last Mile estimates for single-piece mail; for commercial mail, only Processing Duration and Last Mile estimates need to be combined. Figure 3-1 depicts the high-level relationship between the components that make-up end-to-end performance estimates.

Figure 3-1 Components of End-to-End Measurement



The detailed approaches for estimating each component are described in the sections which follow. An important assumption in the approach is that transit-time durations in each phase are largely independent of one another among the defined stratification groups. This means that the same First Mile profile can be applied to similar pieces (strata) going to different destination districts, with different

service standards. Likewise, the same Last Mile profile can be applied to similar pieces (strata) coming from different origin districts with different service standards.

4 Measurement Approach for First Mile

Transit-time in First Mile will be measured through two approaches, one for mail entered through collection boxes and office building lobby chutes[5] and a second approach for mail inducted over the counter in postal retail units.[6] . First Mile profiles will be developed for two sampling groups: Single-Piece Letters/Cards and Single-Piece Flats. The First Mile profiles will be calculated as the aggregation of three individual profile types for each sampling group for each origin district: the Collection Profile and the Carrier Sampling Profile, which are aggregated together to form the Collection Box Profile, and the Retail Profile.

4.1 Collection Box Entry

For collection box entry, the design uses data from two sources. The actual and scheduled collection times for all managed collection points will be used to develop a Collection Profile. This profile will be combined with data from a random sample of collection boxes from which collectors will be prompted to scan some pieces within the box which have barcodes or other unique identifiers already applied. The scanned pieces from this Carrier Sampling can then be tracked to the first automated processing, typically at an Automated Facer Canceller System for letters and cards and an Automated Flat Sorting Machine for flats to form a Carrier Sampling Profile.

4.1.1 Collection Profile

The Collection Profile will be calculated based on the evaluation of daily Postal Service personnel scanning activities for managed collection boxes in the Collection Point Management System (CPMS) with eligible box types and location types. Postal personnel are required to scan a barcode at each managed collection point indicating that they have collected the mail from that collection point at that scan date and time, and these data are captured in CPMS. The profile is used to estimate the volume of mail spending 0 days (expected), 1 day, 2 days, and so on in the box prior to collection.

Because the exact volume of mail in each collection box is not counted for each collection, historical density information for the box will be used to estimate the density in a box every day. The estimation process will use estimates of box density by day of week to account for volume differences across days. The operational requirements for collection box density tests call for such tests to be performed over a two week period at least one time per year. At this time it is anticipated that all density tests will be

[5] This document will refer to all collection boxes and office building lobby chutes simply as collection boxes.

[6] The handling and processing of mail collected by Postal Service personnel during the delivery process from pickup to initial processing is sufficiently similar to that for mail picked up from collection boxes and lobby chutes that the former will not be explicitly measured and it will be assumed have the same First Mile experience as the latter.

performed within a single calendar month, therefore, the estimation process does not need to account for differences across months due to some boxes being tested at different times of year than others. The known density information for the box is combined with reference density proportions by day of week (calculated from a reference table made up of similar boxes – collection boxes with the same 3-digit ZIP Code, box type, and location type) in order to develop density estimates for the box for each day of the week in which it was not tested.

For example, if a box had density tests for three days of the week in August, first the test densities for the box would be added together, and then divided by their corresponding values from the density proportion reference distribution. This number then is multiplied by the density proportion reference distribution value for each missing day of week. Figure 4-1 below provides an example of the process used to estimate density if a box is missing density estimates for a particular day of the week.

Figure 4-1 Collection Density Estimation Example

Example Collection Box *A*
Density Data from Density Tests

Weekday	Density
Monday	38
Tuesday	
Wednesday	
Thursday	28
Friday	22
Saturday	

Example Reference Table Proportions
Calculated from Similar Boxes

Weekday	Density %
Monday	18.5%
Tuesday	18.5%
Wednesday	17.3%
Thursday	17.3%
Friday	18.5%
Saturday	9.9%

Estimated Density Collection Box *A* for Tuesday:

$$\frac{38 + 28 + 22}{18.5\% + 17.3\% + 18.5\%} \times 18.5\% = 30$$

The system will develop density estimates for each box for each day of week. If a collection box does not have any density estimates to use as the basis for formulating the estimates, average historical density estimates from similar boxes within the 3-digit ZIP Code (ZIP3), if available, or district will be used.

The average density data by day of week will need to be adjusted for weeks with holidays/non-collection days. The day of week densities for weeks with additional non-collection days will be estimated by redistributing the density for the non-collection day(s) across the remaining days of the week with scheduled collections, proportional to each day's density proportion. The adjusted densities for the remaining days of the week will be calculated by dividing their current day of week density by the new total week density with the additional non-collection day(s) removed to derive the new day of week density proportion. These proportions will then be used to redistribute the full weekly density for the

collection point. An example of the redistribution process for a sample collection box is provided below in Table 4.1.

Table 4.1 Collection Box Density Reallocation Process for Sample Collection Box

Day of Week	Average Daily Density (pieces)	Density Proportion	Adjusted Density Proportion – Monday Holiday	Adjusted Average Daily Density (pieces)
Monday	200.0	=200/1,000=0.2	=0/800=0.0000	=0*1,000=0.0
Tuesday	200.0	=200/1,000=0.2	=200/800=0.2500	=0.25*1,000=250.0
Wednesday	180.0	=180/1,000=0.18	=180/800=0.2250	=0.225*1,000=225.0
Thursday	170.0	=170/1,000=0.17	=170/800=0.2125	=0.2125*1,000=212.50
Friday	180.0	=180/1,000=0.18	=180/800=0.2250	=0.225*1,000=225.0
Saturday	70.0	=70/1,000=0.07	=70/800=0.0875	=0.0875*1,000=87.5
Total	1,000.0	1.0	1.0000	1,000.0

To calculate the collection profile, the system will ingest the scan data from the Collection Point Management System (CPMS) and keep the latest observed collection scan for each collection box on each date. This may include collection scans occurring on holidays and/or non-collection days. The base unit of calculation for the Collection Profile is origin district and collection date, where collection date is the date of the observed collection scan at a collection box.

If no collection scan is observed for a collection box on a given collection date, no calculations will be executed for that collection box for that date. Based on the collection scan for each managed collection box on a given collection date, the system will determine the date and time of the most recent previous collection scan for that box. To determine the estimated density in the box, and the length of time the mail was in the box, the following steps will be taken.

1. Calculate the densities for collection box *B* on the current collection date *D* with days in collection D_C by evaluating each day *d* from the previous collection scan through the current collection date.

    1.1. If the scan on the previous collection scan date d_{prev} occurred after the last pick-up time and before a configurable cut-off time on that date, then do not calculate a density or days in collection based on the previous scan date.

    1.2. If the previous collection scan occurred before the last pick-up time on that scan date d_{prev}, then calculate the density for collection box *B* on the current collection date *D* with days in collection $D_{C=}D - d_{prev}$ as the density r_j based on the day of week *j* from the historical reference table for that collection box, multiplied by a function of density information and assumed mail induction behaviors. Lacking any data upon which to estimate otherwise, the initial function has been defined as the proportion of the day remaining between the collection time and the last pick-up (LPU) time, assuming the mail is inducted into the box evenly across the hours of the day:

$$Dns_{B,D,D_C=D-d_{prev}} = r_j \frac{(LPU\ time - Latest\ Collection\ Scan\ Time)}{24\ hours}$$

For example, if the current collection date is June 5 and the previous collection date was June 3, the density for the previous collection scan date is 200, the last pick-up time of the collection box on that date is 16:00, and the last collection scan for that day occurred at 13:00, $Dns_{B,D,D_C=D-d_{prev}}$ would be calculated as 200*(3/24)= 25 with days in collection D_C equal to 6/5/2015 – 6/3/2015 = 2.

1.3. Calculate the density for collection box *B* on the current collection date D with days in collection $D_C = D - d_n$ for any remaining days d_n between the previous collection scan date and the current collection date as the density r_j based on the day of week *j* from the reference table for that collection box.

$$Dns_{B,D,D_C=D-d_n} = r_j$$

where d_n ranges from d_{prev}+1 through D-1.

1.4. If the collection scan on the current collection date *D* occurred after the last pick-up time and before a configurable cut-off time on the collection date, then calculate the density for collection box *B* on the current collection date *D* with days in collection $D_C = D - D = 0$ as the density r_j based on the day of week *j* from the reference table for that collection box.

$$Dns_{B,D,D_C=0} = r_j$$

1.5. If the latest observed collection scan on the current collection date occurred prior to the last-pick-up time, calculate the density for collection box *B* on the current collection date *D* with days in collection as r_j based on the day of week *j* from the reference table for that collection box, multiplied by a function of density information and assumed mail induction behaviors. The initial function has been defined as 1 minus the proportion of day remaining between the collection time and the last pick-up (LPU), assuming equal volumes distributed across hours of the day:

$$Dns_{B,D,D_C=0} = r_j \left(1 - \frac{(LPU\ time - Latest\ Collection\ Scan\ Time)}{24\ hours}\right)$$

The Collection Profile Dns_{D,D_C} for the district on collection date *D* is expressed as the total density for the district/collection date collected in D_C days (0, 1, 2, etc.). It is calculated by summing together the densities for all collection boxes in the district for collection date *D* attributed the same number of days in collection D_C (0, 1, 2, etc. days).

$$Dns_{D,D_C} = \sum_{B} Dns_{B,D,D_C}$$

To summarize, if the Collection Point Management System scans indicate that the last scheduled collection for every box occurred as expected within a district every collection day, the Collection Profile would show all density in the category of 0 days in collection. However, if scans indicate that boxes were collected early or not at all for scheduled collection dates, the Collection Profile would show density falling into categories of 1 day, 2 days, etc. to estimate the volume of mail with a delay in collection.

4.1.2 Carrier Sampling

To develop the Carrier Sampling profiles for the two sampling groups of Single-Piece Letters/Cards and Single-Piece Flats, a random sample of eligible managed collection points will be taken. These samples will be used to estimate the proportion of pieces spending 0 days (expected), 1 day, 2 days, etc. between collection and initial mail processing.

The sample size will be selected to achieve the desired level of precision for carrier sampling performance at a district level on a weekly basis for the two sampling groups of letters/cards and flats.

4.1.2.1 Carrier Sampling Targets

Historical data from the EXFC system were analyzed to estimate the proportion of mail with 0 days in First-Mile. The 10th percentile value among districts was selected as a conservative estimate of expected performance to be used in the derivation of required samples sizes. This performance assumption is combined with targeted precision levels for each sampling group to determine the minimum sample targets for sampling group g at the district/week level N_g^D and ZIP3/week level N_g^Z using the following formula:

$$N_g^i = \frac{P_g(1-P_g)}{(d_g/z_{\alpha/2})^2}$$

where
i = *D* for district/week level; *Z* for ZIP3/week level
P_g = district level First Mile on-time rate of sampling group g
d_g = target precision level for sampling group g
$z_{\alpha/2}$ = 1.96 for the 95% confidence interval

The resulting targets represent the number of collection points to be sampled each week in each district for each sampling group. The formula above, which is based on simple random sampling (SRS), yielded very similar results to precision estimates obtained from probability proportional to size (PPS) sampling with equal numbers of pieces taken from each box due to the high level of intra-cluster correlation between pieces in the same box. The SRS formula was selected as a conservative approach for setting

the target, as it yields slightly larger required sample sizes. In addition it is easier to implement for the sample size selection framework process. PPS sampling will be used to select collection boxes.

Initial sampling targets will be set at approximately 200 collection boxes per week per district which are expected to yield First Mile performance estimates with margins of error of less than 0.5% for 90 percent of districts for quarterly performance of letters. The remaining districts are expected to have First Mile performance estimates with margins of error between approximately 0.5% and 1%. Alaska may have larger margins of error for First Mile performance due to the distance between some collection boxes and the processing plants. The margins of error for flats are expected to be larger than for letters and will depend greatly on the volume of available flats to scan in collection boxes.

4.1.2.2 Carrier Sampling Methodology

The district level sampling targets will be distributed across the 3-digit ZIP Code areas in proportion to volumes of mail originating from each ZIP Code. In the initial phase, delivery points will be used as a proxy for volumes until the data source containing volume data from collection boxes is complete. Minimum sampling targets will be established for each 3-digit ZIP Code area to ensure coverage of all areas in measurement each week, and will encompass 3-digit ZIP Code areas which have eligible collection boxes and for which there are a sufficient number of boxes from which to select.[7] The sampling targets will also be distributed across the days of week in proportion to volume estimates by day so that days with higher volumes of mail deposited in collection boxes will have more samples than days with lower volumes. Initially, the estimates of volumes by day of week will be taken from the Origin-Destination Information System (ODIS) at a national level. When the collection box density data are more complete, these data may be used to obtain either national or district level day-of-week proportions to be used for allocating the sampling targets. Targets will be adjusted to account for non-collection days such as national or local holidays by removing the non-collection day and reallocating the weekly target across the remaining days of the week. Targets will also be adjusted to account for data usability issues to ensure that sufficient data are available for measurement.

On a given sampling date, collection boxes will be considered eligible for sampling if they are expected to be collected by postal personnel with a scanning device capable of receiving sampling requests and capturing mailpiece scans. In the sampling process, collection boxes will be randomly selected each day and with probability proportional to their estimated density to meet the targeted day of week sample size. Collection box density information used in the PPS random sampling will be pulled from the reference table that has estimated densities for each collection point by day of week, using the same data used for the Collection Profile calculations.

[7] There are a small number of 3-digit ZIP Codes which are eligible for measurement but which either have no collection boxes or so few that it would be operationally impractical to include in this sampling process. Similar to EXFC today, such ZIP Codes will be excluded from the Carrier Sampling process but will be included in other aspects of measurement.

PPS sampling was selected for the first stage sampling method because analysis of available historical density data shows that there are large differences in densities among collection boxes. Using PPS, boxes with larger volumes will have a higher probability of selection but all boxes will have a non-zero, known probability of selection in the sample. Collection boxes will be randomly selected to meet the larger of the sample size requirements from among the letters/cards and flats sampling group targets with PPS using the density size for each box on the sampling date.

Once a sampling request has been triggered, Postal Service personnel will be prompted to scan barcodes from a configurable number of letters and flats from the box. They will then simply choose from available pieces within the box and will not be directed to perform a random sampling process. While not strictly a statistical sample of pieces, the data from the randomly selected boxes will be treated as if they were taken from randomly selected pieces, a reasonable assumption given the nature of deposit of mail into a collection box. As long as Postal Service personnel follow explicit instructions to mix scanned pieces from randomly selected boxes back into the collected mail so that the scanned pieces are handled the same as unscanned pieces, it is appropriate to use sampling estimation techniques to estimate performance of all collection mail.

One limitation to note is that at this time, there are no data available to indicate how frequently barcoded and uniquely identifiable flats will be found in collection boxes. Because single-piece flats occur far less frequently than letters in the mail stream overall, there is a greater risk of not achieving sampling targets for flats. Once robust data are available from Carrier Sampling, the usability rate for single-piece flats may need to be adjusted to reflect their relative frequency of occurrence in collection as compared to letter/cards, and new strategies for obtaining First Mile data for flats may potentially need to be developed. Potential strategies include ideas such as designing density tests to include additional data on flats volumes, using the data from the sampling attempts to refine collection box density estimates, and/or combining letters and flats together for profile estimation.

4.1.3 Carrier Sampling Profile

The Carrier Sampling Profile is based on the First Mile performance of mailpieces scanned by Postal Service personnel at collection boxes during First Mile sampling. The base unit of calculation for the Carrier Sampling Profile is at the origin district/collection date and First Processing Operation (FPO) grouping level within each sampling group. The collection date is equivalent to the sampling date. FPO indicates the first automated processing operation that is observed for a piece of mail. Two groupings have been defined: FPO1 will be comprised of the outgoing processing operations (the expected type of initial processing) and FPO2 will consist of all other processing operations.

The number of days in the Carrier Sampling Profile or Carrier Sampling Days in Phase D_{CS} is calculated as follows:

$$D_{CS} = d_I - d_S$$

where

d_I is the anticipated induction date based on first mail processing

d_S is the date of the scan from sampling at collection

The anticipated induction date d_I is equal to the date of the first mail processing scan if the scan occurs after a configurable cut-off time for the FPO grouping on that day and before the end of the day. For example, if the configurable cut-off time is 15:00 and the first mail processing scan occurs between 15:00 and 23:59 on 4/17/2105, then d_I = 4/17/2015. If the first mail processing scan occurs between the start of day and the configurable cut-off time by FPO group on that day, d_I is equal to the value of (First Mail Processing Scan Date – 1). For example, if the configurable cut-off time is 15:00 and the first mail processing scan occurs between 0:00 and 14:59 on 4/17, then d_I = 4/16. If d_I is a non-collection day, then d_I is adjusted to the closest previous valid collection day.

The Carrier Sampling Profile at the district/collection date/FPO grouping level for each sampling group will be calculated as the weighted average proportion of pieces having 0, 1, 2, etc. days prior to first processing. The PPS weight to be used in the Carrier Sampling Profile calculations for all mailpieces from sampled collection box *SB* for sampling group *G* is based on the density sizes assigned to each collection point during the Carrier Sampling process, the number of collection boxes sampled, and the number of usable pieces sampled from each collection box on that date:

$$Weight_{G,D,SB} = \frac{\sum_i M_{D,i}}{n_D m_{G,D,SB}}$$

where
G = sampling group
D = collection date (same as the sampling date)
SB = sampled collection box
$M_{D,i}$ = the density size used in PPS sampling for each collection box *i* on collection date *D*, regardless of whether they were selected in the sampling process
n_D = the number of collection boxes sampled on collection date *D*, regardless of whether any usable pieces were scanned
$m_{G,D,SB}$ = the number of usable pieces scanned for sampling group *G* at the sampled collection box *SB*

The Carrier Sampling Profile calculation to derive the percentage of mail for sampling group *G*, collection date *D*, and FPO grouping *F* with Carrier Sampling Days in Phase D_{CS} equal to *k* is as follows:

$$Carrier\ Sampling\ Profile_{G,D,F,k} = \frac{\sum_{SB} Weight_{D,SB} * Pieces_{G,F,D,SB,k}}{\sum_{SB,D_{CS}} Weight_{D,SB} * Pieces_{G,F,D,SB,D_{CS}}}$$

where *k* ranges from -1 through 30. This range represents the vast majority of possible values for Carrier Sampling days in phase D_{CS} and a reasonable cut-off for calculation purposes.

4.1.4 Collection Box Profile

The Collection Box Profile for managed Collection Point Management System collection boxes will be calculated by combining the Carrier Sampling Profile for each sampling group *G* at the origin district/collection date/FPO grouping level with the Collection Profile at the origin district/collection date level. The method to create the collection box profile is based upon a reasonable assumption that the time in collection and time in Carrier Sampling are independent – that is, there is no reason to believe that mail that is delayed in collection is more or less likely to be delayed in transit between collection and first processing. The method to develop the collection box profile is described in the following steps:

1. Identify all combinations of collection dates *D* and days in collection D_{CS} in the Carrier Sampling Profile for a sampling group, district, and FPO grouping that yield the same anticipated induction date *I*.
2. Combine each record in the Carrier Sampling profile for the sampling group/origin district/FPO grouping with anticipated induction date *I* and collection date *D* with all records from the Collection Profile for the district with collection date *D*. For each combination of records, multiply the Carrier Sampling density proportion with the collection density from the Collection Profile to create the estimated density. Add together days in Carrier Sampling D_{CS} with days in collection D_C to derive total days in First Mile D_{FM} .
3. Calculate the total density profile for anticipated induction date *I* with days in First Mile D_{FM} for the sampling group, district, and FPO grouping by aggregating all records with the same anticipated induction date and days in First Mile across collection dates.

$$Dns_{G,F,I,D_{FM}=D_C+D_{CS}} = \sum_{D,D_C,D_{CS}} Dns_{D,D_C} CSProfile_{G,F,D,D_{CS}}$$

4. Calculate the Collection Box Profile expressed as density proportions by dividing by the total density for anticipated induction date *I*.

$$Collection\ Box\ (CB)\ Profile_{G,F,I,k} = \frac{Dns_{G,F,I,k}}{\sum_{D_{FM}} Dns_{G,F,I,D_{FM}}}$$

where *k* ranges from -1 through 30. This range represents the vast majority of possible values for Days in First Mile D_{FM} and a reasonable cut-off for calculation purposes.

4.2 Retail Entry

The proposed solution for First Mile measurement of single-piece mail entered at retail locations is to leverage all Point of Sale (POS) scan data for First-Class Mail with Special Services, such as Certified Mail. The acceptance date and time will be captured in the POS system for all such accountable pieces, and they can be tracked from acceptance through their first automated processing because the processing

equipment automatically captures the Special Services barcodes. This measurement approach assumes that retail mailpieces with ancillary services are handled in the same way from acceptance through initial processing as mailpieces inducted over the counter without Special Services and, as such, are a representative subset of retail single-piece mail. Under this solution, no sampling is required for the retail location type. The design will be to use all accountable retail pieces which can be measured to calculate the Retail Profile.

4.2.1 Retail Mail Profile

The formation of the profile will be accomplished through the following steps:

1. For each piece, calculate the collection date d_S as equal to the acceptance scan date/time from the POS system if the acceptance scan occurs before a configurable cutoff time for the scan date. If the acceptance scan occurs after a configurable cutoff time for the scan date, d_S is equal to the acceptance scan date +1. If d_S falls on a non-collection day, advance d_S to the next valid collection day.

2. For each mailpiece, calculate the anticipated induction date d_I as described in section 4.1.3 Carrier Sampling Profile.

3. Calculate the First Mile Days in Phase for retail pieces D_{FM} as $d_I - d_S$.

4. Calculate the Retail Profile for each sampling group at the district/anticipated induction date/FPO grouping level as the percentages of retail mail with 0, 1, 2, etc. days in First Mile.

$$Retail\ Profile_{G,F,I,k=} \frac{Dns_{G,F,D=I-k,I}}{\sum_D Dns_{G,F,D,I}}$$

   where *k* ranges from -1 through 30. This range represents the vast majority of possible values for Days in First Mile D_{FM} and a reasonable cut-off for calculation purposes.

4.3 First Mile Profile

The Collection Box Profile and Retail Profile will then be combined to form the First Mile Profile at the origin district/anticipated induction date/FPO grouping level for each sampling group. The profiles for each sampling group will be calculated as the average of the Collection Box and Retail profiles, weighted by the volume proportion that each collection location type represents of the total District originating volume based on available density information.

$$FM\ Profile_{G,F,I,D_{FM}=k} = w_{G,B} * CB\ Profile_{G,F,I,k} + w_{G,R} * Retail\ Profile_{G,F,I,k}$$

where
$w_{G,B}$ is the estimated percentage of volume collected from collection boxes
$w_{G,R}$ is the estimated percentage of volume collected from retail

$w_{G,B} + w_{G,R} = 1$
k ranges from -1 through 30, representing the majority of possible values for D_{FM}.

Until more recent data are generated, the initial source for the weights from collection and retail will be national level estimates made from a 2013 Mail Source Study.

At the conclusion of this step, the result is a set of estimates of the proportion of mail spending -1, 0, 2 through 30 days in First Mile for each origin district, anticipated induction date, and FPO group for single-piece letters/cards and single-piece flats. Table 4.2 below shows the first 10 days of a sample profile.

Table 4.2 Sample Data from First Mile Profile for Atlanta for Letters/Cards

Anticipated Induction Date	FPO	Proportion of Mail Spending *k* Days in First Mile											
		-1	0	1	2	3	4	5	6	7	8	9	10
06/11/2015	1	0.01	0.97	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/11/2015	2	0.00	0.95	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/12/2015	1	0.00	0.98	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/12/2015	2	0.00	0.94	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00

5 Measurement Approach for Processing Duration

The approach for measurement of the Processing Duration transit-time is to use all of the mailpieces for which the Postal Service has the requisite information available to compute accurate performance measures. The use of processing data generated by tens of billions of pieces of mail provides a very rich database for all products, and allows for the capability to provide service measurement results at a very detailed level, such as by product-district-entry type-service standard.

For single-piece mail, Processing Duration is the transit-time from first automated processing, which has been labeled Anticipated Induction Date and was described above in section 4.1.3. Mailpieces that already have unique identifiers applied will be combined with pieces to which the postal processing equipment applies a unique barcode at this first automation point, to enable tracking virtually all single-piece letters, cards, and flats through each step of automated processing. The stopping point is the Anticipated Delivery Date, which represents the date on which the last processing scan occurred, adjusted for non-delivery days and scan times occurring after the clearance time, indicating that the mail is being processed for delivery the next day.

Single-piece mail will be identified in the Informed Visibility (IV) system as a letter or flat based upon the type of processing equipment on which it was handled. Likewise, the location of the first processing scan will determine the origin plant for the piece. Since the exact 3-digit ZIP Code in which the mail was entered will be unknown for most single-piece mail, a process to allocate the mail to the ZIP Codes that

the plant serves will be used. The allocation process is designed to provide estimates of the volumes coming from each 3-digit ZIP area so that the proper district assignments can be made in situations where plants handle mail for multiple districts. The process will use estimates of the proportion of mail coming from each ZIP Code to each plant to assign the origin 3-digit ZIP Code to mail having the same anticipated induction date, origin plant, and shape. The originating volume proportions will initially be based on the distribution of delivery points at the 3-digit ZIP Code level based on Address Management System (AMS) delivery statistics data, and in the future may be enhanced to use collection box density data to develop the proportions. The destination ZIP Code will be determined during the initial processing as well, either using the address on the piece or the ZIP Code assigned by the Postal Service. With the origin and destination ZIP Codes assigned, the service standard can be determined for each piece and the calculation of days in processing can be made. The Processing Duration for single piece mail D_{PD} (0, 1, 2, etc. days in processing) is calculated as

$$D_{PD} = d_P - d_I - N_{SP}$$

where

d_p is the anticipated delivery date based on final processing
d_I is the anticipated induction date based on first mail processing
N_{SP} is the number of Non-Delivery Days between the beginning of the calculated date of (Anticipated Induction Date + Service Standard) and the beginning of the Anticipated Delivery Date.

For commercial mail, Processing Duration represents the days between the Start-the-Clock date and the Anticipated Delivery Date. Information about the product, shape, origin ZIP Code, destination ZIP Code and entry-type come from the electronic documentation provided by commercial mailers. The Processing Duration for commercial letters, cards, and flats D_{PD} (0, 1, 2, etc. days in processing) is calculated as

$$D_{PD} = d_P - d_S - N_{SP}$$

where

d_p is the anticipated delivery date based on final processing
d_S is the start-the-clock date
N_{SP} is the number of Non-Delivery Days between the beginning of the calculated date of (Start-the-Clock Date + Service Standard) and the beginning of the Anticipated Delivery Date.

6 Measurement Approach for Last Mile

The Last Mile represents the final leg of transit in this approach, and is the time between the anticipated delivery date based on the final processing of a piece and the actual delivery date. Measurement of the Last Mile will be made based upon a process by which Postal Service personnel will be prompted to scan the barcodes on letters and flats at randomly selected delivery points as they are delivering the mail. This section describes the sampling approach and methodology for calculating the Last Mile Profile which can then be combined with First Mile Profile and Processing Duration to form the desired overall service measures.

6.1 Last Mile Sampling

Seven sampling groups have been established for Last Mile:

- Single-Piece and Presort First-Class Mail Flats
- Periodicals Letters and Flats
- Presort First-Class Mail Letters/Cards
- Single-Piece First-Class Mail Letters/Cards – Remittance and Reply Mail
- Single-Piece First-Class Mail Letters/Cards – All Other
- Standard Mail and Bound Printed Matter Flats
- Standard Mail Letters/Cards

As a general rule, when Postal Service personnel approach delivery points randomly designated for sampling, the instruction will be to scan the barcodes on all of the mail being delivered on the sampling date, across all of the sampling groups. At delivery points with large volumes of mail, such as large businesses, Postal personnel will be instructed to scan a configurable maximum number of pieces to represent performance at that address. Under these assumptions, the sample size targets define the number of delivery points to be sampled each day, within each district.

6.1.1 Sampling Targets

The initial sample size targets were established leveraging the available data from the current service measurement systems. Simulation runs of different sampling methods and sample sizes were conducted. Estimation bias and variance were measured. Operational aspects such as the probability of making a sampling request at a delivery point with no measureable mail available to scan were also considered. Analysis of the simulation results and consideration of operational feasibility led to the selection of probability proportional to size sampling of delivery points using the timely information which will be available in the IV system about expected mailpieces for each delivery point. The details of the sampling process will be explained in the next section. The selected sample size of 3,000 delivery points per week per district, or approximately 500 delivery points per day is expected to be sufficient to yield the precision levels in Table 6.1 below for 90 percent of districts for the required quarterly service performance estimates. Ninety percent was selected so that the vast majority of estimates are expected

to fall within the range each quarter, while recognizing that outliers will likely exist in a given time period, sampling group and estimation category due to random variability and unanticipated events.

Table 6.1 Maximum Width of Confidence Interval for On-Time Scores for 90% of Districts

Sampling Group	95% Confidence Interval (+/-) Quarterly Results
First-Class Mail Flats	1.51%
Periodicals	0.81%
Single-Piece FCM Letters/Cards – Remittance and Reply	N/A
Single-Piece FCM Letters/Cards - Other	N/A
Standard Mail Flats	0.68%
Presort First-Class Mail Letters	0.32%
Standard Mail Letters	0.24%

Precision is driven by the number of pieces sampled and the variability of performance of the mail in processing and in Last Mile. The simulation results were based on data from FY15 Quarter 2. The simulation runs did not contain data for Single-Piece Letters categories because there were no comparable data available. Therefore, simulation model based estimates of expected precision are not available. However, the margins of error are expected to be less than 1 percent, in line with the other letters sampling groups, based on the relatively large volumes of Single-Piece Letters and analysis of EXFC data of performance of mail in the Last Mile. With the sample size of approximately 500 delivery points per day per district, margins of error for quarterly service performance estimates should be less than 1 percent for all products except First-Class Mail Flats, where the maximum is expected to be 3 percent and Periodicals, where the maximum is expected to be 2 percent. These values are expected under the assumptions that overall service and Last Mile performance levels remain similar to or improve from data used in the simulation models.

The use of the FY15 Quarter 2 data for simulating the precision estimates should serve as a conservative baseline. Once the Informed Visibility sampling system has been fully operational for at least one fiscal quarter so that data are available to estimate service performance and margins of error, evaluations of the sample size will be made to assess whether the desired levels of precision have been achieved and whether the sampling targets need to be increased or if they can be lowered. Over time, if there are repeated incidences of the same district as an outlier, the sampling target for that specific district may be adjusted to achieve acceptable precision levels when operationally feasible. At this time, the non-contiguous postal- districts (Alaska, Caribbean, and Honolulu) are viewed as most likely to be repeat outliers based upon the analyses conducted from historical data. Should an entire sampling category fail to meet acceptable precision levels, adjustments to the sampling process can be made to place more emphasis on that category to increase the sample size for that sampling group.

Specific sampling targets for each 3-digit ZIP Code area will be set for each delivery day. These targets will be calculated so that the ZIP-level targets are proportional to the distribution of total delivery points within the district. Configurable minimum targets for each ZIP3 area will be established to ensure sampling requests in each ZIP3 area on each eligible delivery date. The number of sampling requests to be made on a day will be the sampling target plus additional requests needed as a result of missed requests or locations for which scans are not usable for measurement. Usability factors will be calculated by examining the outcome of each sampling request. For example, if the proportional ZIP3/day sample target N_{zw} is 40 delivery points and the usability factor is 1.25, the final ZIP3/day sampling target is calculated as 40 x 1.25 = 50 delivery points.

While most districts are expected to have the target sample size of 3,000 delivery points per week, exceptions may be required in situations where the number of delivery points, eligible carrier routes and mail volumes are too low to operationally support these sampling levels. Initial analyses indicate that Alaska, Honolulu, and Caribbean districts may require lower sampling targets.

6.1.2 Sampling Methodology

Random sampling with probability proportional to size will be used to select the targeted number of delivery points within each 3-digit ZIP Code area each delivery day. All active delivery points will be eligible for sampling. The PPS size of a delivery point on a given day will be based on information about the measurable mailpieces expected to be delivered to the delivery point on the sampling day. The IV system will contain information about the measurable pieces which have been processed, referred to as "in inventory," for each delivery point, allowing the sampling system to leverage very detailed, timely information for sampling. The following steps describe the process for examining pieces in inventory to calculate the expected number of pieces and the size for each delivery point.

1. Mailpieces will be included in the available inventory if the latest observed processing operation is included in a configurable list of operation codes indicating mail is nearly ready for delivery and the scan occurred after the clearance time for that operation within five days prior to the sampling date.

2. Historical data will be used to develop a reference data source which contains the probability of delivery for a mailpiece in -1, 0, 1, 2, 3, 4, 5, and 6+ days in Last Mile based on its sampling group, district, and the Days Left to meet service standard based on the latest available processing scan. This reference data will be used in estimating the expected pieces for each delivery point on each sampling date.

   Days left to meet service standard is calculated as the service standard of the mailpiece minus its Processing Duration days in phase. Table 6.2 shows the Days Left groupings have been defined for each sampling group in order to have sufficient data for estimation.

Table 6.2 Day Left Groups by Sampling Group

Sampling Group	Days Left to Meet Service Standard				
FCM Flats	<0	0	1	>=2	N/A
Periodicals	<0	0	1	>=2	N/A
PFCM Letters/Cards	<0	0	1	>=2	N/A

SPFC Remittance Letters/Cards	<0	0	1	>=2	N/A
SPFC Non-Remittance Letters/Cards	<0	0	1	>=2	N/A
Standard and BPM Flats	<0	0	1	2	>=3
Standard Letters/Cards	<0	0	1	>=2	N/A

3. A size will be calculated for each delivery point on each sampling date to be used in the random selection process with probability proportional to size. The PPS size will be based on the estimated number of pieces expected to be delivered on the sampling date for a given delivery point.

   3.1. On each sampling date, the sampling group, district, service standard, start-the-clock date, anticipated delivery date, Processing Duration days in phase, and Days Left to meet service standard for each mailpiece in inventory will be determined based upon the latest available processing information.

   3.2. Using this information, the IV system will estimate the probability of each mailpiece in inventory being delivered on the sampling date based on the corresponding value in the historical reference data for its sampling group, destination district, Days Left to meet service standard, and Last Mile days in phase. For example, for an Overnight Presort First-Class Mail letter in inventory for Northern Virginia on May 20 with start-the-clock on May 18 that received its last processing scan on May 19 at 3:30 AM in Delivery Point Sequencing, the look-up value would be Presort FCM letters, Northern Virginia, 0 Days Left, 1 day in Last Mile.

   3.3. For each delivery point, the system will then calculate the total number of expected pieces s_g for the sampling date for each sampling group *g* by summing the probabilities of delivery on the sampling date for all mailpieces in inventory for that sampling group.

   3.4. The total size S_i^{zd} for each delivery point *i* in ZIP3 *z* for a given sampling date *d* will be

$$S_i^{zd} = \sqrt{\frac{\sum_{g=1}^{7} w_g s_g}{\sum_{g=1}^{7} w_g} \cdot \frac{\max(\sum_{g=1}^{7} s_g, \bar{s})}{\bar{s}}}$$

   where w_g is the weight assigned to each sampling group *g*, and $\bar{s}$ is the configurable maximum number of pieces that postal personnel will be required to scan at a delivery point. The initial values of w_g will be set to a value of 1, giving each sampling group the same weight. Once the system is operational and data are available for analysis, it may be desirable to modify the weights to place more emphasis on the probable presence of mail from a particular sampling group to address statistical precision issues for the sampling group.

   3.5. If the PPS size S_i^{zd} calculated for a delivery point on a given sampling date is less than the established minimum size (0.01), then S_i^{zd} will be equal to the minimum value in order to ensure that each delivery point has a non-zero probability of selection.

   3.6. To account for the situations where it is not operationally feasible for postal personnel to scan all pieces at a delivery point, a second stage sampling weight for each delivery point will

be needed to weight delivery points appropriately. The second stage sampling weight $SSSW_i^{zd}$ for each delivery point *i* is represented by the following formula:

$$SSSW_i^{zd} = \frac{\max(\sum_{g=1}^{7} s_g, \bar{s})}{\bar{s}}$$

3.7. The PPS weight for a delivery point, *SA* on sampling date *d* is defined as:

$Weight_{d,SA} = \frac{\sum_i S_i^{zd}}{S_{i=SA}^{zd} N^{zd}} SSSW_{i=SA}^{zd}$ where

S_i^{zd} = the PPS size of delivery point *i* on sampling day *d* in ZIP3 *z*
$SSSW_i^{zd}$ = the second stage sampling weight for delivery point *i* on sampling day *d* in ZIP3 *z*
$\sum S_i^{zd}$ = the sum of PPS sizes across all delivery points on sampling day *d* in ZIP3 *z*
N^{zd} = the number of valid (not excluded) sampled delivery point on sampling day *d* in ZIP3 *z* whether or not they received mail.

4. Delivery points will be selected on each sampling date to reach the established target for the day, using random sampling with probability proportional to size S_i^{zd}.

6.2 Last Mile Profile

Postal personnel will be prompted to scan pieces with a barcode to be delivered at the selected delivery point up to a configurable maximum number of pieces. By doing this, any scanned pieces, whether they were in the inventory or not, will be assessed for eligibility for inclusion into the Last Mile profile (for example, pieces that bypass processing operations downstream). It is anticipated that in some cases a delivery point may receive more mail than is operationally feasible to scan at delivery, in which case Postal Service personnel will be asked to scan up to a configurable maximum number of pieces. Once sampling has been completed, the delivery scans will be matched with measurement eligible mailpieces from the processing leg. All matched scans passing eligibility requirements will be used for calculating the Last Mile Profiles. The base unit of calculation for the Last Mile Profile is at the district/anticipated delivery date/Days Left to meet service standard within each sampling group. The following steps explain the process for calculating the Last Mile profile.

1. The number of days in Last Mile or Last Mile Days in Phase D_{LM} will be calculated as follows:

$$D_{LM} = d_D - d_P - N_{PD}$$

where
d_D is the date of mail delivery
d_P is the anticipated delivery date, calculated based on the last processing operation
N_{PD} is the number of non-delivery days between the anticipated delivery date and the actual delivery date

2. Last Mile Profiles at the district/anticipated delivery date/Days Left level will be calculated as the weighted average percentage of pieces with -1, 0, 1, 2, through 30 days in Last Mile. The PPS weight to be used was defined above in Step 3.7 of section 6.1.2.

The Last Mile Profile calculation to derive the percentage of mail for sampling group *G*, anticipated delivery date *I*, and Days Left grouping *DL* with Last Mile Days in phase *P* is as follows:

$$Last\ Mile\ Profile_{G,I,DL,P} = \frac{\sum_{SA} Weight_{d=P+I,SA} * Pieces_{G,DL,d=P+I,SA,P}}{\sum_{SA,k} Weight_{d=k+I,SA} * Pieces_{G,DL,d=k+I,SA,k}}$$

where *k* ranges from -1 through 30 days in Last Mile. $Pieces_{G,DL,d=P+I,SA,P}$ represents the number of mailpieces scanned at sampled delivery point *SA* with Days Left grouping *DL*, and Last Mile Days in Phase *P* for Sampling Group *G* and a particular sampling date *d*, where *d* equals the anticipated delivery date *I* plus Last Mile Days in Phase *P*. $Pieces_{G,DL,d=k+I,SA,k}$ allows for different values for *k*, ranging from -1 to 30, representing all the possible values for Last mile Days in Phase.

There will likely be situations in which there are no or too few sampled pieces available within a particular calculation group, given the detailed calculation level defined. For such cases, the approach will be to collapse across the Days Left to Meet Service Standard categories to the extent needed to have sufficient data for the remaining groups. Using 0 Days Left as the reference grouping because that is the value expected to be most common, Days Left groupings will be collapsed inwards towards the reference grouping. For example, if there are insufficient data in the <0 Days Left grouping for the Standard/Bound Printed Matter Flats sampling group, <0 and 0 Days Left will be collapsed into one grouping of <=0 Days Left. If there are insufficient data in the >=3 Days Left grouping, >=3 and 2 Days Left will be collapsed into one grouping of >=2 Days Left. The process is depicted in tabular form below.

Table 6.3 All Sampling Groups except Standard/Bound Printed Matter Flats

Initial Days Left Groupings	1st Level Collapsed Groupings	2nd Level Collapsed Groupings
< 0	<= 0	All
0		
1	>=1	
>=2		

Table 6.4 Standard/Bound Printed Matter Flats Example

Initial Days Left Groupings	1st Level Collapsed Groupings	2nd Level Collapsed Groupings	3rd Level Collapsed Groupings
< 0	<= 0	<= 0	All
0			
1	1	>= 1	

Initial Days Left Groupings	1st Level Collapsed Groupings	2nd Level Collapsed Groupings	3rd Level Collapsed Groupings
2	>= 2		
>= 3			

Upon completion of this step, a Last Mile profile indicating the proportion of mail which spent -1, 0, 1, 2, through 30 days in Last Mile will be available for each sampling group, destination district, anticipated delivery date, and Days Left grouping. An example of a Last Mile profile is shown below in Table 6.5.

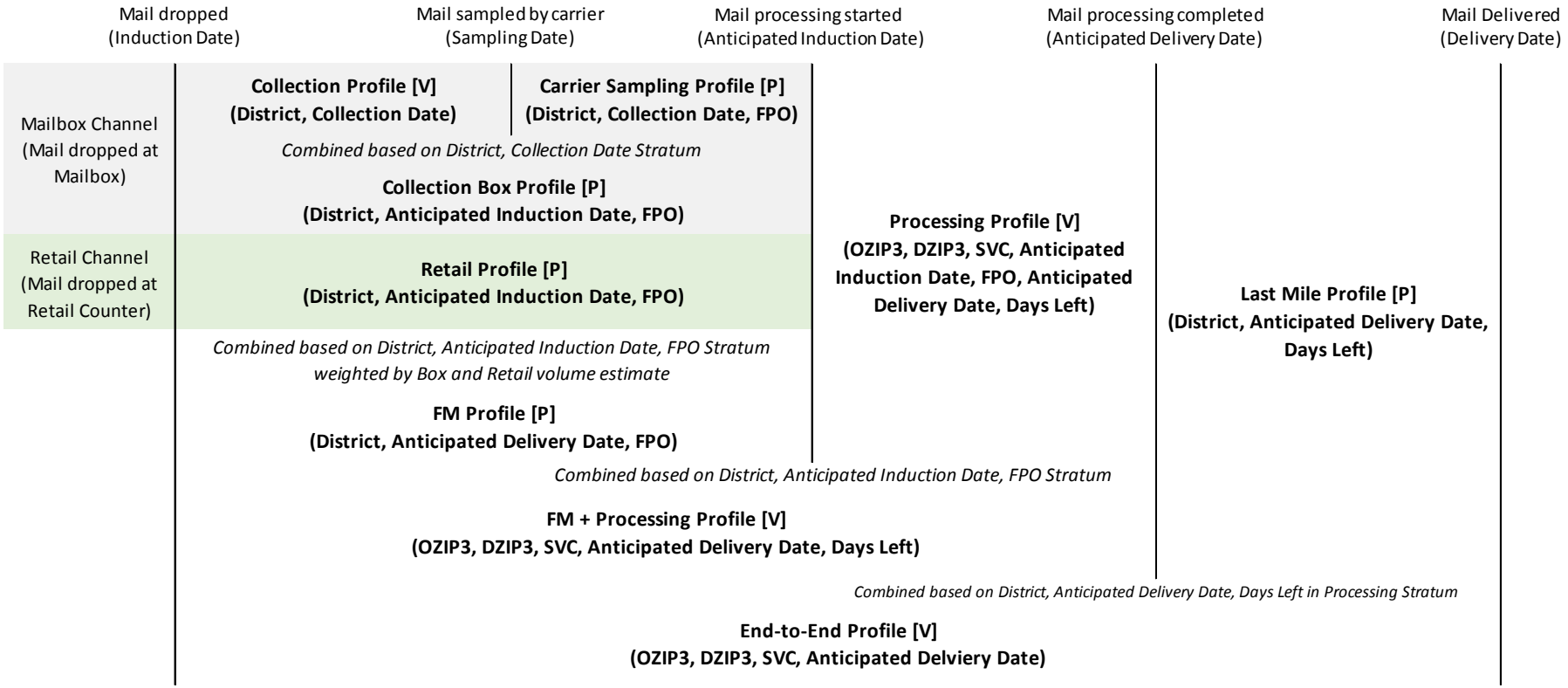
Table 6.5 Sample Data from Last Mile Profile for District *D* for Periodicals

Anticipated Delivery Date	Days Left Group	Proportion of Mail Spending *k* Days in Last Mile							
		-1	0	1	2	3	4	5	6+
06/11/2015	<=0	0.01	0.99	0.00	0.00	0.00	0.00	0.00	0.00
06/11/2015	>=1	0.00	0.50	0.38	0.08	0.02	0.01	0.01	0.00
06/12/2015	ALL	0.01	0.95	0.01	0.01	0.01	0.01	0.00	0.00

7 Overall Service Performance Estimation

Overall service performance estimation for Single-Piece First-Class Mail involves the combination of the First Mile Profile, Processing Duration aggregates, and Last Mile Profile to form estimates of the proportion of mail delivered within the service standard, as well as the proportion delivered within one, two, and three days of the service standard. For all other products, performance estimates will be made by combining Processing Duration aggregates with Last Mile Profiles. This section will describe the methodology for computing service performance estimates and their variances. Figure 7-1 below provides a view of how the parts are joined together.

Figure 7-1 End-to-End Process Illustration



[P] indicates that the profile is expressed as percentages; [V] indicates that the profile is expressed as mailpiece volume or estimated mailpiece volume.

7.1 Relationships between Sampling Groups and Estimation Levels

Reports of service performance will be made at varying levels to meet PRC reporting requirements and Postal Service management needs. The sampling groups for First Mile and Last Mile estimation are less granular than the required service performance reporting levels. However, the groups are reasonable to apply to detailed Processing Duration data by understanding the relationships between the measurement legs and by making certain assumptions about the independence between the legs. For example, the same Last Mile Profile has been designated for Presort First-Class Mail letters/cards across all service standard groups. This means that for a given destination district, anticipated delivery date and Days Left to meet service standard category, Presort letters/cards with an Overnight Service Standard and mail with a Two-Day service standard will have the same Last Mile Profile applied.

Days Left to Meet Service Standard has been selected as a stratification category due to its importance in flats processing. For Standard Mail in particular, high mail volumes and less automated sorting capacity have yielded processing plans that allow for balancing workload in both mail processing and delivery. As a result, the transit times in Last Mile are impacted by how many days are left to meet the service standard. Because the Processing Duration and the Last Mile are not independent, estimates made without taking the relationship into consideration would be biased. Note that this stratification has replaced the former stratification of the data by the last processing operation type and location based upon extensive analysis of the data from several quarters of data in the current measurement system.

Table 7.1 below shows the alignment for which Last Mile sampling groups are aligned with Processing Duration data for many of the required performance estimates.

Table 7.1 Performance Measurement Subgroup to Last Mile Sampling Group Alignment

Performance Measurement Subgroups	Last Mile Sampling Group
Single-Piece First Class Mail Flats, Two-Day	FCM Flats
Single-Piece First Class Mail Flats, Three-To-Five-Day	
Presort First Class Mail Flats, Overnight	
Presort First Class Mail Flats, Two-Day	
Presort First Class Mail Flats, Three-To-Five-Day	
Periodicals Origin Entry	Periodicals
Periodicals Products (Within County, Outside County), Origin Entry	
Periodicals DDU Entry	
Periodicals DSCF Entry	
Periodicals DADC Entry	
Periodicals DNDC Entry	

Performance Measurement Subgroups	Last Mile Sampling Group
Periodicals Destination Entry	Periodicals
Periodicals Products (Within County, Outside County), Destination Entry	
Presort First Class Mail Letter/Cards, Overnight	Presort FCM Letters
Presort First Class Mail Letter/Cards, Two-Day	
Presort First Class Mail Letter/Cards, Three-To-Five-Day	
Single-Piece First Class Mail Letter/Cards, Remittance, Two-Day	Single-Piece Letters - Remittance
Single-Piece First Class Mail Letter/Cards, Remittance, Three-To-Five-Day	
Single-Piece First Class Mail Letter/Cards, Non-Remittance, Two-Day	Single-Piece Letters – Other
Single-Piece First Class Mail Letter/Cards, Non-Remittance, Three-To-Five-Day	
Standard Mail Flats, Origin Entry	Standard/ BPM Flats
Standard Mail Products (Basic Flats, Mixed Flats, High Density and Saturation Flats, Carrier Route), Origin Entry by Service Standard Group	
Bound Printed Matter Flats, Origin Entry	
Standard Mail Flats, DDU Entry	
Standard Mail Flats, DSCF Entry	
Standard Mail Flats, DNDC Entry	
Standard Mail Products (Basic Flats, Mixed Flats, High Density and Saturation Flats, Carrier Route), DDU Entry	
Standard Mail Products (Basic Flats, Mixed Flats, High Density and Saturation Flats, Carrier Route), DSCF Entry	
Standard Mail Products (Basic Flats, Mixed Flats, High Density and Saturation Flats, Carrier Route), DNDC Entry	
Bound Printed Matter Flats, Destination Entry	
Standard Mail Letter/Cards, DSCF Entry	Standard Letters
Standard Mail Letter/Cards, DNDC Entry	
Standard Mail Letter/Cards, Origin Entry	
Standard Mail Products (Basic Letters, Mixed Letters, High Density and Saturation Letters), DSCF Entry	
Standard Mail Products (Basic Letters, Mixed Letters, High Density and Saturation Letters), DNDC Entry	
Standard Mail Products (Basic Letters, Mixed Letters, High Density and Saturation Letters), Origin Entry and Service Standard Groups	

Performance Measurement Subgroups which also include a First-Mile Profile are shown below in Table 7.2.

Table 7.2 Performance Measurement Subgroup to First Mile Sampling Group Alignment

Performance Measurement Subgroups	First Mile Sampling Group
Single-Piece First Class Mail Flats, Two-Day	Single-Piece FCM Flats
Single-Piece First Class Mail Flats, Three-To-Five-Day	
Single-Piece First-Class Mail Letters/Cards Two-Day	Single-Piece FCM Letters
Single-Piece First-Class Mail Letters/Cards Three-To-Five-Day	

7.2 Estimation of Overall Service Performance

Estimation of overall performance involves combining Processing Duration information with the Last Mile profile for all groups and another step of combining First Mile profile with Processing Duration information for the single-piece categories. The methodology for Last Mile is the same. Therefore, to simplify the documentation, this section has been organized to describe the application of First Mile and Processing Duration first so that the resulting data are in the same format as for groups for which First Mile profiles are not needed.

7.2.1 Estimation of First Mile to Anticipated Delivery Date

First Mile Profile results at the origin district/anticipated induction date/FPO grouping level will be applied to volumes from the Processing Duration leg and Last Mile to calculate end-to-end single-piece mail performance results for each origin ZIP3/anticipated induction date/FPO grouping/Destination ZIP3/anticipated delivery date/Days Left grouping. Origin district level First Mile Profiles will be applied to Processing Duration data based upon the origin district derived from the origin ZIP Code of the Processing Duration data. The methodology is based upon the assumption that time in First Mile is independent of the Processing Duration and Last Mile time, as this initial duration cannot be anticipated or affected by downstream events. The steps to apply the First Mile Profile to Processing Duration volume profiles are described below:

1. The appropriate First Mile Profile will be combined with volumes from the Processing Duration to derive the Pre-Last Mile Profile and adjusted Days in Phase D_{FMP}, where $D_{FMP} = D_{FM} + D_{PD}$. The Pre-Last Mile Profile will be calculated at the level of OZIP3/anticipated induction date/FPO/performance measurement subgroup/DZIP3/anticipated delivery date/Days Left to meet service standard. Days Left continues to be calculated based only on processing scan information to maintain stratification levels established in sampling. The following formula represents the method for calculating this profile, representing the estimated volume of mail spending 0, 1, 2, etc. days prior to Last Mile:

$$Pre-Last\ Mile\ Profile_{G,SG,I,F,A,J_{LM}} = \sum_{J_{LM}=J-D_{FM}} Vol_{G,SG,I,F,A,DL,J} * First\ Mile\ Profile_{G,F,I,D_{FM}}$$

2. Next, the system will aggregate the Pre-Last Mile Profile volumes across anticipated induction dates to the OZIP3/DZIP3/performance measurement subgroup/anticipated delivery date/Days Left level so that these data align with the level of calculation for commercial mail.

7.2.2 Estimate of Overall Service Performance

Overall on-time performance for combinations of subgroup/OZIP3/DZIP3/anticipated delivery date/Days Left groupings are calculated using a methodology similar to what is currently applied in Intelligent Mail Accuracy and Performance System . The Processing Duration volumes for the groupings are combined with the Last Mile Profile percentages with corresponding sampling group/district/Days Left groupings for each Last Mile days in phase value *P*.

Specifically, the on-time performance calculation for subgroup SG combined with Last Mile sampling group G for anticipated delivery date *A* can be expressed as follows:

$$Ontime\ Performance_{G,SG,A} = \frac{\sum_{DL,J,P \le J} Vol_{G,SG,A,DL,J} * Last\ Mile\ Profile_{G,A,DL,P}}{\sum_{DL,J} Vol_{G,SG,A,DL,J}}$$

where $Vol_{G,SG,A,DL,J}$ = the Processing Duration volume for performance measurement subgroup *SG*, corresponding to Last Mile sampling group *G*, with anticipated delivery day *A*, Days Left grouping *DL*, and actual Days Left to meet service standard *J*. *J* is not necessarily equal to *DL* for open-ended Days Left groupings such as *DL* < 0 days or *DL* >= 2 days, etc.

Overall scores at higher levels of aggregation than ZIP3/anticipated delivery date, such as district, area, and nation are calculated as the average of individual ZIP3/anticipated delivery date results, weighted by the proportion of Processing Duration volumes that each ZIP3 represents.

ZIP3, district, area, and national overall on-time performance estimates across longer time periods, e.g., week, month, quarter-to-date, are calculated as the average of anticipated delivery date results at that level of aggregation, weighted by the proportion of Processing Duration volumes that each anticipated delivery date represents.

Service Variance estimates follow the same estimation process, where the definition for On Time is replaced by within +n days of service standard, where n takes on a value of 0 for On Time, and 1, 2, and 3 for the defined Service Variance calculation categories.

7.3 Estimation of Variance and Margin of Error of the Estimates

Service performance estimates are calculated as the ratio of the estimated number of pieces delivered on-time divided by the estimated number of pieces delivered. Both the numerator and the denominator of this ratio are estimated based on sample data. Estimates of the accuracy of service performance estimates are calculated using standard statistical methods for estimating the variance of a ratio estimate.

Statistical methods allow for the evaluation of the accuracy of data collected through random sampling of a population ("sampling error"), but statistical methods cannot be used to evaluate other types of error ("non-sampling error"). In particular, there are two types of non-sampling error that cannot be evaluated. First, the population sampled from only includes mail pieces identified as measurable through available plant scans. It is not possible to evaluate the extent to which the exclusion of unscanned or non-measurable mail introduces error in service performance measurement estimates. Second, data from accountable mail inducted at retail postal units is used to represent First Mile duration for all pieces mailed at retail units. The service performance estimates assume the First Mile is the same for accountable pieces and non-accountable pieces, and there is not a method to evaluate the error that this assumption introduces. The methodology described in this section is focused on estimating the variance of performance estimates which arises from sampling activities in First Mile and Last Mile.

The variance of the estimate of on-time performance is the total of two components:

$$\text{Total Variance} = \text{First Mile Variance} + \text{Last Mile Variance}$$

where:

First Mile Variance is the variance associated with sampling at origin for estimating First Mile profile

Last Mile Variance is the variance associated with the sampling at destination for estimating Last Mile profile.

Origins and destinations can be any geographic area—a district, the nation, etc. For example, the estimate of on-time performance for mail originating in a district has the district as the origin and the nation as the destination.

For performance subgroups which do not have a First Mile sampling component, First Mile Variance=0 and no calculations for First Mile Variance are needed. The calculation of Last Mile Variance is also simplified when there is no First Mile as part of the estimate. Thus, Single-Piece First-Class Mail Letters/Cards and Flats represent the most complex of the variance estimates due to the complexity of the performance estimates themselves.

7.3.1 Restating Notation Needed for Estimation

To make it easier to follow, Table 7.3 below contains the descriptions for notation used for estimating variance.

Table 7.3 Descriptions of Notation used for Calculating Variance Estimates

Symbol	Description
G	First Mile Sampling Group for First Mile Variance calculations; Last Mile sampling group for Last Mile variance calculations
SG	Performance Measurement Subgroup; this may be a single dimension (e.g. Two-Day service standard performance for single-piece FCM) or multiple dimensions (e.g. performance across all entry types and service standards for Standard Mail)

Symbol	Description
SA	Sampled Address in Last Mile
SB	Sampled Collection Box in First Mile on a given collection date
m_{SB}	Eligible mailpiece from sampled collection box *SB* in First Mile on a given collection date
D	Collection Date
A	Anticipated Delivery Date
I	Anticipated Induction Date
DL	Days Left Grouping for Last Mile
F	FPO Grouping
n_F	Number of sampled mailpieces for FPO grouping *F*
n_{DL}	Number of sampled delivery points with mail for Days Left grouping *DL*
OD	Origin District; for Last Mile Variance may be an aggregation of multiple origins
DD	Destination District; for First Mile Variance may be an aggregation of multiple destinations
D_C	Days in Collection from daily CPMS scanning activities
D_{CS}	Carrier Sampling Days in Phase
D_{FM}	First Mile Days in Phase
$Weight_{m_{SB}}$	Sampling weight for the sampled collection box of mailpiece m_{SB} on a given collection date as defined in First Mile Profile and Performance calculations requirements
$Weight_{SA}$	Sampling weight for a sampled delivery point *SA* on a given delivery date as defined in Last Mile Profile and Performance calculations requirements
P	Last Mile Days in Phase
J	Specific value for Days Left after processing for First and Last Mile combined after plant processing for a piece to still be on time according to SVC; based on processing scan information only
J_{FM}	Days left for First Mile = *J* – *P*
J_{LM}	Days left for Last Mile = *J* – D_{FM}
CP_{OD,D,D_C}	Collection profile percentage from daily CPMS scanning activities for a specific origin district, collection date, and days in collection
$FMP_{OD,I,F,D_{FM}}$	First Mile Profile percentage for a specific origin district, anticipated induction date, FPO grouping and Days in First Mile
$LMP_{DD,A,DL,P}$	Last Mile Profile percentage for a specific destination district, anticipated delivery date, Days Left grouping and Days in Last Mile
$Vol_{DD,I,DL,F,J}$	Volume of mail for destination district DD with anticipated induction date I, Days Left grouping DL, FPO grouping F, and J Days Left in processing for a specific origin district, First Mile sampling group, performance measurement

Symbol	Description
	subgroup, and anticipated delivery date
$Vol_{OD,I,DL,F,J}$	Volume of mail for origin district OD with anticipated induction date I, Days Left grouping DL, FPO grouping F, and J Days Left in processing for a specific destination district, Last Mile sampling group, performance measurement subgroup, and anticipated delivery date
$Pieces_{SA,DL,P}$	Number of pieces of mail scanned at sampled delivery point SA with Days Left grouping DL, and Last Mile Days in Phase P

7.3.2 Last Mile Variance from First Mile Sampling:

Variance of overall service performance estimates from First Mile Sampling stems from the Carrier Sampling component only; all other First Mile data components (Collection Profile and Retail Profile) represent all eligible data for their respective results, not obtained from sampling processes.

The objective is to estimate First Mile variance of the estimated on-time performance for a specific origin district, First Mile sampling group, performance measurement subgroup, and anticipated delivery date. First Mile variance will be calculated by anticipated delivery date because this is the level at which overall performance estimates are defined (i.e., estimates of performance for a quarter will be based on the pieces with anticipated delivery date within the quarter). The First Mile sampling data will be aggregated for all anticipated induction dates corresponding to a given anticipated delivery date for these calculations.

The following steps are defined to calculate First Mile variance:

1. Apply the Last Mile Profile to the Processing Duration volume for destination district DD with anticipated induction date I, Days Left grouping DL, FPO grouping F, and J Days Left in processing to estimate the volume of mail by days Left for First Mile for each possible value of J_{FM}, across all values of DL, P, and all relevant destination districts:

$$Vol_{I,F,J_{FM}} = \sum_{DD,DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J} * LMP_{DD,DL,P}$$

2. Calculate $Y_{m_{SB},F}$ as follows

$$Y_{m_{SB},F} = \frac{\sum_{J_{FM},D_C \leq J_{FM}-D_{CS}(m_{SB})} Vol_{I(m_{SB}),F,J_{FM}} * Weight_{m_{SB}} * \frac{CP_{D(m_{SB}),D_C}}{\sum_k CP_{D(m_{SB}),D_C=k}}}{\sum_{J_{FM}} Vol_{I(m_{SB}),F,J_{FM}}}$$

where $D_{CS}(m_{SB})$ is the Carrier Sampling days in phase for the sampled mailpiece from collection box *SB*, $D(m_{SB})$ is the collection date for the sampled mailpiece from collection box *SB*, $I(m_{SB})$ is the anticipated induction date for the sampled mailpiece from collection box *SB*, and k ranges from 0 through 30, which represents the vast majority of possible values for Days in Collection and a

reasonable cut-off for measurement.

3. Calculate $X_{m_{SB},F}$ as follows:

$$X_{m_{SB},F} = Weight_{m_{SB}}$$

Note that the Collection Profile term is left out in this equation because summation across all possible values of days in collection for the Collection Profile proportion yields a value of 1.

4. Calculate $\overline{X_F}$ as follows:

$$\overline{X_F} = \frac{\sum_{m_{SB}} X_{m_{SB},F}}{n_F}$$

5. Calculate R_F as follows:

$$R_F = \frac{\sum_{m_{SB}} Y_{m_{SB},F}}{\sum_{m_{SB}} X_{m_{SB},F}}$$

6. Calculate the unit variance for FPO grouping *F* across all sampled mailpieces for the specific origin district, First Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_F = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

If less than a configurable number of sampled pieces are available for the unit variance calculation, collapse the FPO groupings so that the unit variance is calculated for all FPO groupings combined.

7. Calculate the First Mile Variance of estimated on-time performance as:

$$FMVar_c = w^2 * \frac{\sum_F \left[\left(\sum_{I,J_{FM}} Vol_{I,F,J_{FM}}\right)^2 * UnitVar_F\right]}{\left(\sum_{I,F,J_{FM}} Vol_{I,F,J_{FM}}\right)^2}$$

where *c* is the specific combination of origin district, sampling group, and anticipated delivery date for the relevant performance measurement subgroup, and *w* is the percentage of total originating volume that is from the collection box channel, as defined in First Mile Profile.

8. To calculate variances for aggregates across origin districts and/or anticipated delivery dates, the following formula will be used:

$$FMVar = \frac{\sum_C [(Vol_c)^2 * FMVar_c]}{(\sum_C Vol_c)^2}$$

where
C is the set of anticipated delivery dates and/or origin districts related to the performance estimate
$FMVar_c$ = the value of FMVar for the combination *c*
Vol_c = the total processing volume for combination *c*.

7.3.3 Variance from Last Mile Sampling

To calculate the Last Mile variance of the estimated on-time performance for a specific destination district, Last Mile sampling group, performance measurement subgroup, and anticipated delivery date, the following steps are needed:

1. If the sampling group has a First Mile, apply the First Mile Profile to the Processing Duration volume to estimate the volume of mail by Days Left for Last Mile for each possible value of J_{LM} across all values of First Mile Days in Phase D_{FM}, all FPO groupings, and all relevant anticipated induction dates and origin districts:

$$Vol_{DL,J_{LM}} = \sum_{OD,I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{OD,I,DL,F,J} * FMP_{OD,I,F,D_{FM}}$$

If the sampling group does not have a First Mile, then $J_{LM} = J$ and $Vol_{DL,J_{LM}} = Vol_{DL,J}$.

2. Calculate $Y_{SA,DL}$ as follows:

$$Y_{SA,DL} = \frac{\sum_{J_{LM},P \le J_{LM}} Vol_{DL,J_{LM}} * Weight_{SA} * Pieces_{SA,DL,P}}{\sum_{J_{LM}} Vol_{DL,J_{LM}}}$$

3. Calculate $X_{SA,DL}$ as follows:

$$X_{SA,DL} = Weight_{SA} * \sum_P Pieces_{SA,DL,P}$$

4. Calculate $\overline{X_{DL}}$ as follows:

$$\overline{X_{DL}} = \frac{\sum_{SA} X_{SA,DL}}{n_{DL}}$$

5. Calculate R_{DL} as follows:

$$R_{DL} = \frac{\sum_{SA} Y_{SA,DL}}{\sum_{SA} X_{SA,DL}}$$

6. Calculate the unit variance for Days Left grouping DL across all sampled delivery points SA for a given destination district, Last Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_F = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

If less than a configurable minimum number of sampled delivery points are available for the unit variance calculation, collapse the Days Left groupings so that the unit variance is calculated for all DL groupings combined.

7. Calculate the Last Mile Variance of estimated on-time performance as:

$$LMVar_c = \frac{\sum_{DL}\left[\left(\sum_{J_{LM}} Vol_{DL,J_{LM}}\right)^2 * UnitVar_{DL}\right]}{\left(\sum_{DL,J_{LM}} Vol_{DL,J_{LM}}\right)^2}$$

where *c* is the specific combination of destination district, sampling group, and anticipated delivery date for the relevant performance measurement subgroup.

Calculate aggregates across destination districts and/or anticipated delivery dates as follows:

$$LMVar = \frac{\sum_C [(Vol_c)^2 * LMVar_c]}{(\sum_C Vol_c)^2}$$

where
C is the set of anticipated delivery dates and/or destination districts related to the performance estimate
$LMVar_c$ = the value of LMVar for the combination *c*
Vol_c = the total processing volume for combination *c.*

7.3.4 Overall Variance and Margin of Error Calculations

The total variance for estimated overall on-time performance is calculated as

$$TotVar = FMVar + LMVar$$

It is often desirable to calculate confidence intervals for the performance estimates and historically a 95% confidence level has been used for these performance estimates. The margin of error (half the width) of the confidence interval is defined as follows:

$$Margin\ of\ Error = 1.96\sqrt{TotVar}$$

7.3.5 Calculating Variance and Margin of Error for Performance Estimates

The sections above have described the general methodology for calculating the variance for performance estimates. In practice, scores are often needed at different geographic levels, including postal district, postal area, and the nation. Further, there are several types of performance estimates which are needed:

- Originating scores – for example, the performance of mail originating from district *D,* going to anywhere in the country
- Destinating scores – for example, the performance of mail originating from anywhere in the country, going to district *D*
- Origin/Destination Composite – the weighted average of the originating score and destination score, representing the performance of all mail either originating from District *D* or destinating to district *D.*

To calculate variances for specific estimates such as an originating or destinating score for a district, area, or the nation, the Processing Duration volumes corresponding to the performance measurement subgroup for each variance component (FMVar and LMVar) must be specified correctly. It must include not only the relevant performance measurement subgroup (service standard, entry type, etc.), but also the correct geographic subset of origin and destination districts. For example, to calculate an originating district score variance requires the calculation of one First Mile variance component ($FMVar = FMVar_C$), and as many as 67 Last Mile variance components if the origin district sends mail to all 67 districts. An originating area score requires the calculation of First Mile variance components for each district in the area, and as many as 67 Last Mile variance components if the origin area sends mail to all 67 districts. For commercial mail estimates where only Last Mile applies, the calculations are simplified by eliminating the First Mile terms.

The most complex variance estimates are those for Origin/Destination Composite scores, particularly for Single-Piece First-Class Mail, where both First Mile and Last Mile variance terms apply. The variance of the estimates includes additional terms to estimate the covariance for the portions of the estimates comprised of mail that both originates and destinates within the same district (or area, for area level

scores). The steps required and formulas needed for these composite estimates have been provided in the Appendix to this document.

8 Appendix

Origin/Destination Composite scores for a postal administrative district or area are formed by taking a weighted average of the origin score and destination score for the district or area. In this case, mail that both originates and destinates within the district or area is contained within both scores. Therefore, when calculating the precision of the Origin/Destination Composite score, the covariance between the origin and destination scores must be accounted for. This section provides a description of the steps and formulas necessary for calculating the variance and margin of error for Origin/Destination (O/D) Composite service performance scores for a particular district or postal area.

1. The total variance for estimated end-to-end on-time O/D composite performance for mail originating from district *D* or destinating to district *D* is calculated as

$$E2EVar = LMVar + FMVar$$

$$= C1^2 * LMVAR_{OD=D,DD=Nation-D} \quad (1)$$

$$+LMVar_{OD=Nation,D,DD=D} \quad (2)$$

$$+C4^2 * FMVAR_{OD=Nation-D,DD=D} \quad (3)$$

$$+FMVar_{OD=D,DD=D,Nation} \quad (4)$$

1.1 To calculate the variance from Last Mile Sampling, which is the summation of term (1) and (2), the proportions C1, C2 and C3 need to be derived by using the Processing Duration volume and First Mile Profile to estimate the volume of mail by Days Left for Last Mile for each possible value of J_{LM} across all values of First Mile Days in Phase D_{FM}, all First Processing Operation (FPO) groupings, and all relevant anticipated induction dates for a given specific destination district(s), specific origin district(s), Last Mile sampling group, performance measurement subgroup, anticipated delivery date.

1.2 The volume associated with C1 corresponds to

$$Vol_{DL,J_{LM}|OD=D,DD=Nation-D} = \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|DD=Nation-D,OD=D} * FMP_{OD=D,I,F,D_{FM}}$$

1.3 The volume associated with C2 corresponds to

$$Vol_{DL,J_{LM}|OD=D,DD=D} = \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|DD=D,OD=D} * FMP_{OD=D,I,F,D_{FM}}$$

1.4 The volume associated with C3 corresponds to

$$Vol_{DL,J_{LM}|OD=Nation,DD=D} = \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|DD=D,OD=Nation} * FMP_{OD=Nation,I,F,D_{FM}}$$

1.5 C1 = $$\frac{Vol_{DL,J_{LM}|OD=D,DD=Nation-D}}{Vol_{DL,J_{LM}|OD=D,DD=Nation-D}+Vol_{DL,J_{LM}|OD=D,DD=D}+Vol_{DL,J_{LM}|OD=Nation,DD=D}}$$

1.6 C2 = $$\frac{Vol_{DL,J_{LM}|OD=D,DD=D}}{Vol_{DL,J_{LM}|OD=D,DD=Nation-D}+Vol_{DL,J_{LM}|OD=D,DD=D}+Vol_{DL,J_{LM}|OD=Nation,DD=D}}$$

1.7 C3 = $$\frac{Vol_{DL,J_{LM}|OD=Nation,DD=D}}{Vol_{DL,J_{LM}|OD=D,DD=Nation-D}+Vol_{DL,J_{LM}|OD=D,DD=D}+Vol_{DL,J_{LM}|OD=Nation,DD=D}}$$

1.8 Calculate $LMVAR_{OD=D,DD=Nation-D}$ in term (1)

1.8.1 If the sampling group has a First Mile, apply the First Mile Profile to the Processing Duration volume to estimate the volume of mail by Days Left for Last Mile for each possible value of J_{LM} across all values of First Mile Days in Phase D_{FM}, all First Processing Operation (FPO) groupings, and all relevant anticipated induction dates all destination districts other than district D, origin district D, Last Mile sampling group, performance measurement subgroup, anticipated delivery date.

$$Vol_{DL,J_{LM}|OD=D,DD=Nation-D}$$

$$= \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|OD=D,DD=Nation-D} * FMP_{OD=D,I,F,D_{FM}}$$

1.8.2 If the sampling group does not have a First Mile, then $J_{LM} = J$ and

$$Vol_{DL,J_{LM}} = Vol_{DL,J}$$

1.8.3 Calculate $Y_{SA,DL}$ as follows:

$$Y_{SA,DL} = \frac{\sum_{J_{LM},P \le J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=Nation-D} * Weight_{SA} * Pieces_{SA,DL,P}}{\sum_{J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=Nation-D}}$$

1.8.4 Calculate $X_{SA,DL}$ as follows:

$$X_{SA,DL} = Weight_{SA} * \sum_{P} Pieces_{SA,DL,P}$$

1.8.5 Calculate $\overline{X_{DL}}$ as follows:

$$\overline{X_{DL}} = \frac{\sum_{SA} X_{SA,DL}}{n_{DL}}$$

1.8.6 Calculated R_{DL} as follows:

$$R_{DL} = \frac{\sum_{SA} Y_{SA,DL}}{\sum_{SA} X_{SA,DL}}$$

1.8.7 Calculate the unit variance for Days Left grouping DL across all sampled delivery points SA for the all the districts other than D, Last Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_{DL} = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

1.8.8 If less than a configurable minimum number of sampled delivery points are available for the unit variance calculation, collapse the Days Left (DL) groupings so that the unit variance is calculated for all DL groupings combined.

1.8.9 Calculate the Last Mile Variance of estimated on-time performance as:

$$LMVar_{C|OD=D,DD=Nation-D} = \frac{\sum_{DL}\left[\left(\sum_{J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=Nation-D}\right)^2 * UnitVar_{DL}\right]}{\left(\sum_{DL,J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=Nation-D}\right)^2}$$

where *c* = sampling group and anticipated delivery date for the relevant performance measurement subgroup.

1.8.10 Calculate aggregates across anticipated delivery days for the relevant performance estimate as follows:

$$LMVar_{OD=D,DD=Nation-D} = \frac{\sum_C \left[\left(Vol_{C|OD=D,DD=Nation-D}\right)^2 * LMVar_c\right]}{\left(\sum_C Vol_{C|OD=D,DD=Nation-D}\right)^2}$$

where
c is the set of anticipated delivery dates related to the performance estimate
$LMVar_c$ = the value of LMVar for the combination *c*
Vol_c = the total processing volume for combination *c*

1.9 Next, the second term in the variance for E2EVAR is defined as

$$LMVar_{OD=Nation,D,DD=D}$$

$$= LMVar\left[C2 * OTP_{Orig=D,Dest=D} + C3 * OTP_{Orig=Nation,Dest=D}\right]$$

$$= lMVar\left[\frac{\mathrm{C2} * \sum Y_i^1}{\Sigma X_i} + \frac{\mathrm{C3} * \Sigma Y_i^2}{\Sigma X_i}\right]$$

$$= lMVar[\frac{\mathrm{C2} * \sum Y_i^1 + \mathrm{C3} * \sum Y_i^2}{\Sigma X_i} = lMVar\,(\frac{\Sigma Y_i}{\Sigma X_i})$$

OTP is on time performance estimate from the Last Mile.

1.9.1 If the sampling group has a First Mile, apply the First Mile Profile to the Processing Duration volume to estimate the volume of mail by Days Left for Last Mile for each possible value of J_{LM} across all values of First Mile Days in Phase D_{FM}, all First Processing Operation groupings, and all relevant anticipated induction dates for a destination district D, origin district D, last mile sampling group, performance measurement subgroup, anticipated delivery date.

$$Vol_{DL,J_{LM}|OD=D,DD=D} = \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|OD=D,DD=D} * FMP_{OD=D,I,F,D_{FM}}$$

1.9.2 Calculate ${Y^1}_{SA,DL}$ as follows:

$${Y^1}_{SA,DL} = \frac{\sum_{J_{LM},P\leq J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=D} * Weight_{SA} * Pieces_{SA,DL,P}}{\sum_{J_{LM}} Vol_{DL,J_{LM}|OD=D,DD=D}}$$

If the sampling group has a First Mile, apply the First Mile Profile to the Processing Duration volume to estimate the volume of mail by Days Left for Last Mile for each possible value of J_{LM} across all values of First Mile Days in Phase D_{FM}, all First Processing Operation groupings, and all relevant anticipated induction dates for a destination district D, all origin districts, Last Mile sampling group, performance measurement subgroup, anticipated delivery date.

$$Vol_{DL,J_{LM}|OD=Nation,DD=D} = \sum_{I,F,D_{FM},J=D_{FM}+J_{LM}} Vol_{I,DL,F,J|OD=Nation,DD=D} * FMP_{OD=Nation,I,F,D_{FM}}$$

1.9.3 Calculate ${Y^2}_{SA,DL}$ as follows:

$${Y^2}_{SA,DL} = \frac{\sum_{J_{LM},P\leq J_{LM}} Vol_{DL,J_{LM}|OD=Nation,DD=D} * Weight_{SA} * Pieces_{SA,DL,P}}{\sum_{J_{LM}} Vol_{DL,J_{LM}|OD=Nation,DD=D}}$$

1.9.4 Calculate $X_{SA,DL}$ as follows:

$$X_{SA,DL} = Weight_{SA} * \sum_P Pieces_{SA,DL,P}$$

1.9.5 Calculate $\overline{X_{DL}}$ as follows:

$$\overline{X_{DL}} = \frac{\sum_{SA} X_{SA,DL}}{n_{DL}}$$

1.9.6 Calculated R_{DL} as follows:

$$R_{DL} = \frac{\sum_{SA}\left(C2 * Y^1{}_{SA,DL} + C3 * Y^2{}_{SA,DL}\right)}{\sum_{SA} X_{SA,DL}} = \frac{\sum_{SA}(Y_{SA,DL})}{\sum_{SA} X_{SA,DL}}$$

1.9.7 Calculate the unit variance for Days Left grouping DL across all sampled delivery points SA for the new composite Y, Last Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_{DL} = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

1.9.8 If less than a configurable minimum number of sampled delivery points are available for the unit variance calculation, collapse the Days Left groupings so that the unit variance is calculated for all DL groupings combined.

1.9.9 Calculate the Last Mile Variance of estimated on-time performance as:

$$LMVar_{C|OD=Nation,D,DD=D} = \frac{\sum_{DL}\left[\sum_{J_{LM}}\left(C2*Vol_{DL,J_{LM}|OD=D,DD=D}+C3*Vol_{DL,J_{LM}|OD=Nation,DD=D}\right)^2 * UnitVar_{DL}\right]}{\left(\sum_{DL,J_{LM}}\left(C2*Vol_{DL,J_{LM}|OD=D,DD=D}+C3*Vol_{DL,J_{LM}|OD=Nation,DD=D}\right)\right)^2}$$

where *c* = sampling group, and anticipated delivery date for the relevant performance measurement subgroup.

1.9.10 Calculate the following summations across anticipated delivery days for the relevant performance estimate as follows:

$$LMVar_{OD=Nation,D,DD=D} = \frac{\sum_C\left[\left(Vol_{c|OD=Nation,D,DD=D}\right)^2 * LMVar_{c|OD=Nation,D,DD=D}\right]}{\left(\sum_C Vol_{c|OD=Nation,D,DD=D}\right)^2}$$

where
c is the set of anticipated delivery dates related to the performance estimate
$LMVar_c$ = the value of LMVar for the combination *c*
Vol_c = the total processing volume for combination *c*

1.10 To calculate the variance from First Mile Sampling, which is the summation of term (3) and (4) in E2EVAR, the proportions C4, C5 and C6 must be calculated by using the Processing Duration volume and Last Mile Profile with anticipated induction date I, First Processing Operation grouping F, and J days left in processing to estimate the volume of mail by days Left for First Mile for each possible value of J_{FM}, across all values of DL, P for a given specific

destination district(s), specific origin district(s), First Mile sampling group, performance measurement subgroup and anticipated delivery date.

1.11 The volume associated with C4 corresponds to

$$Vol_{I,F,J_{FM}|OD=Nation-D,DD=D} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=Nation-D,DD=D} * LMP_{DD=D,DL,P}$$

1.12 The volume associated with C5 corresponds to

$$Vol_{I,F,J_{FM}|OD=D,DD=D} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=D,DD=D} * LMP_{DD=D,DL,P}$$

1.13 The volume associated with C6 corresponds to

$$Vol_{I,F,J_{FM}|OD=D,DD=Nation} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=D,DD=Nation} * LMP_{DD=Nation,DL,P}$$

1.14 C4 = $\frac{Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}}{Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=Nation}}$

1.15 C5 = $\frac{Vol_{I,F,J_{FM}|OD=D,DD=D}}{Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=Nation}}$

1.16 C6 = $\frac{Vol_{I,F,J_{FM}|OD=D,DD=Nation}}{Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=D}+Vol_{I,F,J_{FM}|OD=D,DD=Nation}}$

1.17 Calculate $FMVAR_{OD=Nation-D,DD=D}$ in term (3)

1.17.1 Apply the Last Mile Profile to the Processing Duration volume with anticipated induction date I, FPO grouping F, and J days left in processing to estimate the volume of mail by days Left for First Mile for each possible value of J_{FM}, across all values of DL, P for a destination district D, origin district of all districts other than D, First Mile sampling group, performance measurement subgroup and anticipated delivery date.

$$Vol_{I,F,J_{FM}|OD=Nation-D,DD=D} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=Nation-D,DD=D} * LMP_{DD=D,DL,P}$$

1.17.2 Calculate $Y_{m_{SB},F}$ as follows

$$Y_{m_{SB},F} = \frac{\sum_{J_{FM},D_C \le J_{FM}-D_{CS}(m_{SB})} Vol_{I(m_{SB}),F,J_{FM}|OD=Nation-D,DD=D} * Weight_{m_{SB}} * \frac{CP_{D(m_{SB}),D_C}}{\sum_k CP_{D(m_{SB}),D_C=k}}}{\sum_{J_{FM}} Vol_{I(m_{SB}),F,J_{FM}|OD=Nation-D,DD=D}}$$

where $D_{CS}(m_{SB})$ is the Carrier Sampling days in phase for the sampled mailpiece from collection box *SB*, *D(m_{SB})* is the collection date for the sampled mailpiece from collection box *SB*, *I(m_{SB})* is the anticipated induction date for the sampled mailpiece

from collection box *SB*, and k ranges from 0 through 30, which represents the vast majority of possible values for Days in Collection and a reasonable cut-off for measurement.

1.17.3 Calculate $X_{m_{SB},F}$ as follows:

$$X_{m_{SB},F} = Weight_{m_{SB}}$$

The Collection Profile term is left out in this equation because summation across all possible values of days in collection for the Collection Profile proportion yields a value of 1.

1.17.4 Calculate $\overline{X_F}$ as follows:

$$\overline{X_F} = \frac{\sum_{m_{SB}} X_{m_{SB},F}}{n_F}$$

1.17.5 Calculate R_F as follows:

$$R_F = \frac{\sum_{m_{SB}} Y_{m_{SB},F}}{\sum_{m_{SB}} X_{m_{SB},F}}$$

1.17.6 Calculate the unit variance for First Processing Operationgrouping *F* across all sampled mailpieces for the specific First Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_F = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

1.17.7 If less than a configurable minimum number of sampled pieces are available for the unit variance calculation, collapse the FPO groupings so that the unit variance is calculated for all FPO groupings combined.

1.17.8 Calculate the First Mile Variance of estimated on-time performance as:

$$FMVar_{C|OD=Nation-D,DD=D} = w^2 * \frac{\sum_F \left[\left(\sum_{I,J_{FM}} Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}\right)^2 * UnitVar_F\right]}{\left(\sum_{I,F,J_{FM}} Vol_{I,F,J_{FM}|OD=Nation-D,DD=D}\right)^2}$$

where

c = sampling group, and anticipated delivery date for the relevant performance measurement subgroup

w = the percentage of total originating volume that is from the collection box channel, as defined in First Mile Profile and Performance Calculations Requirement 32

1.17.9 Calculate aggregates across anticipated delivery dates for the relevant performance estimate as follows:

$$FMVar_{OD=Nation-D,DD=D} = \frac{\sum_C \left[\left(Vol_{c|FMVar_{C|OD=Nation-D,DD=D}} \right)^2 * FMVar_{c|FMVar_{C|OD=Nation-D,DD=D}} \right]}{\left(\sum_C Vol_{c|FMVar_{C|OD=Nation-D,DD=D}} \right)^2}$$

where
C is the set of anticipated delivery dates related to the performance estimate
$FMVar_c$ = the value of FMVar for the combination *c*
Vol_c = the total processing volume for combination *c*

1.18 Next, calculate term (4) in the E2EVAR.

$$FMVar_{OD=D,DD=D,Nation}$$

$$= FMVar\left[C5 * OTP_{Orig=D,Dest=D} + C6 * OTP_{Orig=D,Dest=Nation}\right]$$

$$= FMVar\left[\frac{C5 * \sum Y_i^1}{\Sigma X_i} + \frac{C6 * \Sigma Y_i^2}{\Sigma X_i}\right]$$

$$= FMVar[\frac{C5 * \sum Y_i^1 + C6 * \sum Y_i^2}{\Sigma X_i} = FMVar\left(\frac{\Sigma Y_i}{\Sigma X_i}\right)$$

1.18.1 Apply the Last Mile Profile to the Processing Duration volume with anticipated induction date I, First Processing Operation grouping F, and J days left in processing to estimate the volume of mail by days Left for First Mile for each possible value of J_{FM}, across all values of DL, P for a destination district of D, origin district of D, First Mile sampling group, performance measurement subgroup and anticipated delivery date.

$$Vol_{I,F,J_{FM}|OD=D,DD=D} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=D,DD=D} * LMP_{DD=D,DL,P}$$

1.18.2 Calculate $Y^1_{m_{SB},F}$ as follows

$$Y^1_{m_{SB},F} = \frac{\sum_{J_{FM},D_C \le J_{FM}-D_{CS}(m_{SB})} Vol_{I(m_{SB}),F,J_{FM}|OD=D,DD=D} * Weight_{m_{SB}} * \frac{CP_{D(m_{SB}),D_C}}{\sum_k CP_{D(m_{SB}),D_C=k}}}{\sum_{J_{FM}} Vol_{I(m_{SB}),F,J_{FM}|OD=D,DD=D}}$$

where $D_{CS}(m_{SB})$ is the Carrier Sampling days in phase for the sampled mailpiece

from collection box *SB*, *D(m_{SB})* is the collection date for the sampled mailpiece from collection box *SB*, *I(m_{SB})* is the anticipated induction date for the sampled mailpiece from collection box *SB*, and k ranges from 0 through 30, which represents the vast majority of possible values for Days in Collection and a reasonable cut-off for measurement.

1.18.3 Apply the Last Mile Profile to the Processing Duration volume with anticipated induction date I, FPO grouping F, and J days left in processing to estimate the volume of mail by days Left for First Mile for each possible value of J_{FM}, across all values of DL, P for a destination district D, origin district of all districts, First Mile sampling group, performance measurement subgroup and anticipated delivery date.

$$Vol_{I,F,J_{FM}|OD=D,DD=Nation} = \sum_{DL,P,J=J_{FM}+P} Vol_{DD,I,DL,F,J||OD=D,DD=Nation} * LMP_{DD=Nation,DL,P}$$

1.18.4 Calculate $Y^2_{m_{SB},F}$ as follows

$$Y^2_{m_{SB},F} = \frac{\sum_{J_{FM},D_C \leq J_{FM}-D_{CS}(m_{SB})} Vol_{I(m_{SB}),F,J_{FM}|OD=D,DD=Nation} * Weight_{m_{SB}} * \frac{CP_{D(m_{SB}),D_C}}{\sum_k CP_{D(m_{SB}),D_C=k}}}{\sum_{J_{FM}} Vol_{I(m_{SB}),F,J_{FM}|OD=D,DD=Nation}}$$

where $D_{CS}(m_{SB})$ is the Carrier Sampling days in phase for the sampled mailpiece from collection box *SB*, *D(m_{SB})* is the collection date for the sampled mailpiece from collection box *SB*, *I(m_{SB})* is the anticipated induction date for the sampled mailpiece from collection box *SB*, and k ranges from 0 through 30, which represents the vast majority of possible values for Days in Collection and a reasonable cut-off for measurement.

1.18.5 Calculate $X_{m_{SB},F}$ as follows:

$$X_{m_{SB},F} = Weight_{m_{SB}}$$

The Collection Profile term is left out in this equation because summation across all possible values of days in collection for the Collection Profile proportion yields a value of 1.

1.18.6 Calculate $\overline{X_F}$ as follows:

$$\overline{X_F} = \frac{\sum_{m_{SB}} X_{m_{SB},F}}{n_F}$$

1.18.7 Calculate R_F as follows:

$$R_F = \frac{\sum_{m_{SB}}(C5 * Y^1_{m_{SB},F} + C6 * Y^2_{m_{SB},F})}{\sum_{m_{SB}} X_{m_{SB},F}} = \frac{\sum_{m_{SB}} Y_{mSB,F}}{\sum_{m_{SB}} X_{m_{SB},F}}$$

1.18.8 Calculate the unit variance for FPO grouping *F* across all sampled mailpieces for the First Mile sampling group, and anticipated delivery date as follows. Subscripts have been left off to simplify notation:

$$UnitVar_F = \frac{1}{\bar{X}^2}\left(\frac{(\sum Y^2)/n-(\sum Y/n)^2}{n-1} + R^2\frac{(\sum X^2)/n-(\sum X/n)^2}{n-1} - 2R\frac{(\sum XY)/n-(\sum X/n)(\sum Y/n)}{n-1}\right)$$

1.18.9 If less than a configurable minimum number of sampled pieces are available for the unit variance calculation, collapse the FPO groupings so that the unit variance is calculated for all FPO groupings combined.

1.18.10 Calculate the First Mile Variance of estimated on-time performance as:

$$FMVar_{c|OD=D,DD=D,Nation} = w^2 * \frac{\sum_F\left[\left(\sum_{I,J_{FM}}(C5*Vol_{I,F,J_{FM}|OD=D,DD=D}+C6*Vol_{I,F,J_{FM}|OD=D,DD=Nation})\right)^2 * UnitVar_F\right]}{\left(\sum_{I,F,J_{FM}}(C5*Vol_{I,F,J_{FM}|OD=D,DD=D}+C6*Vol_{I,F,J_{FM}|OD=D,DD=Nation})\right)^2}$$

where

c = the specific combination sampling group, and anticipated delivery date for the relevant performance measurement subgroup

w = the percentage of total originating volume that is from the collection box channel, as defined in First Mile Profile and Performance Calculations Requirement 32

1.18.11 Calculate aggregates across anticipated delivery dates for the relevant performance estimate as follows:

$$FMVar_{OD=D,DD=D,Nation} = \frac{\sum_C\left[\left(Vol_{c|OD=Nation,D,DD=D}\right)^2 * FMVar_{c|OD=Nation,D,DD=D}\right]}{\left(\sum_C Vol_{c|OD=Nation,D,DD=D}\right)^2}$$

where

c is the set of anticipated delivery dates related to the performance estimate

$FMVar_c$ = the value of FMVar for the combination *c*

Vol_c = the total processing volume for combination *c*