SAS/STAT® 13.1 User's Guide
The SURVEYSELECT Procedure

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Chapter 99
The SURVEYSELECT Procedure

Contents

Overview: SURVEYSELECT Procedure

The SURVEYSELECT procedure provides a variety of methods for selecting probability-based random samples. The procedure can select a simple random sample or can sample according to a complex multistage sample design that includes stratification, clustering, and unequal probabilities of selection. With probability sampling, each unit in the survey population has a known, positive probability of selection. This property of probability sampling avoids selection bias and enables you to use statistical theory to make valid inferences from the sample to the survey population.

To select a sample with PROC SURVEYSELECT, you input a SAS data set that contains the sampling frame, which is the list of units from which the sample is to be selected. The sampling units can be individual observations or groups of observations (clusters). You also specify the selection method, the desired sample size or sampling rate, and other selection parameters. PROC SURVEYSELECT selects the sample and produces an output data set that contains the selected units, their selection probabilities, and their sampling weights. When you select a sample in multiple stages, you invoke the procedure separately for each stage of selection, inputting the frame and selection parameters for each current stage.

PROC SURVEYSELECT provides methods for both equal probability sampling and probability proportional to size (PPS) sampling. In equal probability sampling, each unit in the sampling frame, or in a stratum, has the same probability of being selected for the sample. In PPS sampling, a unit's selection probability is proportional to its size measure. For details about probability sampling methods, see Lohr (2010); Kish (1965, 1987); Kalton (1983); Cochran (1977).

PROC SURVEYSELECT provides the following equal probability sampling methods:

- simple random sampling (without replacement)

- unrestricted random sampling (with replacement)

- systematic random sampling

- sequential random sampling

- Bernoulli sampling

This procedure also provides Poisson sampling and the following probability proportional to size (PPS) sampling methods:

- PPS sampling without replacement

- PPS sampling with replacement

- PPS systematic sampling

- PPS algorithms for selecting two units per stratum

- sequential PPS sampling with minimum replacement

The procedure uses fast, efficient algorithms for these sample selection methods. Thus, it performs well even for large input data sets or sampling frames.

PROC SURVEYSELECT can perform stratified sampling by selecting samples independently within strata, which are nonoverlapping subgroups of the survey population. Stratification controls the distribution of the sample size in the strata. It is widely used in practice toward meeting a variety of survey objectives. For example, with stratification you can ensure adequate sample sizes for subgroups of interest, including small subgroups, or you can use stratification toward improving the precision of the overall estimates. When you use a systematic or sequential selection method, PROC SURVEYSELECT can also sort by control variables within strata for the additional control of implicit stratification.

For stratified sampling, PROC SURVEYSELECT provides survey design methods to allocate the total sample size among the strata. Available allocation methods include proportional, Neyman, and optimal allocation. Optimal allocation maximizes the estimation precision within the available resources, taking into account stratum sizes, costs, and variances.

PROC SURVEYSELECT provides replicated sampling, where the total sample is composed of a set of replicates, and each replicate is selected in the same way. You can use replicated sampling to study variable nonsampling errors, such as variability in the results obtained by different interviewers. You can also use replication to estimate standard errors for combined sample estimates and to perform a variety of other resampling and simulation tasks.

Getting Started: SURVEYSELECT Procedure

In this example, an Internet service provider conducts a customer satisfaction survey. The survey population consists of the company's current subscribers. The company plans to select a sample of customers from this population, interview the selected customers, and then make inferences about the entire survey population from the sample data.

The SAS data set Customers contains the sampling frame, which is the list of units in the survey population. The sample of customers will be selected from this sampling frame. The data set Customers is constructed from the company's customer database. It contains one observation for each customer, with a total of 13,471 observations.

The following PROC PRINT statements display the first 10 observations of the data set Customers and produce Figure 99.1:

```
title1 'Customer Satisfaction Survey';
title2 'First 10 Observations';
proc print data=Customers(obs=10);
run;
```

Figure 99.1 Customers Data Set (First 10 Observations)

```
                    Customer Satisfaction Survey
                       First 10 Observations

         Obs      CustomerID     State     Type     Usage

          1      416-87-4322       AL      New        839
          2      288-13-9763       GA      Old        224
          3      339-00-8654       GA      Old       2451
          4      118-98-0542       GA      New        349
          5      421-67-0342       FL      New        562
          6      623-18-9201       SC      New         68
          7      324-55-0324       FL      Old        137
          8      832-90-2397       AL      Old       1563
          9      586-45-0178       GA      New        615
         10      801-24-5317       SC      New        728
```

In the SAS data set Customers, the variable CustomerID uniquely identifies each customer. The variable State contains the state of the customer's address. The company has customers in four states: Georgia (GA), Alabama (AL), Florida (FL), and South Carolina (SC). The variable Type equals 'Old' if the customer has subscribed to the service for more than one year; otherwise, the variable Type equals 'New'. The variable Usage contains the customer's average monthly service usage, in minutes.

The following sections illustrate the use of PROC SURVEYSELECT for probability sampling with three different designs for the customer satisfaction survey. All three designs are one-stage, with customers as the sampling units. The first design is simple random sampling without stratification. In the second design, customers are stratified by state and type, and the sample is selected by simple random sampling within strata. In the third design, customers are sorted within strata by usage, and the sample is selected by systematic random sampling within strata.

Simple Random Sampling

The following PROC SURVEYSELECT statements select a probability sample of customers from the Customers data set by using simple random sampling:

```
title1 'Customer Satisfaction Survey';
title2 'Simple Random Sampling';
proc surveyselect data=Customers method=srs n=100
               out=SampleSRS;
run;
```

The PROC SURVEYSELECT statement invokes the procedure. The DATA= option names the SAS data set Customers as the input data set from which to select the sample. The METHOD=SRS option specifies simple random sampling as the sample selection method. In simple random sampling, each unit has an equal probability of selection, and sampling is without replacement. Without-replacement sampling means that a unit cannot be selected more than once. The N= option specifies a sample size of 100 customers. The OUT= option stores the sample in the SAS data set named SampleSRS.

Figure 99.2 displays the output from PROC SURVEYSELECT, which summarizes the sample selection. A sample of 100 customers is selected from the data set Customers by simple random sampling. With simple random sampling and no stratification in the sample design, the selection probability is the same for all units in the sample. In this sample, the selection probability for each customer equals 0.007423, which is the sample size (100) divided by the population size (13,471). The sampling weight equals 134.71 for each customer in the sample, where the weight is the inverse of the selection probability. If you specify the STATS option, PROC SURVEYSELECT includes the selection probabilities and sampling weights in the output data set. (This information is always included in the output data set for more complex designs.)

The random number seed is 39647. PROC SURVEYSELECT uses this number as the initial seed for random number generation. Because the SEED= option is not specified in the PROC SURVEYSELECT statement, the seed value is obtained by using the time of day from the computer's clock. You can specify SEED=39647 to reproduce this sample.

Figure 99.2 Sample Selection Summary

```
                    Customer Satisfaction Survey
                        Simple Random Sampling

                     The SURVEYSELECT Procedure

             Selection Method     Simple Random Sampling


                 Input Data Set               CUSTOMERS
                 Random Number Seed               39647
                 Sample Size                        100
                 Selection Probability         0.007423
                 Sampling Weight                 134.71
                 Output Data Set              SAMPLESRS
```

The sample of 100 customers is stored in the SAS data set SampleSRS. PROC SURVEYSELECT does not display this output data set. The following PROC PRINT statements display the first 20 observations of SampleSRS:

```
title1 'Customer Satisfaction Survey';
title2 'Sample of 100 Customers, Selected by SRS';
title3 '(First 20 Observations)';
proc print data=SampleSRS(obs=20);
run;
```

Figure 99.3 displays the first 20 observations of the output data set SampleSRS, which contains the sample of customers. This data set includes all the variables from the DATA= input data set Customers. If you do not want to include all variables, you can use the ID statement to specify which variables to copy from the input data set to the output (sample) data set.

Figure 99.3 Customer Sample (First 20 Observations)

```
                    Customer Satisfaction Survey
               Sample of 100 Customers, Selected by SRS
                        (First 20 Observations)

         Obs       CustomerID      State     Type      Usage

          1       017-27-4096       GA       New        168
          2       026-37-3895       AL       New         59
          3       038-54-9276       GA       New        785
          4       046-40-3131       FL       New         60
          5       070-37-6924       GA       New        524
          6       100-58-3342       FL       New        302
          7       107-61-9029       AL       New        235
          8       110-95-0432       FL       New         12
          9       112-81-9251       SC       New        347
         10       137-33-0478       GA       New        551
         11       143-83-4677       AL       New        203
         12       147-19-9164       GA       New        172
         13       159-51-0606       FL       New        102
         14       164-14-7799       GA       Old        388
         15       165-05-7323       SC       New        606
         16       174-69-3566       AL       Old        111
         17       177-69-6934       FL       New        202
         18       181-58-3508       AL       Old        261
         19       207-41-8446       AL       Old        183
         20       207-64-7308       GA       New        193
```

Stratified Sampling

In this section, stratification is added to the sample design for the customer satisfaction survey. The sampling frame, which is the list of all customers, is stratified by State and Type. This divides the sampling frame into nonoverlapping subgroups formed from the values of the State and Type variables. Samples are then selected independently within the strata.

PROC SURVEYSELECT requires that the input data set be sorted by the STRATA variables. The following PROC SORT statements sort the Customers data set by the stratification variables State and Type:

```
proc sort data=Customers;
   by State Type;
run;
```

The following PROC FREQ statements display the crosstabulation of the Customers data set by State and Type:

```
title1 'Customer Satisfaction Survey';
title2 'Strata of Customers';
proc freq data=Customers;
   tables State*Type;
run;
```

Figure 99.4 presents the table of State by Type for the 13,471 customers. There are four states and two levels of Type, forming a total of eight strata.

Figure 99.4 Stratification of Customers by State and Type

```
                    Customer Satisfaction Survey
                         Strata of Customers

                         The FREQ Procedure

                      Table of State by Type

            State      Type

            Frequency|
            Percent  |
            Row Pct  |
            Col Pct  |New      |Old      | Total
            ---------+--------+--------+
            AL       |   1238 |    706 |   1944
                     |   9.19 |   5.24 |  14.43
                     |  63.68 |  36.32 |
                     |  14.43 |  14.43 |
            ---------+--------+--------+
            FL       |   2170 |   1370 |   3540
                     |  16.11 |  10.17 |  26.28
                     |  61.30 |  38.70 |
                     |  25.29 |  28.01 |
            ---------+--------+--------+
            GA       |   3488 |   1940 |   5428
                     |  25.89 |  14.40 |  40.29
                     |  64.26 |  35.74 |
                     |  40.65 |  39.66 |
            ---------+--------+--------+
            SC       |   1684 |    875 |   2559
                     |  12.50 |   6.50 |  19.00
                     |  65.81 |  34.19 |
                     |  19.63 |  17.89 |
            ---------+--------+--------+
            Total        8580     4891    13471
                         63.69    36.31   100.00
```

The following PROC SURVEYSELECT statements select a probability sample of customers from the Customers data set according to the stratified sample design:

```
title1 'Customer Satisfaction Survey';
title2 'Stratified Sampling';
proc surveyselect data=Customers method=srs n=15
                  seed=1953 out=SampleStrata;
   strata State Type;
run;
```

The STRATA statement names the stratification variables State and Type. In the PROC SURVEYSELECT statement, the METHOD=SRS option specifies simple random sampling. The N= option specifies a sample size of 15 customers for each stratum. If you want to specify different sample sizes for different strata, you can use the N=*SAS-data-set* option to name a secondary data set that contains the stratum sample sizes. The SEED= option specifies 1953 as the initial seed for random number generation.

Figure 99.5 displays the output from PROC SURVEYSELECT, which summarizes the sample selection. A total of 120 customers are selected.

Figure 99.5 Sample Selection Summary

```
                 Customer Satisfaction Survey
                     Stratified Sampling

                   The SURVEYSELECT Procedure

         Selection Method     Simple Random Sampling
         Strata Variables                      State
                                                Type


              Input Data Set            CUSTOMERS
              Random Number Seed             1953
              Stratum Sample Size              15
              Number of Strata                  8
              Total Sample Size               120
              Output Data Set         SAMPLESTRATA
```

The following PROC PRINT statements display the first 30 observations of the output data set SampleStrata:

```
title1 'Customer Satisfaction Survey';
title2 'Sample Selected by Stratified Design';
title3 '(First 30 Observations)';
proc print data=SampleStrata(obs=30);
run;
```

Figure 99.6 displays the first 30 observations of the output data set SampleStrata, which contains the sample of 120 customers, 15 customers from each of the eight strata. The variable SelectionProb contains the selection probability for each customer in the sample. Because customers are selected with equal probability within strata in this design, the selection probability equals the stratum sample size (15) divided by the stratum

population size. The selection probabilities differ from stratum to stratum because the stratum population sizes differ. The selection probability for each customer in the first stratum (State='AL' and Type='New') is 0.012116, and the selection probability for customers in the second stratum is 0.021246. The variable SamplingWeight contains the sampling weights, which are computed as inverse selection probabilities.

Figure 99.6 Customer Sample (First 30 Observations)

```
                   Customer Satisfaction Survey
                 Sample Selected by Stratified Design
                        (First 30 Observations)


                                             Selection    Sampling
    Obs     State    Type     CustomerID     Usage     Prob       Weight

      1      AL      New      015-57-9903       26     0.012116    82.5333
      2      AL      New      052-18-5029      576     0.012116    82.5333
      3      AL      New      064-72-0145       88     0.012116    82.5333
      4      AL      New      291-22-2497     1221     0.012116    82.5333
      5      AL      New      305-62-6833      187     0.012116    82.5333
      6      AL      New      309-63-9722      534     0.012116    82.5333
      7      AL      New      413-76-0209      435     0.012116    82.5333
      8      AL      New      492-18-7867       70     0.012116    82.5333
      9      AL      New      508-16-8324      189     0.012116    82.5333
     10      AL      New      561-82-0366      392     0.012116    82.5333
     11      AL      New      685-24-1718       74     0.012116    82.5333
     12      AL      New      800-20-2155       21     0.012116    82.5333
     13      AL      New      857-94-2672       77     0.012116    82.5333
     14      AL      New      918-29-9618      540     0.012116    82.5333
     15      AL      New      963-93-4916       33     0.012116    82.5333
     16      AL      Old      000-88-0484      401     0.021246    47.0667
     17      AL      Old      005-80-0241      114     0.021246    47.0667
     18      AL      Old      171-99-9085      210     0.021246    47.0667
     19      AL      Old      182-45-1938      160     0.021246    47.0667
     20      AL      Old      208-99-1105       60     0.021246    47.0667
     21      AL      Old      229-48-6213     1169     0.021246    47.0667
     22      AL      Old      265-55-4763     1370     0.021246    47.0667
     23      AL      Old      467-73-7465       14     0.021246    47.0667
     24      AL      Old      509-38-7128      173     0.021246    47.0667
     25      AL      Old      601-71-3629      142     0.021246    47.0667
     26      AL      Old      603-40-7787      302     0.021246    47.0667
     27      AL      Old      702-39-0977      270     0.021246    47.0667
     28      AL      Old      861-79-5340      101     0.021246    47.0667
     29      AL      Old      908-20-0603      340     0.021246    47.0667
     30      AL      Old      937-69-9106      182     0.021246    47.0667
```

Stratified Sampling with Control Sorting

The next sample design for the customer satisfaction survey uses stratification by State and also control sorting by Type and Usage within State. After stratification and control sorting, customers are selected by systematic random sampling within strata. Selection by systematic sampling, together with control sorting before selection, spreads the sample uniformly over the range of type and usage values within each stratum (state). The following PROC SURVEYSELECT statements select a probability sample of customers from the Customers data set according to this design:

```
title1 'Customer Satisfaction Survey';
title2 'Stratified Sampling with Control Sorting';
proc surveyselect data=Customers method=sys rate=.02
                  seed=1234 out=SampleControl;
   strata State;
   control Type Usage;
run;
```

The STRATA statement names the stratification variable State. The CONTROL statement names the control variables Type and Usage. In the PROC SURVEYSELECT statement, the METHOD=SYS option requests systematic random sampling. The RATE= option specifies a sampling rate of 2% for each stratum. The SEED= option specifies the initial seed for random number generation.

Figure 99.7 displays the output from PROC SURVEYSELECT, which summarizes the sample selection. A sample of 271 customers is selected by using systematic random sampling within strata determined by State. The sampling frame Customers is sorted by control variables Type and Usage within strata. The type of sorting is serpentine, which is the default when SORT=NEST is not specified. See the section "Sorting by CONTROL Variables" on page 8483 for a description of serpentine sorting. The sorted data set replaces the input data set. (To leave the input data set unsorted and store the sorted input data in another data set, use the OUTSORT= option.) The output data set SampleControl contains the sample of customers.

Figure 99.7 Sample Selection Summary

```
                    Customer Satisfaction Survey
                Stratified Sampling with Control Sorting


                      The SURVEYSELECT Procedure

         Selection Method      Systematic Random Sampling
         Strata Variable                            State
         Control Variables                           Type
                                                    Usage
         Control Sorting                        Serpentine


              Input Data Set                 CUSTOMERS
              Random Number Seed                  1234
              Stratum Sampling Rate               0.02
              Number of Strata                       4
              Total Sample Size                    270
              Output Data Set              SAMPLECONTROL
```

Syntax: SURVEYSELECT Procedure

The following statements are available in the SURVEYSELECT procedure:

> **PROC SURVEYSELECT** *options* ;
>   **CONTROL** *variables* ;
>   **FREQ** *variable* ;
>   **ID** *variables* ;
>   **SAMPLINGUNIT | CLUSTER** *variables* < / *options* > ;
>   **SIZE** *variable* ;
>   **STRATA** *variables* < / *options* > ;

The PROC SURVEYSELECT statement invokes the SURVEYSELECT procedure. Optionally, it identifies input and output data sets. It also specifies the selection method, the sample size, and other sample design parameters. The PROC SURVEYSELECT statement is required.

The SIZE statement identifies the variable that contains the size measures of the sampling units. This statement is required for any probability proportional to size (PPS) selection method unless you specify the PPS option in the SAMPLINGUNIT statement.

The remaining statements are optional. The STRATA statement identifies a variable or set of variables that stratify the input data set. When you specify a STRATA statement, PROC SURVEYSELECT selects samples independently from the strata that are formed by the STRATA variables. The STRATA statement also provides options to allocate the total sample size among the strata.

The SAMPLINGUNIT statement identifies a variable or set of variables that group the input data set observations into sampling units (clusters). Sampling units are nested within strata. When you specify a SAMPLINGUNIT statement, PROC SURVEYSELECT selects clusters instead of individual observations.

The CONTROL statement identifies variables for ordering units within strata. It can be used for systematic and sequential sampling methods. The ID statement identifies variables to copy from the input data set to the output data set of selected units.

The FREQ statement identifies a variable that contains the frequency of occurrence for each observation. The FREQ statement is available only for sample allocation when no sample is selected, which you can request by specifying the ALLOC= and NOSAMPLE options in the STRATA statement.

The following sections describe the PROC SURVEYSELECT statement and then describe the other statements in alphabetical order.

PROC SURVEYSELECT Statement

> **PROC SURVEYSELECT** *options* ;

The PROC SURVEYSELECT statement invokes the SURVEYSELECT procedure. Optionally, it identifies input and output data sets. If you do not name a DATA= input data set, the procedure selects the sample from the most recently created SAS data set. If you do not name an OUT= output data set to contain the sample of selected units, the procedure still creates an output data set and names it according to the DATA*n* convention.

The PROC SURVEYSELECT statement also specifies the sample selection method, the sample size, and other sample design parameters.

If you do not specify a selection method, PROC SURVEYSELECT uses simple random sampling (METHOD=SRS) by default unless you specify a SIZE statement or the PPS option in the SAMPLINGUNIT statement. If you do specify a SIZE statement (or the PPS option), PROC SURVEYSELECT uses probability proportional to size selection without replacement (METHOD=PPS) by default. See the description of the METHOD= option for more information.

You can use the SAMPSIZE=*n* option to specify the sample size, or you can use the SAMPSIZE=*SAS-data-set* option to name a secondary input data set that contains stratum sample sizes. You must specify a sample size or sampling rate except when you request one of the following: random assignment (GROUPS=); Poisson sampling (METHOD=POISSON); Brewer's method or Murthy's method, either of which selects two units from each stratum (METHOD=PPS_BREWER or METHOD=PPS_MURTHY); or sample allocation for a specified margin (MARGIN=).

You can provide stratum sample sizes, sampling rates, initial seeds, minimum size measures, maximum size measures, and certainty size measures in a secondary input data set. For more information, see the descriptions of the SAMPSIZE=, SAMPRATE=, SEED=, MINSIZE=, MAXSIZE=, CERTSIZE=, and CERTSIZE=P= options. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT. For more information, see the section "Secondary Input Data Set" on page 8497.

Table 99.1 summarizes the options available in the PROC SURVEYSELECT statement. Descriptions of the options follow in alphabetical order.

Table 99.1 PROC SURVEYSELECT Statement Options

Option	Description
Input and Output Data Sets	
DATA=	Names the input SAS data set
OUT=	Names the output SAS data set that contains the sample
OUTSORT=	Names an output SAS data set that stores the sorted input data set
Selection Method	
METHOD=	Specifies the sample selection method
Sample Size	
SAMPSIZE=	Specifies the sample size
SELECTALL	Selects all stratum units when the sample size exceeds the total
Sampling Rate	
SAMPRATE=	Specifies the sampling rate
NMIN=	Specifies the minimum stratum sample size
NMAX=	Specifies the maximum stratum sample size
Replicated Sampling	
REPS=	Specifies the number of sample replicates
Size Measures	
MINSIZE=	Specifies the minimum size measure
MAXSIZE=	Specifies the maximum size measure
CERTSIZE=	Specifies the certainty size measure
CERTSIZE=P=	Specifies the certainty proportion
Control Sorting	
SORT=	Specifies the type of sorting

Table 99.1   *continued*

Option	Description
Random Number Generation	
SEED=	Specifies the initial seed
RANUNI	Requests the RANUNI random number generator
Random Assignment	
GROUPS=	Requests random assignment
Displayed Output	
NOPRINT	Suppresses the display of all output
OUT= Data Set Contents	
CERTUNITS=	Includes number of certainty units
JTPROBS	Includes joint probabilities of selection
OUTALL	Includes all observations from the DATA= input data set
OUTHITS	Includes a distinct copy of each selected unit
OUTSEED	Includes the initial seed for each stratum
OUTSIZE	Includes additional design and sampling frame information
STATS	Includes selection probabilities and sampling weights

You can specify the following options in the PROC SURVEYSELECT statement:

CERTSIZE < =*value* | *SAS-data-set* >

specifies the certainty size measure that PROC SURVEYSELECT uses to identify units that are selected with certainty. You can provide a single certainty *value* for the entire sample selection, or you can provide stratum-level certainty values by specifying a *SAS-data-set*. The certainty size values must be positive numbers.

You can use the SIZE statement to provide size measures for the sampling units. PROC SURVEYSELECT selects with certainty all sampling units whose size measures are greater than or equal to the certainty size value. After removing the certainty units, the procedure selects the remainder of the sample by using the method that you specify in the METHOD= option. The OUT= output data set contains a variable named Certain that identifies units that are selected with certainty. The selection probability of each certainty unit is one.

This option is available for the following PPS selection methods: METHOD=PPS, METHOD=PPS_SAMPFORD, METHOD=PPS_SYS, and METHOD=PPS_WR. The CERTSIZE= option is not available when you specify a SAMPLINGUNIT statement.

You can provide certainty size values by specifying one of the following forms:

CERTSIZE=*value*

specifies a single certainty size *value*, which must be a positive number. If you request a stratified sample design by specifying the STRATA statement, PROC SURVEYSELECT uses the certainty value to determine certainty selections for all strata.

CERTSIZE=*SAS-data-set*

names a *SAS-data-set* that contains stratum-level certainty size values. You should provide the certainty values in the data set variable named _CERTSIZE_. Each observation in this data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= data set. The order of the stratum groups in the CERTSIZE= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

CERTSIZE

indicates that certainty size values are provided in a secondary input data set that you name in another option (for example, the SAMPSIZE=*SAS-data-set* option). This data set should include a variable named _CERTSIZE_ that contains the certainty values. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

CERTSIZE=P < =*p* | *SAS-data-set* >

specifies the certainty proportion that PROC SURVEYSELECT uses for iterative certainty selection. You can provide a single certainty proportion *p* for the entire sample, or you can provide stratum-level certainty proportions by specifying a *SAS-data-set*.

The certainty proportions must be positive numbers. You can specify a certainty proportion as a number between 0 and 1. Or you can specify a proportion in percentage form as a number between 1 and 100, which PROC SURVEYSELECT converts to a proportion. The procedure treats the value 1 as 100% instead of 1%.

You can use the SIZE statement to provide size measures for the sampling units. PROC SURVEYSELECT computes the certainty size as the certainty proportion *p* of the total size for all units. The procedure selects with certainty the sampling units whose size measures are greater than or equal to the certainty size. After removing these certainty units from consideration, the procedure computes a new certainty size as the certainty proportion of the total size of the remaining units and again identifies certainty units. PROC SURVEYSELECT repeats this process until no more certainty units are selected. After certainty selection is complete, the remainder of the sample is selected by using the method that you specify in the METHOD= option. The OUT= output data set contains a variable named Certain that identifies units that are selected with certainty. The selection probability of each certainty unit is one.

This option is available for METHOD=PPS and METHOD=PPS_SAMPFORD. This option is not available when you specify a SAMPLINGUNIT statement.

You can provide certainty size proportions by specifying one of the following forms:

CERTSIZE=P=*p*

specifies a single certainty size proportion *p*, which must be a positive number. If you request a stratified sample design by specifying the STRATA statement, PROC SURVEYSELECT uses the certainty proportion *p* to determine certainty selections for all strata.

CERTSIZE=P=*SAS-data-set*

names a *SAS-data-set* that contains stratum-level certainty size proportions. You should provide the certainty proportions in the data set variable named _CERTP_. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= input data set. The order of the stratum groups in the CERTSIZE=P= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

CERTSIZE=P

indicates that certainty size proportions are provided in a secondary input data set that you name in another option (for example, the SAMPSIZE=*SAS-data-set* option). You should provide the certainty proportions in the data set variable named _CERTP_. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

CERTUNITS=NOPRINT | OUTPUT

controls the display and output of information about certainty selection. This option is available when you specify the CERTSIZE= or CERTSIZE=P= option. CERTUNITS=NOPRINT suppresses display of the number of certainty units in the "Sample Selection Summary" table. For more information, see the section "Displayed Output" on page 8503. CERTUNITS=OUTPUT includes the number of certainty units in the output data set. For more information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

DATA=*SAS-data-set*

names the *SAS-data-set* from which PROC SURVEYSELECT selects the sample. If you omit the DATA= option, the procedure uses the most recently created SAS data set. In sampling terminology, the input data set is the *sampling frame* (the list of units from which the sample is selected).

By default, the procedure uses input data set observations as sampling units and selects a sample of these units. Alternatively, you can use the SAMPLINGUNIT statement to define sampling units as groups of observations (clusters).

GROUPS=*n* **|** **(***values***)**

requests random assignment of the observations in the input data set to groups. You can specify the total number of groups as *n*, which must be a positive integer. Or you can provide a list of group size *values*, which are positive integers that specify the number of observations in the groups. When you use a STRATA statement, PROC SURVEYSELECT performs the specified random assignment independently in each stratum. Otherwise, the procedure performs the random assignment for the entire data set.

When you specify GROUPS=*n*, PROC SURVEYSELECT randomly assigns the observations in the data set (or stratum) to *n* groups. The number of observations in each group is equal, or as nearly equal as possible. For example, if the data set contains 100 observations and you specify GROUPS=3, PROC SURVEYSELECT creates three groups that contain 33, 33, and 34 observations. This is equivalent to specifying GROUPS=(33, 33, 34).

When you specify GROUPS=*values*, the number of groups is determined by the number of group size values that you list. You can separate the values with blanks or commas, and the list of values must be enclosed in parentheses. The sum of the group size values must equal the total number of observations in the data set (or in the stratum, if you specify a STRATA statement).

The OUT= data set includes a variable named GroupID that identifies the group assignment of each observation. If you specify the OUTSIZE option, the output data set includes a variable named GroupSize that provides the number of units in the group; the output data set also includes the total number of units and the number of groups (in the data set, or in the stratum if you specify a STRATA statement). For more information, see the section "Random Assignment Output Data Set" on page 8503.

The following options are available when you specify the GROUPS= option: the SEED=, RANUNI, and OUTSEED options, which pertain to random number generation; the REPS= option, which provides independent replicates of the random assignment; the NOPRINT option, which suppresses display of the "Random Assignment" table; and the OUTSIZE option.

The GROUPS= option does not select a sample; you cannot specify sample selection options (for example, METHOD= or SAMPSIZE=) when you use the GROUPS= option. The SAMPLINGUNIT statement is not available when you use the GROUPS= option.

JTPROBS

includes joint probabilities of selection in the OUT= output data set. This option is available for the following probability proportional to size selection methods: METHOD=PPS, METHOD=PPS_SAMPFORD, and METHOD=PPS_WR. By default, PROC SURVEYSELECT outputs joint selection probabilities for METHOD=PPS_BREWER and METHOD=PPS_MURTHY, which select two units per stratum.

For details about computation of joint selection probabilities for a particular sampling method, see the method description in the section "Sample Selection Methods" on page 8485. For more information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

MAXSIZE < =*value* | *SAS-data-set* >

specifies the maximum size measure. You can provide a single maximum *value* for the entire sample selection, or you can provide stratum-level maximum values by specifying a *SAS-data-set*. The maximum size values must be positive numbers.

PROC SURVEYSELECT uses the maximum size values to adjust the size measures, which you can provide by specifying the SIZE statement or by specifying the PPS option in the SAMPLINGUNIT statement. When a size measure exceeds the maximum value, the procedure replaces the size measure with the maximum value.

If you use a SAMPLINGUNIT statement to define sampling units (clusters), PROC SURVEYSELECT adjusts the sampling unit sizes (instead of the observation sizes). If you specify a SIZE statement, the size of a sampling unit is the sum of the size measures of the observations in the unit. If you specify the SAMPLINGUNIT PPS option, the size of a sampling unit is the number of observations in the unit.

When you use a SAMPLINGUNIT statement, the OUT= data set includes a variable named UnitSize that contains the adjusted sampling unit size measures. When you do not use a SAMPLINGUNIT statement, the OUT= data set includes a variable named AdjustedSize that contains the adjusted observation size measures.

You can provide maximum size values by specifying one of the following forms:

MAXSIZE=*value*

specifies a single maximum size *value*, which must be a positive number. If you request a stratified sample design by specifying the STRATA statement, PROC SURVEYSELECT uses the value to adjust size measures in all strata.

MAXSIZE=_SAS-data-set_

names a _SAS-data-set_ that contains stratum-level maximum size values. You should provide the maximum size values in the data set variable named _MAXSIZE_. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= data set. The order of the stratum groups in the MAXSIZE= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

MAXSIZE

indicates that maximum size values are provided in a secondary input data set that you name in another option (for example, the SAMPSIZE=_SAS-data-set_ option). You should provide the maximum size values in the data set variable named _MAXSIZE_. For more information, see the section "Secondary Input Data Set" on page 8497. You can specify only one secondary input data set in each invocation of PROC SURVEYSELECT.

METHOD=_name_

M=_name_

specifies the method for sample selection.

If you do not specify the METHOD= option, PROC SURVEYSELECT uses simple random sampling (METHOD=SRS) by default unless you specify a SIZE statement or the PPS option in the SAMPLINGUNIT statement. If you do specify a SIZE statement (or the PPS option), PROC SURVEYSELECT uses probability proportional to size selection without replacement (METHOD=PPS) by default.

The following values are available for the METHOD= option:

BERNOULLI

requests Bernoulli sampling, which consists of N independent selection trials, each with constant inclusion probability π, where N is the total number of sampling units in the stratum or data set. The sample size is not fixed but is a random variable. See the section "Bernoulli Sampling" on page 8488 for details.

When you specify METHOD=BERNOULLI, you must provide the sampling rate (inclusion probability π) by using the SAMPRATE= option. For stratified sampling (which you request with the STRATA statement), you can specify the same sampling rate for each stratum with the SAMPRATE=_value_ option. Or you can specify different sampling rates for different strata by using the SAMPRATE=(_values_) or SAMPRATE=_SAS-data-set_ option.

Because Bernoulli sampling is based on a specified inclusion probability instead of a fixed sample size, METHOD=BERNOULLI does not use the SAMPSIZE= option. Also, the ALLOC= option in the STRATA statement (which allocates the total sample size among strata) is not available with METHOD=BERNOULLI.

POISSON

requests Poisson sampling. A generalization of Bernoulli sampling, Poisson sampling consists of N independent selection trials with a separate inclusion probability specified for each unit, where N is the total number of sampling units in the stratum or data set. The sample size is not fixed but is a random variable. See the section "Poisson Sampling" on page 8488 for details.

You must provide inclusion probabilities for Poisson sampling in the SIZE variable. The probability values should be between 0 and 1. If a value of the SIZE variable is missing, nonpositive, or greater than 1, PROC SURVEYSELECT omits the observation from sample selection.

Because Poisson sampling is based on specified inclusion probabilities instead of a fixed sample size, METHOD=POISSON does not use the SAMPSIZE= option. Also, the ALLOC= option in the STRATA statement (which allocates the total sample size among strata) is not available with METHOD=POISSON.

The SAMPLINGUNIT statement is not available with METHOD=POISSON.

When METHOD=POISSON is specified with the SAMPRATE= option and without a SIZE statement, PROC SURVEYSELECT uses METHOD=BERNOULLI.

PPS

requests selection with probability proportional to size and without replacement. See the section "PPS Sampling without Replacement" on page 8488 for details. If you specify METHOD=PPS, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement.

PPS_BREWER

BREWER

requests selection according to Brewer's method. Brewer's method selects two units from each stratum with probability proportional to size and without replacement. See the section "Brewer's PPS Method" on page 8492 for details. If you specify METHOD=PPS_BREWER, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement. You do not need to specify the sample size with the SAMPSIZE= option because Brewer's method selects two units from each stratum.

PPS_MURTHY

MURTHY

requests selection according to Murthy's method. Murthy's method selects two units from each stratum with probability proportional to size and without replacement. See the section "Murthy's PPS Method" on page 8493 for details. If you specify METHOD=PPS_MURTHY, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement. You do not need to specify the sample size with the SAMPSIZE= option because Murthy's method selects two units from each stratum.

PPS_SAMPFORD

SAMPFORD

requests selection according to Sampford's method. Sampford's method selects units with probability proportional to size and without replacement. See the section "Sampford's PPS Method" on page 8493 for details. If you specify METHOD=PPS_SAMPFORD, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement.

PPS_SEQ

CHROMY

> requests sequential selection with probability proportional to size and with minimum replacement. This method is also known as Chromy's method. See the section "PPS Sequential Sampling" on page 8491 for details. If you specify METHOD=PPS_SEQ, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement.

PPS_SYS < (*method-options***) >**

> requests systematic selection with probability proportional to size. For more information, see the section "PPS Systematic Sampling" on page 8490. When you specify this method, you must provide size measures by specifying the SIZE statement or the PPS option in the SAMPLINGUNIT statement.
>
> You can specify the following *method-options*:
>
> **DETAILS**
>
>> displays the random start and the systematic interval in the "Sample Selection Summary" table when the design does not include strata or replicates. For more information, see the section "Displayed Output" on page 8503.
>
> **INTERVAL=***value*
>
>> specifies the interval *value* for PPS systematic selection. The interval value must be a positive number. It must not exceed the total of the size measures in the data set (or in each stratum if you specify a STRATA statement). By default, the systematic interval is the ratio of the size measure total to the sample size (which you provide in the SAMPSIZE= option). For more information, see the section "PPS Systematic Sampling" on page 8490.
>>
>> You cannot use the INTERVAL= *method-option* when you specify a sample size in the SAMPSIZE= option or when you specify the ALLOC= option, which allocates the total sample size among strata.
>
> **START=***value*
>
>> specifies the starting *value* for PPS systematic selection. The starting value must be a positive number that is less than the systematic interval. By default, PROC SURVEYSELECT randomly determines a starting point in the systematic interval. For more information, see the section "PPS Systematic Sampling" on page 8490.
>>
>> When you use this option to specify a systematic starting point (instead of allowing the procedure to randomly determine the starting point), the following options for random number generation have no effect: SEED=, RANUNI, and OUTSEED. You cannot use the REPS= option when you specify the START= *method-option*.
>>
>> When the starting value that you provide is not randomly determined, the resulting selection is not a probability-based sample.

PPS_WR

> requests selection with probability proportional to size and with replacement. See the section "PPS Sampling with Replacement" on page 8490 for details. If you specify METHOD=PPS_WR, you must name a size measure variable in the SIZE statement or specify the PPS option in the SAMPLINGUNIT statement.

SEQ

CHROMY

requests sequential selection according to Chromy's method. If you specify METHOD=SEQ and do not specify a SIZE statement (or the PPS option in the SAMPLINGUNIT statement), PROC SURVEYSELECT uses sequential zoned selection with equal probability and without replacement. See the section "Sequential Random Sampling" on page 8486 for details.

If you specify METHOD=SEQ and also specify a SIZE statement (or the PPS option in the SAMPLINGUNIT statement), PROC SURVEYSELECT uses METHOD=PPS_SEQ, which is sequential selection with probability proportional to size and with minimum replacement. See the section "PPS Sequential Sampling" on page 8491 for more information.

SRS

requests simple random sampling, which is selection with equal probability and without replacement. See the section "Simple Random Sampling" on page 8485 for details. METHOD=SRS is the default if you do not specify the METHOD= option and also do not specify a SIZE statement (or the PPS option in the SAMPLINGUNIT statement).

SYS < (*method-options***) >**

requests systematic random sampling. If you specify this option and do not specify a SIZE statement (or the PPS option in the SAMPLINGUNIT statement), PROC SURVEYSELECT uses systematic random sampling with equal probability. For more information, see the section "Systematic Random Sampling" on page 8486.

If you specify this option and also specify a SIZE statement (or the PPS option in the SAMPLINGUNIT statement), PROC SURVEYSELECT uses systematic random sampling with probability proportional to size (METHOD=PPS_SYS). For more information, see the section "PPS Systematic Sampling" on page 8490.

You can specify the following *method-options*:

DETAILS

displays the random start and the systematic interval in the "Sample Selection Summary" table when the design does not include strata or replicates. For more information, see the section "Displayed Output" on page 8503.

INTERVAL=*value*

specifies the interval for systematic random sampling. The interval *value* must be a positive number and must not exceed the number of sampling units in the data set (or the number of units in each stratum, if you specify a STRATA statement).

By default, PROC SURVEYSELECT determines the systematic interval from the sampling rate or sample size that you provide in the SAMPRATE= or SAMPSIZE= option, respectively. When you specify the sampling rate, PROC SURVEYSELECT computes the systematic interval as the inverse of the sampling rate. When you specify the sample size, the procedure computes the interval as the ratio of the number of sampling units to the sample size. For more information, see the section "Systematic Random Sampling" on page 8486.

You cannot use the INTERVAL= *method-option* when you specify the SAMPSIZE= option, the SAMPRATE= option, or the ALLOC= option (which allocates the total sample size among strata).

START=*value*

specifies the starting *value* for systematic selection. The starting value must be a positive number that is less than the systematic interval. By default, PROC SURVEYSELECT randomly determines a starting point in the systematic interval. For more information, see the section "Systematic Random Sampling" on page 8486.

When you use this option to specify a systematic starting point (instead of allowing the procedure to randomly determine the starting point), the following options for random number generation have no effect: SEED=, RANUNI, and OUTSEED. You cannot use the REPS= option when you specify the START= *method-option*.

When the starting value that you provide is not randomly determined, the resulting selection is not a probability-based sample.

URS

requests unrestricted random sampling, which is selection with equal probability and with replacement. See the section "Unrestricted Random Sampling" on page 8486 for details.

MINSIZE < =*value* **|** *SAS-data-set* **>**

specifies the minimum size measure. You can provide a single minimum *value* for the entire sample selection, or you can provide stratum-level minimum values by specifying a *SAS-data-set*. The minimum size values must be positive numbers.

PROC SURVEYSELECT uses the minimum size values to adjust the size measures, which you provide by specifying the SIZE statement or by specifying the PPS option in the SAMPLINGUNIT statement. When a size measure is less than the minimum value, the procedure replaces the size measure with the minimum value.

If you use a SAMPLINGUNIT statement to define sampling units (clusters), PROC SURVEYSELECT adjusts the sampling unit sizes (not the observation sizes). If you specify a SIZE statement, the size of a sampling unit is the sum of the size measures of the observations in the unit. If you specify the SAMPLINGUNIT PPS option, the size of a sampling unit is the number of observations in the unit.

When you use a SAMPLINGUNIT statement, the OUT= data set includes a variable named UnitSize that contains the adjusted sampling unit size measures. When you do not use a SAMPLINGUNIT statement, the OUT= data set includes a variable named AdjustedSize that contains the adjusted observation size measures.

You can provide minimum size values by specifying one of the following forms:

MINSIZE=*value*

specifies a single minimum size *value*, which must be a positive number. If you request a stratified sample design by specifying the STRATA statement, PROC SURVEYSELECT uses the minimum value to adjust size measures in all strata.

MINSIZE=*SAS-data-set*

names a *SAS-data-set* that contains stratum-level minimum size values. You should provide the minimum size values in the data set variable named _MINSIZE_. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear

in the DATA= input data set. The order of the stratum groups in the MINSIZE= data set must match the order of the groups in the DATA= input data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

MINSIZE

indicates that minimum size values are provided in a secondary input data set that you name in another option (for example, the SAMPSIZE=*SAS-data-set* option). You should provide the minimum size values in the data set variable named _MINSIZE_. For more information, see the section "Secondary Input Data Set" on page 8497. You can specify only one secondary input data set in each invocation of PROC SURVEYSELECT.

NMAX=n

specifies the maximum stratum sample size n for the SAMPRATE= option. When you specify the SAMPRATE= option, PROC SURVEYSELECT calculates the stratum sample size by multiplying the total number of units in the stratum by the specified sampling rate. If this sample size is greater than the value NMAX=n, then PROC SURVEYSELECT selects only n units.

The maximum sample size n must be a positive integer. The NMAX= option is available only with the SAMPRATE= option, which can be used with equal probability selection methods (METHOD=SRS, METHOD=URS, METHOD=SYS, and METHOD=SEQ). The NMAX= option is not available with METHOD=BERNOULLI, where the SAMPRATE= option specifies the constant inclusion probability.

NMIN=n

specifies the minimum stratum sample size n for the SAMPRATE= option. When you specify the SAMPRATE= option, PROC SURVEYSELECT calculates the stratum sample size by multiplying the total number of units in the stratum by the specified sampling rate. If this sample size is less than the value NMIN=n, then PROC SURVEYSELECT selects n units.

The minimum sample size n must be a positive integer. The NMIN= option is available only with the SAMPRATE= option, which can be used with equal probability selection methods (METHOD=SRS, METHOD=URS, METHOD=SYS, and METHOD=SEQ). The NMIN= option is not available with METHOD=BERNOULLI, where the SAMPRATE= option specifies the constant inclusion probability.

NOPRINT

suppresses the display of all output. You can use the NOPRINT option when you want only to create an output data set. Note that this option temporarily disables the Output Delivery System (ODS). For more information, see Chapter 20, "Using the Output Delivery System."

OUT=SAS-data-set

names the output data set. If you omit the OUT= option, the data set is named DATA*n*, where n is the smallest integer that makes the name unique. If you request sample selection by specifying the METHOD= option, the output data set contains the observations that are selected for the sample. If you request sample allocation without sample selection by specifying the ALLOC= and NOSAMPLE options in the STRATA statement, the output data set contains the allocated sample sizes. If you request random assignment by specifying the GROUPS= option, the output data set contains all observations in the input data set together with their assigned group identification.

When PROC SURVEYSELECT selects a sample, the output data set contains the units that are selected, sample design information, and selection statistics. You can specify options that control the information

to include in the output data set. For more information, see the descriptions of the following options: JTPROBS, OUTALL, OUTHITS, OUTSEED, OUTSIZE, and STATS. For more information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

By default, the sample output data set contains only those units that are selected for the sample. To include all observations from the input data set in the output data set, use the OUTALL option.

By default, the sample output data set includes one copy of each selected unit, even when a unit is selected more than once, which can occur when you use with-replacement or with-minimum-replacement selection methods. For with-replacement or with-minimum-replacement selection methods, the output data set includes a variable NumberHits that records the number of hits (selections) for each unit. To include a distinct copy of each selection in the output data set when the same unit is selected more than once, use the OUTHITS option.

When you specify the ALLOC= and NOSAMPLE options in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata but does not select a sample. In this case, the OUT= data set contains the allocated sample sizes. For more information, see the section "Allocation Output Data Set" on page 8502.

When you specify the GROUPS= option, PROC SURVEYSELECT randomly assigns observations to groups; it does not select a sample. In this case, the OUT= data set contains all observations from the input data set and includes a variable named GroupID that identifies group assignments. For more information, see the section "Random Assignment Output Data Set" on page 8503.

OUTALL

includes all observations from the DATA= input data set in the OUT= output data set. By default, the output data set includes only those units selected for the sample. When you specify the OUTALL option, the output data set includes all observations from the input data set and also contains a variable that indicates each observation's selection status. The variable Selected equals 1 for an observation that is selected for the sample, and equals 0 for an observation that is not selected. For information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

The OUTALL option is available for equal probability selection methods (METHOD=SRS, METHOD=URS, METHOD=SYS, METHOD=SEQ, and METHOD=BERNOULLI). The OUTALL option is also available for METHOD=POISSON.

OUTHITS

includes a distinct copy of each selected unit in the OUT= output data set when the same sampling unit is selected more than once. By default, the output data set contains a single copy of each unit selected, even when a unit is selected more than once, and the variable NumberHits records the number of hits (selections) for each unit. If you specify the OUTHITS option, the output data set contains m copies of a sampling unit for which NumberHits equals m. For example, with the OUTHITS option a unit that is selected three times is represented by three copies in the output data set.

A sampling unit can be selected more than once by with-replacement and with-minimum-replacement selection methods, which include METHOD=URS, METHOD=PPS_WR, METHOD=PPS_SYS, and METHOD=PPS_SEQ. The OUTHITS option is available for these selection methods.

See the section "Sample Output Data Set" on page 8498 for details about the contents of the output data set.

OUTSEED

includes the initial seed for each stratum in the OUT= output data set. The variable InitialSeed contains the stratum initial seeds. See the section "Sample Output Data Set" on page 8498 for details about the contents of the output data set.

To reproduce the same sample for any stratum in a subsequent execution of PROC SURVEYSELECT, you can specify the same stratum initial seed with the SEED=*SAS-data-set* option, along with the same sample selection parameters. See the section "Random Number Generation" on page 8484 for more information.

The "Sample Selection Summary" table displays the initial random number seed for the entire sample selection, which is the same as the initial seed for the first stratum when the design is stratified. To reproduce the entire sample, you can specify this same seed value in the SEED= option, along with the same sample selection parameters.

Beginning in SAS/STAT 12.1, PROC SURVEYSELECT uses the Mersenne-Twister random number generator by default. In previous releases, PROC SURVEYSELECT uses the RANUNI random number generator, which you can now request by specifying the RANUNI option. To reproduce samples that PROC SURVEYSELECT selects in releases prior to SAS/STAT 12.1, specify the RANUNI option with the SEED= option (for the same input data set and sample selection parameters).

OUTSIZE

includes additional design and sampling frame information in the OUT= output data set.

If you use a STRATA statement, the OUTSIZE option provides stratum-level values in the output data set. Otherwise, the OUTSIZE option provides overall values.

The OUTSIZE option includes the sample size or sampling rate in the output data set, depending on whether you specify the SAMPSIZE= option or the SAMPRATE= option, respectively. For PPS selection methods, the OUTSIZE option includes the total size measure in the output data set. If you do not provide size measures, or if you specify a SAMPLINGUNIT statement, the OUTSIZE option includes the total number of sampling units.

If you request size measure adjustment or certainty selection, the OUTSIZE option includes the following information in the output data set: the minimum size measure if you specify the MINSIZE= option, the maximum size measure if you specify the MAXSIZE= option, the certainty size measure if you specify the CERTSIZE= option, and the certainty proportion if you specify the CERTSIZE=P= option.

For METHOD=BERNOULLI, the OUTSIZE option includes the following information in the output data set: total number of sampling units, selection probability (sampling rate), expected sample size, and actual sample size. See the section "Bernoulli Sampling" on page 8488 for descriptions of these statistics.

For more information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

If you specify the GROUPS= option for random assignment, the OUTSIZE option adds the following information to the output data set: total number of units, number of groups, and number of units in the group. For more information, see the section "Random Assignment Output Data Set" on page 8503.

OUTSORT=*SAS-data-set*

    names an output data set to store the sorted input data set. This option is available when you specify a CONTROL statement to sort the DATA= input data set for systematic or sequential selection methods (METHOD=SYS, METHOD=PPS_SYS, METHOD=SEQ, and METHOD=PPS_SEQ).

    If you specify CONTROL variables but do not name an output data set with the OUTSORT= option, then the sorted data set replaces the input data set.

RANUNI

    requests uniform random number generation by the method of Fishman and Moore (1982), which PROC SURVEYSELECT uses in releases before SAS/STAT 12.1. This is the same random number generator that the RANUNI function provides.

    Beginning in SAS/STAT 12.1, PROC SURVEYSELECT uses the Mersenne-Twister random number generator by default. Developed by Matsumoto and Nishimura (1998), the Mersenne-Twister random number generator has a very long period and good statistical properties. This is the random number generator that the RAND function provides for the uniform distribution.

    See the section "Random Number Generation" on page 8484 for details, and see *SAS Functions and CALL Routines: Reference* for information about the RANUNI and RAND functions.

    You can specify the RANUNI option with the SEED= option to reproduce samples that PROC SURVEYSELECT selects in releases before SAS/STAT 12.1. To reproduce a sample by using the RANUNI and SEED= options, you must also specify the same input data set and sample selection parameters.

REPS=*nreps*

    specifies the number of sample replicates. The value of *nreps* must be a positive integer.

    When you specify the REPS= option, PROC SURVEYSELECT selects *nreps* independent samples, each with the same sample size or sampling rate and the same sample design that you request. The variable Replicate in the OUT= data set contains the sample replicate number.

    You can use replicated sampling to provide a simple method of variance estimation for any form of statistic, and also to evaluate variable nonsampling errors such as interviewer differences. For information about replicated sampling, see Lohr (2010); Wolter (2007); Kish (1965, 1987); Kalton (1983). You can also use the REPS= option to perform a variety of other resampling and simulation tasks. See Cassell (2007) for more information.

SAMPRATE=*value*

SAMPRATE=(*values***)**

SAMPRATE=*SAS-data-set*

RATE=*value*

RATE=(*values***)**

RATE=*SAS-data-set*

    specifies the sampling rate, which is the proportion of units to select for the sample. You can provide a single sampling rate *value* for the entire sample selection, or you can provide stratum sampling rates by specifying *values* or a *SAS-data-set*.

    The sampling rate value must be a positive number. The stratum sampling rate values and the stratum sampling rates that you provide in the *SAS-data-set* must be nonnegative numbers. You can specify a

sampling rate as a number between 0 and 1. Or you can specify a rate in percentage form as a number between 1 and 100, which PROC SURVEYSELECT converts to a proportion. The procedure treats the value 1 as 100% instead of 1%.

This option is available for equal probability selection methods (METHOD=SRS, METHOD=URS, METHOD=SYS, METHOD=SEQ, and METHOD=BERNOULLI). For systematic random sampling (METHOD=SYS), PROC SURVEYSELECT computes the selection interval as the inverse of the sampling rate. For more information, see the section "Systematic Random Sampling" on page 8486. For Bernoulli sampling (METHOD=BERNOULLI), the procedure uses the sampling rate as the inclusion probability. For more information, see the section "Bernoulli Sampling" on page 8488. For the other equal probability selection methods, PROC SURVEYSELECT converts the sampling rate to the sample size before selection by multiplying the total number of units in the stratum or data set by the sampling rate and rounding up to the nearest integer.

You cannot specify both the SAMPRATE= option and the SAMPSIZE= option.

You can provide sampling rates by specifying one of the following forms:

SAMPRATE=_value_

RATE=_value_

   specifies a single sampling rate _value_, which must be a positive number. If you request a stratified sample design by specifying the STRATA statement, PROC SURVEYSELECT uses the rate value for all strata.

SAMPRATE=(_values_**)**

RATE=(_values_**)**

   specifies a list of stratum sampling rate _values_. You can separate the values with blanks or commas, and the list of values must be enclosed in parentheses. The number of stratum sampling rate values should equal the number of strata in the input data set.

   The order of the stratum sampling rate values must match the order of the stratum groups in the DATA= input data set. When you specify a list of values, the input data set must be sorted by the STRATA variables in ascending order; you cannot use the DESCENDING or NOTSORTED option in the STRATA statement.

   The stratum sampling rate values must be nonnegative numbers. If you specify a stratum sampling rate of zero, PROC SURVEYSELECT does not select a sample from the stratum. This has the effect of subsetting the input data set before sample selection; the stratum that you omit is not included in the sampling frame or represented in the sample.

SAMPRATE=_SAS-data-set_

RATE=_SAS-data-set_

   names a _SAS-data-set_ that contains stratum sampling rates. You should provide the sampling rates in the data set variable named _RATE_. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

   This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= input data set. The order of the stratum groups in the SAMPRATE= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information,

see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

The stratum sampling rates must be nonnegative numbers. If you specify a stratum sampling rate of zero, PROC SURVEYSELECT does not select a sample from the stratum. This has the effect of subsetting the input data set before sample selection; the stratum that you omit is not included in the sampling frame or represented in the sample.

SAMPSIZE=*n*
SAMPSIZE=(*values***)**
SAMPSIZE=*SAS-data-set*
N=*n*
N=(*values***)**
N=*SAS-data-set*

specifies the sample size, which is the number of units to select for the sample. You can provide a single sample size *n* for the entire sample selection, or you can provide stratum sample sizes by specifying *values* or a *SAS-data-set*.

The value of *n* must be a positive integer. The stratum sample size values and the stratum sample sizes that you provide in the *SAS-data-set* must be nonnegative numbers. For selection methods that select without replacement, the sample size must not exceed the total number of units in the data set (or the number of units in the stratum, if you specify a STRATA statement).

This option specifies the number of sampling units to select. If you do not specify a SAMPLINGUNIT statement, PROC SURVEYSELECT defines sampling units as observations and selects the number of observations that you specify. If you specify a SAMPLINGUNIT statement, PROC SURVEYSELECT defines sampling units as groups of observations (clusters) and selects the number of clusters that you specify.

If you specify SAMPSIZE=*n* and the ALLOC= option in the STRATA statement, PROC SURVEYSELECT allocates the sample size *n* among the strata according to the allocation method that you request. For more information, see the section "Sample Size Allocation" on page 8494. You cannot specify SAMPSIZE=*values* or SAMPSIZE=*SAS-data-set* when you use the ALLOC= option. You cannot specify SAMPSIZE= with the MARGIN= option, which determines stratum sample sizes that provide the specified margin of error. For more information, see the section "Specifying the Margin of Error" on page 8495.

You cannot specify both the SAMPSIZE= option and the SAMPRATE= option.

You can provide sample size values by specifying one of the following forms:

SAMPSIZE=*n*
N=*n*

specifies a single sample size value *n*, which must be a positive integer. If you request a stratified sample design, PROC SURVEYSELECT selects *n* units from each stratum (unless you also specify the ALLOC= option in the STRATA statement, which allocates the total sample size among the strata).

For methods that select without replacement, the sample size *n* must not exceed the number of units in the stratum unless you also specify the SELECTALL option. If you specify the SELECTALL option, PROC SURVEYSELECT selects all stratum units when the stratum sample size exceeds the total number of units in the stratum.

SAMPSIZE=(*values***)**

N=(*values***)**

> specifies a list of stratum sample size *values*. You can separate the values with blanks or commas, and the list of values must be enclosed in parentheses. The number of sample size values must equal the number of strata in the input data set.
>
> The order of the stratum sample size values must match the order of the stratum groups in the DATA= input data set. When you specify a list of values, the input data set must be sorted by the STRATA variables in ascending order; you cannot use the DESCENDING or NOTSORTED option in the STRATA statement.
>
> The values of the stratum sample sizes must be nonnegative numbers. If you specify a stratum sample size of zero, PROC SURVEYSELECT does not select a sample from the stratum. This has the effect of subsetting the input data set before sample selection; the stratum that you omit is not included in the sampling frame or represented in the sample.

SAMPSIZE=*SAS-data-set*

N=*SAS-data-set*

> names a *SAS-data-set* that contains stratum sample sizes. You should provide the sample sizes in the data set variable named _NSIZE_ or SampleSize. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.
>
> This data set, which is a secondary data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= input data set. The order of the stratum groups in the SAMPSIZE= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.
>
> The stratum sample sizes must be nonnegative numbers. If you specify a stratum sample size of zero, PROC SURVEYSELECT does not select a sample from the stratum. This has the effect of subsetting the input data set before sample selection; the stratum that you omit is not included in the sampling frame or represented in the sample.

SEED < =*value* | *SAS-data-set* **>**

> specifies the initial seed for random number generation. You can provide a single seed *value* for the entire sample selection, or you can provide stratum initial seeds by specifying a *SAS-data-set*. To initialize random number generation, a seed must be a positive integer. If you do not specify this option, or if you specify an initial seed that is negative or zero, PROC SURVEYSELECT uses the time of day from the computer's clock to obtain an initial seed. For more information, see the section "Random Number Generation" on page 8484.
>
> PROC SURVEYSELECT displays the value of the initial seed in the "Sample Selection Summary" table. To reproduce the same sample in a subsequent execution of PROC SURVEYSELECT, you can specify the same initial seed in the SEED= option (for the same input data set and sample selection parameters).
>
> If you specify a STRATA statement, you can provide stratum initial seeds by specifying a *SAS-data-set*. If you do not provide stratum initial seeds, the procedure generates random numbers continuously

across strata from the random number stream that is initialized by the single seed value or by default. You can specify the OUTSEED option to include stratum initial seeds in the output data set.

Beginning in SAS/STAT 12.1, PROC SURVEYSELECT uses the Mersenne-Twister random number generator by default. In previous releases, PROC SURVEYSELECT uses the RANUNI random number generator, which you can now request by specifying the RANUNI option. To reproduce samples that PROC SURVEYSELECT selects in releases before SAS/STAT 12.1, use the RANUNI option with the SEED= option (for the same input data set and sample selection parameters).

You can provide initial seeds by specifying one of the following forms:

SEED=_value_

specifies a single initial seed _value_ for random number generation. To initialize random number generation, the value must be a positive integer.

SEED=_SAS-data-set_

names a _SAS-data-set_ that contains stratum initial seeds. You should provide the stratum initial seeds in the data set variable named _SEED_ or InitialSeed. Each observation in the data set should correspond to a stratum group, which is determined by the values of the STRATA variables.

This data set, which is a secondary input data set, must contain all stratification variables that you specify in the STRATA statement. The data set must also contain all stratum groups that appear in the DATA= input data set. The order of the stratum groups in the SEED= data set must match the order of the groups in the DATA= data set. If formats are associated with the STRATA variables, the formats must be consistent in the two data sets. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

The OUTSEED option includes the stratum initial seeds in the OUT= output data set. You can reproduce the same sample in a subsequent execution of PROC SURVEYSELECT by specifying the same stratum initial seeds (for the same input data set and sample selection parameters). If you need to reproduce the same sample for only a subset of the strata, you can use the same initial seeds for the strata in the subset.

SEED

indicates that stratum initial seeds are provided in a secondary input data set that you name in another option (for example, the SAMPSIZE=_SAS-data-set_ option). You should provide the initial seeds in the data set variable named _SEED_ or InitialSeed. For more information, see the section "Secondary Input Data Set" on page 8497. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

SELECTALL

requests that PROC SURVEYSELECT select all stratum units when the stratum sample size exceeds the total number of units in the stratum. By default, PROC SURVEYSELECT does not allow you to specify a stratum sample size that is greater than the total number of units in the stratum, unless you are using a with-replacement selection method.

The SELECTALL option is available for the following without-replacement selection methods: METHOD=SRS, METHOD=SYS, METHOD=SEQ, METHOD=PPS, and METHOD=PPS_SAMPFORD.

The SELECTALL option is not available for with-replacement selection methods, with-minimum-replacement methods, or those PPS methods that select two units per stratum.

SORT=NEST | SERP

specifies the type of sorting by CONTROL variables. The option SORT=NEST requests nested sorting, and SORT=SERP requests hierarchic serpentine sorting. The default is SORT=SERP. See the section "Sorting by CONTROL Variables" on page 8483 for descriptions of serpentine and nested sorting. Where there is only one CONTROL variable, the two types of sorting are equivalent.

The SORT= option is available when you specify a CONTROL statement for systematic or sequential selection methods (METHOD=SYS, METHOD=PPS_SYS, METHOD=SEQ, and METHOD=PPS_SEQ). When you specify a CONTROL statement, PROC SURVEYSELECT sorts the input data set by the CONTROL variables within strata before selecting the sample.

The SORT= option and the CONTROL statement are not available with a SAMPLINGUNIT statement. See the descriptions of the CONTROL and SAMPLINGUNIT statements for more information.

When you specify a CONTROL statement, you can also use the OUTSORT= option to name an output data set that contains the sorted input data set. Otherwise, if you do not specify the OUTSORT= option, the sorted data set replaces the input data set.

STATS

includes the selection probability and sampling weight in the OUT= output data set for equal probability selection methods when you do not specify a STRATA statement. By default, the output data set does not include these values for equal probability selection methods unless you specify a STRATA statement. The STATS option applies to the following selection methods: METHOD=SRS, METHOD=URS, METHOD=SYS, METHOD=SEQ, and METHOD=BERNOULLI.

In addition to the selection probability and sampling weight, the STATS option includes the following statistics in the output data set for METHOD=BERNOULLI: total number of sampling units, expected sample size, actual sample size, and adjusted sampling weight. See the section "Bernoulli Sampling" on page 8488 for more information.

For PPS selection methods, the output data set contains selection probabilities and sampling weights by default. The STATS option has no effect for PPS methods.

For more information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

CONTROL Statement

CONTROL *variables* **;**

The CONTROL statement names variables for sorting the input data set before sample selection. The CONTROL variables can be character or numeric. If you also specify a STRATA statement, PROC SURVEYSELECT sorts by CONTROL variables within strata.

Control sorting is available for systematic and sequential selection methods (METHOD=SYS, METHOD=PPS_SYS, METHOD=SEQ, and METHOD=PPS_SEQ). Ordering the sampling units before systematic or sequential selection can provide additional control over the distribution of the sample.

Control sorting is not available when you use a SAMPLINGUNIT statement, which defines groups of observations as units (clusters) for sample selection. See the description of the SAMPLINGUNIT statement for information about ordering clusters before systematic or sequential selection.

By default (or if you specify the SORT=SERP option in the PROC SURVEYSELECT statement), PROC SURVEYSELECT uses hierarchic serpentine sorting by the CONTROL variables. If you specify the SORT=NEST option, the procedure uses nested sorting. For more information about serpentine and nested sorting, see the section "Sorting by CONTROL Variables" on page 8483.

You can use the OUTSORT= option in the PROC SURVEYSELECT statement to name an output data set that contains the sorted input data set. If you do not specify the OUTSORT= option when you use the CONTROL statement, then the sorted data set replaces the input data set.

FREQ Statement

FREQ *variable* **;**

The FREQ statement names a numeric variable that contains the frequency of occurrence of each observation. If you use a FREQ statement, PROC SURVEYSELECT assumes that an observation represents n observations, where n is the value of the FREQ variable for the observation. The FREQ statement is not available when you specify a SAMPLINGUNIT statement.

The FREQ statement is available only for sample allocation when no sample is selected, which you can request by specifying the ALLOC= and NOSAMPLE options in the STRATA statement. The ALLOC= option requests allocation of the total sample size among the strata, and the NOSAMPLE option requests that no sample be selected after allocation. When you specify the NOSAMPLE option, the procedure computes stratum sample sizes according to the allocation method that you request, but does not select the sample. See the sections "Allocation Options" on page 8478 and "Sample Size Allocation" on page 8494 for details.

The sum of the FREQ variable values (frequencies) represents the total number of sampling units. The sum of the frequencies in a stratum represents the total number of sampling units in the stratum. When you use a FREQ statement, the sample size allocation is based on the expanded total and stratum frequencies.

Values of the FREQ variable must be nonmissing and nonnegative. If a value of the FREQ variable is 0, PROC SURVEYSELECT ignores the observation. If a value of the FREQ variable is not an integer, PROC SURVEYSELECT uses only the integer portion as the frequency of the observation.

ID Statement

ID *variables* **;**

The ID statement names one or more variables from the DATA= input data set to include in the OUT= output data set of selected units. If there is no ID statement, PROC SURVEYSELECT includes all variables from the input data set in the output data set. The ID variables can be either character or numeric.

SAMPLINGUNIT | CLUSTER Statement

SAMPLINGUNIT | CLUSTER *variables* < / *options* > **;**

The SAMPLINGUNIT statement names variables that identify the sampling units as groups of observations (clusters). The combinations of categories of SAMPLINGUNIT variables define the sampling units. If there is a STRATA statement, sampling units are nested within strata.

When you use a SAMPLINGUNIT statement to define units (clusters), PROC SURVEYSELECT selects a sample of these units by using the selection method and design parameters that you specify in the PROC SURVEYSELECT statement. If you do not use a SAMPLINGUNIT statement, then PROC SURVEYSELECT uses the input data set observations as sampling units by default.

The SAMPLINGUNIT variables are one or more variables in the DATA= input data set. These variables can be either character or numeric. The formatted values of the SAMPLINGUNIT variables determine the SAMPLINGUNIT variable levels. Thus, you can use formats to group values into levels. See the FORMAT procedure in the *Base SAS Procedures Guide* and the FORMAT statement and SAS formats in *SAS Formats and Informats: Reference* for more information.

You can use a SAMPLINGUNIT statement with any equal probability selection method or PPS selection method. The SAMPLINGUNIT statement is not available for Poisson sampling (METHOD=POISSON).

If you specify the PPS option in the SAMPLINGUNIT statement and do not specify a SIZE statement, then the procedure computes sampling unit size as the number of observations in the sampling unit. If you specify a SIZE statement with a SAMPLINGUNIT statement, then the procedure computes sampling unit size by summing the size measures of all observations in the sampling unit.

By default, PROC SURVEYSELECT sorts the input data set by the SAMPLINGUNIT variables within strata before sample selection. This groups the observations into sampling units and orders the sampling units by the SAMPLINGUNIT variables. If you do not want the procedure to sort the input data set by the SAMPLINGUNIT variables, then specify the PRESORTED option in the SAMPLINGUNIT statement. By using the PRESORTED option, you can provide the order of the sampling units for systematic and sequential selection methods. The CONTROL statement is not available with the SAMPLINGUNIT statement.

Note that the SAMPLINGUNIT statement defines groups of observations (clusters) to use as sampling units, and PROC SURVEYSELECT selects a sample of these units. When you use a SAMPLINGUNIT statement, PROC SURVEYSELECT does not select samples of observations from within the sampling units (clusters). To select independent samples within groups, use the STRATA statement.

You can specify the following options in the SAMPLINGUNIT statement after a slash (/):

PPS

computes a sampling unit's size measure as the number of observations in the sampling unit. The procedure then uses these size measures to select a sample according to the PPS selection method that you specify with the METHOD= option in the PROC SURVEYSELECT statement.

This option has no effect when you specify a SIZE statement. When you specify a SIZE statement, the procedure computes sampling unit size by summing the size measures of all observations that belong to the sampling unit.

PRESORTED

requests that PROC SURVEYSELECT not sort the input data set by the SAMPLINGUNIT variables within strata. By default, the procedure sorts the input data set by the SAMPLINGUNIT variables, which groups the observations into sampling units and orders the units by the SAMPLINGUNIT variables.

The PRESORTED option enables you to provide the order of the sampling units. For systematic and sequential selection methods, ordering provides additional control over the distribution of the sample and gives some benefits of proportionate stratification. Systematic and sequential methods include METHOD=SYS, METHOD=PPS_SYS, METHOD=SEQ, and METHOD=PPS_SEQ. See the descriptions of these methods in the section "Sample Selection Methods" on page 8485 for more information.

When you specify the PRESORTED option, the procedure treats the sampling unit groups as NOTSORTED. Like the BY statement option NOTSORTED, this does not mean that the data are unsorted by the SAMPLINGUNIT variables, but rather that the data are arranged in groups (according to values of the SAMPLINGUNIT variables) and that these groups are not necessarily in alphabetical or increasing numeric order. For more information about the BY statement NOTSORTED option, see *SAS Language Reference: Concepts*.

SIZE Statement

SIZE *variable* **;**

The SIZE statement names one and only one variable that contains size measures that are used for PPS selection. The SIZE variable must be numeric.

If you specify a SAMPLINGUNIT statement with a SIZE statement, the procedure computes a sampling unit's size by summing the size measures of all observations that belong to the sampling unit. Alternatively, if you specify the PPS option in the SAMPLINGUNIT statement and do not use a SIZE statement, the procedure computes sampling unit size as the number of observations in the sampling unit.

When the value of a sampling unit's size measure is missing or nonpositive, that sampling unit is excluded from the sample selection. See the section "Missing Values" on page 8483 for more information.

You can adjust the size measure values by using the MAXSIZE= option, the MINSIZE= option, or both of these options in the PROC SURVEYSELECT statement.

All PPS selection methods require size measures, which you can provide by specifying a SIZE statement (or by specifying the PPS option in the SAMPLINGUNIT statement). PPS selection methods include the following: METHOD=PPS, METHOD=PPS_BREWER, METHOD=PPS_MURTHY, METHOD=PPS_SAMPFORD, METHOD=PPS_SEQ, METHOD=PPS_SYS, and METHOD=PPS_WR. For details about how size measures are used in sample selection, see the descriptions of PPS selection methods in the section "Sample Selection Methods" on page 8485.

Note that a sampling unit's size measure, which you provide for PPS selection by specifying a SIZE statement, is not the same as the *sample size*. The sample size is the number of units to select for the sample; you specify the sample size with the SAMPSIZE= option in the PROC SURVEYSELECT statement.

For METHOD=POISSON, the variable that is specified in the SIZE statement provides inclusion probabilities for Poisson sampling. See the section "Poisson Sampling" on page 8488 for details. When the value of the SIZE variable is missing, nonpositive, or greater than 1, the sampling unit is not included in the sample selection.

STRATA Statement

> **STRATA** *variables* < / *options* > ;

The STRATA statement names variables that partition the input data set into nonoverlapping subgroups (strata). The combinations of levels of STRATA variables define the strata. PROC SURVEYSELECT then selects independent samples from these strata, according to the selection method and design parameters that you specify in the PROC SURVEYSELECT statement. For information about the use of stratification in sample design, see Lohr (2010); Kalton (1983); Kish (1965, 1987); Cochran (1977).

The STRATA variables are one or more variables in the DATA= input data set. These variables can be either character or numeric, but the procedure treats them as categorical variables. The formatted values of the STRATA variables determine the STRATA variable levels. Thus, you can use formats to group values into levels. See the FORMAT procedure in the *Base SAS Procedures Guide* and the FORMAT statement and SAS formats in *SAS Formats and Informats: Reference*.

The STRATA variables function much like BY variables, and PROC SURVEYSELECT expects the input data set to be sorted in order of the STRATA variables.

If you specify a CONTROL statement, or if you specify METHOD=PPS, the input data set must be sorted in ascending order by the STRATA variables. This means you cannot use the STRATA option NOTSORTED or DESCENDING when you specify a CONTROL statement or METHOD=PPS.

If your input data set is not sorted by the STRATA variables in ascending order, use one of the following alternatives:

- Sort the data by using the SORT procedure with the STRATA variables in a BY statement.

- Specify the NOTSORTED or DESCENDING option in the STRATA statement (when you do not specify a CONTROL statement or METHOD=PPS). The NOTSORTED option does not mean that the data are unsorted but rather that the data are arranged in groups (according to values of the STRATA variables) and that these groups are not necessarily in alphabetical or increasing numeric order.

- Create an index on the STRATA variables by using the DATASETS procedure (in Base SAS software).

For more information about BY-group processing, see the discussion in *SAS Language Reference: Concepts*. For more information about the DATASETS procedure, see the discussion in the *Base SAS Procedures Guide*.

Allocation Options

The STRATA options request allocation of the total sample size among the strata. You can use the ALLOC= option to specify the allocation method. Available allocation methods include proportional allocation (ALLOC=PROP), optimal allocation (ALLOC=OPTIMAL), and Neyman allocation (ALLOC=NEYMAN). See the section "Sample Size Allocation" on page 8494 for details about these methods.

Instead of requesting that PROC SURVEYSELECT compute the sample allocation, you can provide the allocation proportions by using the ALLOC=(*values*) option or the ALLOC=*SAS-data-set* option. Then PROC SURVEYSELECT allocates the total sample size among the strata according to the proportions that you provide. Allocation proportions are relative stratum sample sizes, n_h/n, where n_h is the stratum h sample size and n is the total sample size.

You can use the SAMPSIZE= option in the PROC SURVEYSELECT statement to specify the total sample size to be allocated among the strata. Alternatively, you can specify the desired margin of error in the MARGIN= option, and the procedure determines the stratum sample sizes that are required to achieve that margin. See the section "Specifying the Margin of Error" on page 8495 for details.

When you request sample allocation, by default PROC SURVEYSELECT computes the allocation of the total sample size among the strata and then selects the sample. If you specify the NOSAMPLE option, the procedure computes the allocation but does not select the sample. In this case the OUT= output data set contains the stratum sample sizes that are computed according to the specified allocation method. See the section "Allocation Output Data Set" on page 8502 for details.

You can use the ALLOC= option with any selection method except METHOD=PPS_BREWER and METHOD=PPS_MURTHY, which select two units from each stratum.

Table 99.2 summarizes the options available in the STRATA statement. Descriptions of the options follow in alphabetical order.

Table 99.2 STRATA Statement Options for Sample Allocation

Option	Description
ALLOC=*name*	Specifies the allocation method
ALLOC=(*values*)	Provides allocation proportions
ALLOCMIN=	Specifies the minimum sample size per stratum
ALPHA=	Specifies the confidence level
COST=	Provides stratum costs
MARGIN=	Specifies the margin of error
NOSAMPLE	Allocates but does not select the sample
STATS	Displays additional allocation statistics
VAR=	Provides stratum variances

You can specify the following options in the STRATA statement after a slash (/):

ALLOC=*name*

specifies the method for allocating the total sample size among the strata. The following values of *name* are available:

PROPORTIONAL

PROP

requests proportional allocation, which allocates the total sample size in proportion to the stratum sizes, where the stratum size is the number of sampling units in the stratum. See the section "Proportional Allocation" on page 8494 for details.

OPTIMAL

OPT

requests optimal allocation, which allocates the total sample size among the strata in proportion to stratum sizes, stratum variances, and stratum costs. See the section "Optimal Allocation" on page 8495 for more information. If you specify ALLOC=OPTIMAL, you must provide the stratum variances with the VAR=(*values*), VAR=*SAS-data-set*, or VAR option. You must provide the stratum costs with the COST=(*values*), COST=*SAS-data-set*, or COST option.

NEYMAN

requests Neyman allocation, which allocates the total sample size among the strata in proportion to the stratum sizes and variances. See the section "Neyman Allocation" on page 8495 for more information. If you specify ALLOC=NEYMAN, you must provide the stratum variances with the VAR=(*values*), VAR=*SAS-data-set*, or VAR option.

ALLOC=(*values***)**

lists stratum allocation proportion *values*. You can separate the values with blanks or commas.

Each allocation proportion specifies the percent of the total sample size to allocate to the corresponding stratum. The number of ALLOC= values must equal the number of strata in the input data set. The sum of the allocation proportions must equal 1.

Each allocation proportion must be a positive number. You can specify each value as a number between 0 and 1. Or you can specify a value in percentage form as a number between 1 and 100, which PROC SURVEYSELECT converts to a proportion. The procedure treats the value 1 as 100% instead of 1%.

List the allocation proportions in the order in which the strata appear in the input data set. If you use the ALLOC=(*values*) option, the input data set must be sorted by the STRATA variables in ascending order. You cannot use the DESCENDING or NOTSORTED option in the STRATA statement.

ALLOC=*SAS-data-set*

names a *SAS-data-set* that contains stratum allocation proportions. You should provide the stratum allocation proportions in the data set variable named _ALLOC_.

Each allocation proportion specifies the percent of the total sample size to allocate to the corresponding stratum. The sum of the allocation proportions must equal 1.

Each allocation proportion must be a positive number. You can specify the value as a number between 0 and 1. Or you can specify the value in percentage form as a number between 1 and 100, which PROC SURVEYSELECT converts to a proportion. The procedure treats the value 1 as 100% instead of 1%.

The ALLOC= data set should contain all the STRATA variables, with the same type and length as in the DATA= input data set. The STRATA groups should appear in the same order in the ALLOC= data set as in the DATA= data set. The ALLOC= data set is a secondary input data set. See the section "Secondary Input Data Set" on page 8497 for details. You can name only one secondary data set in each invocation of PROC SURVEYSELECT.

ALLOCMIN=*n*

specifies the minimum sample size to allocate to a stratum. When you specify ALLOCMIN=*n*, PROC SURVEYSELECT allocates at least *n* sampling units to each stratum. If you do not specify the ALLOCMIN= option, PROC SURVEYSELECT allocates at least one sampling unit to each stratum by default.

The minimum stratum sample size *n* must be a positive integer. The ALLOCMIN value *n* times the number of strata should not exceed the total sample size to be allocated. For without-replacement selection methods, the ALLOCMIN value should not exceed the number of sampling units in any stratum.

ALPHA=*α*

specifies the level of the confidence interval for the MARGIN= determination of stratum sample sizes. See the section "Specifying the Margin of Error" on page 8495 for details.

The value of α must be between 0 and 1; the default is 0.05. A confidence level of α produces a $100(1 - \alpha)\%$ confidence interval. The default of ALPHA=0.05 produces a 95% confidence interval.

COST

indicates that stratum costs are included in the secondary input data set. Use the COST option when you have already named the secondary input data set in another option, such as the VAR=*SAS-data-set* option. You should provide the stratum costs in the data set variable named _COST_.

A stratum cost represents the per-unit cost (the survey cost of a single unit in the stratum). Each stratum cost must be a positive number. Cost values are required if you specify the ALLOC=OPTIMAL option.

COST=(*values***)**

specifies stratum cost *values*, which are required if you specify the ALLOC=OPTIMAL option. You can separate the values with blanks or commas.

A stratum cost represents the per-unit cost (the survey cost of a single unit in the stratum). Each stratum cost must be a positive number.

The number of COST= values must equal the number of strata in the input data set. List the stratum costs in the order in which the strata appear in the input data set. If you use the COST=*values* option, the input data set must be sorted by the STRATA variables in ascending order. You cannot use the DESCENDING or NOTSORTED option in the STRATA statement.

COST=*SAS-data-set*

names a *SAS-data-set* that contains the stratum costs. You should provide the stratum costs in the data set variable named _COST_.

A stratum cost represents the per-unit cost (the survey cost of a single unit in the stratum). Each stratum cost must be a positive number. Stratum costs are required if you specify the ALLOC=OPTIMAL option.

The COST= data set should contain all the STRATA variables, with the same type and length as in the DATA= input data set. The STRATA groups should appear in the same order in the COST= data set as in the DATA= data set. The COST= data set is a secondary input data set. See the section "Secondary Input Data Set" on page 8497 for details. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

MARGIN=*value*

specifies the desired margin of error for estimating the overall mean from the stratified sample. When you specify this option, PROC SURVEYSELECT determines the stratum sample sizes required to achieve this margin *value* for the allocation method or proportions that you specify in the ALLOC= option. See the section "Specifying the Margin of Error" on page 8495 for details.

The margin value must be a positive number. When you specify this option, you must also provide the stratum variances in the VAR=(*values*), VAR=*SAS-data-set*, or VAR option.

You can use the ALPHA= option to set the level of the confidence interval that the MARGIN= computation uses. The default of ALPHA=0.05 specifies a 95% confidence interval.

You can request the MARGIN= option for any allocation method (proportional, optimal, or Neyman) or for allocation proportions that you provide (ALLOC=(*values*) or ALLOC=*SAS-data-set*). When you use the MARGIN= option, you cannot specify a total sample size in the SAMPSIZE= option in the PROC SURVEYSELECT statement.

NOSAMPLE

> requests that PROC SURVEYSELECT allocate the total sample size among the strata but not select the sample. When you specify the NOSAMPLE option, the OUT= output data set contains the stratum sample sizes that PROC SURVEYSELECT computes. See the section "Allocation Output Data Set" on page 8502 for details.

STATS

> displays statistics for the sample allocation. If you specify the MARGIN= option, the STATS option displays the expected margin of error for the allocation. See the section "Specifying the Margin of Error" on page 8495 for details. If you request ALLOC=OPTIMAL or ALLOC=NEYMAN without the MARGIN= option, the STATS option displays the expected variance, which is computed from the stratum variances that you provide and the allocated stratum sample sizes. If you request ALLOC=OPTIMAL, the STATS option also displays the total stratum cost, which is computed from the stratum costs that you provide and the allocated stratum sample sizes.

VAR

> indicates that stratum variances are included in the secondary input data set. Use the VAR option when you have already named the secondary input data set in another option, such as the COST=*SAS-data-set* option. You should provide the stratum variances in the data set variable named _VAR_.

> Each stratum variance must be a positive number. Stratum variances are required if you specify the ALLOC=OPTIMAL, ALLOC=NEYMAN, or MARGIN= option.

VAR=(*values***)**

> lists stratum variance *values*, which are required if you specify the ALLOC=OPTIMAL, ALLOC=NEYMAN, or MARGIN= option. You can separate the values with blanks or commas.

> Each stratum variance must be a positive number. The number of VAR= values must equal the number of strata in the input data set. List the stratum variances in the order in which the strata appear in the input data set. If you use the VAR=(*values*) option, the input data set must be sorted by the STRATA variables in ascending order. You cannot use the DESCENDING or NOTSORTED option in the STRATA statement.

VAR=*SAS-data-set*

> names a *SAS-data-set* that contains the stratum variances. You provide the stratum variances in the VAR= data set variable _VAR_.

> Each stratum variance must be a positive number. Stratum variances are required if you specify the ALLOC=OPTIMAL, ALLOC=NEYMAN, or MARGIN= option.

> The VAR= data set should contain all the STRATA variables, with the same type and length as in the DATA= input data set. The STRATA groups should appear in the same order in the VAR= data set as in the DATA= data set. The VAR= data set is a secondary input data set. See the section "Secondary Input Data Set" on page 8497 for details. You can name only one secondary input data set in each invocation of PROC SURVEYSELECT.

Details: SURVEYSELECT Procedure

Missing Values

PROC SURVEYSELECT treats missing values of STRATA and SAMPLINGUNIT variables like any other STRATA or SAMPLINGUNIT variable value. The missing values form a separate, valid variable level.

When you use a FREQ statement for sample size allocation, all values of the frequency variable must be nonmissing. If there is a missing or nonpositive frequency, PROC SURVEYSELECT does not perform the allocation.

When you specify a SIZE variable, any sampling units that have missing or nonpositive size measures are excluded from the sample selection. The procedure provides a log note that reports the number of observations omitted due to missing or nonpositive size measures.

If you do not use a SAMPLINGUNIT statement with the SIZE statement, your sampling units are input data set observations, and observations that have missing or nonpositive size measures are excluded from the sample selection. If you do use a SAMPLINGUNIT statement with the SIZE statement, the procedure computes sampling unit size by summing the size measures of all observations in the unit. When summing the observation size measures, the procedure omits any observations that have missing or nonpositive size measures. If the size of an entire sampling unit is missing or nonpositive, the procedure excludes that unit from the sample selection. When a sampling unit is selected, the output data set includes all observations that belong to the selected unit, regardless of whether an observation's size measure is missing.

If you provide stratum-level design or allocation information in a secondary input data set, the variable values should be nonmissing. For example, if a stratum value of _NSIZE_ (or SampleSize) in the SAMPSIZE= secondary input data set is missing or negative, PROC SURVEYSELECT cannot select a sample from the stratum. The procedure gives an error message and skips the stratum. Similarly, if other secondary data set variables have missing values for a stratum, a sample cannot be selected from the stratum. These variables include _NRATE_, _MINSIZE_, _MAXSIZE_, _CERTSIZE_, and _CERTP_. Additionally, if any of the sample allocation variables in the secondary input data set have missing or nonpositive values, PROC SURVEYSELECT cannot compute the sample allocation. Variables that provide information for allocation include _ALLOC_, _VAR_, and _COST_. See the section "Secondary Input Data Set" on page 8497 for details.

Sorting by CONTROL Variables

If you specify a CONTROL statement, PROC SURVEYSELECT sorts the input data set by the CONTROL variables before selecting the sample. If you also specify a STRATA statement, the procedure sorts by CONTROL variables within strata. Sorting by CONTROL variables is available for systematic and sequential selection methods, which include METHOD=SYS, METHOD=PPS_SYS, METHOD=SEQ, and METHOD=PPS_SEQ. Sorting provides additional control over the distribution of the sample and gives some benefits of proportionate stratification.

Control sorting is not available when you use a SAMPLINGUNIT statement, which defines groups of observations as units (clusters) for sample selection. See the description of the SAMPLINGUNIT statement for information about ordering clusters before systematic or sequential selection.

When you specify a CONTROL statement, the sorted data set replaces the input data set by default. Alternatively, you can use the OUTSORT= option to name an output data set that contains the sorted input data set.

PROC SURVEYSELECT provides two types of sorting: hierarchic serpentine sorting and nested sorting. By default (or if you specify the SORT=SERP option), the procedure uses serpentine sorting. If you specify the SORT=NEST option, then the procedure sorts by the CONTROL variables according to nested sorting. These two types of sorting are equivalent when there is only one CONTROL variable.

If you request nested sorting, PROC SURVEYSELECT sorts observations in the same order as PROC SORT does for an ascending sort by the CONTROL variables. See the chapter "The SORT Procedure" in the *Base SAS Procedures Guide* for more information. PROC SURVEYSELECT sorts within strata if you also specify a STRATA statement. The procedure first arranges the input observations in ascending order of the first CONTROL variable. Then within each level of the first control variable, the procedure arranges the observations in ascending order of the second CONTROL variable. This continues for all CONTROL variables that are specified.

In hierarchic serpentine sorting, PROC SURVEYSELECT sorts by the first CONTROL variable in ascending order. Then within the first level of the first CONTROL variable, the procedure sorts by the second CONTROL variable in ascending order. Within the second level of the first CONTROL variable, the procedure sorts by the second CONTROL variable in descending order. Sorting by the second CONTROL variable continues to alternate between ascending and descending sorting throughout all levels of the first CONTROL variable. If there is a third CONTROL variable, the procedure sorts by that variable within levels formed from the first two CONTROL variables, again alternating between ascending and descending sorting. This continues for all CONTROL variables that are specified. This sorting algorithm minimizes the change from one observation to the next with respect to the CONTROL variable values, thus making nearby observations more similar. For more information about serpentine sorting, see Chromy (1979) and Williams and Chromy (1980).

Random Number Generation

The probability sampling methods provided by PROC SURVEYSELECT use random numbers in their selection algorithms, as described in the following sections and in the references cited. PROC SURVEYSELECT uses a uniform random number function to generate streams of pseudo-random numbers from an initial starting point, or *seed*. You can use the SEED= option to specify the initial seed. If you do not specify the SEED= option, PROC SURVEYSELECT uses the time of day from the computer's clock to obtain the initial seed. See the description of the SEED= option for details about specifying initial seeds for strata, storing stratum seeds in the output data set, and reproducing samples.

Beginning in SAS/STAT 12.1, PROC SURVEYSELECT uses the Mersenne-Twister random number generator by default. The Mersenne-Twister generator (Matsumoto and Nishimura 1998) has a very long period ($2^{19937} - 1$) and very good statistical properties. The algorithm is a twisted generalized feedback shift register. This is the same random number generator that the RAND function provides for the uniform distribution. See *SAS Functions and CALL Routines: Reference* for more information.

In previous releases, PROC SURVEYSELECT uses the RANUNI random number generator, which you can now request by specifying the RANUNI option. This uniform random number generator is based on the method of Fishman and Moore (1982), which uses a prime modulus multiplicative generator with modulus 2^{31} and multiplier 397,204,094. This is the same uniform random number generator that the RANUNI

function provides. For more information about the RANUNI function, see *SAS Functions and CALL Routines: Reference*.

To reproduce samples that PROC SURVEYSELECT selects in releases before SAS/STAT 12.1, you can use the RANUNI option with the SEED= option (for the same input data set and selection parameters).

Sample Selection Methods

PROC SURVEYSELECT provides a variety of methods for selecting probability-based random samples. With probability sampling, each unit in the survey population has a known, positive probability of selection. This property of probability sampling avoids selection bias and enables you to use statistical theory to make valid inferences from the sample to the survey population. For more information about probability sampling, see Lohr (2010); Kish (1965, 1987); Kalton (1983); Cochran (1977).

In equal probability sampling, each unit in the sampling frame, or in a stratum, has the same probability of being selected for the sample. PROC SURVEYSELECT provides the following methods that select units with equal probability: simple random sampling, unrestricted random sampling, systematic random sampling, sequential random sampling, and Bernoulli sampling. In simple random sampling, units are selected *without replacement*, which means that a unit cannot be selected more than once. Both systematic and sequential equal probability sampling are also without replacement. In unrestricted random sampling, units are selected *with replacement*, which means that a unit can be selected more than once. In with-replacement sampling, the *number of hits* refers to the number of times a unit is selected.

In probability proportional to size (PPS) sampling, a unit's selection probability is proportional to its size measure. PROC SURVEYSELECT provides the following methods that select units with probability proportional to size (PPS): PPS sampling without replacement, PPS sampling with replacement, PPS systematic sampling, PPS sequential sampling, Brewer's method, Murthy's method, and Sampford's method. PPS sampling is often used in cluster sampling, where you select clusters (or groups of sampling units) of varying size in the first stage of selection. For example, clusters might be schools, hospitals, or geographical areas, and the final sampling units might be students, patients, or citizens. Cluster sampling can provide efficiencies in frame construction and other survey operations. For more information, see Lohr (2010); Kalton (1983); Kish (1965), in addition to the other references cited in the following sections.

The following sections give detailed descriptions of the sample selection methods available in PROC SURVEYSELECT. In these sections, n_h denotes the sample size (the number of units in the sample) for stratum h, and N_h denotes the population size (number of units in the population) for stratum h, for $h = 1, 2, \ldots, H$. When the sample design is not stratified, n denotes the sample size, and N denotes the population size. For PPS sampling, M_{hi} represents the size measure for unit i in stratum h, M_h. is the total of all size measures for the population of stratum h, and $Z_{hi} = M_{hi}/M_h$. is the relative size of unit i in stratum h.

Simple Random Sampling

The method of simple random sampling (METHOD=SRS) selects units with equal probability and without replacement. Each possible sample of n different units out of N has the same probability of being selected. The selection probability for each individual unit equals n/N. When you request stratified sampling with a STRATA statement, PROC SURVEYSELECT selects samples independently within strata. The selection probability for a unit in stratum h equals n_h/N_h for stratified simple random sampling.

By default, PROC SURVEYSELECT uses Floyd's ordered hash table algorithm for simple random sampling. This algorithm is fast, efficient, and appropriate for large data sets. See Bentley and Floyd (1987) and Bentley and Knuth (1986) for details.

If there is not enough memory available for Floyd's algorithm, PROC SURVEYSELECT switches to the sequential algorithm of Fan, Muller, and Rezucha (1962), which requires less memory but might require more time to select the sample. When PROC SURVEYSELECT uses the alternative sequential algorithm, it writes a note to the log. To request the sequential algorithm, even if enough memory is available for Floyd's algorithm, you can specify METHOD=SRS2 in the PROC SURVEYSELECT statement.

Unrestricted Random Sampling

The method of unrestricted random sampling (METHOD=URS) selects units with equal probability and with replacement. Because units are selected with replacement, a unit can be selected for the sample more than once. The expected number of hits (selections) for each unit equals n/N when sampling without stratification. For stratified sampling, the expected number of hits for a unit in stratum h equals n_h/N_h. Note that the expected number of hits exceeds 1 when the sample size n is greater than the population size N.

For unrestricted random sampling, by default, the output data set contains a single copy of each unit selected, even when a unit is selected more than once, and the variable NumberHits records the number of hits (selections) for each unit. If you specify the OUTHITS option, the output data set contains m copies of a sampling unit for which NumberHits equals m. For example, with the OUTHITS option a unit that is selected three times is represented by three copies in the output data set. For information about the contents of the output data set, see the section "Sample Output Data Set" on page 8498.

Systematic Random Sampling

The method of systematic random sampling (METHOD=SYS) selects units at a fixed interval throughout the sampling frame or stratum after a random start. If you specify the sample size (or the stratum sample sizes) with the SAMPSIZE= option, PROC SURVEYSELECT uses a fractional interval to provide exactly the specified sample size. The interval equals N/n, or N_h/n_h for stratified sampling. The selection probability for each unit equals n/N, or n_h/N_h for stratified sampling. If you specify the sampling rate (or the stratum sampling rates) with the SAMPRATE= option, PROC SURVEYSELECT uses the inverse of the rate as the interval for systematic selection. The selection probability for each unit equals the specified rate.

Systematic random sampling controls the distribution of the sample by spreading it throughout the sampling frame or stratum at equal intervals, thus providing implicit stratification. You can use the CONTROL statement to order the input data set by the CONTROL variables before sample selection. If you also use a STRATA statement, PROC SURVEYSELECT sorts by the CONTROL variables within strata. If you do not specify a CONTROL statement, PROC SURVEYSELECT applies systematic selection to the observations in the order in which they appear in the input data set.

Sequential Random Sampling

If you specify the METHOD=SEQ option and do not include a SIZE statement, PROC SURVEYSELECT uses the equal probability version of Chromy's method for sequential random sampling. This method selects units sequentially with equal probability and without replacement. See Chromy (1979) and Williams and Chromy (1980) for details. See the section "PPS Sequential Sampling" on page 8491 for a description of Chromy's PPS selection method.

Sequential random sampling controls the distribution of the sample by spreading it throughout the sampling frame or stratum, thus providing implicit stratification according to the order of units in the frame or stratum. You can use the CONTROL statement to sort the input data set by the CONTROL variables before sample selection. If you also use a STRATA statement, PROC SURVEYSELECT sorts by the CONTROL variables within strata. By default (or if you specify the SORT=SERP option), the procedure uses hierarchic serpentine ordering for sorting. If you specify the SORT=NEST option, the procedure uses nested sorting. See the section "Sorting by CONTROL Variables" on page 8483 for descriptions of serpentine and nested sorting. If you do not specify a CONTROL statement, PROC SURVEYSELECT applies sequential selection to the observations in the order in which they appear in the input data set.

Following Chromy's method of sequential selection, PROC SURVEYSELECT randomly chooses a starting unit from the entire stratum (or frame, if the design is not stratified). With this unit as the first one, the procedure treats the stratum units as a closed loop. This is done so that all pairwise (joint) selection probabilities are positive and an unbiased variance estimator can be obtained. The procedure numbers units sequentially from the random start to the end of the stratum and then continues from the beginning of the stratum until all units are numbered.

Beginning with the randomly chosen starting unit, PROC SURVEYSELECT accumulates the expected number of selections (hits), where the expected number of selections $E(S_{hi})$ equals n_h/N_h for all units i in stratum h. The procedure computes

$$I_{hi} = \text{Int}\left(\sum_{j=1}^{i} E(S_{hj})\right) = \text{Int}(in_h/N_h)$$

$$F_{hi} = \text{Frac}\left(\sum_{j=1}^{i} E(S_{hj})\right) = \text{Frac}(in_h/N_h)$$

where $\text{Int}(\cdot)$ denotes the integer part of the number, and $\text{Frac}(\cdot)$ denotes the fractional part.

Considering each unit sequentially, Chromy's method determines whether unit i is selected by comparing the total number of selections for the first $(i-1)$ units,

$$T_{h(i-1)} = \sum_{j=1}^{i-1} S_{hj}$$

with the value of $I_{h(i-1)}$.

If $T_{h(i-1)} = I_{h(i-1)}$, Chromy's method determines whether or not unit i is selected as follows. If $F_{hi} = 0$ or $F_{h(i-1)} > F_{hi}$, then unit i is selected with certainty. Otherwise, unit i is selected with probability

$$(F_{hi} - F_{h(i-1)})/(1 - F_{h(i-1)})$$

If $T_{h(i-1)} = (I_{h(i-1)} + 1)$, Chromy's method determines whether or not unit i is selected as follows. If $F_{hi} = 0$ or $F_{hi} > F_{h(i-1)}$, then the unit is not selected. Otherwise, unit i is selected with probability

$$F_{hi}/F_{h(i-1)}$$

Bernoulli Sampling

Bernoulli sampling, which you request by specifying the METHOD=BERNOULLI option, is an equal probability selection method for which the total sample size is not fixed. PROC SURVEYSELECT performs an independent random selection trial for each of the N sampling units in the input data set by using the constant inclusion probability (sampling rate) that you specify. You can specify a single value of the inclusion probability π to use for all N sampling units, or you can specify separate stratum-level values of π_h to use for the N_h units in each stratum.

You provide the inclusion probability (or probabilities) by specifying the SAMPRATE= option. For stratified sampling (which you request with the STRATA statement), you can specify the same sampling rate for each stratum by using the SAMPRATE=*value* option. Or you can specify different sampling rates for different strata by using the SAMPRATE=(*values*) or SAMPRATE=*SAS-data-set* option.

In Bernoulli sampling, the sample size n (number of units selected) is not fixed; it is a random variable that has a binomial distribution with parameters N and π. The possible values of n range from 0 to N. The expected value of the sample size is πN (or $\pi_h N_h$ for stratified sampling), and the variance of the sample size is $\pi(1-\pi)N$.

For Bernoulli sampling, the selection probability is the inclusion probability that you specify by using the SAMPRATE= option. PROC SURVEYSELECT computes the sampling weight as the inverse of the selection probability, which is $1/\pi$. For Bernoulli sampling, the procedure also computes an adjusted sampling weight as the ratio of the total number of sampling units to the actual sample size, N/n (or N_h/n_h for stratified sampling). The joint selection probability for any two distinct units is π^2. See Särndal, Swensson, and Wretman (1992) for more information.

You can specify the STATS option to include the following information in the OUT= output data set for METHOD=BERNOULLI: total number of sampling units, selection probability, expected sample size, actual sample size, sampling weight, and adjusted sampling weight.

Poisson Sampling

Poisson sampling, which you request by specifying the METHOD=POISSON option, is an unequal probability sampling method for which the total sample size is not fixed. A generalization of Bernoulli sampling, Poisson sampling also consists of independent random selection trials for the N sampling units in the input data set, but the sampling units can have different inclusion probabilities. You provide inclusion probabilities for Poisson sampling in the variable that you specify in the SIZE statement.

The expected value of the sample size for Poisson sampling is $\sum_i \pi_i$, where π_i is the inclusion probability for sampling unit i. The variance of the sample size is $\sum_i \pi_i (1 - \pi_i)$.

For Poisson sampling, the selection probability for unit i is the inclusion probability π_i that you specify by using the SIZE statement. PROC SURVEYSELECT computes the sampling weight for unit i as the inverse of the selection probability, which is $1/\pi_i$. The joint selection probability for any two distinct units i and j is $\pi_i \pi_j$ for Poisson sampling. See Särndal, Swensson, and Wretman (1992) for more information.

PPS Sampling without Replacement

If you specify the METHOD=PPS option, PROC SURVEYSELECT selects units with probability proportional to size and without replacement. The selection probability for unit i in stratum h equals $n_h Z_{hi}$, where n_h is the sample size for stratum h, and Z_{hi} is the relative size of unit i in stratum h. The relative size equals $M_{hi}/M_{h\cdot}$, which is the ratio of the size measure for unit i in stratum h (M_{hi}) to the total of all size measures for stratum h ($M_{h\cdot}$).

Because selection probabilities cannot exceed 1, the relative size for each unit must not exceed $1/n_h$ for METHOD=PPS. This requirement can be expressed as $Z_{hi} \leq 1/n_h$, or equivalently, $M_{hi} \leq M_{h.}/n_h$. If your size measures do not meet this requirement, you can adjust the size measures by using the MAXSIZE= or MINSIZE= option. Or you can request certainty selection for the larger units by using the CERTSIZE= or CERTSIZE=P= option. Alternatively, you can use a selection method that does not have this relative size restriction, such as PPS with minimum replacement (METHOD=PPS_SEQ).

PROC SURVEYSELECT uses the Hanurav-Vijayan algorithm for PPS selection without replacement. Hanurav (1967) introduced this algorithm for the selection of two units per stratum, and Vijayan (1968) generalized it for the selection of more than two units. The algorithm enables computation of joint selection probabilities and provides joint selection probability values that usually ensure nonnegativity and stability of the Sen-Yates-Grundy variance estimator. For details, see Fox (1989); Golmant (1990); Watts (1991).

Notation in the remainder of this section drops the stratum subscript h for simplicity, but selection is still done independently within strata if you specify a stratified design. For a stratified design, n now denotes the sample size for the current stratum, N denotes the stratum population size, and M_i denotes the size measure for unit i in the stratum. If the design is not stratified, this notation applies to the entire sampling frame.

According to the Hanurav-Vijayan algorithm, PROC SURVEYSELECT first orders units within the stratum in ascending order by size measure, so that $M_1 \leq M_2 \leq \ldots \leq M_N$. Then the procedure selects the PPS sample of n observations as follows:

1. The procedure randomly chooses one of the integers $1, 2, \ldots, n$ with probability $\theta_1, \theta_2, \ldots, \theta_n$, where

$$\theta_i = n(Z_{N-n+i+1} - Z_{N-n+i})(T + iZ_{N-n+1})/T$$

   where $Z_j = M_j/M$ and

$$T = \sum_{j=1}^{N-n} Z_j$$

   By definition, $Z_{N+1} = 1/n$ to ensure that $\sum_{i=1}^{n} \theta_i = 1$.

2. If i is the integer selected in step 1, the procedure includes the last $(n - i)$ units of the stratum in the sample, where the units are ordered by size measure as described previously. The procedure then selects the remaining i units according to steps 3 through 6.

3. The procedure defines new normed size measures for the remaining $(N - n + i)$ stratum units that were not selected in steps 1 and 2:

$$Z_j^* = \begin{cases} Z_j/(T + iZ_{N-n+1}) & \text{for } j = 1, \ldots, N - n + 1 \\ Z_{N-n+1}/(T + iZ_{N-n+1}) & \text{for } j = N - n + 2, \ldots, N - n + i \end{cases}$$

4. The procedure selects the next unit from the first $(N - n + 1)$ stratum units with probability proportional to $a_j(1)$, where

$$a_1(1) = iZ_1^*$$
$$a_j(1) = iZ_j^* \prod_{k=1}^{j-1}(1 - (i - 1) P_k) \quad \text{for } j = 2, \ldots, N - n + 1$$

   and

$$P_k = M_k/(M_{k+1} + M_{k+2} + \cdots + M_{N-n+i})$$

5. If stratum unit j_1 is the unit selected in step 4, then the procedure selects the next unit from units $(j_1 + 1)$ through $(N - n + 2)$ with probability proportional to $a_j(2, j_1)$, where

$$a_{j_1+1}(2, j_1) = (i - 1)Z^*_{j_1+1}$$

$$a_j(2, j_1) = (i - 1)Z^*_j \prod_{k=j_1+1}^{j-1} \left(1 - (i - 2)P_k\right) \quad \text{for} \quad j = j_1 + 2, \ldots, N - n + 2$$

6. The procedure repeats step 5 until all n sample units are selected.

If you specify the JTPROBS option, PROC SURVEYSELECT computes the joint selection probabilities for all pairs of selected units in each stratum. The joint selection probability for units i and j in the stratum equals

$$P_{(ij)} = \sum_{r=1}^{n} \theta_r K_{ij}^{(r)}$$

where

$$K_{ij} = \begin{cases} 1 & N - n + r < i \le N - 1 \\ rZ_{N-n+1}/(T + rZ_{N-n+1}) & N - n < i \le N - n + r, \quad j > N - n + r \\ rZ_i/(T + rZ_{N-n+1}) & 1 \le i \le N - n, \quad j > N - n + r \\ \pi_{ij}^{(r)} & j \le N - n + r \end{cases}$$

$$\pi_{ij}^{(r)} = \frac{r(r-1)}{2} P_i Z_j \prod_{k=1}^{i-1} (1 - P_k)$$

$$P_k = M_k/(M_{k+1} + M_{k+2} + \cdots + M_{N-n+r})$$

PPS Sampling with Replacement

If you specify the METHOD=PPS_WR option, PROC SURVEYSELECT selects units with probability proportional to size and with replacement. The procedure makes n_h independent random selections from the stratum of N_h units, selecting with probability $Z_{hi} = M_{hi}/M_{h\cdot}$. Because units are selected with replacement, a unit can be selected for the sample more than once. The expected number of hits (selections) for unit i in stratum h equals $n_h Z_{hi}$. If you specify the JTPROBS option, PROC SURVEYSELECT computes the joint expected number of hits for all pairs of selected units in each stratum. The joint expected number of hits for units i and j in stratum h equals

$$P_{h(ij)} = \begin{cases} n_h(n_h - 1)Z_{hi} Z_{hj} & \text{for} \quad j \ne i \\ n_h(n_h - 1)Z_{hi} Z_{hi}/2 & \text{for} \quad j = i \end{cases}$$

PPS Systematic Sampling

If you specify the METHOD=PPS_SYS option, PROC SURVEYSELECT selects units by systematic random sampling with probability proportional to size. Systematic sampling selects units at a fixed interval throughout the stratum or sampling frame after a random start. PROC SURVEYSELECT uses a fractional interval to provide exactly the specified sample size. The interval equals $M_{h\cdot}/n_h$ for stratified sampling and M/n for sampling without stratification. Depending on the sample size and the values of the size measures, it might

be possible for a unit to be selected more than once. The expected number of hits (selections) for unit i in stratum h equals $n_h M_{hi}/M_{h.} = n_h Z_{hi}$. See Cochran (1977, pp. 265–266) and Madow (1949) for details.

Systematic random sampling controls the distribution of the sample by spreading it throughout the sampling frame or stratum at equal intervals, thus providing implicit stratification. You can use the CONTROL statement to order the input data set by the CONTROL variables before sample selection. If you also use a STRATA statement, PROC SURVEYSELECT sorts by the CONTROL variables within strata. If you do not specify a CONTROL statement, PROC SURVEYSELECT applies systematic selection to the observations in the order in which they appear in the input data set.

PPS Sequential Sampling

If you specify the METHOD=PPS_SEQ option, PROC SURVEYSELECT uses Chromy's method of sequential random sampling. See Chromy (1979) and Williams and Chromy (1980) for details. Chromy's method selects units sequentially with probability proportional to size and with minimum replacement. Selection *with minimum replacement* means that the actual number of hits for a unit can equal the integer part of the expected number of hits for that unit, or the next largest integer. This can be compared to selection *without replacement*, where each unit can be selected only once, so the number of hits can equal 0 or 1. The other alternative is selection *with replacement*, where there is no restriction on the number of hits for each unit, so the number of hits can equal $0, 1, \cdots, n_h$, where n_h is the stratum sample size.

Sequential random sampling controls the distribution of the sample by spreading it throughout the sampling frame or stratum, thus providing implicit stratification according to the order of units in the frame or stratum. You can use the CONTROL statement to sort the input data set by the CONTROL variables before sample selection. If you also use a STRATA statement, PROC SURVEYSELECT sorts by the CONTROL variables within strata. By default (or if you specify the SORT=SERP option), the procedure uses hierarchic serpentine ordering to sort the sampling frame by the CONTROL variables within strata. If you specify the SORT=NEST option, the procedure uses nested sorting. See the section "Sorting by CONTROL Variables" on page 8483 for descriptions of serpentine and nested sorting. If you do not specify a CONTROL statement, PROC SURVEYSELECT applies sequential selection to the observations in the order in which they appear in the input data set.

According to Chromy's method of sequential selection, PROC SURVEYSELECT first chooses a starting unit randomly from the entire stratum, with probability proportional to size. The procedure uses this unit as the first one and treats the stratum observations as a closed loop. This is done so that all pairwise (joint) expected number of hits are positive and an unbiased variance estimator can be obtained. The procedure numbers observations sequentially from the random start to the end of the stratum and then continues from the beginning of the stratum until all units are numbered.

Beginning with the randomly chosen starting unit, Chromy's method partitions the ordered stratum sampling frame into n_h zones of equal size. There is one selection from each zone and a total of n_h hits (selections), although fewer than n_h distinct units might be selected. Beginning with the random start, the procedure accumulates the expected number of hits and computes

$$\mathrm{E}(S_{hi}) = n_h Z_{hi}$$

$$I_{hi} = \mathrm{Int}\left(\sum_{j=1}^{i} \mathrm{E}(S_{hj})\right)$$

$$F_{hi} = \mathrm{Frac}\left(\sum_{j=1}^{i} \mathrm{E}(S_{hj})\right)$$

where $E(S_{hi})$ represents the expected number of hits for unit i in stratum h, $\text{Int}(\cdot)$ denotes the integer part of the number, and $\text{Frac}(\cdot)$ denotes the fractional part.

Considering each unit sequentially, Chromy's method determines the actual number of hits for unit i by comparing the total number of hits for the first $(i-1)$ units,

$$T_{h(i-1)} = \sum_{j=1}^{i-1} S_{hj}$$

with the value of $I_{h(i-1)}$.

If $T_{h(i-1)} = I_{h(i-1)}$, Chromy's method determines the total number of hits for the first i units as follows. If $F_{hi} = 0$ or $F_{h(i-1)} > F_{hi}$, then $T_{hi} = I_{hi}$. Otherwise, $T_{hi} = I_{hi} + 1$ with probability

$$(F_{hi} - F_{h(i-1)})/(1 - F_{h(i-1)})$$

And the number of hits for unit i equals $T_{hi} - T_{h(i-1)}$.

If $T_{h(i-1)} = (I_{h(i-1)} + 1)$, Chromy's method determines the total number of hits for the first i units as follows. If $F_{hi} = 0$, then $T_{hi} = I_{hi}$. If $F_{hi} > F_{h(i-1)}$, then $T_{hi} = I_{hi} + 1$. Otherwise, $T_{hi} = I_{hi} + 1$ with probability

$$F_{hi}/F_{h(i-1)}$$

Brewer's PPS Method

Brewer's method (METHOD=PPS_BREWER) selects two units from each stratum, with probability proportional to size and without replacement. The selection probability for unit i in stratum h equals $2M_{hi}/M_{h.} = 2Z_{hi}$. (Because selection probabilities cannot exceed 1, the relative size for each unit, Z_{hi}, must not exceed $1/2$.)

Brewer's algorithm first selects a unit with probability

$$\frac{Z_{hi}(1 - Z_{hi})}{D_h(1 - 2Z_{hi})}$$

where

$$D_h = \sum_{i=1}^{N_h} \frac{Z_{hi}(1 - Z_{hi})}{1 - 2Z_{hi}}$$

Then a second unit is selected from the remaining units with probability

$$\frac{Z_{hj}}{1 - Z_{hi}}$$

where unit i is the first unit selected. The joint selection probability for units i and j in stratum h equals

$$P_{h(ij)} = \frac{2Z_{hi}Z_{hj}}{D_h}\left(\frac{1 - Z_{hi} - Z_{hj}}{(1 - 2Z_{hi})(1 - 2Z_{hj})}\right)$$

See Cochran (1977, pp. 261–263) and Brewer (1963) for details. Brewer's method yields the same selection probabilities and joint selection probabilities as Durbin's method. See Cochran (1977) and Durbin (1967) for details.

Murthy's PPS Method

Murthy's method (METHOD=PPS_MURTHY) selects two units from each stratum, with probability proportional to size and without replacement. The selection probability for unit i in stratum h equals

$$P_{hi} = Z_{hi}\big(1 + K_h - (Z_{hi}/(1 - Z_{hi}))\big)$$

where $Z_{hi} = M_{hi}/M_{h.}$ and

$$K_h = \sum_{j=1}^{N_h} \big(Z_{hj}/(1 - Z_{hj})\big)$$

Murthy's algorithm first selects a unit with probability Z_{hi}. Then a second unit is selected from the remaining units with probability $Z_{hj}/(1 - Z_{hi})$, where unit i is the first unit selected. The joint selection probability for units i and j in stratum h equals

$$P_{h(ij)} = Z_{hi} Z_{hj} \left(\frac{2 - Z_{hi} - Z_{hj}}{(1 - Z_{hi})(1 - Z_{hj})} \right)$$

See Cochran (1977, pp. 263–265) and Murthy (1957) for details.

Sampford's PPS Method

Sampford's method (METHOD=PPS_SAMPFORD) is an extension of Brewer's method that selects more than two units from each stratum, with probability proportional to size and without replacement. The selection probability for unit i in stratum h equals $n_h M_{hi}/M_{h.} = n_h Z_{hi}$. (Because selection probabilities cannot exceed 1, the relative size for each unit, Z_{hi}, must not exceed $1/n_h$.)

Sampford's method first selects a unit from stratum h with probability Z_{hi}. Then subsequent units are selected with probability proportional to

$$\lambda_{hi} = Z_{hi} / (1 - n_h Z_{hi})$$

and with replacement. If the same unit appears more than once in the sample of size n_h, then Sampford's algorithm rejects that sample and selects a new sample. The sample is accepted if it contains n_h distinct units.

If you specify the JTPROBS option, PROC SURVEYSELECT computes the joint selection probabilities for all pairs of selected units in each stratum. The joint selection probability for units i and j in stratum h equals

$$P_{h(ij)} = K_h \lambda_{hi} \lambda_{hj} \sum_{t=2}^{n_h} \Big(\big[t - n_h (Z_{hi} + Z_{hj})\big] \, L_{h,(n_h - t)}(\bar{ij}) \Big) / n_h^{t-2}$$

where

$$K_h = 1 / \sum_{t=1}^{n_h} \big(t \, L_{h,(n_h - t)} / n_h^t\big)$$

$$L_{h,m} = \sum_{S_h(m)} \lambda_{hi_1} \lambda_{hi_2} \cdots \lambda_{hi_m}$$

and $S_h(m)$ denotes all possible samples of size m, for $m = 1, 2, \ldots, N_h$. The sum $L_{h,m}(\bar{ij})$ is defined similarly to $L_{h,m}$ but sums over all possible samples of size m that do not include units i and j. See Cochran (1977, pp. 262–263) and Sampford (1967) for details.

Sample Size Allocation

If you specify the ALLOC= option in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata according to the method that you request. PROC SURVEYSELECT provides proportional allocation (ALLOC=PROP), optimal allocation (ALLOC=OPTIMAL), and Neyman allocation (ALLOC=NEYMAN). For more information about these allocation methods, see Lohr (2010); Kish (1965); Cochran (1977). You can also directly provide the allocation proportions by using the ALLOC=(*values*) option or the ALLOC=*SAS-data-set* option. Then PROC SURVEYSELECT allocates the sample size among the strata according to the proportions that you provide. Allocation proportions are the relative stratum sample sizes, n_h/n, where n_h is the sample size for stratum h and n is the total sample size.

You can use the SAMPSIZE=*n* option in the PROC SURVEYSELECT statement to specify the total sample size to allocate among the strata. Or you can specify the desired margin of error in the MARGIN= option in the STRATA statement, and PROC SURVEYSELECT computes the stratum sample sizes necessary to achieve that margin of error for the allocation method that you request. See the section "Specifying the Margin of Error" on page 8495 for details.

Proportional Allocation

When you specify the ALLOC=PROP option in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata in proportion to the stratum sizes, where the stratum size is the number of sampling units in the stratum. The allocation proportion of the total sample size for stratum h equals

$$f_h^* = N_h/N$$

where N_h is the number of sampling units in stratum h and N is the total number of sampling units for all strata. If you specify the total sample size n in the SAMPSIZE= option in the PROC SURVEYSELECT statement, the procedure computes the target sample size for stratum h as

$$n_h^* = f_h^* \times n$$

The target sample size values, n_h^*, might not be integers, but the stratum sample sizes are required to be integers. PROC SURVEYSELECT uses a rounding algorithm to convert the n_h^* to integer values n_h and maintain the requested total sample size n. The rounding algorithm includes the restriction that all values of n_h must be at least 1, so that at least one unit is selected from each stratum. If you specify a minimum stratum sample size n_{min} in the ALLOCMIN= option in the STRATA statement, then all values of n_h are required to be at least n_{min}. For without-replacement selection methods, PROC SURVEYSELECT also requires that each stratum sample size must not exceed the total number of sampling units in the stratum, $n_h \leq N_h$. If a target stratum sample size exceeds the number of units in the stratum, PROC SURVEYSELECT allocates the maximum number of units, N_h, to the stratum, and then allocates the remaining total sample size proportionally among the remaining strata.

PROC SURVEYSELECT provides the target allocation proportions f_h^* in the output data set variable AllocProportion. The variable ActualProportion contains the actual proportions for the allocated sample sizes n_h. For stratum h, the actual proportion is computed as

$$f_h = n_h/n$$

where n_h is the allocated sample size for stratum h and n is the total sample size. The actual proportions f_h can differ from the target allocation proportions f_h^* due to rounding, the requirement that $n_h \geq 1$ (or $n_h \geq n_{min}$), and the requirement that $n_h \leq N_h$ for without-replacement selection methods.

Optimal Allocation

When you specify the ALLOC=OPTIMAL option in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata in proportion to stratum sizes, stratum costs, and stratum variances. You provide the stratum costs and variances by using the COST= and VAR= options, respectively.

Optimal allocation minimizes the overall variance for a specified cost, or equivalently minimizes the overall cost for a specified variance. For details, see Lohr (2010); Cochran (1977); Kish (1965). For optimal allocation, PROC SURVEYSELECT computes the proportion of the total sample size for stratum h as

$$f_h^* = \frac{N_h S_h}{\sqrt{C_h}} \Big/ \sum_{i=1}^{H} \frac{N_i S_i}{\sqrt{C_i}}$$

where N_h is the number of sampling units in stratum h, S_h is the standard deviation within stratum h, C_h is the unit cost within stratum h, and H is the total number of strata.

If you specify the total sample size n in the SAMPSIZE= option in the PROC SURVEYSELECT statement, the procedure computes the target sample size for stratum h as

$$n_h^* = f_h^* \times n$$

As described in the section "Proportional Allocation" on page 8494, the values of n_h^* are converted to integer sample sizes n_h by using a rounding algorithm that requires the sum of the stratum sample sizes to equal n. The final stratum sample sizes n_h are also required to be at least 1, or at least n_{min} if you specify a minimum stratum sample size in the ALLOCMIN= option in the STRATA statement. For without-replacement selection methods, the final sample sizes cannot exceed the stratum sizes.

Neyman Allocation

When you specify the ALLOC=NEYMAN option in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata in proportion to stratum sizes and stratum variances. Neyman allocation is a special case of optimal allocation (described in the section "Optimal Allocation" on page 8495), where the costs per unit are the same for all strata. For Neyman allocation, the proportion of the total sample size for stratum h is computed as

$$f_h^* = N_h S_h \Big/ \sum_{i=1}^{H} N_i S_i$$

If you specify the total sample size n in the SAMPSIZE= option in the PROC SURVEYSELECT statement, the procedure computes the target sample size for stratum h as $n_h^* = f_h^* \times n$. The n_h^* are converted to integer sample sizes n_h by using a rounding algorithm that requires the sum of the stratum sizes to equal n. The final sample sizes n_h are required to be at least 1, or at least n_{min} if you specify a minimum sample size in the ALLOCMIN= option in the STRATA statement. For without-replacement selection methods, the final sample sizes must not exceed the stratum sizes.

Specifying the Margin of Error

Instead of specifying the total sample size to allocate among the strata, you can specify the desired margin of error for estimating the overall mean from the stratified sample. Based on the requested allocation method and the stratum variances that you provide, PROC SURVEYSELECT computes the stratum sample sizes that

are required to achieve this margin of error. You specify the margin of error in the MARGIN= option in the STRATA statement, and you provide stratum variances in the VAR= option. You can use the MARGIN= option with any allocation method (proportional, optimal, or Neyman) or with allocation proportions that you provide (ALLOC=(*values*) or ALLOC=*SAS-data-set*).

The margin of error e is the half-width of the $100(1 - \alpha)\%$ confidence interval for the overall mean based on the stratified sample,

$$e = z_{\alpha/2} \times \sqrt{\mathrm{Var}(\bar{y}_{str})}$$

where $\mathrm{Var}(\bar{y}_{str})$ is the variance of the estimate of the mean from the stratified sample and $z_{\alpha/2}$ is the $100(1 - \alpha/2)$ percentile of the standard normal distribution. You can specify the value of α in the ALPHA= option in the STRATA statement. By default, PROC SURVEYSELECT uses a 95% confidence interval (ALPHA=0.05).

For the specified margin of error e, PROC SURVEYSELECT computes the target stratum sample sizes n_h^* for without-replacement selection methods as

$$n_h^* = f_h^* \left(\sum_{i=1}^{H} N_i^2 S_i^2 / f_i^* \right) \Big/ \left((eN/z_{\alpha/2})^2 + \sum_{i=1}^{H} N_i S_i^2 \right)$$

where N_i is the number of sampling units in stratum i, S_i^2 is the variance within stratum i, N is the total number of sampling units for all strata, and H is the total number of strata.

The values of f_h^* are the stratum allocation proportions, which PROC SURVEYSELECT computes according to the allocation method that you request. See the sections "Proportional Allocation" on page 8494, "Optimal Allocation" on page 8495, and "Neyman Allocation" on page 8495 for details.

For with-replacement selection methods, PROC SURVEYSELECT computes the target stratum sample sizes as

$$n_h^* = f_h^* \left(\sum_{i=1}^{H} N_i^2 S_i^2 / f_i^* \right) \Big/ \left(eN/z_{\alpha/2} \right)^2$$

See Lohr (2010, p. 91), Cochran (1977, Chapter 5), and Arkin (1984, Chapter 10) for more information.

The target sample size values n_h^* might not be integers, but the stratum sample sizes are required to be integers. PROC SURVEYSELECT rounds all fractional target sample sizes up to integer sample sizes. If you specify a minimum stratum sample size n_{min} in the ALLOCMIN= option in the STRATA statement, then all stratum sample sizes n_h are required to be at least n_{min}.

For without-replacement selection methods, a stratum sample size cannot exceed the number of units in the stratum. If a target stratum sample size does exceed the number of units in the stratum, the procedure sets $n_h = N_h$ for that stratum, removes the stratum from the variance computation (because it contributes nothing to the sampling error), revises the allocation proportions f_h^* for the remaining strata, and computes the stratum sample sizes again. If a stratum sample size equals the number of units in its stratum, the procedure also removes that stratum from the variance computation and revises the sample sizes for the remaining strata. See Cochran (1977, p. 104) and Arkin (1984, p. 176) for details.

When you specify the STATS option with the MARGIN= option in the STRATA statement, PROC SURVEYSELECT displays the expected margin of error for the sample allocation. The expected margin of error (for the overall mean based on the stratified sample) is computed from the stratum sizes (N_i), the stratum variances that you provide (S_i^2), and the allocated stratum sample sizes that the procedure computes (n_i). For without-replacement selection methods, the expected margin of error is

$$e = z_{\alpha/2} \times \frac{1}{N} \sqrt{\sum_{i=1}^{H} \frac{N_i^2 S_i^2}{n_i} \left(1 - \frac{n_i}{N}\right)}$$

For with-replacement selection methods, the expected margin of error is

$$e = z_{\alpha/2} \times \frac{1}{N} \sqrt{\sum_{i=1}^{H} \frac{N_i^2 S_i^2}{n_i}}$$

The expected margin of error should be less than or equal to the value specified in the MARGIN= option. Any difference between the expected margin and the specified value is due to rounding the target stratum sample sizes up to integer values and increasing stratum sample sizes to equal the required minimum value (ALLOCMIN=).

Secondary Input Data Set

The primary input data set for PROC SURVEYSELECT is the DATA= data set, which contains the list of units from which the sample is selected. You can use a secondary input data set to provide stratum-level design and selection information, such as sample sizes or rates, certainty size values, or stratum costs. This secondary input data set is sometimes called the SAMPSIZE= input data set. You can provide stratum sample sizes in the _NSIZE_ (or SampleSize) variable in the SAMPSIZE= data set.

The secondary input data set must contain all the STRATA variables, with the same type and length as in the DATA= data set. The STRATA groups should appear in the same order in the secondary data set as in the DATA= data set. You can name only one secondary data set in each invocation of PROC SURVEYSELECT.

You must name the secondary input data set in the appropriate PROC SURVEYSELECT or STRATA option, and use the designated variable name to provide the stratum-level values. For example, if you want to provide stratum-level costs for sample allocation, you name the secondary data set in the COST=*SAS-data-set* option in the STRATA statement. The data set must include the stratum costs in a variable named _COST_. You can use the secondary input data set for more than one option if it is appropriate for your design. For example, the secondary data set can include both stratum costs and stratum variances, which are required for optimal allocation (ALLOC=OPTIMAL).

Instead of using a separate secondary input data set, you can include secondary information in the DATA= data set along with the sampling frame. When you include secondary information in the DATA= data set, name the DATA= data set in the appropriate options, and include the required variables in the DATA= data set.

Table 99.3 lists the available secondary data set variables, together with their descriptions and the corresponding options.

Table 99.3 PROC SURVEYSELECT Secondary Data Set Variables

Variable	Description	Statement	Option
ALLOC	Allocation proportion	STRATA	ALLOC=
CERTP	Certainty proportion	PROC	CERTSIZE=P=
CERTSIZE	Certainty size	PROC	CERTSIZE=
COST	Cost	STRATA	COST=
MAXSIZE	Maximum size	PROC	MAXSIZE=
MINSIZE	Minimum size	PROC	MINSIZE=
NSIZE	Sample size	PROC	SAMPSIZE=
RATE	Sampling rate	PROC	SAMPRATE=
SEED	Random number seed	PROC	SEED=
VAR	Variance	STRATA	VAR=

Sample Output Data Set

PROC SURVEYSELECT selects a sample and creates a SAS data set that contains the sample of selected units unless you specify the NOSAMPLE option in the STRATA statement or the GROUPS= option in the PROC SURVEYSELECT statement. When you specify the NOSAMPLE option, PROC SURVEYSELECT allocates the total sample size among strata but does not select a sample; the output data set contains the allocated sample sizes. For more information, see the section "Allocation Output Data Set" on page 8502. When you specify the GROUPS= option, PROC SURVEYSELECT randomly assigns observations to groups and does not select a sample. For more information, see the section "Random Assignment Output Data Set" on page 8503.

You can specify the name of the sample output data set in the OUT= option in the PROC SURVEYSELECT statement. If you omit the OUT= option, the data set is named DATA*n*, where *n* is the smallest integer that makes the name unique.

The output data set contains the units that are selected for the sample. These units are either observations or groups of observations (clusters) that you define by specifying the SAMPLINGUNIT statement. If you do not specify the SAMPLINGUNIT statement to define units (clusters), then PROC SURVEYSELECT uses observations as sampling units by default.

By default, the output data set contains only those units that are selected for the sample. But if you specify the OUTALL option, the output data set includes all observations from the input data set and also contains a variable that indicates each observation's selection status. The variable Selected equals 1 for an observation selected for the sample, and equals 0 for an observation not selected. The OUTALL option is available for equal probability selection methods.

By default, the output data set contains a single copy of each selected unit, even if the unit is selected more than once, and the variable NumberHits records the number of hits (selections) for each unit. A unit can be selected more than once if you use a with-replacement or with-minimum-replacement selection method (METHOD=URS, METHOD=PPS_WR, METHOD=PPS_SYS, or METHOD=PPS_SEQ). If you specify the OUTHITS option, the output data set includes a distinct copy of each selected unit in the output data set. For example, with the OUTHITS option a unit that is selected three times is represented by three copies in the output data set.

The output data set also contains design information and selection statistics, depending on the selection method and output options you specify. The output data set can include the following variables:

- Selected, which indicates whether or not the observation is selected for the sample. This variable is included if you specify the OUTALL option. Selected equals 1 for an observation that is selected for the sample, or 0 for an observation that is not selected.

- STRATA variables, which you specify in the STRATA statement.

- Replicate, which is the sample replicate number. This variable is included when you request replicated sampling with the REPS= option.

- SAMPLINGUNIT (CLUSTER) variables, which you specify in the SAMPLINGUNIT statement.

- ID variables, which you name in the ID statement.

- CONTROL variables, which you specify in the CONTROL statement.

- Zone, which is the selection zone. This variable is included for METHOD=PPS_SEQ.

- SIZE variable, which you specify in the SIZE statement.

- AdjustedSize, which is the adjusted size measure. This variable is included if you request adjusted sizes with the MINSIZE= or MAXSIZE= option when your sampling units are observations.

- UnitSize, which is the sampling unit (or cluster) size measure. This variable is included if you specify the SAMPLINGUNIT statement.

- Certain, which indicates certainty selection. This variable is included if you specify the CERTSIZE= or CERTSIZE=P= option. Certain equals 1 for units that are included with certainty because their size measures exceed the certainty size value or the certainty proportion; otherwise, Certain equals 0.

- NumberHits, which is the number of hits (selections). This variable is included for selection methods that are with replacement or with minimum replacement (METHOD=URS, METHOD=PPS_WR, METHOD=PPS_SYS, and METHOD=PPS_SEQ).

The output data set includes the following variables if you request a PPS selection method or if you specify the STATS option in the PROC SURVEYSELECT statement for other methods:

- ExpectedHits, which is the expected number of hits (selections). This variable is included for selection methods that are with replacement or with minimum replacement, where the same unit can be selected more than once (METHOD=URS, METHOD=PPS_WR, METHOD=PPS_SYS, and METHOD=PPS_SEQ).

- SelectionProb, which is the probability of selection. This variable is included for selection methods that are without replacement.

- SamplingWeight, which is the sampling weight. This variable equals the inverse of ExpectedHits or SelectionProb.

If you specify the STATS or OUTSIZE option for METHOD=BERNOULLI, the output data set contains the following variables. If you specify a STRATA statement, the output data set includes stratum-level values of these variables; otherwise, the output data set includes overall values.

- Total, which is the total number of sampling units

- SelectionProb, which is the selection probability that you specify by using the SAMPRATE= option

- ExpectedN, which is the expected value of the sample size

- SampleSize, which is the actual sample size

If you specify the STATS option for METHOD=BERNOULLI, the output data set also contains the following variable:

- AdjSamplingWeight, which is the adjusted sampling weight

For METHOD=PPS_BREWER and METHOD=PPS_MURTHY, either of which selects two units from each stratum with probability proportional to size, the output data set contains the following variable:

- JtSelectionProb, which is the joint probability of selection for the two units selected from the stratum.

If you specify the JTPROBS option to compute joint probabilities of selection for METHOD=PPS or METHOD=PPS_SAMPFORD, then the output data set contains the following variables:

- Unit, which is an identification variable that numbers the selected units sequentially within each stratum.

- JtProb_1, JtProb_2, JtProb_3, ..., where the variable JtProb_1 contains the joint probability of selection for the current unit and unit 1. Similarly, JtProb_2 contains the joint probability of selection for the current unit and unit 2, and so on.

If you specify the JTPROBS option for METHOD=PPS_WR, then the output data set contains the following variables:

- Unit, which is an identification variable that numbers the selected units sequentially within each stratum.

- JtHits_1, JtHits_2, JtHits_3, ..., where the variable JtHits_1 contains the joint expected number of hits for the current unit and unit 1. Similarly, JtHits_2 contains the joint expected number of hits for the current unit and unit 2, and so on.

If you specify the OUTSIZE option, the output data set contains the following variables. If you specify a STRATA statement, the output data set includes stratum-level values of these variables; otherwise, the output data set includes overall values.

- MinimumSize, which is the minimum size measure specified with the MINSIZE= option. This variable is included if you specify the MINSIZE= option.

- MaximumSize, which is the maximum size measure specified with the MAXSIZE= option. This variable is included if you specify the MAXSIZE= option.

- CertaintySize, which is the certainty size measure specified with the CERTSIZE= option. This variable is included if you specify the CERTSIZE= option.

- CertaintyProp, which is the certainty proportion specified with the CERTSIZE=P= option. This variable is included if you specify the CERTSIZE=P= option.

- Total, which is the total number of sampling units in the stratum. This variable is included if there is no SIZE statement, or if you specify a SAMPLINGUNIT statement.

- TotalSize, which is the total of size measures in the stratum. This variable is included if there is a SIZE statement, or if you specify the PPS option in the SAMPLINGUNIT statement.

- TotalAdjSize, which is the total of adjusted size measures in the stratum. This variable is included if you request adjusted sizes with the MAXSIZE= or MINSIZE= option.

- SamplingRate, which is the sampling rate. This variable is included if you specify the SAMPRATE= option.

- SampleSize, which is the sample size. This variable is included if you specify the SAMPSIZE= option, or if you specify METHOD=PPS_BREWER or METHOD=PPS_MURTHY, either of which selects two units from each stratum.

- Interval, which is the specified systematic interval. This variable is included if you specify the INTERVAL= option for METHOD=SYS or METHOD=PPS_SYS.

- NCertain, which is the number of certainty units. This variable is included if you specify the CERTSIZE= or CERTSIZE=P= option and CERTUNITS=OUTPUT.

If you specify the OUTSEED option, the output data set contains the following variable:

- InitialSeed, which is the initial seed for the stratum.

If you specify the ALLOC= option in the STRATA statement, the output data set contains the following variables:

- Total, which is the total number of sampling units in the stratum.

- Variance, which is the stratum variance. This variable is included if you specify the VAR, VAR=(*values*), or VAR=*SAS-data-set* option for the ALLOC=OPTIMAL, ALLOC=NEYMAN, or MARGIN= allocation option.

- Cost, which is the stratum cost. This variable is included if you specify the COST, COST=(*values*), or COST=*SAS-data-set* option for ALLOC=OPTIMAL.

- AllocProportion, which is the target allocation proportion (the proportion of the total sample size to allocate to the stratum). PROC SURVEYSELECT computes this proportion by using the specified allocation method.

- SampleSize, which is the sample size allocated to the stratum.

- ActualProportion, which is the actual proportion allocated to the stratum. The value of ActualProportion equals the allocated stratum sample size divided by the total sample size. This value can differ from the target AllocProportion due to rounding and other restrictions. See the section "Sample Size Allocation" on page 8494 for details.

Allocation Output Data Set

When you specify the NOSAMPLE option in the STRATA statement, PROC SURVEYSELECT allocates the total sample size among the strata but does not select the sample. In this case, the OUT= data set contains the allocated sample sizes.

You can specify the name of the allocation output data set with the OUT= option in the PROC SURVEYSELECT statement. If you omit the OUT= option, the data set is named DATA*n*, where *n* is the smallest integer that makes the name unique.

The allocation output data set contains one observation for each stratum. The data set can include the following variables:

- STRATA variables, which you specify in the STRATA statement.

- Total, which is the total number of sampling units in the stratum.

- Variance, which is the stratum variance. This variable is included if you specify the VAR, VAR=(*values*), or VAR=*SAS-data-set* option for the ALLOC=OPTIMAL, ALLOC=NEYMAN, or MARGIN= allocation option.

- Cost, which is the stratum cost. This variable is included if you specify the COST, COST=(*values*), or COST=*SAS-data-set* option for ALLOC=OPTIMAL.

- AllocProportion, which is the target allocation proportion (the proportion of the total sample size to allocate to the stratum). PROC SURVEYSELECT computes this proportion by using the specified allocation method.

- SampleSize, which is the sample size allocated to the stratum.

- ActualProportion, which is the actual proportion allocated to the stratum. The value of ActualProportion equals the allocated stratum sample size divided by the total sample size. This value can differ from the target AllocProportion due to rounding and other restrictions. See the section "Sample Size Allocation" on page 8494 for details.

Random Assignment Output Data Set

When you specify the GROUPS= option, PROC SURVEYSELECT provides random assignment of the observations in the DATA= input data set. The OUT= output data set contains all observations in the input data set and identifies the assigned groups. If you do not specify an ID statement, the output data set contains all variables in the input data set. If you specify an ID statement, PROC SURVEYSELECT copies those variable that you specify from the input data set to the output data set.

You can specify the name of the output data set by using the OUT= option in the PROC SURVEYSELECT statement. If you omit the OUT= option, the data set is named DATA*n*, where *n* is the smallest integer that makes the name unique.

The random assignment output data set can include the following variables:

- STRATA variables, if you specify a STRATA statement

- Replicate, which is the replicate identification number. This variable is included when you specify the REPS= option.

- ID variables, if you specify an ID statement

- GroupID, which is the group identification number. If you specify a STRATA statement, PROC SURVEYSELECT performs random assignment independently within strata, and the groups are nested within strata.

- InitialSeed, which is the initial seed for random number generation

If you specify the OUTSIZE option, the random assignment output data set also includes the following variables:

- Total, which is the total number of units in the data set, or the total in the stratum if you specify a STRATA statement

- NGroups, which is the number of groups in the data set, or the number in the stratum if you specify a STRATA statement

- GroupSize, which is the number of units in the observation's group

Displayed Output

By default, PROC SURVEYSELECT displays two tables that summarize the sample selection: the "Sample Selection Method" table and the "Sample Selection Summary" table.

If you request sample allocation but no sample selection, PROC SURVEYSELECT displays two tables that summarize the allocation: the "Sample Allocation Method" table and the "Sample Allocation Summary" table.

If you request random assignment, the procedure displays the "Random Assignment" table.

You can suppress display of these tables by specifying the NOPRINT option.

PROC SURVEYSELECT creates an output data set that contains the units that are selected for the sample. Or if you request sample allocation but no sample selection, PROC SURVEYSELECT creates an output data set that contains the sample size allocation results. If you request random assignment, the procedure creates an output data set that contains the assignments. For more information, see the sections "Sample Output Data Set" on page 8498, "Allocation Output Data Set" on page 8502, and "Random Assignment Output Data Set" on page 8503. The procedure does not display the output data set that it creates. Use PROC PRINT, PROC REPORT, or any other SAS reporting tool to display the output data set.

Sample Selection Method Table

PROC SURVEYSELECT displays the following information in the "Sample Selection Method" table:

- Selection Method

- Sampling Unit Variables, if you specify a SAMPLINGUNIT statement

- Size Measure variable, if you specify a SIZE statement

- Size Measure: Number of Observations, if you specify the PPS option in the SAMPLINGUNIT statement and do not specify a SIZE statement

- Minimum Size Measure, if you specify the MINSIZE= option

- Maximum Size Measure, if you specify the MAXSIZE= option

- Certainty Size Measure, if you specify the CERTSIZE= option

- Certainty Proportion, if you specify the CERTSIZE=P= option

- Strata Variables, if you specify a STRATA statement

- Control Variables, if you specify a CONTROL statement

- Control Sorting (Serpentine or Nested), if you specify a CONTROL statement

- Allocation (Proportional, Neyman, Optimal, or Input), if you specify the ALLOC= option in the STRATA statement

- Margin of Error, if you specify the MARGIN= option in the STRATA statement

- Confidence Level, if you specify the ALPHA= option in the STRATA statement

Sample Selection Summary Table

PROC SURVEYSELECT displays the following information in the "Sample Selection Summary" table:

- Input Data Set name

- Sorted Data Set name, if you specify the OUTSORT= option

- Random Number Seed

- Sample Size or Stratum Sample Size, if you specify the SAMPSIZE=*n* option

- Sample Size Data Set, if you specify the SAMPSIZE=*SAS-data-set* option

- Sampling Rate or Stratum Sampling Rate, if you specify the SAMPRATE=*value* option for METHOD=SRS, METHOD=URS, METHOD=SYS, or METHOD=SEQ.

- Selection Probability or Stratum Selection Probability, if you specify the SAMPRATE=*value* option for METHOD=BERNOULLI

- Sampling Rate Data Set, if you specify the SAMPRATE=*SAS-data-set* option

- Minimum Sample Size or Stratum Minimum Sample Size, if you specify the NMIN= option with the SAMPRATE= option

- Maximum Sample Size or Stratum Maximum Sample Size, if you specify the NMAX= option with the SAMPRATE= option

- Number of Certainty Units, if you specify the CERTSIZE= or CERTSIZE=P= option and do not specify a STRATA statement

- Specified Start, if you specify the START= option for METHOD=SYS or METHOD=PPS_SYS

- Random Start, if you specify the DETAILS option for METHOD=SYS or METHOD=PPS_SYS and do not specify a STRATA statement or the REPS= option

- Specified Interval, if you specify the INTERVAL= option for METHOD=SYS or METHOD=PPS_SYS

- Systematic Interval, if you specify the DETAILS option for METHOD=SYS or METHOD=PPS_SYS and do not specify a STRATA statement or the REPS= option

- Sample Size, if you specify the INTERVAL= option for METHOD=SYS or METHOD=PPS_SYS and do not specify a STRATA statement or the REPS= option

- Allocation Input Data Set name, if you specify the ALLOC=*SAS-data-set* option in the STRATA statement

- Variance Input Data Set name, if you specify the VAR=*SAS-data-set* option in the STRATA statement

- Cost Input Data Set name, if you specify the COST=*SAS-data-set* option in the STRATA statement

- Selection Probability, if you specify METHOD=SRS, METHOD=SYS, or METHOD=SEQ and do not specify a SIZE statement or a STRATA statement

- Expected Number of Hits, if you specify METHOD=URS and do not specify a STRATA statement

- Total Number of Units, if you specify METHOD=BERNOULLI or METHOD=POISSON and do not specify a STRATA statement

- Expected Sample Size, if you specify METHOD=BERNOULLI or METHOD=POISSON and do not specify a STRATA statement

- Sample Size, if you specify METHOD=BERNOULLI or METHOD=POISSON and do not specify a STRATA statement

- Sampling Weight, if you specify an equal probability selection method (METHOD=SRS, METHOD=URS, METHOD=SYS, METHOD=SEQ, or METHOD=BERNOULLI) and do not specify a STRATA statement

- Adjusted Sampling Weight, if you specify METHOD=BERNOULLI and do not specify a STRATA statement

- Number of Strata, if you specify a STRATA statement

- Stratum Minimum Sample Size, if you specify the ALLOCMIN= option in the STRATA statement

- Number of Replicates, if you specify the REPS= option

- Total Sample Size, if you specify a STRATA statement or the REPS= option

- Expected Margin of Error, if you specify the STATS option with the MARGIN= option in the STRATA statement

- Expected Variance, if you specify the STATS option without the MARGIN= option in the STRATA statement for ALLOC=OPTIMAL or ALLOC=NEYMAN

- Total Stratum Costs, if you specify the STATS option with ALLOC=OPTIMAL in the STRATA statement

- Output Data Set name

Sample Allocation Method Table

If you specify the NOSAMPLE option in the STRATA statement, PROC SURVEYSELECT allocates the total sample among the strata but does not select the sample. When you specify the NOSAMPLE option, PROC SURVEYSELECT displays the "Sample Allocation Method" table and the "Sample Allocation Summary" table. The "Sample Allocation Method" table includes the following information:

- Allocation (Proportional, Neyman, Optimal, or Input)

- Margin of Error, if you specify the MARGIN= option in the STRATA statement

- Confidence Level, if you specify the ALPHA= option in the STRATA statement

- Sampling Unit Variables, if you specify a SAMPLINGUNIT statement

- Strata Variables

- Frequency Variable

- Selection Method, if you specify the METHOD= option

Sample Allocation Summary Table

PROC SURVEYSELECT displays the following information in the "Sample Allocation Summary" table.

- Input Data Set name

- Allocation Input Data Set name, if you specify the ALLOC=*SAS-data-set* option in the STRATA statement

- Variance Input Data Set name, if you specify the VAR=*SAS-data-set* option in the STRATA statement

- Cost Input Data Set name, if you specify the COST=*SAS-data-set* option in the STRATA statement

- Number of Strata

- Stratum Minimum Sample Size, if you specify the ALLOCMIN= option in the STRATA statement

- Total Sample Size

- Expected Margin of Error, if you specify the STATS option with the MARGIN= option in the STRATA statement

- Expected Variance, if you specify the STATS option without the MARGIN= option in the STRATA statement for ALLOC=OPTIMAL or ALLOC=NEYMAN

- Total Stratum Costs, if you specify the STATS option with ALLOC=OPTIMAL in the STRATA statement

- Allocation Output Data Set name

Random Assignment Table

If you specify the GROUPS= option, PROC SURVEYSELECT displays the following information in the "Random Assignment" table:

- Input Data Set name

- Strata Variables, if you specify a STRATA statement

- Random Number Seed

- Number of Groups

- Total Number of Units, if you specify the GROUPS=*value* option and do not specify a STRATA statement

- Number of Units per Group, if you specify the GROUPS=*value* option and do not specify a STRATA statement

- Number of Replicates, if you specify the REPS= option

- Number of Strata, if you specify a STRATA statement

- Total Number of Groups, if you specify a STRATA statement or the REPS= option

- Output Data Set name

ODS Table Names

PROC SURVEYSELECT assigns a name to each table that it creates. You can use these names to refer to tables when you use the Output Delivery System (ODS) to select tables and create output data sets. For more information about ODS, see Chapter 20, "Using the Output Delivery System." Table 99.4 lists the table names.

Table 99.4 ODS Tables Produced by PROC SURVEYSELECT

ODS Table Name	Description	Statement	Option
Groups	Random assignment summary	PROC	GROUPS=
Method	Sample selection method	PROC	Default
Method	Sample allocation method	STRATA	NOSAMPLE
Summary	Sample selection summary	PROC	Default
Summary	Sample allocation summary	STRATA	NOSAMPLE

Examples: SURVEYSELECT Procedure

Example 99.1: Replicated Sampling

This example uses the Customers data set from the section "Getting Started: SURVEYSELECT Procedure" on page 8447. The data set Customers contains an Internet service provider's current subscribers, and the service provider wants to select a sample from this population for a customer satisfaction survey.

This example illustrates replicated sampling, which selects multiple samples from the survey population according to the same design. You can use replicated sampling to provide a simple method of variance estimation, or to evaluate variable nonsampling errors such as interviewer differences. For information about replicated sampling, see Lohr (2010); Wolter (2007); Kish (1965, 1987); Kalton (1983).

This design includes four replicates, each with a sample size of 50 customers. The sampling frame is stratified by State and sorted by Type and Usage within strata. Customers are selected by sequential random sampling with equal probability within strata. The following PROC SURVEYSELECT statements select a probability sample of customers from the Customers data set by using this design:

```
title1 'Customer Satisfaction Survey';
title2 'Replicated Sampling';
proc surveyselect data=Customers method=seq n=(8 12 20 10)
                  reps=4 seed=40070 ranuni out=SampleRep;
   strata State;
   control Type Usage;
run;
```

The STRATA statement names the stratification variable State. The CONTROL statement names the control variables Type and Usage.

In the PROC SURVEYSELECT statement, the METHOD=SEQ option requests sequential random sampling. The REPS= option specifies four replicates of this sample. The N=(8 12 20 10) option lists the stratum sample

sizes for each replicate. The N= option lists the stratum sample sizes in the same order as the strata appear in the Customers data set, which has been sorted by State. The sample size of eight customers corresponds to the first stratum, State = 'AL'. The sample size 12 corresponds to the next stratum, State = 'FL', and so on.

The SEED= option specifies 40070 as the initial seed for random number generation. The RANUNI option requests random number generation by the RANUNI generator, which PROC SURVEYSELECT uses in releases before SAS/STAT 12.1. (Beginning in SAS/STAT 12.1, PROC SURVEYSELECT uses the Mersenne-Twister random number generator by default.) You can specify the RANUNI option with the SEED= option to reproduce samples that PROC SURVEYSELECT selects in releases before SAS/STAT 12.1. To reproduce a sample by using the RANUNI and SEED= options, you must also specify the same input data set and sample selection parameters.

Output 99.1.1 displays the output from PROC SURVEYSELECT, which summarizes the sample selection. A total of 200 customers is selected in four replicates. PROC SURVEYSELECT selects each replicate by using sequential random sampling within strata determined by State. The sampling frame Customers is sorted by the control variables Type and Usage within strata, according to hierarchic serpentine sorting. The output data set SampleRep contains the sample.

Output 99.1.1 Sample Selection Summary

```
                    Customer Satisfaction Survey
                         Replicated Sampling

                       The SURVEYSELECT Procedure

            Selection Method      Sequential Random Sampling
                                      With Equal Probability
            Strata Variable                            State
            Control Variables                           Type
                                                       Usage
            Control Sorting                        Serpentine


                 Input Data Set            CUSTOMERS
                 Random Number Seed            40070
                 Number of Strata                  4
                 Number of Replicates              4
                 Total Sample Size               200
                 Output Data Set           SAMPLEREP
```

The following PROC PRINT statements display the selected customers for the first stratum, State = 'AL', from the output data set SampleRep:

```
title1 'Customer Satisfaction Survey';
title2 'Sample Selected by Replicated Design';
title3 '(First Stratum)';
proc print data=SampleRep;
   where State = 'AL';
run;
```

Output 99.1.2 displays the 32 sample customers of the first stratum (State = 'AL') from the output data set SampleRep, which includes the entire sample of 200 customers. The variable SelectionProb contains the selection probability, and SamplingWeight contains the sampling weight. Because customers are selected with equal probability within strata in this design, all customers in the same stratum have the same selection probability. These selection probabilities and sampling weights apply to a single replicate, and the variable Replicate contains the sample replicate number.

Output 99.1.2 Customer Sample (First Stratum)

```
                      Customer Satisfaction Survey
                   Sample Selected by Replicated Design
                            (First Stratum)

                                               Selection    Sampling
  Obs    State   Replicate    CustomerID   Type    Usage        Prob      Weight

   1      AL        1        882-37-7496   New      572    .004115226      243
   2      AL        1        581-32-5534   New      863    .004115226      243
   3      AL        1        980-29-2898   Old      571    .004115226      243
   4      AL        1        172-56-4743   Old      128    .004115226      243
   5      AL        1        998-55-5227   Old       35    .004115226      243
   6      AL        1        625-44-3396   New       60    .004115226      243
   7      AL        1        627-48-2509   New      114    .004115226      243
   8      AL        1        257-66-6558   New      172    .004115226      243
   9      AL        2        622-83-1680   New       22    .004115226      243
  10      AL        2        343-57-1186   New       53    .004115226      243
  11      AL        2        976-05-3796   New      110    .004115226      243
  12      AL        2        859-74-0652   New      303    .004115226      243
  13      AL        2        476-48-1066   New      839    .004115226      243
  14      AL        2        109-27-8914   Old     2102    .004115226      243
  15      AL        2        743-25-0298   Old      376    .004115226      243
  16      AL        2        722-08-2215   Old      105    .004115226      243
  17      AL        3        668-57-7696   New      200    .004115226      243
  18      AL        3        300-72-0129   New      471    .004115226      243
  19      AL        3        073-60-0765   New      656    .004115226      243
  20      AL        3        526-87-0258   Old      672    .004115226      243
  21      AL        3        726-61-0387   Old      150    .004115226      243
  22      AL        3        632-29-9020   Old       51    .004115226      243
  23      AL        3        417-17-8378   New       56    .004115226      243
  24      AL        3        091-26-2366   New       93    .004115226      243
  25      AL        4        336-04-1288   New      419    .004115226      243
  26      AL        4        827-04-7407   New      650    .004115226      243
  27      AL        4        317-70-6496   Old      452    .004115226      243
  28      AL        4        002-38-4582   Old      206    .004115226      243
  29      AL        4        181-83-3990   Old       33    .004115226      243
  30      AL        4        675-34-7393   New       47    .004115226      243
  31      AL        4        228-07-6671   New       65    .004115226      243
  32      AL        4        298-46-2434   New      161    .004115226      243
```

Example 99.2: PPS Selection of Two Units per Stratum

This example describes hospital selection for a survey by using PROC SURVEYSELECT. A state health agency plans to conduct a statewide survey of a variety of different hospital services. The agency plans to select a probability sample of individual discharge records within hospitals by using a two-stage sample design. First-stage units are hospitals, and second-stage units are patient discharges during the study period. Hospitals are stratified first according to geographic region and then by rural/urban type and size of hospital. Two hospitals are selected from each stratum with probability proportional to size.

The data set HospitalFrame contains all hospitals in the first geographical region of the state:

```
data HospitalFrame;
   input Hospital$ Type$ SizeMeasure @@;
   if (SizeMeasure < 20) then Size='Small ';
      else if (SizeMeasure < 50) then Size='Medium';
      else Size='Large ';
   datalines;
034 Rural  0.870   107 Rural  1.316
079 Rural  2.127   223 Rural  3.960
236 Rural  5.279   165 Rural  5.893
086 Rural  0.501   141 Rural 11.528
042 Urban  3.104   124 Urban  4.033
006 Urban  4.249   261 Urban  4.376
195 Urban  5.024   190 Urban 10.373
038 Urban 17.125   083 Urban 40.382
259 Urban 44.942   129 Urban 46.702
133 Urban 46.992   218 Urban 48.231
026 Urban 61.460   058 Urban 65.931
119 Urban 66.352
;
```

In the SAS data set HospitalFrame, the variable Hospital identifies the hospital. The variable Type equals 'Urban' if the hospital is located in an urban area, and 'Rural' otherwise. The variable SizeMeasure contains the hospital's size measure, which is constructed from past data on service utilization for the hospital together with the desired sampling rates for each service. This size measure reflects the amount of relevant survey information expected from the hospital. See Drummond et al. (1982) for details about this type of size measure. The variable Size equals 'Small', 'Medium', or 'Large', depending on the value of the hospital's size measure.

The following PROC PRINT statements display the data set Hospital Frame and produce Output 99.2.1:

```
title1 'Hospital Utilization Survey';
title2 'Sampling Frame, Region 1';
proc print data=HospitalFrame;
run;
```

Output 99.2.1 Sampling Frame

```
                  Hospital Utilization Survey
                   Sampling Frame, Region 1

                                  Size
          Obs     Hospital    Type     Measure     Size

           1        034       Rural     0.870      Small
           2        107       Rural     1.316      Small
           3        079       Rural     2.127      Small
           4        223       Rural     3.960      Small
           5        236       Rural     5.279      Small
           6        165       Rural     5.893      Small
           7        086       Rural     0.501      Small
           8        141       Rural    11.528      Small
           9        042       Urban     3.104      Small
          10        124       Urban     4.033      Small
          11        006       Urban     4.249      Small
          12        261       Urban     4.376      Small
          13        195       Urban     5.024      Small
          14        190       Urban    10.373      Small
          15        038       Urban    17.125      Small
          16        083       Urban    40.382      Medium
          17        259       Urban    44.942      Medium
          18        129       Urban    46.702      Medium
          19        133       Urban    46.992      Medium
          20        218       Urban    48.231      Medium
          21        026       Urban    61.460      Large
          22        058       Urban    65.931      Large
          23        119       Urban    66.352      Large
```

The following PROC SURVEYSELECT statements select a probability sample of hospitals from the HospitalFrame data set by using a stratified design with PPS selection of two units from each stratum:

```
title1 'Hospital Utilization Survey';
title2 'Stratified PPS Sampling';
proc surveyselect data=HospitalFrame method=pps_brewer
               seed=48702 out=SampleHospitals;
   size SizeMeasure;
   strata Type Size notsorted;
run;
```

The STRATA statement names the stratification variables Type and Size. The NOTSORTED option specifies that observations with the same STRATA variable values are grouped together but are not necessarily sorted in alphabetical or increasing numerical order. In the HospitalFrame data set, Size = 'Small' precedes Size = 'Medium'.

In the PROC SURVEYSELECT statement, the METHOD=PPS_BREWER option requests sample selection by Brewer's method, which selects two units per stratum with probability proportional to size. The SEED= option specifies 48702 as the initial seed for random number generation. The SIZE statement names SizeMeasure as the size measure variable. It is not necessary to specify the sample size with the N= option, because Brewer's method always selects two units from each stratum.

Output 99.2.2 displays the output from PROC SURVEYSELECT. A total of eight hospitals were selected from the four strata. The data set SampleHospitals contains the selected hospitals.

Output 99.2.2 Sample Selection Summary

```
                    Hospital Utilization Survey
                      Stratified PPS Sampling

                    The SURVEYSELECT Procedure

               Selection Method    Brewer's PPS Method
               Size Measure                 SizeMeasure
               Strata Variables                    Type
                                                    Size


               Input Data Set            HOSPITALFRAME
               Random Number Seed                48702
               Stratum Sample Size                   2
               Number of Strata                      4
               Total Sample Size                     8
               Output Data Set        SAMPLEHOSPITALS
```

The following PROC PRINT statements display the sample hospitals and produce Output 99.2.3:

```
title1 'Hospital Utilization Survey';
title2 'Sample Selected by Stratified PPS Design';
proc print data=SampleHospitals;
run;
```

Output 99.2.3 Sample Hospitals

```
                        Hospital Utilization Survey
                    Sample Selected by Stratified PPS Design


                                                                    Jt
                                   Size     Selection   Sampling  Selection
   Obs    Type     Size   Hospital Measure    Prob      Weight      Prob

    1     Rural    Small    165     5.893    0.37447    2.67046    0.22465
    2     Rural    Small    141    11.528    0.73254    1.36511    0.22465
    3     Urban    Small    006     4.249    0.17600    5.68181    0.01454
    4     Urban    Small    195     5.024    0.20810    4.80533    0.01454
    5     Urban    Medium   129    46.702    0.41102    2.43297    0.11211
    6     Urban    Medium   218    48.231    0.42448    2.35584    0.11211
    7     Urban    Large    058    65.931    0.68060    1.46929    0.36555
    8     Urban    Large    119    66.352    0.68495    1.45996    0.36555
```

The variable SelectionProb contains the selection probability for each hospital in the sample. The variable JtSelectionProb contains the joint probability of selection for the two sample hospitals in the same stratum. The variable SamplingWeight contains the sampling weight component for this first stage of the design. The final-stage weight components, which correspond to patient record selection within hospitals, can be multiplied by the hospital weight components to obtain the overall sampling weights.

Example 99.3: PPS (Dollar-Unit) Sampling

A small company wants to audit employee travel expenses in an effort to improve the expense reporting procedure and possibly reduce expenses. The company does not have resources to examine all expense reports and wants to use statistical sampling to objectively select expense reports for audit.

The data set TravelExpense contains the dollar amount of all employee travel expense transactions during the past month:

```
data TravelExpense;
   input ID$ Amount @@;
   if (Amount < 500) then Level='1_Low ';
      else if (Amount > 1500) then Level='3_High';
      else Level='2_Avg ';
   datalines;
110   237.18   002   567.89   234   118.50
743    74.38   411 1287.23    782   258.10
216   325.36   174   218.38   568 1670.80
302   134.71   285 2020.70    314    47.80
139 1183.45    775   330.54   425   780.10
506   895.80   239   620.10   011   420.18
672   979.66   142   810.25   738   670.85
192   314.58   243    87.50   263 1893.40
496   753.30   332   540.65   486 2580.35
614   230.56   654   185.60   308   688.43
784   505.14   017   205.48   162   650.42
289 1348.34    691    30.50   545 2214.80
517   940.35   382   217.85   024   142.90
478   806.90   107   560.72
;
```

In the SAS data set TravelExpense, the variable ID identifies the travel expense report. The variable Amount contains the dollar amount of the reported expense. The variable Level equals '1_Low', '2_Avg', or '3_High', depending on the value of Amount.

In the sample design for this audit, expense reports are stratified by Level. This ensures that each of these expense levels is included in the sample and also permits a disproportionate allocation of the sample, selecting proportionately more of the expense reports from the higher levels. Within strata, the sample of expense reports is selected with probability proportional to the amount of the expense, thus giving a greater chance of selection to larger expenses. In auditing terms, this is known as monetary-unit sampling. See Wilburn (1984) for details.

PROC SURVEYSELECT requires that the input data set be sorted by the STRATA variables. The following PROC SORT statements sort the TravelExpense data set by the stratification variable Level.

```
proc sort data=TravelExpense;
   by Level;
run;
```

Output 99.3.1 displays the sampling frame data set TravelExpense, which contains 41 observations.

Output 99.3.1 Sampling Frame

```
           Travel Expense Audit

     Obs    ID      Amount    Level

      1     110      237.18    1_Low
      2     234      118.50    1_Low
      3     743       74.38    1_Low
      4     782      258.10    1_Low
      5     216      325.36    1_Low
      6     174      218.38    1_Low
      7     302      134.71    1_Low
      8     314       47.80    1_Low
      9     775      330.54    1_Low
     10     011      420.18    1_Low
     11     192      314.58    1_Low
     12     243       87.50    1_Low
     13     614      230.56    1_Low
     14     654      185.60    1_Low
     15     017      205.48    1_Low
     16     691       30.50    1_Low
     17     382      217.85    1_Low
     18     024      142.90    1_Low
     19     002      567.89    2_Avg
     20     411     1287.23    2_Avg
     21     139     1183.45    2_Avg
     22     425      780.10    2_Avg
     23     506      895.80    2_Avg
     24     239      620.10    2_Avg
     25     672      979.66    2_Avg
     26     142      810.25    2_Avg
     27     738      670.85    2_Avg
     28     496      753.30    2_Avg
     29     332      540.65    2_Avg
     30     308      688.43    2_Avg
     31     784      505.14    2_Avg
     32     162      650.42    2_Avg
     33     289     1348.34    2_Avg
     34     517      940.35    2_Avg
     35     478      806.90    2_Avg
     36     107      560.72    2_Avg
     37     568     1670.80    3_High
     38     285     2020.70    3_High
     39     263     1893.40    3_High
     40     486     2580.35    3_High
     41     545     2214.80    3_High
```

The following PROC SURVEYSELECT statements select a probability sample of expense reports from the TravelExpense data set by using the stratified design with PPS selection within strata:

```
title1 'Travel Expense Audit';
title2 'Stratified PPS (Dollar-Unit) Sampling';
proc surveyselect data=TravelExpense method=pps n=(6 10 4)
                  seed=47279 out=AuditSample;
   size Amount;
   strata Level;
run;
```

The STRATA statement names the stratification variable Level. The SIZE statement specifies the size measure variable Amount. In the PROC SURVEYSELECT statement, the METHOD=PPS option requests sample selection with probability proportional to size and without replacement. The N=(6 10 4) option specifies the stratum sample sizes, listing the sample sizes in the same order as the strata appear in the TravelExpense data set. The sample size of 6 corresponds to the first stratum, Level = '1_Low'; the sample size of 10 corresponds to the second stratum, Level = '2_Avg'; and 4 corresponds to the last stratum, Level = '3_High'. The SEED= option specifies 47279 as the initial seed for random number generation.

Output 99.3.2 displays the output from PROC SURVEYSELECT. A total of 20 expense reports are selected for audit. The data set AuditSample contains the sample of travel expense reports.

Output 99.3.2 Sample Selection Summary

```
                     Travel Expense Audit
             Stratified PPS (Dollar-Unit) Sampling


                   The SURVEYSELECT Procedure

         Selection Method     PPS, Without Replacement
         Size Measure                           Amount
         Strata Variable                         Level


            Input Data Set         TRAVELEXPENSE
            Random Number Seed             47279
            Number of Strata                   3
            Total Sample Size                 20
            Output Data Set        AUDITSAMPLE
```

The following PROC PRINT statements display the audit sample, which is shown in Output 99.3.3:

```
title1 'Travel Expense Audit';
title2 'Sample Selected by Stratified PPS Design';
proc print data=AuditSample;
run;
```

Output 99.3.3 Audit Sample

```
                        Travel Expense Audit
                Sample Selected by Stratified PPS Design

                                       Selection    Sampling
            Obs     Level    ID     Amount     Prob      Weight

             1     1_Low    024    142.90    0.23949    4.17553
             2     1_Low    614    230.56    0.38640    2.58797
             3     1_Low    110    237.18    0.39750    2.51574
             4     1_Low    782    258.10    0.43256    2.31183
             5     1_Low    192    314.58    0.52721    1.89676
             6     1_Low    216    325.36    0.54528    1.83392
             7     2_Avg    332    540.65    0.37057    2.69853
             8     2_Avg    239    620.10    0.42503    2.35278
             9     2_Avg    162    650.42    0.44581    2.24310
            10     2_Avg    738    670.85    0.45981    2.17479
            11     2_Avg    506    895.80    0.61400    1.62866
            12     2_Avg    517    940.35    0.64454    1.55151
            13     2_Avg    672    979.66    0.67148    1.48925
            14     2_Avg    139   1183.45    0.81116    1.23280
            15     2_Avg    411   1287.23    0.88229    1.13341
            16     2_Avg    289   1348.34    0.92418    1.08204
            17     3_High   568   1670.80    0.64385    1.55316
            18     3_High   263   1893.40    0.72963    1.37056
            19     3_High   285   2020.70    0.77869    1.28421
            20     3_High   545   2214.80    0.85348    1.17167
```

Example 99.4: Proportional Allocation

This example uses the Customers data set from the section "Getting Started: SURVEYSELECT Procedure" on page 8447. The data set Customers contains an Internet service provider's current subscribers, and the service provider wants to select a sample from this population for a customer satisfaction survey. This example illustrates proportional allocation, which allocates the total sample size among the strata in proportion to the strata sizes.

The section "Getting Started: SURVEYSELECT Procedure" on page 8447 gives an example of stratified sampling, where the list of customers is stratified by State and Type. Figure 99.4 displays the strata in a table of State by Type for the 13,471 customers. There are four states and two levels of Type, forming a total of eight strata. A sample of 15 customers was selected from each stratum by using the following PROC SURVEYSELECT statements:

```
title1 'Customer Satisfaction Survey';
title2 'Stratified Sampling';
proc surveyselect data=Customers method=srs n=15
               seed=1953 out=SampleStrata;
   strata State Type;
run;
```

The STRATA statement names the stratification variables State and Type. In the PROC SURVEYSELECT statement, the N= option specifies a sample size of 15 customers for each stratum.

Instead of specifying the number of customers to select from each stratum, you can specify the total sample size and request allocation of the total sample size among the strata. The following PROC SURVEYSELECT statements request proportional allocation, which allocates the total sample size in proportion to the stratum sizes:

```
title1 'Customer Satisfaction Survey';
title2 'Proportional Allocation';
proc surveyselect data=Customers n=1000
                  out=SampleSizes;
   strata State Type / alloc=prop nosample;
run;
```

The STRATA statement names the stratification variables State and Type. In the STRATA statement, the ALLOC=PROP option requests proportional allocation. The NOSAMPLE option requests that no sample be selected after the procedure computes the sample size allocation. In the PROC SURVEYSELECT statement, the N= option specifies a total sample size of 1000 customers to be allocated among the strata.

Output 99.4.1 displays the output from PROC SURVEYSELECT, which summarizes the sample allocation. The total sample size of 1000 is allocated among the eight strata by using proportional allocation. The allocated sample sizes are stored in the SAS data set SampleSizes.

Output 99.4.1 Proportional Allocation Summary

```
              Customer Satisfaction Survey
                 Proportional Allocation

                The SURVEYSELECT Procedure

            Allocation              Proportional
            Strata Variables             State
                                         Type


         Input Data Set                  CUSTOMERS
         Number of Strata                        8
         Total Sample Size                    1000
         Allocation Output Data Set    SAMPLESIZES
```

The following PROC PRINT statements display the allocation output data set SampleSizes, which is shown in Output 99.4.2:

```
title1 'Customer Satisfaction Survey';
title2 'Proportional Allocation';
proc print data=SampleSizes;
run;
```

Output 99.4.2 Stratum Sample Sizes

```
                     Customer Satisfaction Survey
                       Proportional Allocation

                                     Alloc      Sample      Actual
       Obs    State    Type    Total  Proportion   Size    Proportion

        1      AL      New     1238    0.09190      92       0.092
        2      AL      Old      706    0.05241      52       0.052
        3      FL      New     2170    0.16109     161       0.161
        4      FL      Old     1370    0.10170     102       0.102
        5      GA      New     3488    0.25893     259       0.259
        6      GA      Old     1940    0.14401     144       0.144
        7      SC      New     1684    0.12501     125       0.125
        8      SC      Old      875    0.06495      65       0.065
```

The output data set SampleSizes includes one observation for each of the eight strata, which are identified by the stratification variables State and Type. The variable Total contains the number of sampling units in the stratum, and the variable AllocProportion contains the proportion of the total sample size to allocate to the stratum. The variable SampleSize contains the allocated stratum sample size. For the first stratum (State='AL' and Type='New'), the total number of sampling units is 1238 customers, the allocation proportion is 0.09190, and the allocated sample size is 92 customers. The sum of the allocated sample sizes equals the requested total sample size of 1000 customers.

The output data set also includes the variable ActualProportion, which contains actual stratum proportions of the total sample size. The actual proportion for a stratum equals the stratum sample size divided by the total sample size. For the first stratum (State='AL' and Type='New'), the actual proportion is 0.092, while the allocation proportion is 0.09190. The target sample sizes computed from the allocation proportions are often not integers, and PROC SURVEYSELECT uses a rounding algorithm to obtain integer sample sizes and maintain the requested total sample size. Due to rounding and other restrictions, the actual proportions can differ from the target allocation proportions. See the section "Sample Size Allocation" on page 8494 for details.

If you want to use the allocated sample sizes in a later invocation of PROC SURVEYSELECT, you can name the allocation data set in the N=*SAS-data-set* option, as shown in the following PROC SURVEYSELECT statements:

```
title1 'Customer Satisfaction Survey';
title2 'Stratified Sampling';
proc surveyselect data=Customers method=srs n=SampleSizes
                  seed=1953 out=SampleStrata;
   strata State Type;
run;
```

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