



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF ENFORCEMENT
AND COMPLIANCE
ASSURANCE

MEMORANDUM

SUBJECT: Results of the Random Audit of FY 2003 Enforcement Action Data

FROM: David Hindin, Director
Enforcement Targeting & Data Division

A handwritten signature in black ink, appearing to read "Betsy Smidinger", is written over the printed name of the sender.

TO: Regional Enforcement Division Directors
Regional Media Division Directors
Regional Enforcement Coordinators
Lead Compliance and Enforcement Data Stewards

This memorandum reports the results of the Random Audit of FY 2003 Enforcement Action Data (attachment 1). A similar audit of FY 2001 inspection data was conducted in FY 2002. The results of that audit are summarized in attachment 2.

I appreciate your efforts to support this enforcement action audit: there was 100 percent participation across state and Regional programs for both the Clean Water Act and Resource Conservation and Recovery Act programs, and, for the Clean Air Act program, all Regions and all but one state completed the audit. State and Regional participation made this a successful data quality initiative that gives us an objective measurement of the quality of key data used to measure the enforcement program. I will also email this memorandum and final report to all participants who logged onto the audit Web site and thank them for completing the audit for their program.

In designing the audit, care was exercised to ensure that the audit minimized the efforts required of respondents. Even so, we recognize that this took scarce resources to complete. Our ability to characterize, for the first time in a statistically valid manner, the quality of our formal enforcement action data makes this a worthwhile investment.

The audit results provide policy makers, planners, and data system users critical information with which to characterize the quality of data for the three programs examined, including statements such as:

- Clean Air Act formal enforcement action information - 95% of major facilities in the Air Facility System (AFS) had completely accurate data in key fields on state and EPA formal

actions in FY 2003¹.

- Clean Water Act formal enforcement action information - 93% of major facilities in the Permit Compliance System (PCS) had completely accurate data in key fields on state and EPA formal actions in FY 2003¹.
- Resource Conservation and Recovery Act formal enforcement action information - 97% of major facilities in the Resource Conservation Recovery Act Information System (RCRAInfo) had completely accurate data in key fields on state and EPA formal actions in FY 2003¹.

The enforcement action audit is based on a facility sample from AFS, PCS or RCRAInfo. Federal enforcement actions associated with the sampled facilities were retrieved from the Integrated Compliance Information System (ICIS). State enforcement actions associated with the sampled facilities were taken from the respective legacy data system (AFS, PCS, or RCRAInfo).

In order to keep sample sizes at a minimum the audit was designed to provide estimates of accuracy at the national level only. This national level information provides us with an objective measure of how well we are doing in maintaining important information on our enforcement program. Please see the attached report for a break down of these percentages into three different types of errors.

The objective results of this audit reflect favorably on the quality of state and federal enforcement data and can 1) be used to respond positively in discussions of the accuracy of formal enforcement action data maintained in EPA's data systems, 2) accompany important reports and analyses that rely on formal enforcement action data so that the reader can better understand the underlying accuracy of the analyses, and 3) provide a baseline from which improvements in data quality and the impacts of data quality initiatives can be measured.

Feel free to distribute these results to your state counterparts.

Attachments

Attachment 1: Full Report on Results of the Random Audit of FY 2003 Enforcement Action Data

Attachment 2: Fact Sheet on Results of the Random Audit of FY 2001 Inspection Data

CC:

Regional AFS Database Managers

Regional PCS Database Managers

Regional RCRAInfo Database Managers

¹Based on the survey methodology used, we are 95 percent confident that this error rate is within two percent of the true value.

ICIS Database Managers

Regional CAA, CWA, RCRA, and ICIS Program Data Stewards

Regional and State Random Audit Participants

Regional QA Coordinators

Steve Brown, Executive Director, ECOS

ATTACHMENT 1

**RESULTS OF THE RANDOM AUDIT OF FY 2003
ENFORCEMENT ACTION DATA**

June 2005

Prepared for:
U.S. Environmental Protection Agency
Office of Enforcement and Compliance Assurance
Office of Compliance
Information Utilization and Targeting Branch

Prepared by:
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EPA Contract 69-W-039

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1. INTRODUCTION

EPA believes that it is important to its mission that conclusions drawn in its analyses and reports or from data which it manages are sufficiently robust in terms of data quality. Data quality can be assessed in many ways, but it must, at a minimum, meet EPA's program and policy needs and ensure that outside groups are confident about the quality of EPA's data and analysis. In recent years, Inspector General reports have stressed the need for improved data quality in Agency efforts to monitor and measure enforcement and compliance. In addition, recent legislation required each Agency to adopt Information Quality Guidelines to ensure publicly disseminated information meets high standards. In support of the Agency's goals and guidelines, the Office of Compliance (OC) has developed its own Data Quality Strategy. This audit is part of OC's Data Quality Strategy, which includes plans to implement objective assessments of the quality of the data in key compliance and enforcement data fields.

In FY 2002, OC conducted a baseline assessment of the accuracy and completeness of state and federally-reportable inspection data in the Air Facility System (AFS), Permit Compliance System (PCS), and Resource Conservation Recovery Act Information System (RCRAInfo) based on an audit of eight randomly selected facilities per media program (Air, Water, and RCRA). Respondent burden was minimized by using the smallest sample that would yield statistically relevant results. Participation by both the states and Regions reached 100%. The results are finalized in the December 18, 2002 technical report.

This report summarizes an audit of FY03 state and federal formal enforcement action data similar to the inspection audit undertaken in FY02. This audit follows the general approach and builds on the success of the earlier inspection audit. The enforcement action audit provides OC with two pieces of key information:

- 1) Statistical support for statements concerning the overall quality of formal enforcement action data at the *national level* for facilities regulated under the Clean Air Act (CAA), Clean Water Act (CWA), and Resource Recovery and Conservation Act (RCRA). The results of this audit reflect favorably on the quality of state and federal enforcement data, allowing states and EPA to respond objectively and positively in discussions of the accuracy of data in EPA reports and analyses for these highly visible programs.
- 2) A baseline from which improvements in the quality of federally-maintained data can be measured. (Pending adequate funding, OC will consider audits of different key compliance and enforcement data fields in the future.) Such a baseline audit will allow EPA to see if the quality of the enforcement action data improves as a result of OC's data quality efforts.

2. OVERVIEW OF RANDOM AUDIT OF FORMAL ENFORCEMENT ACTION DATA

This overview describes the random audit of formal enforcement action data for the following types of facilities taken from each of the three legacy databases:

- a. AFS: all facilities in the RECAP¹ universe = 42,663 records
- b. PCS: active Major NPDES permits = 6,836 records
- c. RCRAInfo: TSDs and LQGs² = 27,801 records

The approach of the enforcement action audit differs slightly from that of the inspection audit in several ways. First, ICIS was included because it, not the legacy data systems, is the *source of record* for federal enforcement actions. Consequently, the enforcement action audit is based on a facility sample from AFS, PCS or RCRAInfo. Federal enforcement actions associated with the sampled facilities were retrieved from ICIS. State enforcement actions associated with the sampled facilities were taken from the respective legacy data system (AFS, PCS, or RCRAInfo).

A second difference between the two audits lies in the sampling of two subpopulations in the enforcement action audit- facilities with no formal actions during the selected period and facilities with one or more formal actions during the selected period. This was done to minimize the burden of respondents (the random sample size would need to be much larger given action rates are between two and eight percent of facilities).

The last difference lies in the consideration of both initiated and closed federal formal enforcement actions in the audit. For state actions, only closed formal actions were included since these are typically entered into the legacy systems.

The goal of the audit is to enable OC and the Agency to make definitive statements regarding the accuracy of state and federal formal enforcement action data (in AFS, PCS, RCRAInfo, and ICIS data systems) for facilities regulated under the Clean Air Act, Clean Water Act, and Resource Recovery and Conservation Act. For example:

“The EPA and state formal enforcement action information maintained for facilities in the [Air Facility System (AFS)] is XX% accurate.”

¹ The Reporting for Enforcement and Compliance Assurance Priorities (RECAP) universe for the CAA was as follows: Class A, Synthetic Minor, and NESHAP minor sources with an operating status of: Operating, Temporarily Closed, or Seasonal.

²Only federally-reportable populations were studied. In particular, for RCRA only TSDs and LQGs were included in the sampled population.

3. RESULTS OF THE AUDIT

Each of the three media programs was analyzed independently at the national level. One year (federal fiscal year 2003 - October 1, 2002 through September 30, 2003) of formal enforcement action records for 16 randomly selected facilities per state (including Puerto Rico) were audited for each media program – eight facilities with no formal enforcement actions and up to eight facilities with one or more formal enforcement actions. This approach was designed to provide estimates of accuracy at the national level and does not assess data accuracy at the state or Regional level. The audit verified both the accuracy and the completeness of each facility's formal enforcement action records. For each facility, participants were asked to:

- ▶ verify that each of the enforcement actions in ICIS or the federal legacy system did occur;
- ▶ identify any missing enforcement actions; and
- ▶ correct the "date," "lead agency" and/or "action type" fields for the presented actions of sampled facilities.

More detailed information about the way the on-line audit was designed and administered, how facilities were sampled, and the formal enforcement action types included can be found in the Methodology section of this report.

Two different types of accuracy estimates were derived that will help EPA, states, and other data users to understand the accuracy of enforcement action information in the federal data systems. The first approach answers the question, "What percentage of facilities have completely accurate formal enforcement action information?" The second approach answers the question, "How accurate are metrics of formal enforcement action coverage?"

Along with the point estimate error rates for these two analyses, 95 percent confidence intervals are presented. The 95 percent confidence intervals indicate that we are 95 percent confident that the true error rate of the entire population (if a census of every facility were conducted) is within this range. The confidence intervals follow the estimated error rate and are denoted by " \pm [confidence interval value]." Such contextual information is critical to a wide range of downstream analyses and decision-making, including but not limited to: media program administration, data quality assurance programs; state and federal resource planning, compliance and enforcement targeting, and other environmental analyses. The 95 percent confidence interval is generally used to represent the accuracy of estimates made from randomly selected samples. It is used in this manner in this audit.

3.1 Accuracy of Formal enforcement Action Data

Table 1 shows the percentage of facilities in each data system that were found to contain an error in their associated formal enforcement action data. If a facility had one of the following three types of errors it was counted as having an error:

- ▶ a missing action,
- ▶ an erroneous action,
- ▶ an error in selected enforcement action record fields.

These three types of errors are explained in more detail below.

Table 1: Facilities With An Error In Enforcement Action Data	
Environmental Statute	Percentage of Facilities With An Error*
CAA Programs	4.51% ±1.86
CWA Programs	6.87% ±1.97
RCRA Programs	2.71% ±1.78

* The variance (±) is a 95% confidence interval.

The audit results provide policy makers, planners, and data systems users critical information with which to characterize the quality of data for the three programs examined, including statements such as:

- Clean Air Act formal enforcement action information - 95% of major facilities in the Air Facility System (AFS) had completely accurate data in key fields on state and EPA formal actions in FY 2003. Based on the survey methodology used, we are 95 percent confident that this error rate is within two percent of the true value.
- Clean Water Act formal enforcement action information - 93% of major facilities in the Permit Compliance System (PCS) had completely accurate data in key fields on state and EPA formal actions in FY 2003. Based on the survey methodology used, we are 95 percent confident that this error rate is within two percent of the true value.
- Resource Conservation and Recovery Act formal enforcement action information - 97% of major facilities in the Resource Conservation Recovery Act Information System (RCRAInfo) had completely accurate data in key fields on state and EPA formal actions in FY 2003. Based on the survey methodology used, we are 95 percent confident that this error rate is within two percent of the true value.

As stated earlier, the enforcement action audit is based on a facility sample from AFS, PCS or RCRAInfo. Federal enforcement actions associated with the sampled facilities were retrieved from the Integrated Compliance Information System (ICIS). State enforcement actions associated with the sampled facilities were taken from the respective legacy data system (AFS, PCS, or RCRAInfo).

To better understand the types of errors that are occurring in the database, Table 2 breaks down the error rates from Table 1 into three different components:

- Facilities with a missing action: An estimate of percentage of facilities in each database with one or more missing formal action.
- Facilities with an erroneous action: An estimate of percentage of facilities in each data system with an action record that was not supported by audited materials and/or did not in fact occur.
- Facilities with an error in an enforcement action record field: An estimate of the percentage of facilities in each data system with an error in any of the following enforcement action record fields: date, lead agency, and action type. (A date must be off by more than seven days to be considered an error.)

Table 2: Detailed Error Rates			
Environmental Statute	Facilities With A Missing Enforcement Action*	Facilities With an Erroneous Enforcement Action*	Facilities With An Error in an Enforcement Action Record Field*
CAA Programs	0.52% ±0.64	1.20% ±0.93	2.82% ±1.51
CWA Programs	3.68% ±1.46	1.53% ±1.13	1.66% ±0.99
RCRA Programs	1.53% ±1.48	0.08% ±0.09	1.13% ±1.01

* The variance (±) is a 95% confidence interval.

The formal enforcement actions record information (date, lead agency, and type) is more than 97 percent accurate for the three programs examined. Across all three programs, less than two percent of facilities contained erroneous formal enforcement actions. These error rates do not add up to the values in Table 1 because combinations of these three types of errors can (and do) occur in the same facilities.

3.2 Accuracy of Formal Enforcement Action Coverage Metrics

The information collected in the audit can also be used to estimate the accuracy of national formal enforcement action coverage (the percentage of facilities that had one or more formal enforcement action in FY03) metrics. This information, important to program and compliance management, may be used to ensure equitable and effective distribution of resources to achieve enforcement action outcomes (e.g., return to compliance, prevention of non-compliant pollution releases). Table 3 presents:

- the number of facilities in each system
- the baseline percentage of facilities with formal enforcement actions according to each program
- percentage of facilities that are falsely considered to have had an formal enforcement action when no federally-reportable formal enforcement actions occurred and
- the percentage of facilities falsely considered to be without any formal enforcement actions when formal enforcement actions did take place.

The following table indicates that statements asserting that a facility had at least one formal enforcement action during the FY03 time period are accurate 99 percent of the time for all three programs examined. Statements asserting that a facility has not had a formal enforcement action during the time period can be made with 98 to 100 percent accuracy depending on the particular program.

Table 3: Errors in Enforcement Action Designation*				
Data System	# Facilities in the System	% Facilities w/ Enforcement Actions (FY03)	% of Facilities Falsely Considered as having an Enforcement Actions	% of Facilities Falsely Considered without an Enforcement Action
AFS	42,663	4.66%	0.86% ±0.76	0.23% ±0.44
PCS	6,836	8.24%	0.38% ±0.63	2.10% ±1.19
RCRAInfo	27,801	2.00%	0.08% ±0.09	0.00% ±0.00

* The date range of enforcement actions to be included in a facility's record is 10/01/02 to 9/30/03. See Table 4 for details on which types of facilities were included in the audit.

4. AUDIT METHODOLOGY

The audit methodology was developed based on decisions made by the Work Group in developing the initial FY01 inspection audit, on feedback from the inspection audit participants, and on statistical differences related to the fact that fewer facilities have actions than are inspected. Care was exercised to ensure that the methodology minimized the burden on participants.

4.1 PREPARATION AND DISTRIBUTION OF AUDIT SAMPLE

Randomly selected samples were drawn from two strata, or subpopulations, of facilities (facilities with no recorded formal enforcement actions and facilities with one or more recorded formal enforcement actions) within each state. The effective sample totaling 16 facility IDs³ per state was taken from a consolidated data set of federal and state formal enforcement actions. State lead formal enforcement actions for each media were retrieved from three data systems: AFS, PCS, and RCRAInfo; information about federal lead formal enforcement actions for these media were extracted from ICIS.

Facility-based Sample, by Program		
Approximate Population Size	Sample Size per State*	95% Confidence Interval**
CAA: 45,300 facilities in the RECAP universe	816 ⁴ total*** 16 records/state (2 strata)****	3.5% to 6.5%
CWA: 6,500 active major permits	816 total*** 16 records/state (2 strata)****	3.5% to 6.5%
RCRA: 27,480 TSDs and LQGs	816 total*** 16 records/state (2 strata)****	3.5% to 6.5%

* The sample of facilities from each data system were selected independently. The national sample reflects the national distribution of number of formal enforcement actions per facility (i.e., it includes facilities with no formal enforcement actions) over a one-year period, FY 2003.

** The 95% confidence interval is based on *a priori* error rate assumption of 5%, which is equivalent to a 95% accuracy rate.

*** This includes the fifty states and Puerto Rico.

**** The stratified sample in each state includes two subpopulations, or strata: up to eight (8) facilities with one or more formal enforcement action in FY 2003 and eight (8) facilities with no formal enforcement actions in the selected time period.

³ In AFS, an ID covers all permits at the facility. In PCS, an ID relates to a NPDES permit. In RCRAInfo, the IDs selected for the audit were related either to RCRA Large Quantity Generators or Treatment, Storage and Disposal facilities.

⁴ The statistical methodology presents a minimum sample size of 811 (see Section 6). However, for administrative purposes the sample size was maintained at 16 facilities / state and Puerto Rico resulting in a total of 816 records.

A sample size of 16 records per state per data system was deemed technically supportable and was expected to yield appropriate national estimates concerning the accuracy of enforcement action data for each data system. The selected sample size provided a cushion by helping to address the possibility that a small number of states would not fully participate. Statistical weighting of the audit results, however, adjusted for minor over-sampling in the (smaller) states with few qualifying facilities. The weighting protocol also accounted for differences in sample size in those states where there were not eight (8) facilities with formal enforcement actions. A detailed description of the statistical methodologies can be found in Section 5, which covers issues such as sample size, sample selection, and post-audit weighting and statistical analysis.

Review of federally-reportable formal enforcement action records settled (and/or initiated, for federal lead actions) for the sampled facilities in the one year period October 1, 2002 to September 30, 2003 were reviewed. Information about state and local lead formal enforcement actions were taken from the legacy systems (AFS, PCS, and RCRAInfo). Information about federal lead formal enforcement actions were extracted from ICIS. Information about joint federal/state actions were consolidated from ICIS and the relevant media data system.

4.2 AUDITING THE FORMAL ENFORCEMENT ACTION DATA

On April 27, 2004 OC sent an email containing background and instructions for the audit to EPA Regional contacts. Regional staff distributed the instructions to the Region's program staff and to appropriate state agency staff (for state programs with the responsibility of carrying out and reporting formal enforcement actions). Specifically, the instructions guided participants to the audit website where more detailed technical information regarding execution of the audit was maintained.

Participants logged into the "Formal Enforcement Action Audit" website using instructions distributed by email. At the website, each participants was given detailed instructions and the list of sampled IDs for which he/she was responsible. Participants were able to verify the formal enforcement action records at the website.

When participants logged into the website, they selected the state/Region and data system they were auditing. Participants were prompted to provide their contact information so they could be reached if clarification of their responses was needed. They were also asked if they were auditing state or federal formal enforcement actions and were only shown relevant formal enforcement actions. Participants were instructed to print the facility identification information for the sampled IDs and retrieve the final actual enforcement action documents for use in verifying the data system content of the sampled facilities.

Typically, Regional staff review federal lead enforcement actions and delegated state staff review state and local lead enforcement actions. However, during the FY01 Random Audit of Inspection Data, it was discovered that certain Regions maintained hard copy records for both state and federal enforcement actions. This audit was designed to allow an EPA Region to more easily register to audit state records if the Region maintained the records of state-lead enforcement action.

For federal actions, the website displayed EPA formal enforcement actions from ICIS for the one year audit time-frame. For state actions, the website displayed the state formal enforcement actions that were in AFS, PCS, and RCRAInfo in the same time period.

For each formal enforcement action presented, the participants checked the final actual enforcement action documents for the facility selected and confirmed or corrected the following information:

- ▶ Existence or absence of each formal enforcement action record
- ▶ Lead agency issuing the action
- ▶ Date
- ▶ Formal enforcement action type
- ▶ Associated penalty amounts for federal lead actions (EPA staff only).

Users were also prompted to enter any additional formal enforcement actions that did not appear on the screen.

The goal of the audit was to make statements about the accuracy of formal enforcement action information, including whether or not formal enforcement actions had occurred. Therefore, in cases where no formal enforcement actions occurred for a particular program ID, users were asked to verify that this was correct.

Participants were periodically prompted by both the Regions and OC to complete the verifications within the allotted time period. Completion rates for both CWA and RCRA programs was 100 percent. For the CAA program, all Regions and all but one state completed the audit.

4.3 POST VERIFICATION

Once all verifications were complete, the responses were reviewed to ensure they were valid. Errors in responses were corrected. Where there was some question regarding the validity of the response, participants were contacted to verify or clarify details concerning their audit entries. For example, if a participant indicated that a formal enforcement action was missing, the action type was checked to confirm that it was within the audit's scope. Additionally, ICIS was reviewed for all added actions for which EPA was the lead agency. This eliminated recognizing actions that were missed due to a faulty AFS-FRS-ICIS link as an error in enforcement action records. A list of identified errors was prepared for each of the data system leads.

After all the audit responses were reviewed, estimates of the accuracy of formal enforcement action information in each data system were made at the national level. Section 6 contains the details of the methodology employed to make these estimates.

5. ISSUES CONSIDERED IN THE DEVELOPMENT OF THE AUDIT METHODOLOGY

The following issues were discussed by the Identification of Data Problems Work Group (the Work Group) during the development of the audit methodology.

Which universes of facilities and formal enforcement action should be included in the audit?

The Work Group decided that only federally-reportable facilities should be included in the audit. As data entry for enforcement actions are not consistently required for the various types of minor facility permits/IDs across the media programs, minor facilities enforcement actions should not be included. In addition, the Work Group decided that the audit should only include federally-reportable formal enforcement action types for each program.

Should the number of facilities audited per state be the same for all states, or a percentage of the number of facilities in the state?

The Work Group decided to select the same number of facilities for the audit from each state. As with the previous audit, this approach simplifies implementation, minimizes burden on all states and Regions, and maximizes participation. In addition, auditing a slightly larger number of facilities in small states helps decrease the size of the confidence interval without a disproportional burden on these states.

Should the federal formal enforcement action data be pulled from ICIS or the state Legacy Systems (AFS, PCS, and RCRAInfo)?

The Work Group decided to use data from ICIS for federal formal enforcement actions and the legacy systems for state formal enforcement actions because ICIS is the official database of record for federal formal enforcement actions. Facility samples were selected from each program database and ICIS using the Integrated Data for Enforcement Analysis (IDEA) system. To select the federal formal enforcement action data the federal formal enforcement action information was cross referenced with facilities in the program database and ICIS using the Facility Registry System (FRS) linkages.

Should the sample size be increased from 8 facilities per state (the number used in the previous audit)?

The Work Group decided to sample 16 facilities per state per data system (of which eight (8) facilities have one or more formal enforcement action, and eight (8) facilities have no formal enforcement actions). In the previous audit, only 8 facilities per state were audited. The increase in sample size was necessary because the fraction of facilities with an enforcement action for any given year is much smaller than the fraction with inspections. Because the enforcement action audit involved sampling for errors in rare events (i.e., formal enforcement actions within a one-year time period), a larger sample was needed to maintain the same confidence interval as was generated in the Inspection Audit.

6. STATISTICAL METHODOLOGY

Introduction

The approach and methodological details reflect the decisions and input of OC's Data Quality Work Group, the Environmental Council of the States (ECOS), and program leads knowledgeable about CAA, CWA, and RCRA programs and data that are the subject of this audit.

The random audit evaluated separately formal enforcement action data (including ICIS for federal lead actions) for qualifying facilities in the AFS, PCS, RCRAInfo data systems. The goal of the audit was to evaluate the accuracy of the formal enforcement action data in the federal data system of record. To accomplish this goal, a random sample of facilities from each legacy data system was required. Facility-level records were sampled according to the distribution of the number of formal enforcement actions during the one year period. A sample was drawn from the national database that contains the same distribution of formal enforcement actions per selected facility as occurs in the national database. This strategy is discussed in more detail below.

To account for the lower occurrence of formal enforcement actions, the sample size was increased and two subpopulations were sampled. Separate samples of eight (8) facilities each were drawn from:

- a) facilities with no formal enforcement actions in the most recent year and
- b) facilities with one or more formal enforcement actions within the selected sample.

Sampling these two subpopulations using the same sample size as was used in the inspection audit (eight facilities per state) yields a confidence interval approximately the same size as was predicted for the previous audit. The previous inspection audit was based on an *a priori* error rate assumption of 5 percent, which would yielded a 95 percent confidence interval of ± 1.5 percent.

Determining the Sample Size

One of the first steps in designing the audit was to develop estimates of the sample sizes that would yield estimates with various margins of error. The margin of error is expressed as a half-width of a 95 percent confidence interval. Based on previous data quality investigations, we assumed that the true error rate (how often the national data systems contain information that does not match the field records) is less than 5 percent.⁵ In reviewing the sample sizes, the considered the tradeoffs between accuracy of the results and participant burden for each government entity that would be participating in the audit.

The following example shows how a sample size can be calculated using the AFS population (42,075), an assumed error rate of 5 percent, a confidence interval of 95 percent, and a confidence interval width of 3.5 percent to 6.5 percent. The remainder of this section presents the methodological approach and illustrative examples of the statistical methodology followed for designing the sampling and processing the results.

EXAMPLE CALCULATION

In the random audit, population proportions or percentages of some outcomes of interest are estimated. The variable of interest takes a value of either zero or one. For example, the response to a question is "yes - the federal data system accurately reflects the field record" or "no - the federal data system does not

⁵ Sector Facility Indexing Project - 1998, 2001; Region 10's EC-Online - 2000.

match the field record.” Essentially, the population consists of zeroes and ones.

Let “P” denote the proportion of “ones” in the population. For example, if 10% of the 100 facilities in the population have accurate formal enforcement action information, the population can be considered to consist of 10 ones and 90 zeros.

The variance of the characteristic (which takes a value one or zero) in such a population is given by:

$$P(1-P)$$

If a simple random sample of size “n” is selected from such a population and a sample proportion is computed, the variance of the sample proportion “p” is given by:

$$P(1-P)/n$$

The standard deviation of the sample proportion is given by:

$$\text{Square root of } P(1-P)/n \text{ or } \text{Sq}[P(1-P)/n]$$

A 95% confidence interval for the population proportion is given by:

$$p \text{ plus or minus } 1.96 \times \text{Sq}[P(1-P)/n]$$

The half-width of the confidence interval is given by:

$$1.96 \times \text{Sq}[P(1-P)/n]$$

As mentioned above, the true error rate is assumed to be equal to 0.05. For the confidence interval width ranging from 3.5% to 6.5%, the half-width of the interval is 1.5% or 0.015 (6.5% -5%).

Since the half-width of the confidence interval is:

$$1.96 \times \text{Sq}[P(1-P)/n], \text{ this should be equal to } 0.015.$$

That is, n is such that:

$$1.96 \times \text{Sq}[P(1-P)/n] = 0.015$$

Squaring both sides yields:

$$1.96 \times 1.96 \times [P(1-P)/n] = 0.015 \times 0.015$$

Therefore, the sample size is:

$$n = [1.96 \times 1.96 \times P(1-P)] / 0.000225$$

Substituting P=0.05, yields:

$$n = 1.96 \times 1.96 \times 0.05 \times 0.95 / 0.00025$$

$$n = 0.182476 / 0.000225$$

$$n = 811$$

A sample of 811 facilities is required to obtain estimates with the stated precision if sampling occurs from a very large population or when the sampling fraction (the ratio of the number of units in the sample to the number in the population) is low. If sampling occurs from a finite population and the sampling fraction is not close to zero, then the variance of the estimate is slightly less than what has been assumed for sample size calculations. The reduction in variance is achieved by multiplying the variance under a large population by a factor $(1-f)$, where f is the sampling fraction. This term, $(1-f)$, is called the finite population correction. Therefore, the sample size of 811 is required assuming a very large population is reduced by dividing by a factor $(1+f)$.

A sample of 811 is selected from a finite population of 42,500 facilities with formal enforcement actions. Therefore, the sample size is reduced by the finite population correction which is:

$$n \text{ (adjusted)} = n/[1+f/N] = 811/[1+ 811/42,500] = 811/ 1.01927$$

This calculation yields a sample size = 795

The sample of 795 is determined assuming that a simple random sample of formal enforcement actions is selected. However, first facilities (or permits for AFS) are sampled and then formal enforcement actions are selected from the sampled permits. The variance of the estimates based on such a sample of formal enforcement actions is slightly higher than what would occur under simple random sampling. To compensate for this higher variance, the sample size of 795 is increased by simply multiplying by a factor of 1.3. This factor is called the design effect and is the ratio of the variance of the estimate of interest under the design to the variance of the estimate under simple random sampling.⁶ Since there is no estimate of the design effect from previous data, a conservative value of 1.3 is assumed due to clustering of formal enforcement actions within permits. The adjusted sample size is:

$$1.3 \times 795 = 1,034$$

Sample Size

The Data Quality Strategy determined that it was important to be at least 95% confident that the results were within a reasonably small confidence interval. It was also determined that the same size sample for each state (16) would simplify administration of the audit and provide some completed responses above the minimum needed for the audit. The fact that smaller states were “over sampled” when using the same sample size (16 facilities) per state was accounted for in the post-audit statistical processing and weighting.

Accounting for Variation in the Number of Formal Enforcement Actions per Permit/ID

In this data quality audit, facilities that received varying numbers of formal enforcement actions were

⁶ Cochran, W. G., Sampling Techniques, John Wiley & Sons, Third Edition, pg 85.

reviewed and verified. To ensure that the range of formal enforcement actions per permit/ID was adequately represented in the sample, permits were sampled proportionally to the number of formal enforcement actions per permit or facility ID. To do this, the following steps were taken:

1. Sort the permits by the number of formal enforcement actions for each state separately;
2. Separate permits with one or more formal enforcement action from those with no formal enforcement action;
3. Count the total number of permits in each subpopulation;
4. Divide the number of permits by eight (the number of permits to be verified in each subpopulation in each state);
5. Apply a fractional sampling interval to determine which permits should be selected in each state to form the random sample.

EXAMPLE CALCULATION

1. Assume, for example, that in the state of Alaska there are a total of 63 AFS permits with an enforcement action being audited.
2. Dividing the 63 permits by 8 (the subpopulation) yields a sampling interval of 7.87.
3. Select a random number between 0 and 1, say 0.3. A different random number is selected for each state.
4. Multiplying the sampling interval (7.87) by 0.3 yields the fractional sampling interval of 2.36.
5. Adding the sampling interval (7.87) to the fractional sampling interval (2.36) yields a new fractional sampling interval of 10.23.
6. Continue adding the new fractional sampling interval a total of eight times.

The results are as follows:

2.36	18.1	33.84	49.58
10.23	25.97	41.71	57.45

- Round up each interval to determine which observation to include in the sample. In this example, we would select the:

2 nd	18 th	34 th	50 th
10 th	26 th	42 nd	57 th observations.

Development of the Confidence Interval

It is difficult to determine the precision of an estimate under stratified sampling with disproportional allocation without knowing the variability in the sampling weights and the error rates in the different strata. With a sample of 95 formal enforcement actions per data system (total of 285), the 95% confidence interval based on a sample percentage of 5% was determined to be 0.0% to 10.0%. This confidence interval was developed under simple random sampling of formal enforcement actions but adjusted (assuming a design effect of 1.3) for the fact that permits were sampled and formal enforcement actions were selected within select permits.

If the sample is allocated proportionately to each state, the precision is likely to be better than what is

achieved under simple random sampling. The gain in precision depends on the differences in the error rates between states.

To address the possibility that some states may not participate, however, the Work Group decided that each state should be asked to verify 16 permits. If an equal sample size of 16 per state is used, resulting in unequal weights, then there is some loss in precision compared to the use of equal weights. The loss depends on the variability in the sampling weights. The loss from using unequal weights is roughly measured by the quantity:

$$1 + [cv (w_i)]^2$$

where:

cv = the coefficient of variation of the weights measured by taking the standard deviation divided by the mean weight.

w_i = the sampling weight attached to the i th formal enforcement action in the sample.

If a 70% coefficient of variation is assumed for the sampling weights, then the loss would be around 1.5. Even with this loss, the confidence interval would be approximately 3.5% to 6.5%.

Sampling Weights

For producing population-based estimates, each sampled facility for which complete data were available was given a sampling weight. This weight is the number of observations in the population represented by the sample observation. The sampling weight adjusted for unequal probabilities of selection and yields unbiased estimates. The final weight combined a basic weight, which is the inverse of the probability of selection of the record and an adjustment for non-response.

As mentioned above, the Work Group decided that each state should be asked to check formal enforcement action data for 16 permits. As such, the sample size did lead to over-sampling of the smaller states. This over-sampling of some states provided a cushion by helping to address the possibility that some states will not participate. We followed the approach outlined below to address the problem of states not participating in the audit.

Permit weights in some responding states were adjusted to account for permits in the non-responding states. To do this, similar responding and non-responding states were grouped or collapsed and the weights in the responding states were adjusted. This approach is illustrated using the following:

EXAMPLE CALCULATION

- ▶ Assume there are four states in the data quality audit. Assume the number of permits in the population and the sample are as follows:

State	Number of Permits/IDs	Number in the Sub-Sample	Sampling Weight
AA	20	8	2.5
BB	40	8	5.0
CC	15	8	1.87

DD	8	8	1.0
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► Assume that the number of responses in each of the states is as given below:

State	Number of Responses for each Sub-Sample	Sampling Weight Adjusted for Non-Response in the State
AA	8	2.5
BB	6	$6.66 = [(8/6) \times 5.0]$
CC	5	$2.99 = [8/5) \times 1.87]$
DD	0	-

Since there are no responses in state DD, the weight for state DD cannot be adjusted. If states CC and DD are similar with respect to certain characteristics of interest in the survey, then it is possible to collapse states and consider this grouping as one state. If the two states are grouped for weighting purposes, then the combined population is 23, the sample size is 16, and there are 5 responses.

For each of the 5 participants in state CC, the weight is adjusted such that the sum of the weights equals 23 (15 permits in state CC plus 8 permits in state DD). That is, the adjusted weight for permits in state CC is:

$$4.58 = [(23/15) \times 2.99]$$

where:

23 = total number of permits in states CC and DD,

15 = total number of permits in state CC, and

2.99 = adjusted sampling weight in state CC.

The weight of each permit in state CC is 1.87, which when summed, gives a total of 15 permits that should now be adjusted such that the sum of the weights =23.

Another way of looking at this is that there are 23 permits in the population and 5 participants in the sample. The weight is:

$$23/5= 4.6$$

The final weights are:

2.5 for permits in state AA,

6.66 for permits in state BB, and

4.6 for permits in state CC.

7. QUALIFYING FEDERALLY-REPORTABLE FORMAL ENFORCEMENT ACTION TYPES

The following formal enforcement action types were included in the FY03 audit (October 1, 2002 to September 30, 2003):

CAA Formal Enforcement Actions:

State lead actions initiated in FY03, from AFS:

- 1D State Criminal Referral
- 1E Civil Referral to State Attorney
- 2D State Court Consent Decree
- 8C State Administrative Order Issued
- 9C State Civil Action

EPA lead actions initiated or settled in FY03, from ICIS:

- Administrative - Formal
- Judicial

CWA Formal Enforcement Actions:

State lead actions initiated in FY03, from PCS:

- AE Penalty AO Issued by State
- A1 CWA Penalty AO
- A3 NPDES Penalty AO Category II
- A5 Pretreatment Penalty AO
- C1 Time Schedule Order
- 21 Administrative Order
- 22 Administrative Consent Order
- 25 Consent Decree
- 37 Trial Court Order/Judicial Order
- 71 Pretreatment Consent Decree
- 72 Pretreatment AO
- 75 FED Facility Comp Agreement
- 78 Administrative Complaint Filed
- 89 Order of Suspension or Revocation
- 97 Emergency Order, Governor

EPA lead actions initiated or settled in FY03, from ICIS:

- Administrative - Formal
- Judicial

RCRA Formal Enforcement Actions:

State lead actions initiated or settled in FY03, from RCRAInfo:
any code in the 200 series through the 699 series

EPA lead actions initiated or settled in FY03, from ICIS:

- Administrative - Formal
- Judicial

ATTACHMENT 2

RESULTS OF THE RANDOM AUDIT OF FY01 INSPECTION DATA

In FY 2002, OECA conducted a baseline assessment of the accuracy and completeness of state and federally-reportable inspection data by information in AFS, PCS, and RCRAInfo based on an audit of eight randomly selected facilities per media program (Air, Water, and RCRA). To keep respondent burden at a minimum, the audit was designed to provide estimates of accuracy at the national level only, using the smallest sample that would yield statistically relevant results.

This national level information provides us with an objective measure of how well we are doing in maintaining important information on our monitoring program; and provides OECA with a baseline from which improvements in data quality and the impacts of data quality initiatives can be measured. Participation by both the states and Regions reached 100%. The results, finalized in the December 18, 2002 technical report, are summarized below.

- For inspections recorded in the data systems, inspection record information: date, lead agency, and type, are more than 95 percent accurate in all three data systems.
- Fewer than 2 percent of facilities in all three data systems recorded inspections which did not occur within the sample year; the figure for RCRAInfo is zero percent.
- Coverage data (i.e., was a facility inspected within the time frame) is 99 percent accurate for all three data systems.
- Statements asserting the opposite, that a facility was not inspected during the time period, are 92 to 99 percent accurate across the three data systems.

Missing inspections account for the majority of errors in all three data systems.

The above bullets provide various break downs of the results. The following three statements describe the overall quality of inspection data in the AFS, PCS, and RCRAInfo data systems at a national level, based on the audit. These statements answer the question: "What percentage of facilities have completely accurate inspection information?"

1. The inspection information maintained by EPA and the states in AFS is 87% accurate¹.
2. The inspection information maintained by EPA and the states in PCS is 87% accurate¹.
3. The inspection information maintained by EPA and the states in RCRAInfo is 97% accurate¹.

Full details on this study are in the December 18, 2002 report: "Results of the Random Audit of FY 01 Inspection Data."

¹Based on the survey methodology used, we are 95% confident that this error rate is within 4% of the true value for AFS and PCS, and within 2% of the true value for RCRAInfo.