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## **Statistical Analysis of the Post-Election Audit Data 2014 August Primary Elections**

**December 26, 2014**

**Version 1.0**

### **Abstract**

This report presents the analysis of the post-election audit returns performed in the State of Connecticut following the August 12, 2014 primary elections. The audit involved the randomly selected 10% of the districts. The total of 305 audit records were submitted for analysis.

There are 6 records that were improperly filled out and so were not usable for this report. These records merit a follow up, but do appear to show no discrepancy between the hand count and machine count.

There are 24 records that were provided containing empty data. These records were clearly not used for the audits and are not considered for this report.

There are 11 records with differences between hand and machine count greater than or equal to 1. There was 1 record with a discrepancy greater than 1, and that record's discrepancy was 2 votes between the hand and machine counts. This report presents the analysis of the original 275 correct records (90.02%).

The conclusion is that for the audited districts the tabulators appear to be operating properly.

This analysis was performed on request of the Office of the Secretary of the State.

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## Summary

The University of Connecticut Center for Voting Technology Research (VoTeR Center) received the data gathered in the post-election audit performed in the State of Connecticut following the August 12, 2014 election. The audit involved the randomly selected 10% of the districts and the audit returns were conveyed by the Office of the Secretary of the State (SOTS) to the VoTeR Center on December 4, 2014. The audit data received by the Center contains 305 records, where each record represents information about a given candidate: date, district, machine seal number, office, candidate, machine counted total, hand counted total of the votes considered unquestionable by the auditors, hand counted total of the votes considered questionable by the auditors, and the hand counted total, that is, the sum of undisputed and questionable ballots. This report contains several statistical analyses of the audit returns and recommendations.

This report presents the analysis of 275 records. This is the total number of records less the 6 records improperly filled-out and the 24 additional empty records; these records are not considered for this report. There are 11 records with differences between hand and machine count greater than or equal to 1. There was 1 record with a discrepancy greater than 1, and that record's discrepancy was 2 votes between hand and machine counts. The causes for such differences, as reported by the auditors, mostly fall into one of the following:

- Human error in counting.
- Questionably marked ballots, e.g., barely filled in ovals, ovals being marked either as V's or being crossed off.
- In one case 1 ballot was reported missing, which accounts for the difference between the machine and hand counted totals.
- There are four hand-count reports that reported unexplained discrepancies (and none of the discrepancies reported were more than 2 votes):
  - Hartford (Cong. 1, St. Senate 2, Assembly 1)
  - East Lyme (Cong. 2, St. Senate 20, Assembly 37)
  - East Haven (Dist. 5)
  - Middletown (Dist. 11&12)
- In one case (Hartford Dist. 5), it is assumed that a ballot was stuck in the AVOS and run twice, resulting in a one vote discrepancy.

A follow up may be conducted by the SOTS Office for the relevant districts, in this case the report will be revised accordingly.

The data presented in this analysis show that the average reported discrepancy is lower than the average number of questionable votes on the ballots (0.04 versus 0.20). The conclusion is that for the audited districts the tabulators appear to be operating properly.

This analysis was performed on request of the Office of the Secretary of the State.

## Preface

The University Of Connecticut Center for Voting Technology Research (VoTeR Center) received the data gathered in the post-election audit performed in the State of Connecticut following the August 12, 2014 primary elections. The audits of the randomly selected 10% of the districts were conducted in August and September of 2014, and the returns were conveyed by the Office of the Secretary of the State (SOTS) to the VoTeR Center on December 4, 2014.

For the definition of the audit see Connecticut Public Act 07-194 AN ACT CONCERNING THE INTEGRITY AND SECURITY OF THE VOTING PROCESS, approved July 5, 2007. For the instructions on conducting the audit, see Audit Procedures Optical Scan Voting Equipment, Office of the Secretary of the State, November 2007.

In accordance with the Act, the SOTS office conveys the report documenting hand audit returns to the VoTeR Center, and the Center is in turn required to report on its analysis to the SOTS Office:

“(d) ...Such report shall be filed with the Secretary of the State who shall immediately forward such report to The University of Connecticut for analysis. The University of Connecticut shall file a written report with the Secretary of the State regarding such analysis that describes any discrepancies identified. After receipt of such report, the Secretary of the State shall file such report with the State Elections Enforcement Commission.”

The following subsections of the audit law are also highly relevant:

“(i) If the audit officials are unable to reconcile the manual count with the electronic vote tabulation and discrepancies, the Secretary of the State shall conduct such further investigation of the voting machine or tabulator malfunction as may be necessary for the purpose of reviewing whether or not to decertify the voting machine or machines in question or to order the voting machine to be examined and recertified....

(o) As used in this section, “discrepancy” means any difference in vote totals between machine and manual counts in a voting district that exceeds one-half of one percent of the lesser amount of the vote totals between machine and manual counts where such differences cannot be resolved through an accounting of ballots...”

This analysis was performed on request of the Office of the Secretary of the State.

## 1 Overview of the Analysis

This report contains several statistical analyses of the audit returns. The VoTeR Center received 305 records on December 4, 2014. Of these 305 records, 6 are improperly filled out and are not considered for this report. Another 24 records were empty and clearly not used for the audit and are not considered for this report. So the total number of records considered in this report is 275.

The statistical analysis in this report deals with the 275 records (100%). Among 275 (100%) records there are 264 (96.0%) records showing no discrepancy, 10 records (3.6%) showing a discrepancy of 1 vote, and 1 record (0.4%) showing a discrepancy of 2 votes.

The average number of votes recorded for the candidates is 42.9. The overall average number of questionable votes is 0.20. The marked ballots are determined to be “questionable” by the human auditors: a ballot is questionable if the auditors believe that it is marked in such a way that the machine will likely not be able to read it properly. Note that this does not mean that the machine absolutely would not read it. Given that this assessment is based on human judgment call, it is predictable that in many cases hand counts would not match machine counts.

The average absolute discrepancy between the machine count and the hand count performed in the audit is 0.04. This number is computed by taking the sum of the absolute (positive) values of the discrepancies in all records and dividing this sum by the number of records. Thus, on the average reported discrepancy (0.04) is smaller than the average number of reported questionable votes (0.20). Overall this is a good indication, suggesting that, on average, despite the presence of questionably marked ballots, the machine count is very close to the hand count. One conclusion is that hand counting of the ballots during the audit is an error-prone process.

The detailed analyses of the audit returns are given in Sections 3.

## 2 Introduction and Notation

Throughout this document we use the following notation:

- $M$  is used to denote the machine counted ballots
- $U$  is used to denote the number of undisputed hand counted ballots
- $Q$  is used to denote the number of questionable hand counted ballots
- $H$  is the sum of undisputed and questionable ballots, that is,  $H = U + Q$
- $D$  is the discrepancy between the hand counted total and machine total, that is,  $D = H - M$

Thus for a given candidate, we define discrepancy  $D$  as the difference between  $H$  (the sum of the undisputed ballots  $U$  and the questionable ballots  $Q$ ) and  $M$  (the machine count).

If the discrepancy  $D$  is positive then we say that we observe a machine undercount relative to the hand count  $H$ , i.e., the machine counted fewer ballots than the auditors.

If the discrepancy  $D$  is negative then we say that we observe a machine overcount relative to the hand count  $H$ , i.e., the machine counted more ballots than the auditors.

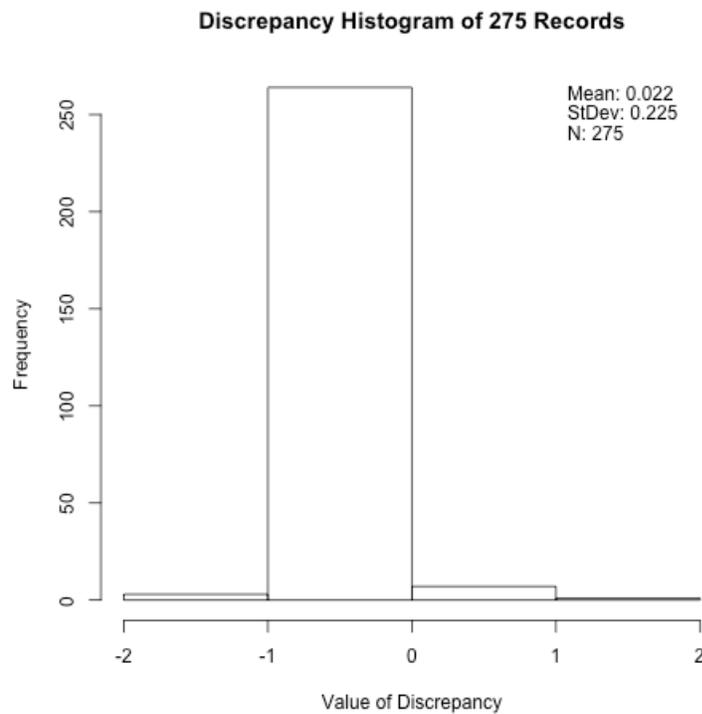
- $|D|$  is the absolute value of the discrepancy (or the positive value of  $D$ )

This means that if  $D$  is positive, then  $|D| = D$ , and if  $D$  is negative, then  $|D| = -D$ .

Note that this presupposes that the hand count does not contain (human counting) errors. This is not necessarily so in actuality. However, since in general it is not possible to ascertain whether the hand counted data contain errors, we assume that the hand counted data is reported correctly, unless a follow up investigation determined otherwise.

## 3 Statistical Analysis of 275 Records

This section deals with 275 records (100%). Figure 1 is the graphical representation of the discrepancy distribution. Later in this section we analyze the absolute value of discrepancy, the pattern of undercounts and overcounts, and the percentage of the votes reported as questionable.



**Figure 1. Discrepancy histogram of 275 Records**

### 3.1 Absolute Value of Discrepancy

Here we give the analysis for the absolute number of discrepancies,  $|D|$ . We include discrepancies for all records for which both the machine count  $M$  and the total hand count  $H$  is given. For the 275 records considered here, the average absolute discrepancy is 0.04, and the standard deviation is 0.22, suggesting that the occurrences of discrepancies are clustered in the vicinity of the average. Table 1 presents tiered view of the absolute value of discrepancies.

**Table 1: Absolute value of discrepancy.**

Description	Counts	% of Counts
Records with discrepancy $ D $ of 0	264	96.0%
Records with discrepancy $ D $ of 1	10	3.6%
Records with discrepancy $ D $ of 2	1	0.4%
Totals:	<b>275</b>	<b>100%</b>

Table 2 presents tiered view of the absolute value of discrepancies by the percentage of discrepancy.

**Table 2: By Percentage of Discrepancy**

Description	Counts	% of Counts
Records with discrepancy 0% to 0.4%	264	96.0%
Records with discrepancy > 0.4% to 1%	4	1.5%
Records with discrepancy > 1%	7	2.5%
Totals:	<b>275</b>	<b>100%</b>

### 3.2 Undercount and Overcount Discrepancies

When considering negative discrepancies (overcounts) and positive discrepancies (undercounts) for the 275 records, the average discrepancy is 0.02, and the standard deviation is 0.22.

Table 3 presents discrepancies for the records that indicate overcounts.

**Table 3: Records indicating overcounting: 3 (1.1% of 275) records with negative values of discrepancy.**

Description	Counts	% of Counts
Records with discrepancy D of -1	3	100%
Totals:	<b>3</b>	<b>100%</b>

Table 4 presents discrepancies for the records that indicate undercounts.

**Table 4: Records indicating undercounting: 8 (2.9% of 275) records with positive values of discrepancy.**

Description	Counts	% of Counts
Records with Discrepancy D of 1	7	82.5%
Records with Discrepancy D of 2	1	12.5%
Totals:	<b>8</b>	<b>100%</b>

### 3.3 Statistics for Questionable Ballot Counts

The average number of questionable votes per record is 0.20. Table 5 presents statistics with respect to the questionable ballots per candidate.

**Table 5: Questionable Ballot Counts.**

<b>Description</b>	<b>Counts</b>	<b>% of Counts</b>
Records with questionable count Q of 0	240	87.3%
Records with questionable count Q > 0 to 2%	17	6.2%
Records with questionable count Q > 2% to 5%	15	5.4%
Records with questionable count Q > 5% to 10%	1	0.4%
Records with questionable count Q > 10%	2	0.7%
Totals:	<b>275</b>	<b>100%</b>

## 4 Conclusions

The analysis observes that on the average the absolute number of reported discrepancies (for complete audit records) is smaller than the average of the reported questionable votes. This is consistent with prior audits. Here one may conclude that tabulation errors, if any, have smaller impact on the counts in comparison to the questionable votes. The conclusion is that for the audited districts the tabulators appear to be operating properly.

We also note that there are improvements in the hand count process. In most cases great attention was paid to the discovered discrepancies. As noted by the auditors, in most of the cases when a discrepancy between the hand and machine counts was observed it was due to the fact that the bubbles were not marked correctly or fully filled in by the voters.

[end]