



**PIMA COUNTY ELECTION INTEGRITY COMMISSION
MEETING MINUTES FOR DECEMBER 16, 2016**
<http://www.pima.gov/commission/ElectionIntegrity.shtml>

The Pima County Election Integrity Commission met in regular session on December 16, 2016 at 9:00 a.m. in the Herbert K. Abrams Building, 3rd Floor Conference Rooms 3108/3110 at 3950 S. Country Club Road, Tucson, Arizona.

ITEM 1. ROLL CALL

Present: Arnie Urken, Mary DeCamp, Brad Nelson, Karen Schutte, Jeff Rogers, Brian Bickel, Bill Beard, and Tom Ryan. Beth Borozan arrived just after the roll call.

Also in Attendance: Ellen Wheeler and Nicole Fyffe, County Administrator's Office; Tom Quigley and David Wisely, Pima County Elections Department.

Absent: Barbara Tellman, Chris Cole.

ITEM 2. PLEDGE OF ALLEGIANCE

The American flag was saluted with the Pledge of Allegiance.

ITEM 3. APPROVAL OF MINUTE SUMMARY – November 18, 2016

It was moved by Bill Beard, seconded by Brian Bickel and carried unanimously to approve the Minutes of the November 18, 2016 meeting.

ITEM 4. CALL TO PUBLIC

No comments from the public.

ITEM 5. INTRODUCTION OF NICOLE FYFFE, EXECUTIVE ASSISTANT TO MR. HUCKELBERRY – Tom Ryan

Ellen Wheeler will be moving on to some other assignments, and introduced Nicole Fyffe as Mr. Huckelberry's liaison to the EIC. Nicole has been with Pima County for fifteen years, beginning with the Sonoran Desert Conservation Plan and acquisition of much of the land for that. She has managed bond projects and the Bond Advisory Committee. As such she has worked on election issues, including the bond elections.

The Commission welcomed Nicole and thanked Ellen Wheeler for her service on the Commission.

ITEM 6. UPDATE ON HERNANDEZ LAWSUIT & PUBLIC RECORDS REQUEST – Brad Nelson

Counsel for Mr. Hernandez, Mr. Nye made a public records request including the cast vote records for the 2016 Primary and General Elections, which were provided to Mr. Nye. In addition, he had requested ballot images for those two elections; Brad informed Mr. Nye that, pending direction from Superior Court Judge Gordon, that request was denied. Brad was notified by the County Attorney's office that the next hearing on this issue will be March 13, 2017 at 10:00 a.m., the subject matter of which will be Pima County's request for a motion to dismiss.

Tom and Bill agreed this Item should remain on the Agenda pending the hearing in March.

Brian asked if Pima County was the only county saving and storing images. Brad explained that election officials in other Arizona counties using the same equipment received requests from Mr. Hernandez's attorney to save their images as well. Some of those counties had already started tabulation and they were unable to comply with the request.

ITEM 7. BALLOT IMAGES: HUCKELBERRY MEMO, WHITE EMAIL, RYAN RESPONSE – Tom Ryan

Tom mentioned the original memo from Mr. Huckelberry about their legislative agenda which included a section on elections and ballot images [a copy of this memo is incorporated into these Minutes as Attachment 1]. There was also an email from Benny White to Mr. Huckelberry on the subject of ballot images with a response from Tom Ryan [a copy of this email is incorporated into these Minutes as Attachment 2]. Tom wanted to distribute this information and added it to the Agenda to comply with Open Meeting Laws.

Ellen asked if the Maryland audit had been completed; Benny White addressed the Commission. He had a conversation with ClearBallot about the audit. Maryland has a State Board of Elections that controls all their elections processes; early in 2016, they decided to have a post-election audit of the General Election in November, involving about six million ballots statewide. They engaged ClearBallot and their systems for that audit. They looked at the digital ballot images captured by the ES&S equipment used throughout the state, instead of rescanning the ballots themselves. The audit has been completed and there are reports available online. The State Board of Elections is compiling a comprehensive report, evaluating all the individual county reports. In short, the ClearBallot auditing system found more votes than recorded by the ES&S equipment. There are a number of reasons for that, which Benny is hopeful will be addressed in the final report.

Bill asked if this audit had been ordered as a test, as a response to a lawsuit, or is there clear legislative authority for this in the State of Maryland. Benny responded that there is clear legislative authority, and he is not aware of a lawsuit. As far as he knows, they were just trying to improve their election systems.

Karen asked Benny if Maryland was the location where the ES&S equipment had a scratch; Benny answered that it was discovered that one or possibly more of their pieces of equipment had a scratch and when the ballot image came through, there was a dark line through an oval. [See Benny's discussion in Attachment 2, page 2 and item 2.] Karen wondered why that wasn't caught during an L&A test.

Arnie asked how the scratch was discovered; Benny understands that a U.S. Senate race had a high number of overvotes.

ITEM 8. 2017 RECOMMENDED LEGISLATIVE CHANGES – Tom Ryan

Tom requested that this Item be moved for later so that the Risk Limiting Audit could be discussed while Brad's IT team was present. The Commission concurred.

ITEM 9. RISK LIMITING AUDIT PILOT STUDY – Tom Ryan / Brad Nelson

- **Status on Elections Department Preparations for Mock Election**
- **Step-by-Step RLA Instructions**

Tom had sent out a list of step-by-step instructions for the audit [a copy of these instructions is incorporated into these Minutes as Attachment 3]. The audit is currently scheduled for January 25th.

Karen suggested doing a Logic and Accuracy Test (L&A) since the object is to conduct this as similarly as possible to a real election. Brad added that the 30,000 ballots that are premarked should be used for the L&A since there is already a known outcome for those. With four machines, Tom Quigley estimates that could take a half a day; four machines rather than the six because there are not the additional Intermittent staff to help run the two other machines. Brad proposes that his staff assist Commission members who will actually be running the machines to tabulate the ballots, if Commission members would like to do that.

There was discussion about creating close margins for triggering an automatic recount. Tom's belief is the purpose is to test the mechanics of the RLA, understanding how it is done and computations necessary, how much time and personnel will be necessary to conduct the audit. It will also be interesting to do a comparison of the cast vote records (CVR) and the actual paper ballots, versus comparing the CVR's with ballot images. Tom recommends that the major portion of the RLA be done by pulling paper ballots and comparing them to get an idea of how much time is involved. Then a subset of ballots could be audited with the ballot images.

The discussion moved to the Ballot Manifest, and how ballots will actually be selected randomly. When the ballots are scanned and serial numbers imprinted on them, and then placed in boxes, Tom Ryan asked how they would be organized. Tom Quigley responded that when a stack of ballots are run, there are bin reports with the range of ballots using serial number designators, plus the total number of ballots in the bin. The serial numbers are sequential, though there may be missing numbers if the ballot goes through the machine more than once because the original number is dropped.

If the ballots are organized by serial number, there needs to be a method to randomly select from those serial numbers. There needs to be a list—the Ballot Manifest—from one to 30,000 or whatever the exact number is and the list of serial numbers with it. The numbers will be randomly chosen, with the corresponding serial number, the ballot will be removed from its box and a place marker added when auditing the paper ballots. For auditing the ballot images, another random selection will be made with the ballot serial numbers, but now a cast vote record needs to be added to associate with the serial number in order to find the image, because images are stored with their cast vote record.

In order to audit either paper ballots or ballot images, the Ballot Manifest needs to have:

- an index, continuous from 1 to 30,000,
- serial number, and
- cast vote record for each index number.

Tom Ryan clarified that he understands and agrees with Dr. Stark's recommendation to not use ballot images for the RLA, but from a standpoint of understanding what is possible, it is in our interest to discover the timing required for the process using ballot images.

The question arose about using the 300 unmarked ballots for the L&A, include them in the RLA, and run them again for the L&A at the end. Another suggestion was to run the 300 on all four machines and would that be sufficient, or should the 300 be manually tabulated? Karen said that when the L&A is done, the ballots have already been manually tabulated because the marking has been predetermined. Tom suggested that each member mark roughly 30 ballots and keep track of their tabulation results, and combine the results in a spreadsheet. The 300 ballots will be run on all four machines and that will be the L&A test. Tom Quigley and David Wisely recommend that each stack of 30 ballots be run separately to verify the individual results.

Tom Ryan has the 10-sided dice; the public is to roll them outside the counting room. A computer connected to the internet will also be required, outside the counting room. David and Tom Quigley will arrange for a computer workstation in the call center, which is right off the counting room where the public can participate.

Since this is a pilot, they only need to do the L&A once. Tom Quigley suggested that the Commission get their ballots to the Elections Department prior to the day of the RLA and Elections staff can verify the spreadsheets a day or two ahead of time. That would cut down on time required the day of the RLA. The ballots will be disbursed to each Commission member now to mark, and then return to the Elections Department with their spreadsheet no later than Friday, January 20, 2017. For the sake of consistency, Elections Department will create and distribute an Excel spreadsheet template for everyone to use.

Tom Quigley asked how the Commission would like them to proceed if there are any discrepancies between the ballots and the spreadsheets. Tom Ryan would rather nothing be fixed. David suggested that they can run the ballots, take whatever number they get and at the end of the day give them back with members' results to review at their leisure to discover the reason for any discrepancy. Tom Quigley said they could do a mockup of the Ballot Manifest, and Tom Ryan concurred.

Arnie asked if the results could be published on the website; Brad suggested that instead of the Elections Department website, they be published on the EIC website. Tom Ryan listed images, CVR's, SOVC's as data to publish.

Tom Ryan will get back in touch with Dr. Stark for his travel plans. He indicated to Tom he was available the 25th and 26th.

It was decided that the L&A test with the 300 ballots will begin at 8:00 a.m. on Wednesday, January 25th, and the RLA process will start at 9:00.

Tom Ryan requested that Minutes of this Item be produced as soon as possible. [Minutes through Item 9 were sent out to members on December 28th.]

Tom would like to invite Eric Spencer to attend. Tom also suggested other counties' elections personnel; Brad will extend the invitation but is not certain what kind of response to expect, and also to the municipal clerks. Brad has invited ES&S personnel to attend, and believes they will have one or two representatives present, one of whom was in Jefferson County when they performed

their RLA. The Call Center room—immediately adjacent to the Counting Room—can accommodate the overflow.

ITEM 10. ELECTION DATABASE STRUCTURE AND DISTRIBUTION – Tom Ryan

Tom Ryan clarified the terminology for CVR; Dr. Stark calls every record a CVR. Then the CVR's are put into a spreadsheet. Tom would like to distinguish between the CVR and the list of CVR's by calling the spreadsheet list the LVR, or List of Vote Records.

Tom Quigley provided him with the LVR along with the daily SOVC's. Tom Ryan wrote a program that evaluates and tallies the CVR's for an election result. For the RLA, Tom Ryan will have a program created in Python that will tabulate results using the LVR. This is to verify that the results from the CVR's agree with the official statement of votes cast. Dr. Stark thinks there needs to be an automated program that creates this LVR with serial numbers in it, and has offered to do that. Tom Quigley said that the process they do is not really manual; they link the two tables in Access and it drops the serial numbers into the LVR. Tom Ryan had thought it had been done by cut-and-paste and David clarified that in the original attempt it had been, because they were dropping it into Excel. But Access can do it from the two tables. Tom Ryan concurred they will do it that way unless Dr. Stark comes up with something he would rather use.

Tom Ryan stated everything in the database structure and distribution looks good. However, he was looking at election data in the Secretary of State's office, and he was curious about statistics on diluted vote margins. To find out how many ballots would need to be looked at in an RLA, Tom reviewed historical data to calculate the number over a lot of races. It turned out to be impossible; for any vote-for-more-than-one election, you can't calculate the diluted margin because you don't know how many ballots were actually cast when looking at the Secretary of State's website. It would be nice to have that as a separate entity in every race – that is, the number of valid ballots – in terms of the election database structure and distribution.

Brian asked if this data could be provided to EIC members to understand the subject better. Tom added that the mock election data could be added to the Commission website, the SOVC and LVR.

ITEM 8. 2017 RECOMMENDED LEGISLATIVE CHANGES – Tom Ryan

Tom distributed a list of suggested revisions to Arizona law [a copy of this list is incorporated into these Minutes as Attachment 4]. The subcommittee needs to go through this list and pare it down. The subcommittee will consist of Tom, Arnie and Bill; according to the Minutes of the last meeting, Barbara was included, though there is some confusion. Jeff volunteered as a fifth member of the subcommittee. Tom suggested the subcommittee meet sometime in early January.

Brad had an update on the *Procedures Manual*; the elections directors and recorders met, through the Arizona Association of Counties. Eric Spencer, State Elections Director, said it is their intention not to amend the current *Manual*, but start from scratch, with the intention that it will be completed before calendar year 2017 is finished.

In light of the earlier conversation about the audit in Maryland, Bill suggested there should be some guidance in state law, rather than in the *Manual* on how election equipment tabulates over- and under-votes. Brad added that in Maryland, not only was this a brand new system for election personnel, this was also the first time voters used this style of ballot; they were all electronic prior to

this so coloring in a bubble on a paper ballot is brand new. When voters go from one type of system to another, everyone is on a learning curve, including equipment maintenance which might have picked up the scratch on their equipment.

Tom would like for the subcommittee to meet the afternoon of January 11, 2017. But under the "Clarity" items on his handout [Attachment 4], he asked Brad who may observe installation and modification of software (not a department employee) [item 18]; Brad responded they are individuals from the County's IT Department, not from Elections Department. They perform administrative functions, such as hooking up printers, setting clocks, etc. Tom asked Brad if he sends out notices to anybody, such as the typical observers; Brad has no objection to this, but he has not sent out notices, since the cameras in the room stream everything. The other is item 20 about field checks by an expert in electronic voting systems. Brad offered a guess; when the Arizona Secretary of State personnel come to conduct their official Logic and Accuracy Test that may fulfill that requirement.

ITEM 11. FUTURE AGENDA ITEMS

Election of EIC Officers
Ballot Images--Barbara Tellman's memo
Tracking Legislation 2017
Invite Recorder's Office

ITEM 12. NEXT MEETING DATES

January 25 and possibly 26, 2017
February 17, 2017

ITEM 13. ADJOURNMENT

It was moved by Bill Beard and seconded by Beth Borozan and unanimously carried to adjourn the meeting. The meeting adjourned at approximately 10:45.



MEMORANDUM

Date: September 6, 2016

To: The Honorable Chair and Members Pima County Board of Supervisors From: C.H. Muckalbert County Administrator

Re: Primary Election Issues Raised at the September 6, 2016 Board of Supervisors Call to the Public

On September 6, 2016 at the Board of Supervisors Call to the Public, several members of the public raised the issue of being able to verify election results using scanned ballots. The current election equipment, new County-owned, has the ability to scan and count ballots. The scanned images are downloaded to an election server for retention; however, the County currently lacks any authority to do anything with these images. We do not have specific approval from the Secretary of State through written elections procedures for the use of scanned images to verify election results.

As you will recall, this issue was included in our 2016 Legislative Agenda. Attached for your information is an excerpt of Item 8 in our December 15, 2015 communication to the Board of Supervisors regarding election integrity. Our request was exceptionally clear to use scanned ballot images in auditing election results. Nearly a year ago, we requested the ability to utilize scanned images, as is now desired by election activists. Unfortunately, the Arizona Legislature did not act on our request, nor has there been any clarifying rule or amendment to the Arizona Elections Manual to allow same.

This matter is now before Pima County Superior Court Judge Richard Gordon. Judge Gordon has heard the initial case requesting a temporary restraining order to keep the County from destroying scanned images. The County stipulated we would retain the scanned images until the litigation is complete. It is possible Judge Gordon could determine if the County has any ability to verify election results via scanned ballots or if we must continue to rely on the current method of vote count verification by selecting specific races and a number of early and Election Day ballots for verification. It should be noted this traditional method of election verification did occur this past weekend via an observed hand audit of selected races, precincts, and early and Election Day ballots. The hand count audit verified the results.

Under current law and per the present Arizona Elections Manual, the County has no authority to use the scanned images to verify election results, and we have no authority to declare the scanned images a public record. A Court could certainly determine otherwise, but any findings related to such in the Superior Court would be subject to review by both the Court of Appeals and the Arizona Supreme Court.

The Honorable Chair and Members, Pima County Board of Supervisors
**Re: Primary Election Issues Raised at the September 6, 2016 Board of Supervisors Call to
the Public**
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Clearly, the preferred method is to have the Arizona Legislature modernize Arizona Election Law to reflect modern elections technology.

CHH/anc

Attachment

c: Ellen Wheeler, Assistant County Administrator
Brad Nelson, Director, Elections Department

Excerpt from December 15, 2015 Board of Supervisors Memorandum,
"Resolution 2015-____, Recommended Legislative Agenda for 2016"

8. Election Integrity.

Arizona's elections laws are at least two decades behind election technology. Current election laws do not take into account significant advances that have occurred in ballot tabulations, scanning and sorting; nor have they kept pace with the dramatic shift from Election Day voting to early mail-in ballot voting. The entire series of election laws in Arizona needs to be revamped by the Secretary of State; but until that occurs, there are a number of significant modifications to existing election laws that can improve voter confidence in reported election results. Pima County has been a leading proponent of improved election integrity and is the only county in Arizona that has an Election Integrity Commission. The County also continues the tradition of checks and balances by dividing election responsibilities between the County Recorder and County Administration, similar to most other counties in Arizona.

The County has been significantly constrained in our ability to provide voters with the transparency needed to reassure the integrity of election results. On numerous occasions, we have asked the County Attorney for legal opinions regarding the flexibility of the County to address modern day election integrity issues. The most recent example was the legal inability to hand count a local County election. The response received from the Secretary of State, as well as the Attorney General, did not confirm the County has the legal authority to hand count local county election results even though they both concurred the idea was sound.

In addition, the County has desired to scan and post scanned ballots as a public record so any interested citizen can count ballots to verify the electronic results. Attached is an opinion from the County Attorney's Office dated April 10, 2008 indicating the County lacks the authority to scan voter ballots and post the scanned images on the internet. These legal obstacles to the County's election integrity initiatives need to be removed, and election laws in Arizona should be modernized to reflect the current technology in election processing and tabulation. Therefore, I recommend the Board endorse the following election integrity modifications to State election laws:

- A. Modify any State law that prevents or precludes hand count or automated audits of local county elections.
- B. Allow the County, in conducting an election, to scan and sort ballot images for auditing election results.
- C. Allow the County to perform tabulation audits using independent software to process ballot images.
- D. Provide authority for the County, at the County's option, to conduct their elections by mail.
- E. Declare as public records, ballots cast in any election if the ballots have been scanned as electronic images. If an electronic image of a ballot has been created, the electronic image can be treated as a public record and be available for public inspection upon request.

Transcript of Email on Ballot Images

NOTE: CONTACT INFORMATION HAS BEEN REDACTED. All other verbiage is as in original email.

From: Tom Ryan
Subject: Re: Digital Ballot Images
Date: November 30, 2016 at 11:25:06 AM MST
To: Benny White
Cc: Chuck Huckelberry, Brad Nelson, F. Ann Rodriguez, Chris Roads, Eric Spencer, Dan Jurkowitz

Benny,
These kinds of problems are precisely why the tabulation process needs to be more transparent, and ballot images are a good way to accomplish that goal. I think the threat of unsubstantiated lawsuits is low, for reasons explained below.

The ES&S DS850 ballot images are indeed binary, and ClearBallot has said that this is not good enough for the kind of processing they do. But ES&S thinks they can get away with it.

With open ballot images, I don't think there will be lawsuits as you suggest, but there could be formal challenges filed in court if the tabulation system is really bad. In Pima County, the election system produces a Cast Vote Record (CVR), a spreadsheet that shows how each ballot was interpreted by the scanner. Given a ballot image, it is easy to see how the image was interpreted. Anyone with access to the images would have access to the CVR.

If someone wishes to make a claim about inaccurate tabulation, they would need to specify exactly which ballots were interpreted incorrectly and that evidence would have to go before a court in order to challenge the election. The claimant would probably have to show that the number of incorrectly interpreted ballots could cause a change in the outcome.

If the system is accurate enough (and especially if we did meaningful audits) there would be no such claims. If the system is seriously problematic, then a court challenge might succeed, as well it should. But I suspect we're somewhere in the middle, where a few ballots will be misinterpreted, but not enough to affect outcomes except perhaps in an extremely low margin contest (a few votes).

No one expects the tabulation process to be perfect. We know that by looking at recount results (which are public). But the idea that our election tabulation system should be hidden from analysis because it might be inaccurate is exactly why people don't trust the election process.

Tom

P.S. I can't cc the members of the EIC due to Open Meetings Law.

On Nov 30, 2016, at 4:39 AM, Benny White wrote:

Chuck,

I read the memo you sent to the Board of Supervisors recommending that digital ballot images should be available to the public. I support the public knowing what is going in in the election processes and machinery but you are recommending a change in public policy that is premature and will expose the various jurisdictions in the state to increased election litigation.

The state of Maryland is undergoing a statewide audit of the ballots cast in the 2016 General Election. There will be a published report but the audit is not fully complete at this point and the report is not yet available. Maryland is using the ClearAudit system to conduct the audit of the results produced by the ES&S DS200 polling place machines and the DS850 central count tabulations. The DS850 machines are the same model as used in Pima County.

Here are a couple of the early lessons learned:

1. The ES&S equipment captures the ballot image in 200 dpi black and white, as opposed to gray scale.
 - a. There are a number of design reasons ES&S chose to do this but it was done in large part due to the speed of the conveyor system on the DS850 and the short time to evaluate the ballot image because of the speed of the ballot throughput. Processor capability and memory capacity were additional factors involved in this design decision.
 - b. The ES&S equipment (in general) fails to discover a significant percentage of the vote marks because it uses black and white versus gray scale imaging.
 - i. These losses are discovered by the ClearAudit system due to its ability to assess the reliability of every vote mark oval and any pixelization that occurs in that vote mark region and then graphically present those vote mark images in reliability order to a human evaluator.
 - ii. The non-detection of vote marks is more significant in mail ballots than in polling place ballots. Initial analysis appears to indicate that this is related to the fact that polling place ballots are marked with a definite marking device, i.e., a black felt tip marker while mail ballots are marked with a variety of marking devices including various colors of ink, different line width, different marking pressure, pencils, pens, etc.
 - iii. This vote loss problem would be impossible to detect unless a system of vote mark reliability like that used in the ClearAudit system was utilized.
2. There were instances of high numbers of overvoted ballots discovered in the results analysis.
 - a. The overvotes were caused by a line that was input onto the ballot image by a scratch on the camera or ccd lens on one or more ES&S machines. Election officials are currently trying to discover, if possible, which machines were involved so that those ballots can be recounted and the results adjusted.
 - b. This additional line(s) across an oval was enough to cause an overvote determination if the voter had marked another voter mark oval in that same race.
 - i. This problem would be extremely difficult to detect looking at one ballot or a limited number of ballot images at once. However, when you look at 100 or more vote mark images in the same display this problem jumps off the screen at you.
 - c. The marks were primarily in mail ballots and affected the President and U.S. Senate races, or at least that is what the early analysis appears to show.

- i. It is speculated at this time that the reason this scratch mark predominately affected the President and U.S. Senate races is that this showed up in the results of the mail ballots and those ballots were probably fed through the ES&S machines in the same orientation for all ballots.

A member of the public looking at these images on their home computer screen or laptop would never discover these problems or understand why what they were looking at was different than the reported results. As a result they might decide to institute a lawsuit and then the jurisdiction would have to spend a lot of money and resources trying to explain why the results were reported as they were.

I appreciate that the Election Integrity Commission is attempting to improve the integrity of our elections but I don't think the members are adequately informed concerning many issues involved with digital images. Due to what is being discovered in the Maryland statewide audit I believe it is premature to adopt a policy of releasing the ballot images to the public at this time.

My recommendation is that you and/or the county attorney representing the county in the pending court hearing contact Larry Moore at ClearBallot to get additional information about what they are learning about digital images produced by the ES&S equipment. Larry can be reached at 857-250-4961. Their website is <http://www.clearballot.com/>. The court needs to be fully informed on this issue prior to issuing a ruling in the pending lawsuit. You should consider having Mr. Moore testify telephonically during the upcoming hearing.

Benny White
Tucson, AZ 85719

DRAFT**Step-by-Step Instructions for a Risk Limiting Audit
Using the Ballot Comparison Method****Introduction**

The Risk Limiting Audit (RLA) involves comparing the interpretation of ballots by the voting system to human interpretations of the same ballots. Differences between the two interpretations are noted. Determining whether the audit can stop depends on the number and nature of these differences, the number of ballots examined so far, the risk limit, and the vote margin; the smaller the risk limit or the smaller the margin, the larger the number of ballots that must be audited.

The comparison of interpretations can be neutral, an *understatement*, or an *overstatement*, depending on the effect of changing the voting system interpretation of the ballot to match the ballot interpretation. Consider the pairwise margin between each winner and each loser in a contest. For instance, a city council election might involve voting for three candidates from a pool of ten, to fill three seats on the council. Each of the three winners can be paired with each of the seven losers, giving twenty-one pairwise margins in that contest. If changing the interpretation of a ballot according to the voting system to make it match the human interpretation of the ballot would widen every pairwise margin in every contest under audit, that ballot has an *understatement*. Understatements do not call the outcome into question. If changing the interpretation according to the voting system to match the human interpretation would narrow any pairwise margin in any contest under audit, the ballot has an *overstatement*. If enough ballots have overstatements, the outcome could be wrong.

Efficient RLAs generally perform ballot interpretation comparisons until there is convincing evidence that the outcome according to a full hand count would agree with the outcome under audit. If convincing evidence is not forthcoming, the audit progresses to a full hand count, which is used to correct the outcome under audit if the two disagree.

[The following instructions should be sufficient to conduct the RLA for the mock election in January. There are some additional considerations needed for elections in which some to-be-audited contests comprise only a small fraction of the cast ballots, e.g., a state legislative race].

Step-by-Step RLA Instructions

1. Create a ballot manifest during scanning. Scan ballots in batches, imprinting a unique serial number on each ballot. Keep ballots in the order in which they were scanned and create labeled stacks or bins of scanned ballots with labeling designed so that individual ballots selected during the audit can be retrieved efficiently. Create a ballot "manifest" that lists how scanned ballots are organized (labeling of stacks, listing the number of ballots in each stack). Conduct quality control measures to ensure that each stack of ballots contains the number of ballots listed in the manifest. The manifest numbering scheme need not be the same as the serial numbers. During the audit, ballots will be randomly selected from the ballot manifest. Reconcile the ballot manifest against other accountings of the number of ballots and against poll books to the extent possible. Resolve any discrepancies before the audit begins.

D R A F T

2. Create a Statement of Votes Cast (SOVC) or other report or canvass with final vote tallies for each contest.

3. Create a list of Cast Vote Records (CVRs), a spreadsheet in which each record specifies how an individual physical ballot was interpreted by the tabulation system. Each record must include the ballot serial number. The audit will compare a sample of physical ballots with the CVRs that correspond to those ballots. The serial numbers on the physical ballots will be used to identify the corresponding CVR.

4. Validate the CVRs. Use a program to read the CVRs and tabulate the votes in all the contests contained therein. The results of this process should yield final tallies that are identical to those shown in the SOVC. If they are not, the CVRs and/or the SOVC are inaccurate. However, if the ballot manifest and the CVRs agree on the total number of ballots in each contest, and agree on the winners of each contest, the audit can proceed. In that case, the margin that should be used in the computation below is the margin according to the re-tabulation of the CVRs, rather than according to the SOVC.

5. Determine the contests to be audited. The contests to be audited may be determined by state or local laws or they may be selected randomly by agreement among local observers, political parties and election officials. If most of the contests are on the ballots of most precincts in the jurisdiction, there is not much time penalty to pay in auditing all the contests simultaneously. If however, a specific contest involves only a small part of the jurisdiction, it may be more efficient to audit that contest separately (more on this later).

6. Determine the size of the initial audit sample. The initial sample size depends on the “diluted margin” which is the margin of victory in votes divided by the total number of ballots cast in each contest to be audited (not the number of valid votes in a contest). Dividing by the number of ballots accounts for the possibility of confusing undervotes or overvotes for a valid vote, or vice versa. Go to the [Post-Election Audit Tools Website](#) and follow the instructions to enter contest data. The elections official may instead develop software tools based on the audit model (See Appendix). For purposes of the pilot program, the risk limit setting should be left at 10%.

Illustration: For zero expected over/understatements, the math is simple. The number 4.8 divided by the diluted margin provides the initial sample size for a 10% risk limit:

Diluted Margin	Equation	Initial Sample Size
50%	$4.8/.5$	10
30%	$4.8/.3$	16
10%	$4.8/.1$	48
2%	$4.8/.02$	240

D R A F T

7. Randomly select ballots for the sample:

1. Ask public observers to roll ten to twenty 10-sided dice to generate a “seed” number for a public-source pseudo-random number generator.
2. Enter the seed on the “Random Sampling” section of the [Audit Tools Website](#).
3. Enter the number of ballots in the contest(s) to be audited.
4. Click “draw sample” to select ballots.
5. Each random number corresponds to one ballot. For example, if there are 1000 ballots total in 5 equal stacks, the ballots in Stack 1 can be ballots 1 through 200; Stack 2 can be ballots 201 through 400, etc. If ballot number 341 is randomly selected, the elections official can pull that ballot by counting into Stack 2. When the ballot is pulled, insert a piece of colored paper as a placeholder so that the ballot can be easily reinserted after completing Step 8.

It is recommended that the Election Department plan a ballot manifest in advance and use the Audit Tools Website to be sure that the plan will work to identify ballots.

8. Compare ballots in the sample with the corresponding CVR entries. Because risk-limiting audits involve comparing individual ballots to the voting system results for each ballot, the audits do not involve a “tally” or count in the traditional way a 1% manual tally is conducted. That is, a 1% manual tally ballot counters are assembled to tally entire precincts or batches of ballots and compare the hand tally totals to the totals produced by the voting system for the same precinct or batch. For risk-limiting audits, a human eye interpretation of each ballot is compared to the CVR for that ballot as recorded by the voting system, so ballots are not “tallied” or counted up and totaled in the usual manner. Instead, we will track any discrepancies we find.

Compare each ballot as follows:

1. Retrieve the ballots chosen for the sample. Those designated to retrieve ballots should not have access to the CVRs for the ballots they retrieve in order to ensure the integrity of the audit.
2. Retrieve the CVR entry for each ballot using the serial number on the ballot (the highest serial number if there are multiple serial numbers) and determine whether the entry matches the human eye interpretation of the votes on the corresponding ballot. Existing ballot interpretation methods may be used, including local rules for determining voter intent.
3. Ensure public observers have the opportunity to compare the CVR entry with the physical ballot. If the public observers or auditors disagree about the interpretation of the votes on the ballot, record the disagreement in a log of the audit process.
4. Record the interpretation of the vote on the physical ballot as determined by the auditors in the log of the audit process. This will be used if the audit escalates to all ballots.
5. Document and share with the public any differences found between the human interpretation and the voting system interpretation. Keep accurate track of all observed discrepancies and the specific candidates they apply to. Tally the understatements and overstatements, if any; they are needed to size the escalated audit sample, if necessary.
6. Document and share with the public any instances in which one or more public observers disagreed with the comparison.

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7. Establish procedures to handle observer challenges to the audit. The public must be allowed to observe, verify and point out procedural problems without interfering with the process.

9. Stop or escalate the sample size if necessary. Depending on the number and type of overstatements and understatement found in the initial sample, the audit may need to be expanded to look at more ballots. To determine how many more ballots should be hand tallied, if any, assuming a similar rate of over/under statements:

1. Go to the [Post-Election Audit Tools Website](#) and follow the instructions to determine whether escalation is necessary.
2. If escalation is necessary, the elections official should explain to the public that the audit might lead to a full hand count if significant differences persist.
3. Retrieve the additional ballots, if any, required by the escalation instructions, and continue the ballot interpretation comparison process until either the process terminates (no additional escalation) or all ballots have been compared.

10. Finish and publish results. If the audit process terminated before all ballots have been compared (the most likely case), then the outcomes (winners) reported by the tabulation system in the SOVC are accepted. If the process terminated because all ballots were compared, then the set of vote discrepancies observed during the audit and the log of ballot interpretations can be used to adjust the outcomes reported in the SOVC. In this case, the outcomes of the election are those resulting from the audit. In either case:

1. Release the results of the audit to the public and the Secretary of State.
2. Record and report the time it took to conduct the audit, with a breakdown of the time needed to scan ballots compared to the time needed to conduct the RLA.
3. Record and report the cost of the audit.

Appendix. Detailed Procedures for the RLA in case someone wants to implement all the steps rather than using the online Audit Tools Website.

1. Validating the CVRs in Step 4. This step requires a program that accumulates ballot selections for each contest. This program will need to be specific to the format of the CVRs or the list of CVRs in spreadsheet form (LVR).
2. Initial sample size in Step 6. The initial sample size is given by the formula:

$$n_0 = -2g \log_*(a) / ((m + 2g(r_1 \log_*(1 - 1/(2g)) + r_2 \log_*(1 - 1/g) + s_1 \log_*(1 + 1/(2g)) + s_2 \log_*(1 + 1/g))))$$

with

m = diluted margin,

a = risk limit,

g = 1.03905,

r_1 = expected rate of 1-vote overstatements per ballot,

r_2 = expected rate of 2-vote overstatements per ballot,

s_1 = expected rate of 1-vote understatement per ballot, and

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s_2 = expected rate of 2-vote understatements per ballot.

The diluted margin is the smallest margin in votes, divided by the total number of ballots cast for each contest, including undervoted and overvoted ballots.

The number n_0 is then adjusted to take into account the fact that differences must be round numbers, as follows: The expected number of differences in the sample of each type is n_0 times the expected rate of those differences. The expected numbers are either rounded to the nearest whole number, or rounded up. Then those numbers of discrepancies are plugged into the stopping rule described below, to determine how many ballots would have to be audited if the estimated number of differences of each type were to be observed in the sample. That number is then used once again to estimate the number of differences of each type the sample would contain; the results are rounded to the nearest integer and plugged into the stopping rule a second time. The result is then the starting sample size.

3. Random number generator in Step 7. The AuditTools page implements a good pseudo-random number generator based on the SHA-256 hash function. There are [many other possibilities](#), both programs and servers.
4. Stopping rule and escalation size in Step 9. The stopping rule implements the following formula:

$$\text{stopping sample size} = \frac{-2g(\log_e(a) + o1\log_e(1-1/(2g)) + o2\log_e(1-1/g) + u1\log_e(1+1/(2g)) + u2\log_e(1+1/g))}{m}$$

with

m = diluted margin,

a = risk limit,

$o1$ = number of 1-vote overstatements in the sample,

$o2$ = number of 2-vote overstatements in the sample,

$u1$ = number of 1-vote understatements in the sample, and

$u2$ = number of 2-vote understatements in the sample,

$g = 1.03905$, but any value greater than one can be used. For $g = 1.03905$, a two-vote overstatement increases the sample size by five times as much as a one-vote overstatement. The estimates based on differences continuing to occur at the observed rate are based on the method described above for estimating the initial sample size, including the method of rounding the expected number of differences of each type.

5. Outcome adjustment, if necessary, in Step 10. If the audit goes to a full hand count, the vote totals in the SOVC will need adjustment according to the recorded discrepancies (under-counts and over-counts for each candidate), together with the manual tracking in step 8.4.

*D R A F T***The January 2017 Mock Election**

The mock election, as originally planned, consists of 29699 ballots, all with the same 6 contests. Since these ballots have already been scanned, we know the official outcomes:

Best Picture (vote for 3)

Bridge of Spies	15500
Mad Max Fury Road	17699
The Big Short	16499
The Brooklyn	8200
The Martian	13400
The Revenant	12000
The Room	5000
The Spotlight	799

Best Actor in a Leading Role (vote for 1)

Eddie Redmayne	5000
Leonardo DiCaprio	799
Matt Damon	12000
Michael Fassbender	11900

Best Actress in a Leading Role (vote for 1)

Brie Larson	5500
Cate Blanchett	5000
Charlotte Rampling	6900
Jennifer Lawrence	5799
Saoirse Ronan	6500

Best Actor in a Supporting Role (vote for 2)

Christian Bale	16900
Mark Ruffalo	10500
Mark Rylance	10500
Sylvester Stallone	7299
Tom Hardy	14199

Best Actress in a Supporting Role (vote for 2)

Alicia Viander	14200
Jennifer Jason Leigh	12699
Kate Winslet	6500
Rachel McAdams	11299
Rooney Mara	14700

Oscars be Funded by the US Government? (vote for 1)

No	14999
Yes	14700

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These ballots will be scanned again during the mock election so it is possible that a few ballots will be interpreted differently. There are no undervotes on these ballots.

The diluted vote margin for each of these contests and the corresponding initial sample sizes (for a 10% risk limit and zero anticipated understatements and overstatements) are as follows:

Category	Diluted Margin	Initial Sample Size ($4.8/\text{margin}$)
Best Picture	$(15500-13400)/29699=0.071$	68
Best Actor	$(12000-11900)/29699=0.0034$	1426
Best Actress	$(6900 - 6500)/29699=0.0135$	357
Best Supporting Actor	$(14199-10500)/29699=0.125$	39
Best Supporting Actress	$(14200-12699)/29699=0.051$	95
Oscars Funded by U.S.?	$(14999-14700)/29969=0.010$	480

The plan, as discussed at EIC meetings, is to augment the 29699 ballots with 300 ballots to be filled out by Commission members. The outcomes (winners) are unlikely to change, but the margins and initial audit sizes may be adjusted slightly.

We plan to run two RLA experiments. The first will use the 29699 + 300 ballots as described, and the second will use only the 300 Commission-cast ballots, where the outcomes are completely unknown to us and there is a greater likelihood of encountering an under- or overstatement.

As this mock election RLA is a pilot study, we do not need to conduct a full audit for all contests. We can select any subset, but the idea is to obtain a good estimate the time and resources involved in conducting RLAs for larger more realistic elections.

ATTACHMENT 4

Suggested Revisions of Arizona Election Law

Policy

- 1) Automatic voter registration to increase voter participation and reduce confusion (16-120)
- 2) Ban the sale/distribution of registration information without voter approval (16-153,168)
- 3) Hold election on weekends or create election holiday to increase participation (16-204)
- 4) Eliminate the EMC certification requirements. Require testing by an accredited lab using standards appropriate for the equipment being tested. (16-442)
- 5) Place more requirements on the state equipment approval committee to include security, equipment failure modes and rates, ballot design constraints, support for auditing. (16-442)
- 6) Remove names of presidential electors from ballot (16-502, 507)
- 7) Establish Vote Centers to allow voting at any location (16-584)
- 8) Rewrite hand count law to encompass both performance and risk-limiting audits. May be able to simplify hand counts if we have RLAs (16-602)
- 9) Audits should be required, and counties should be able to audit additional races (16-602)
- 10) Allow counties to use independent ballot scanning systems (like ClearBallot) for auditing
- 11) Retain ballot images the same period as paper ballots and allow for distribution of ballot images (16-624)
- 12) Allow, but not require, approval or raked voting (16-647, 650)
- 13) Rewrite recount trigger statute. Current law has meaningless triggers. The trigger is generally smaller than the vote variance seen in recounts. (16-661)
- 14) Change 5 day challenge to at least 10 days (16-673)
- 15) Eliminate the ban on "ballot harvesting". Unenforceable. (16-1003H)
- 16) Require release of database information statewide (e.g., CVRs and SOVC) (New)
- 17) Ease rules on regaining the right to vote after felonies. Make it easier for felons in more than one county to regain voting rights all in one court.

Clarity

- 18) 16-447 requires designation of person to observe installation and modification of software (not Election Dept employees). Who is that? Is it done?
- 19) Provide more detail on how systems are to be tested. Every scanner? Every DRE? Sampling method? (16-449)
- 20) Field checks. 16-452 requires "expert in electronic voting systems" to "field check electronic voting systems and recommend needed statutory and procedural changes." Who does this? When are field checks done?
- 21) Voter mark clarification (left vs right) (16-503G)
- 22) Clarify voter intent rules for ballot duplication (16-621)
- 23) Clarify the need for voter anonymity, but without a ban on showing anonymous ballot images. Clarify illegality of placing any voter identifying marks on ballots. (16-1018)
- 24) County reporting should include number of ballots for each contest, number of undervotes, blank votes and overvotes (16-646)
- 25) File formats for county reporting are way too complicated for most users.
- 26) Clarify legal basis for treating federal voters differently than AZ voters. Duplication of partial provisional ballot?
- 27) Replace "precinct committeeman" with "precinct committeeperson".

Deletions

Many of the proposed deletions refer to tally boards that at one time actually counted votes in public at the polling places. Tally boards and their reporting requirements can be deleted. Title 16 Sections 517, 531, 601, 604, 605, 606, 607, 614, 615, 616, 618, 619, 620, 641, 643.