THE
CARTER CENTER

Risk-Limiting Audits

A Guide for Election Observation Efforts

Risk-Limiting Audits

A Guide for Election Observation Efforts

THE
CARTER CENTER

One Copenhill
453 John Lewis Freedom Parkway
Atlanta, GA 30307
(404) 420-5100

www.cartercenter.org

Contents

Introduction 3

The Risk-Limiting Audit 4
Development of the RLA 4
RLA Sequence of Events 5
The Concept of 'Risk-Limiting' 5
RLA Requires Paper Ballots and Complete Chain of Custody 7
Randomness 8
The Ballot Manifest 8
Software 10
Types of Risk-Limiting Audit 11
Ballot Comparison 11
Ballot Polling 13
Batch Comparison 14
Comparison of Audit Types 15
Auditing the Selected Ballots 16
Legislation 16
Time Frame for Conducting the RLA 17

Roles and Responsibilities of EOE Management 18
Which Audits to Observe: Purpose and Scope 18
High-Level Understanding of the RLA 19
Sources of Information for the EOE 20
Sizing the Observer Effort 20
Preparing Observers 21
Data Collection, Analysis, and Reporting 23

On-the-Ground Observation 24
Overall: The Paper Trail – Chain of Custody 25
Voting Options and Preparation of the Ballot Manifest 25
Audit Day Space and Personnel 26
What Is Allowed on the Audit Floor? 27
Workflow 27
Who Are the Auditors? 28
Election Authority Training of Audit Workers 28
Handling the Ballots 28
Observer Access and Understanding 31
The Political Dimension 31

Analysis and Reporting 33

Concluding Thoughts 34

Appendixes 35
Appendix A: Glossary 35
Appendix B: Resources 38
Appendix C: Flow Chart of Sample Ballot Polling RLA Process 41
Appendix D: Understanding the RLA Process and Context: Questions for Consideration 42
Appendix E: Generic, Customizable Observation Forms 44
Appendix F: Code of Conduct 50

Acknowledgements

This guide was drafted by Inge Fryklund and edited by Avery Davis-Roberts and David Carroll. Special thanks to Jennifer Morrell, Judd Choate, Monica Childers, and Sita Ranchod-Nilsson for advice and suggestions during the drafting process. Soyia Ellison, Chris Olson Becker, and Jim Kavanagh provided editing and layout assistance.

Section 1
Introduction

The risk-limiting audit (RLA) is a statistical technique for limiting the risk of certifying an incorrect election outcome—that is, the risk that the apparent winner did not in fact receive the most votes. A random sample of paper ballots is visually checked by auditors, and the results are compared with the outcome reported by the tabulator/scanner equipment. If there is sufficiently strong statistical evidence based on this sample that the reported outcome was correct, the audit stops and the tabulated result is confirmed. If evidence from the sample is inconclusive, another sample is drawn, potentially progressing all the way to a full hand recount. The RLA thus either confirms the reported outcome or corrects it.

An RLA is conducted after an election. But an election observation effort (EOE) can have its most far-reaching effect on election administration by viewing the RLA as one element in a sequence of electoral events—including decisions about voting options and venues, packaging ballots, training of election workers, procedures for documenting the chain of custody of the ballots, ballot security measures, and public outreach. The activities that an election jurisdiction undertakes prior to, during, and after voting determine both audit quality and the political acceptability of election results. This guide approaches RLAs from this holistic perspective, addressing pre-audit steps and decision points that shape the audit while also focusing on the post-election audit days.

The RLA was first used statewide by Colorado in 2017. Other states are gradually adopting statutes requiring or permitting RLAs. The type of voting equipment used will determine whether and which kinds of audits can be conducted; since RLAs require the use of paper ballots, voting equipment that does not produce a paper record does not allow an RLA. Other voting equipment facilitates some varieties of RLA but not others. With increased concerns about cybersecurity, more and more election jurisdictions are moving toward RLA-auditable paper ballots, but the pace depends on both vendor development of equipment and state statutes and procurement budgets. States that have used or piloted RLAs have experimented with different procedures for batching and storing ballots, forming audit boards, and involving citizens. States contemplating RLAs are learning from these experiences about what does and does not work and where the challenges lie.

For all these reasons, "the RLA" is a somewhat fluid term and an EOE should be prepared to encounter a range of choices and methods. This guide to observing RLAs is therefore just that—a guide, rather than a step-by-step manual. Taking a holistic approach, it covers issues and sources of uncertainty or variation from the voter casting a vote through the audit, highlighting issues that have surfaced in previous RLAs, and including a few guesses about the direction that RLAs seem to be moving.

The guide begins with a survey of the history, theory, assumptions, and requirements of the RLA, flagging issues that election observers will need to consider when observing a particular audit. Commonly used terms are listed in Appendix A. It then addresses overall responsibilities of an EOE, and then specifics of on-the-ground observation of RLA implementation. The guide includes lists of resources and checklists and forms that can be customized to aid in observing any RLA.

Finally, this guide focuses on observation issues unique to the RLA and supplements general Carter Center guidance for the observation of any election or audit events and should be used in conjunction with other available methodological tools and resources.

Section 2
The Risk-Limiting Audit

Post-election audits have long been a fixture of American elections. They are a way to check whether apparent winners did in fact receive the most votes, to identify system malfunctions or cybersecurity issues, to foster continuous improvement in election procedures, and to increase citizens' confidence in the integrity of the voting process. Post-election audits are typically open to be viewed by members of the public, the media, and representatives of political parties. Audits may involve hand recounting or rescanning ballots using automated scanner/tabulator equipment.

A tabulation audit is a variety of post-election audit based on selecting some *sample* of cast ballots and checking them to see if a visual inspection matches the original machine-tabulated result. Only a full hand recount checks every ballot rather than a sample. Such recounts are rare, in part because they are expensive, so that level of assurance is rarely obtained. A sampling audit, on the other hand, is efficient enough to do as a regular part of the election process – giving similar (though not perfect) results much more consistently. In states that require them, post-election tabulation audits usually take place during or after canvassing (the summing up and cross-checking of reported results) and before the certification of results.

Development of the RLA

Traditional tabulation audits have a number of shortcomings. They typically audit *precincts* or *voting machines*, which may not be selected randomly, and the selection may or may not be public, which can raise potential transparency problems. More critical, each ballot in the jurisdiction does not have an equal chance of selection. State statutes usually set some fixed percentage of machines or precincts (often between 2% and 5%), to be reexamined and do not take account of the margin of victory in a particular election. In addition, since they specify a fixed percentage, the higher the voter turnout, the larger the absolute number of ballots that must be checked, which can result in inefficiency when more ballots than necessary are checked, or a lack of confidence if too few ballots are checked. Percentage tabulation audits also provide no assurance that if the reported outcome is wrong, it will be detected and corrected. Finally, the statutes that establish most audits rarely specify what to do if the result in the sample recounted does not match the original election result.

In contrast with more traditional post-election tabulation audits that sample voting machines or precincts, the RLA samples individual ballots or batches of ballots, and those ballots must be randomly selected from among all cast votes.

For all these reasons, statisticians over the past 15 years have developed an improved tabulation audit process that could address these problems of efficiency, transparency, and selection method and which could guarantee, within a specified risk limit, that the reported winner of the original tally was indeed the voters' choice. The RLA compares the results from a hand-to-eye review of a *statistically random* sample of *ballots* (rather than precincts or voting machines) with the results originally reported. To date, RLAs have been used or piloted in about a dozen states. The RLA technique has been endorsed by the American Statistical Association and others.[1] Figure 1 shows how the RLA is a variety of tabulation audit, which is, in turn, a variety of post-election audit.

It is important to note that while an RLA can assess the integrity of the election process once a vote has been cast, it does not address a range of other issues related to access to and integrity of the broader electoral process. Such issues include voter education on

1 https://www.amstat.org/asa/files/pdfs/POL-Risk-Limiting_Endorsement.pdf

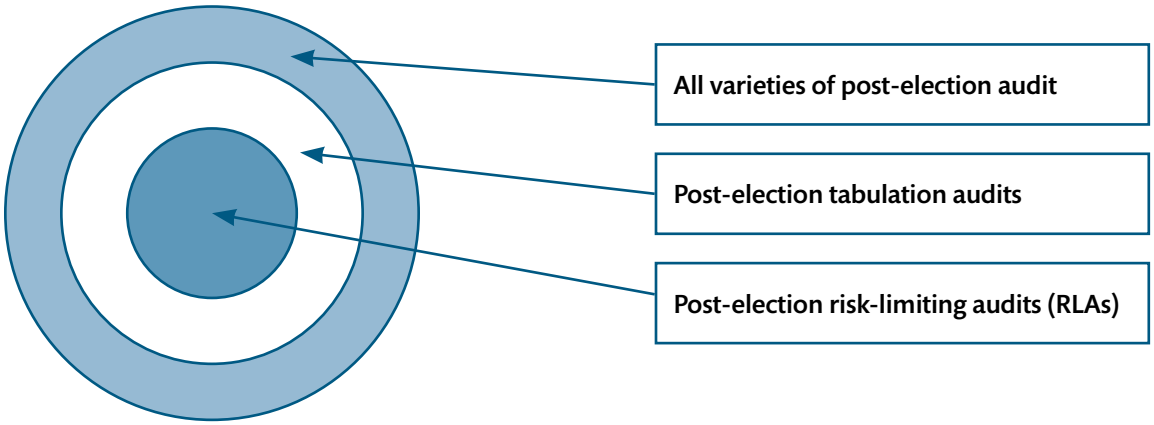


Figure 1. The RLA is a type of tabulation audit, and tabulation audits are a type of post-election audit.

procedures and deadlines; requirements and procedures for registering to vote or changing address; determination of the eligibility of voters; voter ID requirements; the procedures in place to ensure legality of the ballots (e.g., signature match requirements); the location and accessibility of voting locations or drop boxes; and the availability of early or mail-in voting; and other practices or processes that inhibit or facilitate voting. Other components of assessment, such as compliance audits and short-term and long-term election observation, would be required to fully evaluate these issues.

Even without considering these other electoral issues, the RLA is only meaningful to the extent that the ballots being audited were indeed cast by real eligible voters. This is unlikely to be at issue in places where there is widespread independent observation and nonpartisan operation of voting operations at the polling level, coupled with reconciliation against a list of people who voted. However, any time voting takes place where there are no independent checks on operations, ballot-box stuffing is a distinct possibility.[2] In cases of ballot-box stuffing or of other fraudulent votes having been cast, a perfect chain of custody from voting location to audit and a match between audited and reported outcomes would result in an RLA giving a false imprimatur of integrity to the election. In short, an RLA cannot compensate for fraud in the voting process. RLAs were designed to identify faulty hardware and software, whether due to human error or malicious actions. The RLA should be seen as a single layer in the wall required to protect election integrity.

RLA Sequence of Events

Conceptually, the theory behind an RLA is straightforward. The steps are outlined in Figure 2. Individual concepts and processes are discussed below.

The Concept of 'Risk-Limiting'

The RLA does not eliminate the risk of certifying an incorrect outcome. Rather, it "limits" risk, hence the term "risk-limiting." Risk can be eliminated only through a full hand recount. The RLA therefore does not guarantee that the reported outcome was correct, but it has a large chance – quantified by the "risk limit" – of detecting and correcting the outcome if it is wrong.

2 For example, in the Afghan presidential election in 2009, a United Nations team's post-election check of the contents of ballot boxes in Kandahar revealed thousands of ballots marked for the incumbent in identical handwriting (e.g., checkmark made with red felt pen, blue squiggle), with some ballots included in the ballot box (and reflected in the submitted results) not even torn off the ballot pack stub. The submitted results accurately reflected the count of the (fraudulently marked) ballots.

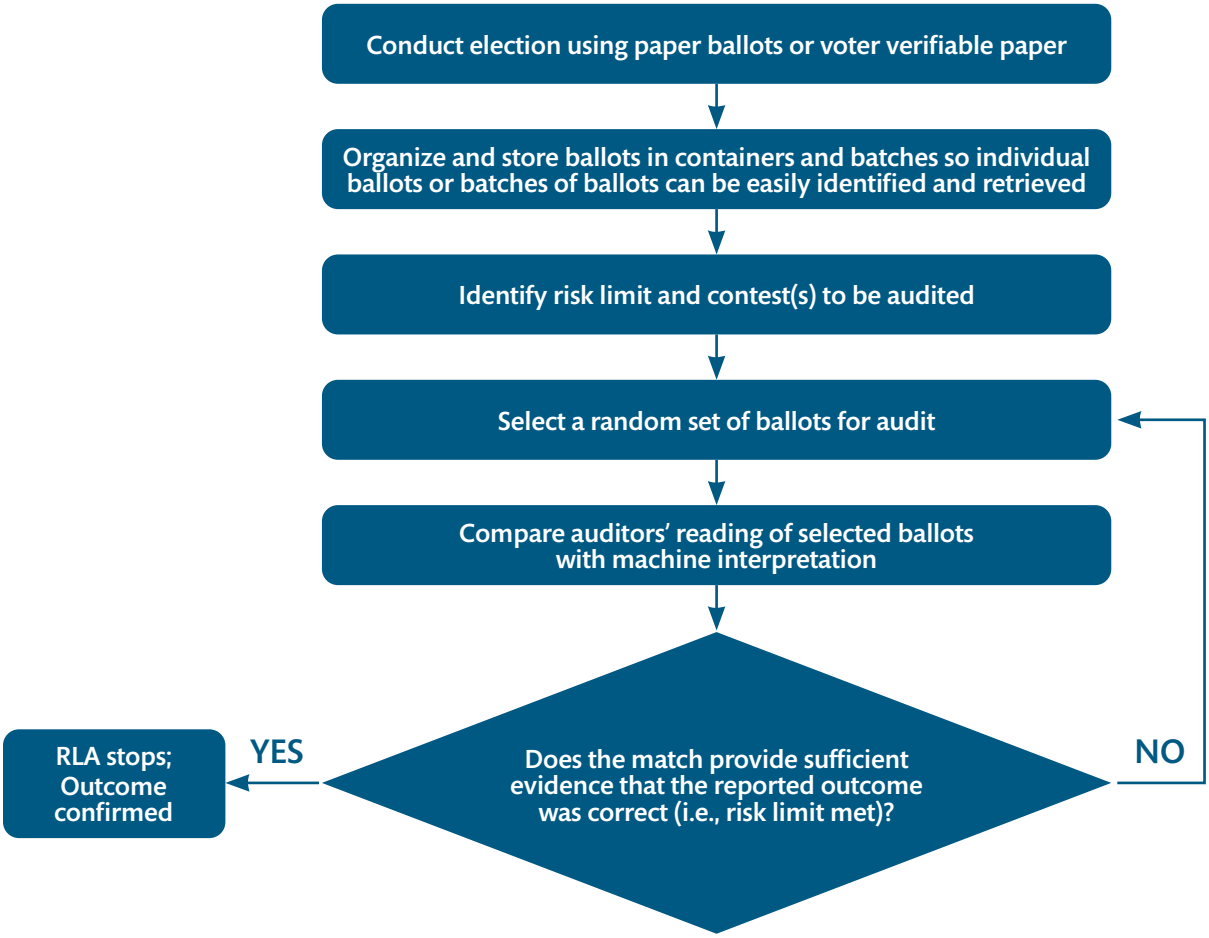


Figure 2. Steps in a risk-limiting audit.

The "risk limit" is set by each jurisdiction. Specific risk limits for an RLA may be set by state statute or statutorily delegated to an official such as the secretary of state. The risk limit might be set either before or after the election. In recent RLAs across the country, risk limits in the range of 4%–10% have been used. A 10% risk limit means that the RLA has a 90% chance of detecting an incorrect outcome. The risk limit is NOT the chance that the outcome is wrong.[3]

The lower the risk limit (e.g., 5%), the greater the chances of detecting and correcting an incorrect result—and the more ballots that will have to be sampled. Lower risk limits, say 1%, tend not to be used because that would be approaching a full hand recount, which defeats the purpose of the sampling audit; it's simpler just to do the full hand recount. A zero risk limit is the same as a full hand recount.

An RLA begins by drawing a sample of ballots. The size of the initial sample depends on the method of RLA used and is an estimate of the number of ballots needed to meet the risk limit, informed by the margin of victory for the apparent winner in the contest of interest. The number of ballots to be checked does not increase with voter turnout. In practice,

3 Statistically, the RLA is a "sequential test of the null hypothesis [the hypothesis of incorrect outcome that we hope can be rejected] that the outcome is wrong. 'Risk' is chance of Type I error: concluding a wrong outcome is right." There is "no possibility of a Type II error" (rejecting a correct outcome) because rounds of the audit continue until either the risk limit is met or there is a full hand recount. See Stark, Philip B., Close Enough for Government (to) Work: Risk-Limiting Post-Election Audits, Slide 25 (2011). Because of this incremental feature, it is impossible for an RLA to reverse a reported result that accurately reflects voters' choices.

jurisdictions often increase the initial sample size to minimize the likelihood that subsequent rounds of auditing will be needed. The calculated sample size is the minimum.

The observed result for the selected sample is compared against the tabulated result. In some RLA methods, this is done on a ballot-by-ballot basis, while others look at total sampled votes in aggregate. If there is sufficiently strong statistical evidence based on this sample that the reported outcome was correct, the audit stops.

If the evidence of the sample is not strong enough to confirm the correctness of the reported result, more ballots are sampled for additional rounds of auditing until the evidence is sufficiently strong that a full hand tally would confirm the original outcome. The audit could conceivably proceed all the way to a full hand recount if the risk limit is not met over successive rounds of sampling. In this sense, the RLA is an "incremental audit." In RLA terminology, the audit stops when the "risk limit is met."

The chosen risk limit is the largest chance that the audit stops short of a full hand recount when the tabulated outcome was in fact wrong – that is, the wrong candidate was reported to have won and the audit fails to detect this.

The RLA doesn't guarantee that the tabulated outcome is correct, but it has a large chance – quantified by the risk limit – of correcting the outcome if it is wrong.

When the audit stops after one or a few iterations, it simply confirms the reported outcome. The RLA does not generate new totals for the results, except in the case of an RLA conducted in a very tight race, in which multiple rounds of ballot sampling lead to a full hand recount, or if there is an original decision (as in Georgia in November 2020) to choose a risk limit of zero – which entails a full hand recount. A full hand tally would provide a definitive answer about the correctness of the machine tally; the RLA essentially provides a more efficient and less resource-intensive way to answer the same question.

The sample size is based on the margin for a specified contest. If a second or third contest is to be audited as well, the sample size should be based on the margin for the closest race.[4] Some jurisdictions require that both statewide and countywide contests be audited. The jurisdiction may well look at some or all of the other contests on the audited ballots ("opportunistic audit"), but it cannot be assumed that the audit confirms the result of any of these other contests. The RLA confirms the result for the specified contest(s), NOT the election as a whole.[5]

Typically, in comparison with precinct or voting machine tabulation audits, RLAs require a smaller number of ballots to be audited to provide statistical confidence that an incorrect election result will not be certified.

Questions for the EOE to Consider

- **What is the chosen risk limit for this audit?**
- **How is the risk limit determined? By statute? By an official?**
- **Who decides which contest(s) are to be audited?**
- **Is the sample size chosen to confirm outcomes for specific contest(s) rather than for the election as a whole?**

RLA Requires Paper Ballots and Complete Chain of Custody

An RLA requires paper ballots. The paper ballot touched by the voter is the "source document" for the audit. Auditors must be able to look at original ballots, including both

4 This is true if all the races are on the same universe of ballots. If they are not, or the overlap is small, it's often more efficient to find samples for each contest independently and then combine them. (For example, given a statewide contest with a 20% margin and a county contest with a 2% margin, it's much more efficient to sample for the 2% just within the county and add it to the statewide sample than having to take the sample needed for a 2% margin statewide. Either one works, mathematically.

5 EOE management should inquire whether there are several contests being audited, and if so whether sample sizes were adjusted for overlapping jurisdictions. This is beyond the scope of what an on-the-ground observer can check.

hand-marked ballots and those printed out for the voter's review from a ballot-marking device.[6] The audit asks whether the tabulated result accurately reflected the voter's choices as observed by the auditors on the paper ballot. This requires that the paper trail – the chain of custody from voter to auditor – be trustworthy. If the paper trail cannot be verified, the audit cannot verify the winner; votes may have been added, subtracted or altered.

Jurisdictions that still use electronic recording voting equipment that does not generate a paper record cannot use the RLA.[7] While traditional machine or precinct recounts may continue to be used as a check on the tabulation, more and more election jurisdictions are switching to paper and thus will be able to use RLAs.

Randomness

The RLA requires random selection from among all the ballots (or batches of ballots) in the jurisdiction – including all ballots cast in early, mail-in, election day, provisional, UOCAVA (Uniformed and Overseas Citizen Absentee Voting Act), and so forth, voting. Randomness requires that all cast ballots have an equal chance of being selected for audit. If selection is truly statistically random (as opposed to haphazard or ad hoc), a relatively small sample is sufficient to determine (to the specified risk limit) whether the sample confirms the whole.

Philip Stark, the statistician who pioneered the RLA concept, gives the analogy of a pot of soup. If the pot – whether a bowlful or a large cauldron – is thoroughly stirred, sampling (i.e., tasting) only a few spoonfuls is sufficient to determine whether the soup needs more salt; there is no reason to take more spoonfuls from a larger container. This is why the number of ballots that have to be sampled for an RLA does not scale with voter turnout.

For an RLA, a 10-sided die is thrown 20 times to yield a "seed," which is used to initiate a random-number algorithm.

True random selection of ballots is impossible as a practical matter. Instead, statistical randomness is approximated by using a pseudorandom number generator (or PRNG) algorithm to identify the ballots to be audited. In the procedure that seems to have become customary in states that have adopted the RLA, interested people (e.g., party representatives, members of civic organizations or the public, and in some places election officials) put their names into a hat. (Other observers may also be present in an audience.) Twenty names are drawn one at a time, and each person in sequence tosses one 10-sided die. Each number is recorded for the audience to see (e.g., on an easel board). This produces a 20-digit number, or "seed," which initiates the random number algorithm.

This ceremony provides some public and party ownership of and support for the RLA and sets the stage for subsequent phases of the process. The seed will later be entered into software that selects the ballots to be pulled for inspection.[8]

The Ballot Manifest

Because the RLA requires a random selection of ballots (or batches), every ballot must be "findable." Every ballot must have an "address" in its storage location so audit staff can locate it and election staff and observers alike can be confident that the, for example, 43rd or 123rd ballot (as required by the random-number algorithm) in a designated container was indeed pulled for audit. Because of this requirement, the process of organizing and storing ballots for an RLA is more involved than for a traditional audit. It is no longer sufficient to box up the ballots in any order in containers of any size and store the containers in a warehouse, perhaps never to be opened again.

6 The paper ballots must be sealed and secured between voting and audit, and the tabulated result "locked down," so there is no possibility of post-election alteration in either the paper record or the tabulation record.

7 In addition to the electronic record, some systems use an internal thermal-paper roll (not readily verifiable by the voter) that records the vote. Some pilot attempts have been made to conduct an RLA checking this paper record against the electronic record, but it is very cumbersome and is unlikely to be seen in future RLAs.

8 In a Colorado seed ceremony held at the secretary of state's office, audience members cheered and applauded when the 20th digit was posted on a board.

The storage arrangement is documented in a "ballot manifest" (inventory), a simple spreadsheet created by election staff to describe the storage locations of all the ballots. This requirement for systematic storage, recorded in the ballot manifest, is the single biggest operational difference between the RLA and older types of tabulation audits, and observers will want to pay particular attention to it. It isn't just the RLA result that can promote confidence in the election; the systematic storage of ballots indicates internal controls that also promote trustworthiness.

It has been said that the RLA is a test of human ability to manage hundreds of thousands of pieces of paper.

Each row in the ballot manifest specifies a container (and perhaps also a precinct or other location), batch, and the number of ballots in that batch. In RLA terminology, a container is a box that can be sealed by some tamper-evident means. Inside it may be batches of ballots (perhaps stored in folders), that is, groups of ballots that will likely have been scanned together. If the jurisdiction uses multipage ballots, the manifest would also include the number of pages. In any case, the manifest structure mirrors the storage arrangements. See Figure 3 for an example.

Containers need not be in any particular order; they just have to be unambiguously labeled. However, election authorities may use sequential numbering of containers to facilitate systematic storage and easy retrieval for audit. The total number of ballots listed on the manifest must be reconciled to the numbers of voters shown in the pollbook or other voter record. It is critical that the numbers of ballots be established independent of the voting equipment; otherwise the voting equipment is checking itself.

It is critical that the numbers of ballots listed on the ballot manifest be established independent of the voting equipment; otherwise the voting equipment is checking itself.

While the RLA literature and election officials often refer to "the" ballot manifest, it is unlikely to be a single spreadsheet prepared at one time. Rather, it is likely to be a single spreadsheet that compiles information about all the ballots within the election jurisdiction and is likely built over time as mail-in ballots are processed, precincts count and package their ballots, UOCAVA ballots are received, and provisional ballots are resolved.

Ballots were fairly easy to account for back when most ballots were cast on a single day at designated polling places with only limited absentee voting. However, voting in the U.S. has expanded to be conducted prior to election day in person or by mail or dropoff point at a variety of locations and over a period of days, weeks or even a month or two. Even with recent attempts to curtail these options, it can be expected that future elections (except in states that vote exclusively by mail) will include ballots from a variety of avenues.

These variations affect how and when the ballot manifest is built and the time pressure for preparing it. Understanding each jurisdiction's rules and procedures for managing all these voting options can be a challenge for EOEs but is important to ensure that all ballots are accounted for and a complete chain of custody is maintained.

Portion of a Ballot Manifest

			# Ballots in Batch
Precinct 1	Container 1	Batch 1	125
Precinct 1	Container 1	Batch 2	130
Precinct 1	Container 1	Batch 3	116
Precinct 1	Container 2	Batch 1	105
Precinct 1	Container 2	Batch 2	122
Precinct 2	Container 1	Batch 1	418
Precinct 2	Container 1	Batch 2	377
Precinct 2	Container 2	Batch 1	782
Mail-in	Container 1	Batch 1	100
Mail-in	Container 1	Batch 2	100

Figure 3. Example of ballot organization.

The logistical ease of locating and retrieving ballots for audit is inextricably tied to decisions about organizing ballots for storage. For example, it is easier to find specific ballots (e.g., the 35th or 87th in sequence) out of a batch of 100 than the 2,038th out of an undivided election day precinct container of 3,000.

If ballots are stored in small, uniform batches, it will be easy to locate particular ballots during sampling, but a proliferation of small batches poses potential challenges for keeping track of all the batches and increases recordkeeping. This puts a premium on election authority strategies for packing batches of ballots in larger containers so there is a hierarchical sort (e.g., in Precinct 4, find Container 6 and then Batch 12) to facilitate finding the desired batch. Conversely, very large batches (e.g., several thousand) may be easy to track, but ballot retrieval could be very difficult.

Ballot security is a related issue. If groups of ballots are sealed soon after voting, there is little risk of ballot loss or alteration. If a very large ballot box (e.g., from election day) is subsequently divided into more manageable batches, the additional handling introduces possibilities of ballot misplacement or a break in chain of custody.

The election authority has to think carefully about the likely audit workload and plan its ballot storage arrangements accordingly.[9] As use of the RLA spreads and election authorities learn from the experience of others, there may be a move toward more consistent use of manageably sized containers. If so, in the future, EOEs may not see many of the large batch challenges for ballot polling described below. Observers should note the election authority's strategies for managing batch size.

Questions for the EOE to Consider

- **Does the jurisdiction have a well-thought-out plan for organizing all ballots for storage?**
- **Did the jurisdiction consider the practical implications of batch size?**
- **How is the ballot manifest created?**
- **How is the chain of custody for containers maintained and documented?**

Software

While the general concept of the RLA is straightforward, the statistics behind the calculations for sample size and determining when the risk level is met can be daunting. Fortunately, statisticians have developed open-source software to manage these decisions.

All jurisdictions that have piloted or used RLAs to date have utilized specialized RLA software. Once the election jurisdiction inputs the margin of tabulated victory for the contest(s) to be audited, the desired risk level and the 20-digit seed, and uploads the ballot manifest and all other required source documents,[10] the RLA software will determine the initial sample size and generate a "work order" for each jurisdiction (e.g., county within a state) that is participating in the audit. For example, "For Precinct 6, pull Container 3, Batch 4, the 43rd ballot in the batch; Container 6, the 17th and 823rd ballot in the stack," and so on. Some available software allows the election authority to input the number of planned audit boards (i.e., two-person teams that review the sample ballots, described further below) and then will generate separate "pull lists" for each audit board.

9 An election supervisor in Georgia commented that she would have chosen a different ballot storage system had she known to expect a full hand recount. Observers should note whether the RLA was announced ahead of time so the storage arrangement could be planned accordingly. Observers would not want to criticize election workers who were dealing with an unannounced RLA and had to work with what they had.

10 The ballot manifest is all that is required for ballot polling. In addition, batch comparison requires a batch totals report (detailing each candidate's votes in each batch of ballots), and ballot comparison requires a cast vote record (CVR) file detailing how the scanner counted every ballot. (These other documentation requirements are part of why the startup cost is higher for batch and ballot comparison RLAs than for ballot polling.)

The ballot selection process is transparent. Anyone using the same open-source pseudo-random number program and plugging in the same seed will get the same list of ballots. There is no mystery or bias in the ballots selected.

After a ballot sample is audited, the audit results are entered into the software, which compares the sample result against the original tabulated outcome. If the evidence is sufficiently strong that the outcome was correct, the software announces that the audit is complete and the election result is confirmed. If the evidence is insufficient, the software generates a new list of ballots to be audited, and so on, until either the outcome is confirmed or sampling proceeds all the way to a full hand recount. The mathematical calculations are all handled by the software.

Several nonprofit, nonpartisan organizations provide open-source software and will contract with election administrators to provide support and training.[11] Open-source software development is ongoing. Software that initially handled only first-past-the-post (FPTP) results can now handle other variants such as plurality, majority, supermajority outcomes, and multiple winners. As of this writing, software is being developed for RLAs for ranked-choice voting systems.

The EOE is in no position to evaluate software. Rather, management should determine whether reputable software is being used and that it is well tested and managed by the election authority and/or outside consultants.

Questions for the EOE to Consider

- **Is the jurisdiction using reputable RLA software tools (either in-house or contracted)?**
- **Who, if anyone, is providing assistance to the jurisdiction? What is the scope of assistance?**

Inputs to the RLA software

- **Margin of victory for the contest(s) to be audited**
- **The chosen risk level**
- **The 20-digit seed for the pseudorandom number generator**
- **Ballot Manifest**
- **Any other required source documents**

Types of Risk-Limiting Audit

While all RLAs involve auditing a randomly chosen set of ballots (or batches of ballots) and comparing the results with the tabulated outcome, there are different varieties of RLA that can be used depending on voting options and voting equipment and processing constraints. For all types, an audit board will review the selected ballots and report the results of their visual inspection.

There are three main varieties of RLA: ballot comparison, ballot polling, and batch comparison,[12] described in Table 1.

Ballot Comparison

A ballot comparison audit requires that each paper ballot selected for audit be matched against its scanned interpretation. The match could be made just by keeping the paper ballots perfectly in the order they were scanned (probably by scanning in very small batches). More typically, each paper ballot as it is initially scanned and counted is imprinted with some (human-readable) identification code. The scanning/tabulating equipment

11 Philip Stark (professor of statistics and associate dean, Division of Mathematical and Physical Sciences, University of California, Berkeley) developed online tools for determining the needed sample size (given the margin of victory and the desired risk limit) and the sequence of ballots to be audited for both ballot comparison (https://www.stat.berkeley.edu/%7Estark/Vote/auditTools.htm) and ballot polling (https://www.stat.berkeley.edu/%7Estark/Vote/ballotPollTools.htm) audits. Open-source software for a ballot comparison audit—referred to as RLATool, was developed beginning in June 2017 by Free and Fair and for Colorado's first statewide use of an RLA for the November 2017 election. See http://freeandfair.us/blog/risk-limiting-audits/. Democracy Works subsequently updated Colorado's software. Colorado now does all programming in-house. The software Colorado produces is open source and available after an election. Colorado is now doing the programming to handle ranked-choice voting. VotingWorks has produced open-source RLA software, called Arlo, which handles batch comparison as well as ballot polling and ballot comparison audits. A list of these resources can be found in the Resources links in Appendix B.

12 There are also ***transitive audits***, in which ballots are rescanned to imprint an identifier on the ballot and create a cast vote record datafile, but as election authorities acquire systems that produce a cast vote record, transitive audits may become a thing of the past. A hybrid audit could also be conducted, e.g., with ballot comparison for mail-in ballots and ballot polling for in-person.

generates a cast vote record (CVR), a uniquely identifiable complete digital representation of each ballot that was scanned and tabulated. The CVR for any ballot would include the ballot type, the vote for each contest on the ballot, scanner, batch, and sequence number, and so forth, as well as the identifier imprinted on the paper ballot. In practice, auditors count through the batch (which should have been kept in scanning order) to find the desired ballot, and then check to confirm that the imprinted identifier matches the identifier captured in the CVR.

If ballots were counted and imprinted at the precinct level, doing a ballot comparison RLA might make it difficult or impossible to preserve voter anonymity. This is especially problematic if the polling station is small or there are unique ballot styles (e.g., for very local races) that would make it possible to infer a voter's identity. For this reason, ballot

Table 1. Three Types of Risk-Limiting Audit

	Ballot Comparison	**Ballot Polling**	**Batch Comparison**
What is audited?	Sample of individual ballots	Sample of individual ballots	Sample of batches of ballots
What is compared by the software?	Compares individual ballots with the machine reading of the same ballots.	Compares totals from the sampled ballots with the overall reported election outcome.	Compares totals from the sampled batches with the machine totals for the same batches.
Voting equipment and process requirements	Requires cast vote record (CVR), an identifier imprinted on each ballot, and keeping the ballots in precise order.	No requirements – can be used with any paper system.	Can be used with any paper system. However, tabulation system must preserve vote totals by batch.
Provides information about accuracy of scanner/tabulator?	Yes, because each selected ballot is compared with its machine interpretation. However, there are rarely enough ballots selected to draw a conclusion about the scanner. Errors might be caught, but if no errors are found, it cannot be concluded that the scanner is accurate.	No information about scanner performance because selected ballots are not compared directly to the corresponding machine interpretation.	Yes. Since all ballots in the batch are tallied, the comparison gives a good indication of tabulator accuracy.
Type of voting and counting	Most suitable for central counting. For precinct-level counting, sequential identifiers on the ballots could reveal voter identity.	Can be used for any voting option (in-person, mail-in, etc.) and precinct-level counting.	Can be used for any voting option (in-person, mail-in, etc.) and precinct level (or central) counting (assuming batch scanning totals preserved).
Number of ballots to be audited	Fewest.	Many more than for ballot comparison.	Many more than ballot comparison, but could be more or fewer than ballot polling; depends on batch sizes.
Method of finding ballots listed by RLA software	Find the correct batch. Count through the batch to find the required ballot(s). Then confirm match between identifier on selected ballot and identifier from CVR (or other identifier that the jurisdiction may have imprinted on the ballot).	Count through the batch. For very large batches, ballot weighing and k-cut methodologies can be used to locate (approximately) the required ballots.	All ballots in each selected batch will be audited.
Significance of batch size	The relatively few ballots needed could be retrieved from any batch size, but election authorities using central counting typically organize ballots into small standardized batches.	Batch size can vary widely with precinct. Batches often very large. May be onerous to find all the required ballots in very large containers.	Easy to identify required batches. Workload depends on batch size. Small batches can be sorted and tallied quickly. Counting all ballots in a large batch may still be easier than finding specific ballots as is required for ballot polling.
Audit process	Auditors review each randomly selected ballot one at a time and enter their interpretation into RLA software.	After all ballots are located, enter each ballot interpretation into RLA software (if available); otherwise, "sort and stack" and complete batch sheet for later data entry.	If software allows, enter ballot interpretation individually online. More likely, "sort and stack" ballots by candidate and complete batch sheet for later data entry.
Ballot storage location	Ballots should all be accessible in one location since ballots from any batch could be required.	Ballots should all be accessible in one location since ballots from any batch could be required.	Batches could be stored and audited in different locations.
Risk limit met?	When all ballot interpretations have been entered, software will compare with tabulated interpretations of those ballots and determine whether risk limit is met.	When all ballot interpretations have been uploaded, software will compare with overall original outcome and determine whether risk limit is met.	When all ballot interpretations have been uploaded, software will compare with machine interpretations of those batches and determine whether risk limit is met.

comparison has been used only when ballots are counted at a centralized facility. An option that has been tested in some pilot RLAs is to take ballots counted at the precinct level and rescan them centrally to imprint an identifier.

During the audit, the RLA software will produce a list of ballots to be pulled for audit (e.g., the 4th, 35th, and 61st in some batch), along with the unique identifier that is imprinted on each of these selected ballots. When, for example, the 61st ballot in a batch is pulled, auditors can confirm that the code imprinted on the ballot matches the code on the work order. Relatively few ballots are sampled for a ballot comparison audit, and jurisdictions able to use it scan ballots at a central facility and organize ballots in small standardized batch sizes. Election staff may therefore pull the few required ballots from batches opened in the storeroom and take the ballots to the audit board.

For any ballot comparison audit, it is important that ballots scanned in a batch be kept in order after scanning, so that a ballot pulled for examination can be matched easily with its CVR. If the paper ballots are not kept in scanning order, it may be very time-consuming to find the ballots the software has specified, as well as impossible to make a match without an imprinted identifier.[13]

As each ballot is pulled from its batch, some placeholder[14] (typically bright colored paper) is inserted so the audited ballot can be returned to its position for storage.[15] At least some Colorado counties use a copy of the required ballot itself. Ideally, the audited ballots would be replaced and the batch sealed after auditing and before the batch is returned to storage. Alternatively, the audited ballots might be stored separately and later replaced in sequence, or they might be kept as a separate batch.

After all the ballots from the work order are pulled, the audit board will begin reviewing them visually. Software used for a ballot comparison RLA typically presents a computer screen one ballot at a time for each required ballot. Auditors enter their reading of the ballot (i.e., which candidate was selected, Yes/No for a ballot initiative) online, review to confirm the accuracy of their entry, and then the software presents a screen for the next ballot to be reviewed. The auditors simply enter what they see; they do not have any information about how the original tabulation counted the ballot. After all the selected ballots in the sample are audited, the RLA software either concludes that the audit is complete or generates a new list of ballots for audit.

Ballot comparison audits provide information about how the tabulation equipment interpreted each ballot and can lead to improvements in the equipment as well as confirmation of the correctness of the outcome. This type of RLA has been used in Colorado since 2017.

Newer voting equipment that produces a CVR seems to be the direction that election device vendors and equipment procurement are moving. But near term, equipment for many elections to be observed will not support ballot comparison audits and many jurisdictions will continue to want precinct-level counting and announcement of results if this is what citizens expect. For these cases, ballot comparison will not be an option.

Ballot Polling

Ballot polling audits can be conducted on any voting system that produces paper ballots; no new voting equipment or CVR is needed and no identifier is imprinted on the ballot.

During the audit, the RLA software will produce a list of ballots to be pulled for audit (e.g., the 4th, 35th, and 61st in some batch). In contrast with ballot comparison, observers are

13 If ballots are imprinted and only slightly out of scanning order, it may be possible to locate roughly (e.g.) the 61st and then check adjacent ballots to find the ballot with the correct imprinted code.

14 Some RLA software prints individual placeholders labeled with the batch and sequence number. This facilitates returning each ballot to its rightful position.

15 This assumes that the sampling is "without replacement." That is, a given ballot can be sampled once and only once. For true randomness (with replacement), a ballot might be selected more than once. Some RLAs allow for this possibility.

likely to see the audit board rather than election staff removing all ballots from a container or batch and searching for the required numbers in sequence. As each ballot is pulled, a placeholder is inserted so the audited ballot can be returned to its position for storage.

Maintenance of scanning order during storage is not important since there is no match to be made between a particular ballot and its CVR. However, once the ballots are taken out of their container or batch folder, they should be stacked neatly and that order maintained as the specified ballots in sequential order are pulled. The ballot polling audit is statistically somewhat forgiving of small accidental errors in ballot selection—say, pulling the 86th rather than 87th in sequence. The sampling is still sufficiently random.

The jurisdiction may subdivide very large scanner batches (e.g., from a precinct that has only one or a few scanner/tabulators) for easier handling during the audit and would document the arrangement in the ballot manifest. The chain of custody must of course be maintained during repackaging of ballots.

Typically, the ballots are reviewed one by one and entered directly into software or recorded one by one on a data entry sheet for later entry. If batches are very large and a large number of ballots are pulled, "sort and stack" may be used, but that process is typical only for batch comparison or full recounts.

After all results for the audit sample are data entered, the software compares the result for the sample to the original overall tabulated result. If the risk level is met, the audit stops; if not, a new round of sampling is conducted.

While this type of RLA confirms (or ultimately corrects) the reported result, it does not provide any information about whether the tabulation equipment could be improved. This is because ballots selected at random likely come from different scanned batches, so there is no match to be made between any particular ballot and its machine interpretation.

Batch Comparison

Batch comparison shares features with both ballot comparison and ballot polling audits. Instead of randomly selecting individual ballots from the ballot manifest, in batch comparison the audit selects batches from the ballot manifest.[16] This method takes advantage of the fact that ballots in fact always are accounted for and usually processed in batches—such as by day of early voting, drop box location, precinct—and ballots in any batch are usually scanned together.

Batch comparison requires that the original tabulation system preserve a record of the tally for each scanned batch—however a batch is defined (e.g., precinct, scanner batch). This method cannot be used if the tabulation equipment does not preserve this granularity, or if large batches have been divided after scanning (e.g., one large precinct into several boxes) and cannot be reconstructed. Batches must be established prior to the random selection of batches.

Once a batch is selected, audit boards sort the ballots and enter the totals for the batch on a batch sheet for later data entry, or enter them individually into the software if that is an option. They have no information about how equipment tallied that batch. There is no need for placeholders as it is the entire batch that is audited. (If several small batches are stored in a single box, a placeholder could be used to return the batch to its position as listed on the container.)

16 While there are formulas used by RLA software to compute the initial sample size for both ballot comparison and ballot polling, the selection of batches also takes into consideration the impact that any one batch can have on the outcome. For example, it would be pointless to audit a batch in which every vote went to the loser; even if 100% of those tallies were in error, the result would only confirm the reported outcome. The software can take into account the relevance or weight of each batch to generate a sufficiently random set of batches for audit. Observers of a batch comparison audit should simply inquire whether the software in use is specifically designed to accommodate batch audits.

Once the tallies for all batches are data entered, the software compares the result for the sampled batches to the original results for those batches. If the risk level is met, the audit stops; if not, a new round of sampling is conducted.

Since all the ballots in an audited batch are from the same scanner batch, batch comparison does provide information about the performance of the scanner.

The size of sampled batches can become an issue for batch comparison. If batch sizes are small, the workload may not be too great, although substantially more ballots will be audited than for a ballot comparison audit. If the batch sizes are large, the audit can be very time-consuming. Still, sorting a batch may be quicker than finding the required ballots in sequence, as is done for both ballot comparison and ballot polling.

Comparison of Audit Types

Over the next few years, EOEs may encounter any of the three main types of audit or hybrid versions used to accommodate multiple voting methods. Ballot comparison requires auditing of the fewest ballots. It is thus quick and efficient and places the least burden on the audit process. However, it depends on equipment that produces a CVR, and it requires a high degree of organization on the part of the election authority to keep small batches of ballots in order. Due to the need to ensure voter anonymity, identifiers are not imprinted at the polling station level. Therefore, ballot comparison is best suited for central counting.

Ballot polling is feasible right now for any election system that produces paper ballots; no new equipment is required, which may make it a common option near term. However, it statistically requires auditing of far more ballots than ballot comparison for the same risk level. For example, in Georgia in 2020, the margin of victory for Joe Biden was 0.3%, which under the ballot polling RLA algorithm with a 10% risk limit would have meant sampling approximately 1.5 million ballots statewide, or 25% of the approximately 5 million votes cast. It may be simpler to count all ballots than to undertake the painstaking process of locating all the individual ballots. Had a ballot comparison audit of the same presidential contest in Georgia been possible, only about 2,500 ballots[17] would have needed to be audited.

If the jurisdiction's tabulation equipment preserves batch-level totals, the choice between ballot polling and batch comparison will depend on the anticipated number of ballots to be audited and the ballot packaging arrangements (as documented in the ballot manifest). For example, if there are very large batches, such as a precinct, it may be easier, with less chance of human error, to count a few thousand ballots if that batch is randomly selected than to locate individual ballots in a large stack.

Questions for the EOE to Consider

- **Which variety of RLA is the jurisdiction using?**
- **How did they decide on this variety? What were their equipment constraints and choice points?**

Public education challenges may also factor into the choice of audit method. Colorado, which uses the sophisticated ballot comparison methodology, does not go into public explanations about what random selection means. Instead, public information emphasizes how the audit looks at individual ballots to make sure the scanner/tabulator counted the ballot the same way. This seems to be satisfactory to the public.[18]

17 Philip Stark's estimate, quoted in Timothy Pratt, "Why Georgia's Unscientific Recount 'Horrified' Experts," Nov. 20, 2020. https://www.thenation.com/article/politics/georgia-recount/

18 Explanation from Judd Choate in a phone conversation.

The sampling theory and methodology behind ballot polling may be difficult to explain to parties and the general public. Why these 1.5 million ballots rather than some others?

Batch comparison, involving a recount of some predefined grouping of ballots, is a procedure more familiar to the public, being analogous to selecting a precinct or voting machine for audit. For these reasons of convenience and communication, as well as avoiding the necessity of finding individual ballots, batch comparison may well come to be preferred over ballot polling.

Auditing the Selected Ballots

For all three types of RLA, once the required ballots are pulled from storage, an audit board[19] composed of at least two members,[20] often with opposing party affiliations, will examine each ballot and record the auditors' reading – that is, which candidate the voter appears to have chosen – for entry into the software. The jurisdiction may have an appeals panel that makes decisions about voter intent if the two members of the audit board are unable to agree. If there was a guide to voter intent used in the original counting of the ballots, the same guide should govern decisions by the audit board. For all varieties of audit, the audit board must have no information about how the ballots were counted when originally tabulated.

The number of audit boards in use depends on the number of ballots to be audited in the time allotted. Colorado uses a single audit board in each county. For the zero-risk RLA in Georgia following the November 2020 election, some counties used as many as 60 audit boards.

Interestingly, the RLA may be the first time that election officials look systematically at the paper ballots and see all the things voters do in marking their ballots.[21] Previous audits may have required only a rescan, or a tabulation of a few precincts, but the RLA gives a jurisdiction-wide sample. This could lead to ballot redesign or to improved instructions.

Legislation

State legislation sets the parameters for conducting election procedures, including the RLA – timing, the audit's relation to recounts and certification, who sets the risk limit, which contests are to be audited, whether pilot audits are required, etc. The legislation may be highly prescriptive or may be more flexible, delegating procedures to rulemaking.

In some states, the risk limit is set by statute. In others, the risk limit is chosen by an election official. The choice of race(s) to audit may be determined by statute or statutorily assigned to an individual, such as the secretary of state. This should be documented in the observer report.

Questions for the EOE to Consider

- **Is the legislative framework clear and easy to operationalize?**
- **Is the statute highly prescriptive, or is it more flexible, delegating procedures to rulemaking?**
- **Who has the authority to choose the race(s) to be audited?**
- **Who has the authority to set the risk limit?**

19 "Audit board" is the usual terminology for the two-person team that examines some or all of the ballots. The number of audit boards in use depends on the expected workload, and the election authority might add audit boards during the course of the audit if needed. Any given ballot is examined by only one audit board.

20 A "rule of two" should be observed in all aspects of audit work: two people with eyes on each ballot and the data entry screen or entering a room where ballots are stored. This check prevents alteration by any one person.

21 There is remarkable creativity in voters' approach to paper ballots. Rather than filling in ovals or completing a line connecting name and office as instructions direct, voters have been known to circle the names of favored candidates or add check marks or X's, cross out the names of the rejected options, add comments or other symbols. On mail-in ballots, voters have used scissors to cut along dashed lines on the page.

RLA statistical concepts can be confusing, and some state legislation was adopted before drafters fully understood the RLA concept. Since any post-election audit must comply with state law, this can present challenges for conducting an RLA.

For purposes of an EOE, it is sufficient to inquire about the statutory scheme, whether its operation is unambiguous, and how the RLA might be constrained by it. This allows the EOE to summarize the statutory requirements and avoid criticizing election authorities for less than ideal procedures if they are doing the best they can within state law.

Time Frame for Conducting the RLA

The post-election calendar is an aspect of the statutory framework that has practical consequences for the conduct of an RLA. States typically have statutory time limits for postmarking and receiving absentee ballots, for canvassing and certifying the vote, and for allowing challenges and automatic or discretionary recounts. The RLA should include every valid ballot and has to fit into this sequence. If it doesn't, the sequence needs to be changed legislatively to accommodate the RLA. Since RLAs sometimes proceed to a full hand recount that can potentially change the outcome of the election (where allowed[22]), it is important that the RLA be completed before certification unless the state provides legal recourse past the certification date to change an outcome if warranted.

Jurisdictions vary in how soon after the election the RLA can be or must be conducted. A delay of several weeks may be necessary so that all mail-in and overseas ballots can be included. Other states want the RLA conducted as soon as possible to forestall the possibility that either computer records or paper ballots might be altered.

For all RLAs, the initial tabulated result (and ballot images, if those are created) should be "frozen" (and published) immediately after tallying so that there can be no alteration of the computer record prior to the audit. Batches should be sealed after the initial count. These practices ensure that the RLA will be a comparison between the voter-completed ballot and the machine interpretation of those same ballots regardless of the elapsed time between election and audit.

The time frame needs to match the type of RLA that will be used. A jurisdiction that can use ballot comparison may finish in a day, as Colorado sometimes does. Ballot polling, especially with a tight margin, may take several days. Georgia required five days for its 2020 full hand tally. If the jurisdiction is trying to fit the RLA into a tight time frame, the result may be a rushed effort or mistakes that reduce credibility and undermine the purposes of the RLA.

Questions for the EOE to Consider

- **Did statutory timelines for auditing, recounting, or certifying have to be adjusted to accommodate the RLA? Why or why not?**
- **Does the governing RLA statute allow the RLA to change the result of the election?**

22 Virginia's statute requires that any RLA be conducted after certification and can have no effect on the result.

Section 3
Roles and Responsibilities of EOE Management

By combining detailed information and analysis about the election, the type of RLA and the election jurisdiction's audit plan with on-the-ground observation of RLA implementation, EOEs can draw conclusions about the integrity and credibility of the election and its reported result(s)—that is, about the trustworthiness of the election outcome. Appendix D provides questions for consideration. Section 3 of this guide describes the roles and responsibilities of EOE management. Section 4 focuses on the roles and observation responsibilities of the on-the-ground observers of the RLA implementation. As noted in the introduction, this manual is intended to supplement other resources and methodological tools available for election observation and so does not cover all aspects of observer deployment, data collection, analysis, and reporting. Rather, it focuses on observation issues unique to the RLA. Table 2 provides a checklist of the roles and responsibilities of EOE management.

Which Audits to Observe: Purpose and Scope

An initial decision for EOEs is the choice of audit to observe. This will likely include considerations such as the political salience of the election—can the EOE's participation foster political acceptance of the audit? There are also considerations of practicality. Can the EOE field observers and manage logistics in the location?

Table 2. Checklist of EOE Management Roles and Responsibilities

	Select election audit to observe
	Establish relationships with election authority and any outside assistance
	Determine type of RLA: Ballot or batch comparison? Ballot polling?
	What software will be used? Managed by consultants or election authority?
	What is the state/election authority's plan for citizen/party education on the type of RLA planned?
	Understand generally the state statutory framework: Roles of state and county officials? How is risk limit set and by whom? Who selects contest(s) to be audited? Is statute flexible or prescriptive? How does the RLA fit with recount and certification deadlines? Can the RLA correct an incorrect result?
	Flow chart election authority's process from vote count through audit
	Determine scope of observation: Ballot manifest creation? Audit day(s) only?
	Size the EOE, considering scope, geographic spread, etc.
	Create/modify data collection forms
	Recruit observers
	Obtain observer credentials
	Arrange logistical support for observers (transportation, food, lodging)
	Train observers on RLAs, jurisdiction specifics, forms, procedures, reporting
	Support observers in the field
	Analyze data from observers
	Debrief observers
	Prepare interim and final reports

The degree of cooperation from the target election authority is an important factor in deciding on and planning the observation effort. These and related issues, including whether an official invitation—which is required—is likely, are often analyzed by a pre-election assessment team. Other questions include whether there is sufficient lead time in credentialing and access to permit the desired scope of observation.

Does the EOE plan to observe a statutory audit that can determine the outcome, or a pilot that can allow the election authority to test out procedures, train employees, and make mistakes without real-world consequences? Will the election authority welcome EOE feedback and recommendations?

How extensive can the observation be? Will it encompass voting, counting and packaging of ballots? Preparation of the ballot manifest? Or will observation only begin with the public seed ceremony or the actual inspection of the ballots? Will EOE observers have only the audit access offered to any other public observer or special status as a nonpartisan observer? Can a sufficient number of observers be fielded so that conclusions can be drawn about the stages observed?

High-Level Understanding of the RLA

EOE management is responsible for establishing a relationship with the election authority[23], understanding its procedures and choices (e.g., avenues for voting, ballot handling workflow, type of RLA, setting the risk limit, statutory constraints, etc.) and establishing the parameters for the EOE. Different states and counties take different approaches, and it cannot be assumed that procedures in one place will be in use in another. The EOE can customize training and observation tools that will enable the on-the-ground observers to collect data on the implementation of the audit.

EOEs should understand the relationship between state- and county-level election authorities. For example, in Colorado, the secretary of state is responsible for running the software that identifies the ballots to be audited, and it sends lists to the counties, which pull the ballots from their storage and conduct the audit.

It is recommended that the EOE prepare a flow chart describing the entire sequence of ballot handling from voter to audit (including all possible avenues for casting a vote) in order to make sure that the EOE fully understands what the election jurisdiction is doing and can deploy on-the-ground observers appropriately. As an example, a generic flow chart prepared for a ballot polling RLA is included in Appendix C.

The flow chart should include enough detail that staff planning the observation can be sure that all ballot pathways are accounted for. Use standard ANSI symbols with rectangles for processes and diamonds for choice points to facilitate distinguishing processes and decisions. Each choice point should have at least two outcomes (Yes/No; This/That/Something Else). Does any process or decision point have no follow-on? If possible, check the flow chart with election authorities to make sure the EOE's understanding is accurate. This information can guide observer training and development of checklists and forms.

The jurisdiction will undoubtedly use software for managing the RLA. The EOE should be able to report whether the software works smoothly, generating successive rounds of auditing until the risk limit is met. Were there problems?

The EOE also should determine which software is used and whether a software contractor is assisting, or if the election authority is making decisions and operating the system. It also is important to assess the working relationship between any contractor and election administration.

23 Determining what constitutes the "election authority" is not always clear-cut. A county audit may be self-contained. Statewide audits may be conducted at county level, but with some state- and some county-level decision-making. Can the state overrule a local practice or decision? At the state level, it is often the secretary of state who oversees elections.

For example, Colorado initially commissioned Free and Fair to write software for its first RLA and had updates prepared by Democracy Works, but is now self-sufficient and is doing its own software modification as needed. In contrast, Georgia used a contractor (VotingWorks) to design and operate the software and train election staff. This goes to sustainability of the system: Will the election authority be able to conduct RLAs on its own even if budget constraints prevent the future use of outside support?

As a practical matter, the EOE needs to know who in government can authorize and credential observer access to the audit, or respond in cases where observers are being denied entry to an audit venue. Will cellphones and internet connection be allowed on the audit premises? This will determine whether on-the-ground observers will use tablets or paper for data collection.

The EOE should also note how the state or other election authority communicates with citizens, parties, and candidates about the RLA. Is there public outreach or training offered for observers?

Sources of Information for the EOE

The RLA is a relatively new technique, and there is a small ecosystem of practitioners, academics, nonprofits,[24] consultants, conferences, the federal Election Assistance Commission, and pioneer election authorities available to provide information, advice, and support to an election authority, and also to an EOE. The statisticians who developed the RLA—particularly Philip Stark, Ron Rivest, and Mark Lindeman—are actively involved in writing and consulting. Any jurisdiction planning its first RLA has likely tapped into this network, as can the EOE. Appendix B lists sources and published papers. In addition, many jurisdictions that have conducted full RLAs or pilots have created videos detailing their procedures, and many are posted on YouTube or on state or county websites.

Sizing the Observer Effort

The EOE needs to determine the size and scope of the planned audit, which depends in part on whether a ballot or batch comparison audit or a ballot polling audit is being implemented. In comparison with a ballot polling audit, ballot comparison audits will require fewer ballots to be examined, meaning the audit in any one city or county may go very quickly, reducing the need for multiple observer days. Is voting conducted through multiple avenues (in-person, mail-in, drop box) or entirely by mail? Will ballot collection and ballot manifest preparation from all these options all be observed?

For example, Colorado (like Oregon) votes exclusively by mail. The City and County of Denver in its 2018 primary counted 146,401 mailed-in ballots and needed to audit only 222 for a ballot comparison audit. Staff pulled the ballots from boxes that had been neatly packaged in batches of 100 as the mail arrived, and one audit board, composed of one Republican and one Democrat, completed its work in a single day. There was little to observe.

In contrast, Georgia in November 2020 planned to conduct a ballot polling audit but decided on a full hand tally (zero-risk-limit RLA) of nearly 5 million ballots across 159 counties. Mail-in, early, election day, and provisional ballots were collected in a variety of containers holding from a few to several thousand ballots. The Carter Center recruited 52 observers, credentialed in time for the five audit days but well after ballot manifest preparation. They observed in 25 counties, representing both rural and urban areas, areas leaning both Democratic and Republican, and covering about 60% of the votes cast. The distribution of observers by location and day was documented in the final report.[25]

24 Active nonprofits include Democracy Fund, Democracy Works, Center for Democracy and Technology, Verified Voting, VotingWorks, the Brennan Center, Open Source Technology Institute, and Common Cause.

25 https://www.cartercenter.org/resources/pdfs/news/peace_publications/democracy/georgia-audit-final-report-033121.pdf

The Colorado and Georgia experiences may represent the extremes in a continuum of observation scope, opportunities, and challenges. Most RLAs are likely to fall somewhere in the middle, but the observer effort has to be "sized" to the task in the particular jurisdiction. A ballot polling audit coupled with multiple avenues for voting and observation beginning with ballot manifest preparation means a larger recruitment effort that needs to start well in advance of the audit.

Preparing Observers

Objectivity and Code of Conduct

All Carter Center election observation missions are conducted in accordance with the Declaration of Principles for International Election Observation and Code of Conduct for International Election Observers (see Appendix F) that were adopted at the United Nations in 2005 and have since been endorsed by more than 50 election observation groups.

Besides adhering to the Code of Conduct, professional behavior during the audit is critical for maintaining observer credibility. Chatting with or taking a coffee break with observers from a single political party may be misperceived. Best to keep professional distance from other observers while still maintaining a friendly demeanor. On the other hand, good relations and communication with the election staff and any RLA contractors are very important. Observers should make it clear that they are there to document honestly and objectively what occurs. In Georgia, Carter Center observers found that election staff were proud of their efforts and eager to show off their operation, and also asked for any suggestions about ways to improve.

Credentials and Timing

To view ballot processing activities—from voting to counting and packaging to secure storage to retrieval for audit to return to storage—observers generally need credentials from the election authority. This is something that the EOE should arrange with the election authority as far in advance of the audit (and ideally the election) as possible, noting that access and accreditation procedures to observe the audit may be different from those to observe other elements of the election. During counting and preparation for the audit, the election authority is likely to be very busy and credential processing could easily be delayed, with resulting delays in the start of observation.

If possible, the organization itself should arrange to be accredited and then allowed to issue credentials to observers recruited even at the last minute. Building trust and negotiating well in advance might facilitate credentialing by the EOE.

Credentialing is also an issue for election observation outside the U.S. For example, national observer groups in Pakistan have sought organizational accreditation to avoid delays in individual observer accreditation. For one election, a national observer group sent a team of volunteers equipped with laptops and printers to the elections office to assist with processing individual credentials.

The Deployment Plan

EOEs do not need to cover 100% of the election authority or audit locations within the jurisdiction of interest or 100% of the hours during which auditing occurs. In effect, observation itself implies sampling. A small number of audit locations (e.g., counties) is sampled in the hopes that the sample is broadly representative and that conclusions about the sample can be appropriately generalized to the whole.

The geographic distribution of observers will depend on several factors. Some locations may be safer than others. Some will be farther away or difficult to reach. Two-person observer teams are desirable—allowing observation of different parts of an audit floor, comparing notes, and supporting one another.

Observers should be deployed as widely as practicable, and the observation report should explain the deployment and any caveats about the representativeness of conclusions.

Finally, even with careful planning, expect the unexpected—election authorities who do not provide timely information about changes in audit hours or locations, election staff who are unfamiliar with the credentials, unanticipated restrictions on numbers of observers, observers who get lost on the way to the audit location, observers with personal emergencies, etc. Arrange for constantly available phone and text (and maybe tech) support.

Training On-the-Ground Observers

First, observers need to understand their role as professional and impartial observers, adhering to a code of conduct. Rules on dress, conduct, and interactions with election staff and other observers should be clear.

Observers should understand RLAs in general and the particular RLA to be observed so they have context for their observations, know what they should see (or not see), and know when deviations from expectations should be reported to the EOE or election authorities. The observation forms provided will guide their observation. Observers who fully understand the event can adjust and add observations or comments that will aid in documenting the audit or flag issues to be addressed in future observations. See Figure 4 for a sample agenda for a training session for observers.

During the coronavirus pandemic, all training for observers in Georgia was conducted using Zoom. Virtual training was very effective and should be considered for future observation efforts. Observers could view flow charts and forms more easily on their own computer screens than when projected in a training room. Trainees could use the chat function to post questions that could be seen and answered by the trainer. Training sessions can be conducted evenings or weekends to accommodate a range of observer schedules. Remote

Sample Training Agenda
Role of nonpartisan observers—code of conduct, interaction with election staff and other observers
RLA concepts
Random sampling of paper ballots
What does "risk limiting" mean?
Ballot manifests
Chain of custody
Types of RLA—ballot comparison, ballot polling, batch comparison
The RLA to be observed: type and scope of this observation effort—ballot manifest preparation, seed, audit days, etc.
Flow chart of this election jurisdiction's process
Forms for observers to use—walk through flow chart and when forms are used; options for free-form addition of observations and comments
Practicalities
Credential process—logistics and any info to be supplied by observers
Needed observer information (contacts, dates, places, and times of availability)
Deployment plan—days and locations to be observed
Meals and lodging (per diem?)
Contact phone numbers for support and troubleshooting during observation
Timing and format (and legibility!) for submitting reports (paper scan, online)
Schedule for debrief sessions
List of contacts at EOE—troubleshooting, problems, questions
Questions?

Figure 4. Sample agenda for a training session for individual observers.

training also makes it easier to broaden the pool of potential observers. Hard-copy credentials and materials may still have to be delivered.

Data Collection, Analysis, and Reporting

The EOE will already have obtained answers to many of the broad questions described earlier in this guide—the type of RLA, how the ballot manifest is prepared, etc. On-the-ground observers can collect information on how the RLA plays out in practice. This requires tools for observers to use to collect information. Observation tools—data collection forms—should be straightforward for observers to complete and should focus their attention on critical questions about audit implementation. Responses have to be readily and quickly compiled by staff—putting a premium on Yes/No and rating-type responses. However, observers should be encouraged to record any important comments and anecdotes, which provide an avenue for reporting the unanticipated.

To prepare data collection forms, start at the endpoint, that is, the points the EOE will want to cover in the final report and then work backward to create the forms. While many RLA issues will be constant across elections, the specific questions asked and steps covered will only be as complete as the EOE's understanding of the event ahead of time. For example, Georgia in 2020 turned out to have far more partisan conflict and more batch size problems than anticipated when the forms were drafted; free-form observer comments captured this information.

The EOE should learn well in advance whether observers will be able to use tablets at election premises and on the audit floor or will be limited to paper. Determine prior to observer training how quickly the forms must be submitted (taking into consideration internet or physical access issues) for the EOE to analyze data and prepare its interim report on schedule.

For paper reporting, determine how forms should be transmitted (e.g., scanned pdf or jpg, smartphone image, Word document) to EOE management. Legibility and resolution are both critical for analysis. Without some standardization of forms input, there could be a back-end challenge of downloading and deciphering images.

Appendix E includes generic observation forms prepared in Microsoft Word. They can be customized for each EOE and for use on paper or electronically on a tablet.

A final step in data collection is conducting the observer debrief as soon as practicable after the audit. This is an opportunity for observers to exchange insights and respond to each other's impressions. It supplements information submitted on forms and allows some quantification of anecdotal information.

Section 4
On-the-Ground Observation

Individual observers are deployed to observe and record on-the-ground activities implementing the audit. Being present in election offices and audit locations, and interacting with election personnel, the media, partisan observers and other civic and nonpartisan observers, observers need to be very conscious of how they represent and advance the EOE. See Figure 5 for a list of responsibilities for individual observers.

Forms provided for the observers will guide them through elements to be recorded. Depending on credentialing and recruitment, on-the-ground observers may not be able to observe all components of the audit. Table 3 is a checklist of on-the-ground observation topics.

General Observer Responsibilities

- Follow code of conduct.
- Observe policies on dress, interaction with election staff and other observers.
- Understand and follow any policies for responding to media inquiries or requests for interviews.
- Be on time for observation shifts; call in promptly if there are unforeseen attendance problems or difficulty in site access.
- Ensure timely and legible submission of observation forms.
- Participate in observer debrief (in person or online).

Figure 5. List of responsibilities for the individual RLA observer.

Table 3. Checklist of on-the-ground observation topics

	Describe ballot manifest preparation (or how ballots were previously packaged).
	Overall impression of audit location: Atmosphere, collegiality, layout and workflow, traffic patterns, waiting times, space for observers to circulate, responsiveness of election supervisors, etc.
	Document chain of custody – from the point observation begins, with information about earlier stages if obtainable.
	Describe security of ballots at audit location: Containers sealed and seal numbers recorded? Sign-in/sign-out from storage? Ballots left unattended on audit tables?
	Audit boards: number and composition (Election staff? Party representatives?) Working relationships collegial? Consistency in process over time and across audit boards? Standards for determining voter intent? How often is there disagreement between audit board members?
	Audit table housekeeping: Clean and well-organized? Ballots neatly stacked?
	Is there an appeals process if audit board numbers cannot agree on voter intent?
	How is data entry done? By whom and when?
	Partisan and civic observers: Present? Cooperative? Interfering? Any observers ejected? Any law enforcement required?
	Party observers: Did they appear to understand the event?
	Election supervisor/staff engagement with credentialed observers and any public viewers: Welcoming? Explaining procedures? Livestreaming?

Overall: The Paper Trail – Chain of Custody

Since the RLA checks to see whether the tabulation reflects how votes were cast, it is critical that the ballots be protected and accounted for from the time a ballot is cast, through all mail-handling, counting, batching, storage, and transportation, until the ballot is selected for audit and then returned to storage. If ballots are left unsecured at any point, the "chain of custody" is broken and it cannot be assumed that the paper ballots under audit are really the same ones cast by the voter. Ballots could have been added, subtracted or altered.

Understanding and documenting the chain of custody from the point observation begins is one of the prime tasks for the on-the-ground observers. If possible, observers should find out how chain of custody was maintained and documented prior to the point observation began. In effect, observation is spot-checking chain-of-custody procedures.

What logs does the election authority use to document transfers of custody of ballot containers? (If possible, collect copies of forms used.) Who signs for delivery and receipt of ballots? Are there seals and seal numbers checked by recipients to make sure that the container has not been opened since it was last opened and sealed? Does the election authority observe the "rule of two" – no one person alone enters the ballot storage room or transports ballots?

The "audit" of 2020 ballots in Maricopa County, Arizona, conducted May-September 2021 violated (among other things) the chain of custody. Ballots were scattered among auditors and left unattended. With the chain of custody destroyed, it is impossible to draw any conclusions about voter intent. While genuine audits conducted prior to this partisan exercise will stand, any future audit of these ballots would be futile. Similarly, with no way to determine whether the voting equipment subpoenaed for use in this exercise was altered, these machines could not be used again for an election.

Voting Options and Preparation of the Ballot Manifest

If possible, and if credentialed early enough, observers should spot check how the ballots from different categories of voting option (mail-in, early, drop box, etc.) are being collected, batched, processed for scanning and counting, etc. How is the ballot manifest being assembled? A successful RLA requires a great deal of front-end work to organize and label the ballot batches. Once this is done, auditing selected ballots is relatively straightforward. If observers are not fielded in time to observe ballot manifest preparation, it may be possible to interview election officials to find out how they batched, scanned, and recorded ballots arriving via different voting options. Ask questions about decisions regarding batch size and whether there were any difficulties in creating the ballot manifest or locating containers for audit.

Mail-In

Some jurisdictions – for example, Colorado and Oregon – vote entirely by mail. Many others offer mail-in as an option, and different states have different definitions of "timely." Observers should confirm that all ballots received by the official deadline are included in the RLA. A deadline for receipt 21 days after the election would mean that the RLA should be delayed accordingly.[26]

Some jurisdictions batch, scan, and package ballots by date of receipt. Empirically, the volume of mail increases as election day approaches, so batches processed on a date-received basis will be in progressively larger batches as time goes on.

Drop Box

Drop box and mail-in batching have similar issues. Batches might be organized by date of emptying the drop box. If there are security concerns or state law requires that the drop box be continuously monitored, daily emptying may be necessary. If drop boxes are emptied less often, there is the problem of inconveniently large batches unless the drop box contents are subdivided either before or after scanning.

Some jurisdictions do not allow processing of mail-in and drop-box ballots ahead of election day, so ballot manifest preparation would be done after the election.

26 There are some statistical techniques for starting an RLA before all votes are in.

Early In-Person

Ballots might be batched by date of voting, with the number of ballots reconciled against the number of people voting that day. Depending on voting location and closeness to election day, the size of day-by-day batches could vary widely.

Election Day In-Person

States that have polling stations and precinct-level counting may have very large ballot boxes – potentially containing several thousand ballots. Ballots are undoubtedly all jumbled together. Are they being subdivided into smaller batches to facilitate later retrieval, or packaged as one large batch? If subdivided, where is this done and by whom? How is the chain of custody documented, and are the small batch totals reconciled against the list of voters? The tabulator typically scans the ballots as the voter feeds them into the scanner, so division of large boxes would facilitate ballot polling but would not be usable for batch comparison.

Provisional Ballots

These are cast in person (typically using a paper ballot) by a voter who comes to a polling station but whose qualifications are in doubt. These provisional ballots might be sent to a central office for signature comparison or perhaps transferred to the voter's correct polling place. How these ballots are batched (e.g., all provisional together; reunited with a polling station) is immaterial for the RLA. It is only necessary that all provisional ballots found to be valid are included on a ballot manifest and have an equal chance of being selected for audit.

Duplicated/Remade Ballots

These are ballots that are ripped or stained and cannot be read by the tabulator. In many states these are duplicated by a team of staffers, transferring the original votes from the damaged ballot onto a clean ballot, which is then read by the tabulator as normal. The original and the duplicate should be marked as such, so that they can be matched up later if needed. If auditors discover that one of the ballots selected for audit is a duplicated ballot, they need to go back and find the matching original ballot – it is the original that should be audited, not the duplicate. Observers may well see duplicated ballots being handled.

Batching and the Ballot Manifest

- **How are early, mail-in, drop box, provisional, election day ballots batched?**
- **If there are large precinct boxes, how are they handled?**
- **How is chain of custody logged?**

Other

There may be other categories of votes that are handled separately – such as UOCAVA (Uniformed and Overseas Citizens Absentee Voting Act) or federal write-in absentee ballots.

Audit Day Space and Personnel

The ballot storage arrangements, the type of audit, the number of audit boards needed, and the audit space required are interrelated issues.

The Audit Space

For a ballot comparison audit, relatively few ballots/batches will have to be pulled for audit, so the audit probably can be conducted in the election authority offices. Colorado counties require only a single two-person audit board, so space in the elections office is not an issue.

Ballot polling and batch comparison will require more batches that have to be handled by audit boards. This could necessitate a large number of audit boards and a large audit floor. For Georgia's November 2020 zero-risk RLA/full hand tally, few of the 159 county elections offices had sufficient space, so most counties had to move all their ballots to a larger space such as the courthouse. Moving ballots leads to challenges for maintaining ballot security during transport, logging the chain of custody, and restacking containers in some order so they can be readily located for ballot retrieval.

Audit board tables should be spaced to allow observers to circulate without interfering with the work.

Observers should report on the overall layout of the audit space and the workflow and traffic pattern moving ballots or containers from (temporary) storage to audit board and back again.

Audit Floor Organization

- Good traffic patterns?
- Audit tables well-spaced?
- Audit floor well-organized?
- Congestion?
- Room for election staff and observers to circulate without obscuring view of audit tables?

What Is Allowed on the Audit Floor?

The paper ballots must be handled and viewed in public. There are two types of problem to avoid: loss or alteration of ballots (the chain of custody issue), and inadvertent damage (e.g., food and coffee). The election authority may have rules about eating and drinking on the audit floor, and observers should note whether rules are followed.

Preventing ballot alteration is critical. Election workers may need pens to record results, but it is typical to require that any pens on the floor be of a different color (e.g., red or green) than the ballot markings (usually blue or black). Observers should take note of pen colors.

Removal of ballots or introduction of new ones is a possibility. This is most likely to happen when ballots are not kept in neat stacks or there are extraneous items on the table, or ballots are left unattended. The vulnerability increases if the audit floor is crowded or partisan observers are leaning over the audit tables.

Audit Table Housekeeping

- Audit table neat?
- Ballots stacked?
- Extraneous items?
- Pens on the table?
- Pen color?
- Coffee cups?
- Food?
- Ballots always attended?

Observers should note the status of audit table "housekeeping" and the general degree of order on the audit floor. Is the space well laid out so observers can circulate around audit tables without obscuring the overall view of the floor? Are individual audit tables clean and organized with no extra materials present? Are audit tables with unsecured ballots ever left unattended? How are ballots secured when audit board members are on break?

Workflow

Ballot containers must be stored securely from the time they are sealed after the votes are counted until the container is opened again for audit. Wherever the jurisdiction stores ballots (whether in the elections office or a temporary audit location), the room should be locked, with the entrance attended whenever it is unlocked. Some jurisdictions use security cameras on ballot storage. A "rule of two" should prevail—access to ballots is never by a single person. Observers should document the security arrangements and adherence to them.

Audit Workflow

- Congestion at ballot storage area?
- Any traffic jams?
- How are ballots moved between storage and audit board(s)
- Audit board downtime while waiting for ballots?
- Are audited ballots replaced in container?

For an efficient audit, the containers should be stored in some systematic way that allows staff or auditors to find a specific container without hunting through a jumble of stacked containers. Observers should document how ballots are stored and whether retrieval is efficient. Ballot storage is an indicator of the jurisdiction's overall degree of organization.

Observers should also document the overall workflow—how are ballots or ballot containers moved between secure storage and audit boards? For example, election staff might pull ballots and take them to the audit board. Staff might carry containers from secure storage to audit table; auditors might go to the storage location to check out another batch. In Georgia, in 2020, audit board members stayed at their tables and raised a sign to request pickup of completed batches or request a new batch; runners carried containers between storage and audit boards.

Ballot Security and Chain of Custody

- Ballot containers sealed when removed from storage?
- Audit boards unseal containers?
- Audit boards reseal containers when finished?
- All transfers of ballots recorded in log?

In all cases, there should be chain-of-custody logs so that sealed containers are logged out of storage and signed as received by the audit board. Custody for a set of ballots should always be unambiguous and documented.

Observers should document whatever system(s) the election authority uses to manage workflow and track chain of custody. Are there "traffic jams" at the secure storage location? Is there audit board downtime as boards wait to receive more ballots to process?

Who Are the Auditors?

Does the jurisdiction view the auditors as nonpartisan staff, or is auditing considered to be a political function requiring balanced Republican and Democratic (or other) participation? How does this policy choice affect the conduct of the audit and the degree of political acceptance of the result?

Colorado views bipartisan participation in every step as key to transparency and uses one Republican and one Democrat on the single audit board for each county. In Georgia's 2020 full hand tally, most county audit boards were staffed by election authority staff and other public employees. While these panels were nonpartisan, there was considerable acrimony on the audit floor on the part of party observers, many of whom did not trust the process and did not understand it.[27]

However, in three Georgia counties, the two parties were asked to send representatives to staff the audit boards, and the political strife was minimal.

Who Are the Auditors?

- **Political party members?**
- **Election or other governmental staff?**
- **Other?**
- **Working relationship between auditors?**

The number of audit boards required and the duration of the audit depends on the type of audit (comparison vs. polling) and the sample size. For example, in the 2018 primary election, when the City and County of Denver had to audit only 222 ballots, the work was quickly completed by the two political party members who fully understood the RLA methodology, and there was neither opportunity nor reason for partisan discord.

Observers should describe the election authority's system for creating audit boards and how audit board members and partisan observers deal with one another. Observers should note whether there seems to be a relationship between party participation and partisan acrimony.

Election Authority Training of Audit Workers

The election authority will have trained its staff (or party members) on the particulars of the audit. Observers should attempt to obtain any training material and, if possible, join a training session. If observers understand what staff and auditors are supposed to do, they will be able to detect deviations from official procedures.

In Georgia, in 2020, when the state switched from the planned ballot polling audit to a full hand tally, a one-hour training video was produced literally overnight. This was made available to Carter Center observers, and some counties played the video on a loop during the audit days so audit staff, observers, and the general public could view it. As the Georgia audit progressed and additional audit boards were needed, new members were recruited and trained by some combination of watching the video and being paired with a more experienced auditor.

Observers should document the training arrangements and any adjustments made if the audit requires recruiting additional audit board members.

Handling the Ballots

Finding the Required Ballots

Once the "work list" of ballots to be checked is generated by the software and provided to an election supervisor, the ballots must be retrieved for examination. The ballot manifest specifies the address (e.g., precinct, container, and batch), but locating the individual ballots for audit could be a challenge.

The first step for all audit types is locating and opening the target container and retrieving the desired batch, when larger containers are subdivided. For both ballot comparison and ballot polling, someone – election staff or audit board members – has to follow the work

27 One partisan observer asked whether the audit board was checking voter signatures on ballots. Ballots are not signed.

order generated by the RLA software to locate the required ballots. Different jurisdictions follow different procedures, and observers should be positioned to observe however the selection process is executed. Election rules almost always prohibit touching of ballots by observers.

Batch comparison: For a batch comparison audit, finding the required batches is the end of the matter, and audit board members proceed directly to auditing the ballots.

Ballot comparison: Any jurisdiction doing ballot comparison (with central counting) will very likely have the ballots organized in small, manageable scanning batches. Counting through them to pull the handful of required ballots should be relatively easy. The imprinted code as well as the ballot's sequential position must be confirmed.

Ballot polling: Ballot polling audits require a much larger number of ballots to be pulled. Jurisdictions doing ballot polling are likely to have an in-person voting option and potentially large precinct ballot boxes. Space requirements may dictate the use of tables for emptying the ballot box and organizing its contents. Hundreds of ballots (or thousands if the contents of the ballot box have not been previously subdivided) may all be jumbled together as they came out of the scanner. The audit board then has to stack the ballots neatly. It is not necessary that the ballots be stacked in any particular order. It is only necessary that once the batch is stacked, that same order be maintained as ballots on the sequential work order are pulled. The randomness assumption of the RLA will be violated if the stack is rearranged during the process of pulling the ballots on the work order.

There are several methods for locating the desired ballots, as described next.

Counting

For reasonably small batches (e.g., a few hundred), it is not too difficult to find the 53rd or 153rd ballot in the stack—just count. Observers should note whether the counting is done systematically so observers can check the count.

Weighing the Stack of Ballots

For a very large stack of ballots (hundreds or more), an option is to weigh a single ballot, and then to add or remove ballots from an estimated point in the stack ("near the 1,500th") until the scale indicates that the correct ballot has been located. It needn't be absolutely precise and probably will not be. The randomness assumptions of the ballot polling RLA aren't violated if the ballot selected is a few one way or the other from the target. Nevertheless, it may be difficult to assure partisan observers that the selection is not in some way biased.

Any reasonable degree of precision depends on having a very precise scale and people trained to use it. These scales may be cost-prohibitive, especially if several audit stations will be operating simultaneously.

K-Cut Methodology

Another alternative for selecting ballots from a very large batch for a ballot polling audit is a statistical technique known as the *k*-cut.[28] It is a somewhat arcane technique, although analogous to "cutting" a deck of cards. As jurisdictions become more sensitive to the problems of large batches and begin to store ballots in more manaeagable units (or switch to batch comparison), observers may be less likely to see this method in action. However, if used, the *k*-cut should follow a systematic procedure.[29]

---

28 Caltech/MIT Voting Technology Project, Sridhar, Mayuri and Rivest, Ronald L., (2018). k-Cut: A Simple Approximately-Uniform Method for Sampling Ballots in Post-Election Audits? https://arxiv.org/abs/1811.08811

29 The k-cut is analogous to repeatedly cutting a deck of playing cards to randomize their order. Suppose the batch contains 1,010 ballots. If the first ballot in the "work order" for selection is the 307th in sequence, estimate a third of the way through the large stack, and cut the deck at this point. Put the top portion of the deck on the bottom and the bottom on top. Cut again at roughly one-third and reverse top and bottom again. Do this a total of six times, and then take the top ballot. This will be treated as the 307th. It may or may not be the 307th from the original sequence, but statistically it is sufficiently randomized. Then do likewise for any other ballots that the work order requires for this container (e.g., 420th, 917th).

Auditing the Sampled Votes

For all audit types, it will be important to observe whether auditors are using guidelines for determining voter intent. During the original tabulation, undervotes and overvotes[30] flagged by the tabulation equipment should have been resolved using a guide to voter intent, and the same guide should be used during the audit.

Ballot comparison: For a ballot comparison audit, the auditors typically enter their reading of each paper ballot one ballot at a time directly on a computer screen in the sequence presented by the RLA software. Once saved, the interpretation cannot be changed. Then the software presents the screen for the next ballot in sequence to be audited.

Ballot polling and batch comparison: For batch comparison, auditors will likely "sort and stack" the ballots by candidate and record their counts on a batch sheet for later data entry. For ballot polling, software may allow ballot by ballot online data entry. Otherwise, ballot polling too will likely use "sort and stack."

Auditors' interpretations must be "blind" – uninfluenced by how the ballots were initially counted.

In none of the audit varieties do auditors know how the scanner/tabulator interpreted these ballots. The auditors' interpretations must be "blind" – uninfluenced by how the ballots were initially counted. The auditors' ballot interpretations or counts are uploaded to the audit software, and the software makes the comparison with the original outcome.

Data entry of any batch sheets is likely handled by a separate data entry team, with one person entering data and the other checking. Partisan and other observers should be able to watch data entry. Some jurisdictions livestream data entry so anyone can observe without interfering.

Observers should determine how and when data entry is done, whether there is two-person verification of entries, whether there is interference from party observers, and how the batch sheets are handled and accounted for.

For all three varieties of audit, after the audit boards have completed their work and their results are uploaded, the RLA software will compare the results from this round of audit to the original tabulation. If the risk limit is met, the software announces that the audit is over. If the risk limit is not met, a new sample with a sequential list of ballots is generated by the software.

Consistency in Procedures

How to sort and count ballots for audit is an issue for both batch comparison and ballot polling. For example, in a two-person contest, the ballots could be sorted into two candidate piles and then counted. Georgia's full hand tally training video showed one person calling out the name of the chosen candidate and the other placing the ballot on the correct pile. Then the piles were to be counted by 25s. This sequence was treated as the "official" process. It was enforced in some counties, but not followed in others, and individual audit boards adopted strategies such as taking turns sorting ballots. Some counted by 10s or did not subdivide at all. Some party observers complained that auditors were not calling out candidate names.

Auditors may be reluctant to follow time-consuming steps, especially when they are dealing with very large batches and exhaustion is setting in.

While the technique is not difficult to carry out, it can be time-consuming and the chances of satisfactorily explaining to partisan observers how the technique was used to pull random ballots are vanishingly small. If the jurisdiction uses the k-cut methodology, it will be important for observers to report how smoothly it was (or was not) done, and how party observers reacted.

30 The scanner records an undervote if it does not register any vote for the contest. Perhaps the voter decided not to cast a vote in this contest. However, the scanner may have failed to detect a genuine vote if, e.g., the voter's mark was too faint to be detected by the scanner setting. Conversely, the scanner might record an overvote if more than one mark was made on the page. Visual inspection, using a guide to voter intent, would determine what the voter intended, and the result would be tallied in the original reported outcome.

There is no one correct way to sort and tally ballots. The jurisdiction should have given the matter some thought and issued directives. Whatever procedures the jurisdiction has adopted, there should be consistency throughout the audit, both across audit boards and over time. There should be no changes in procedures midstream.[31] Observers should report on the method(s) used and the degree of consistency in procedures.

Auditing the Ballots

- **Were auditors clear on their task?**
- **Election supervisor provided help if needed?**
- **Method for locating required ballots (counting, weighing, *k*-cut)?**
- **Counting/sorting procedures consistently followed?**
- **Both auditors viewed every ballot?**
- **Auditors used guidelines for voter intent?**
- **Auditors ever unable to agree?**
- **Appeal panel required?**
- **Batch sheet or online data entry?**
- **Observers able to see the process?**

Observer Access and Understanding

Besides the EOE, other civil society organizations as well as political party representatives will likely be present to observe the audit. Media may also be present. Widespread observation can contribute to public acceptance of the audit and the election result. Conversely, observers' lack of understanding of the process can contribute to acrimony on the audit floor and possibly even reduce trust in the outcome. Overcrowding can compromise the conduct of the audit and the chain of custody. Observers should report on how the audit was conducted and how the audit was observed and understood.

Selecting a precinct or a set of voting machines for audit is easy to understand. These are familiar concepts and bases for selection. In contrast, an RLA involves sampling of individual ballots, and further requires that the sampling be random. Education of party officials and members, civil society organization members, and the public in general should be done well in advance of the audit.

Since many people observing the audit will not have had previous training, audit day efforts by the election authority will be helpful for ensuring accurate information about the process is understood and conveyed by observers. Georgia utilized a training video (prepared by contractor VotingWorks) to train staff, and some counties displayed the same video on a continuous loop on a large monitor during the audit days. This in effect provided on-the-job training for observers. Livestreaming of audit operations (counting, data entry) provides a view to a much wider audience, and also potentially allows closeups—for example, of an audit table, or a data entry screen—that observers onsite may be unable to view. Observers should note the steps taken by the election authority and whether public and party observers seem to understand what they are seeing.

Observers should also note how party and civil society observers are approaching their task. Do they appear systematic in what they watch and record? Do they utilize forms for systematic collection of data? Note comments or objections that are made by observers.

Public Participation

- **Adequate notice of time and location of audit events?**
- **Civil society organizations present?**
- **Election supervisor welcoming?**
- **Informational videos displayed?**
- **Briefing on procedures for observers?**
- **Did observers appear to understand audit purpose and procedures?**
- **Did observers seem to collect observations systematically?**
- **Livestreaming of auditing or data entry?**

The Political Dimension

Colorado takes the philosophical position that parties should be involved in every step of the election (including checking signatures on the mailed-in ballots). The county audit board consists of the Democratic and Republican chairs for the county. This approach gives party buy-in for the result. It is hard for partisans to complain of unfairness or vote rigging if the party chairpersons have signed off on the audit. It also becomes a party responsibility to educate their members..

On-the-ground observers should note whether there is party representation during every stage of the election that they are able to observe. Do party observers seem to understand the process? How are audit boards formed? How do audit board members interact with one another?

It is important that the public—and especially the political parties—understand the audit activity and what it does. In Georgia in 2020, many party observers appeared not to understand the audit process and what it could or could not reveal. Political acrimony on the audit floor was probably fueled by lack of understanding of the RLA, and increased the

31 Frequent and undocumented changes in procedure were one of the many deficiencies in the "audit" of presidential ballots conducted in Maricopa County, Arizona, during May–September 2021.

The Political Dimension

- **Party observers present?**
- **Party representation balanced by election supervisor?**
- **Any interparty conflict?**
- **Election authority or law enforcement intervention required?**
- **Did party observers understand the purpose and scope of audit?**
- **Did party observers document their observations?**

stress level and even personal safety concerns of all involved. As warranted, those initiating an election observation effort may want to seriously consider providing some training in conflict de-escalation techniques for observers operating in highly polarized and tense audit environments.

Section 5
Analysis and Reporting

As observer forms are turned in, EOE staff can begin tabulating the Yes/No, numeric and rating data. This provides a quick statistical picture of the audit—percent of audit boards following consistent procedures, number of counties with batch size problems, number of times law enforcement was called, and so forth—and allows some rapid conclusions about the election jurisdiction's success in managing the audit.

EOEs also should summarize key information about the effort, for example, numbers of observers fielded, distribution of observers across days or counties, and so forth. This allows readers of the report to assess the degree to which conclusions based on the EOE's sample of audit events can be generalized to the entire election jurisdiction.

Immediate press releases and a well-publicized interim report—issued while local voters' attention is still on the specifics of the election—can underscore the integrity of the process. A final report addresses a somewhat different audience—covering more detailed suggestions for improvement in the particular election jurisdiction and highlighting issues (e.g., batch size problems, partisan observers' lack of understanding) that can guide other jurisdictions planning future RLAs. Besides presenting conclusions about the conduct of the particular audit and the credibility of the election outcome, observation reporting can contribute to future improvements in the jurisdiction conducting the audit. Recommendations can suggest more effective public education and procedures that optimize workflow, add transparency to the chain of custody, and improve the smoothness of future audits. A clear, organized, and credible audit process may increase citizen confidence in RLAs and perhaps diminish partisan rancor. See Table 4 for a list of topics a final report can address.

To meet all these goals, managers need to understand the RLA and the particular variety under observation, and establish relationships with the election authority that will facilitate close observation. On-the-ground observers, for their part, need to understand both specifics of the audit and their role in signaling professionalism and nonpartisan assessment—and be able to keep their cool in what may be a very contentious event.

Table 4. Sample Table of Contents for Final Report

	Purposes of the observation mission
	Summary: the jurisdiction, RLA type
	Observation plan
	Timetable
	Geographic distribution of observers
	Number of observers
	Training of observers
	Findings
	Overall
	Ballot manifest
	Chain of custody of ballots
	Professionalism of the audit operation
	Audit board operation
	Transparency
	Public understanding of the audit
	Public education
	Public observation
	Partisan relations
	Recommendations for future RLAs

Section 6
Concluding Thoughts

The main purpose of any post-election audit is to give the public confidence in the integrity of the election. More specifically, a main function of an audit is to convince the loser that he or she lost.

Historically, audits were largely routine. They attracted attention only if there was a very close election and the result was genuinely in doubt. However, political polarization has led to widespread suspicion about results, even when the results reported by the jurisdiction's tabulation system are not close. It is the electoral process itself that is distrusted.

This political reality will inform how election authorities will prepare for, publicize, and conduct their audits, and whether there is political acrimony. Politics also affects how observers carry out their responsibilities, including what they observe, how they ask questions, and what and how they report.

Public understanding of this new audit process is especially critical. Unless the general public and especially the political parties understand RLA concepts and methodology, even the most meticulous and transparent RLA will likely be received with suspicion. Without thoroughgoing public education, the RLA could lead to less public confidence in the election process rather than more.

An EOE can play a key role in increasing citizen confidence in the conduct and results of the electoral process in general and the particular election under observation. A professionally organized observation effort, conducted by an impartial organization such as The Carter Center, acts as an accountability mechanism for the process, provides objective and credible information about the audit, and can provide an evidence-based, nonpartisan endorsement of the outcome. In addition, it can provide useful recommendations for future audit processes.

Appendix A
Glossary

Audit board	The team of two persons who will manually examine and tally the selected ballots.
Auditors	The individuals who serve on audit boards.
Ballot comparison RLA	Each ballot that has been randomly selected for audit is compared against the machine interpretation of that same ballot. This requires that each paper ballot be labeled so that it can be matched against its machine interpretation. This type of RLA not only confirms (or corrects) the outcome, but provides information about the accuracy of the scanners used.
Ballot manifest	A spreadsheet that describes the physical storage location of every cast ballot in a format that allows individually selected ballots to be located and retrieved for audit. It is a spreadsheet listing each ballot container and the number of batches stored within it, and the number of ballots in each batch. For convenience, containers might be identified by precinct, scanner, date of voting, etc.
Ballot-marking device (BMD)	The voter casts a vote by making selections on a computer screen. The machine then prints out a paper ballot with the voter's choices marked. The voter has the opportunity to review the accuracy of the printout before inserting the paper in a tabulator/scanner.
Ballot polling RLA	The randomly selected ballots are interpreted by auditors, and the overall result for the sample is compared with the original tabulation result. This type of RLA does not provide information about the scanning equipment.
Batch comparison RLA	Analogous to ballot comparison, the RLA makes a random selection of batches and compares batch tallies with the machine totals for the same batches.
Cast vote record (CVR)	This is the complete digital representation of each ballot cast. It would include the ballot style, the voter's mark on all contests on the ballot, precinct of voting location, images of the entire ballot, the identifier imprinted on the paper ballot, etc. To be usable for a ballot comparison audit, the CVR datafile must be exported in a way that allows the corresponding paper ballot to be retrieved.
Compliance audit	This type of audit reviews whether the procedural elements of the election operation comply with requirements – including assessing the integrity of the voter registration database and criteria for determining voter eligibility, testing all software, checking the security of voting equipment, ballot boxes and storage rooms, hiring and training of staff, accounting for all ballots sent to a polling station or sent out in the mail, reconciling the number of voted ballots against numbers of voters, etc. It is not a check on the reported results.

Full hand recount (or hand tally)	Each ballot is inspected visually by auditors who record their interpretation of the voters' choices. Depending on state law, the new candidate totals produced by the hand tally may replace the original reported results.
Imprinting	A unique identifier stamped on a paper ballot during scanning to allow identifying the ballot for a ballot comparison audit. Examples include a date and time stamp, or a batch or scanner number plus a sequential number.
Margin of victory	The difference in percent of votes cast totals between the apparent winner and the candidate with the next number of votes.
Diluted margin	The measure of the closeness of the election. It is the ratio of the reported margin (in votes) to the total number of ballots cast (including any blank, undervotes and overvotes)
Opportunistic audits	The margin in the target contest will determine the initial sample size and whether the risk limit has been met, but the election jurisdiction may decide to check the markings for other races/ballot questions on the selected ballots.
Outcome	Set of tabulated winners, not exact vote totals.
Correct outcome	The reported winner did indeed receive the most votes.
Incorrect outcome	The reported winner according to the tabulation did NOT receive the most votes; i.e., the loser was incorrectly identified as the winner. A full hand tally would show a different winner.
Paper ballot	A ballot with choices marked in pen by the voter, e.g., using a check mark or X in a designated space, or filling in an oval, or darkening a line connecting candidate and office.
Pseudorandom Number Generator (PRNG)	A computer algorithm starting from an initial "seed" that generates a sequence of numbers that is approximately random.
Recount	The definition varies by state, but it usually means running the paper ballots through the scanner/tabulator for a second time. When a candidate can demand a "recount" when the margin is small enough, this rescanning is usually what is meant.
Reported results	Whatever the tabulation equipment reported as the election outcome(s).
Risk limit	The largest chance that an incorrect result is not detected and corrected. This is the risk that the election authority has certified the wrong candidate—the person who in fact did not garner the most votes. E.g., a risk limit of 5% means a 95% chance that an incorrect outcome will be detected.
Risk-limiting audit	A variety of tabulation audit that selects a statistically random sample of ballots or batches of ballots for hand review. The RLA does not eliminate risk; it limits risk. The RLA does not produce new candidate totals (unless it turns into a full hand recount). It simply confirms (or corrects) the original outcomes. Did the winner really get more votes?

Sample size for RLA The required sample size does NOT scale (i.e., increase) with the number of votes cast. Rather, it depends on the chosen risk limit and the margin of victory; a very close election will require a larger sample. The required sample size is generated by the RLA software and will be larger for a ballot polling RLA than for a comparison RLA. Election authorities may pick a larger initial sample size than statistically required to avoid the possibility of successive rounds of sampling.

Sample The set of ballots retrieved for visual inspection and counting. For traditional tabulation audits, the percentage of precincts or machines to be recounted (e.g., 1%, 5%) is usually set by statute. An election with a high turnout will require a larger absolute number of ballots to be checked.

Seed The random number entered into a computerized pseudorandom algorithm to initiate the process of randomly selecting ballots for audit. In RLAs, the seed is customarily created by having 20 people each throw a 10-sided die. Any interested party could take the seed and enter it into the software and it will produce the same list of ballots to examine. This ensures transparency in the selection.

Tabulation audit A hand recount of selected voting machines or precincts: Does the machine-tabulated result match the result as indicated on the paper ballots hand-checked by human auditors?

Voter verifiable ballot A ballot produced by a ballot-marking device is not "verified." Rather it is "verifiable" in the sense that if the voter checks the printout before inserting it in the tabulator/scanner, the voter can see whether the choices were recorded accurately. However, studies indicate that voters very often do not check.

Voter's intent While paper ballots include instructions for marking a valid ballot, voters do not always follow the instructions, sometimes crossing out the disfavored candidate(s), circling the preferred name, or placing marks well outside the designated spaces. Determining the voter's intent in order to record the vote for the candidate the voter wanted can be a challenge. Most jurisdictions have guidelines for determining valid and invalid votes. The same guidelines used to interpret ballots during initial counting should be used during the audit.

Zero risk limit RLA An RLA that turns into a full hand recount, whether through successive rounds of sampling or due to an initial decision (usually in a very close race) to sample 100% of the ballots.

Appendix B
Resources

Appel, A. W. & Stark, P. B. (2020). *Evidence-Based Elections: Create a Meaningful Paper Trail*, Then Audit, https://www.cs.princeton.edu/~appel/papers/Appel-Stark-GLTR-2020.pdf

Caltech/MIT Voting Technology Project, Sridhar, Mayuri and Rivest, Ronald L, (2018). k-Cut: A Simple Approximately-Uniform Method for Sampling Ballots in Post-Election Audits? https://arxiv.org/abs/1811.08811

Center for Tech and Civic Rights, *Post-Election Audits*. https://www.techandciviclife.org/course/post-election-audits/

Electiontools.org, *Usability testing kit*. https://electiontools.org/tool/usability-testing-kit/

Garland, L., Lindeman, M., McBurnett, N., Morrell, J., Schneider, M., & Singer, S. (2018) *Principles and Best Practices for Post-Election Tabulation Audits*. https://verifiedvoting.org/publication/principles-and-best-practices-for-post-election-tabulation-audits/

Howard, L., Rivest, R. L. & Stark, P. B. (2019). *A Review of Robust Post-Election Audits*. Brennan Center for Justice. https://www.brennancenter.org/sites/default/files/2019-11/2019_011_RLA_Analysis_FINAL_0.pdf

IFES, Risk Limiting Audits: A Guide for Global Use, (2021) https://www.ifes.org/publications/risk-limiting-audits-guide-global-use

Lindeman, Mark, Stark, Phillip B., and Yates, Vincent S., (2012). "BRAVO: Ballot-polling Risk-limiting Audits to Verify Outcomes" https://www.usenix.org/system/files/conference/evtwote12/evtwote12-final27.pdf (2012)

Lindeman, Mark, and Stark, Phillip B.,"A Gentle Introduction to Risk-limiting Audits," *IEEE Security and Privacy* Special Issue on Electronic Voting (2012) https://www.stat.berkeley.edu/~stark/Preprints/gentle12.pdf

Lindeman, Mark, Rivest, Ronald, and Stark, Phillip B., "Machine Retabulation is not Auditing" (24 March 2013), https://www.stat.berkeley.edu/~stark/Preprints/retabNotAudit13.pdf

Lovato, Jerome, Risk-Limiting Audits – Practical Application, U.S. Election Assistance Commission (2018) https://www.eac.gov/sites/default/files/eac_assets/1/6/Risk-Limiting_Audits_-_Practical_Application_Jerome_Lovato.pdf

Morrell, Jennifer, Knowing It's Right, Part One: Practical Guide to Risk-Limiting Audits, Democracy Fund Election Validation Project (2019) https://democracyfund.org/wp-content/uploads/2020/06/2019_DF_KnowingItsRight_Part1.pdf

Morrell, Jennifer, Knowing It's Right, Part Two: Risk-Limiting Audit Implementation Workbook, Democracy Fund Election Validation Project (2019) https://democracyfund.org/wp-content/uploads/2020/06/2019_DF_KnowingItsRight_Part2.pdf

Morrell, Jennifer, Knowing It's Right, Part Three: Planning and Conducting a Risk-Limiting Audit Pilot, Democracy Fund Election Validation Project (2020) https://www.ncsl.org/Portals/1/Documents/Elections/2020_KnowingItsRight_Part3.pdf

Morrell, Jennifer, Knowing It's Right, Part Four: Ballot Accounting Audits Best Practices Guide, Democracy Fund Election Validation Project (2021) https://democracyfund.org/wp-content/uploads/2021/02/2021_DF_KnowingItsRight_Part4.pdf

RiskLimitingAudits.org (resource links) https://risklimitingaudits.org/resources/

Risk Limiting Audits Working Group: "Risk-Limiting Post-Election Audits: Why and How," October 2012 (version 1.1) https://www.stat.berkeley.edu/~stark/Preprints/RLAwhitepaper12.pdf

Schurmann, Carsten, A Risk-Limiting Audit In Denmark
A Pilot, https://pure.itu.dk/ws/files/83008080/rla.pdf

Stark, Phillip B., and Wagner, David, *Evidence-Based Elections*, IEEE SECURITY AND PRIVACY, SPECIAL ISSUE ON ELECTRONIC VOTING, 2012. https://www.stat.berkeley.edu/~stark/Preprints/evidenceVote12.pdf

Stark, Phillip B., *An Introduction to Risk-Limiting Audits and Evidence-Based Elections* Prepared for the Little Hoover Commission, 2 July 2018, https://www.stat.berkeley.edu/~stark/Preprints/lhc18.pdf

Stark, Phillip B., Ballot Polling Risk-limiting Audits in Two Pages (+1) 2012 https://www.stat.berkeley.edu/~stark/Preprints/bpa2pp.pdf

Stark, Phillip B., Close enough for government [to] work: Risk-Limiting Post-Election Audits. April 2011 Joint Berkeley-Stanford Statistics Colloquium, Stanford University, https://www.stat.berkeley.edu/~stark/Seminars/stanford11.pdf

Stark, Phillip B., Risk-Limiting Audits for Denmark and Mongolia (2014) https://www.stat.berkeley.edu/~stark/Seminars/itu14.pdf

Stark, Phillip B., Tools for Ballot-Polling Risk-Limiting Audits, https://www.stat.berkeley.edu/%7Estark/Vote/ballotPollTools.htm

Stark, Phillip B., Tools for Comparison Risk-Limiting Audits https://www.stat.berkeley.edu/%7Estark/Vote/auditTools.htm

Verified Voting 2018, Principles and Best Practices for Post-Election Tabulation Audits, https://verifiedvoting.org/publication/principles-and-best-practices-for-post-election-tabulation-audits

Verified Voting, Differences Between RLA Methods (2019) https://verifiedvoting.org/wp-content/uploads/2020/05/RLA-Methods.pdf

Verified Voting, Risk-Limiting Audits (RLA) Communication Guide, (2021) https://verifiedvoting.org/wp-content/uploads/2021/01/1.14.21-Verified-Voting-RLA-Communications-Guide.pdf

Verified Voting, What is a Risk-Limiting Audit? (2021) https://verifiedvoting.org/wp-content/uploads/2021/01/VV-What-Is-RLA-V4-Flowchart-2021.pdf

Verified Voting. (2019). *The Role of Risk-Limiting Audits in Evidence-Based Elections*. https://verifiedvoting.org/the-role-of-risk-limiting-audits-in-evidence-based-elections/

Wack, J., and R. Rivest, http://people.csail.mit.edu/rivest/RivestWack-OnTheNotionOfSoftwareIndependenceInVotingSystems.pdf

State-Specific Audits and Pilots

Arizona: Brennan Center for Justice, Howard, Elizabeth, Rosenzweig, Paul, and Baker, Turquoise (2021) Risk-Limiting Audits in Arizona. https://www.brennancenter.org/sites/default/files/2021-01/AZ%20RLA%20WP%20-%20FINAL2%20-%2002.01.21.pdf

California: California Secretary of State Post-Election Risk-Limiting Audit Pilot Program 2011-2013 Final Report to the United States Election Assistance Commission https://votingsystems.cdn.sos.ca.gov/oversight/risk-pilot/final-report-073014.pdf

Colorado: McBurnett, N., The Colorado Risk-Limiting Audit Project (CORLA). http://bcn.boulder.co.us/~neal/elections/corla/

Georgia: Kirk, J., Risk-Limiting Audit Report January 5, 2021 Runoff Election (Bartow County, GA) https://www.bartowcountyga.gov/departments/elections/Audit%20Information/1-5-21/Audit%20Report.pdf

Indiana: Bagga, J., (Indiana Voting System Technical Oversight Program (VSTOP)) 2018: Looking beyond Colorado: Risk Limiting Audits in Indiana, http://electionlab.mit.edu/sites/default/files/2018-12/eas-bagga.pdf

Michigan: Michigan Department of State Bureau of Elections, Risk-Limiting Audit Pilot of the 2020 Michigan Presidential Primary https://www.michigan.gov/documents/sos/Michigan_RLA_Report_693501_7.pdf

New Jersey: Morrell, Jennifer, Democracy Fund. 2019, Putting Election Integrity to the Test: A Case Study of New Jersey's First Pilot of Risk-Limiting Audits. https://electionline.org/resources/new-jersey-rla-case-study/

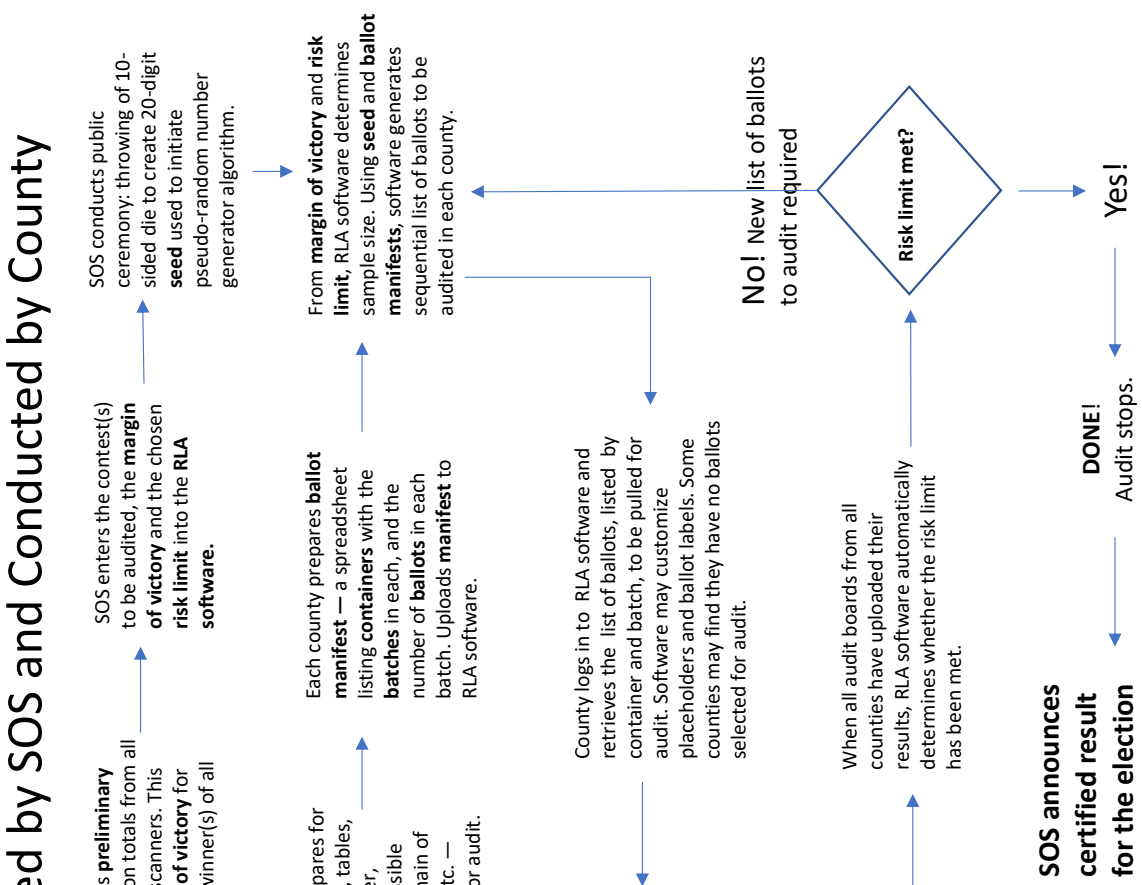
Rhode Island: Rhode Island RLA Working Group, Pilot Implementation Study of Risk-Limiting Audit Methods in the State of Rhode Island, (2019) (Common Cause, Verified Voting, Brennan Center) https://www.commoncause.org/rhode-island/wp-content/uploads/sites/26/2019/08/RI-Report-Design-FINAL-WEB5.pdf

Virginia: Lindeman, Mark (Verified Voting), City of Fairfax, VA Pilot Risk-Limiting Audit (2018) https://verifiedvoting.org/wp-content/uploads/2020/07/2018-RLA-Report-City-of-Fairfax-VA.pdf

Washington: League of Women Voters of Washington, Snohomish County RLA (2019) https://lwvwa.org/in-the-washington-news/7807629

Appendix C

Flow Chart of Sample Ballot Polling RLA Process



Appendix D
Understanding the RLA Process and Context: Questions for Consideration

As part of deploying an election observation effort, the following questions should be considered as a means of collecting data about the RLA process. By collecting information in response to these questions, the observation team should have a well-rounded understanding of how the audit will unfold. This information will inform the training of observers, the data collected on audit days, and the overall analysis of the process by the observation team.

Overall context of the RLA

- When was the RLA introduced? Is this the first time an RLA has been conducted?
- If there have been previous RLAs, how have they gone? Were there any issues, and if so, have they been addressed?
- Does the RLA replace other auditing methods used in previous elections?
- Is there a specific issue or reason that audits are used in this jurisdiction (e.g., previous issues with voting technology), and is an RLA appropriate for the purpose?
- Who is responsible for implementing the RLA at the state level? At the county level?
- Which variety of RLA is the jurisdiction using? How did they decide on this variety, and what were their constraints and decision points in making this choice?
- When will the RLA take place?
- Where will the RLA take place?

The legal framework for the audits

- Is the legal framework clear and easy to operationalize?
- Is the statute highly prescriptive or is it more flexible?
- Are the timelines for conducting the audit reasonable (in the context of certification of election results)?
- Does the statute allow the RLA to change the result of the election?
- Were any adjustments needed to accommodate the timeframe of the RLA?
- Does the legal framework (statute, regulations, or policy) provide for the presence of party representatives? Independent/nonpartisan observers? If so, are there provisions regarding appropriate and meaningful access and limitations?

The parameters of the RLA

- What is the chosen risk limit for this audit?
- How is the risk limit determined? (e.g., by statute or by an election official?)
- Who decides the contests to be audited?
- Is the sample size chosen to confirm outcomes for specific contests rather than for the election as a whole?

Seed generation

- How is the seed number generated?
- Is the process of generating the seed transparent and open to scrutiny by the public and/or candidate and party representatives?

Ballot storage and the ballot manifest

- Does the jurisdiction have a well-thought-out plan for organizing all ballots for storage?
- Did the jurisdiction consider the practical implications of batch size? How so?
- What is the possible maximum/minimum size of the batches?
- How is the ballot manifest created?
- How is the chain of custody for containers maintained and documented?

Audit logistics

- Are there guidelines or policies in place regarding the locations where the audit will take place?
- Do audit location requirements provide enough space to ensure the audit process can unfold smoothly and meaningful observation can take place?

RLA software

- Is the jurisdiction using reputable RLA software tools (either in-house or contracted)?
- Who, if anyone, is providing technical assistance to the jurisdiction? What is the scope of the assistance?

Training and public education

- What training have election workers received on how to conduct the RLA?
- Is the training available to observers?
- Has there been a public education campaign about the RLA and its purpose and scope? Other activities by the election authority to raise awareness of the RLA?
- Who has been the intended audience of this campaign?
- Has there been media coverage of the RLA process?
- What are the public notification requirements regarding the RLA? Is that information easy to find on election authority websites?

Observation

- What are the policies regarding observation of the RLA?
- Is accreditation required for nonpartisan and partisan observation?
- Are there rules regarding the proximity of observers to the audit boards?

Appendix E
Generic, Customizable Observation Forms

RLA Observer Forms

Observer Name:	**Location:**	**Date:**

Form 1: Ballot Batching and Ballot Manifest Preparation:

Briefly describe batching process for each of the following categories of ballots, including the batch size(s), how the ballot batches were sealed, and how this information was recorded on ballot manifest. Please complete one of these forms for each audit location visited.

Category of Ballots	Observed Packaging of Ballots		Comments, including re: - Batch size; - How batches were sealed; - How information was recorded on ballot manifest
	Y	N	
Mail-in			
Drop Box			
Early in Person			
E-day in person			
Provisional			
Other			

Did you have any problems gaining access to site or audit activities?	Y	N
If yes, please describe, as well as the resolution to the issue (if you contacted the management team, please note that here):		

Observer Name:	Location:	Date:

Form 2: Observations of the Audit Location:

This form is intended to capture data about the overall environment in the audit location, including the atmosphere and logistical setup within the space, ballot storage and security at the location, and observer and public access to observe the process.

Please complete one of these forms per observer, per location, per day. If more than one observer is at the audit location at the same time, please note that on the form so the EOE team can reconcile the observations.

You will note that you have three answer options for most questions: Yes, No and Not Observed (N/O). Not Observed can be used when you did not observe behavior related to the question at hand. Please do your best to respond to each question and not leave any question blank.

Overall Impressions of Audit Location

Please circle the adjectives that best describe the atmosphere in the audit location.

1. **Atmosphere**: Calm Cheerful Professional Hectic Confused Tense Angry Other _____

2. **Workspace Organization and Flow:** Using the scale below, please respond to the following statements:

1	2	3	4	5
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree

a) The audit space was spacious enough for the audit:

b) The audit floor was neat and well organized:

c) The workflow/traffic pattern was well organized:

a) The audit boards were continuously busy:

b) There was adequate space for observers:

Ballot Security at Audit Location:

	Y	N	N/O
3. Was the ballot storage room/area secure/guarded at all times?			
4. Were containers well organized in storage area?			
5. Was the storage entrance area free from congestion?			
6. Were ballots (containers/batches) sealed when taken from storage?			
7. Were ballots signed out from storage?			
8. Were ballots logged back into storage after auditing?			

Procedures for Retrieval of Ballots from Storage

	Y	N	N/O
9. Were procedures for opening containers consistently followed?			
10. Were procedures for conveying the ballots to the audit boards consistently followed?			
11. Were the procedures for pulling ballots consistently followed?			
12. Were procedures for requesting batches/containers consistently followed?			
Comments:			

Observers

Republican observers on site (est.) _____ #Democratic observers on site (est.) _____ # Other party _____

Observer organizations present: NAACP ACLU _____ _____ _____

Media? _____ _____ _____ _____

	Republicans			Democrats			Other Observers		
	Y	N	N/O	Y	N	N/O	Y	N	N/O
13. Did election supervisor greet observers?									
14. Did election supervisors explain procedures?									
15. Was there a training video for observers to view?									
16. Were livestream views available?									
17. Did observers appear to understand the audit steps and purpose?									
18. Did observers systematically record observations?									
19. Were there limits on numbers of observers allowed on audit floor? If so, explain below.									
20. Did the election supervisor balance numbers of Republic and Democratic observers?									
21. Did any observers interfere with auditors? If so, explain below.									

22. Did the election supervisor have to intervene? If so, explain below.									
23. Were any observers ejected? If so, explain below.									
24. Was law enforcement required? If so, explain below.									
25. Were there conflicts among observers? If so, explain below.									
Please add details for "Yes" responses to Questions 20-25, and any other comments on observers here:									

26. Did you have any problems gaining access to site or audit activities?	Y	N
If yes, please describe, as well as the resolution to the issue (If you contacted the management team, please note that here):		

RLA Observer Forms

Observer Name:	Location:	Date:

Form 3: Audit Board Observations

Number of audit boards in operation at site at time observing: _____

Audit Board Composition (*please circle*): Election Staff Political Party Representatives

	Audit Boards Individually Observed											
	Audit Board #			Audit Board #			Audit Board #			Audit Board #		
Time of observation												
Number of ballots in batch observed												
Chain of Custody												
	Y	N	N/O	Y	N	N/O	Y	N	N/O	Y	N	N/O
Were the ballots logged as received by the audit board?												
Were ballots unsealed by the audit board?												
Was the seal number recorded?												
Were the ballots resealed after auditing?												
Was a new seal number recorded?												
Were ballots ever left unattended on the audit tables?												
Audit Table and Area Housekeeping												
	Y	N	N/O	Y	N	N/O	Y	N	N/O	Y	N	N/O
Was the audit table neat and organized?												
Were there extraneous items on the audit table?												
Were there food and drinks on the audit table?												
Were only approved pens on the audit table?												
Were any materials inappropriately stored on the floor?												
Ballot organization												
	Y	N	N/O	Y	N	N/O	Y	N	N/O	Y	N	N/O
Did the order of ballots to be audited follow set procedures (e.g., starting with mail-in ballots)?												
Method of finding ballots in the batch (*circle one*)	Count / *k*-cut / Scale			Count / *k*-cut / Scale			Count / *k*-cut / Scale			Count / *k*-cut / Scale		
Were ballot placeholders used correctly?												
Ballot auditing/interpretation												
	Y	N	N/O	Y	N	N/O	Y	N	N/O	Y	N	N/O

RLA Observer Forms

Was the auditors' relationship positive/collegial?												
Did auditors follow procedures for determining voter intent?												
Did the audit board follow consistent procedures for auditing and counting?												
Did auditors receive timely help from election supervisors when needed?												
Did auditors agree on ballot interpretation? (*If no, please describe in comments.*)												
Were established procedures used to resolve disagreements between auditors?												
Did the audit board enter the audited results into the software?												
Did the audit boards complete their batch sheet?												
Were audited ballots put back into the ballot batch or were they stored separately? (*Circle one.*)	Returned / stored separately			Returned / stored separately			Returned / stored separately			Returned / stored separately		
Please provide comments below or on the back of your form. We appreciate your efforts to write legibly!												

If separate data entry team:			
How many data entry teams in operation? _____			
Data entry done immediately or later? By whom? Where? Describe procedure.			
Rule of two followed?		Any interference from observers?	

Did you have any problems gaining access to site or audit activities?	Y	N
If yes, please describe, as well as the resolution to the issue (If you contacted the management team, please note that here):		

Appendix F

Code of Conduct for International Election Observers

This Code of Conduct for International Election Observers was adopted at the United Nations in 2005 along with a Declaration of Principles for International Election Observation. These documents form the basis for credible international election observation and have been endorsed by more than 50 election observation groups. Both documents can be found online at electionstandards.cartercenter.org.

International election observation is widely accepted around the world. It is conducted by intergovernmental and international nongovernmental organizations and associations in order to provide an impartial and accurate assessment of the nature of election processes for the benefit of the population of the country where the election is held and for the benefit of the international community. Much therefore depends on ensuring the integrity of international election observation, and all who are part of this international election observation mission, including long-term and short-term observers, members of assessment delegations, specialized observation teams and leaders of the mission, must subscribe to and follow this Code of Conduct.

Respect Sovereignty and International Human Rights

Elections are an expression of sovereignty, which belongs to the people of a country, the free expression of whose will provides the basis for the authority and legitimacy of government. The rights of citizens to vote and to be elected at periodic, genuine elections are internationally recognized human rights, and they require the exercise of a number of fundamental rights and freedoms. Election observers must respect the sovereignty of the host country, as well as the human rights and fundamental freedoms of its people.

Respect the Laws of the Country and the Authority of Electoral Bodies

Observers must respect the laws of the host country and the authority of the bodies charged with administering the electoral process. Observers must follow any lawful instruction from the country's governmental, security and electoral authorities. Observers also must maintain a respectful attitude toward electoral officials and other national authorities. Observers must note if laws, regulations or the actions of state and/or electoral officials unduly burden or obstruct the exercise of election- related rights guaranteed by law, constitution or applicable international instruments.

Respect the Integrity of the International Election Observation Mission

Observers must respect and protect the integrity of the international election observation mission. This includes following this Code of Conduct, any written instructions (such as terms of reference, directives and guidelines) and any verbal instructions from the observation mission's leadership. Observers must: attend all of the observation mission's required briefings, trainings and debriefings; become familiar with the election law, regulations and other relevant laws as directed by the observation mission; and carefully adhere to the methodologies employed by the observation mission. Observers also must report to the leadership of the observation mission any conflicts of interest they may have and any improper behavior they see conducted by other observers that are part of the mission.

Maintain Strict Political Impartiality at All Times

Observers must maintain strict political impartiality at all times, including leisure time in the host country. They must not express or exhibit any bias or preference in relation to national

authorities, political parties, candidates, referenda issues or in relation to any contentious issues in the election process. Observers also must not conduct any activity that could be reasonably perceived as favoring or providing partisan gain for any political competitor in the host country, such as wearing or displaying any partisan symbols, colors, banners or accepting anything of value from political competitors.

Do Not Obstruct Election Processes

Observers must not obstruct any element of the election process, including pre-election processes, voting, counting and tabulation of results and processes transpiring after election day. Observers may bring irregularities, fraud or significant problems to the attention of election officials on the spot, unless this is prohibited by law, and must do so in a non-obstructive manner. Observers may ask questions of election officials, political party representatives and other observers inside polling stations and may answer questions about their own activities, as long as observers do not obstruct the election process. In answering questions observers should not seek to direct the election process. Observers may ask and answer questions of voters but may not ask them to tell for whom or what party or referendum position they voted.

Provide Appropriate Identification

Observers must display identification provided by the election observation mission, as well as identification required by national authorities, and must present it to electoral officials and other interested national authorities when requested.

Maintain Accuracy of Observations and Professionalism in Drawing Conclusions

Observers must ensure that all of their observations are accurate. Observations must be comprehensive, noting positive as well as negative factors, distinguishing between significant and insignificant factors and identifying patterns that could have an important impact on the integrity of the election process. Observers' judgments must be based on the highest standards for accuracy of information and impartiality of analysis, distinguishing subjective factors from objective evidence. Observers must base all conclusions on factual and verifiable evidence and not draw conclusions prematurely. Observers also must keep a well documented record of where they observed, the observations made and other relevant information as required by the election observation mission and must turn in such documentation to the mission.

Refrain from Making Comments to the Public or the Media before the Mission Speaks

Observers must refrain from making any personal comments about their observations or conclusions to the news media or members of the public before the election observation mission makes a statement, unless specifically instructed otherwise by the observation mission's leadership. Observers may explain the nature of the observation mission, its activities and other matters deemed appropriate by the observation mission and should refer the media or other interested persons to those individuals designated by the observation mission.

Cooperate with Other Election Observers

Observers must be aware of other election observation missions, both international and domestic, and cooperate with them as instructed by the leadership of the election observation mission.

Maintain Proper Personal Behavior

Observers must maintain proper personal behavior and respect others, including exhibiting sensitivity for host-country cultures and customs, exercise sound judgment in personal interactions and observe the highest level of professional conduct at all times, including leisure time.

Violations of This Code of Conduct

In case of concern about the violation of this Code of Conduct, the election observation mission shall conduct an inquiry into the matter. If a serious violation is found to have occurred, the observer concerned may have their observer accreditation withdrawn or be dismissed from the election observation mission. The authority for such determinations rests solely with the leadership of the election observation mission.

Pledge to Follow This Code of Conduct

Every person who participates in this election observation mission must read and understand this Code of Conduct and must sign a pledge to follow it.

The Carter Center at a Glance

The Carter Center was founded in 1982 by former U.S. President Jimmy Carter and his wife, Rosalynn, in partnership with Emory University, to advance peace and health worldwide. A not-for-profit, nongovernmental organization, the Center has helped to improve life for people in more than 80 countries by resolving conflicts; advancing democracy, human rights, and economic opportunity; preventing diseases; and improving mental health care. Please visit www.cartercenter.org to learn more about The Carter Center.

THE
CARTER CENTER

One Copenhill
453 John Lewis Freedom Parkway
Atlanta, GA 30307
(404) 420-5100

www.cartercenter.org