OMB Control # 3265-0024.
Expires: 9/30/2025

Voting System Anomaly Root Cause Analysis Template v2.0

Root Cause Analysis for:

VV40ECT-151: VxMark Stuck in Loop when Printed Ballot Cannot Be Interpreted - Rev. 1
VxSuite, Version 4.0 and EAC Certification #VXS4

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September 11, 2025

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Introduction

An anomaly was reported in VxMarkScan where, under specific conditions the software was unable to start a new voting session. It became stuck in a review state if a ballot was printed and scanned that could not be interpreted. Then when changing the ballot to allow it to be interpreted, starting a new voting session led to another stuck state in a white screen.

There were a number of software features of VxMarkScan that were involved in this anomaly, and understanding how it occurred was important to prevent voting errors in these particular situations.

Anomaly Description

Complete all sections. Descriptions must be as detailed as possible, while being clear and concise since the anomaly is the source of the entire RCA. This detail should include a complete list and/or description of the "symptoms" of the anomaly and the conditions present which the symptoms occurred.

Date of Anomaly: July 1, 2025	Time of Anomaly: 3:59pm
Place of Anomaly: SLI, Wheat Ridge, CO	Person identifying Anomaly: Jessica Myers, VotingWorks
Expected Results of actions leading up to anomaly: Casting and scanning a ballot printed from VxMarkScan would happen without errors. If a ballot does have a problem with the print, such as with the printed QR code, then VxMarkScan should still handle that gracefully, allowing reasonable options to follow up on the ballot, including spoiling it and allowing a new voting session if the user desires one.	

Detailed description of the event / anomaly:

A ballot was printed from a VxMarkScan voting session that included several write-in selections. After reviewing the ballot, and when attempting to cast the ballot in VxMarkScan, the ballot QR code could not be scanned or interpreted properly. Then the ballot could not be spoiled, and there was no option to go back to the main menu. Additionally, the ballot choices could still be reviewed and changed. When the vote choices were changed to eliminate write-ins and choose a listed candidate, then the ballot could be spoiled and a new voting session started.

Upon starting a new voting session at this point, the screen turned white. Removing the pollworker card would then make the screen ask to insert the card again. Inserting the card and the PIN then led to the screen turning white again. Normal function could only resume after rebooting.

If the anomaly is repeatable, provide step by step instructions to recreate it:

To recreate the initial stuck loop after printing the ballot:

- Start a voting session in VxMarkScan, while including many write-in candidates totaling more than 100 characters. Review, print, and cast the ballot.
- The printed QR code is not interpretable by the scanner. Note the “Ask a poll worker for help” error.
- (As a poll worker) Discard the old ballot. Insert a new blank sheet.
- Note that the software does not allow spoiling or resetting the vote session.

To recreate getting stuck in the white screen:

- Do the above, but then change the selected votes to remove all write-ins.
- Go back to the poll worker menu, spoil the ballot, and immediately attempt to start a new voting session. Do not wait for the first ballot to eject completely.
- Note that the screen goes white, and that relogging in using the pollworker card does not get past that.

Chronology of Events / Timeline

Provide a detailed chronology of the events leading up to, and following, the anomaly. Add additional events if necessary.

ID	Date/Time	Description	Entity Org/person	Result / Notes

EAC (Election Assistance Commission) Root Cause Analysis

1	July 1, 2025, 3:59pm	Anomaly is reported to VotingWorks by SLI testers.	Jessica Myers, VotingWorks	Details are shared with the wider VotingWorks team. Discussions focus on the different software aspects of the observations.
2	July 10, 2025	Investigative work is assigned to the software development queue.	Arsalan Sufi, VotingWorks	Two parts of the anomaly had to be investigated: (1) the initial loop when scanning uninterpretable ballots, and (2) getting stuck in a white screen.
3	June 27, 2025	The first part of the anomaly is addressed by preventing uninterpretable QR codes. VxMarkScan content limits were updated to account for write-in character limits.	Kofi Ohene-Adu, VotingWorks	A software update was applied for separate discrepancy VV40ECT-113 to prevent overloading a ballot where the printed QR code would encode too much data. The open source code change can be seen on GitHub here: https://github.com/votingworks/vxsuite/pull/6662 After this, the content limits became: ● 11" sheets: 25 contests max, with 100 maximum combined write-in characters ● 13.25" sheets: 30 contests max, with 90 maximum combined write-in characters This helped in the case of encoding bilingual ballots, and it also applied to this discrepancy VV40ECT-151 to make it less likely to scan an uninterpretable QR code in the first place.
4	August 25, 2025	The second part of the anomaly is addressed by preventing a user from starting a voter session in VxMarkScan while the unit is already ejecting a ballot.	Kevin Shen, VotingWorks	It was noted that the white screen issue could be reproduced when starting a new voting session before the first spoiled ballot is fully ejected. This was due to paper event handling logic, and a fix could be to require users to wait for paper to be ejected before starting a new voting session. Associated open source code changes can be seen here: https://github.com/votingworks/vxsuite/pull/7096

Investigative Team and Method

This section shall describe how the investigative team is assembled by the voting system manufacturer, who it consists of, and how it gathers the data to be used in the analysis. Include the RCA method employed by the manufacturer in conducting the analysis and why this method was used.

Names and Positions of members of the investigation team:
Jessica Myers, Head of Compliance
Arsalan Sufi, Head of Software
Kofi Ohene-Adu, Software Engineer
Kevin Shen, Software Engineer

Describe the data gathering process:

After initial reporting of the anomaly to Jessica Myers, the issue was shared with the wider VotingWorks team. Arsalan Sufi analyzed the software behavior and coordinated the software investigation with other engineers. Kofi Ohene-Adu had contributed to mitigating the first part of the anomaly relating to QR code interpretation when addressing a different issue noted by SLI in VV30ECT-113. Kevin Shen mitigated the stuck “white screen” state after starting a new voting session.

EAC (Election Assistance Commission) Root Cause Analysis

Describe which methodology(s) is used to conduct the root cause analysis:

This investigation followed the “Five Why’s” strategy, initially branching into asking for the root causes of the two main aspects of this issue in software: scanning uninterpretable printed ballot QR codes, and getting into a stuck state when starting a new voting session. The first issue was seen before in another context in VV40ECT-113, and investigations drilled down into the causes of QR code interpretation problems related to write-in limits. The second issue explored the code related to starting a new voting session, eventually focusing on the cause being starting a new session while already ejecting paper.

Findings and Root Cause

Describe the findings of the investigation and explain the root cause(s) based on these findings. If the RCA results in findings that are not directly related to the root cause of the anomaly, these should also be captured as manufacturer product/process improvement steps in an effort to improve the voting system.

The anomaly had two main parts, with separate root causes:

1. **Stuck State Scanning Uninterpretable Ballot**
   The root cause of this first stuck state in the anomaly was a QR code density greater than what the VxMarkScan system can interpret. Scanning a ballot with many write-ins would increase the QR code density due to the increased data encoded, but the print and scan resolution could not handle that QR code properly.

2. **Stuck State When Trying to Start a New Voting Session, Following the Previous Actions**
   The first part of the anomaly was bypassed originally by modifying the ballot votes and spoiling the ballot. Then a new voting session could be started. However, during this process of spoiling the ballot, the VxMarkScan ejects the first paper ballot. Starting a new voting session before the paper ejects fully would lead to the “white screen” stuck state due to paper event handling logic. If the user had to wait for the paper to fully eject first, then the system should never enter that stuck state.

Corrective Action(s)

VotingWorks addressed the first root cause by preventing uninterpretable QR codes, by reducing QR code density when write-in character counts are high (see associated open source code changes here: https://github.com/votingworks/vxsuite/pull/6662). Furthermore new system limits state a limit for number of write-in characters across contests on VxMark.

If a user does exceed that system limit, an additional software patch prevents users from starting a new voting session while paper is being ejected, thereby avoiding the stuck white screen (see associated open source code changes here: https://github.com/votingworks/vxsuite/pull/7096).

Solution Management

The purpose of this section is to manage the corrective action(s) moving forward. This should detail all process changes to manage those corrective actions, and steps taken to ensure the actions eliminate the anomaly over time.

The software changes are reviewed through standard development processes and verified through manual testing of all software releases.