Context Description: Posted Dec. 1, 2006

This draft report was prepared by NIST staff at the request of the Technical Guidelines Development Committee (TGDC) to serve as a point of discussion at the Dec. 4-5 meeting of the TGDC. Prepared in conjunction with members of a TGDC subcommittee, the report is a discussion draft and does not represent a consensus view or recommendation from either NIST or the TGDC. It reflects the conclusions of NIST research staff for purposes of discussion. The TGDC is an advisory group to the Election Assistance Commission, which produces voluntary voting system guidelines and was established by the Help America Vote Act. NIST serves as a technical advisor to the TGDC.

The NIST research and the draft report's conclusions are based on interviews and discussions with election officials, voting system vendors, computer scientists, and other experts in the field, as well as a literature search and the technical expertise of its authors. It is intended to help in developing guidelines for the next generation of electronic voting machine to ensure that these systems are as reliable, accurate, and secure as possible. Issues of certification or decertification of voting systems currently in place are outside the scope of this document and of the TGDC's deliberations.

Discussion Paper on Marginal Marks

1 Preface

This discussion paper describes the direction that the current VVSG'07 draft takes regarding marginal marks. This direction was arrived at after analysis of feedback collected from TGDC members and members of the Election Technology Council of the Information Technology Association of America, primarily between December 2005 and March 2006.

The direction that the current draft takes regarding marginal marks **has not changed** since it received general TGDC approval at the March 2006 TGDC meeting. We provide this review in recognition of the importance of the topic and its potential to generate controversy, and as a service to new TGDC members who may be unaware of the direction previously presented.

2 Discussion

A marginal mark is a mark within a voting target that does not conform to vendor specifications for a reliably detectable vote. The word "marginal" refers to the limit of what is detectable by an optical scanner, not the margin of the page. Marks that are outside of voting targets are called extraneous marks.

A marginal mark is neither clearly countable as a vote nor clearly countable as a non-vote. It is an ambiguous vote, analogous to dimpled chad on a punchcard.

The voter should always be instructed to make an ideal mark, which in a typical optical scan system means completely filling the oval with a #2 pencil. To allow for variations in the marks that diligent voters actually make when trying to follow this instruction, the accidental use of non-approved marking utensils, *et cetera*, optical scanners are configured to accept a relatively wide range of marks as votes (Requirement III.6.8.4-D). Marginal marks are below this range. They happen when voters do not follow instructions or the instructions are inadequate.

Although the criteria are not necessarily simple, vendors are required to specify what constitutes a reliably detectable mark versus a marginal mark (Requirement IV.3.1.2-A.2). If this cannot be accomplished, then the voting system is counting votes using a mystery algorithm. Such a system is not certifiable.

A ballot that was marked with an Electronically-assisted Ballot Marker should never contain marginal marks. If it does, an equipment malfunction has occurred, and it should be handled as such (Requirement III.6.8.2-C).

In the case of precinct counting of manually-marked paper ballots, the precinct count scanner should be configured to reject ballots containing marginal marks (Requirement III.4.1.2-E). For example, a hypothetical optical scanner that detected marks based only on overall darkness could be configured so that a mark that was more than (30 ± 2) % dark would count as a vote, a mark that was less than (10 ± 2) % dark would count as a non-vote, and anything in between would be rejected as marginal. (These numbers are just examples to clarify the general intent, and are not necessarily fit for use in an any given election.)

The uncertainty at both ends of the marginal zone is of no consequence. A mark that was exactly 30 % dark would either be accepted as a vote or rejected as marginal and returned to the voter for clarification. Either way, it would not be mistaken for a non-vote. Similarly, a mark that was exactly 10 % dark would either be accepted as a non-vote or rejected as marginal and returned to the voter for clarification. Either way, it would not be mistaken for a vote. (Detectable marks in the lower range are typically hesitation marks, accidental smudges, or damage to the paper.)

In the central count case, rejection of marginal marks is only helpful if someone is going to examine each affected ballot and judge the intent of the voter. If this is not going to occur, then it is preferable to disable the detection of marginal marks so that every mark is counted either as a vote or as a non-vote. Unfortunately, it is not technically possible to do this without creating the potential for irreproducible tabulation results. For example, if a hypothetical optical scanner that detected marks based only on overall darkness were calibrated to distinguish votes from non-votes using a threshold of (25 ± 2) % darkness, the detection of marks that were between 23 % and 27 % dark would not reproduce on a different scanner of the same kind. Moreover, the detection of marks that happened to fall very close to the actual detection threshold of the scanner as calibrated would not repeat on the same scanner. As the darkness of a mark (or whatever the scanner is measuring) approaches the detection threshold, the signal-to-noise ratio approaches zero. At some point, the noise determines the result that is tabulated.

Short of banning the use of manually-marked paper ballots, which would create a crisis for absentee voting, the best we can do for this central count case is prohibit bias in the detection of marginal marks (Requirement III.6.8.4-H) and advise that the detection of marginal marks be made as repeatable as possible (Requirement III.6.8.4-I).

3 Requirements

Volume II, Terminology Standard

These terms are quoted just to define the acronyms. Other terms such as "optical scanner" and "vote-capture device" are defined in the draft.

EBM: (Electronically-assisted Ballot Marker) VEBD that produces an executed paper ballot as a result. Note: The ballot output by an EBM may or may not include a bar code. An EBM may mark ballot positions on a pre-printed ballot or it may print an entire ballot. The latter kind are called EBPs.

EBP: (Electronic Ballot Printer) EBM that prints an entire ballot.

ECOS: (EMPB-Capable Optical Scanner) Optical scanner used to count EMPBs.

EMPB: (EBM-Marked Paper Ballot) Ballot marked by an EBM.

MCOS: (MMPB-Capable Optical Scanner) Optical scanner used to count MMPBs.

MMPB: (Manually-Marked Paper Ballot) (1) Vote-capture device consisting of a paper ballot and a writing utensil. (2) Paper ballot that was marked by a person using a writing utensil.

VEBD: (Voter-Editable Ballot Device) Vote-capture device that gathers votes via an electronic voter interface and allows the voter to alter previously made selections without spoiling the ballot.

Volume III, Product Standard

Note: The first requirement cited below has been transferred to the HFP subcommittee for further development, as the interaction with the voter is primarily an HFP concern.

→ 4.1.2-E Precinct paper tabulator, capability to reject marginal marks

All paper-based precinct tabulators should provide a capability to

a. Identify a ballot containing one or more marginal marks;

b. Return the ballot to the voter;

c. Provide feedback to the voter that identifies specific contests or ballot issues for which a marginal mark is detected;

d. Allow the voter, at the voter's choice, to correct the ballot or submit the ballot "as is" without correction.

Source: New requirement.

Applies to: Precinct tabulator ^ Paper-based device

D I S C U S S I O N

See Volume III Section 1.4.4. In many cases, correcting a ballot means spoiling it and voting a new one. Erasures are to be avoided.

→ 6.8.2-C ECOS, react to marginal marks and overvotes

ECOS should provide a capability to alert an election judge or central election official when a ballot that is scanned appears to contain marginal marks or overvotes.

Source: New requirement.

Applies to: ECOS

D I S C U S S I O N

If an EMPB appears to contain marginal marks or overvotes, either the EBM is broken or the scanner is broken. Either way, an election judge or central election official should be notified immediately. (Possibly the voter has simply disregarded instructions and marked the ballot manually.)

Test reference: Volume V Section 5.2

→ 6.8.4-D MCOS, accurately detect imperfect marks

MCOS shall detect a 1 mm thick line that is made with a #2 pencil, that crosses the entirety of the voting target on its long axis, that is centered on the voting target, and that is as dark as can practically be made with a #2 pencil, to the satisfaction of Requirement III.5.3.2-B.

Source: Many issues and public comments. Specification of mark originated with recommendation in Issue #1322, changed to reduce ambiguity.

Applies to: MCOS

D I S C U S S I O N

Different optical scanning technologies will register imperfect marks in different ways. Variables include the size, shape, orientation, and darkness of the mark, the location of the mark within the voting target, the wavelength of light used by the scanner, the size and shape of the scanner's aperture, the color of the ink, the sensed background-white and maximum-dark levels, and of course the calibration of the scanner. The mark specified in this requirement is intended to be less than 100 % perfect, but reliably detectable, i.e., not so marginal as to bring the uncontrolled variables to the forefront. In plain English: scanning technologies may vary, but as

a minimum requirement, all of them should be capable of reliably reading *this* mark.

Test reference: Volume V Section 5.3.2

→ 6.8.4-H MCOS, marginal marks, no bias

The detection of marginal marks from manually-marked paper ballots shall not show a bias.

Source: New requirement.

Applies to: MCOS

D I S C U S S I O N

Bias errors are not permissible in any system (1990 VSS 7.3.3.3). An example of bias would be if marginal marks in the first ballot position were detected differently than marginal marks in the second ballot position.

Test reference: Volume V Section 5.2

→ 6.8.4-I MCOS, marginal marks, repeatability

The detection of marginal marks from manually-marked paper ballots should be repeatable.

Source: New requirement.

Applies to: MCOS

D I S C U S S I O N

It is difficult to have confidence in the equipment if consecutive readings of the same ballots on the same equipment yield dramatically different results. However, it is technically impossible to achieve repeatable reading of ballots containing marks that fall precisely on the sensing threshold. See Volume III Section 1.4.4.

Test reference: Volume V Section 5.2

Volume IV, Standards on Data to be Provided

↳ 3.1.2-A.2 User docs, reliably detectable marks

For an optical scanner, the vendor shall document what constitutes a reliably detectable mark versus a marginal mark.

Source: New requirement.

Applies to: Optical scanner

D I S C U S S I O N

See Volume III Section 1.4.4. The specification may be parameterized by configuration values and should state the uncertainty.

Test reference: Volume V Section 4.1