

Director  
Secretary of State – Office of Voting Systems Technology Assessment  
1500 11th Street  
Sacramento CA 95814  
Subject: Election Systems and Software (ES&S) Instant Runoff  
Voting/Ranked Choice Voting Modifications for San Francisco

10 October 06

Addition of AutoMARK, Rev 1.1, and Retest of the Election Systems and Software (ES&S) Instant Runoff Voting/Ranked Choice Voting Modifications for San Francisco

### ***Background Summary***

In 2004, Election Software & Services (ES&S) applied for in Aug 2004 and received a limited certification of a modification to the Unity 2.4.3 system with specially modified Optech Eagle 3P (3PE) precinct ballot counters and Optech IV-C central ballot counter software to meet requirements of the San Francisco's charter for Instant Runoff Voting (IRV)/Ranked Choice Voting (RCV). Subsequent problems were encountered just prior to and during actual elections (Oct 2004 and May 2005). Emergency change certifications were granted for a limited time until a fully qualified system could be developed and fielded. The last temporary certification ended this spring. ES&S has requested an extension of the certification for the Nov 2006 election along with the addition of AutoMARK components to satisfy Help America Vote Act (HAVA) requirements to support voters with disabilities.

The AutoMARK portion of this test, conducted 28 Aug - 01 Sep 2006 in Omaha, NE, at the ES&S offices validated that the AutoMARK could be used to mark a ballot which included the second and third choices for an IRV/RCV contest and that Mandarin and Cantonese audio languages could be supported for San Francisco. The AutoMARK ballot is not expected to be counted directly but is to be copied onto an OpTech format ballot by election staff for processing as an IRA/RCV ballot. The AutoMark ballots may be read and tallied as normal election ballots with second and third choice IRV/RCV contests ignored.

In addition to the AutoMARK test, the California Office of Voting Systems Technology required the IRV/RCV software be retested to include some minor corrections approved for earlier elections under emergency change practices. The initial retest with the AutoMARK ballots was successful but difficulties were encountered with the IRV/RCV portion of the test and it was rescheduled for San Francisco for the period of 25-27 Sep 2006. The difficulties involved the identification that an additional patch was needed which we did not have a trusted source for and a newer problem which was encountered recently and only had a work-around solution.

The final test included verifying the two installed patch changes to Unity, identified as ERM 6.4.3.2a and 6.5.3.2b, which changed three files in ERM 6.5.3.2 and testing the work-around. The patches and other Unity 2.4.3 programs were verified with electronic hash signatures made during the initial reviews, with a source code review confirming that the scope and applicability of the patch changes matched available documents and no other changes were included, with records of the prior submissions, and with regeneration of a trusted copy. Due partially to the close timing of the Nov election, the test was conducted in San Francisco to use equipment which has been used with the a/b patches from the earlier certifications and to test using draft test ballots for the actual upcoming election.

This certification testing showed the IRV/RCV reporting produced the expected results for both the specially created test election and for the Nov election test ballots. Other than a few details

reported in the next section, the description and observed problems reported in the original March 31, 2004 report are still valid. The original report (with annotations of significant changes added) is provided as an attachment to this report as the original may not be available.

### ***Changes from the Original Report.***

1. Test Overview, Item 5. The regression test conducted Aug-Sep 2006 repeated conditions tested in the March 2004 testing but added a few cases. The test objectives exercised in two passes of a three-contest test deck are:

Given the condition on the first choice that

- a. A is highest but less than 50 percent of vote
- b. B is second highest
- c. C is third highest
- d. D is fourth highest
- e. E is fifth highest (or tied with D in one race)

Then set up, in two test decks to test the following Conditions (Cond):

0. A wins the election on first round.
1. A wins the election on second or third round. (baseline, normal expected result)
2. B wins the election on third round or later round
3. C wins the election on last round.
4. Ties occur between D & E on first round (otherwise E would be eliminated).
5. Ties on last round between the second and third leaders totaling more than the first place leader
6. Tie on last round between the first and second leader.

Within the ballots, at least one will have:

- A. Over vote in 1<sup>st</sup> choice contest
- B. Over vote in 2<sup>nd</sup> choice contest
- C. Over vote in 3<sup>rd</sup> choice contest
- D. No vote in 1<sup>st</sup> choice contest
- E. No vote in 2<sup>nd</sup> choice contest
- F. No vote in 3<sup>rd</sup> choice contest
- G. Duplicate vote in 1<sup>st</sup> and 2<sup>nd</sup> choice contests
- H. Duplicate vote in 2<sup>nd</sup> and 3<sup>rd</sup> choice contests
- I. Duplicate vote in 1<sup>st</sup> and 3<sup>rd</sup> choice contests"

In addition to the objectives above, in the San Francisco Nov 2006 draft ballot tests or the special test deck, we added conditions for

- A. Three way tie. [The first version, ERM 6.4.3.2 (RCV)] failed on a three-way tie.
- B. Five way tie. [The later version changed setup for a tie resolution to allow up to 25 way tie using a scrollable window.]
- C. Tie with a total equal to the next higher unique candidate total.  
[The Charter specifies that all candidates within the tie set may be eliminated without drawing.]
- D. C with the next higher candidate a member of another tie set.
- C. Supervisorial contests with different number of candidates in each contest district. This is the condition that resulted in a work-around in an earlier election.

2. The system was tested in this release with XP Professional, Service Pak 2.

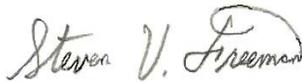
3. Additional Test Equipment"

1. AutoMARK Model A-200-00, AM0206452375
  - a. Voter Aid Terminal (VAT) S/N#
  - b. Spanish, Chinese (Mandarin, Cantonese) languages were installed and tested

**Summary**

Unity 2.4.2 (RCV) with ERM 6.4.3.2b successfully passed all the tests. Procedures for the Supervisorial contests and write-ins are awkward but doable. The system is based on a legacy system that lacks strong security controls and needs to be physically secured when not in public use.

Sincerely,



Steven V. Freeman

**Attachment:**

Report, 3/31/04, Subject: Election Systems and Software (ES&S) Instant Runoff Voting/Ranked Choice Voting Modifications for San Francisco

### **ES&S Unity Software**

ES&S Unity is a suite of program modules. Not all of the modules in the suite need to be installed. In the RCV Modified version tested, the following were not installed or used\:

- ESS Image Manager Version 7.2.0.0
- Ballot On Line Version 1.0.0.0
- iVotronic Image Manager Version 1.2.3.0
- Data Acquisition Manager Version 5.0.3.0

The installation for this test was piecemeal from trusted builds of the various components into a system that had been previously configured. For an accurate map of installed software, the installation disk from the Ciber, Inc, should be installed to a "clean" system and a new disk file map created.

Unity modules are a mixture of C++ and Runtime COBOL modules. The C++ provides the system interface links with the COBOL programs while the COBOL programs support the election database processing.

The Unity programs were installed in two principle application directories and one data directory:

C:\apps\ess\HPM, URS Supports Hardware Program Manager

C:\UNITY\AuditManager, EDM, OPT Supports Election Definition Manager

C:\elecdata\ The directory holding election definitions and data files in subdirectories specific to each election definition.

In addition, a runtime COBOL engine called RMCOBOL is found in  
C:\Programs\RMCOBOL.

The runtime COBOL is supported by a third-party utility which places the following files into C:\Windows\System32

- WOWPANRT.DLL
- WOW32.DLL
- WOWDEB.EXE
- WOWEXEC.EXE
- WOWFAX.DLL
- WOWFAXUI.DLL

**Attachment 2: Sample Reports**

The selection from Ballot Image Election Summary (EL175) below shows the individual record counts from the Optech Eagle precinct counters, the Optech IV-C absentee, the manual Entry ballots (such as duplicated write-in ballots), the Total for all groups and the number counted in the Election Reporting Manager (may show more in candidates added during ERM processing to report counts for qualified write-in candidates). The record counts are shown separate for each Rank Choice in each race.

BALLOT IMAGE ELECTION SUMMARY

JUNE 1 2003

REPORT-EL175 PAGE 001  
ELECTION ID: RCVW

RUN DATE:03/12/04 08:58 AM

RACE AND CANDIDATE	EAGLE	O4C	ENTRY	TOTAL	ERM
15 BALLOTS CAST - TOTAL	410	4310		4720	4720
16 BALLOTS CAST - RCV	325	4225		4550	4550
17 BALLOTS CAST - NON RCV	85	85		170	170
20 BALLOTS CAST - SUPERVISOR 1	246	2066		2312	2312
25 BALLOTS CAST - SUPERVISOR 2	164	2244		2408	2408
1100 BOARD OF LEISURE - FIRST CHOICE					
1100-01 NELSON W. ALDRICH	25	325		350	350
1100-02 CHARLES CURTIS	140	1820		1960	1960
1100-03 EVERETT DIRKSEN	70	910		980	980
1100-04 JOHN HANCOCK	45	585		630	630
1100-05 FLORENCE NIGHTINGALE	45	585		630	630
1100-06 WRITE-IN					
1100-07 OVER VOTES					
1100-08 UNDER VOTES					
1101 BOARD OF LEISURE - SECOND CHOICE					
1101-01 NELSON W. ALDRICH	75	975		1050	1050
1101-02 CHARLES CURTIS	55	715		770	770
1101-03 EVERETT DIRKSEN	20	260		280	280
1101-04 JOHN HANCOCK	50	650		700	700
1101-05 FLORENCE NIGHTINGALE	75	975		1050	1050
1101-06 WRITE-IN					
1101-07 OVER VOTES					
1101-08 UNDER VOTES	50	650		700	700
1102 BOARD OF LEISURE - THIRD CHOICE					
1102-01 NELSON W. ALDRICH	45	585		630	630
1102-02 CHARLES CURTIS	30	390		420	420
1102-03 EVERETT DIRKSEN	40	520		560	560
1102-04 JOHN HANCOCK	25	325		350	350
1102-05 FLORENCE NIGHTINGALE	60	780		840	840
1102-06 WRITE-IN					
1102-07 OVER VOTES					
1102-08 UNDER VOTES	125	1625		1750	1750
1103 DIRECTOR OF RECREATION - FIRST CHOICE					
1103-01 SUSAN B. ANTHONY	25	325		350	350

ES&S/RCV

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1103-02	ANDREW CARNEGIE	115	1495	1610	1610
1103-03	MAMIE EISENHOWER	95	1235	1330	1330
1103-04	WILLIAM R. HEARST	45	585	630	630
1103-05	FRANCIS SCOTT KEY	45	585	630	630
1103-06	WRITE-IN				
1103-07	OVER VOTES				
1103-08	UNDER VOTES				
1104	DIRECTOR OF RECREATION - SECOND CHOICE				
1104-01	SUSAN B. ANTHONY	70	910	980	980
1104-02	ANDREW CARNEGIE	15	195	210	210
1104-03	MAMIE EISENHOWER	80	1040	1120	1120
1104-04	WILLIAM R. HEARST	40	520	560	560
1104-05	FRANCIS SCOTT KEY	85	1105	1190	1190
1104-06	WRITE-IN				
1104-07	OVER VOTES				
1104-08	UNDER VOTES	35	455	490	490
1105	DIRECTOR OF RECREATION - THIRD CHOICE				
1105-01	SUSAN B. ANTHONY	45	585	630	630
1105-02	ANDREW CARNEGIE	25	325	350	350
BALLOT IMAGE ELECTION SUMMARY					

JUNE 1 2003

REPORT-EL175 PAGE 002  
ELECTION ID: RCVW

RUN DATE:03/12/04 08:58 AM

RACE AND CANDIDATE	EAGLE	O4C	ENTRY	TOTAL	ERM
1105-03 MAMIE EISENHOWER	45	585		630	630
1105-04 WILLIAM R. HEARST	25	325		350	350
1105-05 FRANCIS SCOTT KEY	60	780		840	840
1105-06 WRITE-IN					
1105-07 OVER VOTES					
1105-08 UNDER VOTES	125	1625		1750	1750
1106	DIRECTOR OF ENTERTAINMENT - FIRST CHOICE				
1106-01 GEORGE JESSEL					
1106-02 CAROLE LOMBARD	175	2275		2450	2450
1106-03 DOLLY MADISON	35	455		490	490
1106-04 ELEANOR ROOSEVELT	45	585		630	630
1106-05 BILLY ROSE	45	585		630	630
1106-06 KATHRYN SMITH	25	325		350	350
1106-07 WRITE-IN					
1106-08 OVER VOTES					
1106-09 UNDER VOTES					
1107	DIRECTOR OF ENTERTAINMENT - SECOND CHOICE				
1107-01 GEORGE JESSEL					
1107-02 CAROLE LOMBARD	35	455		490	490
1107-03 DOLLY MADISON	30	390		420	420
1107-04 ELEANOR ROOSEVELT	50	650		700	700
1107-05 BILLY ROSE	80	1040		1120	1120
1107-06 KATHRYN SMITH	75	975		1050	1050
1107-07 WRITE-IN					
1107-08 OVER VOTES					
1107-09 UNDER VOTES	55	715		770	770

ES&S/RCV

10/10/2006

1108	DIRECTOR OF ENTERTAINMENT - THIRD CHOICE				
1108-01	GEORGE JESSEL				
1108-02	CAROLE LOMBARD	40	520	560	560
1108-03	DOLLY MADISON	45	585	630	630
1108-04	ELEANOR ROOSEVELT	25	325	350	350
1108-05	BILLY ROSE	60	780	840	840
1108-06	KATHRYN SMITH	45	585	630	630
1108-07	WRITE-IN				
1108-08	OVER VOTES				
1108-09	UNDER VOTES	110	1430	1540	1540
1109	CITY ATTORNEY				
1109-01	NEIL EISENBERG	5	5	10	10
1109-02	STEVE WILLIAMS	10	10	20	20
1109-03	JIM LAZARUS	15	15	30	30
1109-04	DENNIS HERRERA	20	20	40	40
1109-05	WRITE-IN	25	25	50	50
1109-06	OVER VOTES	5	5	10	10
1109-07	UNDER VOTES	5	5	10	10

The Ballot Image Listing (EL174) lists all the ballot image records in one of two optional formats. The first is in coded race and candidate layout showing the race and candidate number selected on each RCV ballot record. These records have already had over-votes eliminated and 1<sup>st</sup> or 2<sup>nd</sup> non-voted choices eliminated to move up the 2<sup>nd</sup> or 3<sup>rd</sup> choice candidates respectfully. An alternate format for this report shows the actual race and candidate labels.

BALLOT IMAGE LISTING

FAMOUS NAMES/100  
 DEMONSTRATION BALLOT

RUN DATE:03/11/04 06:35 PM

ELECTION ID: RCVTEST

PREC.	SEQ.	RACES AND CANDIDATES											
0001		0102-01	0103-07	0104-08	0105-01	0106-07	0107-03	0109-11	0110-01	0111-04	0112-01	0113-08	0114-02
0001		0102-08	0103-01	0104-08	0105-01	0106-03	0107-02	0109-02	0110-03	0111-05	0112-01	0113-02	0114-03
0001		0102-01	0103-02	0104-03	0105-01	0106-04	0107-03	0109-02	0110-07	0111-04	0112-08	0113-02	0114-03
0001		0102-01	0103-02	0104-03	0105-01	0106-04	0107-02	0109-03	0110-06	0111-07	0112-02	0113-01	0114-04
0001		0102-02	0103-08	0104-01	0105-06	0106-07	0107-07	0109-03	0110-04	0111-01	0112-02	0113-07	0114-08
0001		0102-02	0103-01	0104-03	0105-02	0106-01	0107-03	0109-03	0110-08	0111-02	0112-03	0113-01	0114-04
0001		0102-02	0103-04	0104-03	0105-02	0106-03	0107-01	0109-04	0110-02	0111-08	0112-03	0113-04	0114-01
0001		0102-03	0103-02	0104-01	0105-02	0106-01	0107-07	0109-04	0110-01	0111-05	0112-03	0113-01	0114-02
0001		0102-03	0103-02	0104-04	0105-03	0106-06	0107-07	0109-05	0110-11	0111-03	0112-08	0113-04	0114-01
0001		0102-03	0103-04	0104-02	0105-07	0106-03	0107-07	0109-05	0110-03	0111-06	0112-04	0113-02	0114-03
0001		0102-04	0103-01	0104-03	0105-03	0106-01	0107-02	0109-05	0110-01	0111-04	0112-04	0113-08	0114-08
0001		0102-04	0103-03	0104-02	0105-03	0106-07	0107-07	0109-06	0110-01	0111-03	0112-08	0113-05	0114-02
0001		0102-04	0103-07	0104-08	0105-04	0106-01	0107-02	0109-06	0110-02	0111-04	0112-05	0113-01	0114-02
0001		0102-04	0103-02	0104-03	0105-04	0106-02	0107-03	0109-06	0110-11	0111-05	0112-05	0113-01	0114-03
0001		0102-01	0103-02	0104-03	0105-01	0106-02	0107-03	0109-01	0110-02	0111-03	0112-01	0113-02	0114-03
0001		0102-02	0103-05	0104-04	0105-02	0106-07	0107-03	0109-04	0110-06	0111-07	0112-03	0113-02	0114-05
0001		0102-03	0103-06	0104-01	0105-02	0106-04	0107-06	0109-10	0110-11	0111-11	0112-08	0113-08	0114-04
0001		0102-03	0103-04	0104-01	0105-03	0106-04	0107-05	0109-11	0110-05	0111-03	0112-04	0113-08	0114-03
0001		0102-05	0103-08	0104-01	0105-04	0106-03	0107-01	0109-07	0110-01	0111-03	0112-05	0113-02	0114-01
0001		0102-05	0103-03	0104-01	0105-04	0106-02	0107-03	0109-07	0110-02	0111-01	0112-05	0113-03	0114-04
0001		0102-06	0103-04	0104-02	0105-07	0106-07	0107-04	0109-08	0110-04	0111-05	0112-05	0113-01	0114-04

The Ranked Choice Report (EL173) records the results of the RCV algorithm. Asterisk (\*) entries are entries selected for elimination in that pass. Note in the Director of Entertainment race, the initial count had a candidate with 50% + 1 vote so the RCV algorithm was not invoked.

RANKED CHOICE REPORT		JUNE 1 2003		ELECTION ID: RCVW						
RUN DATE:03/12/04 09:01 AM										
Race and Candidate		Pass 1	Pass 2	Pass 3	Pass 4	Pass 5	Pass 6	Pass 7	Pass 8	Pass 9
<b>BOARD OF LEISURE - FIRST CHOICE</b>										
NELSON W. ALDRICH		350*								
CHARLES CURTIS	(Winner 56.667%)	1960	1960	2380						
EVERETT DIRKSEN		980	980	980						
JOHN HANCOCK		630	630*							
FLORENCE NIGHTINGALE		630	840	840						
WRITE-IN		*								
	Eligible Ballots	4550	4410	4200						
	Exhausted Ballots		140	350						
	Total Ballots	4550	4550	4550						
<b>DIRECTOR OF RECREATION - FIRST CHOICE</b>										
SUSAN B. ANTHONY		350*								
ANDREW CARNEGIE		1610	1610	1680	1680					
MAMIE EISENHOWER	(Winner 60.000%)	1330	1330	1750	2520					
WILLIAM R. HEARST		630	630*							
FRANCIS SCOTT KEY		630	840	980*						
WRITE-IN		*								
	Eligible Ballots	4550	4410	4410	4200					
	Exhausted Ballots		140	140	350					
	Total Ballots	4550	4550	4550	4550					
<b>DIRECTOR OF ENTERTAINMENT - FIRST CHOICE</b>										
GEORGE JESSEL										
CAROLE LOMBARD	(Winner 53.846%)	2450								
DOLLY MADISON		490								
ELEANOR ROOSEVELT		630								
BILLY ROSE		630								
KATHRYN SMITH		350								
WRITE-IN										
	Eligible Ballots	4550								
	Exhausted Ballots									
	Total Ballots	4550								

**Selection from System log showing entries for the Ranked Choice Report given above**

```
03-12 08:51 am Absentee GROUP 4 SELECTED FOR UPDATE          EQUIPMENT TYPE O4C - UPDATE PRECINCTS COUNTED:Y
03-12 08:52 am START O4C DOWNLOAD PROGRAM
03-12 08:52 am                                     PRC 0001 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0003 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0006 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0007 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0008 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0009 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0010 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0012 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0013 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0014 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0015 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0016 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0018 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0019 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am                                     PRC 0020 DOWNLOADED FROM IV-C (BALS=260 TOT=260)
03-12 08:52 am STOP O4C DOWNLOAD PROGRAM

03-12 08:53 am RESTART COUNT PROGRAM
03-12 08:55 am ENTERED ELECTION REPORTING MANAGER SYSTEM - REL 6.4.3.2

03-12 08:55 am RESTART COUNT PROGRAM
03-12 08:57 am ENTERED ELECTION REPORTING MANAGER SYSTEM - REL 6.4.3.2

03-12 08:57 am RESTART COUNT PROGRAM
03-12 08:58 am BALLOT IMAGE ELECTION SUMMARY WAS PRINTED TO EL175.LST
03-12 09:00 am RANKED CHOICE REPORT WAS PRINTED TO EL173.LST
03-12 09:01 am RANKED CHOICE REPORT WAS PRINTED TO EL173.LST
03-12 09:58 am EXITED ELECTION REPORTING MANAGER SYSTEM
```

This report is for a special test election run set up to test the behavior with variations in ties. In the second pass, Candidates 3 & 4 were tied and the operator made a choice to eliminate Candidate 4. One of voter whose 1<sup>st</sup> choice was eliminated, selected Candidate 3 for the next choice, creating a three way tie. Again the operator chose to eliminate Candidate 1 which did not effect the remaining tie. In Pass 4, Candidate 2 was selected for elimination resulting in Candidate 3 winning with 100% of the remaining, continuing votes.

RANKED CHOICE REPORT

MARCH 11, 2004

GENERAL ELECTION

RUN DATE:03/11/04 03:26 PM  
ELECTION ID: RCVTEST1

Race and Candidate		Pass 1	Pass 2	Pass 3	Pass 4
Pass 5	Pass 6	Pass 7	Pass 8	Pass 9	
SUPERVISOR OF ELECTIONS					
	CANDIDATE 1	3	3	3*	
	CANDIDATE 2	3	3	3	3*
3	CANDIDATE 3	(Winner100.000%)	2	2	3
	CANDIDATE 4	2	2*		
	CANDIDATE 5	*			
	Eligible Ballots	10	10	9	6
3	Exhausted Ballots			1	4
7	Total Ballots	10	10	10	10
10					
DOG CATCHER					
	CANDIDATE A	(Winner 55.556%)	5		
	CANDIDATE B		4		
	CANDIDATE C				
	CANDIDATE D				
	Eligible Ballots		9		
	Exhausted Ballots		1		
	Total Ballots				