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# Test Plan of EAC 2005 VVSG Certification Testing to be Performed on Dominion Voting Systems 4.14-E

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Prepared for: **Dominion Voting Systems, Inc.**  
1201 18th Street, Suite 210  
Denver, Colorado 80202

Prepared by: **National Technical Systems Huntsville**  
Huntsville Facility  
7800 Hwy 20 West  
Huntsville, AL 35806



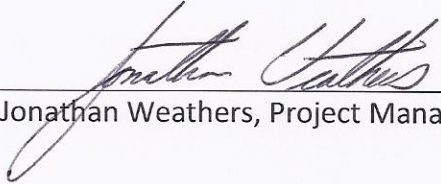
U.S. Election Assistance Commission

**VSTL**

EAC Lab Code 0704

## SIGNATURES

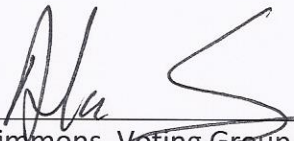
Prepared by:

  
Jonathan Weathers, Project Manager

Date:

4/20/15

Reviewed by:

  
Alan Simmons, Voting Group QA  
Representative

Date:

4/20/15


Approved by:

  
James Long, Program Manager

Date:

4-20-15


Approved by:

  
Robert Hardy, Department Manager

Date:

4/20/15

Reviewed by:

  
Rick Davis, QA Manager

Date:

4/20/15



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## 1.0 INTRODUCTION

Dominion Voting Systems (Dominion), herein referred to as manufacturer, submitted the Democracy Suite (D-Suite) 4.14-E voting system to the U.S. Election Assistance Commission (EAC), application number DVS1501, for certification testing to the 2005 Voluntary Voting System Guidelines Standards (2005 VVSG). D-Suite 4.14-E is a modification to the previously 2005 VVSG certified D-Suite 4.14-D voting system (Certification number: DVS-DemSuite4.14-D), and as such, will be tested by National Technical Systems Huntsville (NTS Huntsville) based on the “modified system” requirements set forth in section 4.4.2.3 of the EAC Testing and Certification Program Manual, Version 1.0. This National Certification Test Plan, hereafter referred to as Test Plan, presents the process and test methods that will be used to validate 2005 VVSG compliance of D-Suite 4.14-E and follows the EAC guidance provided in NOCs 2009-005 and 2013-03.

### 1.1 Description and Overview of EAC Certified System Being Modified

The following subsections describe the EAC Certified System that is baseline for the submitted modification. All information was derived for the Certification Test Report and/or EAC Certificate of Conformance.

#### 1.1.1 Baseline Certified System

The baseline system for this modification is the D-Suite 4.14-D voting system. Tables 1-1 and 1-2 describe the proprietary hardware and software/firmware versions. All certified commercial off-the-shelf (COTS) hardware and software is located in Appendix A – Baseline Certified COTS Hardware and Software. For a complete description of the configuration and description of the D-Suite 4.14-D product, refer to the D-Suite 4.14-D Test Report located on the EAC’s website at <http://www.eac.gov>.

**Table 1-1 Baseline Certified Software**

Software Required For Testing	Software/Firmware Version
EMS Election Event Designer (EED)	4.14.37
EMS Results Tally and Reporting (RTR)	4.14.37
EMS File System Service (FSS)	4.14.37
EMS Audio Studio (AS)	4.14.37
EMS Data Center Manager (DCM)	4.14.37
EMS Election Data Translator (EDT)	4.14.37
EMS Application Server (APPS)	4.14.37
EMS Adjudication	2.4.1.3201
Image Cast Central (ICC)	4.14.17-US
ImageCast Precinct (ICP)	4.14.17-US
ImageCast Evolution (ICE)	4.14.21

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**1.1.1 Baseline Certified System (Continued)**

**Table 1-2 Baseline Certified Voting System Equipment**

Component	Hardware Version
ImageCast Precinct (ICP)	PCOS-320A and PCOS 320-C
ImageCast Evolution (ICE)	PCOS-410A
ICE – Plastic ballot box	Box-410A
ICE – Coroplast Ballot Box	Box-420A
ICP – Metal ballot box	Box-310A
ICP – Plastic Ballot Box	Box-330C
ICP – Coroplast Ballot Box	Box-340C
ICP – Coroplast Ballot Box w/latch	Box-341-C
Image Cast Central (ICC)*	DR-G1130 and DR-X10C

\*ICC scanner hardware is a COTS component.

**1.1.2 Description of Submitted Modifications**

The following modifications were submitted:

1. On the ICE and ICP, the ability to print the write-in images on the paper tape report printouts for the ICE and ICP for the ballot layouts at that precinct.
2. On the ICE, the ability to print the candidate order on the paper tape report printouts of consolidated split precincts to match the candidate order for the ballot layouts for that precinct, instead of listing the candidates in Global Order.
3. On the ICE, to include only the Blank Ballot violation notice in the AuditMark image when casting a blank ballot in an Open Primary election.
4. On the ICE, to play the default English audio when in a two language audio election where a dynamic audio file is missing from the second language, instead of playing the error message “The audio file is missing”.
5. On the EMS, the ballot layout file changed to modify where the term “Write-In” appears in a ballot layout. This modification allows for more flexibility in the size and layout of the write-in box and how the term “Write-In” is positioned relative to other elements.

Except for the ICE, ICP, and EMS application software and the MBS/DCF configuration file (and related documentation), all other software and documentation from the D-Suite 4.14-D system is included in the D-Suite 4.14-E system.

**1.1.3 Initial Assessment**

NTS personnel determined that a limited Functional Configuration Audit will be required to verify that the voting system still meets the 2005 VVSG requirements. Limited in this instance refers to only functional changes that were made in this modification (new features, changes to functions, etc.) or functions that have not changed but may be impacted by the modification.

### 1.1.3 Initial Assessment (Continued)

A source code review will be required for all lines of code (LOC) that were added or modified to ensure that requirements of the 2005 VVSG and the manufacturer’s declared coding conventions are met. The source code submitted for D-Suite 4.14-E was compared to the EAC certified D-Suite 4.14-D source code to determine the extent of the review required. Table 1-3 provides the results of the software comparison.

**Table 1-3 Software Comparison Results**

Product	Baseline	New Version	Added		Deleted		Modified	
			Files	Lines	Files	Lines	Files	Lines
ICE	4.14.21	4.14.24	24	14,079	0	4,142	72	1,232
ICP	4.14.17	4.14.18	15	16,586	0	5,728	93	2,862
EMS	4.14.37	4.14.38	0	0	0	0	1	77
<b>Totals</b>			<b>39</b>	<b>30,665</b>	<b>0</b>	<b>9,870</b>	<b>165</b>	<b>4,094</b>

The submitted Technical Data Package (TDP) is constructed with the certified D-Suite 4.14-D TDP and the D-Suite 4.14-E changes to the certified documents. NTS Huntsville personnel determined that the following documents are impacted by this modification:

- 2.02 System Configuration Overview
- 2.13 System Change Notes
- 2.03 ImageCast Precinct Functionality Description
- 2.05 ImageCast Precinct Software Design And Specification
- 2.08 ImageCast Precinct System Operation Procedures
- 2.05 ImageCast Evolution Software Design And Specification
- 2.08 EMS System Operation Procedures
- ImageCast Evolution Firmware Installation Procedure
- ImageCast Evolution Machine Behavior Settings
- ImageCast Precinct Device Configuration Files

These documents will be reviewed to ensure that all D-Suite 4.14-E changes are properly documented and comply with the 2005 VVSG.

### 1.1.4 Regression Test

Regression testing will be performed to establish assurance that the modifications have no adverse impact on the compliance, integrity, or performance of the system. Based on the initial assessment in section 1.1.3, all modified source code and TDP will be reviewed to determine its compliance with the 2005 VVSG. In addition, the EMS, ICP, and ICE will be subjected to a Functional Configuration Audit to verify that the modifications function as described by the manufacturer in the TDP, meets the applicable 2005 VVSG requirements, and does not adversely impact the overall system functionality. The complete details for all regression testing are located in section 6.3 of this Test Plan.



## 1.2 References

- Election Assistance Commission 2005 Voluntary Voting System Guidelines, Volume I, Version 1.0, “Voting System Performance Guidelines,” and Volume II, Version 1.0, “National Certification Testing Guidelines,” dated December 2005
- Election Assistance Commission Testing and Certification Program Manual, Version 1.0
- Election Assistance Commission Voting System Test Laboratory Program Manual, Version 1.0
- National Voluntary Laboratory Accreditation Program NIST Handbook 150, 2006 Edition, “NVLAP Procedures and General Requirements (NIST Handbook 150),” dated February 2006
- National Voluntary Laboratory Accreditation Program NIST Handbook 150-22, 2008 Edition, “Voting System Testing (NIST Handbook 150-22),” dated May 2008
- United States 107<sup>th</sup> Congress Help America Vote Act (HAVA) of 2002 (Public Law 107-252), dated October 2002
- Quality Assurance Program Manual, Revision 5
- ANSI/NCSL Z540-1, “Calibration Laboratories and Measuring and Test Equipment, General Requirements”
- ISO 10012-1, “Quality Assurance Requirements for Measuring Equipment”
- EAC Requests for Interpretation and Notices of Clarification (listed on [www.eac.gov](http://www.eac.gov))
- EAC Quality Monitoring Program residing on:  
[http://www.eac.gov/testing\\_and\\_certification/quality\\_monitoring\\_program.aspx](http://www.eac.gov/testing_and_certification/quality_monitoring_program.aspx)
- Dominion Voting Systems’ Democracy Suite 4.14-D Modification VSTL Certification Test Report Rev. C (listed on [www.eac.gov](http://www.eac.gov))
- Dominion Voting Systems Democracy Suite 4.14-D Technical Data Package

## 1.3 Terms and Abbreviations

Table 1-4 defines all terms and abbreviations applicable to this Test Report.

**Table 1-4 Terms and Abbreviations**

Term	Abbreviation	Definition
Americans with Disabilities Act of 1990	ADA	ADA is a wide-ranging civil rights law that prohibits, under certain circumstances, discrimination based on disability.
Audio Studio	AS	EMS application used to record audio files.
Audio Tactile Interface	ATI	Voter interface designed to not require visual reading of a ballot. The same ATI is utilized for both the ICP and ICE.
Configuration Management	CM	---
Commercial Off the Shelf	COTS	Commercial, readily available hardware devices (such as card readers, printers or personal computers) or software products (such as operating systems, programming language compilers, or database management systems)

**1.3 Terms and Abbreviations (Continued)**

**Table 1-4 Terms and Abbreviations (Continued)**

Term	Abbreviation	Definition
Direct Record Electronic	DRE	An electronic voting system that utilizes electronic components for the functions of ballot presentation, vote capture, vote recording, and tabulation which are logically and physically integrated into a single unit. A DRE produces a tabulation of the voting data stored in a removable memory component and in printed hardcopy.
United States Election Assistance Commission	EAC	Commission created per the Help America Vote Act of 2002, assigned the responsibility for setting voting system standards and providing for the voluntary testing and certification of voting systems.
EMS Election Event Designer	EED	EMS application used for election definition functionality.
Election Management System	EMS	An umbrella term for the software application used to define and report election projects.
Functional Configuration Audit	FCA	Exhaustive verification of every system function and combination of functions cited in the manufacturer's documentation.
Help America Vote Act	HAVA	Act created by United States Congress in 2002.
ImageCast Precinct	ICP	Precinct-level optical scanner and tabulator with audio voting capabilities.
ImageCast Evolution	ICE	Precinct-level optical scanner, tabulator with audio voting and integrated Ballot-marking Device.
ImageCast Central	ICC	COTS High-speed central ballot scan tabulator.
National Institute of Standards and Technology	NIST	Government organization created to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhances economic security and improves our quality of life.
Operating Procedure	OP	Test Method or Test Procedure.
Relational Database Management System	RDBMS	A database management system (DBMS) that is based on the relational model.
Physical Configuration Audit	PCA	Review by accredited test laboratory to compare voting system components submitted for certification testing to the manufacturer's technical documentation, and confirmation the documentation meets national certification requirements.
Quality Assurance	QA	---
Results, Tally and Reporting	RTR	EMS application used to integrate election results and reporting.
Technical Data Package	TDP	Manufacturer documentation related to the voting system required to be submitted as a precondition of certification testing.

### 1.3 Terms and Abbreviations (Continued)

**Table 1-4 Terms and Abbreviations (Continued)**

Term	Abbreviation	Definition
Trusted Build	---	Final build of source code performed by a trusted source and overseen by the manufacturer which is delivered to the EAC designated repository; also referred to as a "Witness Build".
Voluntary Voting System Guidelines	EAC 2005 VVSG	Published by the EAC, the third iteration of national level voting system standards.
Voting System Test Laboratory	VSTL	An independent, non-federal laboratory qualified to test voting systems to Federal standards.

### 1.4 Project Schedule

Table 1-5 provides the project schedule based on the current estimates. The critical path for a timely project completion is indicated by bold typeface.

**Table 1-5 Estimate Project Schedule**

Task Name	Estimated Start Date	Estimated Finish Date
TDP Review	Mon 4/13/15	Mon 4/27/15
Test Plan	Mon 4/13/15	Wed 6/10/15
NTS Test Plan Creation	Mon 4/13/15	Thu 4/16/15
Dominion Review	Fri 4/17/15	Tue 4/21/15
NTS Revision per Dominion Comments	Wed 4/22/15	Wed 4/22/15
<b>Submission to the EAC</b>	<b>Thu 4/23/15</b>	<b>Thu 4/23/15</b>
<b>EAC Review Time</b>	<b>Fri 4/24/15</b>	<b>Thu 5/21/15</b>
<b>NTS Revisions Based on EAC Comments</b>	<b>Fri 5/22/15</b>	<b>Tue 5/26/15</b>
<b>Submission to the EAC</b>	<b>Wed 5/27/15</b>	<b>Wed 5/27/15</b>
<b>EAC Approval Process</b>	<b>Thu 5/28/15</b>	<b>Wed 6/10/15</b>
Code Review and Builds	Mon 4/13/15	Wed 4/22/15
Source code review	Mon 4/13/15	Fri 4/17/15
Trusted Builds	Mon 4/20/15	Wed 4/22/15
System Loads and Hardening	Tue 4/21/15	Thu 4/23/15
FCA	Fri 4/24/15	Tue 4/28/15
Test Report	Thu 6/11/15	Tue 8/11/15
NTS Test Report Creation	Thu 6/11/15	Wed 6/17/15
Dominion Review	Thu 6/18/15	Mon 6/22/15
NTS Revision per Dominion Comments	Tue 6/23/15	Tue 6/23/15

## 1.4 Project Schedule (Continued)

**Table 1-5 Estimate Project Schedule (Continued)**

Task Name	Estimated Start Date	Estimated Finish Date
Submission to the EAC	Wed 6/24/15	Wed 6/24/15
EAC Review Time	Wed 6/24/15	Wed 6/24/15
NTS Revisions Based on EAC Comments	Thu 6/25/15	Wed 7/22/15
Submission to the EAC	Thu 7/23/15	Mon 7/27/15
EAC Approval Process	Tue 7/28/15	Tue 7/28/15

## 2.0 PRE-CERTIFICATION TESTING AND ISSUES

This section describes any testing that was performed either by a VSTL or the manufacture prior to the submission of the voting system to the EAC.

### 2.1 Evaluation of Prior VSTL Testing

Prior to the submission of D-Suite 4.14-E, NTS performed a 2005 VVSG source code review on D-Suite 4.14-D.1. This code review was performed in accordance with the 2005 VVSG and EAC Testing and Certification Program Manual, Version 1.0. The D-Suite 4.14-D.1 submission modified the EAC certified ICE 4.14.21 source code creating ICE 4.14.23. Table 2-1 describes the changes

**Table 2-1 D-Suite 4.14-D.1 Source Code Comparison**

Product	Baseline	New Version	Added		Deleted		Changed		LOC Total
			Files	Lines	Files	Lines	Files	Lines	
ICE	4.14.21	4.14.23	0	1275	0	2	11	42	1317

No violations to the 2005 VVSG or the manufacturer's declared coding conventions were discovered by NTS source code reviewers. NTS Huntsville recommends the EAC accept the results of this source code review as re-use for the 4.14-E modification.

### 2.2 Evaluation of Prior Non-VSTL Testing

No prior non-VSTL testing was submitted for consideration.

### 2.3 Know Field Issues

This system is a modification to previously-certified systems. There were no systemic or significant issues traceable to any of the previously certified systems.

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### 3.0 MATERIAL REQUIRED FOR TESTING

#### 3.1 Software

Table 3-1 lists the modified proprietary software the manufacturer must submit for testing. All other COTS software required to perform testing was unchanged from the baseline certified system and can be located in Appendix A.

**Table 3-1 Proprietary Software Utilized for Testing**

Software Required For Testing	Software Version
Election Event Designer (EED)	4.14.38
Results Tally and Reporting (RTR)	4.14.38
File System Service (FSS)	4.14.38
Audio Studio (AS)	4.14.38
Data Center Manager	4.14.38
Application Server	4.14.38
EMS Adjudication	2.4.1.3201
EMS Database Server	4.14.38
EMS Election Data Translator (EDT)	4.14.38
EMS NAS Server	4.14.38
ImageCast Evolution	4.14.24
ImageCast Precinct	4.14.18
ImageCast Central	4.14.17

#### 3.2 Hardware

Table 3-2 lists the proprietary hardware the manufacturer must submit for testing. All other COTS hardware required to perform testing was unchanged from the baseline certified system and can be located in Appendix A.

**Table 3-2 Voting Equipment (Evolution and Precinct)**

Equipment	Manufacturer	Model	Serial Number
ICE	Dominion	PCOS 410-A	AAFEBDW0117
ICP	Dominion	PCOS 320-A	WLDAFBH0023
ICE Ballot Box	Dominion	Plastic	AAUCBDQ0074
ICP Ballot Box	Dominion	Plastic	AAUCCEF0219

#### 3.3 Test Materials

The following test material will be required to execute the test.

- Privacy Panels (set of 2 pieces)
- Security Keys
- Thermal Printer Rolls
- Dominion Cleaning Kit
- Sharpie Permanent Markers
- Ballots and/or Blank Stock

### 3.4 Deliverables

The materials listed in Table 3-3 are identified by the manufacturer as the deliverable materials to the end users.

**Table 3-3 Voting System Deliverables**

Deliverable Material	Version	Description
ImageCast Evolution Firmware	4.14.24	ICE Software
ImageCast Precinct Firmware	4.14.18-US	ICP Software
ImageCast Central Count	4.14.17	ICC Software
Election Event Designer	4.14.38	EMS Software
Results Tally and Reporting	4.14.38	EMS Software
File System Service	4.14.38	EMS Software
Audio Studio	4.14.38	EMS Software
Data Center Manager	4.14.38	EMS Software
Application Server	4.14.38	EMS Software
Adjudication	2.4.1.3201	EMS Software
Democracy Suite System Overview	4.14E::324, dated 04/06/15	TDP Document
Democracy Suite Configuration Management Plan	4.14.D::205, dated 10/22/14	TDP Document

### 3.5 Proprietary Data

All data that is considered by the manufacturer as proprietary is marked as such.

## 4.0 TEST SPECIFICATIONS

NTS Huntsville personnel will ensure that all certification testing conducted on the manufacturer’s voting system follows NTS Huntsville’s procedures for testing, the requirements of the EAC 2005 VVSG and EAC Testing and Certification Program Manual, Version 1.0.

### 4.1 Requirements

To evaluate the modification test requirements, each section of the EAC 2005 VVSG was analyzed to determine the applicable tests. The following subsections detail the results of this analysis.

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### 4.1.1 Requirements mapping

Table 4-1 maps the submitted modifications as detailed in Section 1.2 to the 2005 VVSG Requirements. In addition, NTS Huntsville will spot check the QA and CM requirements to ensure that the manufacturer followed their stated QA and CM plans.

**Table 4-1 Modification Requirements Mapping**

Changed Component	Change Description	Impacted 2005 VVSG Requirement
ICE	Added the ability to print the write-in images on the paper tape report printouts for the ICE for the ballot layouts at that precinct.	Vol I Section 2.3.3.1.d Vol I Section 4.1.4.2.d.iv Vol I Section 4.1.5.1.d.ii Vol II Section 6.7
ICE	Added the ability to print the candidate order on the paper tape report printouts of consolidated split precincts to match the candidate order for the ballot layouts for that precinct, instead of listing the candidates in Global Order.	Vol I Section 2.4.3.d Vol II Section 6.7
ICE	Added the ability to include only the Blank Ballot violation notice in the AuditMark image when casting a blank ballot in an Open Primary election.	Vol II Section 6.7
ICE	Added the Ability to play the default English audio when in a two language audio election where a dynamic audio file is missing from the second language, instead of playing the error message "The audio file is missing".	Vol II Section 6.7
ICP	Added the ability to print the write-in images on the paper tape report printouts for the ICP for the ballot layouts at that precinct.	Vol I Section 2.3.3.1.d Vol I Section 4.1.4.2.d.iv Vol I Section 4.1.5.1.d.ii Vol II Section 6.7
EMS	Ballot layout file changed to modify where the term "Write-In" appears in a ballot layout.	Vol I Section 2.2.1.2.C Vol II Section 6.7
TDP	2.02 System Configuration Overview	Vol II Section 2.2.1
TDP	2.13 System Change Notes	Vol II Section 2.11
TDP	2.03 ImageCast Precinct Functionality Description	Vol II Section 2.3
TDP	2.05 ImageCast Precinct Software Design And Specification	Vol II Section 2.5
TDP	2.08 ImageCast Precinct System Operation Procedures	Vol II Section 2.8
TDP	2.05 ImageCast Evolution Software Design And Specification	Vol II Section 2.5
TDP	2.08 EMS System Operation Procedures	Vol II Section 2.8
TDP	ImageCast Evolution Firmware Installation Procedure	Vol II Section 2.8.3
TDP	ImageCast Evolution Machine Behavior Settings	Vol II Section 2.5
TDP	ImageCast Precinct Device Configuration Files	Vol II Section 2.5

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#### 4.1.2 Rational for Excluded Requirements

All requirements excluded from the D-Suite 4.14-E test campaign were determined by NTS Huntsville to not be applicable to the submitted modifications listed in Section 1.1.2 based on one or more of the following criteria:

1. The submitted modification does not impact the specific requirement
2. The specific requirement was previously determined to be not applicable to the baseline system
3. A NOC or RFI has made the specific requirement not applicable

#### 4.1.3 NOCs

Table 4-2 lists the applicable NOCs the EAC has released as of the date of the Plan as it pertains to this test campaign.

**Table 4-2 Applicable NOCs**

NOC ID	Name
2008-003	EAC Conformance Testing Requirements
2009-002	Laboratory Independence Requirement
2009-005	Development and Submission of Test Plans for Modifications to EAC Certified Systems
2012-02	Clarification of System Identification Tool Functionality
2013-02	Detailed Description of Changes for Modifications

#### 4.1.4 RFIs

Table 4-3 lists the applicable RFIs the EAC has released as of the date of the Plan as it pertains to this test campaign

**Table 4-3 Applicable RFIs**

RFI ID	Name
2007-02	EAC Decision on Variable Names
2009-04	EAC Decision on Audit Log Events
2010-02	EAC Decision on Coding Conventions
2010-03	EAC Decision on Database Coding Conventions
2010-05	EAC Decision on Testing of Modifications to a Certified System
2010-07	EAC Decision on Module Length
2010-08	EAC Decision on Calling Sequence
2012-04	EAC Decision on Software Setup Validation
2013-03	EAC Decision on Timestamps

#### 4.2 Hardware Configuration and Design

No hardware configuration or design changes were submitted for D-Suite 4.14-E.

#### 4.3 Software System Functions

The submitted changes described in Section 1.1.2, do not impact the software system functions as described in the D-Suite 4.14-D Test Report.



#### 4.4 Test Case Design

Test cases are designed around specifications and requirements, i.e., what the voting system is supposed to do (per the manufacturers design specifications) and what the voting system is required to do (per the guiding standards document). The tests cases used are primarily functional in nature; however in certain cases non-functional tests may also be used. The test designer selects both valid and invalid inputs and determines the correct output without any knowledge of the test object's internal structure. The acceptable range for system performance and the expected results for each test case are derived from the manufactures documentation and the 2005 VVSG. All test cases are validated and approved by the project lead or other qualified VSTL personnel, i.e., VSTL QA Representative.

##### 4.4.1 Hardware Qualitative Examination Design

No hardware modifications were submitted by the manufacturer.

##### 4.4.2 Hardware Environmental Test Case Design

No hardware modifications were submitted by the manufacturer.

##### 4.4.3 Software Module Test Case Design and Data

NTS Huntsville personnel implements Component Level Testing during the Functional Configuration Audit (FCA) for each component and subcomponent exercising the functionality of each as designed and documented. NTS Huntsville will utilize limited structural-based techniques (white-box testing) mainly in the area of Source Code Review and Security Testing. NTS Huntsville will depend heavily on specification-based techniques (black-box testing) for the individual software components. The most common specification-based techniques applied to the voting system during software testing will be "equivalence partitioning", "boundary value", and "pairwise" testing.

- "Equivalence Partitioning" will be used to evaluate specific software functions and data entry points of the voting system for valid and invalid data during the FCA. For software functions and data entry points, an entry will be made for a valid data requirement and at least one invalid data requirement to test for normal and abnormal conditions.
- "Boundary Value Testing" will be used to evaluate specific software functions and data entry points for minimums and maximums during the FCA. For software functions and data entry points, an entry will be made for all minimum and all maximum documented requirements to test for normal and abnormal conditions. This technique will be used for numeric ranges as well as non-numeric ranges.
- "Pairwise Testing" is a combinatorial method of software testing that, for each pair of input parameters to a system, tests all possible discrete combinations of those parameters. NTS Huntsville uses combinatorial test design to identify the minimum number of tests needed to get the coverage required to exercise the functionality. Combinatorial test design enables testers to get greater test coverage with fewer tests. Note that "coverage", as used here, is referring to functional combinatorial coverage, not requirements coverage.

#### 4.4.4 Software Functional Test Case Design and Data

The specification-based technique used by NTS Huntsville personnel at the functional test case level is “Use Case.” The actors that have been identified are:

- Election Administrator – The actor with responsibility of entering the election definition with translation and audio. This actor is also responsible for maintaining EMS users and the election database.
- Warehouse Technician – The actor responsible for loading the election definition onto the voting equipment. This actor also runs diagnostic test and maintains the units.
- Poll Worker – The actor at the precinct location to set up and close down the voting equipment on election-day.
- Voter – The actor who physically casts the ballot on election-day.
- ADA Voter – The actor with special needs who has to vote unassisted on election-day.
- Election Official – The actor who reports and audits the election result post-election day.

“Use Case” will be utilized during the FCA with a single pass through each component using only valid data. This pass will be considered the “Master Copy” of data to be passed between interfacing points of applications during integration level testing. If a component downstream in the test process needs data from previous processes, the “Master Copy” of data can be used or altered to accelerate the test process. Known tests that will utilize the “Master Copy” of data at the Integration Level are Security and Usability.

#### 4.4.5 System-level Test Case Design

System-level testing examines the ability of proprietary software, hardware, and peripherals in addition to the COTS software, hardware, and peripherals to operate as a complete system. NTS Huntsville utilizes test cases designed to ensure that integrated components function as specified by the manufacturer’s documentation and meet the requirements of the VVSG.

#### 4.5 Security Functions

The submitted modifications as described in section 1.2 do not impact any security functions of the voting system. No security review will be performed.

#### 4.6 TDP Evaluation

NTS Huntsville qualified personnel utilize a TDP Review Matrix which lists every EAC 2005 VVSG requirement pertaining to TDP review. NTS Huntsville will review the documents listed in section 1.1.3 and record the results of the review of each document to the applicable requirements listed in the TDP Review Matrix.

During the TDP review process, each document will be reviewed for completeness, clarity, correctness, and continuity. The review results will be formally reported to manufacturer. If a revised document is received, it will be re-reviewed as discussed in this section. The TDP will be continued to be reviewed during the entire testing process as these documents will be utilized to set up the systems, verify correct operational results and in other tests as needed. At the end of the TDP review process, a Discrepancy Report will be issued listing the non-compliant items on a document-by-document basis, if applicable. A listing of all documents contained in the submitted modified voting system TDP is provided in Appendix B.

#### **4.7 Source Code Review**

As the source code is received, a SHA256 hash value will be created for each source code file. NTS source code team will conduct a visual scan of each line of source code for an initial review and every line of modified source code for acceptance for all languages. This is done to verify compliance of EAC 2005 VVSG coding standards. Each identified violation shall be recorded by making notes of the standards violation along with directory name, file name, and line number.

In circumstance where the coding language facilitates the use of automated tools, NTS will develop a process for conducting the source code review with an automated tool. In addition, NTS Huntsville personnel will perform a manual 10% review of all automated source code review to verify that the automated tool was configured properly.

A technical report of all identified violations will be sent to the manufacturer for resolution on a regular basis. All revised source code will be checked for corrections until the final issue is resolved. At the end of the Source Code review process, a Discrepancy Report will be issued listing all non-compliances. The results will be included in the final test report.

#### **4.8 Source Code Build Process**

NTS Huntsville utilizes a process called "Compliance Builds" for all software builds that are not required to be witnessed by the vendor. A compliance build may be built containing code that does not fully qualify for a trusted build process. This process follows the documented procedures of a "Trusted Build" in the EAC Testing and Certification Program Manual, Version 1.0, with two exceptions: The image products will not be submitted to the EAC, and no manufacturer representative shall be required to be present or on-site for these builds.

NTS Huntsville utilizes the "Trusted Build" process as described in section 5.6 of the EAC Testing and Certification Program Manual, version 1.0.

#### **4.9 QA & CM System Review**

Both the manufacturer submitted QA Plan and CM Plan will be reviewed. The review will be limited to only the changes within this modification to determine compliance with EAC 2005 VVSG Volume II Section 2, and Volume I Sections 8 and 9, EAC stated requirements, and with the requirements of the internal manufacturer documentation. In addition, the manufacturer TDP documentation package will be reviewed to determine if the manufacturer's QA Plan and the CM Plan are being followed. The results of the TDP review shall be entered on a spreadsheet as previously described in Section 4.6 of this test plan. The results of the TDP review, including the QA and CM compliance results of the Technical Data Package Review, will be included in the final test report.

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## **5.0 TEST DATA**

### **5.1 Test Data Recording**

All equipment utilized for test data recording shall be identified in the test data package. For hardware environmental and operational testing, the equipment shall be listed on the Instrumentation Equipment Sheet for each test. The output test data shall be recorded in an appropriate manner as to allow for data analysis. For source code and TDP reviews, results shall be compiled in output reports and submitted to the manufacturer for resolution.

Additionally, all test results, including functional test data, will be recorded on the relevant NTS Huntsville Operating Procedures and Test Cases. Results will also be recorded real-time in engineering log books. Incremental reports will be submitted to the manufacturer and the EAC at the completion of major test areas to communicate progress and results as deemed necessary by the stakeholders.

### **5.2 Test Data Criteria**

NTS Huntsville will evaluate all test data against the manufacturer provided TDP and the requirements set forth in the EAC 2005 VVSG. Per the EAC 2005 VVSG, these parameters shall encompass the test tolerances and samples to define the minimum number of combinations or alternatives of input and output conditions that can be exercised to constitute an acceptable test of the parameters involved. The parameters will also include events with criteria defining the maximum number of interrupts, halts, or other system breaks that may occur due to non-test conditions (excluding events from which recovery occurs automatically or where a relevant status message is displayed).

## **6.0 TEST PROCEDURES AND CONDITIONS**

NTS Huntsville is an independent testing laboratory for systems and components under harsh environments, including dynamic and climatic extremes as well as the testing of electronic voting systems. NTS Huntsville holds the following accreditations:

- ISO-9001:2000
- NVLAP Accredited ISO 17025:2005
- EAC Accredited VSTL, NIST 150,150-22
- A2LA Accredited (Certification No.'s 845.01, 845.02, and 845.03)
- FCC Approved Contractor Test Site (Part 15, 18)

## 6.1 Test Facilities

All testing will be conducted at the NTS Huntsville, AL, facility unless otherwise annotated. Environmental non-operating (storage) and operating hardware testing will be conducted utilizing an adequately sized environmental test chamber or dynamic vibration (shaker) system equipped with the required data gathering support equipment. All remaining operating hardware tests will be conducted at the appropriate test site with the required support equipment. All instrumentation, measuring, and test equipment used in the performance of this test program will be listed on the Instrumentation Equipment Sheet for each test and shall be calibrated in accordance with NTS Quality Assurance Program, which complies with the requirements of ANSI/NCSL Z540-1 and ISO 10012-1.

Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST) by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

Unless otherwise specified herein, all remaining tests, including system level functional testing, shall be performed at standard ambient conditions:

- Temperature: 68 to 75 degrees Fahrenheit ( $\pm 4^{\circ}\text{F}$ )
- Relative Humidity: 20 to 90%
- Atmospheric Pressure: Local Site Pressure

Unless otherwise specified herein, the following tolerances shall be used:

- Time  $\pm 5\%$
- Temperature  $\pm 3.6^{\circ}\text{F}$  ( $2^{\circ}\text{C}$ )
- Vibration Amplitude  $\pm 10\%$
- Vibration Frequency  $\pm 2\%$
- Random Vibration Acceleration
  - 20 to 500 Hertz  $\pm 1.5\text{ dB}$
  - 500 to 2000 Hertz  $\pm 3.0\text{ dB}$
- Random Overall grms  $\pm 1.5\text{ dB}$
- Acoustic Overall Sound Pressure Level  $+4/-2\text{ dB}$

Deviations to the above tolerances may be submitted by the responsible test laboratory with sufficient engineering information to substantiate the deviation request, but only when best effort technique and system limitations indicate the need for a deviation.

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## 6.2 Test Set-up

All voting system components (hardware and software), shall be received and documented utilizing NTS Huntsville Receiving Ticket (WL-218, Nov. '85) and proper QA procedures. When voting system hardware is received, each test article will be unpacked and inspected for obvious signs of degradation and/or damage that may have occurred during transit. Noticeable degradation and/or damage, if present, shall be recorded, photographed, and the manufacturer shall be notified. NTS Huntsville VSTL personnel will notify NTS Huntsville QA personnel that the equipment is ready for receipt inspection. QA personnel shall record the serial numbers and part numbers. Comparison shall be made between those numbers recorded and those listed on the shipper's manifest. Any discrepancies noted shall be brought to the attention of the manufacturer representative for resolution. All TDP and source code modules received will be inventoried and maintained by the Project Lead assigned to testing.

For test setup, the system will be configured as it would for normal field use. This includes connecting all supporting equipment and peripherals. NTS Huntsville will properly configure and initialize the system, and verify that it is ready to be tested by following the procedures detailed in the voting system TDP.

## 6.3 Test Sequence and Description

The components of the voting system will undergo testing to verify that the modification performs as described by the manufacturer and meets the requirements of the 2005 VVSG. NTS personnel will utilize a combination of functional testing and TDP reviews to evaluate the system performance. This modification will be executed in the following sequence.

1. Source code review
2. Trusted build
3. FCA and TDP review are performed in parallel

### 6.3.1 Source Code Review

The sources code review of D-Suite 4.14-E will be based on the previous review of source code changes from D-Suite 4.14-D to D-Suite 4.14-D.1 and the changes from D-Suite 4.14-D.1 to D-Suite 4.14-E. As referenced in section 2.1, NTS is recommending reuse be accepted for previously reviewed source code changes from D-Suite 4.14-D to D-Suite 4.14-D.1 performed under NTS Test Campaign PR035668.

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### 6.3.2 FCA and TDP

Two elections will be created for FCA testing; a general and a primary. The new EMS write-in functionality will be examined in both elections. The ballots created for these two elections will be utilized to verify the following modifications:

- On the ICE and ICP, the ability to print the write-in images on the paper tape report printouts for the ICE and ICP for the ballot layouts at that precinct.
- On the ICE, the ability to print the candidate order on the paper tape report printouts of consolidated split precincts to match the candidate order for the ballot layouts for that precinct, instead of listing the candidates in Global Order.
- On the ICE, the ability to include only the Blank Ballot violation notice in the AuditMark image when casting a blank ballot in an Open Primary election.
- On the ICE, the ability to play the default English audio when in a two language audio election where a dynamic audio file is missing from the second language, instead of playing the error message "The audio file is missing".

In conjunction with the FCA NTS Huntsville will review the modified TDP to ensure that the functional modifications are accurately documented and that the documents adhere to the requirements of the 2005 VVSG.

## 6.4 Test Operations Procedure

These subsections address the procedures that NTS will follow during this modification testing campaign.

### 6.4.1 Pass/Fail Criteria

The PASS/FAIL criteria at the Component Level will be based on the expected result. If the System Under Test (SUT) performs as expected, the test is considered as passed. If the SUT does not perform as expected, the test will be evaluated for tester, test procedure, or test equipment errors. If it is determined there were no tester, test procedure, or test equipment errors, the test will be repeated in an attempt to reproduce the results. If the results cannot be reproduced, the anomaly will be logged and monitored throughout the test campaign and subsequent testing efforts. If the results can be reproduced and the expected results are not met, the SUT will have failed the test. NTS Huntsville personnel will document the error and track the error through resolution.

The PASS/FAIL criterion for System Level testing is whether the system can continue in testing. The System Level test is considered as passed if either 1) no errors are found, or 2) an error is encountered but the system continues to operate and engineering analysis determines that the root cause does not affect system level testing. The system level test is considered failed when an error is encountered and the system is too unstable to continue or engineering analysis determines the root cause could affect further testing. If an error occurs during system level testing, the error shall be documented. If the voting system is able to recover and continue, the test will continue. If the error causes the system to become unstable, the test shall be halted. All errors documented during System Level Testing shall be tracked through resolution.

#### **6.4.2 Discrepancy resolution**

The manufacture will be required to submit a root cause analysis and correct any discrepancy before testing can be resumed. Engineering analysis will be performed to determine what effect the resolution has on the component. A determination will be made whether Regression Testing will be sufficient or a complete re-test is necessary. All discrepancies and their resolutions will be documented on the NTS Huntsville Discrepancy tracking system and the EAC Virtual Review Tool.

#### **6.4.3 Test Results and Assessment**

NTS Huntsville personnel will test every EAC 2005 VVSG requirement impacted by the submitted modification. NTS Huntsville personnel will report all issues discovered during this test campaign to the manufacturer and the EAC. If NTS Huntsville determines there is not enough data to ensure a requirement was met, the test plan will be altered and further testing will be done.

#### **6.4.4 Terms of NTS Huntsville Recommendation for Certification**

The EAC has the final decision as to whether the system meets all the requirements for an EAC-certified system. NTS Huntsville will either recommend approval, if the system meets all applicable sections of the VVSG, or report that the system does not meet all applicable sections of the VVSG.



**APPENDIX A - BASELINE CERTIFIED COTS HARDWARE AND SOFTWARE**

**A.1 Baseline Certified COTS Hardware and Software**

The following tables comprise the Democracy Suite 4.14-D Voting System COTS hardware and software, certified by the EAC on November 25, 2014 (DVS-DemSuite4.14-D).

**Table A-1 Baseline Certified COTS Hardware**

Equipment	Manufacturer	Model
EMS Server PC	Dell	PowerEdge T620
EMS Client PC	Dell	Precision T1700
EMS Express Laptop	Dell	Latitude E6540
ICC Scanners	Canon	DR-X10C
		DR-G1130
ICC Workstation	Dell	OptiPlex 9020
		OptiPlex 9030

**Table A-2 Baseline Certified COTS Support Hardware**

Test Material	Make	Model
USB reader/Writer	Maxim	USB R/W: DS9490R
iButton (SHA-1)	Maxim	DS1963S
ICE external LCD monitor	AOC	E1649FWU
LCD Monitor	Soyo	18.5" wide LCD
LCD Monitor	Samsung	23" wide LCD
LCD Monitor	Dell	1909W
LCD Monitor	Dell	N445N
Footswitch Pair	--	Kinesis
Audio Adapter	Soundwave	USB Soundwave 7.1 Audio Adapter
PCI Software	Soundwave	Soundwave 7.1 PCI Software
USB Software	Soundwave	USB Soundwave 7.1 Software
Compact Flash Cards	RiData	CFC-14A
		RDCF8G-233XMCB2-1
		RDCF16G-233XMCB2-1
		RDCF32G-233XMCB2-1
	SanDisk Extreme	SDCFX-016G
		SDCFX-032G
SanDisk	8 GB	
Compact Flash Reader	SanDisk	USB
	GGI Gear	USB
Networking Switch	D-Link	D-Link DES-1105 5-Port Switch
Mouse	Dell	USB w/rollerball
Mouse	Microsoft	USB w/rollerball
Headphones	Cyber Acoustics	ACM-70
Sip & Puff	Origin Instruments	Air Voter
UPS for ICC	APC	SMC1000
UPS for EMS		SMC1500

**A.1 Baseline Certified COTS Hardware and Software (Continued)**

**Table A-3 Democracy Suite 4.14-D EMS Software Platform Third Party Software Components**

Software Required For Testing	Software Version
Infragistics NetAdvanatage Win Forms 2011.1	2011 Vol.1
TX Text Control Library for .NET	16.0

**Table A-4 Democracy Suite 4.14-D EMS Client Application Software Components**

Software Required For Testing	Software Version
Microsoft Windows 7 x64	6.1
Windows Server 2008 R2 x64	6.1
Adobe Reader	10.1.1
Microsoft .NET Framework 4.0	4.0
Microsoft SQL Server 2008 R2 x64	10.0
Microsoft SQL Server 2008 Express R2 x64	10.50.4000.0
Microsoft SQL Server 2008 R2 SP2x64	10.50.4000.0
Microsoft Visual J# 2.0 Redistributable Package – Second Edition (x64)	2.0
1-Wire Driver version 4.0.3b x64	4.0.3
Java Runtime Environment 6.0 x64	6.0.290
Microsoft Visual C++ 2010 SP1 Redistributable Package(x86)	10.0.40219
Microsoft Access Database Engine 2010 Redistributable	1 (published 12/16/2010)

**Table A-5 Democracy Suite 4.14-D EMS Software Platform Unmodified COTS Components**

Software Required For Testing	Software Version
Infragistics NetAdvanatage Win Forms 2011.1	2011 Vol.1
TX Text Control Library for .NET	16.0
Microsoft.Net Framework Library	4.0
Sox	14.3.1
Log4net	1.2.10
NLog	1.0.0.505
iTextSharp	5.0.5.0
OpenSSL	1.2.3
SQLite	1.0.65.0
Lame	3.99.4
Speex	1.0.4
Ghostsript	9.04
PdfToImage	1.2
SharpSsh package	1.1.1.13
One Wire API for .NET	4.0.2.0
Avalon-framework-cvs-20020806	20020806
Batik	0.20-5
Fop	0.20-5
Microsoft Visual J# 2.0 Redistributable Package – Second Edition (x64)	2.0

**A.1 Baseline Certified COTS Hardware and Software (Continued)**

**Table A-6 Democracy Suite 4.14-D ICP Unmodified COTS Software Components**

Software Required For Testing	Software Version
PNG Reference Library	1.2.24
OpenSSL	1.1.2
Zlib	1.2.3

**Table A-7 Democracy Suite 4.14-D EMS Software Build Environment Components**

Software Required For Testing	Software Version
Microsoft Windows Server 2008 R2 x64	6.1
7-Zip	9.20
Microsoft Visual Studio 2010	10.0
Microsoft SDK for Windows 7	7.1
Microsoft.NET Framework Library	4.0
Microsoft Visual Studio 2010 Service Pack 1	10.0 SP1
Microsoft patch KB2286556	N/A
ImgBurn	2.5.7.0
Infragistics NetAdvantage Win Forms 2011.1	2011 Vol.1
TX Text Control Library for .NET	16.0
Speex	1.0.4
Microsoft Visual J# 2.0 Redistributable Package – Second Edition (x64)	2.0
ActivePerl	5.12.4

**Table A-8 Democracy Suite 4.14-D ICE Software Components**

Software Required For Testing	Software Version
Voting Machine	4.14.21
Election Application	4.14.21
Linux Kernel	2.6.30.9-dvs-21.3
Linux Device File	1.3
Root File System	1.0.21
Ram Disk	1.0.1
Boot Startup Logo	5.0.0
Linux Startup Logo	5.0.0
Boot Loader	1.3.4.29
Motherboard FPGA	1.1.5
Scanner Board FPGA	1.1.2
Logger Controller	1.0.11
Power Controller	2.0.7
Integrated Printer	4.1.6

**A.1 Baseline Certified COTS Hardware and Software (Continued)**

**Table A-9 Democracy Suite 4.14-D ICE Unmodified COTS Software Components**

Software Required For Testing	Software Version
busybox	1.20.2
e2fsprogs	1.42.4
expat	2.1.0
fontconfig	2.9.0
freetype	2.4.9
i2c-tools	3.1.0
libjpeg	v8d
libogg	1.3.0
libpng	1.5.10
libusb	1.0.8
libusb-compat	0.1.3
linux	2.6.30.9
openssl-fips	1.2.3
ppp	2.4.5
qt-everywhere	4.7.3
skell	1.19
soundtouch	1.6.0
speex	1.2rc1
sqlite	3.7.13
sysfsutils	2.1.0
libtiff	4.0.1
tzcode	2012b
tzdata	2012c
usb-modeswitch	1.2.4
usb-modeswitch-data	20120815
zlib	1.2.7
log4cplus	1.0.4.1
quazip	0.5

**Table A-10 Democracy Suite 4.14-D ICE Modified COTS Software Components**

Software Required For Testing	Software Version
Kernel	2.6.30.9-dvs-21.3
U-BOOT	1.3.4.29

**Table A-11 Democracy Suite 4.14-D ICC Software Components**

Software Required For Testing	Software Version
ImageCast Central Application	4.14.17
Image-Analysis DLL	4.14.4

**A.1 Baseline Certified COTS Hardware and Software (Continued)****Table A-12 Democracy Suite 4.14-D ICE Election Firmware Compiler**

<b>Software Required For Testing</b>	<b>Software Version</b>
g++ (GNU C++ compiler)	gcc3.4.0-20040603

**Table A-13 Democracy Suite 4.14-D - ICC Runtime Software Components (Unmodified COTS)**

<b>Software Required For Testing ICC application</b>	<b>Software Version</b>
Imgcomp.dll	2.11
1-Wire driver 64-bit	4.03
Kofax VRS	4.50
VCredist	4/10/2006

**APPENDIX B – TECHNICAL DATA PACKAGE**

**B.1 Baseline Certified TDP**

The documents listed in Table B-1 comprise the Democracy Suite 4.14-D Voting System TDP, certified by the EAC on November 25, 2014 (DVS-DemSuite4.14-D).

**Table B-1 Democracy 4.14-D Certificated Voting System TDP**

Document Title	Version	Date	Document Number
System Overview	4.14.D::301	10/17/14	2.02
System Security Specification	4.14.D::377	10/31/14	2.06
Configuration Management Plan	4.14.D::205	10/22/14	2.11
Quality Assurance Program	1.2.0::80	10/16/12	2.12
System Test and Verification Plan	1.1.0::104	10/16/12	2.07
System Test and Verification Suites	4.14.D::1	8/21/14	2.07
Personnel Training and Deployment Requirements	1.1.0::53	4/9/13	2.10
EMS Functionality Description	4.14.D::251	7/22/14	2.03
ICE Functionality Description	4.14.D::80	10/2/14	2.03
ICP Functionality Description	4.14.D::125	10/20/14	2.03
ICC Functionality Description	4.14.D::88	10/17/14	2.03
ICE System Hardware Specification	1.2.0::305	10/20/14	2.04
ICP System Hardware Specification	1.1.0::98	10/20/14	2.04
ICE System Hardware Characteristics	1.2.0::95	10/20/14	2.04.1
ICP System Hardware Characteristics	1.1.0::56	10/20/14	2.04.1
EMS Software Design and Specification	4.14.D::219	7/22/14	2.05
ICE Software Design and Specification	4.14.D::112	7/28/14	2.05
ICP Software Design and Specification	4.14.D::112	10/20/14	2.05
ICC Software Design and Specification	1.0.0::34	11/30/12	2.05
Adjudication Software Design and Specification	4.14.D::25	7/22/14	2.05
ICP System Operation Procedures	4.14.D::197	7/28/14	2.08
EMS System Operation Procedures	4.14.D::538	10/22/14	2.08
ICE System Operation Procedures	4.14.D::155	7/22/14	2.08
ICC System Operation Procedures	4.14.D::122	10/16/14	2.08
ICP System Maintenance Manual	1.1.0::66	10/16/12	2.09
ICE System Maintenance Manual	1.1.0::115	10/16/12	2.09
EMS System Maintenance Manual	1.0.0::50	10/16/12	2.09
Adjudication System Maintenance Manual	4.14.D::9	7/27/14	2.09
EMS Election Event Designer User's Guide	4.14.D::233	10/21/14	N/A
EMS Results Tally & Reporting User's Guide	4.14.D::153	9/23/14	N/A
EMS Audio Studio User's Manual	4.14.D::49	10/1/14	N/A
Adjudication User's Manual	4.14.D::41	7/28/14	N/A
EMS Build and Install	2.1.0::18	8/11/14	N/A
ICP Device Configuration Files	4.14.D::26	7/30/14	N/A
ImageCast Election Definition Files	3.0.13	4/9/14	N/A
ICP Firmware Build and Install	4.2.14	10/3/12	N/A
ICP Firmware Update Procedure	1.0.0::15	8/14/14	N/A
ICP Technical Guide	1.0.0::9	10/17/12	N/A
ICE Technical Guide	1.0.0::60	10/17/12	N/A
ICE Build Procedure	4.14.D::49	7/21/14	N/A
ICE Firmware Installation Procedure	4.14.D::41	8/26/14	N/A
Dominion Voting C++ Coding Standard	1.0.0::8	7/27/12	N/A
Dominion Voting Usability Study – ICP	1.0.0::26	7/27/12	N/A
Dominion Voting Usability Study – ICE	1.0.0::36	7/13/12	N/A