

# **Ranked Choice Voting Resource Center Universal RCV Tabulator 1.2.0 Voting System Final Test Report**

Report Number: NYS-21007-FTR-01

Prepared for:

<b>Vendor Name</b>	<i>Ranked Choice Voting Resource Center (RCVRC)</i>
<b>Vendor System</b>	<i>Universal RCV Tabulator 1.2.0</i>
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## Revision History

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May 3, 2021	2.0	M. Santos	Updates for NYSBOE comments
May 4, 2021	3.0	M. Santos	Updates for NYSTEC comments

### Disclaimer

The information reported herein must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

All testing conducted for this engagement has been done outside of the U.S. Election Assistance Commission's (EAC) Test and Certification Program. In no way does this test report represent an EAC certification against the Voluntary Voting System Guidelines (VVSG) or any other standard.

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The tests referenced in this document were performed in a controlled environment using specific systems and data sets, and results are related to the specific items tested. Actual results in other environments may vary.

### Opinions and Interpretations

There are no opinions or interpretations included in this report.



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# 1 INTRODUCTION

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SLI Compliance (SLI) is submitting this Final Test Report as a summary of the testing performed and testing leveraged on the **RCVRC Universal RCV Tabulator 1.2.0** against the Voluntary Voting System Guidelines 1.0 (VVSG 1.0) and the State of New York (NY) 2020 Election Law requirements.

In addition, SLI conducted a full documentation review of the **RCVRC Universal RCV Tabulator 1.2.0** Technical Data Package, source code review, security analysis, and functional testing for all NY 2020 Election Law requirements and a subset of modified VVSG 1.0 requirements. This report describes the scope of the testing SLI performed on the **RCVRC Universal RCV Tabulator 1.2.0** and provides an overview of the results and findings.

## 1.1 Test Report Attachments

The following attachments apply to this Test Report:

- Attachment A – New York Requirements Matrix RCVRC Universal RCV Tabulator 1.2.0
- Attachment B – Functional Test Suites
- Attachment C – TDP Documentation Review Suite
- Attachment D – List of Source Code Reviewed
- Attachment E – RCV Source Code Test Suite

## 1.2 References

The following key documents were used in preparing this test plan.

1. Election Assistance Commission Voluntary Voting System Guidelines, 2005 Version 1.0 Volumes I and II (VVSG 1.0)
2. State of New York 2020 Election Law (NY 2020 Election Law)
3. NIST Handbook 150: 2020
4. NIST Handbook 150-22: 2017
5. SLI VSTL Quality System Manual, v 3.3, December 17, 2020

## 1.3 Terms and Abbreviations

The following terms and abbreviations will be used throughout this document:

**Table 1 – Terms and Abbreviations**

Term	Abbreviation	Description
Commercial Off the Shelf	COTS	Term used to designate computer software, hardware or accessories that are ready-made and available for sale, lease, or license to the general public
Election Assistance Commission	EAC	An independent, bipartisan commission created by the Help America Vote Act (HAVA) of 2002 that operates the federal government's voting system certification program.
Election Management System	EMS	The software used by the voting system to describe ballot layout, collect and report election results, and maintain audit trails.
Firmware	NA	A computer program stored in read-only memory (either programmable or non-programmable), that becomes a permanent part of the computing device that is not subject to change or modification without review by the State Board.
Functional Configuration Audit	FCA	The testing activities associated with the functional testing of the system.
Modification	NA	Any change in the software, firmware or hardware, data storage location of files, or any other component of the voting system, and shall require re-examination of certified system or equipment by the State Board.
Physical Configuration Audit	PCA	Confirms that the documentation submitted meets the national certification requirements. Includes Trusted Build activities.
Software	NA	Any programming instructions used by the vote counting system, including but not limited to system programs and application programs. System programs include but are not limited to the operating system, control programs, communication programs, database managers, and device drivers. Application programs include but are not limited to, any program that processes the data.



Term	Abbreviation	Description
Source Code	NA	The computer program in its original form, as written by the programmer. Source code is not executed by the computer directly, but is converted into machine language by compilers, assemblers and interpreters.
State Board	NYSBOE	The New York State Board of Elections.
Technical Data Package	TDP	The data package supplied by the vendor, which includes Functional Requirements, Specifications, End-user documentation, Procedures, System Overview, Configuration Management Plan, Quality Assurance Program, and manuals for each of the required hardware, software, firmware components of a voting system.

## 1.4 System Identification

This section provides a description of the scope of **RCVRC Universal RCV Tabulator 1.2.0** TDP and the documents submitted for testing.

The **RCVRC Universal RCV Tabulator 1.2.0** can process data from voting machines or Election Management Systems that are capable of exporting cast vote records (CVRs) and tabulate a single-winner or multi-winner ranked choice voting election according to a set of rule configurations. The Universal RCV Tabulator outputs the tabulation results in comma separated values (.csv) tabular data format and creates an audit file for the RCV election.

The Universal RCV Tabulator can also convert vendor CVRs to the Common Data Format (CDF) and tabulate a single-winner or multi-winner ranked choice voting election according to the configured rules.

The Universal RCV Tabulator is a stand-alone software package and is not connected directly to any voting system or software.

## 1.5 Software

The following software is required for the execution of all tests. This includes all supporting software such as operating systems, compilers, assemblers, application software, firmware, or any applications used for burning of media.

### 1.5.1 RCVRC Software

**RCVRC Universal RCV Tabulator 1.2.0** software was specifically for a Windows environment in this project.

**Table 2 – Manufacturer Software**

RCVRC Universal RCV Tabulator Windows 1.2.0
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### 1.5.2 COTS Software

COTS software for the **RCVRC Universal RCV Tabulator 1.2.0** implementation was specifically for a Windows environment in this project.

**Table 3 – COTS Software**

Windows 10 Pro Operating System
---------------------------------

## 1.6 Equipment

The following equipment is required for the execution of all tests. This includes hardware, general purpose data processing and communications equipment as applicable.

### 1.6.1 Manufacturer Equipment

No manufacturer equipment specific to RCVRC was used in testing.

### 1.6.2 COTS Equipment

The following COTS equipment was used in testing:

**Table 4 – COTS Equipment**

Dell Inspiron Premium Desktop PC
Samsung SL-M2020W Printer
APC Back-UPS 600 UPC



## 1.7 TDP Documentation

The **RCVRC Universal RCV Tabulator 1.2.0** TDP consists of the following documentation:

**Table 5 – Universal RCV Tabulator 1.2.0 TDP Documentation**

System Version	Document Name	Version Number
URCVT 1.2.0	00-NY Documentation Table of Contents	1.0.0
URCVT 1.2.0	01-NY System Overview	1.0.0
URCVT 1.2.0	02-NY Software Design and Specifications	1.0.0
URCVT 1.2.0	03-NY System Hardware Specification	1.0.0
URCVT 1.2.0	04-NY System Functionality Description	1.0.0
URCVT 1.2.0	05-NY Acceptance Test Procedures	1.0.0
URCVT 1.2.0	06-NY System Design Specification	1.0.0
URCVT 1.2.0	07-NY System Security Specification Requirements	1.0.0
URCVT 1.2.0	08-NY System Operations Procedures	1.0.0
URCVT 1.2.0	09-NY System Maintenance Procedures	1.0.0
URCVT 1.2.0	10-NY Personnel Deployment and Training	1.0.0
URCVT 1.2.0	11-NY L&A Testing	1.0.0
URCVT 1.2.0	12-NY Configuration Management Plan	1.0.0
URCVT 1.2.0	13-NY Quality Assurance Plan	1.0.0
URCVT 1.2.0	14-NY Tabulator Build & Hashing instructions	1.0.0
URCVT 1.2.0	15-NY System Change Notes	1.0.0
URCVT 1.2.0	16-NY System Hardening Procedures	1.0.0
URCVT 1.2.0	17-NY System Test and Verification Specification	1.0.0
URCVT 1.2.0	18-NY User Guide	1.0.0
URCVT 1.2.0	110-NY Tabulation Options for RCV Tabulation	1.0.0
URCVT 1.2.0	120-NY Process Ranked Choice Voting Contest	1.0.0
URCVT 1.2.0	130-NY Expected Outcome RCV Test Sets Single-Winner	1.0.0
URCVT 1.2.0	140-NY Expected Outcome RCV Test Sets Multi-Winner	1.0.0
URCVT 1.2.0	150-NY Ballot Limitations & Maximum Testing Range	1.0.0
URCVT 1.2.0	200-NY Installation Instructions for Universal RCV Tabulator - Windows OS	1.0.0
URCVT 1.2.0	230-NY HashCode Instructions - Windows OS	1.0.0
URCVT 1.2.0	240-NY Command Line Instructions	1.0.0
URCVT 1.2.0	300-NY Configuration File Parameters	1.0.0
URCVT 1.2.0	330-NY Universal RCV Tabulator CVR Files	1.0.0
URCVT 1.2.0	350-NY Universal RCV Tabulator Config Files	1.0.0
URCVT 1.2.0	430-NY Universal RCV Tabulator Operator Log Messages	1.0.0
URCVT 1.2.0	440-NY Universal RCV Tabulator System Tab Hints	1.0.0
URCVT 1.2.0	500-NY System Enhancements for URCVT	1.0.0



## 1.8 Test Materials

The following test materials are required for the performance of testing including, as applicable, cast vote records, standard and optional output data report formats, and any other materials used in testing.

- ES&S voting system Cast Vote Records (CVRs)

## 2 EVALUATION OF PRIOR VSTL TESTING

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Prior VSTL testing has been performed on the **RCVRC Universal RCV Tabulator 1.2.0**, as well as predecessor versions of the utility. As the testing documentation provided to SLI Compliance did not clearly indicate the scope of testing performed, nor did it contain any test case steps that could be verified by SLI Compliance, these results were not leveraged for this test effort.

## 3 MASTER REQUIREMENTS MATRIX

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A master requirements matrix is necessary to demonstrate how all pertinent VVSG 1.0 and NY 2020 Election Law requirements were covered in the **RCVRC Universal RCV Tabulator 1.2.0** test campaign. SLI created a master requirements matrix that provides clear traceability of requirements to test cases for all applicable VVSG 1.0 and NY 2020 Election Law requirements covered in this test effort. This matrix can be found in Attachment A – SLI NYSBOE Requirements Matrix 2020 Universal RCV Tabulator 1.2.0.xlsx.

## 4 SUMMARY OF TESTING AND FINDINGS

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This section contains a summary of the testing conducted and findings observed during the **RCVRC Universal RCV Tabulator 1.2.0** test campaign. The test results summary contains a high-level description of the testing and reviews performed by SLI as well as an explanation of the findings for each area.

### 4.1 TDP Documentation Review

The following section contains a summary of the TDP documentation review and findings observed during the **RCVRC Universal RCV Tabulator 1.2.0** test campaign.

#### 4.1.1 TDP Documentation Review Summary

SLI reviewed the **RCVRC Universal RCV Tabulator 1.2.0** TDP documentation to verify compliance against pertinent VVSG 1.0 and NY 2020 Election Law requirements. In a set of internally developed test cases, SLI traced where each pertinent NY 2020 Election Law requirement is met by the vendor documentation. In addition, SLI used a set of internally

developed PCA document review forms to trace and demonstrate where each pertinent VVSG 1.0 requirement is met by the vendor documentation.

In addition to the SLI developed PCA review forms, SLI has provided a requirements matrix for **RCVRC Universal RCV Tabulator 1.2.0** that includes a mapping of the pertinent NY 2020 Election Law requirements to the corresponding document review test cases.

The PCA review forms and document review test cases contain tracings of the vendor documentation and sections that satisfy the requirements. Thus, the requirements matrix, PCA review forms, and document review test cases demonstrate how the **RCVRC Universal RCV Tabulator 1.2.0** TDP documentation satisfies pertinent VVSG 1.0 and NY 2020 Election Law requirements.

#### 4.1.2 TDP Documentation Review Findings

This section contains findings from the TDP documentation review conducted on the **RCVRC Universal RCV Tabulator 1.2.0**.

- **[NYRT120-2] Internet Connectivity Documentation Inconsistency**
  - **Documentation:**
    - v1.2.0-100.1 – TDP Technical Data Package.pdf
    - v1.2.0-170.1 – Universal RCV Tabulator System Security Specifications.pdf
    - v1.2.0-200.1 – Installation Instructions for Universal RCV Tabulator – Windows OS.pdf
  - **Description:**

As stated in documentation the Universal RCV Tabulator is a stand-alone software package and is not connected directly to any voting system or software. As per System Security Specifications the PC in which the Tabulator is installed shall be disconnected from the internet.
  - **Expected:**

Documentation is consistent with System Security Specifications keeping the stand-alone software package secure by remaining disconnected to the internet.
  - **Observed:**

Installation documentation requires the user to logon to the internet to download the latest version of the tool from Github.
  - **Resolution:**

Issue was addressed with updated documentation.
- **[NYRT120-3] Installation Guide – Windows**
  - **Documentation:**
    - v1.2.0-200.1 – Installation Instructions for Universal RCV Tabulator – Windows OS.pdf
  - **Description:**

Documentation made available to the end user provides all necessary

- information regarding the system or application including but not limited to installation and use.
  - **Expected:**  
Provided documentation is clear and complete.
  - **Observed:**  
The following items were found in documentation:
    - "Using File Explorer, locate the Downloads folder and delete all files and folders in the Downloads folder." does not specify why *all* files, including unrelated files, are to be deleted.
    - "Locate the folder that starts with universal\_rcv\_tabulator folder..." assumes that RVC tabulator was previously installed. No steps or other documentation includes instructions for fresh installations with no previous versions.
    - "Logon to the Internet and locate the latest Universal RCV Tabulator zip file from:" is inconsistent with System Security Specifications outlined in v1.2.0-100.1 – TDP Technical Data Package.pdf
    - There are multiple instances of an incorrect naming convention being used for installed folders such as "Windows-20201008 zip" and "universal\_rcv\_tabulator\_v1.2.0rc20201008\_windows"
    - "Using your mouse left click and drag the window with the **blue** top border down until it looks like the pictures below." This color convention appears to be based on the user settings and is not consistent or controlled.
    - Document appears to have inconsistencies with using left click vs right click vs double left click vs double right click, vs opening file path.
  - **Resolution:**  
Issue was addressed with updated documentation.
- **[NYRT120-4] HashCode Instructions – Windows**
  - **Documentation:**  
v1.2.0-230.1 – HashCode Instructions – Windows OS.pdf
  - **Description:**  
Hashing of software is critical to ensure that installed applications have not been altered, either maliciously, by mistake, or accidentally.
  - **Expected:**  
Documentation will provide steps or methodology to obtain the Hash of the installed software and compare against expected values.
  - **Observed:**  
The following items were found in documentation:
    - "Left click on the Windows folder and left click on the Restore Down icon in upper right hand corner of the window" is not clear about purpose and does not match what was seen during installation.
    - There are instances of an incorrect naming convention being used for installed folders such as "universal\_rcv\_tabulator\_v1.2.0rc20201008\_win" and "universal\_rcv\_tabulator\_v1.2.0rc20201008\_windows"

- Once a Hash Code is successfully created the window does not display the entire Hash. The Windows PowerShell cuts off the hash after approximately 67 characters and replaces the remaining character with an ellipsis.
- **Resolution:**  
Issue was addressed with updated documentation.
- Please note that issues NYRT120-8 through NYRT120-20 are related to a PCA documentation review, which is an in-depth analysis of the documentation against specific VVSG 1.0 criteria. The final TDP delivery was received two days prior to project completion. “Resolutions” listed below are based on partial re-review of the updated documentation, per the request of the New York State Board of Elections, to which significant updates were made.
- **[NYRT120-8] PCA Doc Review - Configuration Management Plan**
  - **Description:**  
The requirements VVSG 1.0 – “V.2:2.11 Configuration Management Plan”, “V.2:2.11.1 Configuration Management Policy”, “V.2:2.11.2 Configuration Identification”, “V.1: 9.3.2 Versioning Conventions”, “V.2:2.11.3 Baseline, Promotion, and Demotion Procedures”, “V.2:2.11.4 Configuration Control Procedures”, “V.2:2.11.5 Release Process”, “V.2:2.11.6 Configuration Audits”, “V.1:9.7.1 Physical Configuration Audit”, “V.1:9.7.2 Functional Configuration Audit”, “V.2:2.11.7 Configuration Management Resources”, “6209.6.D.2 Functional configuration audit”, “6209.6.D.2b Technical Data”, “6209.6.D.3 PCA”, “6209.6.D.3bi Technical data”, “6209.6.D.3c Audit procedure” are examined to verify conformance.
  - **Expected:**  
Documentation will provide steps or methodology to describe internal configuration management plan.
  - **Observed:**  
TDP document points to external documentation specific to Git version control.
  - **Resolution:**  
Documentation provided is incomplete; configuration management includes more than tracking changes in source code. Adherence to pertinent VVSG requirements is needed. Please refer to VVSG 1.0 volume 2, section 2.11.
- **[NYRT120-9] PCA Doc Review - Personnel Deployment Training Requirements**
  - **Description:**  
The requirements VVSG 1.0 – “V.2:2.10.1 Personnel”, “V.2:2.10.2 Training”, “V.2:4.3.5 Availability”, “6209.6.F.6 Logistics, Facilities and Training”, “6209.6.F.7e-g Personnel Required””, “6209.9.A.1c Training”, “6209.9.A.1d Training” are examined to verify conformance.



- **Expected:**  
TDP contains explicit criteria for training of personnel for deployment in an election setting.
- **Observed:**  
From the TDP: “The jurisdiction using this software shall require that all system operators be familiar with all documentation and have demonstrated a thorough knowledge of the operation procedures prior to tabulating ballots in an official election.”  
This puts the responsibility on the jurisdiction to cover the entire scope of personnel deployment and training.
- **Resolution:**  
Issue was addressed with updated documentation.
- **[NYRT120-10] PCA Doc Review - Quality Assurance**
  - **Description:**  
The requirements VVSG 1.0 – “V.2:2.12 Quality Assurance Program”, “V.2:2.12.1 Quality Assurance Policy”, “V.2:2.12.2 Parts & Materials Special Tests and Examinations”, “V.1:8.5 Parts and Materials Special Tests and Examinations”, “V.2:2.12.3 Quality Conformance Inspections”, “V1.1:8.6 Quality Conformance Inspections”, “V.2:2.12.4 Documentation”, “V.1:8.7 – Documentation”, “6209.6.D.2a Vendor responsibility”, “6209.6.D.3 Physical configuration audit” “6209.6.F.3f Quality Assurance Standards”, “6209.6.F.4iii Operator information” are examined to verify conformance.
  - **Expected:**  
Documentation will provide steps or methodology to describe internal quality assurance plan.
  - **Observed:**  
Documentation not provided.
  - **Resolution:**  
Issue was partially addressed with updated documentation. Please refer to VVSG 1.0 volume 2, section 2.12.
- **[NYRT120-11] PCA Doc Review – Software Design and Specification**
  - **Description:**  
The requirements VVSG 1.0 – “V.2:2.5.2 Applicable Documents”, “V.2:2.5.3 Software Overview”, “V.2:2.5.4 Software Standards and Conventions”, “V.2:2.5.5 Software Operating Environment”, “V.2:2.5.5.1 Hardware Environment and Constraints”, “V.2:2.5.5.2 Software Environment”, “V.2:2.5.6 Software Functional Specification”, “V.2:2.5.6.1 Configurations and Operating Modes”, “V.2:2.5.6.2 Software Functions”, “V.2:2.5.7 Programming Specifications”, “V.2:2.5.7.1 Programming Specifications Overview”, “V.2:2.5.7.2 Programming Specifications Details”, “V.2:2.5.8 System Database”, “V.2:2.5.9 Interfaces”, “V.2:2.5.9.1 Interface Identification”, “V.2:2.5.10 Appendices”, “6209.6.F.3 Software Specification”, 6209.6.F.3b





Program description“, “6209.6.F.3c Standards and conventions“, “6209.6.F.3d Specification standards and conventions“, “6209.6.F.3e Test and verification standards“, “6209.6.F.3f Quality assurance standards“, “6209.6.F.3g Operating environment“, “6209.6.F.3i Software environment“, “6209.6.F.3j Interface characteristics“, “6209.6.F.3k Software functional specification“, “6209.6.F.3l Configurations and operating modes“, “6209.6.F.3m External files“, “6209.6.F.3o Programming specifications“, “6209.6.F.3r Acceptance test specification” are examined to verify conformance.

- **Expected:**  
Documentation will provide steps or methodology to describe design and implement plan of software development.
- **Observed:**  
Documentation not provided.
- **Resolution:**  
Documentation provided is incomplete. Adherence to pertinent VVSG requirements is needed. Please refer to VVSG 1.0 volume 2, section 2.5.
- **[NYRT120-13] PCA Doc Review – System Functionality Description**
  - **Description:**  
The requirements VVSG 1.0 – “V.2:2.3 System Functionality Description”, “V.1:4.1.5.1 Ballot Handling”, “6209.6.E Functional tests, security tests and simulated voting”, “6209.6.F.3k Software Functional Specification” are examined to verify conformance.
  - **Expected:**  
Documentation will provide steps or methodology to allow user to successfully utilize application.
  - **Observed:**  
Documentation not provided.
  - **Resolution:**  
Issue was addressed with updated documentation.
- **[NYRT120-14] PCA Doc Review – System Hardware Specifications**
  - **Description:**  
The requirements in VVSG 1.0 – “V.2:2.9”, “6209.6.D.3biii Configuration Baseline Data”, “6209.6.F.5 Maintenance Information” are examined to verify conformance.
  - **Expected:**  
Documentation will provide detailed steps for system maintenance procedures.
  - **Observed:**  
Documentation not provided.
  - **Resolution:**  
Issue was addressed with updated documentation.

- **[NYRT120-15] PCA Doc Review – System Maintenance Procedures**
  - **Description:**

The requirements VVSG 1.0 – “V.2:2.4.1 System Hardware Characteristics”, “V.2:2.4.2 Design and Construction””, “6209.6.F.5 Maintenance Information”, “6209.6.F.7 Maintenance Training and Supply” are examined to verify conformance.
  - **Expected:**

Documentation will provide detailed specifications of the hardware components of the system.
  - **Observed:**

Documentation not provided.
  - **Resolution:**

Issue was sufficiently addressed with updated documentation for this release, though needs additional updates in future releases with more details. Such as steps for fixing specific errors and explaining preventative measures.
  
- **[NYRT120-16] PCA Doc Review – System Operation Procedures**
  - **Description:**

The requirements in VVSG 1.0 – “V.2:2.3 System Functionality Description”, “6209.6.E Functional tests, security tests and simulated voting”, “6209.6.F.3I Configurations and Operating Modes”, “6209.6.F.4i Operator Information”, “6209:6.D3biv Documentation for Distribution” are examined to verify conformance.
  - **Expected:**

Documentation will provide steps or methodology to describe system operation procedures to allow user to successfully utilize application. Each option within the application should be documented as well as how an option selected (or deselected) can impact another option. Required capabilities that may be bypassed or deactivated during installation or operation by the user shall be clearly indicated. Additional capabilities that function only when activated during installation or operation by the user shall be clearly indicated. Additional capabilities that normally are active but may be bypassed or deactivated during installation or operation by the user shall be clearly indicated.
  - **Observed:**

Documentation not provided.
  - **Resolution:**

Issue was addressed with updated documentation.

- **[NYRT120-17] PCA Doc Review – System Overview**
  - **Description:**

The requirements VVSG 1.0 – “V.2:2.2.1 System Description”, “V.2:2.2.2 System Performance”, “6209.6.F.3a System Overview”, “6209.6.F.3siv Security analysis”, “6209.6.F.4i Operator information” are examined to verify conformance.
  - **Expected:**

Documentation will provide basic description of all system steps, and performance considerations.
  - **Observed:**

Documentation not provided.
  - **Resolution:**

Issue was sufficiently addressed with updated documentation for this release, though needs additional updates in future releases .
- **[NYRT120-18] PCA Doc Review – Security Specification**
  - **Description:**

The requirements VVSG 1.0 – “V.2:2.6 System Security Specification”, “V.2:2.6.1 Access Control Policy”, “V.2:2.6.2 Access Control Measures”, “V.1:7.2.1 General Access Control Policy”, “V.1:7.2.1.1 Individual Access Privileges”, “V.2:2.6.4 Software Installation”, “V.1:7.4 Software Security”, “V.1:7.4.1 Software and Firmware Installation”, “V.1:7.4.4 Software Distribution”, “V.1:7.4.6 Software Setup Validation”, “V.1:7.5.1 Maintaining Data Integrity”, “V.1:7.5.4 Shared Operating Environment”, “V.1:7.5.5 Incomplete Election Returns”, “V.2:2.6.6 Other Elements of an Effective Security Program”, “V.1:7.7.3 Protecting Transmitted Data”, “6209.6.F.1 Software qualification”, “6209.6.F.3a System Overview”, “6209.6.F.3n Security” are examined to verify conformance.
  - **Expected:**

Documentation will provide steps or methodology to describe all relevant security processes and policies.
  - **Observed:**

Documentation not provided.
  - **Resolution:**

Issue was addressed with updated documentation.





- **[NYRT120-19] PCA Doc Review – System Test and Verification Specification**
  - **Description:**

The requirements VVSG 1.0 – “V.2:2.7 System Test and Verification Specification”, “V.2:2.7.1 Development Test Specifications”, “V.2:2.7.2 National Certification Test Specifications”, “6209.6.F.3p Test and Verification Specifications” are examined to verify conformance.
  - **Expected:**

Documentation will provide steps or methodology to describe testing plans, procedures, data and performance.
  - **Observed:**

Documentation not provided.
  - **Resolution:**

Issue has not been addressed with updated documentation. Documentation provided is missing the required information. Adherence to pertinent VVSG requirements is needed. Please refer to VVSG 1.0 volume 2, section 2.7
- **[NYRT120-20] FCA Documentation – File Path Naming Convention**
  - **Description:**

The Universal RCV Tabulation software requires the user to point to several directories. These locations point at CSV files compiled with RCVs to be tabulated, as well as a location where results can be output. No documentation details limits to file path configurations.
  - **Expected:**

The user will only be limited by operating system file path locations and naming conventions.
  - **Observed:**

Even though Windows OS allows for certain characters to be used in the naming convention of folders and files, the Universal RCV Tabulator software will not tabulate when using %. When replacing the % symbol with the work "percent" tabulation would complete without error.
  - **Resolution:**

Issue was addressed with updated documentation, stating to not use ‘%’ in file path naming conventions.
- Please note that Findings 21, 23-26 were found in “Multi-pass IRV”, “Exhaust if Multiple Continuing” and “Hare Quota” functionality within the **Universal RCV Tabulator 1.2.0**, which were deemed not relevant for this certification. Please see section 4.2.1 for additional detail.

- **[NYRT120-27]** FCA Documentation – Run Universal RCV Tabulator from Command Line
  - **Description:**

v1.2.0-160.1 - Universal RCV Tabulator User Guide.pdf  
Documentation states that the Universal RCV Tabulator can be run from the command line by typing rcv the flag "-cli" and then a path to an existing config file. The final command line will look something like *\$ rcv -cli home/user/test/ config.json*  
Additionally an extra command can be added at the end to activate the convert-to-cdf function. The final command line will look something like:  
*\$rcv -cli home/user/test/config.json convert-to-cdf ##.*
  - **Expected:**

Documentation is detailed enough that the user is able to successfully run the software from the command line. When the software is successfully run the tool will open with the selected configuration file already loaded and the option to convert-to-cdf selected or unselected based on the command used.
  - **Observed:**

Additional steps of navigating to the correct path and typing in an accepted command other than 'rcv' are required in order to successfully run the software, which are not covered in documentation.  
An acceptable command was found for Windows OS in the form of the shortcut name "RCV Tabulator.lnk" but running the software does not open the GUI. Instead, the software generates all log and reports stored at the output directory dictated by the configuration file.
  - **Resolution:**

Issue was addressed with updated documentation.
- **[NYRT120-28]** FCA Documentation – System Design Specification Document
  - **Description:**

The System Design Specification document details vendor selections for design, installation, and applicable coding standards. The accredited test lab shall confirm the propriety and correctness of these user selections.
  - **Expected:**

A detailed document is submitted with the TDP explain design selections, applicable coding standard selected by the vendor, and any other factors relevant to source code creation.
  - **Observed:**

System Design Specification detailing user selection and applicable standards was not submitted with the TDP.
  - **Resolution:**

Issue was addressed with updated documentation.



- **[NYRT120-29] FCA Documentation – Pre/Post Installation Hashing**
  - **Description:**

Pre-installation and Post-installation hashing is used as both a security measure and a check to ensure the obtained software is the same software delivered by the vendor and certified by the VSTL. This check verifies no files have been compromised or changed before and after installation.
  - **Expected:**

Documentation and procedures detailing how to obtain pre-installation hashes for all relevant files and source code components, as well as post-installation hashes once the software has been installed. The pre and post installation hashes match indicating no changes were made during installation.
  - **Observed:**

Instructions are available for hashing a ZIP which contains all relevant files and source code to be installed.  
No documentation or procedures for hashing pre-installation or post-installation of source code and files of software being installed.
  - **Resolution:**

Issue was addressed with updated documentation.
  
- **[NYRT120-31] FCA Documentation – Missing or Insufficient Documentation**
  - **Description:**

The requirements “6209.2.F.13c”, “6209.2.F.16”, “6209.2.H”, “6209.6.D.2a”, “6209.6.D.2.b.i-iii”, “6209.6.D.3”, “6209.6.D.3.b.i-vi”, “6209.6.D.2”, “6209.6.E.4”, “6209.6.F.3”, “6209.6.F.3.a-g, i-m, o-r, h.i-v, s.i-iv”, “6209.6.F.4.i”, “6209.6.F.7.e-g”, “NYS Law: 7-202.1.r.i”, and VVSG 1.0 – “2.1.5.1.c.vii” are examined to verify conformance.
  - **Expected:**

Documentation will provide steps or methodology to describe information that sufficiently covers each requirement.
  - **Observed:**

The requirements have not been fulfilled and require additional or expanded documentation.
  - **Resolution:**

Issue was partially addressed with updated documentation.



- **[NYRT120-32]** The "v1.2.0-440.1 - Universal RCV Tabulator System Tab Hints contains" inaccurate information.
  - **Description:**  
v1.2.0-160.1 - Universal RCV Tabulator User Guide.pdf  
It has been noted in documentation that the Universal RCV Tabulator can be run through the command line.
  - **Expected:**  
Documentation indicates that by typing a specific set of commands into the terminal on each operating system that the tabulator will run or convert to CDF. It is understood that running through the command line will open the Universal RCV Tabulator v1.2.0 GUI loaded with a JSON and mark the convert to CDF option.
  - **Observed:**  
Commands do not work exactly as documented. Running the tool from the command line appears to skip the GUI and tabulate or convert to PDF directly. SLI believes this is intended though not described in documentation.
  - **Resolution:**  
Issue has been resolved with updated documentation.
- **[NYRT120-33]** CVR Limit Not Achieved
  - **Description:**  
The software shall be capable of tabulating a minimum of five million CVR records. This number was designated by NYSBOE in conjunction with the voter population of New York.
  - **Expected:**  
The Universal RCV Tabulator is capable of successfully tabulating a minimum of five million CVR records with no errors or stalls.
  - **Observed:**  
9 CVS files were tabulated into the RCV Tabulator, each CVS file contained one million CVR records. During tabulation, the RCV Tabulator would stall tabulation at 1.4 million records on the Linux and 1.1 million records for the windows OS. Once the tabulator reached the designated numbers, the program would stall and would not proceed any further.
  - **Resolution:**  
Issue has been resolved with updated documentation, specifying hardware technical requirements for three different CVR expectations (Small – up to 100,000 CVR's, Medium – up to 1,000,000 CVR's, Large – up to 6,000,000 CVR's). Minimum requirements needed for a Windows 10 device were documented (Large configuration), resulting in successful completion of tabulation of six million CVR's, utilizing RCVRC's "Large Configuration" prescribed environment, documented in "URCVT v.1.2.0 03-NY System Hardware Specification v.1.0.0".

- **[NYRT120-34] FCA Documentation – Command Line**
  - **Description:**  
v1.2.0-160.1 - Universal RCV Tabulator User Guide.pdf  
It has been noted in documentation that the Universal RCV Tabulator can be run through the command line.
  - **Expected:**  
Documentation indicates that by typing a specific set of commands into the terminal on each operating system that the tabulator will run or convert to CDF. It is understood that running through the command line will open the Universal RCV Tabulator v1.2.0 GUI loaded with a JSON and mark the convert to CDF option.
  - **Observed:**  
Commands do not work exactly as documented. Running the tool from the command line appears to skip the GUI and tabulate or convert to PDF directly. SLI believes this is intended though not described in documentation.
  - **Resolution:**  
Issue was addressed with updated documentation.
- **[NYRT120-35] FCA Documentation – Alterable Results**
  - **Description:**  
In order to protect the integrity of an election, voting information such as ballots and results are to be protect against any attempt at improper data entry or retrieval.
  - **Expected:**  
Source code, features, or documented methodologies are provided to protect tampering of election information including results.
  - **Observed:**  
Results are in an easy to edit format and are capable of being modified.
  - **Resolution:**  
Issue was addressed with updated documentation.
- **[NYRT120-36] FCA Documentation – Summary Report Information**
  - **Description:**  
Summary reports detail in an easy to read format the results of the election, or in the case of ranked choice voting the results of each contest and how those results were calculated/obtained. These reports contain information making it easy to identify eliminated candidates, elected officials, and any other pertinent information. VVSG 1.0 “2.4.3.c,d,g”
  - **Expected:**  
Summary Report include items such as the contest name, threshold calculations, all candidates within the contest, eliminated candidates, when the candidates were eliminated, elected officials, when the candidates were elected, the number of votes each candidate received, number of overvotes, number of undervotes, etc.



This information is available in each summary report, including when tabulating by precinct

- **Observed:**  
Summary reports do not track or count number of overvotes or undervotes. When tabulating by precinct, Precinct reports do not include any eliminated or elected candidate information. Situations can occur where one candidate appears to have 0 votes in once precinct but ends up winning the precinct in the final round.
- **Resolution:**  
Issue was addressed with updated documentation. The documentation states to not use the "Tabulate by Precinct" function. But provides no further explanation. In future releases this functionality will need to be removed or amended.
- **[NYRT120-37] Configuration File Documentation text file Limits Information**
  - **Description:**  
The "config\_file\_documentation.txt" documentation is a document that contains the limits of each field or settings within the "Universal RCV Tabulator" program.
  - **Expected:**  
All limitations noted within the "config\_file\_documentation.txt" file shall be accurate and portray the actual limits of the software.
  - **Observed:**  
Within the "config\_file\_documentation.txt" file, it states that the limit of the file paths "filePath" and "outputDirectory" are capable of having a string of 1000 characters within the file paths field. However, on the Windows OS, the limit for a folder structure path is around 255 characters.
  - **Resolution:**  
Issue was addressed with updated documentation.

These discrepancies were delivered to NY as well as RCVRC. It was determined via discussion with the State that these non-functional discrepancies pose an acceptably low risk.





## 4.2 Functional Testing

The following section contains a summary of the functional testing performed and findings observed during the **RCVRC Universal RCV Tabulator 1.2.0** test campaign.

### 4.2.1 Functional Testing Summary

The **RCVRC Universal RCV Tabulator 1.2.0** was subject to suites of functional tests based on pertinent VVSG 1.0 and NY 2020 Election Law requirements.

Testing included examination of the functionality employed withing the RCV Tabulator application as well as looking at the application's volume, stress, usability, accuracy, results reporting, performance, auditing and error reporting and recovery aspects. These tests assessed the system's response to a range of both normal and abnormal conditions.

Please note that "Multi-pass IRV" does not apply to New York City because multi-pass IRV is a form of multi-winner RCV election, which elects multiple winners in the same contest. New York City has adopted only single-winner RCV (referred to in our software as "single-winner majority determines winner"), so the multi-pass IRV setting will not be used under current NYC law. A potential issue was encountered with this functionality, but as **Universal RCV Tabulator 1.2.0** is not to be used in NYC, for which this project is intended, the "Multi-pass IRV" issue has not been addressed. The State determined that the issue posed an acceptably low risk.

Please note that "Exhaust if Multiple Continuing" is a setting related to how the software handles ballots with overvoted rankings. Exhaust if multiple continuing is not relevant to New York City because their rule for how to handle overvoted rankings (described under "exhausted ballot" at 1057-g(a)) requires that ballots exhaust when an overvoted ranking is reached. The setting for this rule is called "Exhaust Immediately" in the tabulator software. An issue was encountered with this functionality, but as **Universal RCV Tabulator 1.2.0** is not to be used in NYC, for which this project is intended, the "Exhaust if Multiple Continuing" issue has not been addressed. The State determined that the issue posed an acceptably low risk.

Please note that "Hare Quota" is a setting only used for certain multi-winner RCV contests. No elections in New York City will use multi-winner RCV methods. NYC contests will only use single-winner RCV. The "Hare Quota" setting cannot be set for single-winner RCV contests, so its functionality will not be relevant for New York City RCV contests. An issue was encountered with this functionality, but as **Universal RCV Tabulator 1.2.0** is not to be used in NYC, for which this project is intended, the "Hare Quota" issue has not been addressed. The State determined that the issue posed an acceptably low risk.

## 4.2.2 Functional Test Findings

The following section contains findings from the functional testing conducted on the **RCVRC Universal RCV Tabulator 1.2.0** system components.

- [NYRT120-22] Audit Log Export
  - **Description:**

The electronic records shall be capable of being exported in a non-proprietary format. This export may be used for auditing or analysis purposes, in order to determine if all information within is correct or in order to help troubleshoot any errors that may occur. The error messages shall be displayed within this audit log to allow a trained technician to diagnose and resolve the error.
  - **Expected:**

All electronic logs shall be capable of being exported in order to audit or analysis the information within the technology computing platform. This audit log shall contain all error messages and events that have occurred in order to allow a trained technician to identify and resolve error messages that have occurred on the system.
  - **Observed:**

The Audit log is only capable of being exported when the tabulation process has been completed successfully. There are no additional settings or options to export electronic logs. Thus, the error logs will not be included within the audit log unless tabulation has been completed.
  - **Resolution:**

Issue was sufficiently addressed with updated documentation for this release, though needs additional updates in future releases to be further enhanced in terms of robustness of activity logging .
- [NYRT120-33] CVR Limit Not Achieved
  - **Description:**

The software shall be capable of tabulating a minimum of five million CVR records. This number was designated by NYSBOE in conjunction with the voter population of New York.
  - **Expected:**

The Universal RCV Tabulator is capable of successfully tabulating a minimum of five million CVR records with no errors or stalls.
  - **Observed:**

9 CVS files were tabulated into the RCV Tabulator; each CVS file contained one million CVR records. During tabulation, the RCV Tabulator would stall tabulation at 1.4 million records on the Linux and 1.1 million records for the windows OS. Once the tabulator reached the designated numbers, the program would stall and would not proceed any further.



- **Resolution:**  
Minimum requirements needed for a Windows 10 device were documented, resulting in successful completion of tabulation of six million CVR's, utilizing RCVRC's "Large Configuration" prescribed environment, documented in "URCVT v.1.2.0 03-NY System Hardware Specification v.1.0.0". This issue was satisfactorily resolved.

These Functional discrepancies were satisfactorily resolved for this release. Longer term "NYRT120-22] Audit Log Export" could be further enhanced in terms of robustness of activity logging.

## 4.3 Security Review

The following section contains a summary of the security testing performed and findings observed during the **RCVRC Universal RCV Tabulator 1.2.0** test campaign.

### 4.3.1 Security Review Summary

SLI conducted a security examination against the **RCVRC Universal RCV Tabulator 1.2.0**. The review consisted of an evaluation of pertinent VVSG 1.0 and NY 2019 State Election Law requirements. Utilizing the requirements to validate them, SLI evaluated the security of the **Universal RCV Tabulator 1.2.0**.

#### Physical Security

It was determined that all physical security provided for the **RCVRC Universal RCV Tabulator 1.2.0** is incorporated in the document "*07-NY System Security Specification Requirements*". Note that some physical security recommendations are reliant on jurisdiction policies and/or State of New York State Board of Elections policies.

#### Access Control

It was determined that all access control provided for the **RCVRC Universal RCV Tabulator 1.2.0** is incorporated in the document "*07-NY System Security Specification Requirements*". Access is controlled by a recommendation of at least 2 bipartisan personnel, appropriately trained, performing all activities together. **RCVRC** recommends that the computer require a password in order to gain access to the environment. **RCVRC** also recommends a manual paper log for recording access to the computer. The application itself has a single user level, and deploys without a username/password input, depending on the operating system level access control.

#### Protection against Malicious Software

It was determined that sufficient protections against malicious software are provided for the **RCVRC Universal RCV Tabulator 1.2.0** and are incorporated in documents "*07-NY System Security Specification Requirements*" and "*16-NY System Hardening Procedures*". **RCVRC** maintains that the computer is to be standalone, not a shared environment, with no internet connection. **RCVRC** also provides details for updating of Microsoft Defender.



## Telecommunications

It was determined that sufficient protection policies against use of restricted telecommunications, including internet access, are provided for the **RCVRC Universal RCV Tabulator 1.2.0** and are incorporated in documents “07-NY System Security Specification Requirements”, “200-NY Installation Instructions for Universal RCV Tabulator - Windows OS” and “16-NY System Hardening Procedures”. **RCVRC** maintains that the computer is to be standalone, with no internet connection. The application itself does not have any implemented security.

## Software Setup Validation

It was determined that the RCVRC Universal RCV Tabulator 1.2.0 TDP does recommend device encryption for the operating system storage. Device encryption for OS storage is not required in any of the requirements tested, but is a security enhancing implementation that is highly recommended. The examiner considers it a potential vulnerable point in the system if device encryption is not implemented, as proper processes and procedures not followed during transportation, storage or setup present vulnerabilities.

Generally, unencrypted file systems have the potential to allow for the following compromises given unmonitored unrestricted access to the devices listed:

1. Modification of the boot device for the system
2. Ability to access user password hashes for the device
3. Potential to alter/halt the system on startup or shutdown
4. Access to election specific software
5. Potential for introduction of malicious software

## Hashing

It was determined that appropriate instructions for hashing of the application are provided. The deliverable is to be managed by the State, including delivery of materials to jurisdictions implementing the **RCVRC Universal RCV Tabulator 1.2.0**.

### **4.3.2 Security Review Findings**

The security review conducted on the **RCVRC Universal RCV Tabulator 1.2.0** found that other than some high level access control assertions, **RCVRC** depends heavily on the security policies of the accompanying voting system, as well as the security policies of local jurisdictions.



## 4.4 Source Code Review

The following section contains a summary of the source code review performed and findings observed during the **RCVRC Universal RCV Tabulator 1.2.0** test campaign.

### 4.4.1 Source Code Review Summary

Throughout the Source Code Review effort, results were marked as follows:

- **Accept** – Criteria is accepted as successful.
- **Reject** – Criteria is rejected as unsuccessful.

Test results **Reject** include comments explaining the reason for the result.

Issues encountered during review were documented in the applicable Discrepancy Report. Issues that did not conform to the requirements of the VVSG 1.0 or NY 2020 Election Law requirements were marked as **Discrepancies** (a discrepancy occurs when the source code does not meet defined requirements or specifications).

### 4.4.2 Source Code Review Findings

SLI conducted a review of the **RCVRC Universal RCV Tabulator 1.2.0** source code. All **RCVRC Universal RCV Tabulator 1.2.0** code was reviewed against the pertinent VVSG 1.0 requirements and NYS election code.

The review consisted of four parts: two utilizing the automated source code review tool, Understand, and two utilizing manual reviews.

Understand was utilized with two different sets of review criteria. The first set reviewed the code base for source code related issues. The second set reviewed the code base from a security perspective. The automated analysis returned findings against the implemented criteria set that were then manually reviewed by a Source Code Reviewer.

Review of the findings resulted in a number of discrepancies against requirements set forth by the VVSG 1.0. These findings were validated during manual review for accuracy.

Manual reviews also utilized two different sets of review criteria. The first set reviewed the code base for source code related issues and validated automated results. The second set reviewed the code base from a security perspective. The manual review identified a number of discrepancies. A summary of the results is shown in the following table.

Table 6 – Source Code Review Findings

VVSG 1.0 Requirement	Description	Number of Findings	Risk Level	Comment
Vol 1: 5.2.3.e: Each module shall have a single entry	Multiple return	3	Moderate	More than one return statement in a module, or a single return statement not at the end of a module, will result



point, and a single exit point, for normal process flow.	statements found.			in code that may never be executed. Unexecuted code is considered “Dead Code” and can potentially be exploited to cause unwanted results. This is only acceptable for defensive purposes to protect the program from unexpected critical conditions that may otherwise occur.
Vol 1: 5.2.3.b In addition to the unique name, the modules shall include a set of header comments identifying the module’s purpose, design, conditions, and version history, followed by the operational code.	Incomplete Module Headers	23	Low	Non-functional issue related to ability to read/maintain the source code itself.
Vol 2: 5.4.2.r Has functions with fewer than six levels of indented scope	More than 5 levels of indented scope.	22	Low	Non-functional issue related to ability to read/maintain the source code itself.

These discrepancies were delivered to NY as well as RCVRC. It was determined via discussion with the State that these findings pose an acceptably low risk.

## 5 TRUSTED BUILD

SLI conducted a trusted build as part of the **RCVRC Universal RCV Tabulator 1.2.0** project. The trusted build verified that only the submitted and reviewed source code was applied and used to build the RCVRC UNIVERSAL RCV TABULATOR 1.2.0 output files, or executables, that were used to install the software and firmware for the components tested.

The trusted build was conducted after it was determined that no code modifications were necessary. The trusted build was conducted on site at SLI’s facility. SLI utilized its approved standard lab procedure that details the processes for controlling, managing, and conducting the trusted build. This process included the following:



- Preparation for the Trusted Build – Obtaining and reviewing RCVRC’s procedure for constructing the build platform, verifying the target build platform, and acquiring and verifying the necessary materials.
- Execution of the Trusted Build – SLI performing the compliance and trusted builds by using the step-by-step build procedure, as provided by RCVRC to create a pristine build environment. SLI ascertains and records the following items throughout the build process:
- Build environment details:
  - Windows 10 Pro build 19041.928 (non-critical)
  - OpenJDK 14.0.1 (build 14.0.1+7) (critical)
    - SHA512:  
7546b40977670f24ec68ad82b5d9f52f4fc105410e7bbfec6da0718795f4a82ac26665f1f9f05562ae20710aefe85c8dac05c5345d4e48385e99323a916d2157
- Build results and file hashes:
  - universal\_rcv\_tabulator\_v1.2.0\_windows.zip
    - SHA512:  
e034e29e58da7af8d0a2f0b9ea309a678965b98a8b8ebdb2879c8804e243f679b89e7ab2047b197df250085b8ea106779d9cc8515750177325e373becd234bf
- Final software install files and file hashes
  - universal\_rcv\_tabulator\_v1.2.0\_windows.zip
    - SHA512:  
e034e29e58da7af8d0a2f0b9ea309a678965b98a8b8ebdb2879c8804e243f679b89e7ab2047b197df250085b8ea106779d9cc8515750177325e373becd234bf
- Deliverables to Testing – Upon completion of the build, specific items were sent to the SLI test group. The final result was media containing the following:
  - universal\_rcv\_tabulator\_v1.2.0\_windows.zip
    - SHA512:  
e034e29e58da7af8d0a2f0b9ea309a678965b98a8b8ebdb2879c8804e243f679b89e7ab2047b197df250085b8ea106779d9cc8515750177325e373bebcd234bf
- Final Record Keeping and Archiving Procedures – At the conclusion of the final trusted build process, SLI completed all final record keeping and archiving procedures at SLI’s facility. This record keeping included any unique identifiers, results of the build with version numbers and dates and descriptions of all hashes and images in the repository.



## 6 CONCLUSION

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SLI has completed TDP documentation review, functional testing, security review, and source code review of the **RCVRC Universal RCV Tabulator 1.2.0** application. The testing and reviews were conducted against the identified VVSG 1.0 and NY 2020 Election Law requirements. All findings are included in this Final Test Report and/or accompanying documentation.

The “single-winner RCV” (referred to in the software as “single-winner majority determines winner”) functionality being used by NYSBOE, within the **RCVRC Universal RCV Tabulator 1.2.0** application, was successfully exercised, resulting in the expected results being determined by the application.

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End of Final Test Report

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