



Test Summary Report

for the

Counting the Senate Project

Prepared by
IV&V Australia Pty Ltd

Prepared for
Australian Electoral Commission

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Accredited for compliance with ISO/IEC 17025.

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Revision History

Version	Date	Change	Author
-01	10 July 2018	Original released version.	R. Parkin

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1. Introduction

1.1 Identification

Client name and address	Australian Electoral Commission 50 Marcus Clarke Street Canberra City, ACT 2600	
Project/product name	Counting the Senate Project	
Items under test	EasyCount (ECS)	Version 4.0.35.51606
	BPRS	Version 2.1.50.51128

1.2 Product Description

Purpose	<p>The Counting the Senate Project establishes an ongoing service delivery and management model for counting the Senate ballot papers.</p> <p>The primary focus of the NATA testing for this project was the recent algorithm changes to EasyCount (since it was previously tested in 2016). AEC were also seeking assurance of the integration of ECS with the Ballot Paper Reconciliation System (BPRS).</p> <p>NATA testing is a formal, independent end-of-lifecycle test using a test process that is conformant with ISO 17025.</p>
Application type	ECS is a desktop application referencing a separate database server; BPRS is a web application
Functionality under test	Senate Counting Solution (ECS with BPRS)
Test level/activity	<p>Functional testing of the algorithm-specific changes in the EasyCount update.</p> <p>Regression testing of the general EasyCount functionality to ensure that the Count algorithm is unaffected except as intended by the changes.</p> <p>End to End testing of the integration of BPRS with ECS.</p> <p>The testing was done by Demonstration and Analysis.</p>

1.3 Test Execution Summary

Date(s) of testing	19 – 26 June 2018
Location of testing	Australian Electoral Commission Level 10, 59 Goulburn Street Haymarket, NSW 2000
Test management by	Donna O'Neill



Tested by	Rodney Parkin
Protocol used	[REDACTED]
Deviations required	<p>Test step mark ups were made to correct typographical errors and additional free-play test steps were executed to improve test coverage.</p> <p>General deviations are discussed in Section 2.3 Conformance with Protocol.</p> <p>[REDACTED]</p>
Test result summary	All tests Passed
Location of test results	See Reference 5

1.4 Referenced Documents

Ref	Document Title	Identifier	Source
1.	[REDACTED]	IV&V signed 23 May 2018	AEC
2.	[REDACTED]	Received 10 May 2018	AEC
3.	[REDACTED]	IVVAUST/AEC/083-01	IV&V
4.	[REDACTED]	IVVAUST/AEC/084-01	IV&V
5.	[REDACTED]	IVVAUST/AEC/085-01	IV&V
6.	[REDACTED]	Version 2.0, 5/10/2017	AEC
7.	[REDACTED]	IVVAUST/AEC/080-01	IV&V
8.	[REDACTED]	IVVAUST/AEC/081-01	IV&V
9.	[REDACTED]	IVVAUST/AEC/082-01	IV&V
10.	[REDACTED]	IVVAUST/AEC/087-01	IV&V



2. Test Execution Discussion

2.1 Summary of Test Results

Test Execution Results	
Number of test cases run	43
Number of test cases passed (no failed steps)	43
Number of test cases failed (at least one failed step)	0
Number of planned test cases not run	0

Open Discrepancy Report Results		
Severity	Definition	Number Open
1	<i>Critical.</i> The defect has caused the system to fail. There is no workaround and testing cannot continue.	0
2	<i>Severe.</i> The defect causes some functionality/component to fail. There is a workaround, however, and testing can continue.	0
3	<i>Moderate.</i> The defect produces unexpected results but the system can still function.	0

2.2 Summary of the Testing Performed

2.2.1 The Test Approach

IV&V Australia's scope of work was agreed between the parties to cover key changes to ECS since the previous NATA testing in 2016 (the Senate Reform Project) which included changes to the algorithm and miscellaneous defect fixes. The AEC were also seeking assurance over the integration of ECS with BPRS.

The AEC Counting the Senate Program Test Strategy involved a number of test types and phases, undertaken by both staff internal to the AEC and external vendors, per [REDACTED]. IV&V Australia were responsible for the "NATA testing" test type/phase within that strategy. IV&V Australia did not have visibility into any of the other test types or phases of testing for functionality outside IV&V's scope of work.

The NATA testing was intended as an independent assessment, using a NATA-accredited testing process, to establish confidence that the algorithm changes to Count have been adequately tested and they did not introduce new issues.

IV&V Australia's scope of work involved the following tasks:

- [REDACTED]
- Review the AEC-supplied test strategy, test cases and test data spreadsheets to ensure that the test method and test case selection for NATA testing of the in-scope Count and BPRS functionality was adequate and correct.

- Conduct dry run testing using the AEC-supplied tests to review the test procedures and to prepare for the formal NATA test run.
- Conduct the formal NATA test.
- Prepare a NATA-endorsed Test Summary Report (this document).

2.2.2 Test Method/Test Case Selection

AEC supplied the Count and BPRS test cases, spreadsheets and data files used during testing.

IV&V Australia conducted a desk review of the AEC test strategy, test cases and test data to determine the adequacy of the test baseline. Specifically, the review confirmed whether:

- The data spreadsheets correctly reflect changes to the algorithm;
- The test steps correctly reflect the modified spreadsheets;
- The test cases adequately cover the changes made;
- The intents of the test cases were still met, given the changes;
- The test cases that are considered to be out of scope by the AEC should be included in IV&V's test set; and
- The BPRS test cases adequately provide assurance over the integration of data into ECS.

This review was conducted using the test cases and test data spreadsheets [REDACTED] as the primary reference for the ECS modifications. [REDACTED] were provided to the AEC.

The test case review was followed by a test procedure review/informal dry run of the tests to check test step flow, completeness of prerequisites, adequacy of datasets and adequacy of the test environment. [REDACTED] were provided to the AEC.

Both reviews helped to identify potential improvements to the test cases and test procedures, such as:

- Minor typographical errors that should be ignored
- Additional free-play test steps and/or test data to improve test coverage
- A more efficient way of ordering and running the tests.

During testing, this took the form of test step deviations, document "mark-ups" and free-played test steps. These changes are described in detail in Section 2.3 Conformance with Protocol.

The test case review identified that the test data for one test case (2.2.9 Surplus distribution in a different order to election) that has been previously included in the Count test suite was not supplied by the AEC. AEC advised that this is an area of low risk and so could be omitted.

The test procedure review identified that the test steps for validating SSO login were weak. AEC advised that this functionality should be removed from the scope of testing.

The reviews also raised some questions about the use of the Load Test Scenario functionality/ test harness. AEC provided a test harness validation procedure to help mitigate any concerns. This is discussed in Section 2.2.3 below.

2.2.3 Test Harness Validation

Load Test Scenario

Most of the Count test suite consists of small artificial electoral events which are designed to provoke specific scenarios. The AEC provided a test harness for loading the ballot data for these artificial electoral events into ECS. This is a combination of the Load Test Scenario functionality in ECS and a SQL script for clearing the database between electoral events.

This data loading process is different to the mechanism to be used in production and different to the method used for the most recent few rounds of ECS NATA testing. This raised questions about whether a count based on data loaded by the test harness would always give the same result as data loaded via BPRS in production.

To examine this, IV&V Australia conducted a test harness validation activity, as follows:

- Executed an AEC-supplied test harness validation procedure, TC 64106. TC 64106 demonstrates that the developed Load Test Scenario data importer tool and the BPRS VCP Import Data function produces the same notional preferences, count results, and Distribution of Preferences report. This was demonstrated using 2016 ACT Federal Senate election data.
- Reviewed and free-played the associated SQL Clear script plus the two stored procedures it invokes, to show that it correctly reinitialised the database and did not appear to introduce any unintended side effects

There were no test step failures while running TC 64106 or in the SQL script review and there were no differences in the numbers in the reports; however, there were minor differences in the annotations in the reports.

It should be noted that there are differences between ECS using an electoral event loaded using Load Test Scenario and ECS using an electoral event loaded via BPRS. Whilst the final Count result appears to be identical, some minor uncertainty remains because:

- The two methods use different software to convert from the actual ballot data to the “Notional BTL Preferences” which raises the possibility that a software error in this area might pass the tests but introduce a Count error in production.
- Load Test Scenario cannot load informal ballot papers. This is a minor issue, as none of these artificial test scenarios included any informal ballot papers.
- The converted ballots are presented as coming from a single VCP, as opposed to the data loaded through BPRS that comes from multiple VCPs. As a consequence, ECS reports that the data loaded through Load Test Scenario leaves Unverified VCPs and that these are not being included in the count.

It should be noted that there is a minor weakness in the test harness validation method in that the conversion of the actual 2016 ACT Federal Senate ballots to the form required to load via Load Test Scenario is not itself validated.

SQL Compare Script

SQL Compare script was written to compare the ballot papers and count results in two databases. Typically, this was used to compare the results of the 2016 Federal Senate events

(counted using the version of ECS current at that time) with the results when the data was loaded through BPRS and counted with the new version of ECS.

The validation consisted of free-play testing, and the conclusion was that the script appears to correctly compare two ECS databases for: Ballot Paper Counts, Formal Ballot Paper Counts, Notional Preferences, Results, and Audit Trails.

[REDACTED]

2.2.4 Formal Test Activities

The formal NATA test event involved the following test activities:

- Test execution was done in two phases - a data capture phase followed by an analysis phase. The start and stop times for each phase were documented on the test logs for each test case.
- The data capture phase was conducted at AEC's Sydney premises on a combination of the DEV and PROD environments. Test environment information was captured in a number of screenshots and configuration files, which are discussed in Section 5 of this document. [REDACTED]
- The analysis phase was conducted at IV&V Australia's premises.
- The formal test executed a library of AEC-supplied Count and BPRS test cases, spreadsheets and data files. [REDACTED]
- All of the test cases were run on ECS software version 4.0.35.51606, and where relevant, BPRS software version 2.1.50.51128.
- All of the test cases required some adaptation and deviations during test execution. These were identified on the test log for the test case and are discussed in Section 2.3 of this document.
- ESRP checks (regression tests). During the 2016 NATA testing for the Senate Reform Project, three defects remained Open/Resolved at the completion of testing:
 - For this current version of ECS under test, ESRP-97 was again observed during normal testing but it is considered to be Resolved and did not cause a failure.
 - AEC advised that ESRP-84 and ESRP-95 cannot occur in the ECS version under test. IV&V conducted some free-play exploration around this functionality to create conditions as close as reasonably practical to those conditions. The issues were not observed and so it can reasonably be assumed that they have been fixed.
- All test cases Passed, with no failed steps.
- There were two issues reported to AEC. One was resolved by skipping an invalid test step and the other was a cosmetic issue with the Distribution of Preferences Report.
- The Pass/Fail test results for each test case are provided in Section 3 of this document.

- [REDACTED] These include:
 - The scanned test cases with pass/fail results and test step mark-ups
 - The test logs for each test case, with free-play steps documented
 - The reports generated during the data capture phase
 - ESRP free-play test checks
 - Test harness validation records
 - Correspondence on issues seen during testing.

The testing was conducted in accordance with IV&V Australia's testing process, which is accredited by the National Association of Testing Authorities, Australia (NATA) to be in compliance with *ISO 17025-2005 General requirements for the competence of testing and calibration laboratories*.

2.3 Conformance with Protocol

Testing was performed in conformance with the [REDACTED] with the following exceptions:

- *Two test execution phases.* Most tests were conducted in two phases. During the first phase, sufficient test steps were executed such that all of the reports required by any of the test cases were generated as a data capture activity. The second phase consisted of a subsequent analysis of the reports and verification of the results using those reports.
- *Test cases that had common setup steps.* Some Count test cases have similar setup steps to load the data file and run a count, with the differences being solely in the analysis of the reports generated.

The setup steps were confirmed to be correct for each test case, but the steps were not actually re-run. The test cases were grouped together on one test log, with an indication that the setup was performed at the start of the sequence.

- *Test cases that required adaptation to flow procedurally.* Some test cases had test steps which did not flow as written and required some adaptation during test execution to achieve the expected results.

Where these work-arounds occurred, the deviations were noted in the test logs. Care was taken to ensure that the intent of the tests was still met.

- *Test cases that required additional verification steps to improve test coverage* (eg, generating and analysing additional reports). These steps were executed as free-play steps and documented in the test logs.
- *Test steps that were not run.* TC 57039 had an incorrect test step that was skipped and test steps that relate to SSO were skipped.
- *Test cases that were duplicates of each other.* Some Count tests are essentially identical to each other, with only trivial differences in documentation detail. The test cases were grouped together on one test log, with an indication that as the first test passed, the others passed also.

2.4 Limitations with the Test Process

During the pre-formal test activities (ie, reviews, dry run), IV&V Australia raised a number of concerns regarding technical limitations and constraints with the test process and the test methods available for IV&V to use (as opposed to those used for previous projects).

The more critical elements of these were largely mitigated prior to the formal test. To summarise:

- *Limitations in test coverage.* The test case review found that there were a number of specific verifications removed from the Count test case suite (from the previous NATA testing), which weakened the suite. For the most part, IV&V Australia effectively remediated these limitations by free-playing extra steps during the tests to reinstate the verifications (using the previous tests as a guide). One previous test case (2.2.9) had to be omitted entirely because the test data was not available in the test environment.

With regards the BPRS test cases, IV&V's scope of work was largely to demonstrate that it is possible to import data through BPRS to ECS and have it counted as expected. The wider BPRS functionality was out of scope and IV&V did not have visibility into any other testing of this functionality (eg, negative tests).

- *Differences to the production environment.* Previous NATA testing of ECS has been done in environments that were set up by the AEC to be as close as practical to the real production environment in which ECS would run. For Counting the Senate testing, there were differences to the production environment which raised some concerns.

Whilst each of these differences is individually low risk, taken together they created uncertainty as to whether the test results are applicable to the final software run in a properly configured production environment.

- *Data loading.* The new method of data loading is different to how it will be in production and different to what has been done for the last few rounds of IV&V's ECS testing. The differences add minor potential for concealing a defect (see Section 2.2.3 Test Harness Validation).
- *Test environment.* This round of testing has involved some components running on "office" production PCs and on a PC in a DEV environment. The DEV environment had some non-production software loaded (eg SQL Server Management Studio). This raises the potential for defects that exist in the production environment to be missed when using the test configuration.

3. Detailed Test Results

This section presents the specific test results for each test case executed during testing. Note that a test case is considered to have passed if there were no failed steps.

The following convention has been used for the Comments:

- Deviation (DEV) - A test step deviation was needed to allow efficient execution of the tests.
- Doc (DOC) – A document amendment was necessary, usually due to a typographical error in the test steps.
- Note (NOTE) - Information (additional or as required by test procedure) is included in the test log.
- Free-play (FREE) – Additional verification steps were executed to improve test coverage (eg, generating and analysing additional reports).

The specific nature of the Comments is documented in the test logs.

Test Case/ Data	Title	Result	Comment
31697/ 2.2.6	Surplus Transfer - Two Elected with Same Vote; Electoral office determines the order of the election	Pass	NOTE, DEV, DOC
31699/ 2.1.1	First Preference Count - None Elected on First Count	Pass	DEV, NOTE, FREE
31702/ 2.1.1	Candidate Exclusion - Single exclusion causing a Single election, no Surplus (Count 2)	Pass	DEV
31703/ 2.1.1	Candidate Exclusion - Early Exclusion (Count 1)	Pass	DEV
31701/ 2.2.3.1	Surplus transfer causing two candidates elected on equal vote	Pass	NOTE, DEV
31704/ 2.1.2	First Preference Count - One Elected with Surplus (Count 1)	Pass	NOTE, DEV, DOC
31705/ 2.1.4	First Preference Count - Two Elected with Same Vote (Count 1)	Pass	NOTE, DEV
31709/ 2.2.5	Surplus Transfer - Two Elected with Different Vote	Pass	DEV, NOTE
31804/ 2.2.5	Surplus Transfer to candidate with no votes	Pass	DEV
31711/ 2.5.3	Last Elected During Transfer	Pass	NOTE, DEV
31712/ 2.7.2	Tie Resolution - Three Candidates tied for Exclusion; resolved by Count back	Pass	NOTE, DEV, DOC
31713/ 2.7.4	Tie Resolution - Three Candidates tied for Exclusion; resolved by Draw	Pass	NOTE, DEV
31714/ 2.6	Commencing and reporting on the Second Count	Pass	DEV, NOTE, DOC, FREE
31717/ 2.6	Change order of Election on second count	Pass	DEV, FREE
31715/ 2.6.2	Handling of Duplicates	Pass	NOTE, DEV, DOC



Test Case/ Data	Title	Result	Comment
31718/ 2.6.6	Election with less than a Quota	Pass	DEV, NOTE, DOC, FREE
31719/ 2.6.6	Multiple candidates elected with less than a Quota	Pass	DEV, DOC
32828/ 2.6.6	Candidates with same first preference (not in quota & how reported)	Pass	DEV, DOC
32829/ 2.6.6	No preferences for any of 12 candidates (not in quota and how reported)	Pass	NOTE
33418/ 2.6.6	Check quota is correctly calculated (only includes adjusted 1st preference votes)	Pass	NOTE
31720/ TraiNing	First Preference Count - Elected with No Surplus	Pass	DEV, NOTE
31721/ TraiNing	Surplus Transfer - Surplus Transfer at Count 2	Pass	DEV
31722/ TraiNing	Surplus Transfer - Newly Elected do not receive a Surplus Transfer	Pass	DEV
31723/ TraiNing	Candidate Exclusion - Single Elected with Multiple Transfer Values (Causing an Election on the First Transfer)	Pass	DEV
31724/ TraiNing	Candidate Exclusion - Exclusion with Multiple Transfer Values (Causing a Fractional Loss)	Pass	DEV, DOC
31726/ TraiNing	Candidate Exclusion - Exclusion with Multiple Transfer Values (single excluded candidate) Causing a Gain by a Fractional Count 8	Pass	DEV, DOC
31728/ TraiNing	Candidate Exclusion - Single Exclusion with Election	Pass	DEV
31729/ TraiNing	Candidate Exclusion - Single Exclusion with No Election	Pass	DEV
31748/ TraiNing	Tie Resolution - Two Candidates tied for exclusion; (resolved by Count Back)	Pass	DEV
31749/ TraiNing	Tie Resolution - Two Candidates tied for exclusion; (resolved by Draw)	Pass	DEV, DOC
31806/ 2.2.2	Surplus Transfer with Election	Pass	NOTE, DEV
32105/ 2.2.7	Surplus Transfer - Two Elected with Same Vote; Count back used to resolve it	Pass	NOTE, DEV
32314/ 2.7.5	Tie Resolution - Three candidates tied for last two vacancies	Pass	NOTE, DEV
32315/ 2.7.6	Tie Resolution - Two candidates tied for last vacancy	Pass	NOTE, DEV, DOC
32777/ 2.0.6	Preferences flows for full MATLs and no paper exhaustion	Pass	NOTE, DEV
32779/ 2.0.1	Preference flows for SATL and paper exhaustion	Pass	NOTE, DEV, FREE, DOC
32780/ 2.0.2	Preference flows for two preference MATLs and paper exhaustion	Pass	NOTE, DEV, DOC, FREE
32940/ 2.0.7	Preference flows for full BTL preferences	Pass	NOTE, DEV
32969/ 2.5.1	Ineligible candidate	Pass	NOTE, DEV



Test Case/ Data	Title	Result	Comment
32971/ 2.5.4	Quota calculation with votes exhausting at the first count	Pass	NOTE, DEV, DOC
57039	Counting Algorithm Tests - Running SQL Script to confirm matching Data for States that is Reconciled	Pass	NOTE, DEV, DOC
57190	End-to-End - Confirming Data from BPRS matches EasyCount	Pass	DEV, NOTE, FREE, DOC
57772	Counting Algorithm Tests - Running SQL Script to confirm result matches will change when VCP's from BPRS has changed	Pass	NOTE, DEV, FREE

4. Summary of Outstanding Issues

At the conclusion of formal testing, there are no Open issues.



5. Test Environment

The data capture testing phase was conducted at AEC's Sydney premises on a combination of the DEV and PROD environments. Test environment information was captured in a number of screenshots and configuration files. [REDACTED]

The test environment was configured and controlled by the AEC.

At the start of each test day, IV&V Australia confirmed that the environment and software under test were unchanged.

Items under test	EasyCount (ECS)	Version 4.0.35.51606
	BPRS	Version 2.1.50.51128

Config	PC ID	Specification	Operating System
1.	[REDACTED]	Intel Core i7-4790 CPU @ 3.60GHz; 8.00GB RAM	Windows 7 Enterprise SP1, 64-bit
Config 1 was used to access BPRS and to load data into BPRS. BPRS was running on a web server at [REDACTED] BPRS was accessed using Internet Explorer version 11.0. Data was loaded into the BPRS processing stream using WinSCP version 5.7.7.			
2.	[REDACTED]	Intel Xeon CPU E5-2680 0 @ 2.70GHz; 16.0GB RAM	Windows Server 2012 R2 Standard, 64-bit
Config 2 was used to run ECS and to run SQL scripts on the database. ECS and the SQL scripts access a SQL Server database instance running on server TST-SQL21-CG02. SQL scripts were run using SQL Server Management Studio version 10.50.6560.0. Reports generated by ECS were copied from the Config 2 desktop by AEC staff and emailed to IV&V Australia for analysis.			

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