Appendix 2E

Part 1

Validity of the Electronic Implementation of the Counting Rules – Dáil, European and Local Elections

THE POLICY INSTITUTE, TRINITY COLLEGE DUBLIN

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1 Summary

This strand is dedicated to testing if the counting software in the Integrated Election Software (IES) developed by NEDAP/Powervote is a faithful implementation of the Irish system as laid out in the Government's Count Requirements and commentary on Count Rules, for Dáil and Local Elections. We did this by writing our own counting software (henceforth to be known as the Coyle-Doyle implementation) and checking the results obtained by this against those obtained by version 131 of the IES software. The Coyle-Doyle count software was implemented by the TCD research team using the Government's specifications. It was developed independently of the IES system. It operates separately from the IES system and is functionally independent.

We used the three real election datasets (from the 2002 Dáil elections in the Meath, Dublin-North and Dublin-West constituencies) as well as a large number of artificial datasets, created by generating random votes and by manually generating votes. The majority of our datasets were made up of random votes. In consultation with Prof. Michael Marsh and Dr. Ken Benoit from the Political Science Department in TCD, a set of interesting or difficult count scenarios were identified. Many of these arose naturally in the randomly generated poll. For those that did not, synthetic datasets of votes were created that embodied those scenarios.

The two systems were in complete agreement in the majority (approximately 99.9%) of the tested scenarios. However, divergences in the number of votes allocated to candidates during surplus distributions were observed in a number of elections. **These results show that the counting software in version 131 of the IES developed by NEDAP/Powervote is not a completely faithful implementation of the Irish system as laid out in the Government's Count Requirements and commentary on Count Rules, for Dáil and Local Elections.**

1.1 Recommendations

- The error in the version 131 of IES counting implementation should be corrected. Given that this error survived the software development and testing process, it would be instructive to look at the source code that produced this bug. The existence of this error raises questions about the coding and testing practises involved in the development of the system.

- The counting of future elections can be validated by an independent implementation. Therefore, we recommend that after every future election the mixed and numbered votes are made available so the result may be verified.

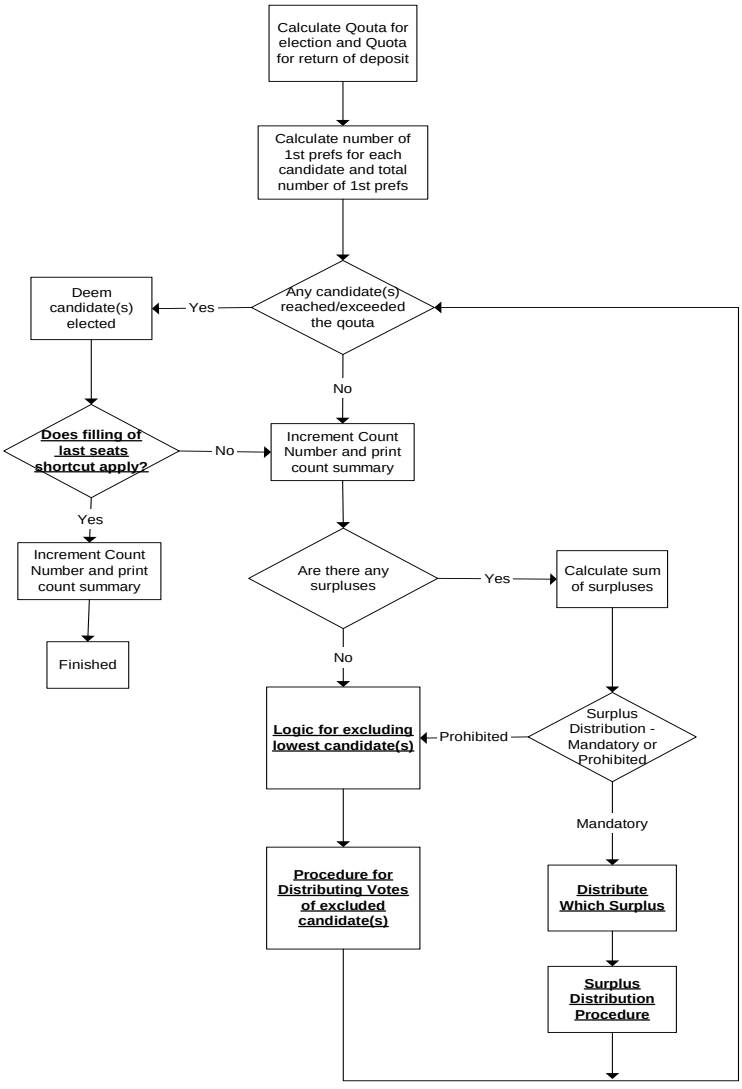
- If the Commission feels that the level of testing performed by the TCD research team is appropriate, then this level of testing should be performed on the actual build used in the election.

2 The Coyle-Doyle Implementation of PR-STV

The rules for an STV count were made available to us in the Government's Count Requirements and commentary on Count Rules. As a first step we produced a set of flowcharts that describe the logic of the count rules. The high level flowchart is shown in Figure 1. Appendix C contains more in-depth lower level flow charts.

The logic described in these flowcharts was implemented in the Java programming language by Lorcan Coyle and Dónal Doyle (henceforth to be known as the Coyle-Doyle implementation). This implementation returns an election result and also tracks the allocation of every vote at every count in an election. This allows us to confirm if the Integrated Election Software (IES) performed correctly at the granularity of individual votes as well as the overall election result. When testing the IES on an election dataset, the TCD research team test that the Coyle-Doyle implementation behaves exactly the same at every granularity.

Figure 1. A high level flowchart of the election logic



3 Tests on the three 2002 Dáil Election counts

The first tests of the IES were performed on the three e-voting 2002 Dáil election datasets. These datasets are publicly available and were provided to the TCD research team by the Commission on

Electronic Voting on CD ROM. The Coyle-Doyle implementation was found to produce the same result as the IES at every granularity (henceforth this will be seen as a successful test on a dataset). Summary tables showing the overall election results of the two versions of these counts are shown in Appendix D.

These tests confirm that the three 2002 e-voting Dáil elections were counted correctly by the IES. The counting of future elections can also be validated in this way provided the mixed and numbered votes are made available.

3.1 Volume testing and interesting count situations

From an analysis of the counting algorithm one can determine a number of interesting or difficult situations that can occur in a count. In consultation with Prof. Michael Marsh and Dr. Ken Benoit from the Political Science Department in TCD, further sets of interesting situations were identified. One example of this would be deciding which candidate to eliminate when two or more lowest candidates have an equal number of votes.

There are only three real Irish e-voting datasets in existence. In order to further test the IES counting implementation further artificial datasets were created. There were two types of testing performed; volume tests with random data, and testing for specific counting situations. During the volume testing many of the interesting situations we identified arose. In order to test situations that did not occur in the volume testing specific synthetic datasets were manually created. A list of interesting situations is shown in Appendix A.

A total of 12148 datasets were created; 5030 European election datasets, 5473 Local Election datasets and 1645 Town Council Election Datasets. The performance of the IES counting implementation was validated against the Coyle-Doyle implementation and confirmed to be in complete agreement in the majority (approximately 99.9%) of the tested scenarios. However, divergences in the number of votes allocated to candidates during surplus distributions were observed in a number of elections (six Local Elections and one European Election). Inspections showed that these divergences are due to an error in the IES implementation.

These results show that version 131 of the counting software in the IES developed by NEDAP/Powervote is not a completely faithful implementation of the Irish system as laid out in the Government's Count Requirements and commentary on Count Rules, for Dáil and Local Elections.

4 Failures in the IES counting implementation

The divergences in election counts between the IES system and the Coyle-Doyle system occur intermittently during the distribution of surpluses, specifically in the distribution of surpluses where the number of transferable votes is larger than the surplus itself (described in detail in the Government's Count Requirements and Commentary on Count Rules, Section 7 subsection 3). The following two paragraphs outline the Government's description of the part of the procedure that is pertinent to this discussion.

> *This surplus distribution is dependent on a transfer factor. The transfer factor is defined as the number of votes in the surplus divided by the total number of transferable votes in the "last set of votes". This transfer factor is multiplied in turn by the total number of votes in*

each sub-set of next available preferences for continuing candidates (note that the transfer factor is not applied to the sub-set of non-transferable votes in the "last set of votes"). The number of units (disregarding remainders) in the resulting quotient for each sub-set is the number of votes from that sub-set which should be included in the surplus distribution.
If the total number of units in all the quotients is less than the surplus, the remainders in the quotients must be examined. In this situation, the number of votes for inclusion in the surplus distribution from particular sub-sets is increased by one each based on "the highest remainders" in the quotients, until the difference between the total number of units and the surplus is made up. By way of example, if the total number of units in all the quotients is five less than the surplus, the sub-sets with the five highest remainders in their quotients each contribute an additional vote to the surplus distribution.

Errors occur as a result of the representation of the transfer factor. Figure 2 is a section of a printout from the IES system of one of our randomly generated elections where this error manifests itself (specifically in the surplus distribution of the sixth count). From this Figure, we can see that the transfer factor is defined as 52/180. Commonly, fractions are represented in code as floating point numbers, i.e. 52/180 could be represented as 0.28888888888888886. In our example, Candidate D has 45 next available preferences from the set of transferable votes, so when 45 is multiplied by the floating point transfer factor the result is 12.999999999999998. The most common way of getting the number of units in the resulting quotient for each subset is to disregard the remainder. In this example IES has disregarded .999999999999998 leaving a result of 12. Clearly the result of 45*52/180 is exactly 13, but due to the fact that the transfer factor was represented as a floating point number, fidelity was lost.

Surplus Distribution: Sixth Count

Poll: County or City Council **Date of Poll: Friday 11 June 2004**
Constituency: Co. Wicklow-Arklow LEA **Number of seats: 5**
Candidate: B Candidate **Last set of votes:**
Votes in surplus: 52 Total: 222
Surplus arose in count: 5 Non-Transferable: 42
Transferable: 180
Transfer factor: 52/180

Candidate	Transferables in last set	Transfers by units	Remainder /180	Ranking of remainders	Transfers by remainder	Total transfers
Candidate, C,	52	15	4		0	15
Candidate, D,	45	12	0		0	12
Candidate, F,	42	12	24	2	1	13
Candidate, G,	41	11	152	1	1	12
Total	180	50			2	52

Number of unfilled seats: 3
Number of continuing candidates: 4

Figure 2. A printout from the IES system which shows an error in the transfer of surplus votes

If Candidate D is allocated 12 transfer votes there are 2 remaining votes (rather than 1 vote) to be transferred. The algorithm transfers 2 votes based on "*the highest remainders*", thus candidates G and F are both allocated an additional vote. The net result of this error is that a vote that should be transferred to candidate D is transferred to candidate F instead. **Clearly this shows that the counting software in version 131 of the IES developed by NEDAP/Powervote is not a fully faithful implementation of the Irish system under these circumstances.**

The problems inherent with dealing with precision in floating point numbers are well documented, and can be avoided by using appropriate software techniques. This raises questions about the quality of previous testing as this is the only point in the algorithm where floating point numbers are needed.

5 Miscellaneous software and usability issues

Two further issues were found during the testing of the IES software:

- As the software is changed, new "builds" are issued. Our tests are only valid in the context of the software build that the team have tested. Clearly the important software to test is that which will be used on Election Day. We were initially issued with build 126. We were subsequently issued with build 131 and performed our testing on this build. **If it is felt that the level of testing that the research team have performed is appropriate then this level of testing should be performed on the actual build used in the election.**

- After an election has been counted by the IES, it is possible to export a summary of every count in the election. However, the TCD research team found that in situations involving tied candidates the software failed to export these summaries. Although the summaries cannot be exported, they can be viewed on screen and are correct. It should be noted that this is not an error in the count accuracy.

Appendix A List of interesting situations tested in the IES

Surplus Distributions

- Surplus distributions
    - Where the number of transferable votes are less than the surplus
    - Where the number of transferable votes are equal to the surplus
    - Where the number of transferable votes are more than the surplus
- Surplus votes are distributed using the transfer factor and multiple candidates have equal remainder quotients
    - Where the number of votes to be transferred is different
    - Where the number of votes to be transferred is equal and the candidates have different numbers of votes at an earlier count
    - Where the number of votes to be transferred is equal and the candidates have the same numbers of votes at every earlier count – this can only be resolved by the drawing of lots
- Candidates tied with equal surpluses
- Undistributed Surpluses – this occurs when a surplus or surpluses are too small to affect the outcome of the election
- Multiple Candidates elected with surpluses where
    - A surplus is distributed
    - No surpluses are distributed

Candidate Eliminations

- Elimination of a single candidate when there are available surpluses (but this surplus is too small to affect the outcome of the election)
- Elimination of multiple candidates in a single count
- Elimination of a candidate when the bottom two candidates have equal votes, including:
    - Situations where the bottom candidates have different numbers of votes at an earlier count
    - Situations where this occurs after the first count – this can only be resolved by the drawing of lots
    - Situations where the bottom candidates have equal numbers of votes at every count – this can only be resolved by the drawing of lots

Miscellaneous

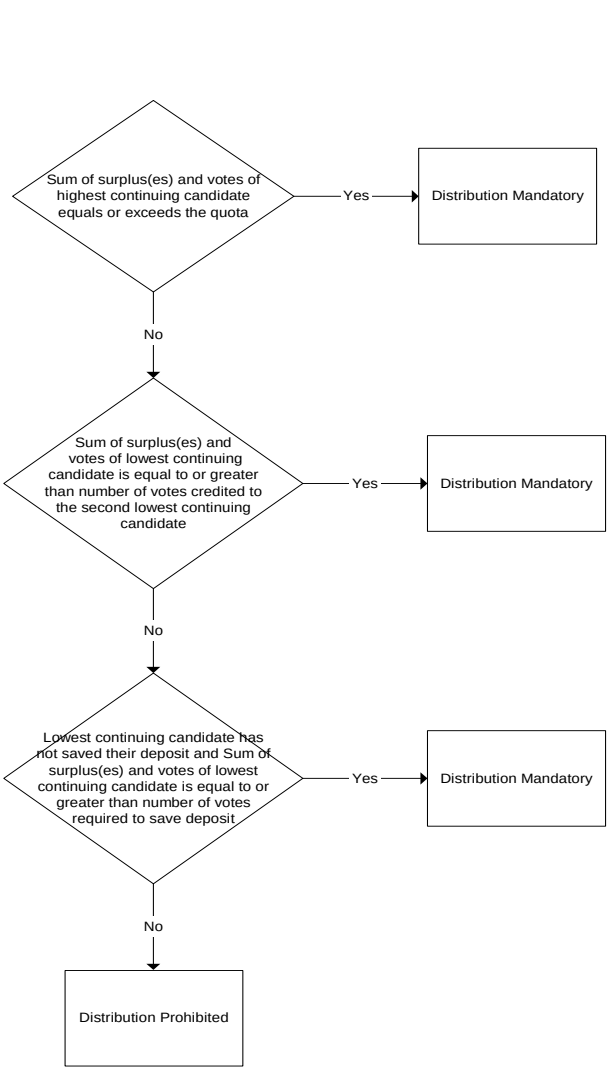
- Situations where all candidates have equal numbers of votes in the first count – this can only be resolved by the drawing of lots
- All candidates receive only first preferences including:
    - Situations where all candidates receive the same number of first preferences

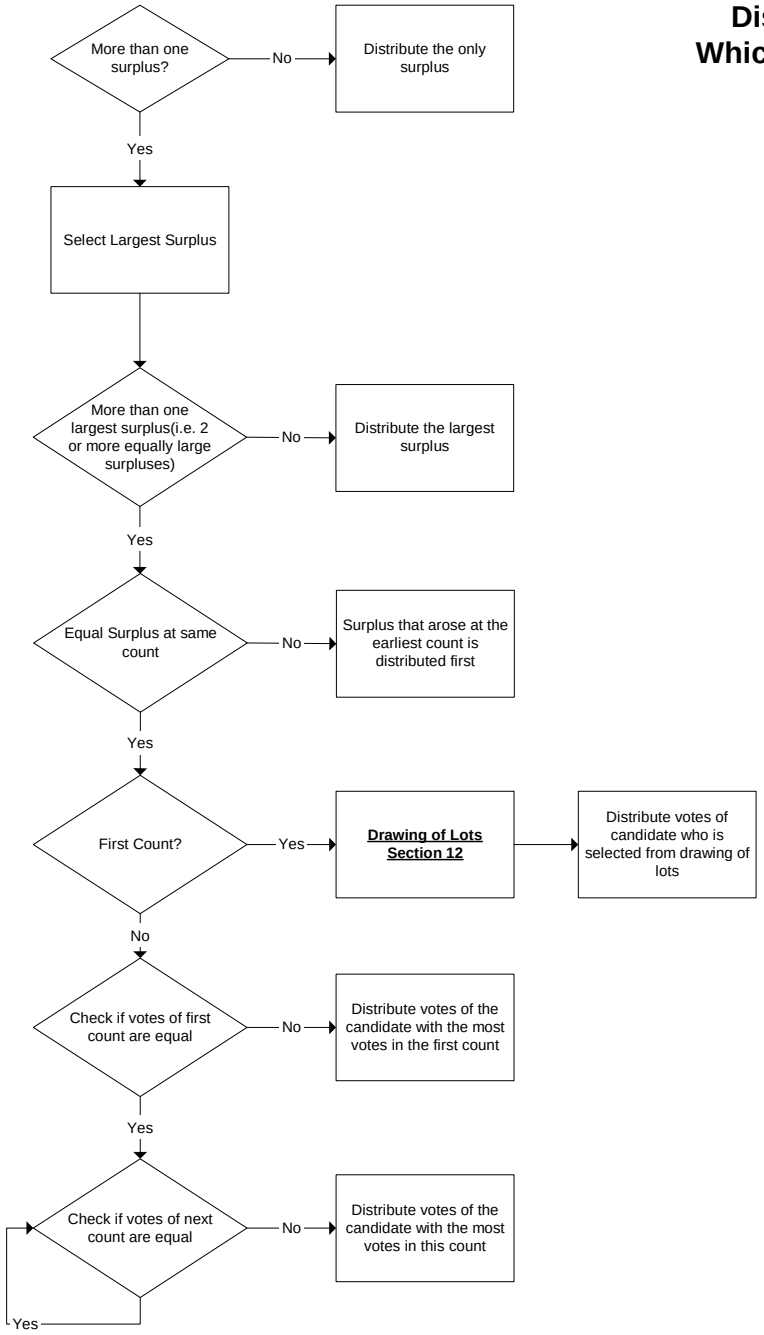
Situations where no votes have a full selection of preferences (i.e. preferences from 1 to the number of candidates)

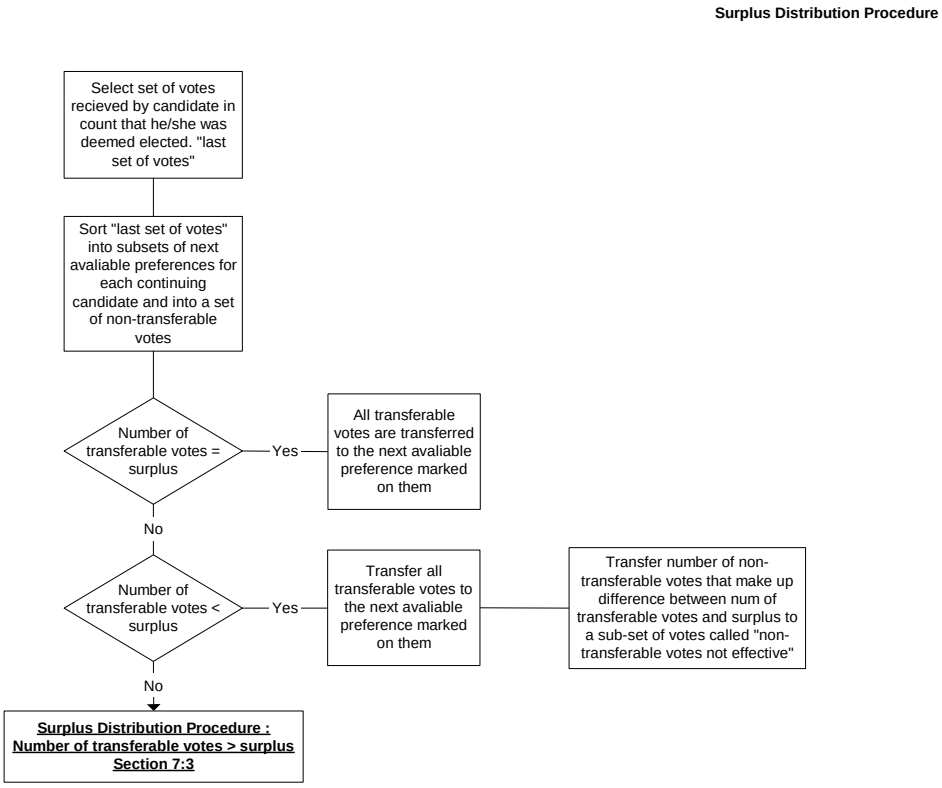
Appendix B Referenced documents

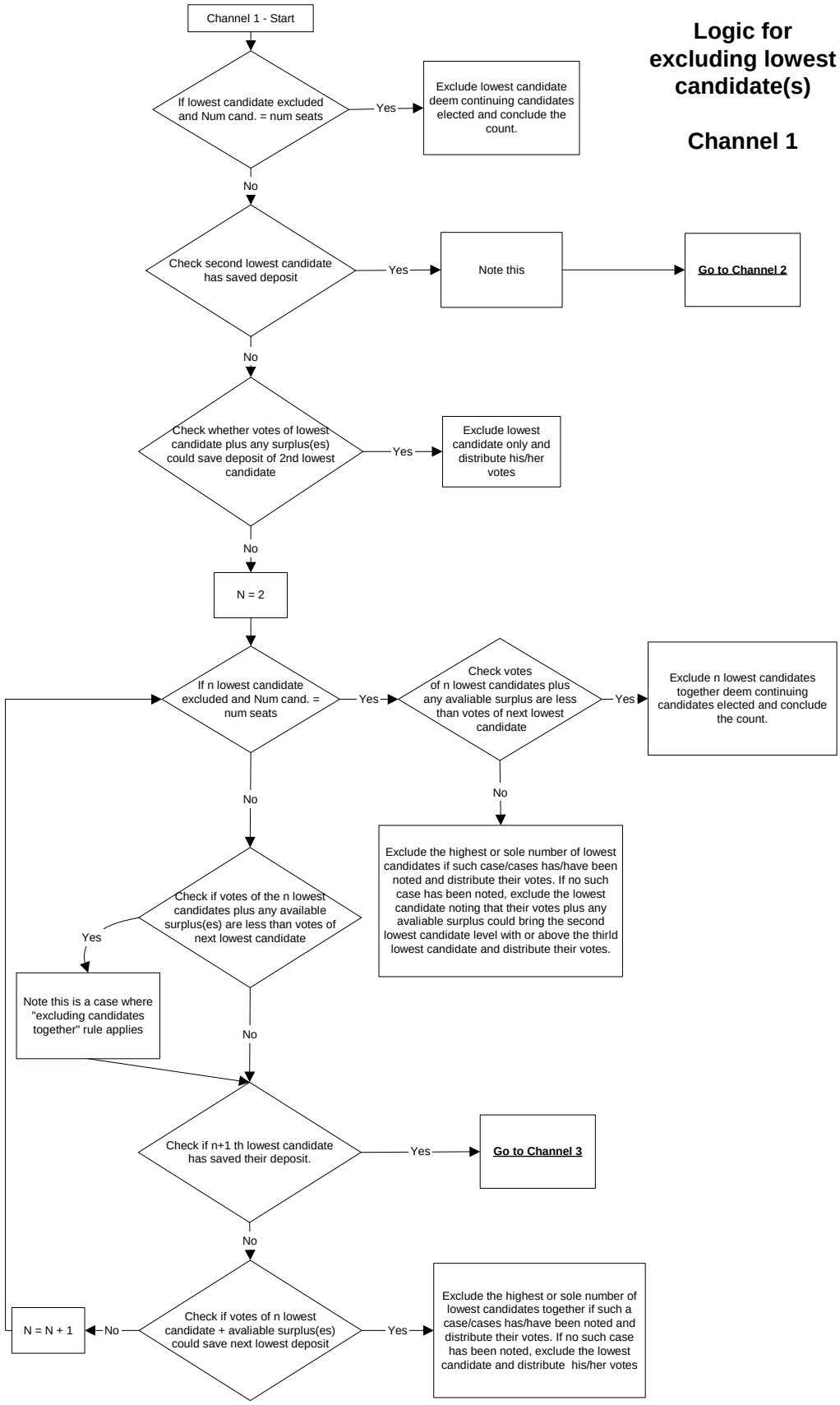
No.	Company	Title	Date
1	PTB	*Test Report*	20-03-2003
2		*Test Report 2*	17-09-2003
3		*Software Requirements for Voting Machines*	18-03-2003
4		*Test Report*	08-09-1998
5	Zerflow	*Electronic Voting Security Assessment*	27-03-2002
6		*Review*	04-07-2003
7	TNO	*Test Report: Program Reading Unit Model ESI 1*	28-10-2003
8		*Test Report: Voting Machine Type ESI 2 (Standards IEC 60839-1-2, etc)*	30-06-2003
9		*Test Report: Voting Machine Type ESI 2 (Standards IEC 60839-1-3)*	29-10-2003
10		*Test Report: Voting Machine Model PRU (Standards EN 50082-2, etc)*	06-08-2003
11		*Test Report: Voting Machine Model PRU (Standards IEC 60068-2, etc)*	08-08-2003
12	KEMA	*Certificate No. 2028725.01 issued to NEDAP*	20-06-2003
13	Nathean	*Architectural Assessment and Code Review of IES for use at June 2004 Elections*	23-12-2003
14		*Code Review of IES Build 0111*	23-12-2003
15	ERS	*Software Validation Report*	15-12-2003

Appendix C Detailed flowcharts of the PR-STV algorithm



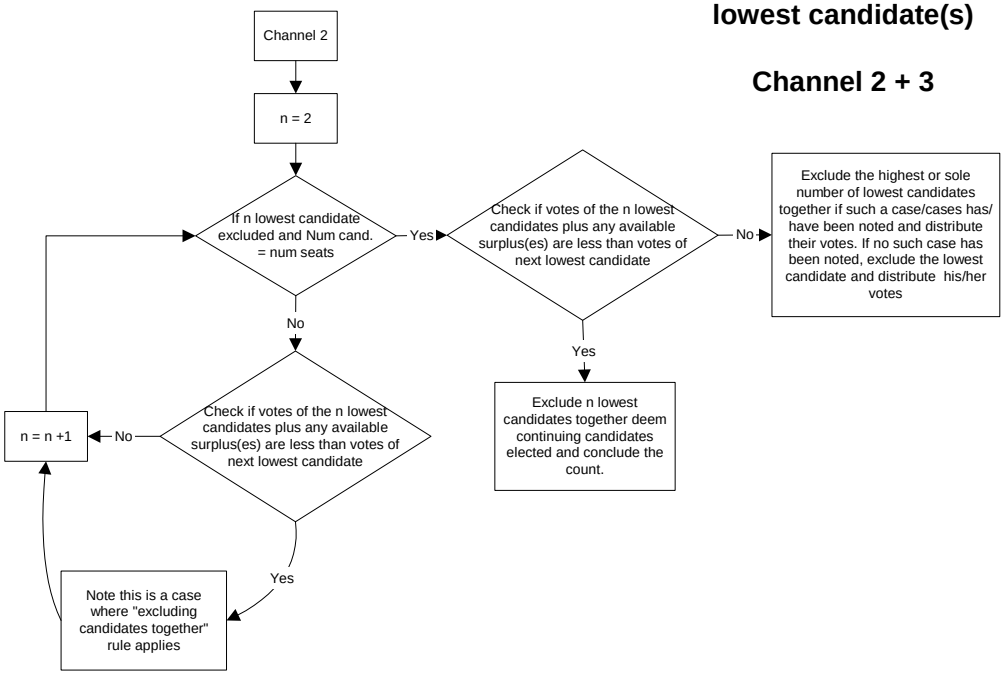

Distribute Which Surplus
More than one surplus?
No
Distribute the only surplus
Yes
Select Largest Surplus
More than one largest surplus(i.e. 2 or more equally large surpluses)
No
Distribute the largest surplus
Yes
Equal Surplus at same count
No
Surplus that arose at the earliest count is distributed first
Yes
First Count?
Yes
Drawing of Lots Section 12
Distribute votes of candidate who is selected from drawing of lots
No
Check if votes of first count are equal
No
Distribute votes of the candidate with the most votes in the first count
Yes
Check if votes of next count are equal
No
Distribute votes of the candidate with the most votes in this count
Yes

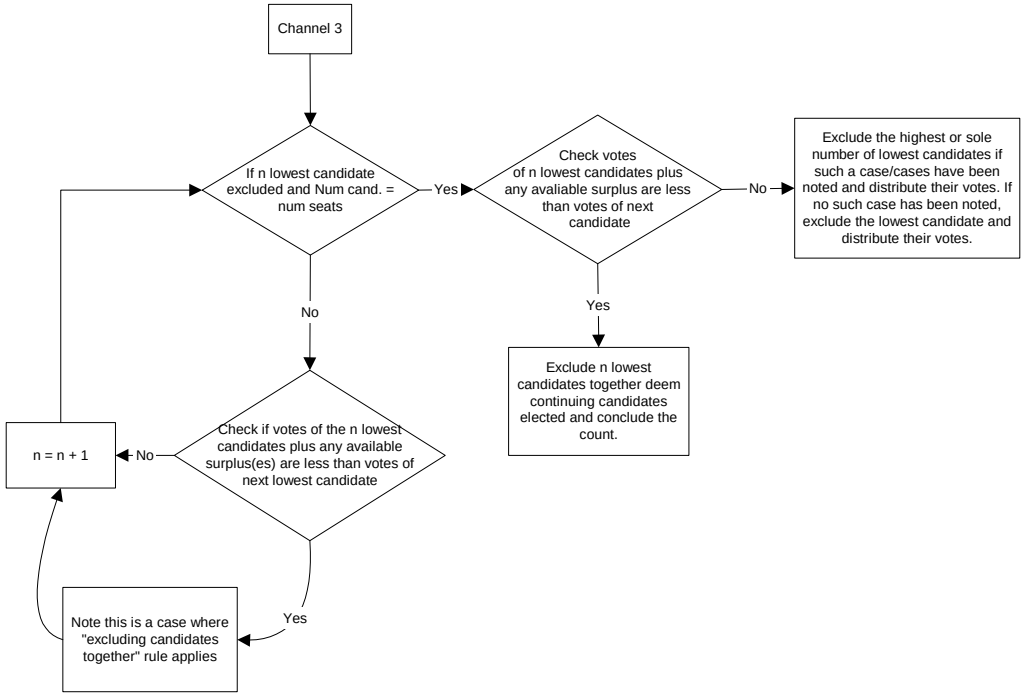

Surplus Distribution Procedure
Select set of votes recieved by candidate in count that he/she was deemed elected. "last set of votes"
Sort "last set of votes" into subsets of next avaliable preferences for each continuing candidate and into a set of non-transferable votes
Number of transferable votes = surplus
Yes
All transferable votes are transferred to the next avaliable preference marked on them
No
Number of transferable votes < surplus
Yes
Transfer all transferable votes to the next avaliable preference marked on them
Transfer number of non-transferable votes that make up difference between num of transferable votes and surplus to a sub-set of votes called "non-transferable votes not effective"
No
Surplus Distribution Procedure : Number of transferable votes > surplus Section 7:3

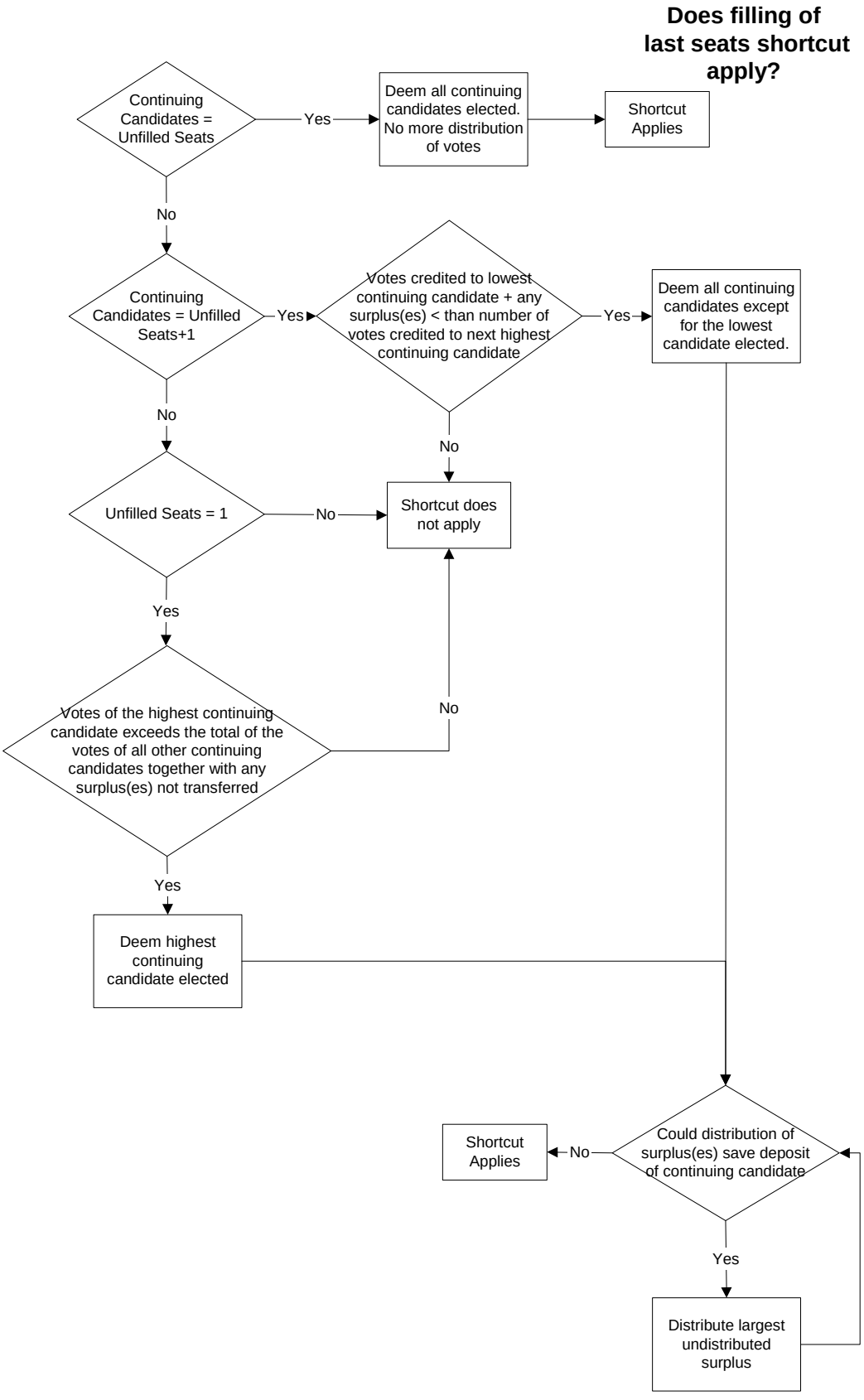

Logic for excluding lowest candidate(s)
Channel 1
Channel 1 - Start
If lowest candidate excluded and Num cand. = num seats
Yes
Exclude lowest candidate deem continuing candidates elected and conclude the count.
No
Check second lowest candidate has saved deposit
Yes
Note this
Go to Channel 2
No
Check whether votes of lowest candidate plus any surplus(es) could save deposit of 2nd lowest candidate
Yes
Exclude lowest candidate only and distribute his/her votes
No
N = 2
If n lowest candidate excluded and Num cand. = num seats
Yes
Check votes of n lowest candidates plus any avaliable surplus are less than votes of next lowest candidate
Yes
Exclude n lowest candidates together deem continuing candidates elected and conclude the count.
No
Exclude the highest or sole number of lowest candidates if such case/cases has/have been noted and distribute their votes. If no such case has been noted, exclude the lowest candidate noting that their votes plus any avaliable surplus could bring the second lowest candidate level with or above the thirld lowest candidate and distribute their votes.
No
Check if votes of the n lowest candidates plus any available surplus(es) are less than votes of next lowest candidate
Yes
Note this is a case where "excluding candidates together" rule applies
No
Check if n+1 th lowest candidate has saved their deposit.
Yes
Go to Channel 3
No
Check if votes of n lowest candidate + avaliable surplus(es) could save next lowest deposit
Yes
Exclude the highest or sole number of lowest candidates together if such a case/cases has/have been noted and distribute their votes. If no such case has been noted, exclude the lowest candidate and distribute his/her votes
No
N = N + 1

Logic for excluding lowest candidate(s)

Channel 2 + 3






Does filling of last seats shortcut apply?
Continuing Candidates = Unfilled Seats
Yes
Deem all continuing candidates elected. No more distribution of votes
Shortcut Applies
No
Continuing Candidates = Unfilled Seats+1
Yes
Votes credited to lowest continuing candidate + any surplus(es) < than number of votes credited to next highest continuing candidate
Yes
Deem all continuing candidates except for the lowest candidate elected.
No
No
Unfilled Seats = 1
No
Shortcut does not apply
Yes
Votes of the highest continuing candidate exceeds the total of the votes of all other continuing candidates together with any surplus(es) not transferred
No
Yes
Deem highest continuing candidate elected
Shortcut Applies
No
Could distribution of surplus(es) save deposit of continuing candidate
Yes
Distribute largest undistributed surplus

Appendix D Details of the check of the 2002 counts

Dublin North

The following tables present the results of the Meath 2002 count on the IES and Coyle-Doyle software. The table shows that the counts tally at the count level. In fact, they tally at the level of individual votes (i.e. vote id's match).

Integrated Election Software - Dublin North 2002 - 4 Seats

Votes Cast : 43942 Quota : 8789 Required to recoup election expenses : 2198

Candidate Name	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Result
Boland, Cathal, F.G.	1177	1189	1216	0	0	0	0	0	Excluded
Daly, Clare, S.P.	5501	5551	5730	5796	6244	6590	6772	7523	Excluded
Davis, Mick, S.F.	1350	1382	1424	1440	0	0	0	0	Excluded
Glennon, Jim, F.F.	5892	5945	6028	6152	6294	6511	6596	8640	Elected
Goulding, Ciaran, Non-P	914	1009	0	0	0	0	0	0	Excluded
Kennedy,Michael, F.F.	5253	5309	5368	5422	5532	5732	5801	0	Excluded
Owen, Nora, F.G.	4012	4030	4132	4720	4763	0	0	0	Excluded
Quinn, Eamonn, Non-P	285	0	0	0	0	0	0	0	Excluded
Ryan, Seán, Lab	6359	6407	6535	6665	6847	8578	9128	9128	Elected
Sargent, Trevor, G.P.	7294	7380	7678	7818	8118	9785	8789	8789	Elected
Walshe, David Henry, C.C. CSP	247	0	0	0	0	0	0	0	Excluded
Wright, G.V., F.F.	5658	5707	5739	5777	5868	6139	6249	8617	Elected
Non-transferable	0	33	92	152	276	607	607	1245	
	43942	43942	43942	43942	43942	43942	43942	43942	

Coyle-Doyle Implementation - Dublin North 2002 - 4 Seats

Votes Cast : 43942 Quota : 8789 Required to recoup election expenses : 2198

Candidate Name	Count 1	Count 2	Count 3	Count 4	Count 5	Count 6	Count 7	Count 8	Result
Boland, Cathal, F.G.	1177	1189	1216	0	0	0	0	0	Excluded
Daly, Clare, S.P.	5501	5551	5730	5796	6244	6590	6772	7523	Excluded
Davis, Mick, S.F.	1350	1382	1424	1440	0	0	0	0	Excluded
Glennon, Jim, F.F.	5892	5945	6028	6152	6294	6511	6596	8640	Elected
Goulding, Ciaran, Non-P	914	1009	0	0	0	0	0	0	Excluded
Kennedy,Michael, F.F.	5253	5309	5368	5422	5532	5732	5801	0	Excluded
Owen, Nora, F.G.	4012	4030	4132	4720	4763	0	0	0	Excluded
Quinn, Eamonn, Non-P	285	0	0	0	0	0	0	0	Excluded
Ryan, Seán, Lab	6359	6407	6535	6665	6847	8578	9128	9128	Elected
Sargent, Trevor, G.P.	7294	7380	7678	7818	8118	9785	8789	8789	Elected
Walshe, David Henry, C.C. CSP	247	0	0	0	0	0	0	0	Excluded
Wright, G.V., F.F.	5658	5707	5739	5777	5868	6139	6249	8617	Elected
Non-transferable	0	33	92	152	276	607	607	1245	
	43942	43942	43942	43942	43942	43942	43942	43942	

Dublin West

The following tables present the results of the Dublin West 2002 count on the IES and Coyle-Doyle software. As before, the table shows that the counts tally at the count level. Again, they tally at the level of individual votes.

Integrated Election Software - Dublin West 2002 - 3 Seats							
Votes Cast : 29988	Quota : 7498		Required to recoup election expenses : 1875				
Candidate Name	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**	**Count 6**	**Result**
Bonnie, Robert	748	0	0	0	0	0	Excluded
Burton, Joan	3810	4020	4079	4375	5125	6300	Elected
Doherty Ryan, Deirdre	2300	2386	2698	3056	3728	0	Excluded
Higgins, Joe	6442	6660	6731	7853	7853	7853	Elected
Lenihan, Brian	8086	8086	7498	7498	7498	7498	Elected
Mc Donald, Mary Lou	2404	2498	2524	0	0	0	Excluded
Morrissey, Tom	2370	2480	2554	2662	0	0	Excluded
Smyth, John Thomas	134	0	0	0	0	0	Excluded
Terry, Sheila	3694	3783	3829	3982	4863	5669	Excluded
Non-transferable		75	75	562	921	2668	
	29988	29988	29988	29988	29988	29988	

Coyle-Doyle Implementation - Dublin West 2002 - 3 Seats							
Votes Cast : 29988	Quota : 7498		Required to recoup election expenses : 1875				
Candidate Name	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**	**Count 6**	**Result**
Bonnie, Robert	748	0	0	0	0	0	Excluded
Burton, Joan	3810	4020	4079	4375	5125	6300	Elected
Doherty Ryan, Deirdre	2300	2386	2698	3056	3728	0	Excluded
Higgins, Joe	6442	6660	6731	7853	7853	7853	Elected
Lenihan, Brian	8086	8086	7498	7498	7498	7498	Elected
Mc Donald, Mary Lou	2404	2498	2524	0	0	0	Excluded
Morrissey, Tom	2370	2480	2554	2662	0	0	Excluded
Smyth, John Thomas	134	0	0	0	0	0	Excluded
Terry, Sheila	3694	3783	3829	3982	4863	5669	Excluded
Non-transferable		75	75	562	921	2668	
	29988	29988	29988	29988	29988	29988	

Meath

The following tables present the results of the Meath 2002 count on the IES and Coyle-Doyle software. As before, the table shows that the counts tally at the count level. Again, they tally at the level of individual votes.

Integrated Election Software - Meath 2002 - 5 Seats					
Votes Cast : 64081	Quota : 10681	Required to recoup election expenses : 2671			
Candidate Name	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**
Brady, Johnny	8493	8751	8787	8833	8879
Bruton, John	7617	7693	7725	7880	8121
Colwell, Jane	263	265	0	0	0
Dempsey, Noel	11534	10681	10681	10681	10681
English, Damien	5958	6019	6071	6139	6265
Farrelly , John V	3877	3892	3903	3937	3978
Fitzgerald, Brian	3722	3751	3807	3920	4105
Kelly, Tom	1373	1380	1403	1566	0
O' Brien, Pat	1199	1202	1244	0	0
O' Byrne, Fergal	2337	2353	2406	2630	2830
Redmond, Michael	180	181	0	0	0
Reilly, Joe	6042	6093	6144	6267	6385
Wallace, Mary	8759	9072	9104	9284	9645
Ward, Peter	2727	2748	2769	2844	2964
Non-transferable			37	100	228
	64081	64081	64081	64081	64081

Integrated Election Software - Meath 2002 - 5 Seats					
Votes Cast : 64081	Quota : 10681	Required to recoup election expenses : 2671			
Candidate Name	**Count 6**	**Count 7**	**Count 8**	**Count 9**	**Result**
Brady, Johnny	8987	9110	9577	9876	Elected
Bruton, John	8454	9148	10881	10881	Elected
Colwell, Jane	0	0	0	0	Excluded
Dempsey, Noel	10681	10681	10681	10681	Elected
English, Damien	6639	7376	8725	10154	Elected
Farrelly , John V	4052	4273	0	0	Excluded
Fitzgerald, Brian	4464	5139	5258	0	Excluded
Kelly, Tom	0	0	0	0	Excluded
O' Brien, Pat	0	0	0	0	Excluded
O' Byrne, Fergal	0	0	0	0	Excluded
Redmond, Michael	0	0	0	0	Excluded
Reilly, Joe	6710	7122	7348	8080	Excluded
Wallace, Mary	10007	10261	10374	11635	Elected
Ward, Peter	3595	0	0	0	Excluded
Non-transferable	492	971	1237	2774	
	64081	64081	64081	64081	

Coyle-Doyle Implementation - Meath 2002 - 5 Seats					
Votes Cast : 64081	Quota : 10681	Required to recoup election expenses : 2671			
Candidate Name	**Count 1**	**Count 2**	**Count 3**	**Count 4**	**Count 5**
Brady, Johnny	8493	8751	8787	8833	8879
Bruton, John	7617	7693	7725	7880	8121
Colwell, Jane	263	265	0	0	0
Dempsey, Noel	11534	10681	10681	10681	10681
English, Damien	5958	6019	6071	6139	6265
Farrelly , John V	3877	3892	3903	3937	3978
Fitzgerald, Brian	3722	3751	3807	3920	4105
Kelly, Tom	1373	1380	1403	1566	0
O' Brien, Pat	1199	1202	1244	0	0
O' Byrne, Fergal	2337	2353	2406	2630	2830
Redmond, Michael	180	181	0	0	0
Reilly, Joe	6042	6093	6144	6267	6385
Wallace, Mary	8759	9072	9104	9284	9645
Ward, Peter	2727	2748	2769	2844	2964
Non-transferable			37	100	228
	64081	64081	64081	64081	64081

Coyle-Doyle Implementation - Meath 2002 - 5 Seats					
Votes Cast : 64081	Quota : 10681	Required to recoup election expenses : 2671			
Candidate Name	**Count 6**	**Count 7**	**Count 8**	**Count 9**	**Result**
Brady, Johnny	8987	9110	9577	9876	Elected
Bruton, John	8454	9148	10881	10881	Elected
Colwell, Jane	0	0	0	0	Excluded
Dempsey, Noel	10681	10681	10681	10681	Elected
English, Damien	6639	7376	8725	10154	Elected
Farrelly , John V	4052	4273	0	0	Excluded
Fitzgerald, Brian	4464	5139	5258	0	Excluded
Kelly, Tom	0	0	0	0	Excluded
O' Brien, Pat	0	0	0	0	Excluded
O' Byrne, Fergal	0	0	0	0	Excluded
Redmond, Michael	0	0	0	0	Excluded
Reilly, Joe	6710	7122	7348	8080	Excluded
Wallace, Mary	10007	10261	10374	11635	Elected
Ward, Peter	3595	0	0	0	Excluded
Non-transferable	492	971	1237	2774	
	64081	64081	64081	64081	