

Functional specification for vote count

Using the Weighted
Inclusive Gregory
Method

Version 1.4

Document control

| | |
|--------------------------|--|
| Title: | Functional specification for vote count using WIGM |
| Author: | |
| Document purpose: | Defines the WIGM vote count algorithm for the PRCC count engine. This method of counting is to be used for Local Government Councillor elections as a result of legislative changes introduced in 2018. |

Change history

| Version | Revision date | Revision by | Reason for change |
|---------|---------------|-------------|--|
| 0.1 | 23/09/2019 | | Initial draft of the WIGM vote count algorithm for review. |
| 0.2 | 04/10/2019 | | Includes exclusion logic and incorporates feedback from received 2/10/2019. |
| 0.3 | 11/10/2019 | | Incorporates review comments from the Elections Division Results Team received on the 8/10/2019. |
| 1.0 | 15/10/2019 | | Include Traceability Matrix, mapping Vote Count Processing Steps to the LG regulations. |
| 1.1 | 08/11/2019 | | Remove processing steps relating to a Candidate's Elected Position. Candidates elected at the same count are to be elected simultaneously at the completion of the count. (Update Step 7, 8, 13, 9. Remove Step 37). |
| 1.2 | 16/12/2019 | | In Step 22 remove f). When calculating Count Totals there is no need to record Ballot Papers Set Aside = Quota when Candidate Surplus = 0 as this can be derived. |
| 1.3 | 27/02/2020 | | Incorporate items from Management's Response to the PWC Interim Report on WIGM. |
| 1.4 | 22/04/2020 | | Update Step 9 – Process Draw for Surplus Distribution and Step 26 – Process Draw for Exclusion to specify how draw results are determined when vote count results are required to be repeatable. Update Principle 2 and 5 in Section 2.2 as directed by the LGR Project Steering Committee. |

Distribution

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Acceptance

The undersigned have reviewed this document and hereby approves this document.

| Approver | Approval | Date |
|------------|----------|------------|
| [REDACTED] | | 15/10/2019 |
| [REDACTED] | | 15/10/2019 |

Key references

| Ref ID | Document | Author | Location |
|--------|--|------------|---|
| 1 | <i>Local Government (General) Amendment (Elections) Regulations 2018</i> | | https://gazette.legislation.nsw.gov.au/s/o/download.w3p?id=Regulation_2018_2018-749.pdf |
| 2 | <i>Local Government (General) Regulation 2005</i> | | https://www.legislation.nsw.gov.au/#/view/regulation/2005/487/sch5 |
| 3 | 1907 LGR Count Engine Requirements | [REDACTED] | [REDACTED] |
| 4 | Bogan 2016 WIGM Results Spreadsheet | [REDACTED] | [REDACTED] |

| Ref ID | Document | Author | Location |
|--------|---|------------|------------|
| 5 | Bogan 2016 WIGM Scenarios Spreadsheet | [Redacted] | [Redacted] |
| 6 | WIGM Scenarios – Test Conditions | [Redacted] | [Redacted] |
| 7 | Functional Requirements for PR Vote Count | [Redacted] | [Redacted] |
| 8 | Functional Requirements for OP Vote Count | [Redacted] | [Redacted] |
| 9 | PRCC Functional Specifications | [Redacted] | [Redacted] |
| 10 | LA Formality Rules for Data Entry | [Redacted] | [Redacted] |

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Introduction

The Local Government Regulations (2005) were updated as a result of legislative amendments introduced in December 2018. This included the adoption of the Weighted Inclusive Gregory Method of vote counting as outlined in Schedule 5 of the regulations. This vote count algorithm will be implemented in PRCC as the count engine for all Local Government Councillor Elections from 2020 onwards.

Document purpose

The functional specification for the WIGM vote count describes the PRCC count engine algorithm using a flow-chart that outlines the process steps required to distribute ballot paper preferences through a series of counts in order to determine the candidates that are to be elected. The purpose of this document is to form a clear and concise description of the count algorithm such that it can be used as the baseline for development, testing and certification.

Objectives

The document aims to provide sufficient information to enable the Elections Division Results Team to verify the PRCC count logic against Schedule 5 of the regulations, the Count Engine Business Requirements and the WIGM Results Spreadsheets for Bogan 2016 (Reference 4-6).

Scope

The PRCC system supports a number of different vote counting methods as prescribed by the legislative requirements of the different contest types. This document covers the WIGM Vote Count method used for Local Government Councillor Elections where 2 or more councillors are to be elected.

The PRCC Vote Count Functional Specifications for the other vote count methods used for Legislative Council Elections or Legislative Assembly Elections are documented separately in Reference 7 and 8 respectively.

Vote Count using WIGM

Overview

The main purpose of the vote count module is to fully process a Local Government Election Count in order to determine the candidates elected in accordance with the proportional representation counting method using WIGM.

The counting algorithm presented below is required to process the count and preference distribution from the keyed ballot paper preferences for the election. The process includes all the logic necessary for the distribution of preferences, calculation of candidate votes and disregarded fractions so that the required number of candidates is elected.

The method of counting votes for Local Government Elections is as directed by the Local Government (General) Amendment (Elections) Regulations 2018 (Reference 1). Legislation clauses and subclauses quoted in this document are sourced from the above mentioned legislation schedule references.

Where clarification of these regulations was required direction was provided by the Policy Working Group and documented in the Count Engine Business Requirements (Reference 3).

Guiding principles

The following guiding principles underpin the vote count algorithm:

1. The count **MUST** accurately reflect the intent of voters
2. The transfer of votes **MUST** be impartial. All papers should be treated the same
3. The count **MUST** be repeatable despite the minimal exposure to randomness due to the drawing of lots to settle tie-breaks under cl.13
4. The total of all votes across all "accounts" (continuing candidates, finally dealt with, exhausted, and disregarded fractions) **MUST** always equal the initial count for formal papers
5. Individual votes **MUST** never inflate nor deflate within legislative requirements, and will always be accounted for
6. Exhausted **MUST** always reflect the number (i.e. fraction) of votes "lost" from the count due to elector's preferences being exhausted. This includes an appropriate fraction of votes from when a candidate is elected with more exhausted votes than the quota
7. Without compromising the above, the system should be as "easy" to explain as possible
8. All of the above will be transparent, tracked, and verifiable.

Flow chart

The diagram below represents the sequence of steps to be followed to execute the vote count using the WIGM.

Figure 1

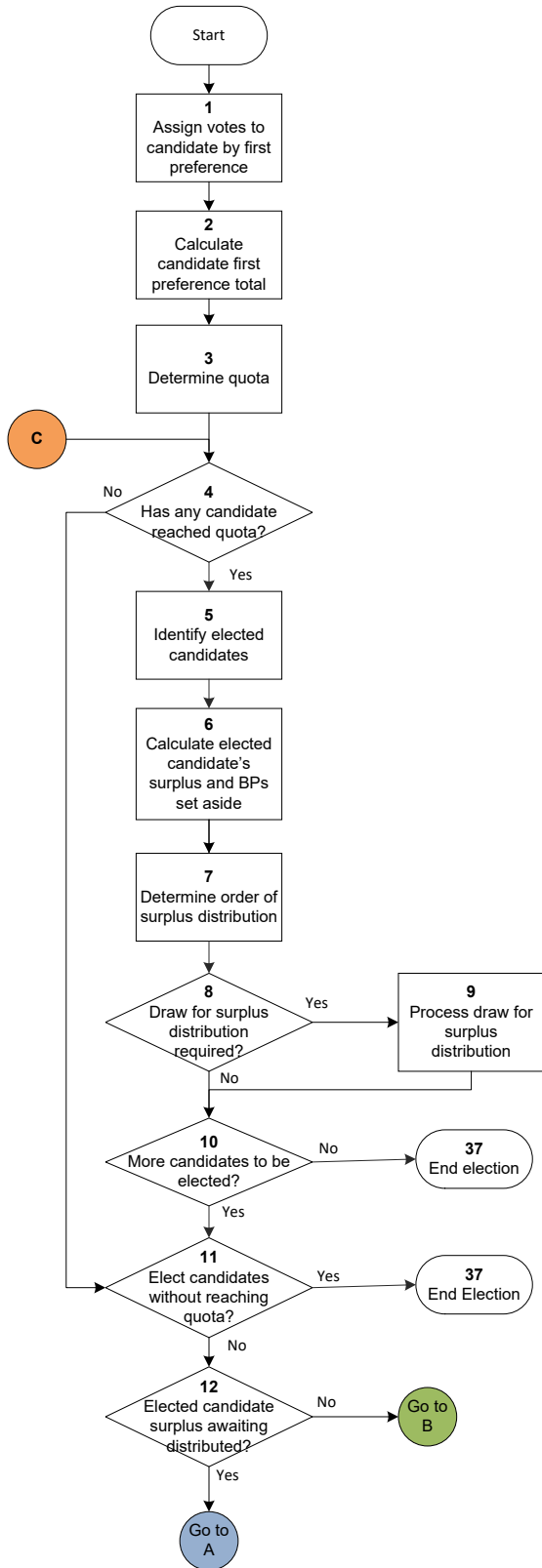
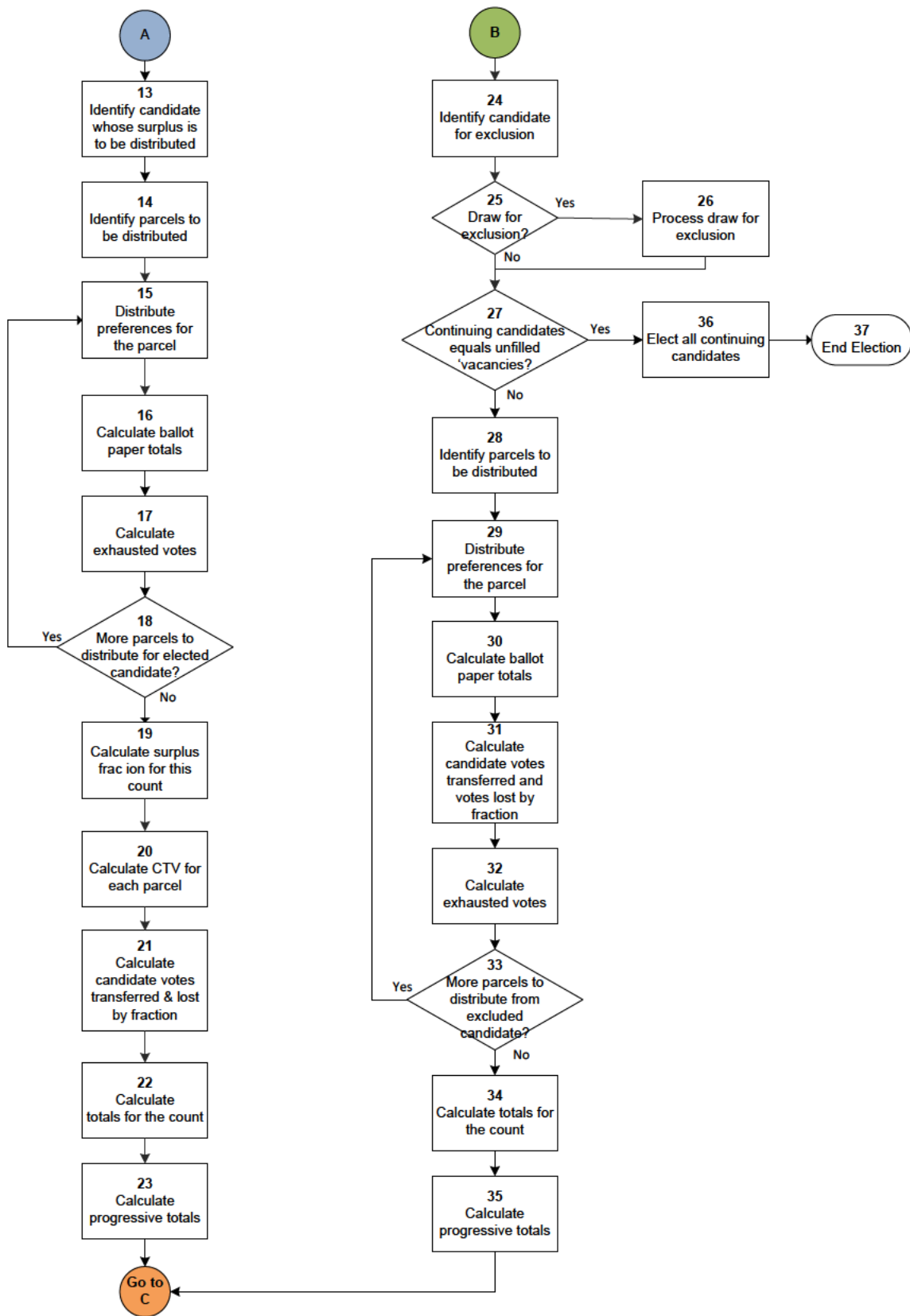


Figure 2



Vote counting method

The Vote Count Algorithm under the Weighted Inclusive Gregory Method of proportional representation vote counting is described below with reference to the steps presented in the flow chart in Figure 1 and Figure 2.

The algorithm is initiated manually once all ballot papers have been data entered and formality checking has been completed for an Election.

The process commences with the assignment of First Preference Votes (designated as Count 1) and continues with subsequent Preference Distributions (Subsequent Counts) until the required Number of Candidates has been elected.

The following information is required by the algorithm for each Election to be counted:

- a. Candidate details; at the beginning of the Count all Candidates are “Continuing”, unless they have been deemed “Ineligible” (e.g. if they have been elected as a Local Government Mayor)
- b. Number of Candidates to be Elected
- c. Number of Formal Votes
- d. Number of Informal Votes
- e. Valid Preference details for each ATL paper, converted into BTL preferences
- f. Valid Preference details for each BTL paper.

A ballot paper is exhausted when there is no next preference for a continuing candidate.

Step 1 – Assign votes to candidate by first preference

For each formal ballot paper, the vote is assigned to the candidate indicated as the first preference (i.e. marked with a number 1).

If this candidate is ineligible to receive votes the ballot paper is assigned to the candidate marked with the next preference (i.e. with the number 2) until an eligible candidate is determined.

If the vote cannot be assigned to an eligible candidate then this vote is exhausted.

Reference 1:

- *Clause 2 Definitions: Next Preference*
- *Clause 3 Count of first preferences*

Step 2 – Calculate Candidate First Preference Total

Each Candidate’s Total of First Preferences (their Progressive Total) is calculated by summing all votes assigned to them. This is the Candidate’s first parcel of ballot papers.

The Total Number of Exhausted Votes resulting from the first preference count is also calculated.

Reference 1:

- *Clause 3 Count of first preferences*
- *Clause 15 Records and publication of results: 15(1)(a), 15(1)(e), 15(1)(f)*

Step 3 – Determine quota

The quota represents the total number of votes sufficient to elect a candidate. The quota is calculated using the following formula:

$$\left(\frac{\text{Total Number of Formal Votes – Total Exhausted Votes on First Preferences}}{\text{Number of Candidates to be Elected + 1}} \right) + 1 = \text{Quota}$$

Any resultant fraction is ignored to obtain an integer value.

Reference 1:

- *Clause 2 Definitions: Quota*
- *Clause 4 Quota*

Step 4 – Has any candidate reached quota?

Each Candidate's current Progressive Total is compared to the Quota. If one or more Continuing Candidates have a Progressive Total greater than or equal to the Quota then continue at **Step 5**. Otherwise, continue at **Step 11**.

Reference 1:

- *Clause 5 Election on first preferences: 5(1), 5(2)*
- *Clause 10 Effect of reaching quota while transfers are proceeding: 10(1)*

Reference 3: Business Requirement WR1.6

Step 5 – Identify elected candidates

All Candidates whose current Progressive Total is greater than or equal to the Quota are elected.

Reference 1:

- *Clause 2 Definitions: Elected Candidate 2(a)*
- *Clause 5 Election on first preferences: 5(1)*
- *Clause 7 Surplus on transfer: 7(1), 7(3)*
- *Clause 10 Effect of reaching quota while transfers are proceeding: 10(1)*

Step 6 – Calculate elected candidate surplus and ballot papers set aside

The Surplus Votes to be distributed for each of these elected candidates is calculated by subtracting the number of votes needed for their election (i.e. the Quota) from the candidate's Progressive Total of Votes.

Surplus Votes for each elected candidate = Candidate's Progressive Total (Votes) – Quota.

If there are Candidates elected by reaching the Quota exactly then they do not have any Surplus Votes available to be distributed and all their ballot papers are to be Set Aside.

Reference 1:

- *Clause 2 Definitions: Surplus*
- *Clause 5 Election on first preference: 5(2)*
- *Clause 7 Surplus on transfer: 7(3)*
- *Clause 10 Effect of reaching quota while transfers are proceeding: 10(3), 10(4)*

Step 7 – Determine order of surplus distribution

The Candidates elected in this Count will have their surplus distributed in order of largest to smallest.

Candidates who were elected at a previous Count will have their surplus distributed before the Candidates elected at this Count even if the Candidates elected at this count have a larger surplus.

The order in which Elected Candidate's surpluses are distributed is recorded.

Reference 1: Clause 8 Transfer of surplus: 8(1), 8(2)

Step 8 – Draw for surplus distribution required?

If there are 2 or more Candidates with equal Progressive Totals that exceed the Quota, then the count process must be reviewed to go back and determine the Previous Count at which the Progressive Totals for these tied Candidates were last unequal and first distribute the Candidate with the highest Progressive Total at that point. The process continues at **Step 10**.

Otherwise, if the 2 or more Candidates have had equal Progressive Totals at all preceding Counts (including Count 1), then a draw must be conducted to determine the order of distributing surpluses for these Candidates. Proceed to **Step 9**.

Note: The assessment as to when these candidates first had an unequal number of votes is determined at the end of each Previous Count, rather than at the end of the distribution of individual Parcels.

Reference 1: Clause 8 Transfer of surplus: 8(3), 8(4)

Step 9 – Process draw for surplus distribution

The system will perform a Manual Draw or an Automatic Draw depending on the configuration setting specified for the Election Event. This setting is configured using the Maintain System Configuration function defined in Chapter 4 of the PRCC Functional Specifications (Reference 9).

For a manual draw the Count process will "pause" and the system will present the details of the Candidates with equal Progressive Totals to allow the manual draw procedure to take place. The Draw for Surplus Distribution function is defined in Chapter 6 of the PRCC Functional Specifications (Reference 9).

In the case of an automatic draw where the Vote Count is required to produce repeatable results (i.e. Configuration Parameter SubsequentRunRepeatable is set to True) the system will use the draw results from a previous Vote Count that has been run with the same eligible candidates as this Vote Count. Otherwise a random number generator to determine the outcome of the draw as defined by [Random Selection Processing](#).

Once the result of the draw is determined, the order in which each tied Candidate's surplus is distributed is recorded, at which point any outstanding identification of the surplus distribution order is completed and processing automatically continues.

The draw results are recorded within the database to ensure the vote count is repeatable and for reporting purposes.

Reference 1:

- *Clause 13 Deciding by lot: 13(2)*

Reference 3:

- *Business Requirement WR1.2*
- *Business Requirement WR1.3*

Step 10 – More candidates to be elected?

After candidates who have reached the quota have been elected, a check is performed to determine if all vacancies have been filled.

If the Total Number of Candidates Elected is equal to the Number of Candidates to be Elected, no further counting (processing) is required and the process is terminated at **Step 37**.

If there are unfilled vacancies then the counting process continues at **Step 11** to determine whether all vacancies can be filled by Continuing Candidates without having reached the quota.

Reference 1: Clause 11 Election without reaching quota 11(1)

Step 11 – Elect candidates without reaching quota?

Under certain conditions identified below, Continuing Candidates who have not reached the quota are elected to the remaining unfilled vacancies. These conditions could be satisfied even if there are outstanding Surpluses that are yet to be distributed.

Condition 1:

If the Number of Candidates Elected + Number of Continuing Candidates (who have not reached the quota) = Number of Candidates to be Elected, then all remaining candidates are elected.

Condition 2:

If only 1 unfilled vacancy remains and a Continuing Candidate has a Progressive Total which is greater than the total votes of all the other candidates remaining in the count + all un-transferred surpluses then that Candidate is elected without further exclusions taking place.

This is determined as follows:

Progressive Total for a Continuing Candidate >

$$\left(\begin{array}{l} \text{Sum of the Progressive Total for all other} \\ \text{Continuing Candidates} \end{array} + \begin{array}{l} \text{Surplus Votes not} \\ \text{Transferred} \end{array} \right)$$

Condition 3:

If there is more than 1 unfilled vacancy remaining then the Continuing Candidates are ordered in descending order of their Progressive Total and assigned to the unfilled vacancies in this order. If the votes of the Candidate assigned to the last vacancy is greater than all un-transferred surplus + the votes of all other continuing candidates who have fewer votes than that candidate then that candidate and the candidates who have a progressive total > than this candidate's progressive total are all elected without further exclusions taking place.

This is determined as follows:

Progressive Total for the Candidate Assigned to the Last Vacancy >

$$\left(\begin{array}{l} \text{Sum of the Progressive Total for Continuing} \\ \text{Candidates with Votes less than the Candidate} \\ \text{Assigned to the Last Vacancy} \end{array} + \begin{array}{l} \text{Surplus Votes not} \\ \text{Transferred} \end{array} \right)$$

Condition 4:

If there is 1 unfilled vacancy and 2 Continuing Candidates with the same Progressive Total remaining in the count and there are no un-transferred surpluses then determine whether a draw for exclusion is required.

Go back through the count process and determine the previous Count at which the Progressive Totals for these 2 were last unequal and exclude the Candidate with the lowest Progressive Total at that point and elect the remaining candidate. If the 2 Candidates have had equal Progressive Totals at all preceding Counts (including Count 1), then a draw must be conducted to determine the Candidate to be Excluded as per **Step 26**.

If any one of these conditions are satisfied and all vacancies have been filled then the counting process terminates at **Step 37**. Otherwise, the process continues at **Step 12** to determine whether a distribution of surplus votes or exclusion is performed.

Reference 1:

- *Clause 6 Surplus on first count: 6(2)*
- *Clause 7 Surplus on transfer 7(5)*
- *Clause 11 Election without reaching quota: 11(1), 11(2), 11(3), 11(4)*
- *Clause 9 Exclusion of lowest candidates: 9(4), 9(7)*

Step 12 – Elected candidate surplus awaiting distribution?

If there are candidates with an undistributed surplus then these Surplus Votes will be distributed to the Continuing Candidates. Proceed to **Step 13**.

If no *Surplus Votes* are available for distribution then the next Count must be an exclusion of the candidate with the lowest current Progressive Total and the distribution of their ballot papers to the continuing candidates. The process continues to **Step 24**.

Reference 1:

- *Clause 6 Surplus on first count: 6(1)*
- *Clause 7 Surplus on transfer: 7(4)*
- *Clause 9 Exclusion of lowest candidates: 9(1)*

Step 13 – Identify candidate whose surplus is to be distributed

The next count will be a distribution of the Surplus Votes of the candidate whose Surplus has not yet been distributed in accordance with the order of surplus distribution defined in Step 7 and Step 9.

Reference 1:

- *Clause 8 Transfer of surplus: 8(1), 8(2), 8(3), 8(4)*
- *Clause 15 Records and publication of results 15(1)(b)*

Step 14 – Identify parcels to be distributed

An Elected Candidate's ballot papers are distributed to the continuing candidates one parcel at a time.

These parcels may come from:

- a. the distribution of first preferences in Count 1;
- b. the distribution of parcels of ballot papers from an elected candidate's surplus; or
- c. the distribution of parcels of ballot papers from an excluded candidate.

For example in the Bogan 2016 WIGM Results Spreadsheet (Reference 4) NEIL received a total of 2 parcels by Count 5 when his surplus was to be distributed;

- **Parcel 1** containing 133 ballot papers was received in Count 1 from the first preference count.
- **Parcel 2** containing 49 ballot papers was received in Count 2 from the distribution of DONALD's 352 ballot papers that he received in Count 1.

Parcel 1 is distributed first as it was received by NEIL in Count 1 and then Parcel 2 is distributed.

Reference 1: Clause 15 Records and publication of results 15(1)(b)

Reference 3: Business Requirement WR1.4

Step 15 – Distribute preferences for the parcel

The ballot papers in each parcel are examined and the next preferred candidate indicated on the ballot paper is identified. If the candidate so indicated is an Eligible Continuing Candidate (i.e. not yet elected or excluded), then the ballot paper is distributed to that candidate.

If this candidate is Ineligible or not “continuing” then the next preferred candidate on the ballot paper is identified until the ballot paper is distributed to an Eligible Continuing Candidate.

If there is no next preference for a continuing candidate on the ballot paper, then the ballot paper is exhausted. If the next preference is duplicated or omitted as defined by the Ballot Paper Formality Rules in Reference 10 then the ballot paper is also exhausted.

Reference 1:

- *Clause 2 Definitions: continuing candidate*
- *Clause 6 Surplus on first count: 6(1), 6(1)(a)*
- *Clause 7 Surplus on transfer: 7(4), 7(5)*
- *Clause 12 Determining order of preference*
- *Clause 15 Records and publication of results 15(1)(b)*

Reference 3: Business Requirement WR1.4

Step 16 – Calculate ballot paper totals

Once the parcel has been distributed, calculate:

- the Total Ballot Papers distributed to each Continuing Candidate
- the Total Exhausted Ballot Papers.

Reference 1: Clause 15 Records and publication of results: 15(1)(b), 15(1)(c)

Step 17 – Calculate exhausted votes

Calculate the total number of Exhausted Votes for this parcel.

Total Exhausted Votes = Total Exhausted Ballot Papers x the transfer value at which the votes were transferred *in* to the Elected Candidate. Exhausted Votes are recorded with their fractional component.

A parcel received from a count of first preferences for the Elected Candidate has a Transfer Value of 1.

Reference 1:

- *Clause 7 Surplus on transfer: 7(6)*
- *Clause 15 Records and publication of results 15(1)(b), 15(1)(e)*

Step 18 – More parcels to distribute for elected candidate?

Have all the Elected Candidate’s parcels been distributed? If so then proceed to **Step 19** to calculate the Surplus Fraction for this Count.

Otherwise return to **Step 15** to distribute the next parcel of ballot papers.

Step 19 – Calculate surplus fraction for this count

The Surplus Fraction can only be calculated once all of the Elected Candidate's parcels have been distributed and the total number of exhausted votes determined.

The Surplus Fraction is calculated using the following formula:

$$\text{Surplus Fraction} = \frac{\text{Surplus Votes}}{\text{Candidate Votes} - \text{Aggregated Value of Exhausted Votes}}$$

The values used in the formula above are specific to the Elected Candidate whose surplus is to be transferred, where:

- Surplus Votes refers to the Elected Candidate's total Surplus Votes
- Candidate Votes is the total number of whole votes for the Elected Candidate, whose Surplus Votes are to be distributed
- Aggregated Value of Exhausted Votes refers to the sum of the votes exhausted at each parcel distribution, expressed as a fraction as determined in Step 17.

If the Surplus Fraction calculated is > 1 then it is to be set to 1. That is, when the Candidate's Surplus is greater than the number of votes to be transferred from the Elected Candidate, since Exhausted Votes cannot be transferred, the Surplus Fraction is set to 1.

Note: When distributing the surplus votes of a candidate elected on first preferences, the regulations refer to Transfer Value rather than the Surplus Fraction, clause 6(1)(b). However the calculation is the same.

Reference 1:

- *Clause 6 Surplus on first count: 6(1)(b)*
- *Clause 7 Surplus on transfer: 7(4)(a)*
- *Clause 15 Records and publication of results 15(1)(b)*

Step 20 – Calculate continued transfer value for each parcel

The Continued Transfer Value is used to determine the value at which the Elected Candidate's Ballot Papers are to be transferred **out** to the Continuing Candidates.

Continued Transfer Value is calculated using the following formula:

$$\text{CTV} = \text{Surplus Fraction} \times \text{the Transfer Value at which the ballot papers were transferred } \mathbf{in} \text{ to the Elected Candidate at a previous count}$$

A parcel received from a count of first preferences for the Elected Candidate has a Transfer Value of 1.

Reference 1:

- *Clause 7 Surplus on transfer: 7(4)(b)*
- *Clause 15 Records and publication of results 15(1)(b)*

Step 21 – Calculate Candidate Votes Transferred and Votes Lost by Fraction

For each parcel calculate the number of votes to be transferred to each Continuing Candidate.

Votes Transferred = Ballot Papers Distributed to the Continuing Candidate x Continued Transfer Value for the parcel. Any resultant fraction is disregarded so that the votes transferred is always an integer value.

The Disregarded Fraction for each Continuing Candidate is recorded separately and used to determine the Votes Lost by Fraction for this parcel.

Votes Lost by Fraction = the sum of all the Candidate Disregarded Fractions – the Disregarded Fraction Previously Accounted for (DFPA).

DFPA in a Surplus Distribution Count = the fraction that was disregarded when the Elected Candidate received the votes at a previous Count x Surplus Fraction for this Count.

Note: Candidates may reach the quota midway through the distribution of an elected candidate's ballot papers. However they will continue to receive votes until all of the elected candidate's parcels have been distributed as candidates are only elected at the end of the transfer.

This is illustrated in the Bogan 2016 WIGM Results Spreadsheet (Reference 4).

- a. at the end of Count 7 DOUGLAS has received 150 votes. The quota is 155.
- b. in Count 8.1, the distribution of MILLIGAN's ballot papers results in 19 votes being transferred to DOUGLAS. Even though MILLIGAN¹ now has enough votes to have exceeded the Quota he is not elected until after Count 8.7.6.3 once all of MILLIGAN's parcels have been distributed.

¹This document is referenced in the Certification of the PRCC Count Software. Following certification, this typographical error was noticed. To correct, it should read: Douglas.

Reference 1:

- Clause 6 Surplus on first count: 6(1)(c), 6(1)(d),
- Clause 7 Surplus on transfer: 7(2)
- Clause 15 Records and publication of results: 15(1)(a), 15(1)(b), 15(1)(c)

Step 22 – Calculate totals for the count

Once all of the Elected Candidate's parcels have been distributed and votes transferred to the continuing candidates the following totals are calculated:

- a. Total Ballot Papers received by each Continuing Candidate from all parcels distributed in this Count;
- b. Total Votes received by each Continuing Candidate from all parcels distributed in this Count;
- c. Total Disregarded Fractions for each Continuing Candidate from all parcels distributed in this Count;
- d. Total Exhausted Ballot Papers from all parcels distributed in this Count;
- e. Aggregated Exhausted Votes (AEV), calculated as the sum of all Exhausted Votes (Step 17) from all parcels distributed in this count;
- f. Total Votes Lost by Fraction from all parcels distributed in this Count;
- g. If the AEV > Quota then Votes Set Aside as Exhausted = AEV – Quota.

Balancing the votes distributed against the surplus

The Continued Transfer Value is used to transfer the votes at a reduced value such that the Total Votes Transferred to the Continuing Candidates + the Total Votes Lost by Fraction = the surplus, if enough votes show a next preference.

If the Aggregated Exhausted Votes **exceed** the Quota, a portion of the Exhausted Votes in excess of the Quota is Set Aside as Exhausted, calculated as $AEV - Quota$. These Exhausted Votes are added to the votes that make up the Elected Candidates Surplus, i.e. Total Votes Transferred to the Continuing Candidates + the Total Votes Lost by Fraction + Votes Set Aside as Exhausted = the surplus.

This is illustrated in the Count 4 of the Bogan 2016 WIGM Results spreadsheet (Reference 4).

In Count 4 RYANS's surplus for distribution is 22. In this count:

- 15 votes were transferred to the Continuing Candidates
- 7 votes were lost by fraction
- 0 votes were set aside as exhausted.

The sum of these votes is 22 which equals RYAN's surplus.

In Count 4 of the Bogan 2016 WIGM Scenario Spreadsheet (Reference 5) the Aggregated Exhausted Votes = 157.9091, exceeding the Quota of 155.

In this Count:

- 14 votes were transferred to the Continuing Candidates
- 5.0909 votes were lost by fraction
- 2.9090 votes were set aside as exhausted.

The sum of these votes is 22 which equals RYAN's surplus.

Reference 1: Clause 15 Records and publication of results 15(1)(a), 15(1)(b), 15(1)(c), 15(1)(f)

Step 23 – Calculate progressive totals

At the conclusion of this count the following new Progressive Totals are calculated:

- a. Continuing Candidate's new Progressive Total (BPs) =
Progressive Total brought forward from previous Count + BPs distributed at this Count
- b. Continuing Candidate's new Progressive Total (Votes) =
Progressive Total brought forward from previous Count + Votes transferred at this Count
- c. New Progressive Total for Exhausted Ballot Papers =
Progressive Total brought forward from previous Count + Exhausted BPs at this Count
- d. Total BPs in the Count = Sum of all Continuing Candidate's new Progressive Total (BPs) +
Exhausted Ballot Papers at this Count
- e. Total Votes in the Count = Sum of all Continuing Candidate's new Progressive Total (Votes)
- f. Total Ballot Papers Set Aside = Progressive Total brought forward from previous Count + Ballot
Papers Set Aside at this Count
- g. New Progressive Total for Votes Lost by Fraction = Progressive Total brought forward from
previous Count + Votes Lost by Fraction at this Count.
- h. New Progressive Total for Votes Set Aside as Exhausted = Progressive Total brought forward
from previous Count + Votes Set Aside as Exhausted at this Count.

A final check is performed to ensure that the Total Votes in the Count (e) + New Progressive Total for Votes Lost by Fraction (g) + New Progressive Total for Votes Set Aside as Exhausted (h) = the Total Formal Ballot Papers in the First Preference Count.

If these figures do not reconcile then display the error message, “An unexpected error has occurred in the vote count process. Contact your system administrator.” and terminate the count.

Reference 1:

- *Clause 6 Surplus on first count: 6(1)(d)*
- *Clause 15 Records and publication of results: 15(1)(a), 15(1)(b), 15(1)(c), 15(1)(f)*

Reference 3: Business Requirement WR1.5

Step 24 – Identify candidate for exclusion

The Candidate for Exclusion will be the Continuing Candidate with the lowest current Progressive Total.

Reference 1:

- *Clause 9 Exclusion of lowest candidate: 9(1)*
- *Clause 15 Records and returns of voting and transfers 15(1)(d)*

Step 25 – Draw for exclusion?

If there are 2 or more Candidates with equal lowest current Progressive Totals, then the Count process must be reviewed to go back and determine the previous Count at which the Progressive Totals for these tied Candidates were last unequal and Exclude the Candidate with the lowest Progressive Total at that point. The process continues at **Step 27** below in the Exclusion Logic.

If the 2 or more Candidates have had equal Progressive Totals at all preceding Counts (including Count 1), then a draw must be conducted to determine the Candidate to be Excluded. Proceed to **Step 26**.

Reference 1:

- *Clause 9 Exclusion of lowest candidate: 9(5)*
- *Clause 15 Records and publication of results 15(1)(d)*

Step 26 – Process draw for exclusion

The system will perform a Manual Draw or an Automatic Draw depending on the configuration setting specified for the Election Event. This setting is configured using the Maintain System Configuration function defined in Chapter 4 of the PRCC Functional Specifications (Reference 9).

For a manual draw the Count process will “pause” and the system will present the details of the Candidates with equal Progressive Totals to allow the manual draw procedure to take place. The Draw for Exclusion function is defined in Chapter 6 of the PRCC Functional Specifications (Reference 9).

In the case of an automatic draw where the Vote Count is required to produce repeatable results (i.e. Configuration Parameter SubsequentRunRepeatable is set to True) the system will use the draw results from a previous Vote Count that has been run with the same eligible candidates as this Vote Count. Otherwise a random number generator will be used to determine the outcome of the draw as defined in by the Random Selection Processing.

Once the result of the draw is determined, the order in which each candidate is to be excluded is recorded and processing automatically continues.

The draw results are recorded within the database to ensure the vote count is repeatable and for reporting purposes.

Reference 1:

- *Clause 9 Exclusion of lowest candidate: 9(6)*
- *Clause 13 Deciding by lot: 13(1)*
- *Clause 15 Records and publication of results 15(1)(d)*

Reference 3:

- *Business Requirement WR1.2*
- *Business Requirement WR1.3*

Step 27 – Continuing candidates equals unfilled vacancies?

If the Number of Candidates elected + Number of Continuing Candidates (not including the Candidate just identified for exclusion) = Number of Candidates to be Elected, then all remaining candidates are to be elected (even if they have not reached the quota) and processing continues from **Step 36**. The actual distribution of the Excluded Candidate's Ballot Papers is not required.

If more Candidates are required to be elected then processing continues from **Step 28** (to distribute an Excluded Candidate's ballot papers).

Reference 1:

- *Clause 9 Exclusion of lowest candidate: 9(7)*
- *Clause 11 Election without reaching quota 11(1)*
- *Clause 15 Records and publication of results 15(1)(d)*

Step 28 – Identify parcels to be distributed

An Excluded Candidate's ballot papers are distributed to the Continuing Candidates one parcel at a time in the order in which the parcels were received.

These parcels may come from:

- a. the distribution of first preferences in Count 1;
- b. the distribution of parcels of ballot papers from an elected candidate's surplus; or
- c. the distribution of parcels of ballot papers from an excluded candidate.

For example in the Bogan 2016 WIGM Results Spreadsheet (Reference 4) BALLARD received a total of 6 parcels by Count 6.

Parcel 1 containing 25 ballot papers was received in Count 1 from the first preference count.

Parcel 2 containing 12 ballot papers was received in Count 2 from the distribution of DONALD's 352 ballot papers that he received in Count 1.

Parcel 3 containing 4 ballot papers was received in Count 3 from the distribution of JACKSON's 213 ballot papers that he received in Count 1.

Parcel 4 containing 8 ballot papers was received in Count 4 from the distribution of RYAN's 154 ballot papers that he received in Count 1.

Parcel 5 containing 1 ballot paper was received in Count 4 from the distribution of RYAN's 42 ballot papers that he received in Count 2.

Parcel 6 containing 1 ballot paper was received in Count 5 from the distribution of NEIL's 133 ballot papers that he received in Count 1.

Parcels are distributed in order of 1 to 6.

Reference 1:

- *Clause 9 Exclusion of lowest candidates 9(2)(b)*
- *Clause 15 Records and publication of results 15(1)(d)*

Step 29 – Distribute preferences for the parcel

The next preferences are examined and the ballot paper is distributed to the next available Eligible Continuing Candidate as defined in the processing for **Step 15**.

Reference 1:

- *Clause 2 Definitions: continuing candidate*
- *Clause 9 Exclusion of lowest candidates: 9(2)(a), 9(2)(b)(i)*
- *Clause 12 Determining order of preference*
- *Clause 15 Records and publication of results 15(1)(d)*

Reference 3: Business Requirement WR1.4

Step 30 – Calculate ballot paper totals

Once the parcel has been distributed, calculate:

- the Total Number of Ballot Papers distributed to each Continuing Candidate
- the Total Number of Exhausted Ballot Papers.

Reference 1: Clause 15 Records and publication of results 15(1)(d), 15(1)(f)

Step 31 – Calculate candidate votes transferred and votes lost by fraction

For each parcel calculate the number of votes to be transferred to each Continuing Candidate.

Votes Transferred = Ballot Papers Distributed x the Transfer Value at which the votes were transferred in to the Excluded Candidate at a previous count.

A parcel received from a count of first preferences for the Excluded Candidate has a Transfer Value of 1.

Any resultant fraction is disregarded so that the votes transferred is always an integer value.

The Disregarded Fraction is recorded separately for each Continuing Candidate and used to determine the Votes Lost by Fraction for this parcel.

Votes Lost by Fraction = the sum of all the Excluded Candidate's Disregarded Fractions – the Disregarded Fraction Previously Accounted for (DFPA).

DFPA in an Exclusion Count = the fraction that was disregarded when the Excluded Candidate received the Votes at a previous Count.

Note: Candidates may reach the quota midway through the distribution of an excluded candidate's ballot papers. However they will continue to receive votes until all of the Excluded candidate's parcels have been distributed.

Reference 1:

- *Clause 9 Exclusion of lowest candidates 9(2)(a), 9(2)(b)(i), 9(2)(b)(ii)*
- *Clause 15 Records and publication of results: 15(1)(a), 15(1)(c), 15(1)(d)*

Step 32 – Calculate Exhausted Votes

Total Exhausted Votes = Total Exhausted Ballot Papers x the Transfer Value at which the votes were transferred **in** to the Excluded Candidate at a previous count. Exhausted Votes are recorded with their fractional component.

A parcel received from a count of first preferences for the Excluded Candidate has a Transfer Value of 1.

Reference 1:

- *Clause 9 Exclusion of lowest candidates 9(3)*
- *Clause 15 Records and publication of results: 15(1)(d), 15(1)(f)*

Step 33 – More parcels to distribute for excluded candidate?

Have all of the Excluded Candidate's parcels been distributed? If so then proceed to **Step 34** to calculate the Surplus Fraction for this Count.

Otherwise return to **Step 29** to distribute the next parcel of ballot papers.

Reference 1:

- *Clause 10 Effect of reaching quota while transfers are proceeding 10(2)*
- *Clause 15 Records and publication of results: 15(1)(d)*

Step 34 – Calculate totals for the count

Once all of the Excluded Candidate's parcels have been distributed and votes transferred to the Continuing Candidates the following totals are calculated:

- a. Total Ballot Papers received by each Continuing Candidate from all parcels distributed in this Count;
- b. Total Votes received by each Continuing Candidate from all parcels distributed in this Count;
- c. Total Disregarded Fractions for each Continuing Candidate from all parcels distributed in this Count;
- d. Total Exhausted Ballot Papers from all parcels distributed in this Count;
- e. Aggregated Exhausted Votes (AEV), calculated as the sum of all Exhausted Votes from all parcels distributed in this count;
- f. Total Votes Lost by Fraction in this Count from all parcels distributed in this Count.

Balancing the Excluded Candidates votes

Total Votes of the Excluded Candidate =
 Total Votes Transferred to the Continuing Candidates + Total Votes Lost by Fraction
 + Aggregated Exhausted Votes

This is illustrated in the Count 6 of the Bogan 2016 WIGM Results Spreadsheet (Reference 4).

In Count 6 BALLARD's Votes available for distribution is 32. In this count:

- 29 votes were transferred to the Continuing Candidates
- $4.3406 - 1.9003 = 2.4403$ votes were lost by fraction²
- 0.5597 votes were set aside as exhausted³

The sum of these votes is 32 which balances to BALLARD's Votes.

This document is referenced in the Certification of the PRCC Count Software. Following certification, these typographical errors were noticed

To correct, they should read:

² $4.9003 - 1.9003 = 3$ votes lost by fraction.

³ 0 votes were set aside as exhausted.

Reference 1:

- *Clause 15 Records and publication of results 15(1)(a), 15(1)(c), 15(1)(d), 15(1)(f)*

Step 35 – Calculate progressive totals

At the conclusion of this count the following new Progressive Totals are calculated:

- Continuing Candidate's new Progressive Total (BPs) =
Progressive Total brought forward from previous Count + BPs distributed at this Count
- Continuing Candidate's new Progressive Total (Votes) =
Progressive Total brought forward from previous Count + Votes transferred at this Count
- New Progressive Total for Exhausted Ballot Papers =
Progressive Total brought forward from previous Count + Exhausted BPs at this Count
- Total BPs in the Count = Sum of all Continuing Candidate's new Progressive Total (BPs) + Exhausted Ballot Papers at this Count
- Total Votes in the Count = Sum of all Continuing Candidate's new Progressive Total (Votes)
- Total Ballot Papers Set Aside = Progressive Total brought forward from previous Count + Total Ballot Papers Set Aside at this Count
- New Progressive Total for Votes Lost by Fraction = Progressive Total brought forward from previous Count + Votes Lost by Fraction at this Count
- New Progressive Total for Votes Set Aside as Exhausted = Progressive Total brought forward from previous Count + Votes Set Aside as Exhausted at this Count.

A final check is performed to ensure that the Total Votes in the Count (e) + New Progressive Total for Votes Lost by Fraction (g) + New Progressive Total for Votes Set Aside as Exhausted (h) = the Total Formal Ballot Papers in the First Preference Count.

If these figures do not reconcile then display the error message, "An unexpected error has occurred in the vote count process. Contact your system administrator." and terminate the count.

Reference 1:

- *Clause 15 Records and publication of results 15(1)(a), 15(1)(c), 15(1)(d), 15(1)(f)*

Step 36 – Elect all continuing candidates

All candidates remaining in the count are elected even if they have not obtained the quota.

Reference 1:

- *Clause 11 Election without reaching quota 11(1)*

Step 37 – End election

End Election Count Process.

Random Selection Processing

Where an Automatic Draw is required, a Random Number Generation Program will be used to performing the random selection of a Candidate where a Surplus Distribution Draw (**Step 9**) or an Exclusion Draw (**Step 26**) is required.

The random selection of candidates for a Surplus Distribution Draw or an Exclusion Draw is as follows:

- a. If X candidates are in the draw, then they are all numbered from 1 to X
- b. The Random Number Generator is used to generate a number between 1 and X
- c. The candidate that matches the number generated is the one to be selected from the draw.

Traceability matrix

In order to ensure that the requirements and regulations are addressed by this specification a traceability matrix is provided below:

Summary of requirements

| Ref. | Requirement | Functional specification ref. |
|-------|--|-------------------------------|
| WR1.1 | Update the Count Engine to apply schedule 5 of the regulations including amendments. | |
| WR1.2 | The Count Engine needs to be configurable to allow tie's to be manually entered by the RO or automatically determined by the system. | Step 9, 26 |
| WR1.3 | The count engine needs to be able to deliver repeatable results. The result of ties that occur during the Distribution of preferences must be captured. | Step 9, 26 |
| WR1.4 | During distributions parcels of votes are NOT to be merged. | Step 14, 15, 29 |
| WR1.5 | Disregarded fractions need to be accounted for in each distribution. Where they have already been accounted for they cannot be double counted and must be shown in the reporting as already accounted for. | Step 23 |
| WR1.6 | To determine the order of election when multiple candidates are elected during a transfer or at the end without quota, candidates are considered elected in the order based on their votes. If there are multiple candidates with the same votes the candidate highest on the poll at the last count or transfer where their votes were unequal, is considered elected first. If those candidates have had equal numbers of votes at all preceding counts or transfers, or there has been no preceding count, the returning officer decides by lot the order elected. | Step 4 |

Traceability of regulations to functional specifications

| Clause | Description | Functional Specification ref. |
|--------|---|-------------------------------|
| 1 | General | |
| 2 | Definitions | Step 1, 3, 5, 6, 15, 29 |
| 3 | Count of first preferences – number of first preferences for each candidate are counted and the aggregate number of first preferences are counted | Step 1, 2 |
| 4 | Quota = (aggregate first preferences/(number of candidates to be elected + 1)) +1 | Step 3 |
| 5(1) | Election on First Preferences – Candidate with >= quota is elected | Step 4, 5 |
| 5(2) | If votes = quota then ballot papers are set aside as finally dealt with | Step 4, 6 |
| 6(1) | Surplus on first count – Transferred to continuing candidates | Step 12, 15, 19, 21, 23 |
| 6(2) | Transfer is subject to Clause 11 and if 1 remaining vacancy can be filled then no further transfer under this clause can be made | Step 11 |
| 7 | Surplus on Transfer | |
| 7(1) | If as a result of a transfer of surplus a candidates total => quota then they are elected | Step 5 |
| 7(2) | Despite reaching quota the transfer completes with all votes transferred | Step 21 |
| 7(3) | If an exact quota is reached (after the transfer) then those papers are set aside as finally dealt with | Step 5, 6 |
| 7(4) | Describes how to transfer surplus to continuing candidates | Step 12, 15, 19, 20 |
| 7(5) | Transfer is subject to Clause 11 and if 1 remaining vacancy can be filled then no further transfer under this clause can be made | Step 11, 15 |
| 7(6) | Aggregate value of exhausted votes (under 7 (4) (a)) are excluded at the value they were transferred to the candidate | Step 17 |
| 8 | Transfer of surpluses | |
| 8(1) | Within the first preference count or any transfer where more than 1 candidate has a surplus, they are transferred in order from largest to smallest | Step 7,13 |
| 8(2) | If there is un-transferred surplus from a previous count, that surplus is transferred first | Step 7, 13 |
| 8(3) | If there are equal surplus at the first count, the RO decide by lot which is transferred first | Step 8, 13 |

| Clause | Description | Functional Specification ref. |
|--------|--|---|
| 8(4) | If there are equal surplus at a later count, lookback to find who was highest when they were not equal but if equal all the way through, the RO to decide by lot | Step 8, 13 |
| 9 | Exclusion of lowest candidate | |
| 9(1) | After first preferences and transfer of surpluses fewer candidates than required have obtained the quota, the lowest candidate on the poll is excluded | Step 12, 24 |
| 9(2) | All unexhausted votes are transferred to continuing candidates | Step 28, 29, 31, 34 |
| 9(3) | Exhausted ballot papers are set aside as finally dealt with | Step 32 |
| 9(4) | Continue to exclude and transfer until all candidates except the number to be elected have been excluded. Candidates remaining not elected become elected | Step 11 |
| 9(5) | When 2 or more to be excluded have the same no. of votes, look back to when they were unequal and the lowest on the poll then is excluded | Step 25 |
| 9(6) | Extension to 9 (5) , if they were tied all the way to first preferences, the RO decide by lot | Step 26 |
| 9(7) | This clause is subject to Clause 11 and if 1 remaining vacancy can be filled then no further transfer under this clause can be made | Step 11, 27 |
| 10 | Effect of reaching quota while transfers are proceeding | |
| 10(1) | If by a transfer from an exclusion (clause 9) the candidate vote \geq quota then they are elected | Step 4, Step 5 Policy Matter 1. Order of election |
| 10(2) | Despite the fact that the candidate has reached the quota, the transfer is to be completed | Step 33 |
| 10(3) | If under clause 9 the candidate votes = quota then those papers are set aside as finally dealt with | Step 6 |
| 10(4) | If under clause 9 the candidate votes $>$ quota then the surplus is transferred as per Clause 7 (4) | Step 6 |
| 11 | Election without reaching quota | |
| 11(1) | When the number of continuing candidates = vacancies remaining then the remaining candidates are elected | Step 10, 11, 27, 36 |
| 11(2) | When only 1 vacancy remains and the votes for a continuing candidate $>$ votes of all other continuing candidates + undistributed surplus then that candidate is elected | Step 11 |

| Clause | Description | Functional Specification ref. |
|--------|--|--|
| 11(3) | When > 1 vacancy remains and the candidate who would be elected to fill the last vacancy has more votes than all the candidates lower on the poll + undistributed surplus then that candidate and all those high on the poll but not elected are elected | Step 11 |
| 11(4) | When only 1 vacancy remains and only 2 continuing candidates with the same number of votes and there are no surplus votes remaining then one candidate is elected as per clauses 9 (5) and (6) | Step 11 |
| 12 | Determining order of preference (elected or excluded candidates are treated as if the names of those candidates had not been on the ballot paper | Step 15, 29 |
| 13 | Deciding by Lot | |
| 13(1) | Describes how the RO is to draw lots to exclude candidates under clause 9 or 11 | Step 26 |
| 13(2) | Describes how the RO is to draw lots to determine which candidates surplus is to be transferred first | Step 9 |
| 14 | Check Counting can be request unless it has been done. NSWEC processes check count all papers as part of data entry | Business process |
| 15 | Records and returns of voting and transfers | |
| 15(1) | At each stage the RO is to keep a record of: a. number of votes for each candidate, b. the transfer of surpluses, c. votes lost through the disregarding of any fractions of votes during the process of transfer, d. the exclusion of candidates and the transfer of their votes, e. the votes which are found to be informal, and f. f) those which at some stage become exhausted votes | Step 2, 21, 22, 23, 31, 34, 35 Step 13-23 Step 21, 22, 23, 31, 34, 35 Step 24-34 Pre-process Step 2, 17, 22, 23, 30, 32, 34, 35 |
| 15(2) | The election manager is to publish the results (including a record of voting, counting and transfers) on the election managers website | Business Process |
| 16 | The RO may determine that references to physical arrangement of ballot papers may not be applicable where electronic counting machines are used | Business process |