Basics

S22 /Staff/ABS 23/09/2016 03:03 PM

Send	To S22 /Staff/ABS@ABS cc bcc
Subject	Fw: Letter from the Electoral Commissioner
Protective Mark	UNCLASSIFIED
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

This is the letter from the AEC commission. I'll send through the previous work done in another email.

S22

----- Forwarded by S22 /Staff/ABS on 23/09/2016 03:02 PM -----

From: Siu-Ming Tam/Staff/ABS
To: Paul Schubert/Staff/ABS@abs, S22 /Staff/ABS@abs,
Date: 23/09/2016 01:56 PM
Subject: Fwd: Letter from the Electoral Commissioner

FYI

Siu-Ming

Siu-Ming Tam (Dr)
Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): +61 2 6252 7160 | (F): + 61 2 6252 6470

(E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land , waters and community. We pay our respects to them and their cultures , and elders, both past and present.

Begin forwarded message:

From: "David Kalisch" <david.kalisch@abs.gov.au>
Date: 21 September 2016 at 2:50:18 PM AEST
To: "Trevor Sutton" <trevor.sutton@abs.gov.au>, "Siu-Ming Tam" <siu-ming.tam@abs.gov.au>
Subject: Fw: Letter from the Electoral Commissioner

Trevor, Siu-Ming

Can you please consider and prepare a response for me to send back to the Electoral Commissioner providing our advice on the most desirable membership testing approach . You have already given some consideration to their current approach based on earlier ABS advice , on a more informal basis, in recent advice you provided to me.

regards

David W. Kalisch
Australian Statistician

02 6252 6705 (w) david.kalisch@abs.gov.au
----- Forwarded by David Kalisch/Staff/ABS on 21/09/2016 02:46 PM -----

From: S47F @aec.gov.au>
To: "'david.kalisch@abs.gov.au'" <david.kalisch@abs.gov.au>,
Cc: "'S22 @abs.gov.au'" <S22 @abs.gov.au>
Date: 21/09/2016 02:30 PM
Subject: Letter from the Electoral Commissioner [SEC=UNOFFICIAL]

UNOFFICIAL
Good afternoon David

Please see the attached letter from Tom.

S22

S47F

S47F | **Personal Assistant to the Commissioner**
National Executive

Australian Electoral Commission
T: S47F | M: S47F | F: S47F

UNOFFICIAL

(See attached file: 20160921-754 - Mr Kalisch.pdf) 20160921-754 - Mr Kalisch.pdf

Document 2

AEC Australian Electoral Commission

Electoral Commissioner

Our ref: 08/1334-2

Mr David Kalisch
Australian Statistician
Australian Bureau of Statistics
Locked Bag 10
Belconnen ACT 2612

Dear Mr Kalisch

Sample Testing of Political Party Membership Lists

As we have recently discussed, I am seeking your confirmation of the methodology the Australian Electoral Commission (AEC) employs for sample checking the membership lists of non-parliamentary political parties registered under Part XI of the *Commonwealth Electoral Act 1918* (the Electoral Act).

You may be aware that s.123(1)(a)(ii) of the Electoral Act provides that an eligible non-parliamentary political party must have at least 500 members and that the AEC conducts membership testing of such political parties per s.138A once per electoral cycle. Such testing for the 45th Parliament will commence later this year.

For each non-parliamentary political party, the AEC will contact a sample of party members to confirm their membership of the party. A sample is used because full testing is prohibitively labour intensive. Our approach is based on advice from the Australian Bureau of Statistics (ABS). This advice provided a methodology where the sample size was scaled depending upon the size of the list of claimed party membership.

The original advice was provided to the AEC in June 2010. In December 2010 the AEC sought ABS views on a variation to the sampling method. In April 2011 the ABS provided updated advice which is now used as the sampling method to test party membership. This method is outlined in appendix three of the AEC Party Registration Guide, replicated in the **Attachment.**

50 Marcus Clarke Street
Canberra City ACT 2600

Locked Bag 4007
Canberra ACT 2601

Tel 02 6271 4411
Fax 02 6215 9954

www.aec.gov.au
ABN 21 133 285 851

I would appreciate if the ABS could confirm the level of risk associated with the method used by the AEC.

The AEC contact person for this matter is S47F on S47F

Yours sincerely

S47F

Tom Rogers

21 September 2016

50 Marcus Clarke Street
Canberra City ACT 2600

Locked Bag 4007
Canberra ACT 2601

Tel 02 6271 4411
Fax 02 6215 9954

www.aec.gov.au
ABN 21 133 285 851

Membership testing process

When a membership list is submitted to the AEC to support either registration or a review, the following steps are taken:

1. The membership list is checked to confirm that it contains between 500 and 550 names.
2. The membership list is checked against the Electoral Roll through an automated process. Party members will fall into the following three categories: matched to one; matched to many; or no match.
3. The names in the categories 'matched to many' and 'no match' are individually checked against the Electoral Roll. These members now fall into one of four categories: matched to the Electoral Roll; deceased; not currently enrolled to vote; or not found on the roll.
4. Unique members – Two or more parties cannot rely on the same members for the purpose of registration or continued registration. The names of party members matched to the Electoral Roll in both stages of testing are then compared to membership lists of other registered political parties to identify any cross party duplicates. Duplicates are removed from the membership list.
5. **Less than 500** – If after this verification process the membership list does not contain 500 names, the party will be issued with a Notice to either vary their application or review submission.
6. **500 or more** – If after this verification process is completed, the membership list contains between 500 and 550 names of electors, the second phase of testing commences.
7. *Random testing* – The membership list is now randomised using an excel function. The size of the random sample is determined by the number of members on the list after steps 2 to 4 are completed.
8. Party members are contacted starting from the top of the randomised list. In the first instance emails are sent to those members with an email address. If no response is received after 24–48 hours the member will be contacted via phone.
9. Contact is attempted on three separate occasions. If after the third attempt the member is still uncontactable they are deemed a *non-response* (**not a denial**) and the next consecutive person on the list is contacted. Phone contact is continued in this way until the required number of contacts is reached.

Membership testing table

To determine whether a political party meets the requirements of the Electoral Act relating to number of members, the AEC as part of party membership testing will contact a random sample of 18–50 members. The determination of the sample size is based on advice from the Australian Bureau of Statistics (ABS). Dependent on the actual sample size, and to allow the AEC to be confident that a political party meets the requirements, a certain percentage of members must confirm their membership when contacted by the AEC. Based on a recommendation from the ABS a political party is permitted a number of

denials, before the AEC would determine that the political party does not meet the number of members' required for registration under the Act.

Membership testing table		
Members Lodged	**Random sample**	**Max denials to pass**
500	18	0
503	26	1
512	30	2
521	34	3
529	38	3
537	42	5
543	46	6
548	50	7
550	50	7

Reproduced from appendix three of the AEC Party Registration Guide: http://www.aec.gov.au/parties_and_representatives/party_registration/guide/appendix3.htm

Basics

[redacted]/Staff/ABS 23/09/2016 03:03 PM

Send	To [redacted]/Staff/ABS@ABS cc bcc
Subject	Fw: AEC sampling advice [DLM=For-Official-Use-Only]
Protective Mark	For-Official-Use-Only
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

The previous work done is attached to this email.

[redacted]

----- Forwarded by [redacted]/Staff/ABS on 23/09/2016 03:03 PM -----

From: Paul Schubert/Staff/ABS
To: [redacted]/Staff/ABS@ABS,
Date: 23/09/2016 01:50 PM
Subject: Fw: AEC sampling advice [DLM=For-Official-Use-Only]

[redacted], as discussed - thanks for organising someone to look at this.

I've asked Siu-Ming to re-send the email from David with the attachment from AEC, just to make sure we understand the context of the current request.

Cheers,
Paul.

Paul Schubert

Program Manager

Statistical Methodology Branch | Methodology Division | Statistical Business Transformation Group |

Australian Bureau of Statistics

(P) (02) 6252 6591 (M) S22 **(F) (02) 6252 6470**

(E) paul.schubert@abs.gov.au (W) www.abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters and community. We pay our respects to them and their cultures, and elders, both past and present.

Begin forwarded message:

From: "David Kalisch" <david.kalisch@abs.gov.au>
Date: 22 September 2016 at 9:31:46 PM AEST
To: "Siu-Ming Tam" <siu-ming.tam@abs.gov.au>
Cc: "Trevor Sutton" <trevor.sutton@abs.gov.au>
Subject: Re: Letter from the Electoral Commissioner

Thanks Siu-Ming

The one aspect that I would like you to consider is whether the number of members that the AEC are sampling, on the basis of our past advice, is a sufficiently large sample to be reasonably confident about its likely accuracy. The current approach tests appears to test relatively few people, which might be suitable if the political party is struggling to get to the minimum 500 members, but may be less suitable if they have a membership list of say 1000.

Regards

David

Sent from my iPad

On 22 Sep 2016, at 5:59 PM, Siu-Ming Tam <siu-ming.tam@abs.gov.au> wrote:

> Hi David
>
> We are working to give you a draft replay next week, or the latest the week after next.
>
> I have asked that the advice provided to AEC be reviewed before finalising the draft reply. The risks that the Commissioner wants to be advised on are the probability of false positives (ie when the sampling method says "yes" when there are less than 500 active members), or the probability of false negatives (ie the method says no when there are actually 500 or more active members).
>
> Siu-Ming
>
> _____
> Siu-Ming Tam (Dr)

Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): +61 2 6252 7160 | (E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

David Kalisch---21/09/2016 02:50:18 PM---Trevor, Siu-Ming Can you please consider and prepare a response for me to send back to the Electoral

From: David Kalisch/Staff/ABS
To: Trevor Sutton/Staff/ABS@ABS, Siu-Ming Tam/Staff/ABS@ABS,
Date: 21/09/2016 02:50 PM
Subject: Fw: Letter from the Electoral Commissioner

Trevor, Siu-Ming

Can you please consider and prepare a response for me to send back to the Electoral Commissioner providing our advice on the most desirable membership testing approach. You have already given some consideration to their current approach based on earlier ABS advice, on a more informal basis, in recent advice you provided to me.

regards

David W. Kalisch
Australian Statistician

02 6252 6705 (w) david.kalisch@abs.gov.au
----- Forwarded by David Kalisch/Staff/ABS on 21/09/2016 02:46 PM -----

From: S47F [redacted]@aec.gov.au>
To: '"david.kalisch@abs.gov.au"' <david.kalisch@abs.gov.au>,
Cc: '"S22 [redacted]@abs.gov.au"' S22 [redacted]@abs.gov.au>
Date: 21/09/2016 02:30 PM
Subject: Letter from the Electoral Commissioner [SEC=UNOFFICIAL]

UNOFFICIAL
Good afternoon David

Please see the attached letter from Tom.

S22 [redacted]

S47F [redacted]

S47F | **Personal Assistant to the Commissioner**
National Executive
Australian Electoral Commission
T: S47F | M: S47F | F: S47F

----- Forwarded by Paul Schubert/Staff/ABS on 23/09/2016 01:43 PM -----

From: Paul Schubert/Staff/ABS
To: Siu-Ming Tam/Staff/ABS@ABS,
Date: 23/09/2016 12:02 PM
Subject: S22 previous advice to AEC [DLM=For-Official-Use-Only]

Siu-Ming,

see the two attachments below.

S47C, S47E(d)

Paul.

Paul Schubert

Program Manager

Statistical Methodology Branch | Methodology Division | Statistical Business Transformation Group | **Australian Bureau of Statistics**

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The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters and community. We pay our respects to them and their cultures, and elders, both past and present.

----- Forwarded by Paul Schubert/Staff/ABS on 23/09/2016 11:58 AM -----

From: Paul Schubert/Staff/ABS
To: Paul Schubert/Staff/ABS@ABS,
Date: 14/05/2015 11:27 AM
Subject: Fw: AEC again

Paul Schubert

Assistant Statistician

Statistical Services | Methodology and Data Management | **Australian Bureau of Statistics**

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----- Forwarded by Paul Schubert/Staff/ABS on 14/05/2015 11:27 AM -----

From: S22 /Staff/ABS
To: S22 /Staff/ABS@ABS,
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 31/05/2010 07:28 PM

Subject: AEC again

S22

S47C, S47E(d)

S22

S47C, S47E(d)

original report

Registration of Federal Political parties.rtf

----- Forwarded by Paul Schubert/Staff/ABS on 23/09/2016 11:58 AM -----

From: mfd.printers@abs.gov.au <mfd.printers@abs.gov.au>
To: schube@abs.gov.au,
Date: 29/02/2016 11:26 AM
Subject: advice to aec
Sent by: <mfd.printers@abs.gov.au>

Reply to: Paul Schubert <schube@abs.gov.au>
Device Name: C4S137PS
Device Model: MX-4111N
Location: Level 4S 137 ABS BELCONNEN

File Format: PDF (Medium)
Resolution: 300dpi x 300dpi

Attached file is scanned image in PDF format.
Use Acrobat(R)Reader(R) or Adobe(R)Reader(R) of Adobe Systems Incorporated to view the document.
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http://www.adobe.com/

mfd.printers@abs.gov.au_20160229_111637.pdf

Assessment of Membership Requirements for the Purpose of Registering Federal Political Parties: Design of Random Test

Background

1. Federal registration as a political party provides rights, benefits and obligations to organisations wishing to promote the election of candidates to the Commonwealth Parliament. For organisations that apply for registration as a (non-Parliamentary) political party, the Electoral Act provisions require that, inter alia, the party to have at least 500 members eligible to be on the electoral roll. Application for registration of a political party is required to include documentary evidence that the party meets this requirement.

2. To test that a party has 500 members who are entitled to enrolment, the Australian Electoral Commission

removes from the list members under 17 years of age;
removes any duplicate memberships on the list;
removes people who have already been used by another party to establish its eligibility for registration; and
conducts a random test for fraudulent membership.

The test for fraudulent membership involves contacting a random sample of people from the membership list by phone and by mail if necessary. Where more than a threshold number of the randomly selected people from the membership list cannot be confirmed as a member, then the membership test would be deemed as having been failed.

3. AEC requested for advice on the appropriate sample size and the appropriate cut-off to be used to assess if the party has 500 members who are entitled to enrolment on the electoral roll.

4. In this report we have recommended a number of options for the size of the sample and the cut-off values. The actual option to be used will depend on considerations of resource affordability and assessment of the risks that would be deemed as reasonable for this purpose. In the following sections I will provide a general framework for consideration, present the recommended options, and discuss some practical implementation issues.

Risk of Wrong Acceptance and Risk of Wrong Rejection

5. The required sample size and the threshold for deciding on the membership assessment depends on the following factors:

(a) the number of names provided on the list, after obvious ineligibles and duplicates are removed;
(b) the level of risks of taking a wrong decision, that the AEC is prepared to accept.

6. Because only a sample of names on the list will be checked, there is the possibility that the assessment may not reflect the validity of names on the full list, leading to risks of wrong decision by the AEC. There are two types of risk to be balanced:

f

the risk of wrongly accepting a membership requirement as being met, when the submitted list contains less than 500 valid members;
the risk of wrongly rejecting a membership requirement as being met, when the number of valid members on the submitted list was actually 500 or more.

7. These two risks are counteracting, and *for a given sample size* it is not possible to set thresholds that could reduce one risk without increasing another. On the other hand, *increasing the sample size*, combined with a judicious choice of threshold values, would have the effect of reducing both risks. We will aim to choose a sample size (and threshold value) for decision that will give a balance between these two risks, ensuring that both will be sufficiently small.

8. We quantify risks in terms of the percentage of samples, out of all possible samples of a given size, that would lead to incorrect decision. For the purpose of assessing the sample size, we balance the risks using the following archetype scenarios:

the risk of wrongly accepting application when there are only 400 valid members out of those on the list; and
the risk of wrongly rejecting application when there are 500 valid members on the list.

9. The former scenario represents the case of a moderate departure from meeting the criterion. A gap of 100 names is considered materially important by the AEC. For applicants with even less valid members, the risk of wrong acceptance will be even lower than those shown. On the other hand, a higher number closer to 500 could be used, although this would make the discrimination harder and would result in a higher sample size. Likewise, for applicants who have submitted at least 500 names, the risk of AEC wrongly rejecting the application will not be larger than those set below based on 500 valid names.

Recommended Sample Sizes

10. The recommended sample sizes are shown in the tables below. Following feedback from the AEC that the acceptance of an invalid list of party members is of greater concern than wrongly rejecting a valid list, three options are presented giving sample sizes and cutoffs under three scenarios in decreasing order of stringency:

Three options are presented:

Option 1: Probability of rejecting a valid list= 10%, probability of accepting an invalid list = 2%
Option 2: Probability of rejecting a valid list= 10%, probability of accepting an invalid list = 5%
Option 3: Probability of rejecting a valid list= 15%, probability of accepting an invalid list = 5%

11. For each option, I present the

(a) the number of people to be contacted for the assessment - this is the number of fully responding persons that has to be selected and contacted for the purpose of the assessment;

(b) the cut-off for accepting that the membership condition is met - If out of the respondents contacts, the number of fraudulent/invalid cases is higher than the cut-off, this is considered as sufficient evidence that the membership requirement has not been met.

Table 1: Recommended sample size and cut-off (i.e. threshold number of fraudulent cases for accepting membership assessment) by number of addresses provided

Option 1: Probability of rejecting a valid list = 10%, probability of accepting an invalid list = 2%

Total Number of Addresses Provided (N)	Sample Size under this option	Cut off for number of fraudulent addresses in sample (above cutoff = rejecting that there are at least 500 correct addresses)	Risk of wrong rejection of application (when the organisation has 500 valid members on the list)	Risk of wrong acceptance of list (when the organisation has 400 valid members on the list)
500	18	0	0.00	0.02
550	47	6	0.13	0.01
600	74	16	0.10	0.02
650	99	28	0.09	0.02
700	124	41	0.11	0.02
750	148	56	0.11	0.02
800	174	73	0.10	0.02
850	199	90	0.11	0.02
900	223	108	0.10	0.02
950	248	127	0.10	0.02
1000	273	147	0.09	0.02

Option 2: Probability of rejecting a valid list=10%, probability of accepting an invalid list=5%

Total Number of Addresses Provided (N)	Sample Size under this option	Cut off for number of fraudulent addresses in sample (above cutoff = rejecting that there are at least 500 correct addresses)	Risk of wrong rejection of application (when the organisation has 500 valid members on the list)	Risk of wrong acceptance of list (when the organisation has 400 valid members on the list)
500	13	0	0.00	0.05
550	36	5	0.10	0.05
600	56	12	0.13	0.04
650	75	22	0.08	0.06
700	95	32	0.11	0.04
750	114	44	0.10	0.05
800	133	57	0.09	0.06
850	153	70	0.11	0.04
900	172	84	0.11	0.05
950	191	99	0.10	0.05
1000	210	114	0.09	0.05

Option 3: Probability of rejecting a valid list=15%, probability of accepting an invalid list=5%

Total Number of Addresses Provided (N)	Sample Size under this option	Cut off for number of fraudulent addresses in sample (above cutoff = rejecting that there are at least 500 correct addresses)	Risk of wrong rejection of application (when the organisation has 500 valid members on the list)	Risk of wrong acceptance the list (when the organisation has 400 valid members on the list)
500	13	0	0.00	0.05
550	30	4	0.13	0.06
600	47	10	0.15	0.05
650	64	18	0.14	0.06
700	81	27	0.14	0.05
750	96	36	0.16	0.04
800	112	47	0.14	0.05
850	128	58	0.15	0.05
900	144	70	0.14	0.06
950	160	81	0.14	0.05
1000	176	95	0.16	0.04

12. The actual option to use will depend on consideration of resource constraints and an assessment of the risks that the public would be prepared to take or accept. Option 3 will be the cheapest but least stringent while option 1 is the most costly but most stringent amongst the three. Other solutions are possible if AEC wishes to consider different balance of risks based on the potential implications of taking wrong decisions.

Applying the Design

13. There are a number of issues arising from applying sampling to the assessment of the membership criteria. These relate to:

- selecting the sample from the list
- dealing with non-respondents to the random test
- applying cut offs for deciding the membership criterion

For valid inference to be made from the random test, it is important that appropriate attention be given to these issues. Some observations are made below on how these should be addressed.

Selecting the Sample from the list

14. The current procedure is to remove obvious invalid names on the list before the random test is applied. Excluded from the list are persons who are not eligible for enrolment, duplicates, and persons who have already been used by another party to establish its eligibility for registration. In deriving the above designs, we have assumed this procedure will continue to be used. There could be economic advantages in doing these removals as part of the random checks. However, to do this would require some assumptions on the prevalence of these invalid cases, and would complicate the design process.

15. After these removals, it is important that the list is "frozen" for the purpose of sample selection and assessment purpose. Further removals of units on the list will risk affecting the validity of the sample, especially if the removals are related to the information provided from the random checks. For example, if from one of the phone call it is established that a section on the frame is fraudulent, then removing the names from the count of persons on the list would bias the estimation.

16. To select the sample, the simplest way is to attach a random number to each name on the list, and then sort the random numbers in ascending order. The first n units will then be included for the sample. An advantage of this approach is that where a unit selected cannot be contacted for the test, it is straightforward to replace the unit by another random selection on the list by taking the next name in the order.

Dealing with Non-respondents

17. Because the random check involves contacting the selected persons by phone (and by mail if necessary) there will usually be cases where the person cannot be contacted, refuse to cooperate, or for other reasons unable to provide the information. Non-response does not include the cases where there are sufficient reasons to establish that the person does not exist - these cases should be counted as invalid members instead.

18. The sample size provided in Table 1 refers to the number of fully responding person. I am assuming that you will be able to substitute any non-respondent by another selection from the list so that the final sample that you could use to ascertain validity of membership could meet the sample size requirement.

19. Non-response adds uncertainty to the check results. Invariably one would have to rely on assumptions about the non-respondents. In the survey world a standard assumption is that the non-respondents can be represented by respondents with a similar background. It is impossible to verify this assumption and to the extent that the proportion of valid members among the non-respondents are different from respondents it will bias the estimation. It is therefore important that a rigorous approach is adopted to ensure sufficient calls are made to contact the person and the level of non-response is minimised. A protocol on how to deal with different call outcomes would be useful. Where it is suspected that large scale fraud results in massive non-response, it is not appropriate to simply keep replacing the units by new sample.

21. The simplest and most conservative approach to the treatment of nonrespondents is to treat them as nonmembers. This is consistent with previous AEC advice that accepting invalid lists is a more serious concern than rejecting a valid list. In taking this step, the AEC must be demonstrably thorough in its attempts to establish the validity of address information.

Applying Cut-offs

22. Once all the checking results are obtained, the next step to make inference about the number of valid members on the list. The best point estimate is given by estimating the percentage of valid members out of the assessed units (i.e. excluding non-respondents which can be invalid or otherwise), and applying this to the total number on the list (which includes non-respondents).

23. For example, if there are N = 800 names from the "clean and frozen" list, and 112 fully responding persons are contacted, of which 42 fraudulent cases are identified while the remaining 70 are valid members, then the estimated number of valid members is equal to 800 x 70/112 = 500.

24. In marginal cases, even if this *estimate* falls below 500 it does not necessarily follow that the actual number of members are below 500. The thresholds, or cut-off, in the table above can be used for deciding. In this example, the table above suggests that in option 3, the cut off value is 47, and since there are only 42 fraudulent members identified from the check, one could safely decide that the membership condition is met.

A more general approach to setting cut-offs

25. It is inconvenient to apply the above recommendation because the cut-off is specific to each option and the relevant sample size and the total count of names on the list. An good approximation can be used to design a more general threshold. This is explained below as a formula:

Let p be the proportion of valid members in the fully responding sample. Let the total count of names on the list be N and the total number of fully responding units in the sample be n. Use the following rule:

If $Np + 1.28\sqrt{\frac{(N-n)Np(1-p)}{(n-1)}} \geq 500$ then accept that the membership condition is met.

The above rule will have one in ten chance risk of wrong rejection.

26. For example, if N = 800, n= 112 and out of these 112 units 45 are found to be fraudulent, then p = 35/80. Substituting these values into the above formula, we get:

$$800 \times \frac{45}{80} + 1.28\sqrt{\frac{(800-112)\times 800}{(112-1)}\left(\frac{45}{112}\right)\times\left(1-\frac{45}{112}\right)} = 478.57 + 1.28 \times 34.52 = 535.36$$

which exceeds 500. Hence in this case we accept the membership condition is met based on the results of the check.

In this calculation, the value 34.52, calculated from the term which has the square root, corresponds to the standard error of the estimated number, which measures the precision of the point estimate 478.57.

27. It is possible to use a more conservative rule to reject application, by replacing the factor in the formula of 1.28 by a higher value 1.64. The risk of wrong rejection would then be one in twenty (5%) instead of one in ten (10%). However, the risk of false acceptance will increase if this more relaxed rule is applied.

28. For example, in Table 3 above, a list of 1000 requires a sample size of 176 (including nonrespondents). If all nonrespondents are considered fraudulent and the total of nonrespondents plus fraudulent respondents is 95 or greater, then the list should be considered invalid

29. If the methods in paragraphs 25 and 26 of the advice above are preferred, they need to be modified to incorporate nonresponse.

30. Using the example in paragraph 26 where the total count of names on the list was 800 and 112 addresses were selected, suppose 102 were fully responding and 40 of the 102 are considered fraudulent. The 10 nonrespondents would be considered fraudulent giving an estimated proportion of valid members of

62/112=0.55.

31. Using the rule given in earlier advice:

ie if $Np+1.28\sqrt{\frac{(N-n)N}{n-1}p(1-p)}\geq 500$ then accept that the membership condition is met.

gives

$$800\times\frac{62}{112}+1.28\sqrt{\frac{(800-112)\times 800}{(112-1)}\left(\frac{62}{112}\right)\times\left(1-\frac{62}{112}\right)}=442.85+1.28\times 35.01=487.66\leq 500$$

The 90% one sided confidence interval is (0, 487.66) which would suggest rejecting the application.

33. Using the rule:

if $Np+1.645\sqrt{\frac{(N-n)N}{n-1}p(1-p)}\geq 500$ then accept that the membership condition is met.

gives

$$800\times\frac{62}{112}+1.645\sqrt{\frac{(800-112)\times 800}{(112-1)}\left(\frac{62}{112}\right)\times\left(1-\frac{62}{112}\right)}=442.85+1.645\times 35.01=500.44>500$$

The 95% one sided confidence interval is (0, 500.44) which would suggest accepting the application.

34. A less conservative approach is to treat nonrespondents as as equally likely to be members or nonmembers as respondents.

Using the previous example where the total count of names on the list is 800 and 112 addresses were selected with 102 fully responding and 40 of the 102 considered fraudulent. Under this less conservative approach, 10*(40/102) or approximately 4 of the 10 nonrespondents would be considered fraudulent giving an estimated proportion of valid members of 40/102=0.6078.

35. This results in an estimate of approximately 44 of the original sample of 112 names as being fraudulent, and so if Table 3 is in use, as 44 falls below the cut-off of 47 the application would be accepted.

36. Alternatively, using the rule given in earlier advice:

ie if $Np + 1.28\sqrt{\frac{(N-n)N}{n-1}p(1-p)} \geq 500$ then accept that the membership condition is met. n in this case now refers to the number of responses rather than the initial sample.

gives

$$800 \times \frac{62}{102} + 1.28\sqrt{\frac{(800-102)\times 800}{(102-1)}\left(\frac{62}{102}\right)\times\left(1-\frac{62}{102}\right)} = 486.27 + 1.28 \times 36.30 = 532.74 > 500$$

90% one sided confidence interval is (0, 532.74) which would suggest accepting the application.

Further calculations give a 95% one sided confidence interval of (0, 545.99)

S22 and S22
Statistical Services Branch
Australian Bureau of Statistics

5 November 2008

36

S47F

From: S22 @abs.gov.au]
Sent: Friday, 15 April 2011 3:30 PM
To: S47F
Cc: S22
Subject: Re: Advice provided to AEC regarding membership testing for party registration applications and reviews [SEC=UNCLASSIFIED]
Attachments: correspondence to S22 Dec2010.pdf

S47F

I am sorry I have not able to get back to you earlier. S22 and I had a good chat about a week ago, and I promised to put my thoughts together. I also asked my staff to do some number crunching to enable me provide you with the information that he is after.

As I explained to S22 I consider it reasonable that the AEC apply a sample based assessment procedure, and made this process transparent to applicants. It is also reasonable to limit the number of names provided in order to ensure the membership criterion can be tested in practice.

S47C, S47E(d)

I would advice that you ask your applicants to provide the best list they put forward, and if there are more than say 550, they should make an effort to cull it to ensure people on the list can be contacted and can vouch for their being party member. S47C, S47E(d)
S47C, S47E(d)

We applied the algorithm and update the table attached to the procedures (see below). Let me know if there is any need for finetuning required as it would be possible to change the sample number and cutoffs if you want to change the risks you are prepared to accept.

Happy to further discuss if you have any query.

Sincerely,

S22

Table supplied by ABS showing confidences in membership testing
(lists from 500-550)

Members Lodged	Random sample	Max denials to pass	accepting only 400 - risk %	rejecting 500 risk - %
500	18	0	1.80	0.00
501	18	0	1.74	3.53
502	18	0	1.68	6.93
503	26	1	1.99	1.05
504	26	1	1.91	1.80
505	26	1	1.83	2.72
506	26	1	1.75	3.79
507	26	1	1.67	4.98
508	26	1	1.60	6.28
509	26	1	1.54	7.68
510	26	1	1.47	9.17
511	26	1	1.41	10.73
512	30	2	2.64	3.26
513	30	2	2.53	3.97
514	30	2	2.43	4.75
515	30	2	2.32	5.59
516	30	2	2.23	6.50
517	30	2	2.13	7.47
518	30	2	2.04	8.50
519	30	2	1.96	9.58
520	30	2	1.88	10.71
521	34	3	2.86	4.68
522	34	3	2.74	5.35
523	34	3	2.62	6.08
524	34	3	2.51	6.85
525	34	3	2.40	7.67
526	34	3	2.30	8.53
527	34	3	2.20	9.44
528	34	3	2.11	10.38
529	38	4	2.85	5.52
530	38	4	2.72	6.17
531	38	4	2.61	6.86
532	38	4	2.49	7.59
533	38	4	2.39	8.36
534	38	4	2.28	9.16
535	38	4	2.18	10.01
536	38	4	2.09	10.88
537	42	5	2.60	6.65
538	42	5	2.48	7.32
539	42	5	2.37	8.02
540	42	5	2.27	8.76
541	42	5	2.17	9.53
542	42	5	2.07	10.33
543	46	6	2.43	6.86
544	46	6	2.32	7.50
545	46	6	2.22	8.18
546	46	6	2.12	8.89
547	46	6	2.02	9.63
548	50	7	2.27	6.78
549	50	7	2.17	7.40
550	50	7	2.07	8.05

Reg4124

from email from s22 *ABS 15.04.11*

Document 6

Basics

"S22 " 08/10/2024 01:36 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: Fwd: S22 previous advice to AEC [SEC=OFFICIAL]
Protective Mark	OFFICIAL
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

From: S22 @abs.gov.au>
Sent: Tuesday, September 27, 2016 12:27 PM
To: Siu-Ming Tam <siu-ming.tam1@abs.gov.au>
Cc: S22 @abs.gov.au>; S22 @abs.gov.au>; Paul Schubert <Paul.Schubert@abs.gov.au>
Subject: Re: Fwd: S22 previous advice to AEC [DLM=For-Official-Use-Only]

Hi,

In response/addition to some of Siu-Ming's comments:

The hypergeometric distribution is fairly standard to calculate and included in most packages. For example, the HYPGEOM.DIST(...) function in excel, phyper(...) in R, and CDF('HYPER',...) in SAS will calculate the cumulative probabilities for you.

The formula in paragraph 25 can be derived as the variance for the HT estimator of a domain total under SRSWOR, the domain in this case being fraudulent members.

That is, we have var = $N^2/n(1-f)s^2$. The formula is just plugging in some numbers for the specific case, such as $s^2=p(1-p)n/(n-1)$ and $N(1-f)=N-n$
The formula is based on applying the normal approximation to the hypergeometric distribution to calculate the probability (1.28 is the 90th percentile of a standard normal distribution).

S47C, S47E(d)

I think the example is still consistent, because the criterion is an accept/reject criterion. In option 3 the cut-off value is 47, but the observed number is 45 - so we know that the cut-off is satisfied at the 15% level of significance. The example shows that we also have acceptance at the 10% significance level as well. Also, the calculation is wrong 478.57 + 1.28 x 34.52 = 522.76 not the answer given of 535.36. This is based on using 1.645 instead of 1.28 as the SE multiplier (which is another value used in the example).

Cheers,

S22
Assistant Director (a/g)
Business Statistics Methodology | Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: Siu-Ming Tam/Staff/ABS
To: S22 /Staff/ABS@ABS,
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 26/09/2016 09:20 AM
Subject: Re: Fwd: S22 s previous advice to AEC [DLM=For-Official-Use-Only]

S22

I have a quick review of S22 paper. It is very well written.

The comments I have are:

. I would like to see the formula underpinning the numbers in Option 1, Option 2 and Option 3. He must have developed a smart way of calculating the cumulative hyper-geometric probabilities.
. Para 25 - should the factor "(n-1)" in the denominator of the term under the square root be read as "n"
. We need to advise AEC how to compute the Type 2 error under the more general approach described in

para 25

[redacted]
S47C, S47E(d)

Siu-Ming

Siu-Ming Tam (Dr)
Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): [redacted] | (E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters and community. We pay our respects to them and their cultures, and elders, both past and present.

From: Siu-Ming Tam/Staff/ABS
To: [redacted]/Staff/ABS@abs,
Cc: [redacted]/Staff/ABS@abs, [redacted]/Staff/ABS@abs, Paul Schubert/Staff/ABS@abs
Date: 23/09/2016 04:59 PM
Subject: Fwd:[redacted] previous advice to AEC [DLM=For-Official-Use-Only]

[redacted]
S22

[redacted]
S22

It will be good if [redacted] S2 can read the attached two documents and then organise a chat with us to finalise the scope of the work. Primarily I would like [redacted] S2 to double check the methods outlined in the attached documents, see what needs to be improved, if any, and then draft a reply for David.

The risks asked by the AEC are type 1 and type 2 errors.

[redacted]
S22

Siu-Ming

Siu-Ming Tam (Dr)
Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): S22 | (F): + 61 2 6252 6470
(E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

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Begin forwarded message:
From: "Paul Schubert" <paul.schubert@abs.gov.au>
To: "Siu-Ming Tam" <siu-ming.tam@abs.gov.au>
Subject: S22 **previous advice to AEC [DLM=For-Official-Use-Only]**
Siu-Ming,

see the two attachments below.

S47C, S47E(d)

Paul.

Paul Schubert
Program Manager
Statistical Methodology Branch | Methodology Division | Statistical Business Transformation Group |
Australian Bureau of Statistics
(P) (02) 6252 6591 (M) S22 **(F) (02) 6252 6470**
(E) paul.schubert@abs.gov.au (W) www.abs.gov.au

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----- Forwarded by Paul Schubert/Staff/ABS on 23/09/2016 11:58 AM -----

From: Paul Schubert/Staff/ABS
To: Paul Schubert/Staff/ABS@ABS,
Date: 14/05/2015 11:27 AM
Subject: Fw: AEC again

Paul Schubert
Assistant Statistician
Statistical Services | Methodology and Data Management | **Australian Bureau of Statistics**
(P) (02) 6252 6591 (M) S22 **(F) (02) 6252 7784**
(E) paul.schubert@abs.gov.au (W) www.abs.gov.au
----- Forwarded by Paul Schubert/Staff/ABS on 14/05/2015 11:27 AM -----

From: S22 /Staff/ABS
To: S22 /Staff/ABS@ABS,
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 31/05/2010 07:28 PM

Subject: AEC again

S22 ,

S47C, S47E(d)

S22

S47C, S47E(d)

original report

(See attached file: Registration of Federal Political parties.rtf)

----- Forwarded by Paul Schubert/Staff/ABS on 23/09/2016 11:58 AM -----

From: mfd.printers@abs.gov.au <mfd.printers@abs.gov.au>
To: schube@abs.gov.au,
Date: 29/02/2016 11:26 AM
Subject: advice to aec
Sent by: <mfd.printers@abs.gov.au>

Reply to: Paul Schubert <schube@abs.gov.au>
Device Name: C4S137PS
Device Model: MX-4111N
Location: Level 4S 137 ABS BELCONNEN

File Format: PDF (Medium)
Resolution: 300dpi x 300dpi

Attached file is scanned image in PDF format.
Use Acrobat(R)Reader(R) or Adobe(R)Reader(R) of Adobe Systems Incorporated to view the document.
Adobe(R)Reader(R) can be downloaded from the following URL:
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http://www.adobe.com/
(See attached file: mfd.printers@abs.gov.au _20160229_111637.pdf)[attachment "mfd.printers@abs.gov.au_20160229_111637.pdf " deleted by Siu-Ming Tam/Staff/ABS]
[attachment "Registration of Federal Political parties.rtf" deleted by Siu-Ming Tam/Staff/ABS]

Document 7

Basics

Siu-Ming Tam/Staff/ABS 09/11/2016 10:06 AM

Send	To	Paul Schubert/Staff/ABS@ABS, [redacted]/Staff/ABS@ABS
	cc	
	bcc	
Subject		Fw: Sample Testing of Political Party Membership Lists - your reference: 08/1334-2 [DLM=For-Official-Use-Only]
Protective Mark		**For-Official-Use-Only**
Information management markers		☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat		☐ ATIC
Categories		External Communication\General

Paul [redacted]

For your information and records.

I would like to thank [redacted] for his excellent work to support the request from AEC.

Siu-Ming

Siu-Ming Tam (Dr)
Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): +61 2 6252 7160 | (E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

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----- Forwarded by Siu-Ming Tam/Staff/ABS on 09/11/2016 10:05 AM -----

From: David Kalisch/Staff/ABS
To: tom.rogers@aec.gov.au,
Cc: Siu-Ming Tam/Staff/ABS@ABS
Date: 09/11/2016 09:50 AM
Subject: Sample Testing of Political Party Membership Lists - your reference: 08/1334-2 [DLM=For-Official-Use-Only]
Sent by: S22

Dear Mr Rogers,

Please find attached our response to your correspondence of 21 September, reference: 08/1334-2.

Letter to T Rogers.pdf Calculator.xlsx Technical appendix.docx 20160921-754 - Mr Kalisch.pdf

Yours sincerely

David W. Kalisch
Australian Statistician

02 6252 6705 (w) david.kalisch@abs.gov.au

Document 8

Australian Bureau of Statistics

ABS House
45 Benjamin Way
Belconnen ACT 2617

Locked Bag 10
Belconnen ACT 2616
Telephone: (02) 6252 6705

Australian Statistician

Mr Tom Rogers
Electoral Commissioner
Australian Electoral Commission
50 Marcus Clarke Street
Canberra City
ACT 2600

Dear Mr Rogers

I am responding to your letter of 21 September, 2016 in which you asked the Australian Bureau of Statistics (ABS) to review the 2011 advice on sampling method to test Political Party Membership lists, and to confirm the level of risks associated with the sampling method used by the AEC.

2 We have reviewed the sampling method outlined in the Attachment to your letter. Whilst we are generally happy with it, the method does not describe precisely how AEC treats non-response in the final assessment of the size of membership lists. In our earlier advice to AEC earlier, we said:

"Non-response adds uncertainty to the check results. Invariably one would have to rely on assumptions about the non-respondents. In the survey world a standard assumption is that the non-respondents can be represented by respondents with a similar background. It is impossible to verify this assumption and to the extent that the proportion of valid members among the non-respondents are different from respondents it will bias the estimation. It is therefore important that a rigorous approach is adopted to ensure sufficient calls are made to contact the person and the level of non-response is minimised. A protocol on how to deal with different call outcomes would be useful. Where it is suspected that large scale fraud results in massive non-response, it is not appropriate to simply keep replacing the units by new sample.

The simplest and most conservative approach to the treatment of non-respondents is to treat them as non-members. This is consistent with previous AEC advice that accepting invalid lists is a more serious concern than rejecting a valid list. In taking this step, the AEC must be demonstrably thorough in its attempts to establish the validity of address information..."

This advice is still current.

3 We have also reviewed the sample size and maximum number of denials to pass the test, as outlined in the Attachment of your letter. Whilst most of the figures are correct, we have made a small number of changes, in order to better reflect the risks of wrong rejection (when there are 500 valid members) to be less than 10%, and wrong acceptance (where there are 400 valid members) of less than 2%.

4 The size of both types of risk for the sampling plans outlined in your letter is summarised in the attached spreadsheet. To further assist the AEC, we have included the following in the attached spreadsheet:

a. a look-up table, extended from 500 names and 1,000 names. This allows quick reference to sample sizes, maximum number of denials to pass the test, and risk parameters as summarised in para 3 above;

b. a "risk calculator" for AEC to calculate the risks with alternative assumptions of the invalid list size (eg setting 450 instead of 400), and different sampling plans; and

c. a "sampling plan calculator" for AEC to calculate the sample size required and maximum number of denials to pass the test, for alternative assumption of invalid list size, and risks.

5 I also attach a technical appendix underpinning our advice above for comprehensiveness of documentation. Should you require further information, please contact Dr Siu-Ming Tam, Chief Methodologist on 02 6252 7160.

Yours sincerely

S22

Mr David W. Kalisch

9 November 2016

Sheet Name	Description
Table (10% & 2%)	List of required sample sizes cut-off values for member list sizes from 500 to 1000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 400 valid members; - no more than a 10% chance of incorrectly rejecting a list with 500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 400 valid members - Probability of incorrectly rejecting a list with 500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 500 up to 1000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 10%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 550 members, a sample size of 45 and max denials of 6 will give a Probability of rejecting a valid list of 10.11%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 400 - risk	Rejecting 500 - risk
500	18	0	1.7%	0.0%
501	18	0	1.6%	3.6%
502	18	0	1.5%	7.0%
503	26	1	1.8%	0.7%
504	26	1	1.7%	1.4%
505	26	1	1.6%	2.3%
506	26	1	1.6%	3.4%
507	26	1	1.5%	4.5%
508	26	1	1.4%	5.8%
509	26	1	1.4%	7.2%
510	26	1	1.3%	8.7%
511	32	2	1.6%	2.6%
512	32	2	1.6%	3.3%
513	32	2	1.5%	4.1%
514	32	2	1.4%	5.0%
515	32	2	1.3%	6.0%
516	32	2	1.3%	7.0%
517	32	2	1.2%	8.1%
518	32	2	1.2%	9.3%
519	37	3	1.5%	3.9%
520	37	3	1.4%	4.6%

521	37	3	1.4%	5.4%
522	37	3	1.3%	6.2%
523	37	3	1.2%	7.1%
524	37	3	1.2%	8.0%
525	37	3	1.1%	9.0%
526	41	4	1.6%	4.3%
527	41	4	1.5%	5.0%
528	41	4	1.4%	5.7%
529	41	4	1.3%	6.4%
530	41	4	1.3%	7.2%
531	41	4	1.2%	8.1%
532	41	4	1.1%	9.0%
533	41	4	1.1%	9.9%
534	44	5	1.7%	5.1%
535	44	5	1.6%	5.7%
536	44	5	1.5%	6.4%
537	44	5	1.5%	7.1%
538	44	5	1.4%	7.9%
539	44	5	1.3%	8.7%
540	44	5	1.3%	9.5%
541	47	6	1.8%	5.4%
542	47	6	1.7%	6.0%
543	47	6	1.6%	6.6%
544	47	6	1.6%	7.3%
545	47	6	1.5%	8.0%
546	47	6	1.4%	8.8%
547	47	6	1.3%	9.6%
548	50	7	1.8%	5.9%
549	50	7	1.7%	6.4%
550	50	7	1.6%	7.1%
551	50	7	1.6%	7.7%
552	50	7	1.5%	8.4%
553	50	7	1.4%	9.2%

554	50	7	1.3%	9.9%
555	53	8	1.7%	6.5%
556	53	8	1.7%	7.1%
557	53	8	1.6%	7.7%
558	53	8	1.5%	8.4%
559	53	8	1.4%	9.1%
560	53	8	1.4%	9.8%
561	56	9	1.7%	6.7%
562	56	9	1.6%	7.3%
563	56	9	1.5%	8.0%
564	56	9	1.5%	8.6%
565	56	9	1.4%	9.3%
566	59	10	1.7%	6.6%
567	59	10	1.6%	7.2%
568	59	10	1.5%	7.8%
569	59	10	1.4%	8.4%
570	59	10	1.4%	9.1%
571	59	10	1.3%	9.8%
572	61	11	1.9%	6.5%
573	61	11	1.8%	7.0%
574	61	11	1.7%	7.6%
575	61	11	1.6%	8.2%
576	61	11	1.5%	8.8%
577	61	11	1.4%	9.4%
578	64	12	1.7%	7.2%
579	64	12	1.6%	7.7%
580	64	12	1.5%	8.3%
581	64	12	1.4%	8.9%
582	64	12	1.3%	9.6%
583	66	13	1.8%	6.7%
584	66	13	1.7%	7.2%
585	66	13	1.7%	7.8%
586	66	13	1.6%	8.3%

587	66	13	1.5%	8.9%
588	66	13	1.4%	9.6%
589	68	14	1.9%	6.8%
590	68	14	1.8%	7.4%
591	68	14	1.7%	7.9%
592	68	14	1.6%	8.5%
593	68	14	1.6%	9.0%
594	68	14	1.5%	9.6%
595	70	15	1.9%	7.1%
596	70	15	1.9%	7.6%
597	70	15	1.8%	8.1%
598	70	15	1.7%	8.6%
599	70	15	1.6%	9.2%
600	70	15	1.5%	9.8%
601	72	16	2.0%	7.3%
602	72	16	1.9%	7.8%
603	72	16	1.8%	8.4%
604	72	16	1.7%	8.9%
605	72	16	1.6%	9.5%
606	75	17	1.7%	8.1%
607	75	17	1.6%	8.6%
608	75	17	1.5%	9.2%
609	75	17	1.4%	9.7%
610	77	18	1.8%	7.5%
611	77	18	1.7%	8.0%
612	77	18	1.6%	8.5%
613	77	18	1.6%	9.1%
614	77	18	1.5%	9.6%
615	79	19	1.8%	7.5%
616	79	19	1.7%	8.0%
617	79	19	1.7%	8.5%
618	79	19	1.6%	9.1%
619	79	19	1.5%	9.6%

620	81	20	1.8%	7.6%
621	81	20	1.7%	8.1%
622	81	20	1.7%	8.6%
623	81	20	1.6%	9.1%
624	81	20	1.5%	9.7%
625	83	21	1.8%	7.7%
626	83	21	1.7%	8.2%
627	83	21	1.6%	8.7%
628	83	21	1.6%	9.2%
629	83	21	1.5%	9.8%
630	85	22	1.8%	7.9%
631	85	22	1.7%	8.4%
632	85	22	1.6%	8.9%
633	85	22	1.5%	9.4%
634	85	22	1.5%	10.0%
635	87	23	1.7%	8.1%
636	87	23	1.7%	8.6%
637	87	23	1.6%	9.1%
638	87	23	1.5%	9.7%
639	89	24	1.8%	8.0%
640	89	24	1.7%	8.4%
641	89	24	1.6%	8.9%
642	89	24	1.5%	9.5%
643	89	24	1.4%	10.0%
644	91	25	1.7%	8.3%
645	91	25	1.6%	8.8%
646	91	25	1.5%	9.3%
647	91	25	1.5%	9.8%
648	93	26	1.7%	8.2%
649	93	26	1.6%	8.7%
650	93	26	1.5%	9.2%
651	93	26	1.5%	9.7%
652	95	27	1.7%	8.2%

653	95	27	1.6%	8.7%
654	95	27	1.5%	9.2%
655	95	27	1.4%	9.7%
656	97	28	1.6%	8.2%
657	97	28	1.6%	8.7%
658	97	28	1.5%	9.2%
659	97	28	1.4%	9.7%
660	98	29	2.0%	7.3%
661	98	29	1.9%	7.8%
662	98	29	1.8%	8.2%
663	98	29	1.7%	8.7%
664	98	29	1.6%	9.1%
665	98	29	1.5%	9.6%
666	100	30	1.7%	8.3%
667	100	30	1.6%	8.7%
668	100	30	1.6%	9.2%
669	100	30	1.5%	9.7%
670	102	31	1.7%	8.4%
671	102	31	1.6%	8.9%
672	102	31	1.5%	9.4%
673	102	31	1.4%	9.8%
674	103	32	2.0%	7.6%
675	103	32	1.9%	8.0%
676	103	32	1.8%	8.5%
677	103	32	1.7%	8.9%
678	103	32	1.6%	9.4%
679	103	32	1.5%	9.8%
680	105	33	1.7%	8.6%
681	105	33	1.6%	9.1%
682	105	33	1.5%	9.6%
683	107	34	1.7%	8.4%
684	107	34	1.6%	8.9%
685	107	34	1.5%	9.3%

686	107	34	1.5%	9.8%
687	108	35	2.0%	7.7%
688	108	35	1.9%	8.1%
689	108	35	1.8%	8.5%
690	108	35	1.7%	9.0%
691	108	35	1.6%	9.4%
692	108	35	1.6%	9.9%
693	110	36	1.7%	8.8%
694	110	36	1.6%	9.3%
695	110	36	1.5%	9.7%
696	112	37	1.7%	8.7%
697	112	37	1.6%	9.2%
698	112	37	1.5%	9.6%
699	113	38	2.0%	7.6%
700	113	38	1.9%	8.0%
701	113	38	1.8%	8.4%
702	113	38	1.7%	8.9%
703	113	38	1.7%	9.3%
704	113	38	1.6%	9.7%
705	115	39	1.7%	8.8%
706	115	39	1.6%	9.2%
707	115	39	1.5%	9.7%
708	117	40	1.6%	8.8%
709	117	40	1.6%	9.2%
710	117	40	1.5%	9.7%
711	118	41	1.9%	7.8%
712	118	41	1.8%	8.2%
713	118	41	1.8%	8.6%
714	118	41	1.7%	9.0%
715	118	41	1.6%	9.4%
716	118	41	1.5%	9.9%
717	119	42	2.0%	8.0%
718	119	42	1.9%	8.3%

719	119	42	1.8%	8.7%
720	119	42	1.7%	9.2%
721	119	42	1.7%	9.6%
722	121	43	1.7%	8.8%
723	121	43	1.7%	9.2%
724	121	43	1.6%	9.7%
725	123	44	1.7%	8.9%
726	123	44	1.6%	9.3%
727	123	44	1.5%	9.8%
728	124	45	1.9%	7.9%
729	124	45	1.9%	8.3%
730	124	45	1.8%	8.7%
731	124	45	1.7%	9.1%
732	124	45	1.6%	9.6%
733	124	45	1.6%	10.0%
734	125	46	2.0%	8.2%
735	125	46	1.9%	8.5%
736	125	46	1.8%	8.9%
737	125	46	1.7%	9.4%
738	125	46	1.7%	9.8%
739	127	47	1.7%	9.1%
740	127	47	1.6%	9.5%
741	127	47	1.6%	9.9%
742	128	48	2.0%	8.2%
743	128	48	1.9%	8.6%
744	128	48	1.8%	9.0%
745	128	48	1.8%	9.4%
746	128	48	1.7%	9.8%
747	130	49	1.7%	9.2%
748	130	49	1.6%	9.6%
749	130	49	1.6%	10.0%
750	131	50	2.0%	8.3%
751	131	50	1.9%	8.6%

752	131	50	1.8%	9.0%
753	131	50	1.7%	9.4%
754	131	50	1.7%	9.8%
755	133	51	1.7%	9.3%
756	133	51	1.6%	9.7%
757	135	52	1.7%	9.1%
758	135	52	1.6%	9.5%
759	135	52	1.5%	10.0%
760	136	53	1.9%	8.3%
761	136	53	1.8%	8.7%
762	136	53	1.7%	9.1%
763	136	53	1.7%	9.4%
764	136	53	1.6%	9.9%
765	137	54	2.0%	8.2%
766	137	54	1.9%	8.6%
767	137	54	1.8%	9.0%
768	137	54	1.7%	9.4%
769	137	54	1.7%	9.8%
770	139	55	1.7%	9.3%
771	139	55	1.6%	9.7%
772	140	56	2.0%	8.1%
773	140	56	1.9%	8.5%
774	140	56	1.8%	8.8%
775	140	56	1.8%	9.2%
776	140	56	1.7%	9.6%
777	142	57	1.7%	9.2%
778	142	57	1.6%	9.6%
779	142	57	1.6%	10.0%
780	143	58	1.9%	8.4%
781	143	58	1.8%	8.8%
782	143	58	1.8%	9.1%
783	143	58	1.7%	9.5%
784	143	58	1.6%	9.9%

785	144	59	2.0%	8.4%
786	144	59	1.9%	8.7%
787	144	59	1.8%	9.1%
788	144	59	1.8%	9.5%
789	144	59	1.7%	9.9%
790	146	60	1.7%	9.5%
791	146	60	1.6%	9.9%
792	147	61	2.0%	8.4%
793	147	61	1.9%	8.7%
794	147	61	1.8%	9.1%
795	147	61	1.7%	9.5%
796	147	61	1.7%	9.9%
797	149	62	1.6%	9.5%
798	149	62	1.6%	9.9%
799	150	63	1.9%	8.5%
800	150	63	1.8%	8.8%
801	150	63	1.8%	9.2%
802	150	63	1.7%	9.5%
803	150	63	1.6%	9.9%
804	151	64	2.0%	8.5%
805	151	64	1.9%	8.8%
806	151	64	1.8%	9.2%
807	151	64	1.8%	9.5%
808	151	64	1.7%	9.9%
809	153	65	1.7%	9.6%
810	155	66	1.6%	9.4%
811	155	66	1.6%	9.8%
812	156	67	1.9%	8.4%
813	156	67	1.8%	8.7%
814	156	67	1.7%	9.1%
815	156	67	1.7%	9.4%
816	156	67	1.6%	9.8%
817	157	68	1.9%	8.4%

818	157	68	1.9%	8.7%
819	157	68	1.8%	9.1%
820	157	68	1.7%	9.5%
821	157	68	1.6%	9.8%
822	158	69	2.0%	8.4%
823	158	69	1.9%	8.8%
824	158	69	1.8%	9.1%
825	158	69	1.8%	9.5%
826	158	69	1.7%	9.8%
827	160	70	1.6%	9.7%
828	161	71	2.0%	8.3%
829	161	71	1.9%	8.7%
830	161	71	1.8%	9.0%
831	161	71	1.7%	9.4%
832	161	71	1.7%	9.7%
833	163	72	1.6%	9.6%
834	163	72	1.6%	9.9%
835	164	73	1.9%	8.6%
836	164	73	1.8%	8.9%
837	164	73	1.7%	9.3%
838	164	73	1.7%	9.6%
839	164	73	1.6%	10.0%
840	165	74	1.9%	8.7%
841	165	74	1.8%	9.0%
842	165	74	1.8%	9.3%
843	165	74	1.7%	9.7%
844	167	75	1.6%	9.6%
845	167	75	1.6%	10.0%
846	168	76	1.9%	8.6%
847	168	76	1.8%	9.0%
848	168	76	1.7%	9.3%
849	168	76	1.7%	9.7%
850	169	77	2.0%	8.4%

851	169	77	1.9%	8.7%
852	169	77	1.8%	9.0%
853	169	77	1.8%	9.4%
854	169	77	1.7%	9.7%
855	170	78	2.0%	8.5%
856	170	78	1.9%	8.8%
857	170	78	1.9%	9.1%
858	170	78	1.8%	9.5%
859	170	78	1.7%	9.8%
860	172	79	1.6%	9.8%
861	173	80	1.9%	8.5%
862	173	80	1.9%	8.8%
863	173	80	1.8%	9.2%
864	173	80	1.7%	9.5%
865	173	80	1.7%	9.9%
866	174	81	2.0%	8.6%
867	174	81	1.9%	8.9%
868	174	81	1.8%	9.3%
869	174	81	1.8%	9.6%
870	174	81	1.7%	9.9%
871	175	82	2.0%	8.7%
872	175	82	1.9%	9.0%
873	175	82	1.8%	9.4%
874	175	82	1.8%	9.7%
875	177	83	1.7%	9.7%
876	178	84	2.0%	8.5%
877	178	84	1.9%	8.8%
878	178	84	1.8%	9.1%
879	178	84	1.8%	9.5%
880	178	84	1.7%	9.8%
881	180	85	1.6%	9.8%
882	181	86	1.9%	8.6%
883	181	86	1.8%	9.0%

884	181	86	1.8%	9.3%
885	181	86	1.7%	9.6%
886	181	86	1.6%	10.0%
887	182	87	1.9%	8.8%
888	182	87	1.8%	9.1%
889	182	87	1.8%	9.4%
890	182	87	1.7%	9.7%
891	183	88	2.0%	8.6%
892	183	88	1.9%	8.9%
893	183	88	1.9%	9.2%
894	183	88	1.8%	9.5%
895	183	88	1.7%	9.9%
896	185	89	1.6%	9.9%
897	186	90	1.9%	8.8%
898	186	90	1.8%	9.1%
899	186	90	1.8%	9.4%
900	186	90	1.7%	9.7%
901	187	91	2.0%	8.6%
902	187	91	1.9%	8.9%
903	187	91	1.8%	9.2%
904	187	91	1.8%	9.5%
905	187	91	1.7%	9.9%
906	188	92	2.0%	8.7%
907	188	92	1.9%	9.0%
908	188	92	1.8%	9.3%
909	188	92	1.8%	9.7%
910	188	92	1.7%	10.0%
911	189	93	2.0%	8.8%
912	189	93	1.9%	9.1%
913	189	93	1.9%	9.5%
914	189	93	1.8%	9.8%
915	191	94	1.7%	9.9%
916	192	95	1.9%	8.8%

917	192	95	1.9%	9.1%
918	192	95	1.8%	9.4%
919	192	95	1.7%	9.7%
920	194	96	1.6%	9.9%
921	195	97	1.9%	8.8%
922	195	97	1.8%	9.1%
923	195	97	1.7%	9.4%
924	195	97	1.7%	9.7%
925	196	98	1.9%	8.6%
926	196	98	1.9%	8.9%
927	196	98	1.8%	9.3%
928	196	98	1.7%	9.6%
929	196	98	1.7%	9.9%
930	197	99	1.9%	8.8%
931	197	99	1.9%	9.1%
932	197	99	1.8%	9.4%
933	197	99	1.8%	9.7%
934	199	100	1.6%	9.9%
935	200	101	1.9%	8.8%
936	200	101	1.8%	9.1%
937	200	101	1.7%	9.4%
938	200	101	1.7%	9.8%
939	201	102	1.9%	8.7%
940	201	102	1.9%	9.0%
941	201	102	1.8%	9.3%
942	201	102	1.7%	9.6%
943	201	102	1.7%	9.9%
944	202	103	1.9%	8.9%
945	202	103	1.9%	9.2%
946	202	103	1.8%	9.5%
947	202	103	1.7%	9.8%
948	205	105	1.9%	8.7%
949	205	105	1.9%	8.9%

950	205	105	1.8%	9.2%
951	205	105	1.7%	9.6%
952	205	105	1.7%	9.9%
953	206	106	1.9%	8.8%
954	206	106	1.8%	9.1%
955	206	106	1.8%	9.4%
956	206	106	1.7%	9.7%
957	207	107	2.0%	8.7%
958	207	107	1.9%	9.0%
959	207	107	1.8%	9.3%
960	207	107	1.8%	9.6%
961	207	107	1.7%	9.9%
962	208	108	2.0%	8.9%
963	208	108	1.9%	9.2%
964	208	108	1.8%	9.4%
965	208	108	1.8%	9.8%
966	211	110	1.9%	8.7%
967	211	110	1.9%	9.0%
968	211	110	1.8%	9.3%
969	211	110	1.7%	9.6%
970	211	110	1.7%	9.9%
971	212	111	1.9%	8.9%
972	212	111	1.9%	9.2%
973	212	111	1.8%	9.5%
974	212	111	1.7%	9.8%
975	213	112	2.0%	8.8%
976	213	112	1.9%	9.1%
977	213	112	1.8%	9.4%
978	213	112	1.8%	9.7%
979	213	112	1.7%	10.0%
980	214	113	2.0%	9.0%
981	214	113	1.9%	9.2%
982	214	113	1.8%	9.5%

983	214	113	1.8%	9.8%
984	217	115	1.9%	8.9%
985	217	115	1.8%	9.2%
986	217	115	1.8%	9.5%
987	217	115	1.7%	9.8%
988	218	116	2.0%	8.8%
989	218	116	1.9%	9.1%
990	218	116	1.8%	9.3%
991	218	116	1.8%	9.6%
992	218	116	1.7%	9.9%
993	219	117	1.9%	9.0%
994	219	117	1.9%	9.2%
995	219	117	1.8%	9.5%
996	219	117	1.8%	9.8%
997	220	118	2.0%	8.9%
998	220	118	1.9%	9.1%
999	220	118	1.9%	9.4%
1000	220	118	1.8%	9.7%

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 500 and 400 respectively
There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified
There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	550
Sample size	44
Maximum number of denials allowed	6

ASSUMPTIONS	
Valid list size	500
Invalid list size	400
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	10%

RESULT		
Probability of false rejection	9.17%	<10% (OK)
Probability of false acceptance	2.14%	>2% (Not OK)

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 1000, 10% and 2% the approximate value returned are 214 and 115.

INPUTS	
Members Lodged	550
Desired probability of false rejection	10%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	500
Unacceptable list	400

RESULT	
Approximate sample size required	46
Approximate maximum number of denials	6

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.181818
B	-1.28308
n0	49.80051
n1	45.66387
mu0	4.181818
mu1	12.54545
sig0	1.868165
sig1	2.894149
c0	6.075968
c1	6.101598

Technical appendix

The paper contains the derivations used to come up with the formula applied in the advice given to the AEC

Mathematical description of the problem

The (simplified) problem is a quality control problem which has two competing hypothesis:

- H_0: the list provided contains 500 valid members
- H_1: the list provided contains 400 valid members

The notation used in this document is given below:

Symbol	Description
N	Number of members lodged
n	Number of members sampled
K	True number of invalid members
k	Number of invalid members found in the sample
c	Maximum number of invalid members allowed
μ_h	Expected number of invalid members in the sample, assuming hypothesis *h* is true
σ_h	Standard deviation of invalid members in the sample, assuming hypothesis *h* is true

The exact probabilities desired to perform the test are the cumulative hypergeometric probabilities.

$$Pr(False\ Acceptance) = Pr(k \leq c|H_1) = \sum_{k=0}^{c} \frac{\binom{N-400}{k}\binom{400}{n-k}}{\binom{N}{n}} = F(c, n, N-400, N)$$

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \leq c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-500}{k}\binom{500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c, n, N-500, N)$$

These are the values provided in the *Calculator – Error rates* sheet in the Calculator workbook

There exist numerous functions built into various program to calculate the cumulative hypergeometric distribution. However, we want to fix these probabilities to specified values. So we actually need solve the following problem:

$$Choose\ c, n\ such\ that:$$

$$F(c, n, N-400, N) \leq \beta$$

$$1 - F(c, n, N-500, N) \leq \alpha$$

The default values are α=10% and β=2%. Also, we would like to choose the sample size to be as small as possible.

Approximate solution using the normal approximation

One way to do this is through the use of the normal approximation to the hypergeometric distribution. We have:

$$\mu_0 = n\frac{N-500}{N} \quad \sigma_0 = \sqrt{n\frac{N-500}{N}\frac{500}{N}\frac{N-n}{N-1}}$$

$$\mu_1 = n\frac{N-400}{N} \quad \sigma_1 = \sqrt{n\frac{N-400}{N}\frac{400}{N}\frac{N-n}{N-1}}$$

We can then use the approximations (incorporating the "continuity correction"):

$$F(c,n,N-400,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right)$$

$$F(c,n,N-500,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right)$$

And we have functions for inverting these equations through the normal quantiles. Substituting these values in gives us:

$$\Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right) \leq \beta \Rightarrow \frac{c+\frac{1}{2}-\mu_1}{\sigma_1} \leq z_\beta \Rightarrow c \geq \mu_1 - \frac{1}{2} + z_\beta\sigma_1$$

$$1-\Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right) \leq \alpha \Rightarrow \frac{c+\frac{1}{2}-\mu_0}{\sigma_0} \geq z_{1-\alpha} \Rightarrow c \leq \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0$$

We can eliminate the cut-off value by setting the above inequalities to equalities, leading to an equation in 1 variable:

$$\mu_1 - \frac{1}{2} + z_\beta\sigma_1 = \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0 \Rightarrow A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} = 0$$

$$Where \quad A = \frac{500-400}{N} \qquad B = \frac{z_\beta\sqrt{(N-400)400} - z_{1-\alpha}\sqrt{(N-500)500}}{N}$$

This does not have an analytic solution, but it can be numerically solved using newton's method. An approximate solution can be obtained by assuming large N and we have

$$A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} \approx A\sqrt{n} + B = 0 \Rightarrow n^{(0)} = \left(\frac{B}{A}\right)^2$$

We know this initial solution will be too high if A>0, B<0 (with larger error for larger N). We then apply newton updates to this initial solution:

$$n^{(i+1)} = n^{(i)} - \frac{A\sqrt{n^{(i)}} + B\sqrt{\frac{N-n^{(i)}}{N-1}}}{\frac{A}{2\sqrt{n^{(i)}}} - \frac{B}{2\sqrt{(N-n^{(i)})(N-1)}}}$$

Two updates will be sufficient (firstly because the initial approximation is close, and also because the function is smooth). Once a sufficiently good solution for n is found, it is rounded up to the nearest integer:

$$n^* = \lceil n^{(2)} \rceil$$

This can then be plugged back into the formulae for μ_0, μ_1, σ_0, σ_1 to get a value for the cut-off:

$$\Rightarrow c^* = round\left[\frac{\left(\mu_1^* - \frac{1}{2} + z_\beta \sigma_1^*\right) + \left(\mu_0^* - \frac{1}{2} + z_{1-\alpha}\sigma_0^*\right)}{2}\right]$$

The values c^* and n^* are provided in the *Calculator – Sample size* sheet in the Calculator workbook.

To see the newton updates are useful, with N=1000, α=10%, and β=2%, we get $n^{(0)}$=271 whereas $n^{(2)}$=214. Not applying the updates means that much larger sample sizes appear to be needed.

Modifying the approximate solution

The above solution will give values c^* and n^* that can be entered into the exact formula

$$F(c^*, n^*, N-400, N) \leq \beta$$

$$1 - F(c^*, n^*, N-500, N) \leq \alpha$$

These values should be approximately on the inequality. The approximations used means these equalities may not be exactly equal satisfied. So, a small line search around the optimal sample size is used to get values that satisfy the two constraints. This is why the c and n values in the table provided does not always agree with the calculator.

There are some qualitative relationships outlined in the table below a larger population will need a smaller sample size to achieve a certain level of error.

Parameter change	Effect on Probability of falsely accepting (β)	Effect on Probability of falsely rejecting (α)
N increases	Increase	Decrease
N decreases	Decrease	Increase
n increases	Increase	Decrease
n decreases	Decrease	Increase
c increases	Decrease	Increase
c decreases	Increase	Decrease

Basics

Anders Holmberg/Staff/ABS 11/03/2021 05:50 PM

Send	To S22 /Staff/ABS@ABS cc bcc
Subject	Re: Fw: 9.30am CBR: MEETING Dr Gruen and S22 Briefing on AEC - advice the ABS provided to the AEC in 2016 and 2017 on electoral enrolments [SEC=OFFICIAL]
Protective Mark	OFFICIAL
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

Thank you S22 ,

This is great and comprises the story nicely.

S22

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
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Executive Assistant: S22
(P) + S22 | (E) S22 @abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters and community. We pay our respects to them and their cultures, and elders, both past and present.

S22 Hi Anders, As requested, here are the slides I s... 11/03/2021 05:42:17 PM

From: S22 /Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Date: 11/03/2021 05:42 PM
Subject: Fw: 9.30am CBR: MEETING Dr Gruen and S22 Briefing on AEC - advice the ABS provided to the AEC in 2016 and 2017 on electoral enrolments [SEC=OFFICIAL]

Hi Anders,

As requested, here are the slides I sent to Teresa for feedback.

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

----- Forwarded by S22 /Staff/ABS on 11/03/2021 05:40 PM -----

From: S22 /Staff/ABS
To: Teresa Dickinson/Staff/ABS@ABS
Date: 11/03/2021 10:21 AM
Subject: Fw: 9.30am CBR: MEETING Dr Gruen and S22 Briefing on AEC - advice the ABS provided to the AEC in 2016 and 2017 on electoral enrolments [SEC=OFFICIAL]

Hi Teresa,

I was hoping to get your feedback on the slides I've put together for the briefing for David next week. S22 mentioned that you would have a good sense of whether this is the right level of detail.

Briefing on ABS advice provided to the AEC.pptx

The slides get more detailed as they progress.

I've also put the advice that was provided to the AEC in 2016 here.
(Subject: Fw: Sample Testing of Political Party Membership Lists - your reference: 08/1334-2 [DLM=For-Official-Use-Only]; Database: MDMD Admin WDB; Author: Siu-Ming Tam; Created: 10/03/2021; Doc Ref: DCOO-BYY8XP)

Thanks!

S22
Assistant Director, Household Statistics Methodology
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(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

----- Forwarded by S22 /Staff/ABS on 10/03/2021 05:01 PM -----

9.30am CBR: MEETING Dr Gruen and S22 Briefing on

AEC - advice the ABS provided to the AEC in 2016 and 2017 on electoral enrolments [SEC=OFFICIAL]

Wed 17/03/2021 3:30 PM - 4:15 PM

Attendance is for [redacted]

Chair: **David Gruen/Staff/ABS**

Sent by: [redacted]**/Staff/ABS**

Location: Dr Gruens Office / Meeting Room - dial in using: 3932 1064

Required: [redacted]/Staff/ABS@ABS

Optional: Teresa Dickinson/Staff/ABS@ABS

Description

Personal Notes

Advice the ABS provided to the AEC in 2016 and 2017 on electoral enrolments

S22

March 2021 briefing for David Gruen

Key points

- AEC need to assess the validity of political party membership lists when political parties register
- Legislation – a political party needs to have at least 500 members
- Bare minimum requirement – political party members should be people who are on the current electoral role
- AEC also provide additional quality assurance measure to verify whether the list of people provided are actually valid members of the political party in question

Key points

- It is expensive and time consuming to check if all registered members on a list provided to the AEC are valid members
- So, the AEC is prepared to sample from the list instead, and use the results from the sample to infer whether a list has 500 or more valid members
- Saves time and resources, but increases risk of making incorrect decisions

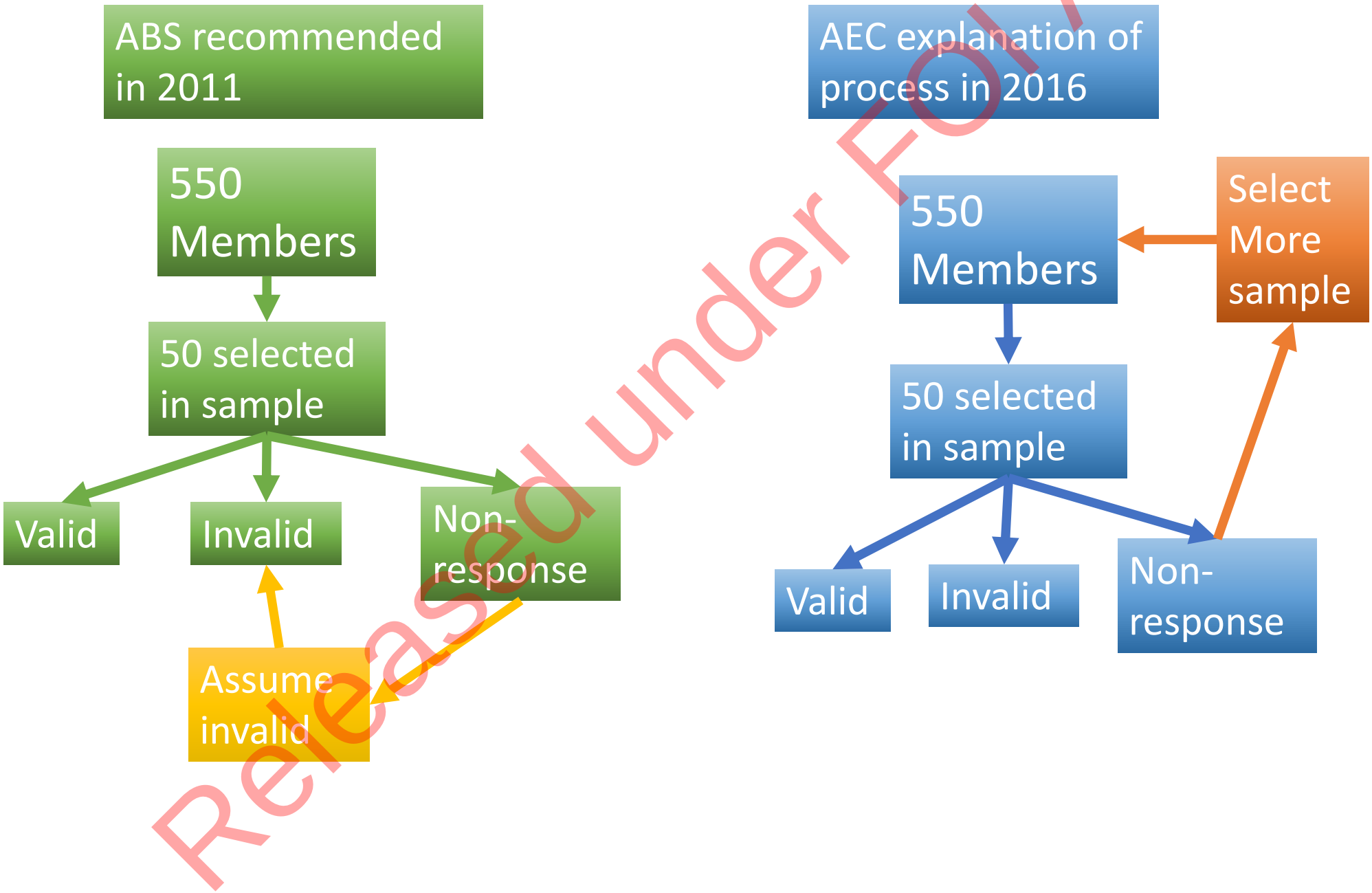
S47C, S47E(d)

  - AEC needs to be prepared for challenge if they reject a registration based on these rules

Details

- Where does ABS/MD fit in?
- Quantitative framework
- We know how to calculate the risk of making incorrect decisions based on sampling
- Accepting a list as valid, when the list is invalid
- Rejecting a list as invalid, when the list is actually valid
- Up to AEC to decide the trade off between risk, cost, and time
- Updating previous advice provided by MD in 2011

S47C, S47E(d)



S47C, S47E(d)

How does it work?

- Risk tolerance was set for two scenarios
  1. A list of members is provided, with only 400 valid members
  2. A list of members is provided, with 500 valid members
- A sample of members is selected, and the AEC checks how many members in the sample are invalid
- If the number of invalid members in the sample is too high, the AEC rejects the list. Otherwise the list is accepted as valid

How does it work?

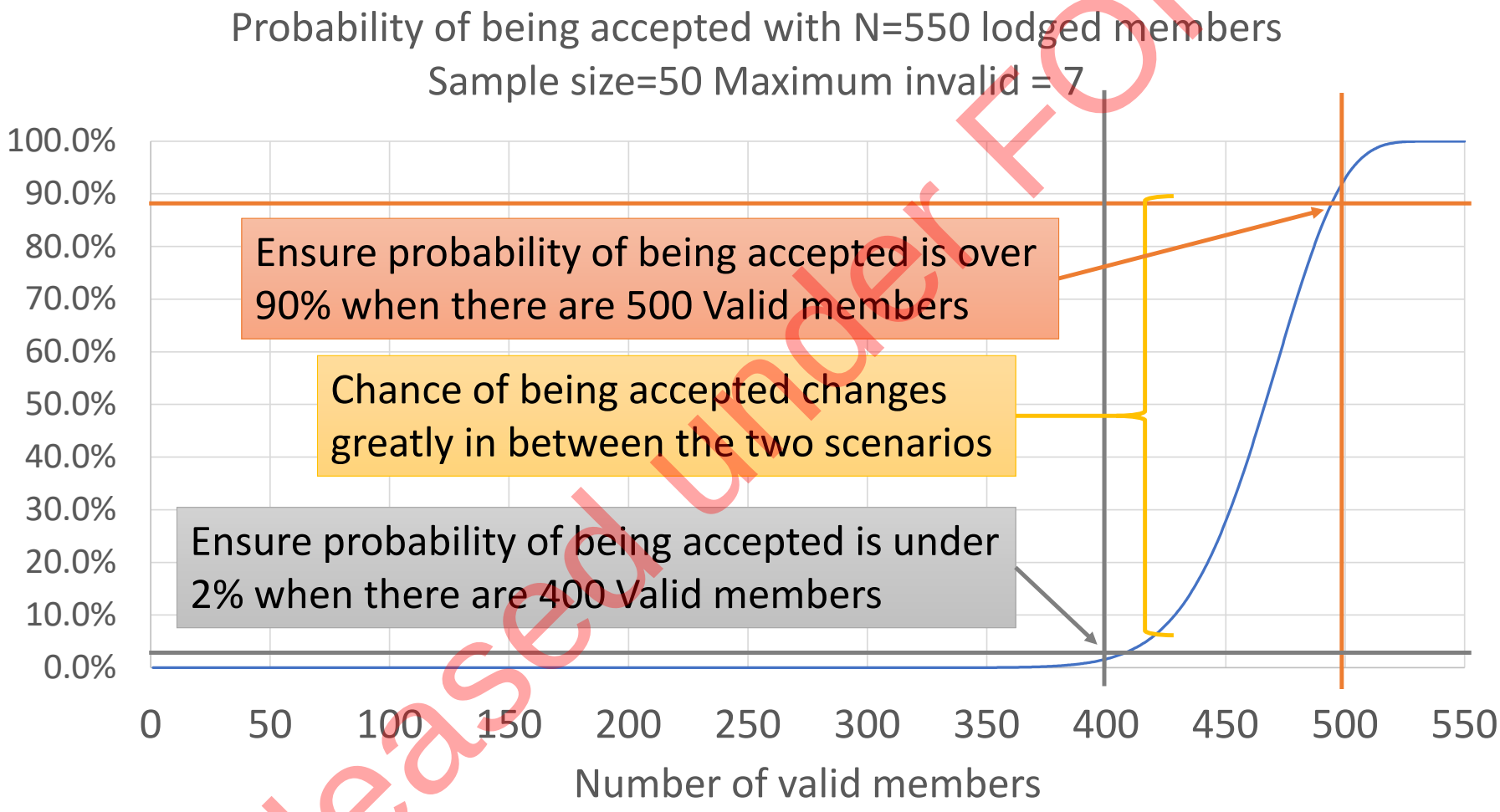
Ideally, we want to…..

- Accept the list when the truth is scenario 2 in 90% of samples
- Reject the list when the truth is scenario 1 in 98% of samples
- Select as small a sample size as possible

	List has 500 valid members	List has 400 valid members
Accept the list based on the sample	**>90%**	**<2%**
Reject the list based on the sample	**<10%**	**>98%**

How does it work?

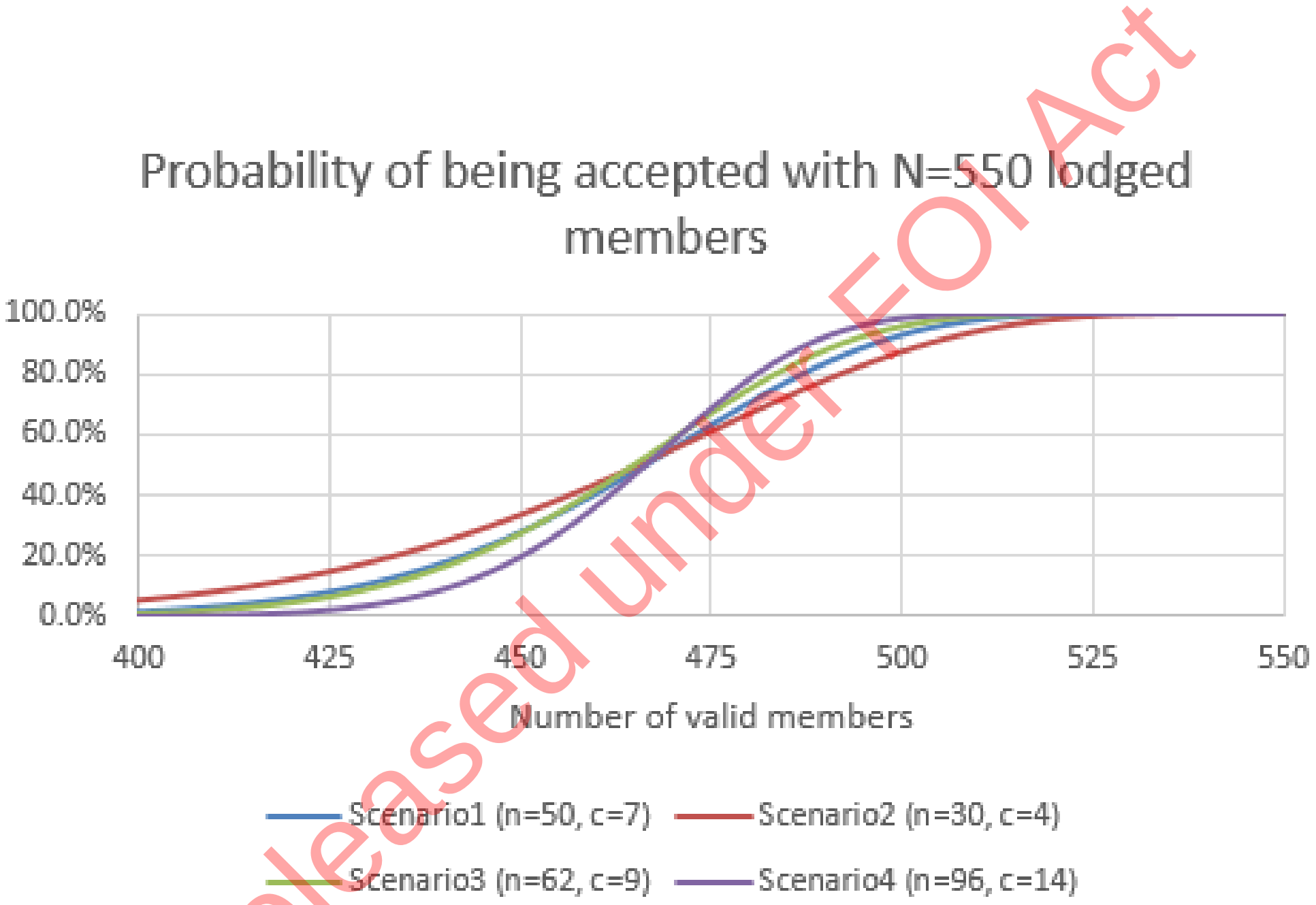
- We use the two scenarios to “anchor” the problem, and get a solution
- Once we have a solution, the risk can be calculated for all scenarios
- For example, for a list of size 550, the recommended sample size is 50, and the maximum number of invalid members in the sample is 7.
- We can then consider the chance that the list is accepted under all possible scenarios from have 0 valid members all the way up to having 550 valid members



How does it work?

- Can also alter the risk levels to obtain different sample size

Risk of accepting a list with 400 members	Risk of rejecting a list with 500 valid members	Sample size required
2%	10%	50
4%	20%	30
1%	5%	62
0.2%	1%	96



How it works

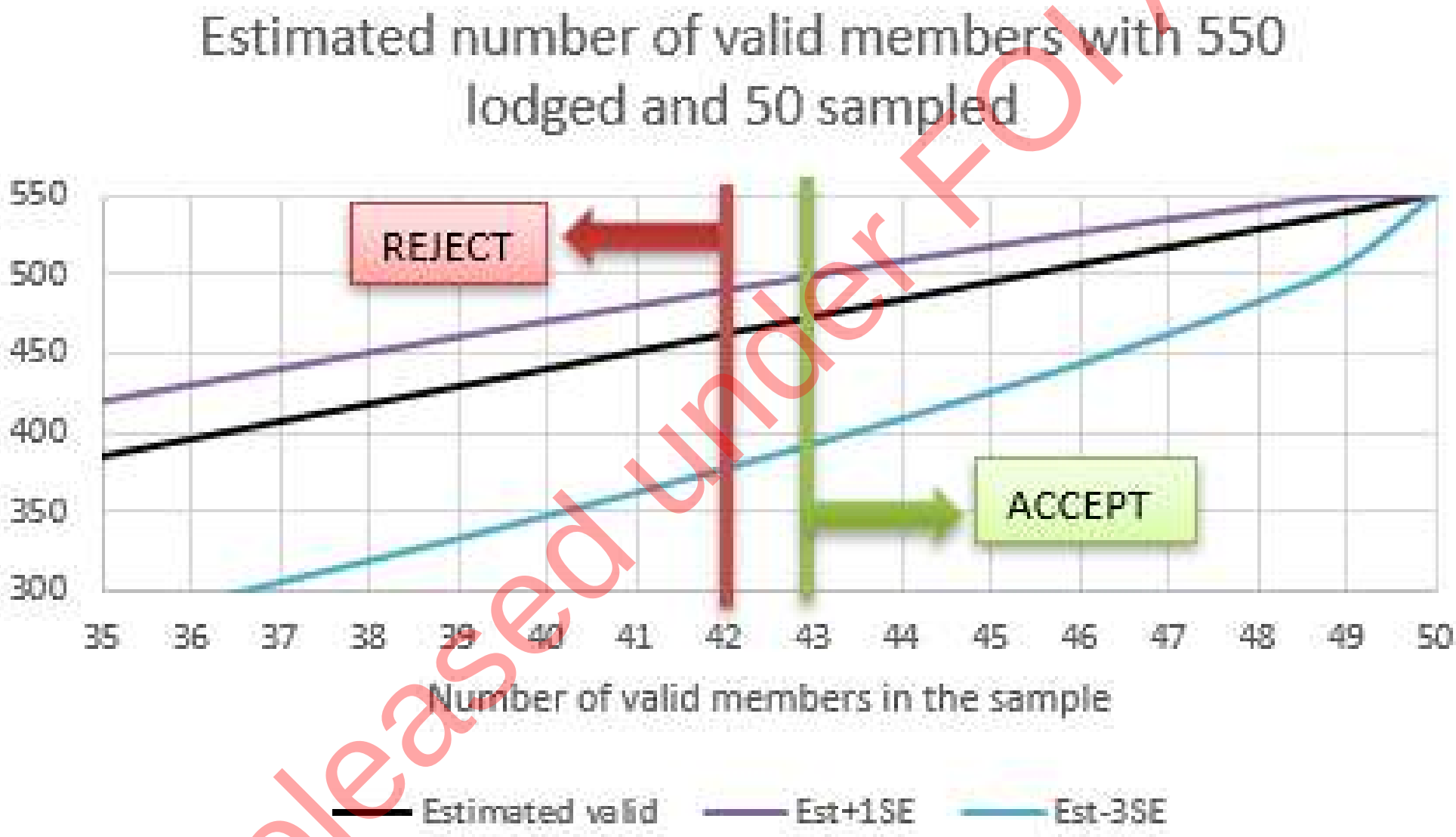
- Alternative way to think of the problem
- Same set-up, but instead of using the sample directly, we could think of *estimating* the number of valid members in the sample
- If the estimated number of valid members is close enough to 500, then we accept the list
- If we get 7 denials and 43 valid members in a sample of 50, this is a percentage in the sample of 43/50 = 86%
- Apply the estimate of 86% to the total list size: 86% x 550 = 473
- The standard error on the above estimate is 27

How it works

So the estimate at the decision point is….

- ~1 standard error below from the acceptable list size of 500
- ~3 standard errors above the unacceptable list size 400

Similar to a 95% confidence interval….but not symmetric because the risk tolerance are not equal for making mistakes on either side.



S47C

S47C, S47E(d)

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S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

Basics

"Anders Holmberg"
anders.holmberg@abs.gov.au

01/10/2024 11:19 AM

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au>	
	cc	
	bcc	
Subject	FW: Fw: Sampling work for the AEC [SEC=OFFICIAL]	
Protective Mark	OFFICIAL	
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy	**Caveat** ☐ ATIC
Categories	External Communication\General	

1 attachment

Registration of Federal Political parties - Previous advice.rtf

---

From: S22 [redacted]@abs.gov.au>
Sent: Thursday, February 4, 2021 10:18 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S22 [redacted]@abs.gov.au>; Paul Schubert <Paul.Schubert@abs.gov.au>
Subject: Re: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi Anders,

I've sent an invite for Monday.

I also double checked, and the risk rates I gave in my email are the wrong way around - the 2% is for a

"false acceptance", with 10% for "false rejection". The spreadsheet attached in my email has it the correct way around.

Regarding the justification, the risk rates themselves came from the original work in 2011. I've included the advice provided, and there were a few options on various risk rates given at this time.
I'll also forward the advice provided from November 2016. I do some further digging and see if there is correspondence from the AEC I can pass on as well.

S47C, S47E(d)

Recommended Sample Sizes

10. The recommended sample sizes are shown in the tables below. Following feedback from the AEC that the acceptance of an invalid list of party members is of greater concern than wrongly rejecting a valid list, three options are presented giving sample sizes and cutoffs under three scenarios in decreasing order of stringency:

Three options are presented:

Option 1: Probability of rejecting a valid list= 10%, probability of accepting an invalid list = 2%
Option 2: Probability of rejecting a valid list= 10%, probability of accepting an invalid list = 5%
Option 3: Probability of rejecting a valid list= 15%, probability of accepting an invalid list = 5%

2011 Advice

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
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(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: Anders Holmberg/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 03/02/2021 05:38 PM
Subject: Re: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi S22 ,

S22

The inquiry came from David Gruen who wants to have this explained to him. S47C, S47E(d)

S47C, S47E(d)

I do have one basic one though. Do you recall how the tolerance limits were set and how the Electoral commission reasoned? If they did.

cheers,

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
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(E): Anders.Holmberg@abs.gov.au | **(W)**: www.abs.gov.au

From: S22 Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: Paul Schubert/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 03/02/2021 02:09 PM
Subject: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi Anders,

S22

I've given an explanation of how things work below.

Let me know if you want to discuss further.

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
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----- Forwarded by S22 /Staff/ABS on 03/02/2021 02:04 PM -----

From: S22 /Staff/ABS
To: S22 /Staff/ABS@ABS

Date: 03/02/2021 10:14 AM
Subject: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi S2 ,

S47C

Cheers,

S22

Assistant Director, Household Statistics Methodology
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(E) S22 @abs.gov.au **(W)** www.abs.gov.au

----- Forwarded by S22 /Staff/ABS on 03/02/2021 09:41 AM -----

From: Anders Holmberg/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: Paul Schubert/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 27/01/2021 09:22 PM
Subject: Re: Fw: Sampling work for the AEC [SEC=OFFICIAL]

S47C, S47E(d)

regards,

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): **Anders.Holmberg@abs.gov.au** | **(W)**: **www.abs.gov.au**

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From: S22 /Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: S22 Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 27/01/2021 04:09 PM
Subject: Re: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi Anders, S47C, S47E(d)

S47C, S47E(d)

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Wednesday, 27 January 2021 12:11 pm
To: S22 @abs.gov.au>

CC: S22 @abs.gov.au>,Paul Schubert <paul.schubert@abs.gov.au>
Subject: Fw: Sampling work for the AEC [SEC=OFFICIAL]

Hi S22,

Here is the background information fyi. I just spoke to David G. A briefing fro him and possibly Teresa is not urgent, so it can wait until S22 is back from leave,

cheers.

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): **Anders.Holmberg@abs.gov.au** | **(W)**: **www.abs.gov.au**

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----- Forwarded by Anders Holmberg/Staff/ABS on 27/01/2021 12:08 PM -----

From: S22 Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Date: 27/01/2021 11:57 AM
Subject: Sampling work for the AEC [SEC=OFFICIAL]

Good morning,

Please find attached the 'Sampling work for the AEC' as requested.

(See attached file: AEC.pdf)
Kind Regards,

S22
Executive Assistant to Teresa Dickinson
Deputy Australian Statistician
Census and Data Services Group | Australian Bureau of Statistics
(P) S22
(E) S22 **@abs.gov.au** **(W)** **www.abs.gov.au**

The population can be thought of as consisting of 3 groups

- People who do not respond (J)
- People who respond as not a member of the party (K)
- People who respond as a member of the party (L)

With a total population of J+K+L = N. The sampling and decision process works as follows:

- Keep sampling without replacement until n responding units are found (i.e. k+l=n)
- Non-responding people cannot be distinguished
- Reject the list if there are too many responding units which are not a member of a political party (i.e. reject if k>c for some appropriately chosen cut-off value c)

This means the joint probability of observing the k out of the n responding people as invalid, and j non-responding is given by:

$$\Pr(k,j) = \frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j}$$

This is a multivariate hypergeometric distribution for 3 groups multiplied by a factor. The factor in the equation is accounting for the stopping rule – that *n* responding units are needed. The stopping rule reduces the total number of possible samples of (n+j) units to be selected at random from N units.

Ignoring the information from the non-responding units

This joint distribution can be marginalised over the non-responding units to obtain a distribution for the number of invalid members:

$$\Pr(k) = \sum_{j=0}^{J}\frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j} = \binom{K}{k}\binom{L}{n-k}\sum_{j=0}^{J}\frac{\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j} = \frac{\binom{K}{k}\binom{L}{n-k}}{\binom{K+L}{n}}$$

This distribution is almost identical with the original distribution underlying the previous calculations. The only exception is we now have K+L<N due to the presence of J non-responding units.

The calculations in the spreadsheet provided are assuming that K+L=N. This means the "population" in the spreadsheets provided is referring to the responding list size, not the full list size. In terms of deductive evidence, we merely require N-j to be at least 500 to ensure that ignoring non-response can still be consistent with a list having 500 valid members.

We also need to consider using the observed response rate in an ad-hoc fashion by using it to convert the "K" and "L" parameters from the old version to their "responding" version. We can get an unbiased estimate of the response rate as:

$$r = \frac{n-1}{n-1+j} \quad and \quad K^* = rK \quad L^* = rL$$

Using information from the non-responding units

If the number of responding people in the sample becomes too large, then we would begin to doubt the validity of the list. This is particularly true if political parties discover the sampling strategy used and provides inaccurate contact information for the invalid members. So, it would be useful to include a cut-off for the number of non-responding people allowed.

Bayesian approach

Want to infer J, K, and L from the data. Calculate the following probabilities:

$$\Pr(L \geq 500 | k, j, n, N)$$

$$\Pr(L \leq 400 | k, j, n, N)$$

Likelihood is as given previously

$$\Pr(k, j | n, K, J) = \frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N}{n+j}} \frac{n}{n+j}$$

Using a uniform prior for K we have

$$\Pr(K, L, J | j, k, n, N) \propto \binom{K}{k}\binom{L}{n-k}\binom{J}{j}$$

This is a well-known distribution sometimes referred to as Polya's urn, on the three numbers (K-k), (L-n+k), (J-j) with parameters (k+1, n-k+1, j+1)

$$\Pr(K, L, J | j, k, n, N) = \frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N+2}{n+j+2}} \quad K \geq k, L \geq n-k, J \geq j \quad K+L+J = N$$

This distribution has mean ± standard deviations for each parameter of:

$$\hat{K} = k + (N-n-j)\hat{p}_K \pm \sqrt{\frac{\hat{p}_K(1-\hat{p}_K)}{n+j+4}(N-n-j)(N+n+j+3)} \quad where \quad \hat{p}_K = \frac{k+1}{n+j+3}$$

$$\hat{L} = n-k + (N-n-j)\hat{p}_L \pm \sqrt{\frac{\hat{p}_L(1-\hat{p}_L)}{n+j+4}(N-n-j)(N+n+j+3)} \quad where \quad \hat{p}_L = \frac{n-k+1}{n+j+3}$$

$$\hat{J} = j + (N-n-j)\hat{p}_J \pm \sqrt{\frac{\hat{p}_J(1-\hat{p}_J)}{n+j+4}(N-n-j)(N+n+j+3)} \quad where \quad \hat{p}_J = \frac{j+1}{n+j+3}$$

We can use a normal approximation to calculate the probabilities as:

$$\Pr(L \geq 500|k,j,n,N) \approx 1 - \Phi\left(\frac{500 - [n-k+(N-n-j)\hat{p}_L]}{\sqrt{\frac{\hat{p}_L(1-\hat{p}_L)}{n+j+4}(N-n-j)(N+n+j+3)}}\right)$$

$$\Pr(L \leq 400|k,j,n,N) \approx \Phi\left(\frac{400 - [n-k+(N-n-j)\hat{p}_L]}{\sqrt{\frac{\hat{p}_L(1-\hat{p}_L)}{n+j+4}(N-n-j)(N+n+j+3)}}\right)$$

Accounting for non-response

We may wish to consider including a further prior over the non-responding units to either put them into "valid" or "invalid" groups. One way to do this is to assume a binomial distribution

$$\Pr(K_{NR}|J,K,L,\theta) = \binom{J}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{J-K_{NR}}$$

The probability parameter θ can depend on any of J, K, or L. One intuitive choice is to assume θ=K/(K+L) which corresponds to non-informative non-response.

This means the new prior is given as:

$$\Pr(K,L,K_{NR},J|N,\theta) = \Pr(K,L,J|N,\theta)\Pr(K_{NR}|J,K,L,\theta) = \frac{1}{\binom{N+2}{N}}\binom{J}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{J-K_{NR}}$$

And new posterior is given as:

$$\Pr(K,L,K_{NR},J|k,j,n,N,\theta) \propto \binom{K}{k}\binom{L}{n-k}\binom{J}{j}\binom{J}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{J-K_{NR}}$$

This can be expressed as:

$$\Pr(K,L,K_{NR},L_{NR}|\theta,N) = \frac{1}{\binom{N+2}{N}}\binom{K_{NR}+L_{NR}}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{L_{NR}}$$

And the new likelihood is given as:

$$\Pr(k,j|K,L,K_{NR},L_{NR},\theta,n,N) = \frac{\binom{K}{k}\binom{L}{n-k}\binom{K_{NR}+L_{NR}}{j}}{\binom{N}{n+j}}\frac{n}{n+j}$$

Leading to a new posterior distribution of:

$$\Pr(K, L, K_{NR}, L_{NR}|\theta, j, k, n, N) \propto \binom{K}{k}\binom{L}{n-k}\binom{K_{NR}+L_{NR}}{j}\binom{K_{NR}+L_{NR}}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{L_{NR}}$$

This is obviously not a standard probability distribution. We can go part-way to calculating the normalising constant by analytically summing over K and L

$$\sum_{K=0}^{N-K_{NR}-L_{NR}} \binom{K}{k}\binom{N-K_{NR}-L_{NR}-K}{n-k} = \binom{N-K_{NR}-L_{NR}+1}{n+1}$$

This gives a normalising constant equal to:

$$\sum_{K_{NR}=0}^{N}\sum_{L_{NR}=0}^{N-K_{NR}} \binom{N-K_{NR}-L_{NR}+1}{n+1}\binom{K_{NR}+L_{NR}}{j}\binom{K_{NR}+L_{NR}}{K_{NR}}\theta^{K_{NR}}(1-\theta)^{L_{NR}}$$

What we really want to calculate though is the following:

$$\Pr(L + L_{NR} \geq 500|k, j, n, N, \theta)$$

$$\Pr(L + L_{NR} \leq 400|k, j, n, N, \theta)$$

Sheet Name	Description
Table (10% & 2%)	List of required sample sizes cut-off values for member list sizes from 500 to 1000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 400 valid members; - no more than a 10% chance of incorrectly rejecting a list with 500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 400 valid members - Probability of incorrectly rejecting a list with 500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 500 up to 1000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 10%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 550 members, a sample size of 45 and max denials of 6 will give a Probability of rejecting a valid list of 10.11%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 400 - risk	Rejecting 500 - risk
500	18	0	1.7%	0.0%
501	18	0	1.6%	3.6%
502	18	0	1.5%	7.0%
503	26	1	1.8%	0.7%
504	26	1	1.7%	1.4%
505	26	1	1.6%	2.3%
506	26	1	1.6%	3.4%
507	26	1	1.5%	4.5%
508	26	1	1.4%	5.8%
509	26	1	1.4%	7.2%
510	26	1	1.3%	8.7%
511	32	2	1.6%	2.6%
512	32	2	1.6%	3.3%
513	32	2	1.5%	4.1%
514	32	2	1.4%	5.0%
515	32	2	1.3%	6.0%
516	32	2	1.3%	7.0%
517	32	2	1.2%	8.1%
518	32	2	1.2%	9.3%
519	37	3	1.5%	3.9%
520	37	3	1.4%	4.6%

521	37	3	1.4%	5.4%
522	37	3	1.3%	6.2%
523	37	3	1.2%	7.1%
524	37	3	1.2%	8.0%
525	37	3	1.1%	9.0%
526	41	4	1.6%	4.3%
527	41	4	1.5%	5.0%
528	41	4	1.4%	5.7%
529	41	4	1.3%	6.4%
530	41	4	1.3%	7.2%
531	41	4	1.2%	8.1%
532	41	4	1.1%	9.0%
533	41	4	1.1%	9.9%
534	44	5	1.7%	5.1%
535	44	5	1.6%	5.7%
536	44	5	1.5%	6.4%
537	44	5	1.5%	7.1%
538	44	5	1.4%	7.9%
539	44	5	1.3%	8.7%
540	44	5	1.3%	9.5%
541	47	6	1.8%	5.4%
542	47	6	1.7%	6.0%
543	47	6	1.6%	6.6%
544	47	6	1.6%	7.3%
545	47	6	1.5%	8.0%
546	47	6	1.4%	8.8%
547	47	6	1.3%	9.6%
548	50	7	1.8%	5.9%
549	50	7	1.7%	6.4%
550	50	7	1.6%	7.1%
551	50	7	1.6%	7.7%
552	50	7	1.5%	8.4%
553	50	7	1.4%	9.2%

554	50	7	1.3%	9.9%
555	53	8	1.7%	6.5%
556	53	8	1.7%	7.1%
557	53	8	1.6%	7.7%
558	53	8	1.5%	8.4%
559	53	8	1.4%	9.1%
560	53	8	1.4%	9.8%
561	56	9	1.7%	6.7%
562	56	9	1.6%	7.3%
563	56	9	1.5%	8.0%
564	56	9	1.5%	8.6%
565	56	9	1.4%	9.3%
566	59	10	1.7%	6.6%
567	59	10	1.6%	7.2%
568	59	10	1.5%	7.8%
569	59	10	1.4%	8.4%
570	59	10	1.4%	9.1%
571	59	10	1.3%	9.8%
572	61	11	1.9%	6.5%
573	61	11	1.8%	7.0%
574	61	11	1.7%	7.6%
575	61	11	1.6%	8.2%
576	61	11	1.5%	8.8%
577	61	11	1.4%	9.4%
578	64	12	1.7%	7.2%
579	64	12	1.6%	7.7%
580	64	12	1.5%	8.3%
581	64	12	1.4%	8.9%
582	64	12	1.3%	9.6%
583	66	13	1.8%	6.7%
584	66	13	1.7%	7.2%
585	66	13	1.7%	7.8%
586	66	13	1.6%	8.3%

587	66	13	1.5%	8.9%
588	66	13	1.4%	9.6%
589	68	14	1.9%	6.8%
590	68	14	1.8%	7.4%
591	68	14	1.7%	7.9%
592	68	14	1.6%	8.5%
593	68	14	1.6%	9.0%
594	68	14	1.5%	9.6%
595	70	15	1.9%	7.1%
596	70	15	1.9%	7.6%
597	70	15	1.8%	8.1%
598	70	15	1.7%	8.6%
599	70	15	1.6%	9.2%
600	70	15	1.5%	9.8%
601	72	16	2.0%	7.3%
602	72	16	1.9%	7.8%
603	72	16	1.8%	8.4%
604	72	16	1.7%	8.9%
605	72	16	1.6%	9.5%
606	75	17	1.7%	8.1%
607	75	17	1.6%	8.6%
608	75	17	1.5%	9.2%
609	75	17	1.4%	9.7%
610	77	18	1.8%	7.5%
611	77	18	1.7%	8.0%
612	77	18	1.6%	8.5%
613	77	18	1.6%	9.1%
614	77	18	1.5%	9.6%
615	79	19	1.8%	7.5%
616	79	19	1.7%	8.0%
617	79	19	1.7%	8.5%
618	79	19	1.6%	9.1%
619	79	19	1.5%	9.6%

620	81	20	1.8%	7.6%
621	81	20	1.7%	8.1%
622	81	20	1.7%	8.6%
623	81	20	1.6%	9.1%
624	81	20	1.5%	9.7%
625	83	21	1.8%	7.7%
626	83	21	1.7%	8.2%
627	83	21	1.6%	8.7%
628	83	21	1.6%	9.2%
629	83	21	1.5%	9.8%
630	85	22	1.8%	7.9%
631	85	22	1.7%	8.4%
632	85	22	1.6%	8.9%
633	85	22	1.5%	9.4%
634	85	22	1.5%	10.0%
635	87	23	1.7%	8.1%
636	87	23	1.7%	8.6%
637	87	23	1.6%	9.1%
638	87	23	1.5%	9.7%
639	89	24	1.8%	8.0%
640	89	24	1.7%	8.4%
641	89	24	1.6%	8.9%
642	89	24	1.5%	9.5%
643	89	24	1.4%	10.0%
644	91	25	1.7%	8.3%
645	91	25	1.6%	8.8%
646	91	25	1.5%	9.3%
647	91	25	1.5%	9.8%
648	93	26	1.7%	8.2%
649	93	26	1.6%	8.7%
650	93	26	1.5%	9.2%
651	93	26	1.5%	9.7%
652	95	27	1.7%	8.2%

653	95	27	1.6%	8.7%
654	95	27	1.5%	9.2%
655	95	27	1.4%	9.7%
656	97	28	1.6%	8.2%
657	97	28	1.6%	8.7%
658	97	28	1.5%	9.2%
659	97	28	1.4%	9.7%
660	98	29	2.0%	7.3%
661	98	29	1.9%	7.8%
662	98	29	1.8%	8.2%
663	98	29	1.7%	8.7%
664	98	29	1.6%	9.1%
665	98	29	1.5%	9.6%
666	100	30	1.7%	8.3%
667	100	30	1.6%	8.7%
668	100	30	1.6%	9.2%
669	100	30	1.5%	9.7%
670	102	31	1.7%	8.4%
671	102	31	1.6%	8.9%
672	102	31	1.5%	9.4%
673	102	31	1.4%	9.8%
674	103	32	2.0%	7.6%
675	103	32	1.9%	8.0%
676	103	32	1.8%	8.5%
677	103	32	1.7%	8.9%
678	103	32	1.6%	9.4%
679	103	32	1.5%	9.8%
680	105	33	1.7%	8.6%
681	105	33	1.6%	9.1%
682	105	33	1.5%	9.6%
683	107	34	1.7%	8.4%
684	107	34	1.6%	8.9%
685	107	34	1.5%	9.3%

686	107	34	1.5%	9.8%
687	108	35	2.0%	7.7%
688	108	35	1.9%	8.1%
689	108	35	1.8%	8.5%
690	108	35	1.7%	9.0%
691	108	35	1.6%	9.4%
692	108	35	1.6%	9.9%
693	110	36	1.7%	8.8%
694	110	36	1.6%	9.3%
695	110	36	1.5%	9.7%
696	112	37	1.7%	8.7%
697	112	37	1.6%	9.2%
698	112	37	1.5%	9.6%
699	113	38	2.0%	7.6%
700	113	38	1.9%	8.0%
701	113	38	1.8%	8.4%
702	113	38	1.7%	8.9%
703	113	38	1.7%	9.3%
704	113	38	1.6%	9.7%
705	115	39	1.7%	8.8%
706	115	39	1.6%	9.2%
707	115	39	1.5%	9.7%
708	117	40	1.6%	8.8%
709	117	40	1.6%	9.2%
710	117	40	1.5%	9.7%
711	118	41	1.9%	7.8%
712	118	41	1.8%	8.2%
713	118	41	1.8%	8.6%
714	118	41	1.7%	9.0%
715	118	41	1.6%	9.4%
716	118	41	1.5%	9.9%
717	119	42	2.0%	8.0%
718	119	42	1.9%	8.3%

719	119	42	1.8%	8.7%
720	119	42	1.7%	9.2%
721	119	42	1.7%	9.6%
722	121	43	1.7%	8.8%
723	121	43	1.7%	9.2%
724	121	43	1.6%	9.7%
725	123	44	1.7%	8.9%
726	123	44	1.6%	9.3%
727	123	44	1.5%	9.8%
728	124	45	1.9%	7.9%
729	124	45	1.9%	8.3%
730	124	45	1.8%	8.7%
731	124	45	1.7%	9.1%
732	124	45	1.6%	9.6%
733	124	45	1.6%	10.0%
734	125	46	2.0%	8.2%
735	125	46	1.9%	8.5%
736	125	46	1.8%	8.9%
737	125	46	1.7%	9.4%
738	125	46	1.7%	9.8%
739	127	47	1.7%	9.1%
740	127	47	1.6%	9.5%
741	127	47	1.6%	9.9%
742	128	48	2.0%	8.2%
743	128	48	1.9%	8.6%
744	128	48	1.8%	9.0%
745	128	48	1.8%	9.4%
746	128	48	1.7%	9.8%
747	130	49	1.7%	9.2%
748	130	49	1.6%	9.6%
749	130	49	1.6%	10.0%
750	131	50	2.0%	8.3%
751	131	50	1.9%	8.6%

752	131	50	1.8%	9.0%
753	131	50	1.7%	9.4%
754	131	50	1.7%	9.8%
755	133	51	1.7%	9.3%
756	133	51	1.6%	9.7%
757	135	52	1.7%	9.1%
758	135	52	1.6%	9.5%
759	135	52	1.5%	10.0%
760	136	53	1.9%	8.3%
761	136	53	1.8%	8.7%
762	136	53	1.7%	9.1%
763	136	53	1.7%	9.4%
764	136	53	1.6%	9.9%
765	137	54	2.0%	8.2%
766	137	54	1.9%	8.6%
767	137	54	1.8%	9.0%
768	137	54	1.7%	9.4%
769	137	54	1.7%	9.8%
770	139	55	1.7%	9.3%
771	139	55	1.6%	9.7%
772	140	56	2.0%	8.1%
773	140	56	1.9%	8.5%
774	140	56	1.8%	8.8%
775	140	56	1.8%	9.2%
776	140	56	1.7%	9.6%
777	142	57	1.7%	9.2%
778	142	57	1.6%	9.6%
779	142	57	1.6%	10.0%
780	143	58	1.9%	8.4%
781	143	58	1.8%	8.8%
782	143	58	1.8%	9.1%
783	143	58	1.7%	9.5%
784	143	58	1.6%	9.9%

785	144	59	2.0%	8.4%
786	144	59	1.9%	8.7%
787	144	59	1.8%	9.1%
788	144	59	1.8%	9.5%
789	144	59	1.7%	9.9%
790	146	60	1.7%	9.5%
791	146	60	1.6%	9.9%
792	147	61	2.0%	8.4%
793	147	61	1.9%	8.7%
794	147	61	1.8%	9.1%
795	147	61	1.7%	9.5%
796	147	61	1.7%	9.9%
797	149	62	1.6%	9.5%
798	149	62	1.6%	9.9%
799	150	63	1.9%	8.5%
800	150	63	1.8%	8.8%
801	150	63	1.8%	9.2%
802	150	63	1.7%	9.5%
803	150	63	1.6%	9.9%
804	151	64	2.0%	8.5%
805	151	64	1.9%	8.8%
806	151	64	1.8%	9.2%
807	151	64	1.8%	9.5%
808	151	64	1.7%	9.9%
809	153	65	1.7%	9.6%
810	155	66	1.6%	9.4%
811	155	66	1.6%	9.8%
812	156	67	1.9%	8.4%
813	156	67	1.8%	8.7%
814	156	67	1.7%	9.1%
815	156	67	1.7%	9.4%
816	156	67	1.6%	9.8%
817	157	68	1.9%	8.4%

818	157	68	1.9%	8.7%
819	157	68	1.8%	9.1%
820	157	68	1.7%	9.5%
821	157	68	1.6%	9.8%
822	158	69	2.0%	8.4%
823	158	69	1.9%	8.8%
824	158	69	1.8%	9.1%
825	158	69	1.8%	9.5%
826	158	69	1.7%	9.8%
827	160	70	1.6%	9.7%
828	161	71	2.0%	8.3%
829	161	71	1.9%	8.7%
830	161	71	1.8%	9.0%
831	161	71	1.7%	9.4%
832	161	71	1.7%	9.7%
833	163	72	1.6%	9.6%
834	163	72	1.6%	9.9%
835	164	73	1.9%	8.6%
836	164	73	1.8%	8.9%
837	164	73	1.7%	9.3%
838	164	73	1.7%	9.6%
839	164	73	1.6%	10.0%
840	165	74	1.9%	8.7%
841	165	74	1.8%	9.0%
842	165	74	1.8%	9.3%
843	165	74	1.7%	9.7%
844	167	75	1.6%	9.6%
845	167	75	1.6%	10.0%
846	168	76	1.9%	8.6%
847	168	76	1.8%	9.0%
848	168	76	1.7%	9.3%
849	168	76	1.7%	9.7%
850	169	77	2.0%	8.4%

851	169	77	1.9%	8.7%
852	169	77	1.8%	9.0%
853	169	77	1.8%	9.4%
854	169	77	1.7%	9.7%
855	170	78	2.0%	8.5%
856	170	78	1.9%	8.8%
857	170	78	1.9%	9.1%
858	170	78	1.8%	9.5%
859	170	78	1.7%	9.8%
860	172	79	1.6%	9.8%
861	173	80	1.9%	8.5%
862	173	80	1.9%	8.8%
863	173	80	1.8%	9.2%
864	173	80	1.7%	9.5%
865	173	80	1.7%	9.9%
866	174	81	2.0%	8.6%
867	174	81	1.9%	8.9%
868	174	81	1.8%	9.3%
869	174	81	1.8%	9.6%
870	174	81	1.7%	9.9%
871	175	82	2.0%	8.7%
872	175	82	1.9%	9.0%
873	175	82	1.8%	9.4%
874	175	82	1.8%	9.7%
875	177	83	1.7%	9.7%
876	178	84	2.0%	8.5%
877	178	84	1.9%	8.8%
878	178	84	1.8%	9.1%
879	178	84	1.8%	9.5%
880	178	84	1.7%	9.8%
881	180	85	1.6%	9.8%
882	181	86	1.9%	8.6%
883	181	86	1.8%	9.0%

884	181	86	1.8%	9.3%
885	181	86	1.7%	9.6%
886	181	86	1.6%	10.0%
887	182	87	1.9%	8.8%
888	182	87	1.8%	9.1%
889	182	87	1.8%	9.4%
890	182	87	1.7%	9.7%
891	183	88	2.0%	8.6%
892	183	88	1.9%	8.9%
893	183	88	1.9%	9.2%
894	183	88	1.8%	9.5%
895	183	88	1.7%	9.9%
896	185	89	1.6%	9.9%
897	186	90	1.9%	8.8%
898	186	90	1.8%	9.1%
899	186	90	1.8%	9.4%
900	186	90	1.7%	9.7%
901	187	91	2.0%	8.6%
902	187	91	1.9%	8.9%
903	187	91	1.8%	9.2%
904	187	91	1.8%	9.5%
905	187	91	1.7%	9.9%
906	188	92	2.0%	8.7%
907	188	92	1.9%	9.0%
908	188	92	1.8%	9.3%
909	188	92	1.8%	9.7%
910	188	92	1.7%	10.0%
911	189	93	2.0%	8.8%
912	189	93	1.9%	9.1%
913	189	93	1.9%	9.5%
914	189	93	1.8%	9.8%
915	191	94	1.7%	9.9%
916	192	95	1.9%	8.8%

917	192	95	1.9%	9.1%
918	192	95	1.8%	9.4%
919	192	95	1.7%	9.7%
920	194	96	1.6%	9.9%
921	195	97	1.9%	8.8%
922	195	97	1.8%	9.1%
923	195	97	1.7%	9.4%
924	195	97	1.7%	9.7%
925	196	98	1.9%	8.6%
926	196	98	1.9%	8.9%
927	196	98	1.8%	9.3%
928	196	98	1.7%	9.6%
929	196	98	1.7%	9.9%
930	197	99	1.9%	8.8%
931	197	99	1.9%	9.1%
932	197	99	1.8%	9.4%
933	197	99	1.8%	9.7%
934	199	100	1.6%	9.9%
935	200	101	1.9%	8.8%
936	200	101	1.8%	9.1%
937	200	101	1.7%	9.4%
938	200	101	1.7%	9.8%
939	201	102	1.9%	8.7%
940	201	102	1.9%	9.0%
941	201	102	1.8%	9.3%
942	201	102	1.7%	9.6%
943	201	102	1.7%	9.9%
944	202	103	1.9%	8.9%
945	202	103	1.9%	9.2%
946	202	103	1.8%	9.5%
947	202	103	1.7%	9.8%
948	205	105	1.9%	8.7%
949	205	105	1.9%	8.9%

950	205	105	1.8%	9.2%
951	205	105	1.7%	9.6%
952	205	105	1.7%	9.9%
953	206	106	1.9%	8.8%
954	206	106	1.8%	9.1%
955	206	106	1.8%	9.4%
956	206	106	1.7%	9.7%
957	207	107	2.0%	8.7%
958	207	107	1.9%	9.0%
959	207	107	1.8%	9.3%
960	207	107	1.8%	9.6%
961	207	107	1.7%	9.9%
962	208	108	2.0%	8.9%
963	208	108	1.9%	9.2%
964	208	108	1.8%	9.4%
965	208	108	1.8%	9.8%
966	211	110	1.9%	8.7%
967	211	110	1.9%	9.0%
968	211	110	1.8%	9.3%
969	211	110	1.7%	9.6%
970	211	110	1.7%	9.9%
971	212	111	1.9%	8.9%
972	212	111	1.9%	9.2%
973	212	111	1.8%	9.5%
974	212	111	1.7%	9.8%
975	213	112	2.0%	8.8%
976	213	112	1.9%	9.1%
977	213	112	1.8%	9.4%
978	213	112	1.8%	9.7%
979	213	112	1.7%	10.0%
980	214	113	2.0%	9.0%
981	214	113	1.9%	9.2%
982	214	113	1.8%	9.5%

983	214	113	1.8%	9.8%
984	217	115	1.9%	8.9%
985	217	115	1.8%	9.2%
986	217	115	1.8%	9.5%
987	217	115	1.7%	9.8%
988	218	116	2.0%	8.8%
989	218	116	1.9%	9.1%
990	218	116	1.8%	9.3%
991	218	116	1.8%	9.6%
992	218	116	1.7%	9.9%
993	219	117	1.9%	9.0%
994	219	117	1.9%	9.2%
995	219	117	1.8%	9.5%
996	219	117	1.8%	9.8%
997	220	118	2.0%	8.9%
998	220	118	1.9%	9.1%
999	220	118	1.9%	9.4%
1000	220	118	1.8%	9.7%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 500 and 400 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	540
Sample size	68
Maximum number of denials allowed	11
Number of non-responding units	4

ASSUMPTIONS	
Valid list size	500
Invalid list size	400
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	10%

RESULT		
Expected # of responding members	510	
Expected # of responding valid (valid list)	472	
Expected # of responding valid (invalid list)	377	
Probability of false rejection	0.19%	<10% (OK)
Probability of false acceptance	2.85%	>2% (Not OK)

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 1000, 10% and 2% the approximate value returned are 214 and 115.

INPUTS	
Members Lodged	550
Desired probability of false rejection	10%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	500
Unacceptable list	400

RESULT	
Approximate sample size required	46
Approximate maximum number of denials	6

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.181818
B	-1.28308
n0	49.80051
n1	45.66387
mu0	4.181818
mu1	12.54545
sig0	1.868165
sig1	2.894149
c0	6.075968
c1	6.101598

S47C, S47E(d)

MDMD Admin WDB "S22" 04/10/2024 05:21 PM

Basics

"S22" 04/10/2024 05:21 PM
S22@abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au>	
	cc	
	bcc	
Subject	S47C, S47E(d)	
Protective Mark	OFFICIAL	
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy	Caveat ☐ ATIC
Categories		

From: S22@abs.gov.au>
Sent: Tuesday, February 9, 2021 3:39 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S22@abs.gov.au>; Paul Schubert <Paul.Schubert@abs.gov.au>
Subject: S47C, S47E(d)

Hi Anders,

S22

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: Anders Holmberg/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 09/02/2021 03:04 PM
Subject: S47C, S47E(d)

Thank you S2 ,

S47C, S47E(d)

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | **(W)**: www.abs.gov.au

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From: S22 Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 09/02/2021 12:53 PM
Subject: S47C, S47E(d)

Hi Anders (again),

S47C, S47E(d)

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: S22 Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 09/02/2021 09:57 AM
Subject: S47C, S47E(d)

Hi Anders,

S47C, S47E(d)

S47C, S47E(d)

[redacted]

Cheers,

[redacted]
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) [redacted]
(E) [redacted]@abs.gov.au **(W)** www.abs.gov.au

From: Anders Holmberg/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, Paul Schubert/Staff/ABS@ABS
Date: 08/02/2021 05:00 PM
Subject: S47C, S47E(d)

Hi S22 ,

S47C, S47E(d)

cheers,

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): **Anders.Holmberg@abs.gov.au** | **(W)**: **www.abs.gov.au**

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From: S22 /Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: Paul Schubert/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 04/02/2021 10:57 AM
Subject: S47C, S47E(d)

Hi Anders,

S47C, S47E(d)

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 **@abs.gov.au** **(W)** **www.abs.gov.au**

----- Forwarded by S22 /Staff/ABS on 04/02/2021 10:47 AM -----

From: Siu-Ming Tam/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: S22 Staff/ABS@ABS
Date: 17/03/2017 04:50 PM
Subject: S47C, S47E(d)

S22

S47C, S47E(d)

Siu-Ming

Siu-Ming Tam (Dr)
Chief Methodologist /General Manager | Methodology Division | Australian Bureau of Statistics
(P): +61 2 6252 7160 | (E): Siu-Ming.Tam@abs.gov.au | (W): www.abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters and community. We pay our respects to them and their cultures, and elders, both past and present.

----- Forwarded by Siu-Ming Tam/Staff/ABS on 17/03/2017 04:49 PM -----

From: S22 /Staff/ABS
To: Siu-Ming Tam/Staff/ABS@ABS,
Cc: Paul Schubert/Staff/ABS@ABS, Trevor Sutton/Staff/ABS@ABS
Date: 17/03/2017 04:46 PM
Subject: S47C, S47E(d)

Hi Siu-Ming,

S47C, S47E(d)

S47C, S47E(d)

Apologies for the short notice,
S22

S22
Executive Officer to the Australian Statistician
Governance & Parliamentary Liaison Branch | **Australian Bureau of Statistics**
(P) S22 **(M)** S22
(E) S22 **@abs.gov.au** **(W)** **www.abs.gov.au**

Technical appendix

The paper contains the derivations used to come up with the formula applied in the advice given to the AEC.

Mathematical description of the problem

The (simplified) problem is a quality control problem which has two competing hypothesis:

- H_0: the list provided contains 500 valid members
- H_1: the list provided contains 400 valid members

The notation for tolerance risks are; α the probability of *falsely* rejecting H_0, i.e. falsely concluding we have <500 members, and β the probability of *falsely* concluding there are 500 members or more although the true number is 400, i.e. false acceptance of the invalid list in H_1.

The notation used in this document is given below:

Symbol	Description
N	Number of members lodged
n	Number of members sampled
K	True number of invalid members lodged
k	Number of invalid members found in the sample
c	Maximum number of invalid members to pass the test (ie decision boundary)
μ_h	Expected number of invalid members in the sample, assuming hypothesis *h* is true
σ_h	Standard deviation of invalid members in the sample, assuming hypothesis *h* is true

The exact probabilities desired to perform the test are the cumulative hypergeometric probabilities.

$$Pr(False\ Acceptance) = Pr(k \le c|H_1) = \sum_{k=0}^{c} \frac{\binom{N-400}{k}\binom{400}{n-k}}{\binom{N}{n}} = F(c,n,N-400,N)$$

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \le c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-500}{k}\binom{500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c,n,N-500,N)$$

These are the values provided in the *Calculator – Error rates* sheet in the Calculator workbook

There exist numerous functions built into various program to calculate the cumulative hypergeometric distribution. However, we want to fix these probabilities to specified values. So we actually need solve the following problem:

$$Choose\ c,n\ such\ that:$$

$$F(c,n,N-400,N) \le \beta$$

$$1 - F(c,n,N-500,N) \le \alpha$$

The default values are α=10% and β=2%. Also, we would like to choose the sample size to be as small as possible.

Approximate solution using the normal approximation

One way to do this is through the use of the normal approximation to the hypergeometric distribution. We have:

$$\mu_0 = n\frac{N-500}{N} \quad \sigma_0 = \sqrt{n\frac{N-500}{N}\frac{500}{N}\frac{N-n}{N-1}}$$

$$\mu_1 = n\frac{N-400}{N} \quad \sigma_1 = \sqrt{n\frac{N-400}{N}\frac{400}{N}\frac{N-n}{N-1}}$$

We can then use the approximations (incorporating the "continuity correction"):

$$F(c,n,N-400,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right)$$

$$F(c,n,N-500,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right)$$

And we have functions for inverting these equations through the normal quantiles. Substituting these values in gives us:

$$\Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right) \leq \beta \Rightarrow \frac{c+\frac{1}{2}-\mu_1}{\sigma_1} \leq z_\beta \Rightarrow c \geq \mu_1 - \frac{1}{2} + z_\beta\sigma_1$$

$$1-\Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right) \leq \alpha \Rightarrow \frac{c+\frac{1}{2}-\mu_0}{\sigma_0} \geq z_{1-\alpha} \Rightarrow c \leq \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0$$

We can eliminate the cut-off value by setting the above inequalities to equalities, leading to an equation in 1 variable:

$$\mu_1 - \frac{1}{2} + z_\beta\sigma_1 = \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0 \Rightarrow A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} = 0$$

$$Where \quad A = \frac{500-400}{N} \qquad B = \frac{z_\beta\sqrt{(N-400)400} - z_{1-\alpha}\sqrt{(N-500)500}}{N}$$

This does not have an analytic solution, but it can be numerically solved using newton's method. An approximate solution can be obtained by assuming large N and we have

$$A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} \approx A\sqrt{n} + B = 0 \Rightarrow n^{(0)} = \left(\frac{B}{A}\right)^2$$

We know this initial solution will be too high if A>0, B<0 (with larger error for larger N). We then apply newton updates to this initial solution:

$$n^{(i+1)} = n^{(i)} - \frac{A\sqrt{n^{(i)}} + B\sqrt{\frac{N-n^{(i)}}{N-1}}}{\frac{A}{2\sqrt{n^{(i)}}} - \frac{B}{2\sqrt{(N-n^{(i)})(N-1)}}}$$

Two updates will be sufficient (firstly because the initial approximation is close, and also because the function is smooth). Once a sufficiently good solution for n is found, it is rounded up to the nearest integer:

$$n^* = \lceil n^{(2)} \rceil$$

This can then be plugged back into the formulae for μ_0, μ_1, σ_0, σ_1 to get a value for the cut-off:

$$\Rightarrow c^* = round\left[\frac{\left(\mu_1^* - \frac{1}{2} + z_\beta \sigma_1^*\right) + \left(\mu_0^* - \frac{1}{2} + z_{1-\alpha}\sigma_0^*\right)}{2}\right]$$

The values c^* and n^* are provided in the *Calculator – Sample size* sheet in the Calculator workbook.

To see the newton updates are useful, with N=1000, α=10%, and β=2%, we get $n^{(0)}$=271 whereas $n^{(2)}$=214. Not applying the updates means that much larger sample sizes appear to be needed.

Modifying the approximate solution

The above solution will give values c^* and n^* that can be entered into the exact formula

$$F(c^*, n^*, N-400, N) \leq \beta$$

$$1 - F(c^*, n^*, N-500, N) \leq \alpha$$

These values should be approximately on the boundary of the inequality. The approximations used means these equalities may not be exactly satisfied. So, a small line search around the optimal sample size is used to get values that satisfy the two constraints. This is why the c and n values in the table provided does not always agree with the calculator.

There are some qualitative relationships outlined in the table below. These indicate the direction each risk is adjusted by when making changes to one parameter in the sampling plan, holding the other two parameters constant.

Parameter change	Effect on Probability of falsely rejecting (α)	Effect on Probability of falsely accepting (β)
N increases	Increase	Decrease
N decreases	Decrease	Increase
n increases	Increase	Decrease
n decreases	Decrease	Increase
c increases	Decrease	Increase
c decreases	Increase	Decrease

S22

From: S22
Sent: Thursday, 10 June 2021 11:15 AM
To: David Gruen
Cc: S22 ; S22 ; S22
Subject: Re: S47C, S47E(d)
[SEC=OFFICIAL]

Hi David,

S47C, S47E(d)

Kind regards,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: David Gruen/Staff/ABS
To: S22 /Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, S22 /Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 10/06/2021 10:07 AM
Subject: Re: S47C, S47E(d)

S47C, S47E(d)

S22

S47C, S47E(d)

Thanks
David

S47C, S47E(d)

From: S22 /Staff/ABS
To: David Gruen/Staff/ABS@ABS
Cc: S22 /Staff/ABS@ABS, S22 /Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 09/06/2021 02:25 PM
Subject: Revised slides for AEC briefing on electoral enrolment methodology [SEC=OFFICIAL]

Hi David

S47C, S47E(d)

Thanks

S22

S22

Executive Officer to the Australian Statistician, Dr David Gruen

Australian Bureau of Statistics

(P) S22 | (M) S22

(E) S22 @abs.gov.au | (W) **www.abs.gov.au**

Anders Holmberg

From: Anders Holmberg
Sent: Wednesday, 25 August 2021 4:56 PM
To: David Gruen
Cc: S22 ; Teresa Dickinson
Subject: Re: Fw: Letter from the Commissioner | Assurance of the membership testing methodology – non-contacts [SEC=OFFICIAL]

Thanks for the heads-up David,

Yes let's discuss this first.

S22

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | **(W)**: www.abs.gov.au

Executive Assistant: S22
(P) S22 | (E) S22 @abs.gov.au

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From: David Gruen/Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Cc: Teresa Dickinson/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 25/08/2021 04:32 PM
Subject: Fw: Letter from the Commissioner | Assurance of the membership testing methodology – non-contacts [SEC=OFFICIAL]

Hi Anders

We need to craft a reply to Tom Rogers' letter, which is specifically on the ABS statistical advice, S22
S22

S47C, S47E(d)

S22 -- could you please set something up for next week with me, Teresa, Anders and anyone else he thinks should be on the call?

Thx
David
----- Forwarded by David Gruen/Staff/ABS on 25/08/2021 04:24 PM -----

From: "S47F @aec.gov.au>

To: "'david.gruen@abs.gov.au'" <david.gruen@abs.gov.au>
Date: 25/08/2021 12:47 PM
Subject: Letter from the Commissioner | Assurance of the membership testing methodology – non-contacts [SEC=OFFICIAL]

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and k is safe.

Dear Dr Gruen

Please find the attached letter from the Commissioner S22

Regards
S47

S47F **| Personal Assistant to the Commissioner**
Executive Leadership Team | Executive Leadership Team
Australian Electoral Commission
T: S47F **X:** S47 **M:** S47F

AEC Australian Electoral Commission Make sure you're **enrolled to vote.** Visit www.aec.gov.au

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If you have received this transmission in error please notify us immediately by return email and delete all copies. If this email or any attachments have been sent to you in error, that error does not constitute waiver of any confidentiality, privilege or copyright in respect of information in the email or attachments. [attachment "25 08 2021 - Dr Gruen - 2021 Address non-contacts - AEC-ABS.pdf" deleted by Anders Holmberg/Staff/ABS] S22 S22

Anders Holmberg

From: David Gruen
Sent: Wednesday, 8 September 2021 12:22 PM
To: Anders Holmberg
Cc: Teresa Dickinson
Subject: Fw: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

Categories: Blue Category

Hi Anders

We are asked, as a matter of some urgency, to provide updated guidance using the same approach as before (that is, for non-responses, randomly choosing another potential member, with the non-response not counting as a non-member). The new Law requires non-Parliamentary parties to have a minimum of 1500 members rather than 500, and Tom Rogers is asking for advice applied to membership lists between 1500 and 2000.

Do you think we can give me the required answers by the end of the week?

Thx
David
----- Forwarded by David Gruen/Staff/ABS on 08/09/2021 12:14 PM -----

From: "S47F @aec.gov.au>
To: "'david.gruen@abs.gov.au'" <david.gruen@abs.gov.au>
Date: 08/09/2021 11:54 AM
Subject: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and k is safe.

Dear Dr Gruen

Please find the attached letter and Membership testing methodology calculator from Mr Rogers.

Regards
S47F

S47F | **Personal Assistant to the Commissioner**
Executive Leadership Team | Executive Leadership Team
Australian Electoral Commission
T: S47F **X:** S47 **M:** S47F

of any confidentiality, privilege or copyright in respect of information in the email or

08 09 2021 - Dr Gruen - Follow...

Calculator.xlsx

attachments.

AEC Australian Electoral Commission

Electoral Commissioner

Dr David Gruen
Australian Statistician
Australia Bureau of Statistics
Locked Bag 10
Belconnen, ACT, 2616

Dear Dr Gruen,

Follow-up to previous letter – request for advice

As you know from our Commission meeting last Friday, the Australian Electoral Commission (AEC) is considering options that would enable it to test whether a non-parliamentary party meets the new measures now required under the Electoral Act following the passage of the Electoral Legislation Amendment (Party Registration Integrity) Act 2021. Recent changes to the Electoral Act specify the requirement to for a non-parliamentary party to have at least 1,500 members before that party can be registered by the AEC.

One of the options being considered by the Commission is to continue using the existing membership testing process (with random sampling), scaled to align with the new 1,500 member requirement. This would see the AEC contact a random sample of party members until the required number of confirmations or denials is reached.

Importantly, the AEC has continued to receive applications to register as a political party since the new measures have come into effect and we need to process these applications within the timeframes outlined in the legislation. The option to continue using the existing membership testing process, would allow the AEC to continue to administer the political party registration process in the interim while the Commission considers other options. There is a need for an interim process as an investigation of other options, as discussed at the Commission meeting, will take time to complete.

As a matter of some urgency, can the Australian Bureau of Statistics (ABS) please provide updated guidance on the sampling methodology to be applied to membership lists of 1,500 to 2,000 members, using similar parameters to the previous methodology.

Previously, the ABS provided a guide for the size of random samples for membership lists containing up to 1,000 members, which I have attached to this letter. This allowed the AEC to decide an appropriate ‘upper limit’ for the size of membership lists that could be accepted by the AEC. It would be greatly appreciated if the ABS could provide a similar guide for the size of random samples for membership lists containing of up to 2,000 members.

Again, I thank you for your continued assistance in regard to ensuring the effectiveness of the membership testing methodology for the purpose of ascertaining that a ‘non-Parliamentary’ party has the required number of members.

Yours sincerely

S47F

Tom Rogers S47F

7 September 2021.

Anders Holmberg

From: Anders Holmberg
Sent: Thursday, 9 September 2021 5:51 PM
To: David Gruen
Subject: Draft letter informing S47F about our assistance [SEC=OFFICIAL]

Categories: Blue Category

Hi David,

Here is a draft mail as requested plus the calculator as reference

Dear S,

The ABS have updated the sample size calculator as a solution to the new situation described in your letter.

The calculator has been signed off by the Chief Methodologist and was forwarded by ABS to S47F and S47 at the AEC. They confirmed the following settings.

- Keep the same 10% and 2% risk parameters as in the previous calculator. This means the following alterations have been made:
-
- An Increase of the valid list size to 1500 so the risk of rejecting a valid application with 1500 members is 10%.
- An increase of the invalid list size to 1200. This maintains the relationship of the invalid list as 20% smaller than the valid list. The risk of accepting an invalid application containing only 1200 members is 2%.
- In the calculator spreadsheet there is a table to help determine the sample size. The table covers from 1500 up to 3000 lodged names.

Calculator - 1500 list size.xl...

Best regards,

David.

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | **(W)**: www.abs.gov.au

Executive Assistant: S22
(P) S22 | (E) S22 @abs.gov.au

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Anders Holmberg

From: David Gruen
Sent: Friday, 10 September 2021 9:05 AM
To: Tom Rogers
Cc: Anders Holmberg
Subject: New calculator for non-Parliamentary political parties [SEC=OFFICIAL]

Categories: Blue Category

Dear Tom,

The ABS has updated the sample size calculator for the new circumstances described in your letter.

The calculator has been signed off by our Chief Methodologist S22 [redacted] and was forwarded by ABS to S47F [redacted] and S47F [redacted] at the AEC. They confirmed the following settings.

- The risk parameters have been kept at 10% and 2%, as in the previous calculator. This means the following alterations have been made:
-
- An Increase of the valid list size to 1500 so the risk of rejecting a valid application with 1500 members is up to 10%.
- An increase of the invalid list size to 1200. This means the invalid list is 20% smaller than the valid list (as it was previously). The risk of accepting as valid an application containing only 1200 members is up to 2%.
- In the calculator spreadsheet there is a table to help determine the required sample size. The table covers from 1500 up to 3000 lodged names.
-

I note that the required random sample size for a list of 2000 lodged names is 110, which I think is significantly smaller than you had feared it might be.

I attach a copy of the updated calculator spreadsheet for your convenience.

-

Cheers
David

Calculator - 1500 list size.xl...

Anders Holmberg

From: David Gruen
Sent: Thursday, 7 October 2021 3:37 PM
To: S22
Cc: Anders Holmberg
Subject: Re: Fw: updated list with 6% and 2% [SEC=OFFICIAL]

Great. Thanks S22 . S47E(d), S47C

S47E(d), S47C

Cheers
David

From: S22 /Staff/ABS
To: David Gruen/Staff/ABS@ABS
Cc: Anders Holmberg/Staff/ABS@ABS
Date: 07/10/2021 03:31 PM
Subject: Re: Fw: updated list with 6% and 2% [SEC=OFFICIAL]

Hi David,

S47E(d), S47C

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: David Gruen/Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS, S22 /Staff/ABS@ABS
Date: 07/10/2021 09:29 AM
Subject: Re: Fw: updated list with 6% and 2% [SEC=OFFICIAL]

Thanks Anders and S22

S47E(d), S47C

Cheers
David

From: Anders Holmberg/Staff/ABS
To: David Gruen/Staff/ABS@ABS
Cc: "Tom Rogers" <Tom.Rogers@aec.gov.au>
Date: 06/10/2021 08:17 PM
Subject: Fw: updated list with 6% and 2% [SEC=OFFICIAL]

Dear David and Tom,

I thank S22 for the update. For comparison please find the attached the sampling plan table with up to 6 % false rejection risk and the updated calculator.

Best regards,

Anders

[attachment "Table 1500 list size 6 pct false rejection.pdf" deleted by David Gruen/Staff/ABS]

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The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters, and community. We pay our respects to them and their cultures, and elders, both past and present.

----- Forwarded by Anders Holmberg/Staff/ABS on 06/10/2021 08:07 PM -----

From: S22 /Staff/ABS
To: Anders Holmberg/Staff/ABS@ABS
Date: 06/10/2021 06:09 PM
Subject: updated list with 6% and 2% [SEC=OFFICIAL]

Hi Anders,

Please find the updated spreadsheet below
[attachment "Calculator - 1500 list size and 6pct false rejection.xlsx" deleted by David Gruen/Staff/ABS]

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Sheet Name	Description
Table (6% & 2%)	List of required sample sizes cut-off values for member list sizes from 1500 to 2000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 1200 valid members; - no more than a 6% chance of incorrectly rejecting a list with 1500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 1200 valid members - Probability of incorrectly rejecting a list with 1500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 1500 up to 3000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 6%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 1523 members, a sample size of 27 and max denials of 1 will give a Probability of rejecting a valid list of 6.09%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 1200 - risk	Rejecting 1500 - risk
1500	18	0	1.8%	0.0%
1501	18	0	1.7%	1.2%
1502	18	0	1.7%	2.4%
1503	18	0	1.7%	3.6%
1504	18	0	1.7%	4.7%
1505	18	0	1.7%	5.8%
1506	27	1	1.6%	0.4%
1507	27	1	1.6%	0.6%
1508	27	1	1.6%	0.8%
1509	27	1	1.6%	1.0%
1510	27	1	1.5%	1.3%
1511	27	1	1.5%	1.5%
1512	27	1	1.5%	1.8%
1513	27	1	1.5%	2.1%
1514	27	1	1.5%	2.4%
1515	27	1	1.4%	2.8%
1516	27	1	1.4%	3.1%
1517	27	1	1.4%	3.5%
1518	27	1	1.4%	3.9%
1519	27	1	1.3%	4.3%
1520	27	1	1.3%	4.7%
1521	27	1	1.3%	5.2%
1522	27	1	1.3%	5.6%
1523	33	2	1.8%	1.2%
1524	33	2	1.7%	1.4%
1525	33	2	1.7%	1.5%
1526	33	2	1.7%	1.7%
1527	33	2	1.6%	1.9%
1528	33	2	1.6%	2.1%
1529	33	2	1.6%	2.3%
1530	33	2	1.6%	2.5%
1531	33	2	1.5%	2.7%
1532	33	2	1.5%	3.0%
1533	33	2	1.5%	3.2%
1534	33	2	1.5%	3.4%
1535	33	2	1.4%	3.7%
1536	33	2	1.4%	4.0%
1537	33	2	1.4%	4.3%

1538	33	2	1.4%	4.6%
1539	33	2	1.4%	4.9%
1540	33	2	1.3%	5.2%
1541	33	2	1.3%	5.5%
1542	33	2	1.3%	5.8%
1543	38	3	1.8%	1.9%
1544	38	3	1.8%	2.1%
1545	38	3	1.7%	2.2%
1546	38	3	1.7%	2.4%
1547	38	3	1.7%	2.6%
1548	38	3	1.6%	2.8%
1549	38	3	1.6%	3.0%
1550	38	3	1.6%	3.2%
1551	38	3	1.6%	3.4%
1552	38	3	1.5%	3.6%
1553	38	3	1.5%	3.8%
1554	38	3	1.5%	4.0%
1555	38	3	1.5%	4.2%
1556	38	3	1.4%	4.5%
1557	38	3	1.4%	4.7%
1558	38	3	1.4%	5.0%
1559	38	3	1.4%	5.2%
1560	38	3	1.3%	5.5%
1561	38	3	1.3%	5.8%
1562	42	4	1.9%	2.3%
1563	42	4	1.9%	2.4%
1564	42	4	1.9%	2.6%
1565	42	4	1.8%	2.7%
1566	42	4	1.8%	2.9%
1567	42	4	1.8%	3.1%
1568	42	4	1.8%	3.2%
1569	42	4	1.7%	3.4%
1570	42	4	1.7%	3.6%
1571	42	4	1.7%	3.8%
1572	42	4	1.6%	4.0%
1573	42	4	1.6%	4.2%
1574	42	4	1.6%	4.4%
1575	42	4	1.6%	4.6%
1576	42	4	1.5%	4.8%
1577	42	4	1.5%	5.0%
1578	42	4	1.5%	5.3%
1579	42	4	1.5%	5.5%
1580	42	4	1.4%	5.7%
1581	42	4	1.4%	6.0%
1582	46	5	1.9%	2.9%
1583	46	5	1.9%	3.0%
1584	46	5	1.8%	3.2%
1585	46	5	1.8%	3.3%
1586	46	5	1.8%	3.5%
1587	46	5	1.7%	3.6%

1588	46	5	1.7%	3.8%
1589	46	5	1.7%	4.0%
1590	46	5	1.7%	4.2%
1591	46	5	1.6%	4.4%
1592	46	5	1.6%	4.6%
1593	46	5	1.6%	4.7%
1594	46	5	1.5%	5.0%
1595	46	5	1.5%	5.2%
1596	46	5	1.5%	5.4%
1597	46	5	1.5%	5.6%
1598	46	5	1.4%	5.8%
1599	50	6	1.8%	3.1%
1600	50	6	1.8%	3.3%
1601	50	6	1.8%	3.4%
1602	50	6	1.7%	3.6%
1603	50	6	1.7%	3.7%
1604	50	6	1.7%	3.9%
1605	50	6	1.6%	4.1%
1606	50	6	1.6%	4.2%
1607	50	6	1.6%	4.4%
1608	50	6	1.6%	4.6%
1609	50	6	1.5%	4.8%
1610	50	6	1.5%	5.0%
1611	50	6	1.5%	5.2%
1612	50	6	1.5%	5.4%
1613	50	6	1.4%	5.6%
1614	50	6	1.4%	5.8%
1615	50	6	1.4%	6.0%
1616	53	7	2.0%	3.2%
1617	53	7	2.0%	3.3%
1618	53	7	1.9%	3.5%
1619	53	7	1.9%	3.6%
1620	53	7	1.9%	3.8%
1621	53	7	1.8%	3.9%
1622	53	7	1.8%	4.1%
1623	53	7	1.8%	4.2%
1624	53	7	1.7%	4.4%
1625	53	7	1.7%	4.6%
1626	53	7	1.7%	4.7%
1627	53	7	1.6%	4.9%
1628	53	7	1.6%	5.1%
1629	53	7	1.6%	5.3%
1630	53	7	1.6%	5.5%
1631	53	7	1.5%	5.7%
1632	53	7	1.5%	5.9%
1633	57	8	1.7%	3.7%
1634	57	8	1.7%	3.9%
1635	57	8	1.7%	4.0%
1636	57	8	1.6%	4.2%
1637	57	8	1.6%	4.3%

1638	57	8	1.6%	4.5%
1639	57	8	1.6%	4.7%
1640	57	8	1.5%	4.8%
1641	57	8	1.5%	5.0%
1642	57	8	1.5%	5.2%
1643	57	8	1.4%	5.4%
1644	57	8	1.4%	5.5%
1645	57	8	1.4%	5.7%
1646	57	8	1.4%	5.9%
1647	60	9	1.8%	3.6%
1648	60	9	1.8%	3.7%
1649	60	9	1.8%	3.9%
1650	60	9	1.7%	4.0%
1651	60	9	1.7%	4.2%
1652	60	9	1.7%	4.3%
1653	60	9	1.6%	4.5%
1654	60	9	1.6%	4.6%
1655	60	9	1.6%	4.8%
1656	60	9	1.6%	4.9%
1657	60	9	1.5%	5.1%
1658	60	9	1.5%	5.3%
1659	60	9	1.5%	5.5%
1660	60	9	1.4%	5.6%
1661	60	9	1.4%	5.8%
1662	63	10	1.8%	3.7%
1663	63	10	1.8%	3.8%
1664	63	10	1.8%	4.0%
1665	63	10	1.7%	4.1%
1666	63	10	1.7%	4.3%
1667	63	10	1.7%	4.4%
1668	63	10	1.6%	4.6%
1669	63	10	1.6%	4.7%
1670	63	10	1.6%	4.9%
1671	63	10	1.6%	5.0%
1672	63	10	1.5%	5.2%
1673	63	10	1.5%	5.4%
1674	63	10	1.5%	5.5%
1675	63	10	1.4%	5.7%
1676	63	10	1.4%	5.9%
1677	66	11	1.8%	3.9%
1678	66	11	1.8%	4.0%
1679	66	11	1.7%	4.2%
1680	66	11	1.7%	4.3%
1681	66	11	1.7%	4.5%
1682	66	11	1.6%	4.6%
1683	66	11	1.6%	4.7%
1684	66	11	1.6%	4.9%
1685	66	11	1.5%	5.1%
1686	66	11	1.5%	5.2%
1687	66	11	1.5%	5.4%

1688	66	11	1.5%	5.6%
1689	66	11	1.4%	5.7%
1690	66	11	1.4%	5.9%
1691	69	12	1.7%	4.0%
1692	69	12	1.7%	4.2%
1693	69	12	1.7%	4.3%
1694	69	12	1.6%	4.5%
1695	69	12	1.6%	4.6%
1696	69	12	1.6%	4.7%
1697	69	12	1.6%	4.9%
1698	69	12	1.5%	5.0%
1699	69	12	1.5%	5.2%
1700	69	12	1.5%	5.4%
1701	69	12	1.4%	5.5%
1702	69	12	1.4%	5.7%
1703	69	12	1.4%	5.9%
1704	71	13	2.0%	3.7%
1705	71	13	2.0%	3.8%
1706	71	13	1.9%	4.0%
1707	71	13	1.9%	4.1%
1708	71	13	1.9%	4.2%
1709	71	13	1.8%	4.4%
1710	71	13	1.8%	4.5%
1711	71	13	1.8%	4.6%
1712	71	13	1.7%	4.8%
1713	71	13	1.7%	4.9%
1714	71	13	1.7%	5.1%
1715	71	13	1.6%	5.2%
1716	71	13	1.6%	5.4%
1717	71	13	1.6%	5.5%
1718	71	13	1.5%	5.7%
1719	71	13	1.5%	5.9%
1720	74	14	1.8%	4.3%
1721	74	14	1.8%	4.4%
1722	74	14	1.7%	4.5%
1723	74	14	1.7%	4.7%
1724	74	14	1.7%	4.8%
1725	74	14	1.6%	4.9%
1726	74	14	1.6%	5.1%
1727	74	14	1.6%	5.2%
1728	74	14	1.5%	5.4%
1729	74	14	1.5%	5.5%
1730	74	14	1.5%	5.7%
1731	74	14	1.5%	5.9%
1732	77	15	1.7%	4.4%
1733	77	15	1.7%	4.5%
1734	77	15	1.6%	4.6%
1735	77	15	1.6%	4.8%
1736	77	15	1.6%	4.9%
1737	77	15	1.5%	5.0%

1738	77	15	1.5%	5.2%
1739	77	15	1.5%	5.3%
1740	77	15	1.5%	5.5%
1741	77	15	1.4%	5.6%
1742	77	15	1.4%	5.8%
1743	77	15	1.4%	6.0%
1744	79	16	1.9%	4.1%
1745	79	16	1.8%	4.2%
1746	79	16	1.8%	4.3%
1747	79	16	1.8%	4.4%
1748	79	16	1.7%	4.6%
1749	79	16	1.7%	4.7%
1750	79	16	1.7%	4.8%
1751	79	16	1.7%	5.0%
1752	79	16	1.6%	5.1%
1753	79	16	1.6%	5.3%
1754	79	16	1.6%	5.4%
1755	79	16	1.5%	5.6%
1756	79	16	1.5%	5.7%
1757	79	16	1.5%	5.9%
1758	81	17	2.0%	4.1%
1759	81	17	1.9%	4.2%
1760	81	17	1.9%	4.3%
1761	81	17	1.9%	4.4%
1762	81	17	1.8%	4.6%
1763	81	17	1.8%	4.7%
1764	81	17	1.8%	4.8%
1765	81	17	1.7%	5.0%
1766	81	17	1.7%	5.1%
1767	81	17	1.7%	5.2%
1768	81	17	1.7%	5.4%
1769	81	17	1.6%	5.5%
1770	81	17	1.6%	5.7%
1771	81	17	1.6%	5.8%
1772	81	17	1.5%	6.0%
1773	84	18	1.7%	4.7%
1774	84	18	1.7%	4.9%
1775	84	18	1.6%	5.0%
1776	84	18	1.6%	5.1%
1777	84	18	1.6%	5.3%
1778	84	18	1.6%	5.4%
1779	84	18	1.5%	5.5%
1780	84	18	1.5%	5.7%
1781	84	18	1.5%	5.8%
1782	84	18	1.4%	6.0%
1783	86	19	1.9%	4.3%
1784	86	19	1.8%	4.4%
1785	86	19	1.8%	4.6%
1786	86	19	1.8%	4.7%
1787	86	19	1.7%	4.8%

1788	86	19	1.7%	4.9%
1789	86	19	1.7%	5.1%
1790	86	19	1.7%	5.2%
1791	86	19	1.6%	5.3%
1792	86	19	1.6%	5.5%
1793	86	19	1.6%	5.6%
1794	86	19	1.5%	5.8%
1795	86	19	1.5%	5.9%
1796	88	20	1.9%	4.3%
1797	88	20	1.9%	4.4%
1798	88	20	1.9%	4.6%
1799	88	20	1.8%	4.7%
1800	88	20	1.8%	4.8%
1801	88	20	1.8%	4.9%
1802	88	20	1.7%	5.1%
1803	88	20	1.7%	5.2%
1804	88	20	1.7%	5.3%
1805	88	20	1.7%	5.5%
1806	88	20	1.6%	5.6%
1807	88	20	1.6%	5.7%
1808	88	20	1.6%	5.9%
1809	90	21	2.0%	4.3%
1810	90	21	2.0%	4.5%
1811	90	21	1.9%	4.6%
1812	90	21	1.9%	4.7%
1813	90	21	1.9%	4.8%
1814	90	21	1.8%	5.0%
1815	90	21	1.8%	5.1%
1816	90	21	1.8%	5.2%
1817	90	21	1.7%	5.3%
1818	90	21	1.7%	5.5%
1819	90	21	1.7%	5.6%
1820	90	21	1.6%	5.8%
1821	90	21	1.6%	5.9%
1822	93	22	1.7%	4.9%
1823	93	22	1.7%	5.1%
1824	93	22	1.6%	5.2%
1825	93	22	1.6%	5.3%
1826	93	22	1.6%	5.5%
1827	93	22	1.5%	5.6%
1828	93	22	1.5%	5.7%
1829	93	22	1.5%	5.9%
1830	95	23	1.9%	4.4%
1831	95	23	1.8%	4.6%
1832	95	23	1.8%	4.7%
1833	95	23	1.8%	4.8%
1834	95	23	1.7%	4.9%
1835	95	23	1.7%	5.0%
1836	95	23	1.7%	5.2%
1837	95	23	1.6%	5.3%

1838	95	23	1.6%	5.4%
1839	95	23	1.6%	5.6%
1840	95	23	1.6%	5.7%
1841	95	23	1.5%	5.8%
1842	95	23	1.5%	6.0%
1843	97	24	1.9%	4.6%
1844	97	24	1.8%	4.7%
1845	97	24	1.8%	4.8%
1846	97	24	1.8%	4.9%
1847	97	24	1.7%	5.1%
1848	97	24	1.7%	5.2%
1849	97	24	1.7%	5.3%
1850	97	24	1.6%	5.4%
1851	97	24	1.6%	5.6%
1852	97	24	1.6%	5.7%
1853	97	24	1.6%	5.9%
1854	97	24	1.5%	6.0%
1855	99	25	1.9%	4.6%
1856	99	25	1.8%	4.7%
1857	99	25	1.8%	4.9%
1858	99	25	1.8%	5.0%
1859	99	25	1.7%	5.1%
1860	99	25	1.7%	5.2%
1861	99	25	1.7%	5.4%
1862	99	25	1.6%	5.5%
1863	99	25	1.6%	5.6%
1864	99	25	1.6%	5.8%
1865	99	25	1.6%	5.9%
1866	101	26	1.9%	4.6%
1867	101	26	1.9%	4.7%
1868	101	26	1.8%	4.8%
1869	101	26	1.8%	4.9%
1870	101	26	1.8%	5.1%
1871	101	26	1.7%	5.2%
1872	101	26	1.7%	5.3%
1873	101	26	1.7%	5.4%
1874	101	26	1.6%	5.6%
1875	101	26	1.6%	5.7%
1876	101	26	1.6%	5.8%
1877	101	26	1.6%	6.0%
1878	103	27	1.9%	4.7%
1879	103	27	1.9%	4.8%
1880	103	27	1.8%	4.9%
1881	103	27	1.8%	5.1%
1882	103	27	1.8%	5.2%
1883	103	27	1.7%	5.3%
1884	103	27	1.7%	5.4%
1885	103	27	1.7%	5.5%
1886	103	27	1.6%	5.7%
1887	103	27	1.6%	5.8%

1888	103	27	1.6%	5.9%
1889	105	28	1.9%	4.7%
1890	105	28	1.9%	4.8%
1891	105	28	1.8%	4.9%
1892	105	28	1.8%	5.1%
1893	105	28	1.8%	5.2%
1894	105	28	1.7%	5.3%
1895	105	28	1.7%	5.4%
1896	105	28	1.7%	5.6%
1897	105	28	1.6%	5.7%
1898	105	28	1.6%	5.8%
1899	105	28	1.6%	5.9%
1900	107	29	1.9%	4.8%
1901	107	29	1.8%	4.9%
1902	107	29	1.8%	5.0%
1903	107	29	1.8%	5.1%
1904	107	29	1.8%	5.2%
1905	107	29	1.7%	5.3%
1906	107	29	1.7%	5.5%
1907	107	29	1.7%	5.6%
1908	107	29	1.6%	5.7%
1909	107	29	1.6%	5.8%
1910	107	29	1.6%	6.0%
1911	109	30	1.9%	4.8%
1912	109	30	1.8%	4.9%
1913	109	30	1.8%	5.1%
1914	109	30	1.8%	5.2%
1915	109	30	1.7%	5.3%
1916	109	30	1.7%	5.4%
1917	109	30	1.7%	5.5%
1918	109	30	1.6%	5.7%
1919	109	30	1.6%	5.8%
1920	109	30	1.6%	5.9%
1921	111	31	1.9%	4.8%
1922	111	31	1.8%	4.9%
1923	111	31	1.8%	5.0%
1924	111	31	1.8%	5.1%
1925	111	31	1.7%	5.3%
1926	111	31	1.7%	5.4%
1927	111	31	1.7%	5.5%
1928	111	31	1.7%	5.6%
1929	111	31	1.6%	5.7%
1930	111	31	1.6%	5.9%
1931	113	32	1.9%	4.8%
1932	113	32	1.8%	4.9%
1933	113	32	1.8%	5.0%
1934	113	32	1.8%	5.1%
1935	113	32	1.7%	5.3%
1936	113	32	1.7%	5.4%
1937	113	32	1.7%	5.5%

1938	113	32	1.6%	5.6%
1939	113	32	1.6%	5.7%
1940	113	32	1.6%	5.9%
1941	113	32	1.6%	6.0%
1942	115	33	1.8%	4.9%
1943	115	33	1.8%	5.0%
1944	115	33	1.8%	5.2%
1945	115	33	1.7%	5.3%
1946	115	33	1.7%	5.4%
1947	115	33	1.7%	5.5%
1948	115	33	1.6%	5.6%
1949	115	33	1.6%	5.8%
1950	115	33	1.6%	5.9%
1951	117	34	1.8%	4.9%
1952	117	34	1.8%	5.0%
1953	117	34	1.8%	5.1%
1954	117	34	1.7%	5.2%
1955	117	34	1.7%	5.3%
1956	117	34	1.7%	5.4%
1957	117	34	1.6%	5.6%
1958	117	34	1.6%	5.7%
1959	117	34	1.6%	5.8%
1960	117	34	1.6%	5.9%
1961	119	35	1.8%	4.9%
1962	119	35	1.8%	5.0%
1963	119	35	1.7%	5.2%
1964	119	35	1.7%	5.3%
1965	119	35	1.7%	5.4%
1966	119	35	1.6%	5.5%
1967	119	35	1.6%	5.6%
1968	119	35	1.6%	5.7%
1969	119	35	1.6%	5.9%
1970	119	35	1.5%	6.0%
1971	121	36	1.7%	5.0%
1972	121	36	1.7%	5.1%
1973	121	36	1.7%	5.2%
1974	121	36	1.7%	5.4%
1975	121	36	1.6%	5.5%
1976	121	36	1.6%	5.6%
1977	121	36	1.6%	5.7%
1978	121	36	1.5%	5.8%
1979	121	36	1.5%	6.0%
1980	123	37	1.7%	5.0%
1981	123	37	1.7%	5.1%
1982	123	37	1.7%	5.2%
1983	123	37	1.6%	5.3%
1984	123	37	1.6%	5.5%
1985	123	37	1.6%	5.6%
1986	123	37	1.6%	5.7%
1987	123	37	1.5%	5.8%

1988	123	37	1.5%	5.9%
1989	125	38	1.7%	5.0%
1990	125	38	1.7%	5.1%
1991	125	38	1.6%	5.2%
1992	125	38	1.6%	5.4%
1993	125	38	1.6%	5.5%
1994	125	38	1.6%	5.6%
1995	125	38	1.5%	5.7%
1996	125	38	1.5%	5.8%
1997	125	38	1.5%	6.0%
1998	126	39	2.0%	4.5%
1999	126	39	2.0%	4.6%
2000	126	39	1.9%	4.7%
2001	126	39	1.9%	4.8%
2002	126	39	1.9%	4.9%
2003	126	39	1.8%	5.0%
2004	126	39	1.8%	5.1%
2005	126	39	1.8%	5.2%
2006	126	39	1.7%	5.3%
2007	126	39	1.7%	5.4%
2008	126	39	1.7%	5.6%
2009	126	39	1.6%	5.7%
2010	126	39	1.6%	5.8%
2011	126	39	1.6%	5.9%
2012	128	40	1.8%	5.1%
2013	128	40	1.8%	5.2%
2014	128	40	1.7%	5.3%
2015	128	40	1.7%	5.4%
2016	128	40	1.7%	5.5%
2017	128	40	1.6%	5.6%
2018	128	40	1.6%	5.7%
2019	128	40	1.6%	5.8%
2020	128	40	1.6%	6.0%
2021	130	41	1.7%	5.1%
2022	130	41	1.7%	5.2%
2023	130	41	1.7%	5.3%
2024	130	41	1.7%	5.4%
2025	130	41	1.6%	5.6%
2026	130	41	1.6%	5.7%
2027	130	41	1.6%	5.8%
2028	130	41	1.5%	5.9%
2029	132	42	1.7%	5.1%
2030	132	42	1.7%	5.2%
2031	132	42	1.7%	5.3%
2032	132	42	1.6%	5.4%
2033	132	42	1.6%	5.5%
2034	132	42	1.6%	5.6%
2035	132	42	1.6%	5.8%
2036	132	42	1.5%	5.9%
2037	132	42	1.5%	6.0%

2038	133	43	2.0%	4.6%
2039	133	43	1.9%	4.7%
2040	133	43	1.9%	4.8%
2041	133	43	1.9%	4.9%
2042	133	43	1.8%	5.0%
2043	133	43	1.8%	5.1%
2044	133	43	1.8%	5.2%
2045	133	43	1.8%	5.3%
2046	133	43	1.7%	5.4%
2047	133	43	1.7%	5.5%
2048	133	43	1.7%	5.7%
2049	133	43	1.6%	5.8%
2050	133	43	1.6%	5.9%
2051	135	44	1.8%	5.1%
2052	135	44	1.8%	5.2%
2053	135	44	1.7%	5.3%
2054	135	44	1.7%	5.4%
2055	135	44	1.7%	5.5%
2056	135	44	1.6%	5.7%
2057	135	44	1.6%	5.8%
2058	135	44	1.6%	5.9%
2059	137	45	1.7%	5.1%
2060	137	45	1.7%	5.2%
2061	137	45	1.7%	5.3%
2062	137	45	1.7%	5.5%
2063	137	45	1.6%	5.6%
2064	137	45	1.6%	5.7%
2065	137	45	1.6%	5.8%
2066	137	45	1.6%	5.9%
2067	139	46	1.7%	5.2%
2068	139	46	1.7%	5.3%
2069	139	46	1.6%	5.4%
2070	139	46	1.6%	5.5%
2071	139	46	1.6%	5.6%
2072	139	46	1.6%	5.7%
2073	139	46	1.5%	5.8%
2074	139	46	1.5%	5.9%
2075	140	47	2.0%	4.6%
2076	140	47	1.9%	4.7%
2077	140	47	1.9%	4.8%
2078	140	47	1.9%	4.9%
2079	140	47	1.8%	5.0%
2080	140	47	1.8%	5.1%
2081	140	47	1.8%	5.2%
2082	140	47	1.7%	5.3%
2083	140	47	1.7%	5.4%
2084	140	47	1.7%	5.5%
2085	140	47	1.7%	5.7%
2086	140	47	1.6%	5.8%
2087	140	47	1.6%	5.9%

2088	140	47	1.6%	6.0%
2089	142	48	1.7%	5.3%
2090	142	48	1.7%	5.4%
2091	142	48	1.7%	5.5%
2092	142	48	1.6%	5.6%
2093	142	48	1.6%	5.7%
2094	142	48	1.6%	5.8%
2095	142	48	1.6%	5.9%
2096	144	49	1.7%	5.3%
2097	144	49	1.7%	5.4%
2098	144	49	1.6%	5.5%
2099	144	49	1.6%	5.6%
2100	144	49	1.6%	5.7%
2101	144	49	1.6%	5.8%
2102	144	49	1.5%	5.9%
2103	145	50	2.0%	4.7%
2104	145	50	1.9%	4.8%
2105	145	50	1.9%	4.8%
2106	145	50	1.9%	4.9%
2107	145	50	1.8%	5.0%
2108	145	50	1.8%	5.1%
2109	145	50	1.8%	5.2%
2110	145	50	1.8%	5.3%
2111	145	50	1.7%	5.5%
2112	145	50	1.7%	5.6%
2113	145	50	1.7%	5.7%
2114	145	50	1.6%	5.8%
2115	145	50	1.6%	5.9%
2116	145	50	1.6%	6.0%
2117	147	51	1.7%	5.3%
2118	147	51	1.7%	5.4%
2119	147	51	1.7%	5.6%
2120	147	51	1.6%	5.7%
2121	147	51	1.6%	5.8%
2122	147	51	1.6%	5.9%
2123	147	51	1.6%	6.0%
2124	148	52	2.0%	4.7%
2125	148	52	2.0%	4.8%
2126	148	52	1.9%	4.9%
2127	148	52	1.9%	5.0%
2128	148	52	1.9%	5.1%
2129	148	52	1.8%	5.2%
2130	148	52	1.8%	5.3%
2131	148	52	1.8%	5.4%
2132	148	52	1.7%	5.5%
2133	148	52	1.7%	5.6%
2134	148	52	1.7%	5.8%
2135	148	52	1.7%	5.9%
2136	148	52	1.6%	6.0%
2137	150	53	1.8%	5.4%

2138	150	53	1.7%	5.5%
2139	150	53	1.7%	5.6%
2140	150	53	1.7%	5.7%
2141	150	53	1.6%	5.8%
2142	150	53	1.6%	5.9%
2143	150	53	1.6%	6.0%
2144	152	54	1.7%	5.4%
2145	152	54	1.7%	5.5%
2146	152	54	1.6%	5.6%
2147	152	54	1.6%	5.7%
2148	152	54	1.6%	5.8%
2149	152	54	1.6%	5.9%
2150	153	55	2.0%	4.7%
2151	153	55	2.0%	4.8%
2152	153	55	1.9%	4.9%
2153	153	55	1.9%	5.0%
2154	153	55	1.9%	5.1%
2155	153	55	1.8%	5.2%
2156	153	55	1.8%	5.3%
2157	153	55	1.8%	5.4%
2158	153	55	1.7%	5.5%
2159	153	55	1.7%	5.6%
2160	153	55	1.7%	5.7%
2161	153	55	1.7%	5.8%
2162	153	55	1.6%	5.9%
2163	155	56	1.7%	5.4%
2164	155	56	1.7%	5.5%
2165	155	56	1.7%	5.6%
2166	155	56	1.7%	5.7%
2167	155	56	1.6%	5.8%
2168	155	56	1.6%	5.9%
2169	155	56	1.6%	6.0%
2170	156	57	2.0%	4.8%
2171	156	57	2.0%	4.9%
2172	156	57	1.9%	5.0%
2173	156	57	1.9%	5.1%
2174	156	57	1.9%	5.2%
2175	156	57	1.8%	5.3%
2176	156	57	1.8%	5.4%
2177	156	57	1.8%	5.5%
2178	156	57	1.7%	5.6%
2179	156	57	1.7%	5.7%
2180	156	57	1.7%	5.8%
2181	156	57	1.7%	5.9%
2182	158	58	1.8%	5.4%
2183	158	58	1.7%	5.5%
2184	158	58	1.7%	5.6%
2185	158	58	1.7%	5.7%
2186	158	58	1.7%	5.8%
2187	158	58	1.6%	5.9%

2188	158	58	1.6%	6.0%
2189	160	59	1.7%	5.4%
2190	160	59	1.7%	5.6%
2191	160	59	1.6%	5.7%
2192	160	59	1.6%	5.8%
2193	160	59	1.6%	5.9%
2194	160	59	1.6%	6.0%
2195	161	60	2.0%	4.8%
2196	161	60	1.9%	4.9%
2197	161	60	1.9%	5.0%
2198	161	60	1.9%	5.1%
2199	161	60	1.8%	5.2%
2200	161	60	1.8%	5.3%
2201	161	60	1.8%	5.4%
2202	161	60	1.7%	5.5%
2203	161	60	1.7%	5.6%
2204	161	60	1.7%	5.7%
2205	161	60	1.7%	5.8%
2206	161	60	1.6%	5.9%
2207	163	61	1.7%	5.4%
2208	163	61	1.7%	5.5%
2209	163	61	1.7%	5.6%
2210	163	61	1.6%	5.7%
2211	163	61	1.6%	5.8%
2212	163	61	1.6%	5.9%
2213	164	62	2.0%	4.8%
2214	164	62	2.0%	4.9%
2215	164	62	1.9%	5.0%
2216	164	62	1.9%	5.1%
2217	164	62	1.9%	5.2%
2218	164	62	1.8%	5.3%
2219	164	62	1.8%	5.4%
2220	164	62	1.8%	5.5%
2221	164	62	1.7%	5.6%
2222	164	62	1.7%	5.7%
2223	164	62	1.7%	5.8%
2224	164	62	1.7%	5.9%
2225	164	62	1.6%	6.0%
2226	166	63	1.7%	5.5%
2227	166	63	1.7%	5.6%
2228	166	63	1.7%	5.7%
2229	166	63	1.6%	5.8%
2230	166	63	1.6%	5.9%
2231	166	63	1.6%	6.0%
2232	167	64	2.0%	4.9%
2233	167	64	1.9%	5.0%
2234	167	64	1.9%	5.1%
2235	167	64	1.9%	5.2%
2236	167	64	1.8%	5.3%
2237	167	64	1.8%	5.4%

2238	167	64	1.8%	5.5%
2239	167	64	1.8%	5.6%
2240	167	64	1.7%	5.7%
2241	167	64	1.7%	5.8%
2242	167	64	1.7%	5.9%
2243	167	64	1.7%	6.0%
2244	169	65	1.7%	5.5%
2245	169	65	1.7%	5.6%
2246	169	65	1.7%	5.7%
2247	169	65	1.6%	5.8%
2248	169	65	1.6%	5.9%
2249	171	66	1.7%	5.5%
2250	171	66	1.7%	5.6%
2251	171	66	1.6%	5.7%
2252	171	66	1.6%	5.8%
2253	171	66	1.6%	5.9%
2254	171	66	1.6%	6.0%
2255	172	67	1.9%	4.9%
2256	172	67	1.9%	5.0%
2257	172	67	1.9%	5.1%
2258	172	67	1.8%	5.2%
2259	172	67	1.8%	5.3%
2260	172	67	1.8%	5.4%
2261	172	67	1.8%	5.5%
2262	172	67	1.7%	5.6%
2263	172	67	1.7%	5.6%
2264	172	67	1.7%	5.7%
2265	172	67	1.6%	5.8%
2266	172	67	1.6%	5.9%
2267	173	68	2.0%	4.9%
2268	173	68	2.0%	5.0%
2269	173	68	1.9%	5.1%
2270	173	68	1.9%	5.2%
2271	173	68	1.9%	5.3%
2272	173	68	1.8%	5.3%
2273	173	68	1.8%	5.4%
2274	173	68	1.8%	5.5%
2275	173	68	1.8%	5.6%
2276	173	68	1.7%	5.7%
2277	173	68	1.7%	5.8%
2278	173	68	1.7%	5.9%
2279	175	69	1.7%	5.5%
2280	175	69	1.7%	5.6%
2281	175	69	1.7%	5.7%
2282	175	69	1.7%	5.8%
2283	175	69	1.6%	5.9%
2284	176	70	2.0%	4.9%
2285	176	70	2.0%	5.0%
2286	176	70	1.9%	5.1%
2287	176	70	1.9%	5.2%

2288	176	70	1.9%	5.2%
2289	176	70	1.9%	5.3%
2290	176	70	1.8%	5.4%
2291	176	70	1.8%	5.5%
2292	176	70	1.8%	5.6%
2293	176	70	1.7%	5.7%
2294	176	70	1.7%	5.8%
2295	176	70	1.7%	5.9%
2296	178	71	1.7%	5.5%
2297	178	71	1.7%	5.6%
2298	178	71	1.7%	5.7%
2299	178	71	1.7%	5.8%
2300	178	71	1.6%	5.9%
2301	179	72	2.0%	4.9%
2302	179	72	2.0%	5.0%
2303	179	72	1.9%	5.1%
2304	179	72	1.9%	5.2%
2305	179	72	1.9%	5.3%
2306	179	72	1.9%	5.4%
2307	179	72	1.8%	5.4%
2308	179	72	1.8%	5.5%
2309	179	72	1.8%	5.6%
2310	179	72	1.7%	5.7%
2311	179	72	1.7%	5.8%
2312	179	72	1.7%	5.9%
2313	181	73	1.7%	5.6%
2314	181	73	1.7%	5.7%
2315	181	73	1.7%	5.7%
2316	181	73	1.7%	5.8%
2317	181	73	1.6%	5.9%
2318	182	74	2.0%	4.9%
2319	182	74	2.0%	5.0%
2320	182	74	1.9%	5.1%
2321	182	74	1.9%	5.2%
2322	182	74	1.9%	5.3%
2323	182	74	1.8%	5.4%
2324	182	74	1.8%	5.5%
2325	182	74	1.8%	5.6%
2326	182	74	1.8%	5.7%
2327	182	74	1.7%	5.8%
2328	182	74	1.7%	5.9%
2329	182	74	1.7%	6.0%
2330	184	75	1.7%	5.6%
2331	184	75	1.7%	5.7%
2332	184	75	1.7%	5.8%
2333	184	75	1.6%	5.9%
2334	184	75	1.6%	6.0%
2335	185	76	2.0%	5.0%
2336	185	76	1.9%	5.1%
2337	185	76	1.9%	5.2%

2338	185	76	1.9%	5.3%
2339	185	76	1.8%	5.4%
2340	185	76	1.8%	5.5%
2341	185	76	1.8%	5.5%
2342	185	76	1.8%	5.6%
2343	185	76	1.7%	5.7%
2344	185	76	1.7%	5.8%
2345	185	76	1.7%	5.9%
2346	187	77	1.7%	5.6%
2347	187	77	1.7%	5.7%
2348	187	77	1.7%	5.8%
2349	187	77	1.6%	5.9%
2350	187	77	1.6%	6.0%
2351	188	78	2.0%	5.0%
2352	188	78	1.9%	5.1%
2353	188	78	1.9%	5.2%
2354	188	78	1.9%	5.3%
2355	188	78	1.8%	5.4%
2356	188	78	1.8%	5.4%
2357	188	78	1.8%	5.5%
2358	188	78	1.8%	5.6%
2359	188	78	1.7%	5.7%
2360	188	78	1.7%	5.8%
2361	188	78	1.7%	5.9%
2362	190	79	1.7%	5.6%
2363	190	79	1.7%	5.7%
2364	190	79	1.7%	5.8%
2365	190	79	1.6%	5.9%
2366	190	79	1.6%	6.0%
2367	191	80	1.9%	5.0%
2368	191	80	1.9%	5.1%
2369	191	80	1.9%	5.2%
2370	191	80	1.9%	5.3%
2371	191	80	1.8%	5.4%
2372	191	80	1.8%	5.5%
2373	191	80	1.8%	5.6%
2374	191	80	1.7%	5.6%
2375	191	80	1.7%	5.7%
2376	191	80	1.7%	5.8%
2377	191	80	1.7%	5.9%
2378	193	81	1.7%	5.6%
2379	193	81	1.7%	5.7%
2380	193	81	1.6%	5.8%
2381	193	81	1.6%	5.9%
2382	194	82	1.9%	5.0%
2383	194	82	1.9%	5.1%
2384	194	82	1.9%	5.2%
2385	194	82	1.9%	5.2%
2386	194	82	1.8%	5.3%
2387	194	82	1.8%	5.4%

2388	194	82	1.8%	5.5%
2389	194	82	1.8%	5.6%
2390	194	82	1.7%	5.7%
2391	194	82	1.7%	5.8%
2392	194	82	1.7%	5.9%
2393	194	82	1.6%	6.0%
2394	195	83	2.0%	5.0%
2395	195	83	1.9%	5.1%
2396	195	83	1.9%	5.2%
2397	195	83	1.9%	5.3%
2398	195	83	1.9%	5.4%
2399	195	83	1.8%	5.5%
2400	195	83	1.8%	5.5%
2401	195	83	1.8%	5.6%
2402	195	83	1.8%	5.7%
2403	195	83	1.7%	5.8%
2404	195	83	1.7%	5.9%
2405	197	84	1.7%	5.7%
2406	197	84	1.7%	5.7%
2407	197	84	1.7%	5.8%
2408	197	84	1.6%	5.9%
2409	198	85	2.0%	5.0%
2410	198	85	1.9%	5.1%
2411	198	85	1.9%	5.2%
2412	198	85	1.9%	5.3%
2413	198	85	1.9%	5.4%
2414	198	85	1.8%	5.4%
2415	198	85	1.8%	5.5%
2416	198	85	1.8%	5.6%
2417	198	85	1.8%	5.7%
2418	198	85	1.7%	5.8%
2419	198	85	1.7%	5.9%
2420	198	85	1.7%	6.0%
2421	200	86	1.7%	5.7%
2422	200	86	1.7%	5.8%
2423	200	86	1.6%	5.9%
2424	201	87	2.0%	5.0%
2425	201	87	1.9%	5.1%
2426	201	87	1.9%	5.2%
2427	201	87	1.9%	5.3%
2428	201	87	1.8%	5.4%
2429	201	87	1.8%	5.4%
2430	201	87	1.8%	5.5%
2431	201	87	1.8%	5.6%
2432	201	87	1.7%	5.7%
2433	201	87	1.7%	5.8%
2434	201	87	1.7%	5.9%
2435	201	87	1.7%	6.0%
2436	202	88	2.0%	5.1%
2437	202	88	2.0%	5.2%

2438	202	88	1.9%	5.2%
2439	202	88	1.9%	5.3%
2440	202	88	1.9%	5.4%
2441	202	88	1.8%	5.5%
2442	202	88	1.8%	5.6%
2443	202	88	1.8%	5.7%
2444	202	88	1.8%	5.8%
2445	202	88	1.7%	5.9%
2446	202	88	1.7%	5.9%
2447	204	89	1.7%	5.7%
2448	204	89	1.7%	5.8%
2449	204	89	1.7%	5.9%
2450	205	90	2.0%	5.0%
2451	205	90	2.0%	5.1%
2452	205	90	1.9%	5.2%
2453	205	90	1.9%	5.3%
2454	205	90	1.9%	5.4%
2455	205	90	1.8%	5.4%
2456	205	90	1.8%	5.5%
2457	205	90	1.8%	5.6%
2458	205	90	1.8%	5.7%
2459	205	90	1.7%	5.8%
2460	205	90	1.7%	5.9%
2461	205	90	1.7%	6.0%
2462	207	91	1.7%	5.8%
2463	207	91	1.7%	5.9%
2464	207	91	1.6%	5.9%
2465	208	92	1.9%	5.1%
2466	208	92	1.9%	5.2%
2467	208	92	1.9%	5.2%
2468	208	92	1.9%	5.3%
2469	208	92	1.8%	5.4%
2470	208	92	1.8%	5.5%
2471	208	92	1.8%	5.6%
2472	208	92	1.8%	5.7%
2473	208	92	1.7%	5.8%
2474	208	92	1.7%	5.8%
2475	208	92	1.7%	5.9%
2476	209	93	2.0%	5.1%
2477	209	93	2.0%	5.2%
2478	209	93	1.9%	5.2%
2479	209	93	1.9%	5.3%
2480	209	93	1.9%	5.4%
2481	209	93	1.9%	5.5%
2482	209	93	1.8%	5.6%
2483	209	93	1.8%	5.7%
2484	209	93	1.8%	5.7%
2485	209	93	1.8%	5.8%
2486	209	93	1.7%	5.9%
2487	211	94	1.7%	5.7%

2488	211	94	1.7%	5.8%
2489	211	94	1.7%	5.9%
2490	212	95	2.0%	5.1%
2491	212	95	1.9%	5.1%
2492	212	95	1.9%	5.2%
2493	212	95	1.9%	5.3%
2494	212	95	1.9%	5.4%
2495	212	95	1.8%	5.5%
2496	212	95	1.8%	5.6%
2497	212	95	1.8%	5.6%
2498	212	95	1.8%	5.7%
2499	212	95	1.7%	5.8%
2500	212	95	1.7%	5.9%
2501	212	95	1.7%	6.0%
2502	213	96	2.0%	5.1%
2503	213	96	2.0%	5.2%
2504	213	96	1.9%	5.3%
2505	213	96	1.9%	5.4%
2506	213	96	1.9%	5.5%
2507	213	96	1.9%	5.6%
2508	213	96	1.8%	5.6%
2509	213	96	1.8%	5.7%
2510	213	96	1.8%	5.8%
2511	213	96	1.8%	5.9%
2512	213	96	1.7%	6.0%
2513	215	97	1.7%	5.8%
2514	215	97	1.7%	5.9%
2515	215	97	1.7%	6.0%
2516	216	98	2.0%	5.2%
2517	216	98	1.9%	5.2%
2518	216	98	1.9%	5.3%
2519	216	98	1.9%	5.4%
2520	216	98	1.9%	5.5%
2521	216	98	1.8%	5.6%
2522	216	98	1.8%	5.6%
2523	216	98	1.8%	5.7%
2524	216	98	1.7%	5.8%
2525	216	98	1.7%	5.9%
2526	216	98	1.7%	6.0%
2527	217	99	2.0%	5.2%
2528	217	99	2.0%	5.2%
2529	217	99	1.9%	5.3%
2530	217	99	1.9%	5.4%
2531	217	99	1.9%	5.5%
2532	217	99	1.9%	5.6%
2533	217	99	1.8%	5.6%
2534	217	99	1.8%	5.7%
2535	217	99	1.8%	5.8%
2536	217	99	1.8%	5.9%
2537	217	99	1.7%	6.0%

2538	219	100	1.7%	5.9%
2539	219	100	1.7%	5.9%
2540	220	101	2.0%	5.1%
2541	220	101	2.0%	5.2%
2542	220	101	1.9%	5.3%
2543	220	101	1.9%	5.4%
2544	220	101	1.9%	5.4%
2545	220	101	1.9%	5.5%
2546	220	101	1.8%	5.6%
2547	220	101	1.8%	5.7%
2548	220	101	1.8%	5.8%
2549	220	101	1.8%	5.9%
2550	220	101	1.7%	5.9%
2551	222	102	1.7%	5.8%
2552	222	102	1.7%	5.9%
2553	222	102	1.7%	6.0%
2554	223	103	1.9%	5.2%
2555	223	103	1.9%	5.3%
2556	223	103	1.9%	5.3%
2557	223	103	1.9%	5.4%
2558	223	103	1.8%	5.5%
2559	223	103	1.8%	5.6%
2560	223	103	1.8%	5.7%
2561	223	103	1.8%	5.7%
2562	223	103	1.7%	5.8%
2563	223	103	1.7%	5.9%
2564	223	103	1.7%	6.0%
2565	224	104	2.0%	5.2%
2566	224	104	1.9%	5.3%
2567	224	104	1.9%	5.3%
2568	224	104	1.9%	5.4%
2569	224	104	1.9%	5.5%
2570	224	104	1.8%	5.6%
2571	224	104	1.8%	5.7%
2572	224	104	1.8%	5.8%
2573	224	104	1.8%	5.8%
2574	224	104	1.7%	5.9%
2575	226	105	1.7%	5.8%
2576	226	105	1.7%	5.9%
2577	226	105	1.7%	6.0%
2578	227	106	1.9%	5.2%
2579	227	106	1.9%	5.3%
2580	227	106	1.9%	5.3%
2581	227	106	1.9%	5.4%
2582	227	106	1.8%	5.5%
2583	227	106	1.8%	5.6%
2584	227	106	1.8%	5.7%
2585	227	106	1.8%	5.7%
2586	227	106	1.7%	5.8%
2587	227	106	1.7%	5.9%

2588	229	107	1.7%	5.8%
2589	229	107	1.7%	5.9%
2590	229	107	1.6%	6.0%
2591	230	108	1.9%	5.2%
2592	230	108	1.9%	5.3%
2593	230	108	1.9%	5.4%
2594	230	108	1.8%	5.4%
2595	230	108	1.8%	5.5%
2596	230	108	1.8%	5.6%
2597	230	108	1.8%	5.7%
2598	230	108	1.7%	5.8%
2599	230	108	1.7%	5.8%
2600	230	108	1.7%	5.9%
2601	231	109	2.0%	5.1%
2602	231	109	1.9%	5.2%
2603	231	109	1.9%	5.3%
2604	231	109	1.9%	5.4%
2605	231	109	1.9%	5.5%
2606	231	109	1.8%	5.5%
2607	231	109	1.8%	5.6%
2608	231	109	1.8%	5.7%
2609	231	109	1.8%	5.8%
2610	231	109	1.7%	5.9%
2611	231	109	1.7%	6.0%
2612	232	110	2.0%	5.2%
2613	232	110	2.0%	5.3%
2614	232	110	1.9%	5.3%
2615	232	110	1.9%	5.4%
2616	232	110	1.9%	5.5%
2617	232	110	1.9%	5.6%
2618	232	110	1.8%	5.6%
2619	232	110	1.8%	5.7%
2620	232	110	1.8%	5.8%
2621	232	110	1.8%	5.9%
2622	232	110	1.7%	6.0%
2623	234	111	1.7%	5.9%
2624	234	111	1.7%	6.0%
2625	235	112	1.9%	5.2%
2626	235	112	1.9%	5.3%
2627	235	112	1.9%	5.4%
2628	235	112	1.9%	5.4%
2629	235	112	1.8%	5.5%
2630	235	112	1.8%	5.6%
2631	235	112	1.8%	5.7%
2632	235	112	1.8%	5.8%
2633	235	112	1.7%	5.8%
2634	235	112	1.7%	5.9%
2635	236	113	2.0%	5.2%
2636	236	113	2.0%	5.2%
2637	236	113	1.9%	5.3%

2638	236	113	1.9%	5.4%
2639	236	113	1.9%	5.5%
2640	236	113	1.9%	5.6%
2641	236	113	1.8%	5.6%
2642	236	113	1.8%	5.7%
2643	236	113	1.8%	5.8%
2644	236	113	1.8%	5.9%
2645	236	113	1.7%	6.0%
2646	238	114	1.7%	5.9%
2647	238	114	1.7%	6.0%
2648	239	115	1.9%	5.2%
2649	239	115	1.9%	5.3%
2650	239	115	1.9%	5.4%
2651	239	115	1.9%	5.5%
2652	239	115	1.8%	5.5%
2653	239	115	1.8%	5.6%
2654	239	115	1.8%	5.7%
2655	239	115	1.8%	5.8%
2656	239	115	1.7%	5.9%
2657	239	115	1.7%	5.9%
2658	240	116	2.0%	5.2%
2659	240	116	2.0%	5.3%
2660	240	116	1.9%	5.3%
2661	240	116	1.9%	5.4%
2662	240	116	1.9%	5.5%
2663	240	116	1.9%	5.6%
2664	240	116	1.8%	5.7%
2665	240	116	1.8%	5.7%
2666	240	116	1.8%	5.8%
2667	240	116	1.8%	5.9%
2668	240	116	1.7%	6.0%
2669	242	117	1.7%	5.9%
2670	243	118	2.0%	5.2%
2671	243	118	1.9%	5.3%
2672	243	118	1.9%	5.3%
2673	243	118	1.9%	5.4%
2674	243	118	1.9%	5.5%
2675	243	118	1.8%	5.6%
2676	243	118	1.8%	5.7%
2677	243	118	1.8%	5.7%
2678	243	118	1.8%	5.8%
2679	243	118	1.7%	5.9%
2680	243	118	1.7%	6.0%
2681	244	119	2.0%	5.2%
2682	244	119	1.9%	5.3%
2683	244	119	1.9%	5.4%
2684	244	119	1.9%	5.5%
2685	244	119	1.9%	5.5%
2686	244	119	1.8%	5.6%
2687	244	119	1.8%	5.7%

2688	244	119	1.8%	5.8%
2689	244	119	1.8%	5.9%
2690	244	119	1.7%	5.9%
2691	246	120	1.7%	5.9%
2692	246	120	1.7%	6.0%
2693	247	121	1.9%	5.3%
2694	247	121	1.9%	5.3%
2695	247	121	1.9%	5.4%
2696	247	121	1.9%	5.5%
2697	247	121	1.8%	5.6%
2698	247	121	1.8%	5.6%
2699	247	121	1.8%	5.7%
2700	247	121	1.8%	5.8%
2701	247	121	1.7%	5.9%
2702	247	121	1.7%	6.0%
2703	248	122	2.0%	5.2%
2704	248	122	1.9%	5.3%
2705	248	122	1.9%	5.4%
2706	248	122	1.9%	5.5%
2707	248	122	1.9%	5.5%
2708	248	122	1.8%	5.6%
2709	248	122	1.8%	5.7%
2710	248	122	1.8%	5.8%
2711	248	122	1.8%	5.8%
2712	248	122	1.7%	5.9%
2713	250	123	1.7%	5.9%
2714	250	123	1.7%	6.0%
2715	251	124	1.9%	5.3%
2716	251	124	1.9%	5.3%
2717	251	124	1.9%	5.4%
2718	251	124	1.8%	5.5%
2719	251	124	1.8%	5.6%
2720	251	124	1.8%	5.6%
2721	251	124	1.8%	5.7%
2722	251	124	1.7%	5.8%
2723	251	124	1.7%	5.9%
2724	251	124	1.7%	6.0%
2725	252	125	2.0%	5.2%
2726	252	125	1.9%	5.3%
2727	252	125	1.9%	5.4%
2728	252	125	1.9%	5.5%
2729	252	125	1.9%	5.5%
2730	252	125	1.8%	5.6%
2731	252	125	1.8%	5.7%
2732	252	125	1.8%	5.8%
2733	252	125	1.8%	5.9%
2734	252	125	1.7%	5.9%
2735	253	126	2.0%	5.2%
2736	253	126	2.0%	5.3%
2737	253	126	1.9%	5.4%

2738	253	126	1.9%	5.4%
2739	253	126	1.9%	5.5%
2740	253	126	1.9%	5.6%
2741	253	126	1.8%	5.7%
2742	253	126	1.8%	5.8%
2743	253	126	1.8%	5.8%
2744	253	126	1.8%	5.9%
2745	253	126	1.7%	6.0%
2746	255	127	1.7%	6.0%
2747	256	128	1.9%	5.3%
2748	256	128	1.9%	5.4%
2749	256	128	1.9%	5.4%
2750	256	128	1.9%	5.5%
2751	256	128	1.8%	5.6%
2752	256	128	1.8%	5.7%
2753	256	128	1.8%	5.7%
2754	256	128	1.8%	5.8%
2755	256	128	1.7%	5.9%
2756	256	128	1.7%	6.0%
2757	257	129	2.0%	5.3%
2758	257	129	1.9%	5.3%
2759	257	129	1.9%	5.4%
2760	257	129	1.9%	5.5%
2761	257	129	1.9%	5.6%
2762	257	129	1.8%	5.6%
2763	257	129	1.8%	5.7%
2764	257	129	1.8%	5.8%
2765	257	129	1.8%	5.9%
2766	257	129	1.7%	5.9%
2767	259	130	1.7%	6.0%
2768	260	131	1.9%	5.3%
2769	260	131	1.9%	5.3%
2770	260	131	1.9%	5.4%
2771	260	131	1.9%	5.5%
2772	260	131	1.8%	5.6%
2773	260	131	1.8%	5.6%
2774	260	131	1.8%	5.7%
2775	260	131	1.8%	5.8%
2776	260	131	1.7%	5.9%
2777	260	131	1.7%	5.9%
2778	261	132	2.0%	5.3%
2779	261	132	1.9%	5.3%
2780	261	132	1.9%	5.4%
2781	261	132	1.9%	5.5%
2782	261	132	1.9%	5.6%
2783	261	132	1.8%	5.6%
2784	261	132	1.8%	5.7%
2785	261	132	1.8%	5.8%
2786	261	132	1.8%	5.9%
2787	261	132	1.7%	5.9%

2788	262	133	2.0%	5.3%
2789	262	133	2.0%	5.3%
2790	262	133	1.9%	5.4%
2791	262	133	1.9%	5.5%
2792	262	133	1.9%	5.5%
2793	262	133	1.9%	5.6%
2794	262	133	1.8%	5.7%
2795	262	133	1.8%	5.8%
2796	262	133	1.8%	5.8%
2797	262	133	1.8%	5.9%
2798	264	134	1.7%	6.0%
2799	265	135	1.9%	5.3%
2800	265	135	1.9%	5.3%
2801	265	135	1.9%	5.4%
2802	265	135	1.9%	5.5%
2803	265	135	1.8%	5.6%
2804	265	135	1.8%	5.6%
2805	265	135	1.8%	5.7%
2806	265	135	1.8%	5.8%
2807	265	135	1.7%	5.9%
2808	265	135	1.7%	5.9%
2809	266	136	2.0%	5.3%
2810	266	136	1.9%	5.3%
2811	266	136	1.9%	5.4%
2812	266	136	1.9%	5.5%
2813	266	136	1.9%	5.6%
2814	266	136	1.8%	5.6%
2815	266	136	1.8%	5.7%
2816	266	136	1.8%	5.8%
2817	266	136	1.8%	5.9%
2818	266	136	1.8%	5.9%
2819	267	137	2.0%	5.3%
2820	267	137	2.0%	5.3%
2821	267	137	1.9%	5.4%
2822	267	137	1.9%	5.5%
2823	267	137	1.9%	5.6%
2824	267	137	1.9%	5.6%
2825	267	137	1.9%	5.7%
2826	267	137	1.8%	5.8%
2827	267	137	1.8%	5.9%
2828	267	137	1.8%	5.9%
2829	269	138	1.7%	6.0%
2830	270	139	1.9%	5.3%
2831	270	139	1.9%	5.4%
2832	270	139	1.9%	5.5%
2833	270	139	1.9%	5.5%
2834	270	139	1.8%	5.6%
2835	270	139	1.8%	5.7%
2836	270	139	1.8%	5.7%
2837	270	139	1.8%	5.8%

2838	270	139	1.8%	5.9%
2839	270	139	1.7%	6.0%
2840	271	140	2.0%	5.3%
2841	271	140	1.9%	5.4%
2842	271	140	1.9%	5.5%
2843	271	140	1.9%	5.5%
2844	271	140	1.9%	5.6%
2845	271	140	1.8%	5.7%
2846	271	140	1.8%	5.7%
2847	271	140	1.8%	5.8%
2848	271	140	1.8%	5.9%
2849	271	140	1.8%	6.0%
2850	272	141	2.0%	5.3%
2851	272	141	2.0%	5.4%
2852	272	141	1.9%	5.5%
2853	272	141	1.9%	5.5%
2854	272	141	1.9%	5.6%
2855	272	141	1.9%	5.7%
2856	272	141	1.8%	5.7%
2857	272	141	1.8%	5.8%
2858	272	141	1.8%	5.9%
2859	272	141	1.8%	6.0%
2860	275	143	2.0%	5.3%
2861	275	143	1.9%	5.4%
2862	275	143	1.9%	5.4%
2863	275	143	1.9%	5.5%
2864	275	143	1.9%	5.6%
2865	275	143	1.8%	5.7%
2866	275	143	1.8%	5.7%
2867	275	143	1.8%	5.8%
2868	275	143	1.8%	5.9%
2869	275	143	1.7%	6.0%
2870	276	144	2.0%	5.3%
2871	276	144	1.9%	5.4%
2872	276	144	1.9%	5.4%
2873	276	144	1.9%	5.5%
2874	276	144	1.9%	5.6%
2875	276	144	1.9%	5.7%
2876	276	144	1.8%	5.7%
2877	276	144	1.8%	5.8%
2878	276	144	1.8%	5.9%
2879	276	144	1.8%	6.0%
2880	277	145	2.0%	5.3%
2881	277	145	2.0%	5.4%
2882	277	145	1.9%	5.5%
2883	277	145	1.9%	5.5%
2884	277	145	1.9%	5.6%
2885	277	145	1.9%	5.7%
2886	277	145	1.9%	5.7%
2887	277	145	1.8%	5.8%

2888	277	145	1.8%	5.9%
2889	277	145	1.8%	6.0%
2890	280	147	1.9%	5.3%
2891	280	147	1.9%	5.4%
2892	280	147	1.9%	5.5%
2893	280	147	1.9%	5.5%
2894	280	147	1.9%	5.6%
2895	280	147	1.8%	5.7%
2896	280	147	1.8%	5.7%
2897	280	147	1.8%	5.8%
2898	280	147	1.8%	5.9%
2899	280	147	1.7%	6.0%
2900	281	148	2.0%	5.3%
2901	281	148	1.9%	5.4%
2902	281	148	1.9%	5.5%
2903	281	148	1.9%	5.5%
2904	281	148	1.9%	5.6%
2905	281	148	1.9%	5.7%
2906	281	148	1.8%	5.8%
2907	281	148	1.8%	5.8%
2908	281	148	1.8%	5.9%
2909	281	148	1.8%	6.0%
2910	282	149	2.0%	5.3%
2911	282	149	2.0%	5.4%
2912	282	149	1.9%	5.5%
2913	282	149	1.9%	5.6%
2914	282	149	1.9%	5.6%
2915	282	149	1.9%	5.7%
2916	282	149	1.8%	5.8%
2917	282	149	1.8%	5.8%
2918	282	149	1.8%	5.9%
2919	282	149	1.8%	6.0%
2920	285	151	1.9%	5.4%
2921	285	151	1.9%	5.4%
2922	285	151	1.9%	5.5%
2923	285	151	1.9%	5.6%
2924	285	151	1.8%	5.7%
2925	285	151	1.8%	5.7%
2926	285	151	1.8%	5.8%
2927	285	151	1.8%	5.9%
2928	285	151	1.8%	5.9%
2929	286	152	2.0%	5.3%
2930	286	152	2.0%	5.4%
2931	286	152	1.9%	5.5%
2932	286	152	1.9%	5.5%
2933	286	152	1.9%	5.6%
2934	286	152	1.9%	5.7%
2935	286	152	1.8%	5.7%
2936	286	152	1.8%	5.8%
2937	286	152	1.8%	5.9%

2938	286	152	1.8%	6.0%
2939	287	153	2.0%	5.3%
2940	287	153	2.0%	5.4%
2941	287	153	1.9%	5.5%
2942	287	153	1.9%	5.5%
2943	287	153	1.9%	5.6%
2944	287	153	1.9%	5.7%
2945	287	153	1.9%	5.8%
2946	287	153	1.8%	5.8%
2947	287	153	1.8%	5.9%
2948	287	153	1.8%	6.0%
2949	290	155	1.9%	5.4%
2950	290	155	1.9%	5.4%
2951	290	155	1.9%	5.5%
2952	290	155	1.9%	5.6%
2953	290	155	1.8%	5.7%
2954	290	155	1.8%	5.7%
2955	290	155	1.8%	5.8%
2956	290	155	1.8%	5.9%
2957	290	155	1.8%	5.9%
2958	291	156	2.0%	5.3%
2959	291	156	1.9%	5.4%
2960	291	156	1.9%	5.5%
2961	291	156	1.9%	5.5%
2962	291	156	1.9%	5.6%
2963	291	156	1.9%	5.7%
2964	291	156	1.8%	5.7%
2965	291	156	1.8%	5.8%
2966	291	156	1.8%	5.9%
2967	291	156	1.8%	6.0%
2968	292	157	2.0%	5.3%
2969	292	157	2.0%	5.4%
2970	292	157	1.9%	5.5%
2971	292	157	1.9%	5.6%
2972	292	157	1.9%	5.6%
2973	292	157	1.9%	5.7%
2974	292	157	1.8%	5.8%
2975	292	157	1.8%	5.8%
2976	292	157	1.8%	5.9%
2977	292	157	1.8%	6.0%
2978	295	159	1.9%	5.4%
2979	295	159	1.9%	5.5%
2980	295	159	1.9%	5.5%
2981	295	159	1.9%	5.6%
2982	295	159	1.8%	5.7%
2983	295	159	1.8%	5.8%
2984	295	159	1.8%	5.8%
2985	295	159	1.8%	5.9%
2986	295	159	1.7%	6.0%
2987	296	160	2.0%	5.4%

2988	296	160	1.9%	5.4%
2989	296	160	1.9%	5.5%
2990	296	160	1.9%	5.6%
2991	296	160	1.9%	5.6%
2992	296	160	1.8%	5.7%
2993	296	160	1.8%	5.8%
2994	296	160	1.8%	5.8%
2995	296	160	1.8%	5.9%
2996	296	160	1.8%	6.0%
2997	297	161	2.0%	5.4%
2998	297	161	1.9%	5.5%
2999	297	161	1.9%	5.5%
3000	297	161	1.9%	5.6%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 1500 and 1200 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	2000
Sample size	119
Maximum number of denials allowed	36

ASSUMPTIONS	
Valid list size	1500
Invalid list size	1200
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	6%

RESULT		
Probability of false rejection	7.25%	>6% (Not OK)
Probability of false acceptance	1.51%	<2% (OK)

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 2000, 6% and 2% the approximate value returned are 119 and 36. When these

INPUTS	
Members Lodged	2000
Desired probability of false rejection	6%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	1500
Unacceptable list	1200

RESULT	
Approximate sample size required	119
Approximate maximum number of denials	36

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.15
B	-1.67936
n0	125.3451
n1	117.9047
mu0	29.75
mu1	47.6
sig0	4.582074
sig1	5.184025
c0	36.37409
c1	36.45331

S22

From: S22
Sent: Friday, 10 September 2021 3:13 PM
To: Joanne Reid
Cc: David Gruen; S47F Tom Rogers
Subject: Re: FW: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

Hi Joanne,

S47C, S47E(d)

Regards,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 @abs.gov.au **(W)** www.abs.gov.au

From: "Joanne Reid" <Joanne.Reid2@aec.gov.au>
To: "S22 @abs.gov.au>
Cc: "S47F @aec.gov.au>, "Tom Rogers" <Tom.Rogers@aec.gov.au>, "S47F S47F @aec.gov.au>, "david.gruen@abs.gov.au" <david.gruen@abs.gov.au>
Date: 10/09/2021 02:33 PM
Subject: FW: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and k

Hi S22

S47C, S47E(d)

Regards,

Joanne Reid | Assistant Commissioner
Disclosure, Assurance & Engagement Branch
Australian Electoral Commission
T: (02) 6271 4489 **X:** S47 **M:** S47F

From: S47F @aec.gov.au>
Sent: Thursday, 9 September 2021 4:42 PM
To: Joanne Reid <Joanne.Reid2@aec.gov.au>
Cc: S47F @aec.gov.au>
Subject: FW: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

FYI

S47F **| Director**
Parliamentary Engagement and Party Registration Section | Disclosure, Assurance & Engagement Branch
Australian Electoral Commission
T: S47F **X:** S47 **M:** S47F

From: S22 @abs.gov.au>
Sent: Thursday, 9 September 2021 4:29 PM
To: S47F @aec.gov.au>; S47F @aec.gov.au>
Cc: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: Fw: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

Hi S47F

Here is the updated spreadsheet.
(See attached file: Calculator - 1500 list size.xlsx)

Regards,

S22
Assistant Director, Household Statistics Methodology

Methodology Division | **Australian Bureau of Statistics**

(P) S22

(E) S22 @abs.gov.au **(W)** www.abs.gov.au

----- Forwarded by S22 /Staff/ABS on 09/09/2021 04:27 PM -----

From: Anders Holmberg/Staff/ABS
To: Staff/ABS@ABS
Date: 09/09/2021 04:25 PM
Subject: Re: Fw: Letter from the Commissioner | Follow-up to previous letter – request for advice [SEC=OFFICIAL]

Hi S22

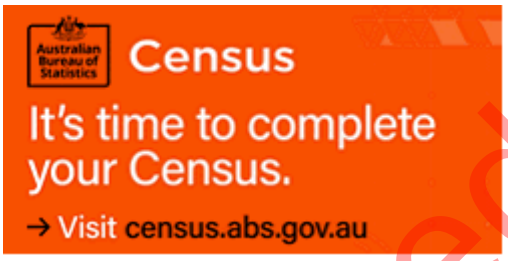
Send it through to them right away and I will send a letter to David who can inform S47F that they have received the calculator.

Thanks a lot.

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | **(W)**: www.abs.gov.au

Executive Assistant: S22
(P) S22 | (E) S22 @abs.gov.au



The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters, and community. We pay our respects to them and their cultures, and elders, both past and present.

Sheet Name	Description
Table (10% & 2%)	List of required sample sizes cut-off values for member list sizes from 1500 to 2000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 1200 valid members; - no more than a 10% chance of incorrectly rejecting a list with 1500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 1200 valid members - Probability of incorrectly rejecting a list with 1500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 1500 up to 2000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 10%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 1500 members, a sample size of 17 and max denials of 0 will give a Probability of accepting a valid list of 2.20%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 1200 - risk	Rejecting 1500 - risk
1500	18	0	1.8%	0.0%
1501	18	0	1.7%	1.2%
1502	18	0	1.7%	2.4%
1503	18	0	1.7%	3.6%
1504	18	0	1.7%	4.7%
1505	18	0	1.7%	5.8%
1506	18	0	1.6%	7.0%
1507	18	0	1.6%	8.1%
1508	18	0	1.6%	9.2%
1509	26	1	1.9%	1.0%
1510	26	1	1.9%	1.2%
1511	26	1	1.9%	1.4%
1512	26	1	1.8%	1.7%
1513	26	1	1.8%	2.0%
1514	26	1	1.8%	2.3%
1515	26	1	1.8%	2.6%
1516	26	1	1.7%	2.9%
1517	26	1	1.7%	3.3%
1518	26	1	1.7%	3.6%
1519	26	1	1.7%	4.0%
1520	26	1	1.6%	4.4%
1521	26	1	1.6%	4.8%
1522	26	1	1.6%	5.3%
1523	26	1	1.6%	5.7%
1524	26	1	1.5%	6.1%
1525	26	1	1.5%	6.6%
1526	26	1	1.5%	7.1%
1527	26	1	1.5%	7.5%
1528	26	1	1.5%	8.0%
1529	26	1	1.4%	8.5%
1530	26	1	1.4%	9.0%
1531	26	1	1.4%	9.5%
1532	32	2	1.8%	2.7%
1533	32	2	1.8%	2.9%
1534	32	2	1.8%	3.2%
1535	32	2	1.8%	3.4%
1536	32	2	1.7%	3.7%
1537	32	2	1.7%	3.9%

1538	32	2	1.7%	4.2%
1539	32	2	1.6%	4.5%
1540	32	2	1.6%	4.8%
1541	32	2	1.6%	5.1%
1542	32	2	1.6%	5.4%
1543	32	2	1.5%	5.7%
1544	32	2	1.5%	6.0%
1545	32	2	1.5%	6.4%
1546	32	2	1.5%	6.7%
1547	32	2	1.5%	7.0%
1548	32	2	1.4%	7.4%
1549	32	2	1.4%	7.8%
1550	32	2	1.4%	8.1%
1551	32	2	1.4%	8.5%
1552	32	2	1.3%	8.9%
1553	32	2	1.3%	9.3%
1554	32	2	1.3%	9.7%
1555	38	3	1.5%	4.2%
1556	38	3	1.4%	4.5%
1557	38	3	1.4%	4.7%
1558	38	3	1.4%	5.0%
1559	38	3	1.4%	5.2%
1560	38	3	1.3%	5.5%
1561	38	3	1.3%	5.8%
1562	38	3	1.3%	6.1%
1563	38	3	1.3%	6.3%
1564	38	3	1.2%	6.6%
1565	38	3	1.2%	6.9%
1566	38	3	1.2%	7.2%
1567	38	3	1.2%	7.6%
1568	38	3	1.2%	7.9%
1569	38	3	1.1%	8.2%
1570	38	3	1.1%	8.5%
1571	38	3	1.1%	8.9%
1572	38	3	1.1%	9.2%
1573	38	3	1.1%	9.6%
1574	38	3	1.1%	9.9%
1575	43	4	1.3%	5.0%
1576	43	4	1.3%	5.2%
1577	43	4	1.2%	5.5%
1578	43	4	1.2%	5.7%
1579	43	4	1.2%	6.0%
1580	43	4	1.2%	6.2%
1581	43	4	1.2%	6.5%
1582	43	4	1.1%	6.8%
1583	43	4	1.1%	7.0%
1584	43	4	1.1%	7.3%
1585	43	4	1.1%	7.6%
1586	43	4	1.1%	7.9%
1587	43	4	1.0%	8.2%

1588	43	4	1.0%	8.5%
1589	43	4	1.0%	8.8%
1590	43	4	1.0%	9.1%
1591	43	4	1.0%	9.5%
1592	43	4	0.9%	9.8%
1593	46	5	1.6%	4.7%
1594	46	5	1.5%	5.0%
1595	46	5	1.5%	5.2%
1596	46	5	1.5%	5.4%
1597	46	5	1.5%	5.6%
1598	46	5	1.4%	5.8%
1599	46	5	1.4%	6.0%
1600	46	5	1.4%	6.3%
1601	46	5	1.4%	6.5%
1602	46	5	1.3%	6.7%
1603	46	5	1.3%	7.0%
1604	46	5	1.3%	7.2%
1605	46	5	1.3%	7.5%
1606	46	5	1.2%	7.8%
1607	46	5	1.2%	8.0%
1608	46	5	1.2%	8.3%
1609	46	5	1.2%	8.6%
1610	46	5	1.2%	8.9%
1611	46	5	1.1%	9.2%
1612	46	5	1.1%	9.4%
1613	46	5	1.1%	9.7%
1614	49	6	1.7%	5.3%
1615	49	6	1.7%	5.5%
1616	49	6	1.6%	5.7%
1617	49	6	1.6%	5.9%
1618	49	6	1.6%	6.1%
1619	49	6	1.5%	6.3%
1620	49	6	1.5%	6.5%
1621	49	6	1.5%	6.7%
1622	49	6	1.5%	7.0%
1623	49	6	1.4%	7.2%
1624	49	6	1.4%	7.4%
1625	49	6	1.4%	7.7%
1626	49	6	1.4%	7.9%
1627	49	6	1.3%	8.2%
1628	49	6	1.3%	8.4%
1629	49	6	1.3%	8.7%
1630	49	6	1.3%	8.9%
1631	49	6	1.3%	9.2%
1632	49	6	1.2%	9.5%
1633	49	6	1.2%	9.8%
1634	52	7	1.7%	5.7%
1635	52	7	1.7%	5.9%
1636	52	7	1.7%	6.1%
1637	52	7	1.6%	6.3%

1638	52	7	1.6%	6.5%
1639	52	7	1.6%	6.7%
1640	52	7	1.6%	6.9%
1641	52	7	1.5%	7.2%
1642	52	7	1.5%	7.4%
1643	52	7	1.5%	7.6%
1644	52	7	1.5%	7.8%
1645	52	7	1.4%	8.1%
1646	52	7	1.4%	8.3%
1647	52	7	1.4%	8.5%
1648	52	7	1.4%	8.8%
1649	52	7	1.3%	9.0%
1650	52	7	1.3%	9.3%
1651	52	7	1.3%	9.6%
1652	52	7	1.3%	9.8%
1653	55	8	1.7%	6.1%
1654	55	8	1.7%	6.3%
1655	55	8	1.7%	6.5%
1656	55	8	1.7%	6.7%
1657	55	8	1.6%	6.9%
1658	55	8	1.6%	7.1%
1659	55	8	1.6%	7.3%
1660	55	8	1.5%	7.6%
1661	55	8	1.5%	7.8%
1662	55	8	1.5%	8.0%
1663	55	8	1.5%	8.2%
1664	55	8	1.4%	8.4%
1665	55	8	1.4%	8.7%
1666	55	8	1.4%	8.9%
1667	55	8	1.4%	9.2%
1668	55	8	1.3%	9.4%
1669	55	8	1.3%	9.7%
1670	55	8	1.3%	9.9%
1671	58	9	1.7%	6.5%
1672	58	9	1.7%	6.7%
1673	58	9	1.6%	6.9%
1674	58	9	1.6%	7.1%
1675	58	9	1.6%	7.3%
1676	58	9	1.6%	7.5%
1677	58	9	1.5%	7.7%
1678	58	9	1.5%	7.9%
1679	58	9	1.5%	8.1%
1680	58	9	1.5%	8.4%
1681	58	9	1.4%	8.6%
1682	58	9	1.4%	8.8%
1683	58	9	1.4%	9.1%
1684	58	9	1.4%	9.3%
1685	58	9	1.3%	9.5%
1686	58	9	1.3%	9.8%
1687	61	10	1.7%	6.7%

1688	61	10	1.6%	6.9%
1689	61	10	1.6%	7.1%
1690	61	10	1.6%	7.3%
1691	61	10	1.6%	7.5%
1692	61	10	1.5%	7.7%
1693	61	10	1.5%	7.9%
1694	61	10	1.5%	8.1%
1695	61	10	1.5%	8.3%
1696	61	10	1.4%	8.5%
1697	61	10	1.4%	8.7%
1698	61	10	1.4%	8.9%
1699	61	10	1.4%	9.2%
1700	61	10	1.3%	9.4%
1701	61	10	1.3%	9.6%
1702	61	10	1.3%	9.9%
1703	63	11	1.9%	6.3%
1704	63	11	1.9%	6.5%
1705	63	11	1.9%	6.7%
1706	63	11	1.8%	6.9%
1707	63	11	1.8%	7.0%
1708	63	11	1.8%	7.2%
1709	63	11	1.7%	7.4%
1710	63	11	1.7%	7.6%
1711	63	11	1.7%	7.8%
1712	63	11	1.6%	8.0%
1713	63	11	1.6%	8.2%
1714	63	11	1.6%	8.4%
1715	63	11	1.6%	8.6%
1716	63	11	1.5%	8.8%
1717	63	11	1.5%	9.0%
1718	63	11	1.5%	9.3%
1719	63	11	1.5%	9.5%
1720	63	11	1.4%	9.7%
1721	63	11	1.4%	9.9%
1722	66	12	1.7%	7.3%
1723	66	12	1.7%	7.5%
1724	66	12	1.6%	7.7%
1725	66	12	1.6%	7.9%
1726	66	12	1.6%	8.1%
1727	66	12	1.6%	8.3%
1728	66	12	1.5%	8.5%
1729	66	12	1.5%	8.7%
1730	66	12	1.5%	8.9%
1731	66	12	1.5%	9.1%
1732	66	12	1.4%	9.3%
1733	66	12	1.4%	9.5%
1734	66	12	1.4%	9.7%
1735	66	12	1.4%	10.0%
1736	68	13	1.9%	6.8%
1737	68	13	1.9%	6.9%

1738	68	13	1.9%	7.1%
1739	68	13	1.8%	7.3%
1740	68	13	1.8%	7.5%
1741	68	13	1.8%	7.7%
1742	68	13	1.7%	7.8%
1743	68	13	1.7%	8.0%
1744	68	13	1.7%	8.2%
1745	68	13	1.7%	8.4%
1746	68	13	1.6%	8.6%
1747	68	13	1.6%	8.8%
1748	68	13	1.6%	9.0%
1749	68	13	1.5%	9.2%
1750	68	13	1.5%	9.4%
1751	68	13	1.5%	9.6%
1752	68	13	1.5%	9.9%
1753	71	14	1.7%	7.6%
1754	71	14	1.7%	7.8%
1755	71	14	1.6%	8.0%
1756	71	14	1.6%	8.2%
1757	71	14	1.6%	8.4%
1758	71	14	1.6%	8.5%
1759	71	14	1.5%	8.7%
1760	71	14	1.5%	8.9%
1761	71	14	1.5%	9.1%
1762	71	14	1.5%	9.3%
1763	71	14	1.4%	9.6%
1764	71	14	1.4%	9.8%
1765	71	14	1.4%	10.0%
1766	73	15	1.9%	7.1%
1767	73	15	1.9%	7.3%
1768	73	15	1.8%	7.4%
1769	73	15	1.8%	7.6%
1770	73	15	1.8%	7.8%
1771	73	15	1.7%	8.0%
1772	73	15	1.7%	8.1%
1773	73	15	1.7%	8.3%
1774	73	15	1.6%	8.5%
1775	73	15	1.6%	8.7%
1776	73	15	1.6%	8.9%
1777	73	15	1.6%	9.1%
1778	73	15	1.5%	9.3%
1779	73	15	1.5%	9.5%
1780	73	15	1.5%	9.7%
1781	73	15	1.5%	9.9%
1782	75	16	2.0%	7.2%
1783	75	16	1.9%	7.3%
1784	75	16	1.9%	7.5%
1785	75	16	1.9%	7.7%
1786	75	16	1.8%	7.8%
1787	75	16	1.8%	8.0%

1788	75	16	1.8%	8.2%
1789	75	16	1.7%	8.4%
1790	75	16	1.7%	8.6%
1791	75	16	1.7%	8.8%
1792	75	16	1.7%	8.9%
1793	75	16	1.6%	9.1%
1794	75	16	1.6%	9.3%
1795	75	16	1.6%	9.5%
1796	75	16	1.5%	9.7%
1797	75	16	1.5%	9.9%
1798	78	17	1.7%	8.1%
1799	78	17	1.6%	8.3%
1800	78	17	1.6%	8.5%
1801	78	17	1.6%	8.7%
1802	78	17	1.6%	8.8%
1803	78	17	1.5%	9.0%
1804	78	17	1.5%	9.2%
1805	78	17	1.5%	9.4%
1806	78	17	1.5%	9.6%
1807	78	17	1.4%	9.8%
1808	80	18	1.9%	7.3%
1809	80	18	1.8%	7.5%
1810	80	18	1.8%	7.7%
1811	80	18	1.8%	7.8%
1812	80	18	1.7%	8.0%
1813	80	18	1.7%	8.2%
1814	80	18	1.7%	8.3%
1815	80	18	1.7%	8.5%
1816	80	18	1.6%	8.7%
1817	80	18	1.6%	8.9%
1818	80	18	1.6%	9.1%
1819	80	18	1.5%	9.3%
1820	80	18	1.5%	9.5%
1821	80	18	1.5%	9.6%
1822	80	18	1.5%	9.8%
1823	82	19	1.9%	7.4%
1824	82	19	1.9%	7.6%
1825	82	19	1.8%	7.8%
1826	82	19	1.8%	7.9%
1827	82	19	1.8%	8.1%
1828	82	19	1.7%	8.3%
1829	82	19	1.7%	8.5%
1830	82	19	1.7%	8.6%
1831	82	19	1.7%	8.8%
1832	82	19	1.6%	9.0%
1833	82	19	1.6%	9.2%
1834	82	19	1.6%	9.4%
1835	82	19	1.5%	9.5%
1836	82	19	1.5%	9.7%
1837	82	19	1.5%	9.9%

1838	84	20	1.9%	7.6%
1839	84	20	1.9%	7.8%
1840	84	20	1.8%	7.9%
1841	84	20	1.8%	8.1%
1842	84	20	1.8%	8.3%
1843	84	20	1.7%	8.5%
1844	84	20	1.7%	8.6%
1845	84	20	1.7%	8.8%
1846	84	20	1.7%	9.0%
1847	84	20	1.6%	9.2%
1848	84	20	1.6%	9.3%
1849	84	20	1.6%	9.5%
1850	84	20	1.6%	9.7%
1851	84	20	1.5%	9.9%
1852	86	21	1.9%	7.7%
1853	86	21	1.9%	7.8%
1854	86	21	1.9%	8.0%
1855	86	21	1.8%	8.2%
1856	86	21	1.8%	8.3%
1857	86	21	1.8%	8.5%
1858	86	21	1.7%	8.7%
1859	86	21	1.7%	8.9%
1860	86	21	1.7%	9.0%
1861	86	21	1.7%	9.2%
1862	86	21	1.6%	9.4%
1863	86	21	1.6%	9.6%
1864	86	21	1.6%	9.8%
1865	86	21	1.5%	9.9%
1866	88	22	1.9%	7.8%
1867	88	22	1.9%	8.0%
1868	88	22	1.9%	8.1%
1869	88	22	1.8%	8.3%
1870	88	22	1.8%	8.5%
1871	88	22	1.8%	8.6%
1872	88	22	1.7%	8.8%
1873	88	22	1.7%	9.0%
1874	88	22	1.7%	9.1%
1875	88	22	1.7%	9.3%
1876	88	22	1.6%	9.5%
1877	88	22	1.6%	9.7%
1878	88	22	1.6%	9.9%
1879	90	23	1.9%	7.8%
1880	90	23	1.9%	8.0%
1881	90	23	1.9%	8.1%
1882	90	23	1.8%	8.3%
1883	90	23	1.8%	8.5%
1884	90	23	1.8%	8.6%
1885	90	23	1.8%	8.8%
1886	90	23	1.7%	9.0%
1887	90	23	1.7%	9.1%

1888	90	23	1.7%	9.3%
1889	90	23	1.6%	9.5%
1890	90	23	1.6%	9.7%
1891	90	23	1.6%	9.8%
1892	92	24	1.9%	7.9%
1893	92	24	1.9%	8.0%
1894	92	24	1.9%	8.2%
1895	92	24	1.8%	8.3%
1896	92	24	1.8%	8.5%
1897	92	24	1.8%	8.7%
1898	92	24	1.8%	8.8%
1899	92	24	1.7%	9.0%
1900	92	24	1.7%	9.2%
1901	92	24	1.7%	9.4%
1902	92	24	1.6%	9.5%
1903	92	24	1.6%	9.7%
1904	92	24	1.6%	9.9%
1905	94	25	1.9%	8.0%
1906	94	25	1.9%	8.1%
1907	94	25	1.9%	8.3%
1908	94	25	1.8%	8.4%
1909	94	25	1.8%	8.6%
1910	94	25	1.8%	8.8%
1911	94	25	1.7%	8.9%
1912	94	25	1.7%	9.1%
1913	94	25	1.7%	9.3%
1914	94	25	1.7%	9.4%
1915	94	25	1.6%	9.6%
1916	94	25	1.6%	9.8%
1917	94	25	1.6%	10.0%
1918	96	26	1.9%	8.1%
1919	96	26	1.9%	8.3%
1920	96	26	1.8%	8.4%
1921	96	26	1.8%	8.6%
1922	96	26	1.8%	8.8%
1923	96	26	1.8%	8.9%
1924	96	26	1.7%	9.1%
1925	96	26	1.7%	9.3%
1926	96	26	1.7%	9.4%
1927	96	26	1.6%	9.6%
1928	96	26	1.6%	9.8%
1929	96	26	1.6%	9.9%
1930	98	27	1.9%	8.2%
1931	98	27	1.9%	8.3%
1932	98	27	1.8%	8.5%
1933	98	27	1.8%	8.6%
1934	98	27	1.8%	8.8%
1935	98	27	1.7%	9.0%
1936	98	27	1.7%	9.1%
1937	98	27	1.7%	9.3%

1938	98	27	1.7%	9.5%
1939	98	27	1.6%	9.6%
1940	98	27	1.6%	9.8%
1941	98	27	1.6%	10.0%
1942	100	28	1.9%	8.2%
1943	100	28	1.8%	8.4%
1944	100	28	1.8%	8.5%
1945	100	28	1.8%	8.7%
1946	100	28	1.7%	8.9%
1947	100	28	1.7%	9.0%
1948	100	28	1.7%	9.2%
1949	100	28	1.7%	9.4%
1950	100	28	1.6%	9.5%
1951	100	28	1.6%	9.7%
1952	100	28	1.6%	9.9%
1953	102	29	1.9%	8.2%
1954	102	29	1.8%	8.4%
1955	102	29	1.8%	8.5%
1956	102	29	1.8%	8.7%
1957	102	29	1.7%	8.8%
1958	102	29	1.7%	9.0%
1959	102	29	1.7%	9.1%
1960	102	29	1.7%	9.3%
1961	102	29	1.6%	9.5%
1962	102	29	1.6%	9.6%
1963	102	29	1.6%	9.8%
1964	102	29	1.6%	10.0%
1965	104	30	1.8%	8.4%
1966	104	30	1.8%	8.5%
1967	104	30	1.8%	8.7%
1968	104	30	1.7%	8.8%
1969	104	30	1.7%	9.0%
1970	104	30	1.7%	9.1%
1971	104	30	1.7%	9.3%
1972	104	30	1.6%	9.5%
1973	104	30	1.6%	9.6%
1974	104	30	1.6%	9.8%
1975	104	30	1.5%	10.0%
1976	106	31	1.8%	8.4%
1977	106	31	1.8%	8.6%
1978	106	31	1.7%	8.7%
1979	106	31	1.7%	8.9%
1980	106	31	1.7%	9.0%
1981	106	31	1.7%	9.2%
1982	106	31	1.6%	9.3%
1983	106	31	1.6%	9.5%
1984	106	31	1.6%	9.7%
1985	106	31	1.6%	9.8%
1986	108	32	1.8%	8.3%
1987	108	32	1.8%	8.5%

1988	108	32	1.7%	8.6%
1989	108	32	1.7%	8.8%
1990	108	32	1.7%	8.9%
1991	108	32	1.7%	9.1%
1992	108	32	1.6%	9.3%
1993	108	32	1.6%	9.4%
1994	108	32	1.6%	9.6%
1995	108	32	1.5%	9.7%
1996	108	32	1.5%	9.9%
1997	110	33	1.7%	8.4%
1998	110	33	1.7%	8.6%
1999	110	33	1.7%	8.7%
2000	110	33	1.7%	8.9%
2001	110	33	1.6%	9.1%
2002	110	33	1.6%	9.2%
2003	110	33	1.6%	9.4%
2004	110	33	1.6%	9.5%
2005	110	33	1.5%	9.7%
2006	110	33	1.5%	9.9%
2007	112	34	1.7%	8.4%
2008	112	34	1.7%	8.6%
2009	112	34	1.7%	8.7%
2010	112	34	1.6%	8.9%
2011	112	34	1.6%	9.0%
2012	112	34	1.6%	9.2%
2013	112	34	1.6%	9.4%
2014	112	34	1.5%	9.5%
2015	112	34	1.5%	9.7%
2016	112	34	1.5%	9.8%
2017	114	35	1.7%	8.5%
2018	114	35	1.7%	8.6%
2019	114	35	1.6%	8.8%
2020	114	35	1.6%	8.9%
2021	114	35	1.6%	9.1%
2022	114	35	1.6%	9.2%
2023	114	35	1.5%	9.4%
2024	114	35	1.5%	9.5%
2025	114	35	1.5%	9.7%
2026	114	35	1.5%	9.9%
2027	115	36	2.0%	7.6%
2028	115	36	2.0%	7.8%
2029	115	36	1.9%	7.9%
2030	115	36	1.9%	8.0%
2031	115	36	1.9%	8.2%
2032	115	36	1.8%	8.3%
2033	115	36	1.8%	8.5%
2034	115	36	1.8%	8.6%
2035	115	36	1.7%	8.8%
2036	115	36	1.7%	8.9%
2037	115	36	1.7%	9.1%

2038	115	36	1.7%	9.2%
2039	115	36	1.6%	9.4%
2040	115	36	1.6%	9.5%
2041	115	36	1.6%	9.7%
2042	115	36	1.6%	9.8%
2043	117	37	1.8%	8.6%
2044	117	37	1.7%	8.7%
2045	117	37	1.7%	8.9%
2046	117	37	1.7%	9.0%
2047	117	37	1.7%	9.2%
2048	117	37	1.6%	9.3%
2049	117	37	1.6%	9.5%
2050	117	37	1.6%	9.6%
2051	117	37	1.5%	9.8%
2052	117	37	1.5%	9.9%
2053	119	38	1.7%	8.7%
2054	119	38	1.7%	8.8%
2055	119	38	1.7%	9.0%
2056	119	38	1.6%	9.1%
2057	119	38	1.6%	9.3%
2058	119	38	1.6%	9.4%
2059	119	38	1.6%	9.6%
2060	119	38	1.5%	9.7%
2061	119	38	1.5%	9.9%
2062	121	39	1.7%	8.7%
2063	121	39	1.6%	8.8%
2064	121	39	1.6%	9.0%
2065	121	39	1.6%	9.1%
2066	121	39	1.6%	9.3%
2067	121	39	1.5%	9.4%
2068	121	39	1.5%	9.6%
2069	121	39	1.5%	9.7%
2070	121	39	1.5%	9.9%
2071	122	40	2.0%	7.8%
2072	122	40	1.9%	7.9%
2073	122	40	1.9%	8.0%
2074	122	40	1.9%	8.2%
2075	122	40	1.8%	8.3%
2076	122	40	1.8%	8.5%
2077	122	40	1.8%	8.6%
2078	122	40	1.8%	8.7%
2079	122	40	1.7%	8.9%
2080	122	40	1.7%	9.0%
2081	122	40	1.7%	9.2%
2082	122	40	1.7%	9.3%
2083	122	40	1.6%	9.5%
2084	122	40	1.6%	9.6%
2085	122	40	1.6%	9.8%
2086	122	40	1.6%	9.9%
2087	124	41	1.7%	8.8%

2088	124	41	1.7%	8.9%
2089	124	41	1.7%	9.1%
2090	124	41	1.6%	9.2%
2091	124	41	1.6%	9.4%
2092	124	41	1.6%	9.5%
2093	124	41	1.6%	9.7%
2094	124	41	1.5%	9.8%
2095	124	41	1.5%	10.0%
2096	125	42	2.0%	7.9%
2097	125	42	2.0%	8.0%
2098	125	42	1.9%	8.2%
2099	125	42	1.9%	8.3%
2100	125	42	1.9%	8.5%
2101	125	42	1.8%	8.6%
2102	125	42	1.8%	8.7%
2103	125	42	1.8%	8.9%
2104	125	42	1.8%	9.0%
2105	125	42	1.7%	9.2%
2106	125	42	1.7%	9.3%
2107	125	42	1.7%	9.5%
2108	125	42	1.7%	9.6%
2109	125	42	1.6%	9.8%
2110	125	42	1.6%	9.9%
2111	127	43	1.8%	8.8%
2112	127	43	1.7%	9.0%
2113	127	43	1.7%	9.1%
2114	127	43	1.7%	9.3%
2115	127	43	1.7%	9.4%
2116	127	43	1.6%	9.6%
2117	127	43	1.6%	9.7%
2118	127	43	1.6%	9.9%
2119	129	44	1.7%	8.8%
2120	129	44	1.7%	8.9%
2121	129	44	1.7%	9.1%
2122	129	44	1.6%	9.2%
2123	129	44	1.6%	9.4%
2124	129	44	1.6%	9.5%
2125	129	44	1.6%	9.7%
2126	129	44	1.5%	9.8%
2127	129	44	1.5%	10.0%
2128	130	45	2.0%	8.0%
2129	130	45	2.0%	8.1%
2130	130	45	1.9%	8.3%
2131	130	45	1.9%	8.4%
2132	130	45	1.9%	8.5%
2133	130	45	1.8%	8.7%
2134	130	45	1.8%	8.8%
2135	130	45	1.8%	8.9%
2136	130	45	1.8%	9.1%
2137	130	45	1.7%	9.2%

2138	130	45	1.7%	9.4%
2139	130	45	1.7%	9.5%
2140	130	45	1.7%	9.7%
2141	130	45	1.6%	9.8%
2142	130	45	1.6%	10.0%
2143	132	46	1.7%	9.0%
2144	132	46	1.7%	9.1%
2145	132	46	1.7%	9.2%
2146	132	46	1.7%	9.4%
2147	132	46	1.6%	9.5%
2148	132	46	1.6%	9.7%
2149	132	46	1.6%	9.8%
2150	132	46	1.6%	10.0%
2151	134	47	1.7%	9.0%
2152	134	47	1.7%	9.1%
2153	134	47	1.6%	9.3%
2154	134	47	1.6%	9.4%
2155	134	47	1.6%	9.6%
2156	134	47	1.6%	9.7%
2157	134	47	1.5%	9.9%
2158	135	48	2.0%	8.0%
2159	135	48	1.9%	8.1%
2160	135	48	1.9%	8.2%
2161	135	48	1.9%	8.4%
2162	135	48	1.9%	8.5%
2163	135	48	1.8%	8.6%
2164	135	48	1.8%	8.8%
2165	135	48	1.8%	8.9%
2166	135	48	1.8%	9.0%
2167	135	48	1.7%	9.2%
2168	135	48	1.7%	9.3%
2169	135	48	1.7%	9.5%
2170	135	48	1.7%	9.6%
2171	135	48	1.6%	9.7%
2172	135	48	1.6%	9.9%
2173	137	49	1.7%	9.0%
2174	137	49	1.7%	9.1%
2175	137	49	1.7%	9.3%
2176	137	49	1.6%	9.4%
2177	137	49	1.6%	9.5%
2178	137	49	1.6%	9.7%
2179	137	49	1.6%	9.8%
2180	137	49	1.5%	10.0%
2181	138	50	2.0%	8.1%
2182	138	50	2.0%	8.2%
2183	138	50	1.9%	8.4%
2184	138	50	1.9%	8.5%
2185	138	50	1.9%	8.6%
2186	138	50	1.8%	8.8%
2187	138	50	1.8%	8.9%

2188	138	50	1.8%	9.0%
2189	138	50	1.8%	9.2%
2190	138	50	1.7%	9.3%
2191	138	50	1.7%	9.4%
2192	138	50	1.7%	9.6%
2193	138	50	1.7%	9.7%
2194	138	50	1.6%	9.9%
2195	140	51	1.7%	9.0%
2196	140	51	1.7%	9.2%
2197	140	51	1.7%	9.3%
2198	140	51	1.7%	9.4%
2199	140	51	1.6%	9.6%
2200	140	51	1.6%	9.7%
2201	140	51	1.6%	9.9%
2202	142	52	1.7%	9.0%
2203	142	52	1.7%	9.2%
2204	142	52	1.6%	9.3%
2205	142	52	1.6%	9.4%
2206	142	52	1.6%	9.6%
2207	142	52	1.6%	9.7%
2208	142	52	1.5%	9.9%
2209	143	53	2.0%	8.1%
2210	143	53	1.9%	8.2%
2211	143	53	1.9%	8.3%
2212	143	53	1.9%	8.5%
2213	143	53	1.8%	8.6%
2214	143	53	1.8%	8.7%
2215	143	53	1.8%	8.8%
2216	143	53	1.8%	9.0%
2217	143	53	1.7%	9.1%
2218	143	53	1.7%	9.2%
2219	143	53	1.7%	9.4%
2220	143	53	1.7%	9.5%
2221	143	53	1.6%	9.7%
2222	143	53	1.6%	9.8%
2223	143	53	1.6%	9.9%
2224	145	54	1.7%	9.2%
2225	145	54	1.7%	9.3%
2226	145	54	1.6%	9.4%
2227	145	54	1.6%	9.6%
2228	145	54	1.6%	9.7%
2229	145	54	1.6%	9.8%
2230	145	54	1.5%	10.0%
2231	146	55	1.9%	8.2%
2232	146	55	1.9%	8.4%
2233	146	55	1.9%	8.5%
2234	146	55	1.9%	8.6%
2235	146	55	1.8%	8.7%
2236	146	55	1.8%	8.9%
2237	146	55	1.8%	9.0%

2238	146	55	1.8%	9.1%
2239	146	55	1.7%	9.3%
2240	146	55	1.7%	9.4%
2241	146	55	1.7%	9.5%
2242	146	55	1.7%	9.7%
2243	146	55	1.6%	9.8%
2244	146	55	1.6%	9.9%
2245	148	56	1.7%	9.2%
2246	148	56	1.7%	9.3%
2247	148	56	1.6%	9.5%
2248	148	56	1.6%	9.6%
2249	148	56	1.6%	9.8%
2250	148	56	1.6%	9.9%
2251	149	57	2.0%	8.2%
2252	149	57	1.9%	8.3%
2253	149	57	1.9%	8.4%
2254	149	57	1.9%	8.5%
2255	149	57	1.9%	8.7%
2256	149	57	1.8%	8.8%
2257	149	57	1.8%	8.9%
2258	149	57	1.8%	9.1%
2259	149	57	1.8%	9.2%
2260	149	57	1.7%	9.3%
2261	149	57	1.7%	9.5%
2262	149	57	1.7%	9.6%
2263	149	57	1.7%	9.7%
2264	149	57	1.6%	9.9%
2265	151	58	1.7%	9.2%
2266	151	58	1.7%	9.3%
2267	151	58	1.7%	9.4%
2268	151	58	1.6%	9.6%
2269	151	58	1.6%	9.7%
2270	151	58	1.6%	9.8%
2271	151	58	1.6%	10.0%
2272	152	59	2.0%	8.3%
2273	152	59	1.9%	8.4%
2274	152	59	1.9%	8.5%
2275	152	59	1.9%	8.7%
2276	152	59	1.8%	8.8%
2277	152	59	1.8%	8.9%
2278	152	59	1.8%	9.1%
2279	152	59	1.8%	9.2%
2280	152	59	1.7%	9.3%
2281	152	59	1.7%	9.4%
2282	152	59	1.7%	9.6%
2283	152	59	1.7%	9.7%
2284	152	59	1.6%	9.8%
2285	152	59	1.6%	10.0%
2286	154	60	1.7%	9.3%
2287	154	60	1.7%	9.5%

2288	154	60	1.6%	9.6%
2289	154	60	1.6%	9.7%
2290	154	60	1.6%	9.9%
2291	154	60	1.6%	10.0%
2292	155	61	2.0%	8.3%
2293	155	61	1.9%	8.5%
2294	155	61	1.9%	8.6%
2295	155	61	1.9%	8.7%
2296	155	61	1.8%	8.8%
2297	155	61	1.8%	9.0%
2298	155	61	1.8%	9.1%
2299	155	61	1.8%	9.2%
2300	155	61	1.7%	9.3%
2301	155	61	1.7%	9.5%
2302	155	61	1.7%	9.6%
2303	155	61	1.7%	9.7%
2304	155	61	1.6%	9.9%
2305	157	62	1.7%	9.3%
2306	157	62	1.7%	9.4%
2307	157	62	1.7%	9.5%
2308	157	62	1.6%	9.7%
2309	157	62	1.6%	9.8%
2310	157	62	1.6%	9.9%
2311	158	63	2.0%	8.3%
2312	158	63	1.9%	8.4%
2313	158	63	1.9%	8.5%
2314	158	63	1.9%	8.7%
2315	158	63	1.9%	8.8%
2316	158	63	1.8%	8.9%
2317	158	63	1.8%	9.0%
2318	158	63	1.8%	9.2%
2319	158	63	1.8%	9.3%
2320	158	63	1.7%	9.4%
2321	158	63	1.7%	9.6%
2322	158	63	1.7%	9.7%
2323	158	63	1.7%	9.8%
2324	158	63	1.6%	10.0%
2325	160	64	1.7%	9.4%
2326	160	64	1.7%	9.5%
2327	160	64	1.6%	9.6%
2328	160	64	1.6%	9.8%
2329	160	64	1.6%	9.9%
2330	161	65	2.0%	8.3%
2331	161	65	1.9%	8.4%
2332	161	65	1.9%	8.6%
2333	161	65	1.9%	8.7%
2334	161	65	1.9%	8.8%
2335	161	65	1.8%	8.9%
2336	161	65	1.8%	9.0%
2337	161	65	1.8%	9.2%

2338	161	65	1.8%	9.3%
2339	161	65	1.7%	9.4%
2340	161	65	1.7%	9.6%
2341	161	65	1.7%	9.7%
2342	161	65	1.7%	9.8%
2343	161	65	1.6%	9.9%
2344	163	66	1.7%	9.4%
2345	163	66	1.7%	9.5%
2346	163	66	1.6%	9.7%
2347	163	66	1.6%	9.8%
2348	163	66	1.6%	9.9%
2349	164	67	1.9%	8.4%
2350	164	67	1.9%	8.5%
2351	164	67	1.9%	8.6%
2352	164	67	1.9%	8.7%
2353	164	67	1.8%	8.8%
2354	164	67	1.8%	9.0%
2355	164	67	1.8%	9.1%
2356	164	67	1.8%	9.2%
2357	164	67	1.7%	9.3%
2358	164	67	1.7%	9.5%
2359	164	67	1.7%	9.6%
2360	164	67	1.7%	9.7%
2361	164	67	1.6%	9.9%
2362	164	67	1.6%	10.0%
2363	165	68	2.0%	8.4%
2364	165	68	2.0%	8.6%
2365	165	68	1.9%	8.7%
2366	165	68	1.9%	8.8%
2367	165	68	1.9%	8.9%
2368	165	68	1.9%	9.0%
2369	165	68	1.8%	9.2%
2370	165	68	1.8%	9.3%
2371	165	68	1.8%	9.4%
2372	165	68	1.8%	9.5%
2373	165	68	1.7%	9.7%
2374	165	68	1.7%	9.8%
2375	165	68	1.7%	9.9%
2376	167	69	1.7%	9.4%
2377	167	69	1.7%	9.6%
2378	167	69	1.7%	9.7%
2379	167	69	1.6%	9.8%
2380	167	69	1.6%	9.9%
2381	168	70	2.0%	8.4%
2382	168	70	2.0%	8.5%
2383	168	70	1.9%	8.7%
2384	168	70	1.9%	8.8%
2385	168	70	1.9%	8.9%
2386	168	70	1.9%	9.0%
2387	168	70	1.8%	9.1%

2388	168	70	1.8%	9.3%
2389	168	70	1.8%	9.4%
2390	168	70	1.8%	9.5%
2391	168	70	1.7%	9.6%
2392	168	70	1.7%	9.8%
2393	168	70	1.7%	9.9%
2394	170	71	1.7%	9.4%
2395	170	71	1.7%	9.6%
2396	170	71	1.7%	9.7%
2397	170	71	1.6%	9.8%
2398	170	71	1.6%	9.9%
2399	171	72	2.0%	8.4%
2400	171	72	1.9%	8.6%
2401	171	72	1.9%	8.7%
2402	171	72	1.9%	8.8%
2403	171	72	1.9%	8.9%
2404	171	72	1.8%	9.0%
2405	171	72	1.8%	9.2%
2406	171	72	1.8%	9.3%
2407	171	72	1.8%	9.4%
2408	171	72	1.7%	9.5%
2409	171	72	1.7%	9.6%
2410	171	72	1.7%	9.8%
2411	171	72	1.7%	9.9%
2412	173	73	1.7%	9.5%
2413	173	73	1.7%	9.6%
2414	173	73	1.6%	9.7%
2415	173	73	1.6%	9.8%
2416	173	73	1.6%	10.0%
2417	174	74	1.9%	8.5%
2418	174	74	1.9%	8.6%
2419	174	74	1.9%	8.7%
2420	174	74	1.9%	8.9%
2421	174	74	1.8%	9.0%
2422	174	74	1.8%	9.1%
2423	174	74	1.8%	9.2%
2424	174	74	1.8%	9.3%
2425	174	74	1.7%	9.5%
2426	174	74	1.7%	9.6%
2427	174	74	1.7%	9.7%
2428	174	74	1.7%	9.8%
2429	174	74	1.6%	10.0%
2430	175	75	2.0%	8.5%
2431	175	75	2.0%	8.6%
2432	175	75	1.9%	8.7%
2433	175	75	1.9%	8.8%
2434	175	75	1.9%	9.0%
2435	175	75	1.9%	9.1%
2436	175	75	1.8%	9.2%
2437	175	75	1.8%	9.3%

2438	175	75	1.8%	9.4%
2439	175	75	1.8%	9.6%
2440	175	75	1.7%	9.7%
2441	175	75	1.7%	9.8%
2442	175	75	1.7%	9.9%
2443	177	76	1.7%	9.5%
2444	177	76	1.7%	9.7%
2445	177	76	1.7%	9.8%
2446	177	76	1.6%	9.9%
2447	178	77	2.0%	8.5%
2448	178	77	2.0%	8.6%
2449	178	77	1.9%	8.7%
2450	178	77	1.9%	8.8%
2451	178	77	1.9%	9.0%
2452	178	77	1.9%	9.1%
2453	178	77	1.8%	9.2%
2454	178	77	1.8%	9.3%
2455	178	77	1.8%	9.4%
2456	178	77	1.8%	9.5%
2457	178	77	1.7%	9.7%
2458	178	77	1.7%	9.8%
2459	178	77	1.7%	9.9%
2460	180	78	1.7%	9.6%
2461	180	78	1.7%	9.7%
2462	180	78	1.6%	9.8%
2463	180	78	1.6%	9.9%
2464	181	79	2.0%	8.5%
2465	181	79	1.9%	8.6%
2466	181	79	1.9%	8.7%
2467	181	79	1.9%	8.9%
2468	181	79	1.9%	9.0%
2469	181	79	1.8%	9.1%
2470	181	79	1.8%	9.2%
2471	181	79	1.8%	9.3%
2472	181	79	1.8%	9.4%
2473	181	79	1.7%	9.6%
2474	181	79	1.7%	9.7%
2475	181	79	1.7%	9.8%
2476	181	79	1.7%	9.9%
2477	182	80	2.0%	8.5%
2478	182	80	2.0%	8.7%
2479	182	80	1.9%	8.8%
2480	182	80	1.9%	8.9%
2481	182	80	1.9%	9.0%
2482	182	80	1.9%	9.1%
2483	182	80	1.8%	9.2%
2484	182	80	1.8%	9.3%
2485	182	80	1.8%	9.5%
2486	182	80	1.8%	9.6%
2487	182	80	1.7%	9.7%

2488	182	80	1.7%	9.8%
2489	182	80	1.7%	9.9%
2490	184	81	1.7%	9.6%
2491	184	81	1.7%	9.7%
2492	184	81	1.7%	9.9%
2493	184	81	1.6%	10.0%
2494	185	82	2.0%	8.6%
2495	185	82	1.9%	8.7%
2496	185	82	1.9%	8.8%
2497	185	82	1.9%	9.0%
2498	185	82	1.9%	9.1%
2499	185	82	1.8%	9.2%
2500	185	82	1.8%	9.3%
2501	185	82	1.8%	9.4%
2502	185	82	1.8%	9.5%
2503	185	82	1.7%	9.6%
2504	185	82	1.7%	9.8%
2505	185	82	1.7%	9.9%
2506	187	83	1.7%	9.6%
2507	187	83	1.7%	9.7%
2508	187	83	1.6%	9.8%
2509	187	83	1.6%	10.0%
2510	188	84	1.9%	8.6%
2511	188	84	1.9%	8.7%
2512	188	84	1.9%	8.8%
2513	188	84	1.9%	8.9%
2514	188	84	1.8%	9.1%
2515	188	84	1.8%	9.2%
2516	188	84	1.8%	9.3%
2517	188	84	1.8%	9.4%
2518	188	84	1.7%	9.5%
2519	188	84	1.7%	9.6%
2520	188	84	1.7%	9.8%
2521	188	84	1.7%	9.9%
2522	188	84	1.7%	10.0%
2523	189	85	2.0%	8.6%
2524	189	85	1.9%	8.8%
2525	189	85	1.9%	8.9%
2526	189	85	1.9%	9.0%
2527	189	85	1.9%	9.1%
2528	189	85	1.8%	9.2%
2529	189	85	1.8%	9.3%
2530	189	85	1.8%	9.4%
2531	189	85	1.8%	9.6%
2532	189	85	1.8%	9.7%
2533	189	85	1.7%	9.8%
2534	189	85	1.7%	9.9%
2535	191	86	1.7%	9.7%
2536	191	86	1.7%	9.8%
2537	191	86	1.6%	9.9%

2538	192	87	2.0%	8.6%
2539	192	87	1.9%	8.7%
2540	192	87	1.9%	8.8%
2541	192	87	1.9%	8.9%
2542	192	87	1.9%	9.0%
2543	192	87	1.8%	9.1%
2544	192	87	1.8%	9.2%
2545	192	87	1.8%	9.4%
2546	192	87	1.8%	9.5%
2547	192	87	1.7%	9.6%
2548	192	87	1.7%	9.7%
2549	192	87	1.7%	9.8%
2550	192	87	1.7%	9.9%
2551	193	88	2.0%	8.6%
2552	193	88	2.0%	8.7%
2553	193	88	1.9%	8.8%
2554	193	88	1.9%	9.0%
2555	193	88	1.9%	9.1%
2556	193	88	1.9%	9.2%
2557	193	88	1.8%	9.3%
2558	193	88	1.8%	9.4%
2559	193	88	1.8%	9.5%
2560	193	88	1.8%	9.6%
2561	193	88	1.8%	9.8%
2562	193	88	1.7%	9.9%
2563	193	88	1.7%	10.0%
2564	195	89	1.7%	9.8%
2565	195	89	1.7%	9.9%
2566	195	89	1.6%	10.0%
2567	196	90	1.9%	8.7%
2568	196	90	1.9%	8.8%
2569	196	90	1.9%	8.9%
2570	196	90	1.9%	9.0%
2571	196	90	1.8%	9.1%
2572	196	90	1.8%	9.3%
2573	196	90	1.8%	9.4%
2574	196	90	1.8%	9.5%
2575	196	90	1.8%	9.6%
2576	196	90	1.7%	9.7%
2577	196	90	1.7%	9.8%
2578	196	90	1.7%	9.9%
2579	197	91	2.0%	8.7%
2580	197	91	2.0%	8.8%
2581	197	91	1.9%	8.9%
2582	197	91	1.9%	9.0%
2583	197	91	1.9%	9.1%
2584	197	91	1.9%	9.2%
2585	197	91	1.9%	9.3%
2586	197	91	1.8%	9.4%
2587	197	91	1.8%	9.5%

2588	197	91	1.8%	9.7%
2589	197	91	1.8%	9.8%
2590	197	91	1.7%	9.9%
2591	199	92	1.7%	9.7%
2592	199	92	1.7%	9.8%
2593	199	92	1.7%	9.9%
2594	200	93	2.0%	8.7%
2595	200	93	1.9%	8.8%
2596	200	93	1.9%	8.9%
2597	200	93	1.9%	9.0%
2598	200	93	1.9%	9.1%
2599	200	93	1.8%	9.2%
2600	200	93	1.8%	9.3%
2601	200	93	1.8%	9.4%
2602	200	93	1.8%	9.5%
2603	200	93	1.8%	9.7%
2604	200	93	1.7%	9.8%
2605	200	93	1.7%	9.9%
2606	200	93	1.7%	10.0%
2607	201	94	2.0%	8.7%
2608	201	94	2.0%	8.8%
2609	201	94	1.9%	9.0%
2610	201	94	1.9%	9.1%
2611	201	94	1.9%	9.2%
2612	201	94	1.9%	9.3%
2613	201	94	1.8%	9.4%
2614	201	94	1.8%	9.5%
2615	201	94	1.8%	9.6%
2616	201	94	1.8%	9.7%
2617	201	94	1.8%	9.8%
2618	201	94	1.7%	10.0%
2619	203	95	1.7%	9.8%
2620	203	95	1.7%	9.9%
2621	204	96	2.0%	8.7%
2622	204	96	1.9%	8.8%
2623	204	96	1.9%	8.9%
2624	204	96	1.9%	9.0%
2625	204	96	1.9%	9.1%
2626	204	96	1.8%	9.2%
2627	204	96	1.8%	9.3%
2628	204	96	1.8%	9.4%
2629	204	96	1.8%	9.5%
2630	204	96	1.8%	9.7%
2631	204	96	1.7%	9.8%
2632	204	96	1.7%	9.9%
2633	204	96	1.7%	10.0%
2634	205	97	2.0%	8.8%
2635	205	97	2.0%	8.9%
2636	205	97	1.9%	9.0%
2637	205	97	1.9%	9.1%

2638	205	97	1.9%	9.2%
2639	205	97	1.9%	9.3%
2640	205	97	1.8%	9.4%
2641	205	97	1.8%	9.5%
2642	205	97	1.8%	9.6%
2643	205	97	1.8%	9.7%
2644	205	97	1.8%	9.8%
2645	205	97	1.7%	10.0%
2646	207	98	1.7%	9.8%
2647	207	98	1.7%	9.9%
2648	208	99	2.0%	8.7%
2649	208	99	1.9%	8.8%
2650	208	99	1.9%	8.9%
2651	208	99	1.9%	9.1%
2652	208	99	1.9%	9.2%
2653	208	99	1.8%	9.3%
2654	208	99	1.8%	9.4%
2655	208	99	1.8%	9.5%
2656	208	99	1.8%	9.6%
2657	208	99	1.7%	9.7%
2658	208	99	1.7%	9.8%
2659	208	99	1.7%	9.9%
2660	209	100	2.0%	8.7%
2661	209	100	2.0%	8.8%
2662	209	100	1.9%	8.9%
2663	209	100	1.9%	9.0%
2664	209	100	1.9%	9.1%
2665	209	100	1.9%	9.2%
2666	209	100	1.9%	9.4%
2667	209	100	1.8%	9.5%
2668	209	100	1.8%	9.6%
2669	209	100	1.8%	9.7%
2670	209	100	1.8%	9.8%
2671	209	100	1.7%	9.9%
2672	211	101	1.7%	9.8%
2673	211	101	1.7%	9.9%
2674	212	102	2.0%	8.7%
2675	212	102	1.9%	8.8%
2676	212	102	1.9%	8.9%
2677	212	102	1.9%	9.0%
2678	212	102	1.9%	9.2%
2679	212	102	1.8%	9.3%
2680	212	102	1.8%	9.4%
2681	212	102	1.8%	9.5%
2682	212	102	1.8%	9.6%
2683	212	102	1.8%	9.7%
2684	212	102	1.7%	9.8%
2685	212	102	1.7%	9.9%
2686	213	103	2.0%	8.7%
2687	213	103	2.0%	8.8%

2688	213	103	1.9%	8.9%
2689	213	103	1.9%	9.0%
2690	213	103	1.9%	9.1%
2691	213	103	1.9%	9.3%
2692	213	103	1.9%	9.4%
2693	213	103	1.8%	9.5%
2694	213	103	1.8%	9.6%
2695	213	103	1.8%	9.7%
2696	213	103	1.8%	9.8%
2697	213	103	1.7%	9.9%
2698	215	104	1.7%	9.8%
2699	215	104	1.7%	9.9%
2700	216	105	1.9%	8.8%
2701	216	105	1.9%	8.9%
2702	216	105	1.9%	9.0%
2703	216	105	1.9%	9.1%
2704	216	105	1.9%	9.2%
2705	216	105	1.8%	9.3%
2706	216	105	1.8%	9.4%
2707	216	105	1.8%	9.5%
2708	216	105	1.8%	9.6%
2709	216	105	1.7%	9.7%
2710	216	105	1.7%	9.8%
2711	216	105	1.7%	9.9%
2712	217	106	2.0%	8.8%
2713	217	106	2.0%	8.9%
2714	217	106	1.9%	9.0%
2715	217	106	1.9%	9.1%
2716	217	106	1.9%	9.2%
2717	217	106	1.9%	9.3%
2718	217	106	1.8%	9.4%
2719	217	106	1.8%	9.5%
2720	217	106	1.8%	9.6%
2721	217	106	1.8%	9.7%
2722	217	106	1.7%	9.8%
2723	217	106	1.7%	9.9%
2724	219	107	1.7%	9.9%
2725	220	108	1.9%	8.8%
2726	220	108	1.9%	8.9%
2727	220	108	1.9%	9.0%
2728	220	108	1.9%	9.1%
2729	220	108	1.9%	9.2%
2730	220	108	1.8%	9.3%
2731	220	108	1.8%	9.4%
2732	220	108	1.8%	9.5%
2733	220	108	1.8%	9.6%
2734	220	108	1.7%	9.7%
2735	220	108	1.7%	9.8%
2736	220	108	1.7%	9.9%
2737	221	109	2.0%	8.8%

2738	221	109	1.9%	8.9%
2739	221	109	1.9%	9.0%
2740	221	109	1.9%	9.1%
2741	221	109	1.9%	9.2%
2742	221	109	1.9%	9.3%
2743	221	109	1.8%	9.4%
2744	221	109	1.8%	9.5%
2745	221	109	1.8%	9.6%
2746	221	109	1.8%	9.7%
2747	221	109	1.7%	9.8%
2748	221	109	1.7%	9.9%
2749	223	110	1.7%	9.9%
2750	224	111	1.9%	8.8%
2751	224	111	1.9%	8.9%
2752	224	111	1.9%	9.0%
2753	224	111	1.9%	9.1%
2754	224	111	1.8%	9.2%
2755	224	111	1.8%	9.3%
2756	224	111	1.8%	9.4%
2757	224	111	1.8%	9.5%
2758	224	111	1.8%	9.6%
2759	224	111	1.7%	9.7%
2760	224	111	1.7%	9.8%
2761	224	111	1.7%	9.9%
2762	225	112	2.0%	8.8%
2763	225	112	1.9%	8.9%
2764	225	112	1.9%	9.0%
2765	225	112	1.9%	9.1%
2766	225	112	1.9%	9.2%
2767	225	112	1.8%	9.3%
2768	225	112	1.8%	9.4%
2769	225	112	1.8%	9.5%
2770	225	112	1.8%	9.6%
2771	225	112	1.8%	9.7%
2772	225	112	1.7%	9.8%
2773	225	112	1.7%	9.9%
2774	226	113	2.0%	8.8%
2775	226	113	2.0%	8.9%
2776	226	113	1.9%	9.0%
2777	226	113	1.9%	9.1%
2778	226	113	1.9%	9.2%
2779	226	113	1.9%	9.3%
2780	226	113	1.8%	9.4%
2781	226	113	1.8%	9.5%
2782	226	113	1.8%	9.7%
2783	226	113	1.8%	9.8%
2784	226	113	1.8%	9.9%
2785	226	113	1.7%	10.0%
2786	228	114	1.7%	10.0%
2787	229	115	1.9%	8.9%

2788	229	115	1.9%	9.0%
2789	229	115	1.9%	9.1%
2790	229	115	1.9%	9.2%
2791	229	115	1.8%	9.3%
2792	229	115	1.8%	9.4%
2793	229	115	1.8%	9.5%
2794	229	115	1.8%	9.6%
2795	229	115	1.8%	9.7%
2796	229	115	1.7%	9.8%
2797	229	115	1.7%	9.9%
2798	230	116	2.0%	8.8%
2799	230	116	1.9%	8.9%
2800	230	116	1.9%	9.0%
2801	230	116	1.9%	9.1%
2802	230	116	1.9%	9.2%
2803	230	116	1.9%	9.3%
2804	230	116	1.8%	9.4%
2805	230	116	1.8%	9.5%
2806	230	116	1.8%	9.6%
2807	230	116	1.8%	9.7%
2808	230	116	1.8%	9.8%
2809	230	116	1.7%	9.9%
2810	231	117	2.0%	8.9%
2811	231	117	2.0%	9.0%
2812	231	117	1.9%	9.1%
2813	231	117	1.9%	9.2%
2814	231	117	1.9%	9.3%
2815	231	117	1.9%	9.4%
2816	231	117	1.9%	9.5%
2817	231	117	1.8%	9.6%
2818	231	117	1.8%	9.7%
2819	231	117	1.8%	9.8%
2820	231	117	1.8%	9.9%
2821	231	117	1.7%	10.0%
2822	234	119	2.0%	8.8%
2823	234	119	1.9%	8.9%
2824	234	119	1.9%	9.0%
2825	234	119	1.9%	9.1%
2826	234	119	1.9%	9.2%
2827	234	119	1.8%	9.3%
2828	234	119	1.8%	9.4%
2829	234	119	1.8%	9.5%
2830	234	119	1.8%	9.6%
2831	234	119	1.8%	9.7%
2832	234	119	1.7%	9.8%
2833	234	119	1.7%	9.9%
2834	235	120	2.0%	8.9%
2835	235	120	1.9%	9.0%
2836	235	120	1.9%	9.1%
2837	235	120	1.9%	9.2%

2838	235	120	1.9%	9.3%
2839	235	120	1.9%	9.4%
2840	235	120	1.8%	9.5%
2841	235	120	1.8%	9.6%
2842	235	120	1.8%	9.7%
2843	235	120	1.8%	9.8%
2844	235	120	1.8%	9.9%
2845	235	120	1.7%	10.0%
2846	236	121	2.0%	8.9%
2847	236	121	2.0%	9.0%
2848	236	121	1.9%	9.1%
2849	236	121	1.9%	9.2%
2850	236	121	1.9%	9.3%
2851	236	121	1.9%	9.4%
2852	236	121	1.9%	9.5%
2853	236	121	1.8%	9.6%
2854	236	121	1.8%	9.7%
2855	236	121	1.8%	9.8%
2856	236	121	1.8%	9.9%
2857	238	122	1.7%	10.0%
2858	239	123	1.9%	8.9%
2859	239	123	1.9%	9.0%
2860	239	123	1.9%	9.1%
2861	239	123	1.9%	9.2%
2862	239	123	1.9%	9.3%
2863	239	123	1.8%	9.4%
2864	239	123	1.8%	9.5%
2865	239	123	1.8%	9.6%
2866	239	123	1.8%	9.7%
2867	239	123	1.7%	9.8%
2868	239	123	1.7%	9.9%
2869	240	124	2.0%	8.9%
2870	240	124	2.0%	9.0%
2871	240	124	1.9%	9.1%
2872	240	124	1.9%	9.2%
2873	240	124	1.9%	9.3%
2874	240	124	1.9%	9.4%
2875	240	124	1.8%	9.5%
2876	240	124	1.8%	9.6%
2877	240	124	1.8%	9.7%
2878	240	124	1.8%	9.8%
2879	240	124	1.8%	9.9%
2880	240	124	1.7%	10.0%
2881	241	125	2.0%	9.0%
2882	241	125	2.0%	9.0%
2883	241	125	1.9%	9.1%
2884	241	125	1.9%	9.2%
2885	241	125	1.9%	9.3%
2886	241	125	1.9%	9.4%
2887	241	125	1.9%	9.5%

2888	241	125	1.8%	9.6%
2889	241	125	1.8%	9.7%
2890	241	125	1.8%	9.8%
2891	241	125	1.8%	9.9%
2892	244	127	2.0%	8.9%
2893	244	127	1.9%	9.0%
2894	244	127	1.9%	9.1%
2895	244	127	1.9%	9.2%
2896	244	127	1.9%	9.3%
2897	244	127	1.8%	9.4%
2898	244	127	1.8%	9.5%
2899	244	127	1.8%	9.6%
2900	244	127	1.8%	9.7%
2901	244	127	1.8%	9.8%
2902	244	127	1.7%	9.9%
2903	244	127	1.7%	10.0%
2904	245	128	2.0%	9.0%
2905	245	128	1.9%	9.1%
2906	245	128	1.9%	9.2%
2907	245	128	1.9%	9.3%
2908	245	128	1.9%	9.4%
2909	245	128	1.9%	9.5%
2910	245	128	1.8%	9.6%
2911	245	128	1.8%	9.7%
2912	245	128	1.8%	9.8%
2913	245	128	1.8%	9.9%
2914	245	128	1.8%	10.0%
2915	248	130	1.9%	9.0%
2916	248	130	1.9%	9.0%
2917	248	130	1.9%	9.1%
2918	248	130	1.9%	9.2%
2919	248	130	1.8%	9.3%
2920	248	130	1.8%	9.4%
2921	248	130	1.8%	9.5%
2922	248	130	1.8%	9.6%
2923	248	130	1.8%	9.7%
2924	248	130	1.7%	9.8%
2925	248	130	1.7%	9.9%
2926	249	131	2.0%	8.9%
2927	249	131	1.9%	9.0%
2928	249	131	1.9%	9.1%
2929	249	131	1.9%	9.2%
2930	249	131	1.9%	9.3%
2931	249	131	1.8%	9.4%
2932	249	131	1.8%	9.5%
2933	249	131	1.8%	9.6%
2934	249	131	1.8%	9.7%
2935	249	131	1.8%	9.8%
2936	249	131	1.7%	9.9%
2937	250	132	2.0%	8.9%

2938	250	132	2.0%	9.0%
2939	250	132	1.9%	9.1%
2940	250	132	1.9%	9.2%
2941	250	132	1.9%	9.3%
2942	250	132	1.9%	9.4%
2943	250	132	1.9%	9.5%
2944	250	132	1.8%	9.6%
2945	250	132	1.8%	9.7%
2946	250	132	1.8%	9.8%
2947	250	132	1.8%	9.9%
2948	250	132	1.8%	10.0%
2949	251	133	2.0%	9.0%
2950	251	133	2.0%	9.1%
2951	251	133	2.0%	9.2%
2952	251	133	1.9%	9.3%
2953	251	133	1.9%	9.3%
2954	251	133	1.9%	9.4%
2955	251	133	1.9%	9.5%
2956	251	133	1.8%	9.6%
2957	251	133	1.8%	9.7%
2958	251	133	1.8%	9.8%
2959	251	133	1.8%	9.9%
2960	254	135	1.9%	9.0%
2961	254	135	1.9%	9.1%
2962	254	135	1.9%	9.2%
2963	254	135	1.9%	9.3%
2964	254	135	1.9%	9.4%
2965	254	135	1.8%	9.5%
2966	254	135	1.8%	9.6%
2967	254	135	1.8%	9.7%
2968	254	135	1.8%	9.8%
2969	254	135	1.8%	9.9%
2970	254	135	1.7%	10.0%
2971	255	136	2.0%	9.0%
2972	255	136	1.9%	9.1%
2973	255	136	1.9%	9.2%
2974	255	136	1.9%	9.3%
2975	255	136	1.9%	9.4%
2976	255	136	1.9%	9.4%
2977	255	136	1.8%	9.5%
2978	255	136	1.8%	9.6%
2979	255	136	1.8%	9.7%
2980	255	136	1.8%	9.8%
2981	255	136	1.8%	9.9%
2982	256	137	2.0%	9.0%
2983	256	137	2.0%	9.1%
2984	256	137	2.0%	9.1%
2985	256	137	1.9%	9.2%
2986	256	137	1.9%	9.3%
2987	256	137	1.9%	9.4%

2988	256	137	1.9%	9.5%
2989	256	137	1.8%	9.6%
2990	256	137	1.8%	9.7%
2991	256	137	1.8%	9.8%
2992	256	137	1.8%	9.9%
2993	259	139	1.9%	9.0%
2994	259	139	1.9%	9.1%
2995	259	139	1.9%	9.2%
2996	259	139	1.9%	9.3%
2997	259	139	1.9%	9.4%
2998	259	139	1.8%	9.5%
2999	259	139	1.8%	9.6%
3000	259	139	1.8%	9.7%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 1500 and 1200 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	2000
Sample size	103
Maximum number of denials allowed	31

ASSUMPTIONS	
Valid list size	1500
Invalid list size	1200
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	10%

RESULT		
Probability of false rejection	9.15%	<10% (OK)
Probability of false acceptance	2.13%	>2% (Not OK)

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 2000, 10% and 2% the approximate value returned are 103 and 31. When these

INPUTS	
Members Lodged	2000
Desired probability of false rejection	10%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	1500
Unacceptable list	1200

RESULT	
Approximate sample size required	103
Approximate maximum number of denials	31

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.15
B	-1.56106
n0	108.3064
n1	102.7233
mu0	25.75
mu1	41.2
sig0	4.281013
sig1	4.843413
c0	30.73634
c1	30.75285

S22

From: S22
Sent: Friday, 11 June 2021 11:08 AM
To: S22
Subject: Re: AEC details [SEC=OFFICIAL]

Hi S22,

S47E(d), S47C

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22@abs.gov.au **(W)** www.abs.gov.au

From: S22/Staff/ABS
To: S22/Staff/ABS@ABS
Date: 02/06/2021 10:35 AM
Subject: Re: AEC details [SEC=OFFICIAL]

Hi S2,

S47E(d), S47C

Thanks,

S22

Household Statistics Methodology | Methodology Division | **Australian Bureau of Statistics**

(P) S22 **(E)** S22 **@abs.gov.au (W) www.abs.gov.au**

From: S22 Staff/ABS
To: S22 /Staff/ABS@ABS
Date: 11/05/2021 10:28 AM
Subject: AEC details [SEC=OFFICIAL]

Hi S22,

S22

S47E(d), S47C

Cheers,

S22
Assistant Director, Household Statistics Methodology
Methodology Division | **Australian Bureau of Statistics**
(P) S22
(E) S22 **@abs.gov.au (W) www.abs.gov.au**

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S22

From: S22
Sent: Monday, 11 July 2022 4:11 PM
To: Anders Holmberg
Subject: S47E(d), S47C

Hi Anders,

S47E(d), S47C

Cheers,
S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Monday, 11 July 2022 2:43 PM
To: S22 @abs.gov.au>
Subject: S47E(d), S47C

Thanks S22

S47E(d), S47C

Cheers,

Anders

From: S22 @abs.gov.au>
Sent: Monday, 11 July 2022 1:32 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47E(d), S47C

Hi Anders,

S47E(d), S47C

Cheers,
S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Monday, 11 July 2022 11:39 AM
To: S22 @abs.gov.au>
Subject: S47E(d), S47C

FYI, at this point.

They will send more later.

Anders

From: S22 @abs.gov.au> **On Behalf Of** Anders Holmberg
Sent: Monday, 11 July 2022 11:30 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47E(d), S47C

Hi Anders,

Would you like me to organise a meeting?

S22

From: S47E(d)
Sent: Friday, 8 July 2022 9:22 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S22 @abs.gov.au; S47F @aec.gov.au>; S47F @aec.gov.au>; S47F @aec.gov.au>; S47E(d)
Subject: S47E(d), S47C

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Dear Mr Anders Holmberg,

S47E(d), S47C

Kind regards,
S47F | **Legal Officer**
Legal Services Section | Legal & Procurement Branch
Australian Electoral Commission
M: S47F

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S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

Anders Holmberg

From: Anders Holmberg
Sent: Friday, 29 July 2022 5:09 PM
To: S47F
Cc: S47F
Subject: RE: AEC party sampling methodology - summary of meeting of 21 July 2022 (LEX1984) [SEC=OFFICIAL]

Categories: Blue Category

Dear S47F

I think you got it. I have added some extra clarification and some edits in red below. The purple I suggest you delete. (It is impossible to use statistical theory to say anything about the confidence of rejecting (or accepting) that there are >=1500 among the 4680. You can be *pretty sure* that there are not 1500 among the 1650 but I cannot calculate how sure you can be and it is a bit beside the point. With a small sample size and poor quality list it's just not how you would set up and perform a statistical test.

(As a simple example, if the first 150 you checked were invalid you'd need to find one more among the remaining 1500 to definitely reject with 100 % certainty. At the same time if the first 1499 were members you still need one more of the remaining 151 to 100% accept. Through randomised sampling probability theory controls the risks and optimises (minimises) the required sample size for those controls. If there are systematic patterns in the lists and it is not randomised it is more or less impossible to be very accurate about the decision probabilities of a test.)

Hope this helps.

Best regards,

Anders

From: S47F @aec.gov.au>
Sent: Friday, 29 July 2022 2:18 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: AEC party sampling methodology - summary of meeting of 21 July 2022 (LEX1984) [SEC=OFFICIAL]

Dear Anders

Thank you for meeting with S47F and I last week on Thursday 21 July. At that meeting we discussed the ABS methodology for sampling and testing membership of political parties used by the AEC. You kindly reviewed some questions we had and considered some issues raised by applications for review of the decision to deregister VoteFlux.Org | Upgrade Democracy! (the Party). The purpose of this email is to summarise the key points raised in that discussion. I would be grateful if you could confirm that I have set out your advice correctly. If not, I would be grateful if you could edit the response or reply clarify any points.

If possible, we would be grateful for your response by Monday 1 July 2022. We may provide this information to the Electoral Commission for the purposes of their review of the decision to deregister the Party.

1. What conclusions can be drawn in relation to the list of 4680 names in the Party's list, following the delegate's decision to test the top 1,650 names of that list (the sub-list)?

With respect to the test conducted it is not the randomisation or not that is causing the false rejection (or false acceptance) rate to land outside the limits. It is the sample size that control the test conditions. If you had randomised you would have been able to say something about the whole list as the final sample (probabilistically) would have referred to the 4680 not just the 1650. Nevertheless you still would have needed a bigger sample size to get the desired risk rates.

You advised that as the Party's list was not randomised before the sub-list was made (as only the top 1650 names were selected) it is not possible to draw any meaningful statistical conclusions about the Party's whole list of 4680 from the results of testing the sub-list. You can only say something about the selected 1650. This is because, without randomisation there is *no chance* of the other records being selected. You explained this by the analogy of attempting to sample from a deck of cards for aces. Having failed to first shuffle the deck, chunking the bottom half away, and then sample from what is left will not give you useful information about all original cards. Those thrown away were never in the running.

The test done indicates a list with low proportion of eligible members among the 1650.

DELETE As would usually be the case, as the test of the sub-list failed, it is possible to conclude (to the level of confidence to which the test is set) that the sub-list of 1,650 did not include 1,500 members.

2. What are the alternative options for testing the larger list?

You explained that a larger sample size would be required to test a large list to the same degree of confidence. Current sampling is calibrated so that the probability of accepting an invalid list is less than 2%, and the probability of falsely rejecting a valid list is less than 6%. You estimated that the sample size required to test the full list of 4680 names would be over 300. You also advised that excel spreadsheet calculator provided to the AEC could provide information about the sample size required to test a list of 4680 names to different levels of confidence.

We have now used the calculator (attached), to calculate that sampling a list of 4680 members, where the desired probability of false rejection is 6% and the desired probability of false acceptance is 2%, would require an approximate sample size of **564** and a maximum number of denials allowed of 399.

3. Does filtering names affect the error rates?

You explained that in your view, the arguments made in S47F paper with respect to filtering names increasing the error rate are without foundation. You explained that, provided the filtering process is done in accordance with the ABS methodology, filtering names works in favour of parties by removing from a list members who would not have been capable of meeting the requirements.

Correct this would improve the 'quality' of the list and decrease the occurrence of finding denials (non-members) in the list sample.

4. Your general comments on S47F paper

You considered that it was not instructive to consider in depth S47F hypothetical example. That example started from the premise that the party has more than 1,500 and sought to prove that a specific list could be rejected by the sampling methodology.

You agreed with the general proposition that if the correct sampling size was not adopted in relation to a larger list, the likelihood of false rejection increased. This is shown by the calculator.

We also discussed generally the rationale for requiring a smaller sampling size as a practical and fair method for testing party lists. We discussed the difficulties of testing a larger list. Since the requirement is minimum 1500 a party with a very large list that is 'low quality' in the sense that it contains a high percentage of non-members will require a very big sample size to control false rejection risks. This relates to the incentives of parties to keep good records of their members and provide the AEC with a high quality list. Providing large low quality lists should be discouraged.

S47F | **Senior Government Lawyer**
Legal Services Section | Legal & Procurement Branch
Australian Electoral Commission
M: S47F

FILE 95/364

COPY

Australian Bureau of Statistics

Address correspondence to:
Statistical Support Section
PO Box 10
Belconnen ACT 2616
Fax: 06 253 1033

FACSIMILE TRANSMISSION SHEET

To: S47F

From: S22

Of: Funding and Disclosure,
Australian Electoral Commission

Phone: S22

Fax: S22

Number of Pages 2

Date: 04/09/96 05:29 PM

Subject: Party Registration - Sample Composition.

S47F

I have been asked to forward on to you, information regarding a sample to ensure that a party registering with the AEC is eligible to do so. I have attached a table illustrating the amount of people from a sub-population you would expect to find in a sample of 20 people.

If you have any questions about, this please ring me on S22.

S22

Senior Research Officer
Statistical Support Section
Australian Bureau of Statistics

If there are **99%** of membership applications that would return a positive response when approached by AEC, then the following table illustrates the probability of selecting a number of positive responses in a **sample of 20**.

Number of positive responses in sample of twenty (n_k)	Probability of achieving n_k positive responses in the sample	Probability (%) of getting n_k or less positive responses in Sample
16	0.00	0.00
17	0.10	0.10
18	1.59	1.69
19	16.52	18.21
20	81.79	100.00

Note that this is based on a Simple random sample with replacement. These results are still a good approximation to the random sample without replacement. This means that whether you have 500 membership applications or 750 membership applications this table should still be appropriate.

Mail Document

$N = 500$

$n = 20$

TRUE $p = 0.9$ (table1) 8/20

own 0.95 (table2) 19/20.

To: S47F
cc:
bcc:
From: S22
Date: **28/08/96 05:11 PM**
Subject: **Probabilities**
Categories:

S47F

Here are the required probabilities

When p=.9

Number of instances in the sample (n_h)	Probability of having n_h in the sample (%)	Cumulative Probability (%)
11	0.01	0.01
12	0.04	0.05
13	0.20	0.25
14	0.89	1.14
15	3.19	4.33
16	8.98	13.31
17	19.01	32.32
18	28.52	60.84
19	27.02	87.86
20	12.16	100.00

When p=.95:

$$\sum_{i=1}^{n_h} {}^{n}C_i \; p^i (1-p)^{n-i}$$

Number of instances in the sample (n_h)	Probability of having n_h in the sample (%)	Cumulative Probability (%)
14	0.03	0.03
15	0.22	0.25
16	1.33	1.58
17	5.96	7.54
18	18.87	26.41
19	37.74	64.15
20	35.85	100.00

Item: 4

see fol: 91 for final.

Issue: **Party Registration - Policy Formulation**

Purpose

That the Commission adopt a policy of relying on signed membership applications including a declaration of entitlement to enrolment and supported by a statutory declaration signed by the applicant party's secretary to satisfy itself of the eligibility of non-parliamentary parties for registration.

Background

Under the Commonwealth Electoral Act, to be eligible for registration, a non-parliamentary party must have at least 500 members entitled to enrolment as distinct from an entitlement to vote.

Previous policy sought to determine a party's eligibility by undertaking two checks:

1. checking claimed members against the Electoral Roll; and
2. conducting a mail out survey of a sample of eligible members to estimate membership numbers by a process of extrapolation.

The problems with this policy are that: (1) at any given time, between 5% and 20% of those entitled to enrolment are not registered on the roll thus underestimating the number of eligible members; and (2) mail out surveys are an unreliable method of ascertaining likely membership numbers because of the typically high number of non-responses.

At its meeting on 26 July 1996 the Commission considered several policy issues and options for future procedures. This paper sets out an alternative policy based on the Commission's discussions of 26 July and the subsequent consideration of the issues within the AEC.

Policy Proposal

Step 1 *Membership Declarations*

Applicant parties are to supply a minimum of 500 membership forms incorporating declarations of both party membership and entitlement to enrolment. (Parties will be advised to supply the maximum number of declarations possible.) The Commission would supply a suitable proforma for parties to use providing a suitably worded explanation of the criteria for entitlement. The forms would also include an explanation of the requirement for the Commission to validate the claimed membership of the party and incorporate a consent for the form to be forwarded in support of the application. (It would be acceptable for parties to prepare membership forms to their own specification as long as the required wording is incorporated.)

The forms must be accompanied by a statutory declaration from the secretary of the applicant party attesting to the authenticity of the documents provided.

In correspondence with applicant parties we would explain the legal ramifications of the statutory declaration and emphasise that the Commission would undertake its own (unspecified) checks on the authenticity of the declarations.

Step 2. Check of authenticity

Telephone contact to be made with a sample of members, drawn randomly, to verify the authenticity of the membership declarations. The sample will be conducted in accordance with advice from the Australian Bureau of Statistics.

The Electoral Commissioner, as delegate of the Commission, will retain the discretion to authorise such further checks as considered appropriate in each case.

Comment

The underlying aim is to check the veracity of declarations, not to attempt the impossible task of arriving at actual figures for membership and entitlement to enrolment. In accordance with advice from the Australian Bureau of Statistics, tolerance will be limited taking into account the Statutory Declaration attesting to the validity of all membership declarations and the fact that members will have been asked by their party to consent to being contacted by the AEC. Furthermore, when making telephone contact, AEC officers will advise reluctant respondents of the possible consequences for the applicant party of a negative response. Should any persons express doubt about whether the contacting officer is genuinely from the AEC, they will be invited to call us back as a means of verification.

Deletion of Entitlement Check

Section 126 of the Act requires the Commission to determine whether a party should be registered. Previous policy and recent proposals have incorporated a check to RMANS as a means of checking entitlement. You will have noted, however, that this is not included in the steps proposed above.

Upon reflection, the RMANS check may put the Commission in conflict with the Act and leave us open to challenge. The reason is that, typically, 5%-20% of those entitled to enrolment are not enrolled at any given time. By requiring parties to have a minimum of 500 members on the roll, the Commission could in effect be requiring that they have up to 600 members entitled to enrolment.

The risk of not conducting a check to RMANS, on the other hand, is that some persons might incorrectly declare their eligibility to enrolment. This risk is reduced, however, by the fact that the declaration form will make clear the eligibility requirements. It should also be borne in mind that the Commission's existing enrolment policy requires no further evidence of entitlement on the claim card than a declaration by the elector.

Summary

It is essential to adopt a fair and equitable process within the limitations of the legislation.

The practical problems identified above are:

- it is difficult to verify entitlement to enrolment without, in effect, applying a standard higher than that specified by the Act;
- the procedure of extrapolating the results of a mail out survey carries a considerable risk of denying registration to an eligible party because mail out surveys typically have low response rates; and
- there is a risk of inconsistency between the standards of proof required for entitlement to enrolment compared with actual enrolment.

The process now recommended is in accordance with the stated preference of the Commission for working from declarations supported by a statutory declaration from the applicant party.

It provides a more accurate assessment of a party's ability to satisfy the membership criterion while avoiding the deficiencies of the sampling method currently used. Applicant parties are already required to provide a list of members' names and addresses. The requirement for information to be provided in this form adds very little to the parties' workload in collecting this information. In addition, applicant parties will benefit from more rapid processing and greater certainty. The provision of 500 or more genuine membership forms should allow a party to be registered within five weeks, far less than the six to eight weeks currently allowed under optimum conditions.

The spirit of the Act, in requiring 500 members, is that a party should have a substantial level of community support. Whichever process is adopted will inevitably involve a degree of risk. The proposal outlined above should enable the Commission to determine registration applications without the risk of setting a standard higher than that contemplated by the Act, while at the same time ensuring that parties are not registered unless they have the required substantial level of support.

Recommendation

That the Commission approve a policy requiring that non-parliamentary parties applying for registration provide proof of membership in the form of signed membership applications incorporating a declaration of entitlement to enrolment and authenticated by telephone sample.

RECOMMENDATION APPROVED/NOT APPROVED

Dated this .....day of .....September 1996.

T R Morling
Chairperson

W J Gray
Electoral Commissioner

W McLennan
Commissioner

FILE 95/866

95
129

COPY

Australian Bureau of Statistics

Address correspondence to:
Statistical Support Section
PO Box 10
Belconnen ACT 2616
Fax: 06 253 1033

FACSIMILE TRANSMISSION SHEET

To: S47F

Of: Funding and Disclosure
AEC

Fax: S22

Date: 29/10/96 04:24 PM

Subject: Comfirmation of Interpretation

From: S22

Phone: S22

Number of Pages 2

94
128

Dear S47F ,

Your interpretation of the table that I supplied to you in September is correct. Just to reiterate this:

- the probabilities in the table are approximations based on a sample of twenty. These approximation are accurate for any large populations (say greater than 400). Hence for populations of 500 or 750 the probabilities given in the table would not vary to any significant degree.

- if a sample of twenty is selected and **more than one** denial occurs, then the probability of this occurring is small (1.69%). From this we could infer that the percentage of people in the population that wish to join the party is less than 99%.

  The probability that the sample will contain either none or one denial is 98.31%. If either of these cases occur, then we have **no** significant evidence that there are less than 99% percent of people in the population who wish to join the party. So, the Commission should accept that the party has the required membership.

If you need any further clarification, please call me.

Yours sincerely,

S22

Senior Research Officer
Statistical Support Section

29 October 1996

(127 93

FAX Message

Message to:	Message from:	
S22 Statistical Support Section ABS Phone: Fax: S22	S47F Funding and Disclosure AEC Phone: Fax: S47F	Date sent: 29 October, 1996 Our reference: Priority: No. of pages: 2

S22

The following letter to you is just seeking confirmation that I understand correctly how to use the probability table you supplied. I'm also dropping a courtesy copy to Mr McLennan.

Regards

S47F

29 October, 1996

(128 92

Australian Electoral Commission AEC

In reply please quote 95/864

Contact Officer S47F

Telephone Fax S47F

West Block
Parkes ACT 2600

PO Box E201
Queen Victoria Terrace
ACT 2600

Telephone (06) 271 4411
Facsimile (06) 271 4556

S22
Senior Research Officer
Statistical Support Section
Australian Bureau of Statistics
PO Box 10
BELCONNEN ACT 2616

Dea S22

I refer to the probability table you provided and our subsequent telephone conversation in connection with sample checking the Australian Electoral Commission proposes undertaking of claimed party membership. Can you please confirm for me whether the following are correct interpretations of that table:

- the probabilities expressed in your table based on a sample of 20 will not vary to any significant degree irrespective of whether the population is 500 or 750 and therefore are indicative for varying population sizes; and

- the probabilities are such that the Commission should accept that a party has the required membership where the sample resulted in no denial or only one denial but not in cases where the sample resulted in two or more denials.

Thanks again for your help in this matter.

Yours sincerely

S47F
Director
Funding and Disclosure

28 October 1996

c.c. Mr W McLennan
Australian Statistician

S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Wednesday, 20 July 2022 5:59 PM
To: S47E(d)
Cc: S47F
Subject: S47C, S47E(d)

Attachments:

Dear S47F

S47C, S47E(d)

S47C, S47E(d)

Anders

From: S47E(d)
Sent: Friday, 8 July 2022 9:22 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S22 @abs.gov.au; S47F @aec.gov.au>; S47F @aec.gov.au>; S47F @aec.gov.au>; S47E(d)
Subject: S47C, S47E(d)

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Dear Mr Anders Holmberg,

S47C, S47E(d)

Kind regards,
S47F **| Legal Officer**
Legal Services Section | Legal & Procurement Branch
Australian Electoral Commission
M: S47F

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S47C, S47E(d)

S47C, S47E(d)

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S47C, S47E(d)

S47C, S47E(d)

Anders Holmberg

From: [redacted]
Sent: Friday, 2 September 2022 2:44 PM
To: 'Tom.Rogers@aec.gov.au'
Cc: [redacted]; [redacted]; Anders Holmberg
Subject: RE: Sent to Anders: Letter from Commissioner | Non-Parliamentary political party membership testing methodology [SEC=OFFICIAL:Sensitive]
Attachments: EC22-000082 Response Letter to the AEC Comissioner.pdf

Categories: Blue Category

OFFICIAL: Sensitive

Good afternoon Mr Rogers,

Please find attached a letter from Dr Gruen regarding the Non-Parliamentary political party membership testing methodology.

Regards,

[redacted]
Executive Officer to the Australian Statistician, Dr David Gruen AO
Australian Bureau of Statistics
(P) [redacted] (M) [redacted]
(E) [redacted]@abs.gov.au (W) www.abs.gov.au

From: [redacted]@aec.gov.au>
Sent: Wednesday, 24 August 2022 9:51 AM
To: David Gruen <david.gruen@abs.gov.au>
Cc: [redacted]@aec.gov.au>
Subject: Sent to Anders: Letter from Commissioner | Non-Parliamentary political party membership testing methodology [SEC=OFFICIAL:Sensitive]

OFFICIAL: Sensitive

Dear Dr Gruen,

Please find a letter and attachments from the Electoral Commissioner regarding the Non-Parliamentary political party membership testing methodology.

Kind regards,

[redacted]

[redacted] **| Chief of Staff**

National Executive | Australian Electoral Commission
T: S47F X: S47 M: S47F

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OFFICIAL: Sensitive

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Australian Bureau of Statistics

OFFICIAL: Sensitive

Ref: EC22-000082

Mr Tom Rogers
Australian Electoral Commissioner
Australian Electoral Commission
10-12 Mort Street
Canberra ACT 2600

Tom.Rogers@aec.gov.au

Tom

Dear Mr Rogers

Non-Parliamentary political party membership testing methodology

Thank you for your letter of 23 August concerning the deregistration of the political party S22 and the political party membership testing methodology used by the AEC.

Before responding to the six questions you posed, it is worth summarising some of the relevant detail. In requesting a review of the decision to deregister S22, S47F constructs a hypothetical example in which:

(i) a political party has more than 1,500 legitimate members, but
(ii) the membership testing methodology used by the AEC rejects the hypothesis that the party has 1,500 or more members.

S47F's hypothetical example relies on the argument that a political party can "have members that cannot be validated against the electoral roll."

This is the crux of S47F argument. If a political party has members who are legitimate electors but:

(i) cannot be validated against the electoral role, or
(ii) who deny membership when asked (despite being valid members of the political party)

then the membership testing methodology used by the AEC (and recommended by the ABS) cannot work. That testing methodology relies on being able to accurately identify legitimate electors who are members of the political party. If it is not possible to accurately identify such electors, then the methodology cannot work and should not be used.

Therefore, a key question in assessing whether S47F s objections have merit is this:

> Is it reasonable to require a political party to provide a list of between 1,500 and 1,650 legitimate electors who are members of the political party and are willing and able to confirm their membership when asked?

If it is considered reasonable to require a political party to provide such a list, then the testing methodology used by the AEC is appropriate and can be used as recommended by the ABS.

Locked Bag 10, Belconnen ACT 2616
Telephone: 1300 135 070 | www.abs.gov.au

If the AEC had unlimited resources, it could allow a political party to provide a members' list of arbitrary length – potentially many multiples of 1,500. For every person on that list, the AEC could then determine if they were a legitimate elector and, if so, contact them to confirm that they were a member of the political party. From there, it would be straightforward to determine whether the political party had at least 1,500 legitimate members or not.

The key reason for using the membership testing methodology recommended by the ABS is to limit the resource burden on the AEC of testing for political party membership.

Having summarised the relevant detail, I now provide answers to the six questions you posed.

1. *The AEC understands that if the Commission writes back to the party requesting a smaller list (between 1500-1650 members), then this can be tested in accordance with the extant testing methodology. Is this correct?*

   Yes

2. *What statistical options are available to conduct further testing in relation to the Party's list of 4680 members to establish whether the party has 1500 members?*

   (a) You could randomly select a sample from the entire list of 4680. You can set the chosen probabilities with the tool provided. To achieve a probability of <.02 to falsely accept a list and <.06 to falsely reject a list would require a sample size of approximately 564. With a sample size of 564, the maximum number of denials allowed would be 399.

   (b) Alternatively, you could check all the names on the entire list until you identify 1500 eligible members, or until you exhaust the list having identified less than 1500 eligible members.

3. *For each of these options what is the probability of falsely accepting a list? What is the probability of falsely rejecting a list?*

   For option 2a), the probabilities are as specified, namely <.02 to falsely accept a list and <.06 to falsely reject a list.

   For option 2b), provided the checking is done accurately, the probabilities of falsely accepting a list or falsely rejecting a list are both zero.

4. S47F *claims that it is not possible for the AEC to accurately test parties with more than 1650 members using the current testing methodology (*S22 *Attachments, pp 13, 21). Is this correct?*

   The AEC is testing whether a political party has at least 1,500 members. Provided a political party has at least 1,500 members, whether it has more than 1,650 is not relevant. The testing methodology can be applied appropriately once a political party provides a list of between 1,500 and 1,650 members.

5. S47F *claims that there is a mistake in the AEC's membership testing list -- in one column of the table, it says there can be 3 denials, where it should be 4 denials according to* S47F *(*S22 *Attachments, pp 20, 43). Is this correct? If so, does this error have any other consequences for the table?*

   Yes. S47F s specific criticism about the entry in the relevant column of the table is correct. That error has no other consequences for the table.

6. *Is there anything in* S47F *s statistical material that would lead the ABS to change or modify their advice to date?*

   No. As discussed in detail earlier in this letter, the testing methodology requires a political party to provide to the AEC a list of between 1,500 and 1,650 legitimate electors who are members of the political party and are willing and able to confirm their membership when asked. That in turn requires a political party to have a list of people who are actually members of the party.

I hope this is helpful.

Yours sincerely

S22

Dr David Gruen AO
Australian Statistician

2 September 2022

Basics

"S22 " 09/09/2024 05:32 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL:Sensitive]
Protective Mark	OFFICIAL:Sensitive
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

OFFICIAL: Sensitive

OFFICIAL: Sensitive

From: S22
Sent: Monday, June 26, 2023 2:48 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: RE: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]

Hi Anders,

S47E(d), S47C

Cheers,
S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Monday, June 26, 2023 2:23 PM
To: S22 @abs.gov.au>
Subject: RE: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]

OFFICIAL: Sensitive

Thanks S22

S47E(d), S47C

Anders

OFFICIAL: Sensitive

From: S22 @abs.gov.au>
Sent: Monday, June 26, 2023 12:42 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: RE: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]

OFFICIAL: Sensitive

Hi Anders,

S47E(d), S47C

S47E(d), S47C

S47E(d), S47C

Cheers,
S22

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Saturday, June 24, 2023 10:24 PM
To: S22 @abs.gov.au>
Subject: RE: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]

OFFICIAL: Sensitive

Hi,

S47E(d), S47C

S47E(d), S47C

Anders

OFFICIAL: Sensitive

From: S22 @abs.gov.au>
Sent: Thursday, June 22, 2023 1:28 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: RE: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]

OFFICIAL: Sensitive

Hi Anders,

S47E(d), S47C

S47E(d), S47C

Cheers,
S22

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Thursday, June 22, 2023 12:32 PM
To: S22 @abs.gov.au>
Subject: FW: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]
Importance: High

OFFICIAL: Sensitive

Hi S22 ,

The question is in the letter

Anders

OFFICIAL: Sensitive

From: S22 @abs.gov.au>
Sent: Thursday, June 22, 2023 10:41 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: FW: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]
Importance: High

In regards to my previous email.

Kind regards,
S2

Executive Assistant to the Australian Statistician, Dr David Gruen AO
Australian Bureau of Statistics
(P) S22 (M) S22
(E) S22 @abs.gov.au (W) www.abs.gov.au

From: S47F @aec.gov.au>
Sent: Thursday, June 22, 2023 10:33 AM
To: Jenet Connell <jenet.connell@abs.gov.au>
Cc: S47F @aec.gov.au>; S47F @aec.gov.au>; S22 S22 @abs.gov.au>
Subject: Letter from the Commissioner | Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology [SEC=OFFICIAL]
Importance: High

Dear Ms Connell

Please see the attached letter and attachments from Mr Rogers regarding advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology.

Regards
S47F

S47F | **Personal Assistant to the Commissioner**
Executive Leadership Team
Australian Electoral Commission
T: S47F **X:** S47 **M:** S47F

Australian Bureau of Statistics

Ref: EC23-000237

Mr Tom Rogers
Electoral Commissioner
Australian Electoral Commission

Tom.Rogers@aec.gov.au
Cc: S47F @aec.gov.au; S47F @aec.gov.au

Dear Tom

This letter is in reply to the letter you sent on 22 June to Ms Jenet Connell, who was acting Australian Statistician while I was attending conferences overseas.

In that letter, you raised two issues. Let me deal with them in turn.

The first issue has to do with the testing results for three parties S22 S22 S47E(d), S47C

S47E(d), S47C

The second issue you raise is whether the ABS has any concerns about the proposed change to the existing methodology, which involves updating the current 'step 4' in the way you outline in your letter. The answer is that the ABS has no concerns with the updated methodology as you outline it. The statistical approach the AEC uses, which has been recommended by the ABS, remains valid.

I hope this deals satisfactorily with the issues you have raised in your letter.

Yours sincerely,

S22

Dr David Gruen AO
Australian Statistician

6 July 2023

S47E(d), S47C

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AEC Australian Electoral Commission

Electoral Commissioner

Ms Jenet Connell
A/g Australian Statistician
Australian Bureau of Statistics

By email: jenet.connell@abs.gov.au

Dear Ms Connell

Advice sought from Australian Bureau of Statistics on non-Parliamentary political party membership testing methodology

I am writing to you regarding the ongoing assistance that the Australian Bureau of Statistics (ABS) has provided in relation to the membership testing methodology used by the Australian Electoral Commission (AEC). The testing provides assurance that non-Parliamentary political parties meet the requirement to have at least 1,500 members. At the outset, I wish to convey my sincere thanks to you and your staff for your previous advice regarding the membership testing methodology. This is a complex area of the party registration process and the support from the ABS has been invaluable.

S47E(d) and 47C

S47E(d) and 47C

2. Does the ABS have any concerns about the following proposed change to the existing methodology, updating the current 'step 4' (**Attachment E**).

   When a membership list is submitted to the AEC to support either registration or review, the following steps are taken

   1) *The membership list is checked to confirm that it contains between 1,500 and 1,650 names.*
   2) *The membership list is checked against the Electoral Roll through an automated process. Party members will fall into the following three categories: matched to one; matched to many; or no match.*
   3) *The names in the categories 'matched to many' and 'no match' are individually checked against the Electoral Roll. These members now fall into one of four categories: matched to the Electoral Roll; deceased; not currently enrolled to vote; or not found on the roll.*
   4) **Updated Step 4 incorporating s 123A process:** The names of party members matched to the Electoral Roll in both stages of testing are then compared to membership lists of other registered non-Parliamentary political parties to identify any cross-party duplicates.
      i. All cross-party duplicate members are contacted and given 30 days to nominate the party they wish to support.
      ii. Members who confirm that they wish to support the party undergoing testing are retained in the list.
      iii. Members who do not reply or who deny membership are removed from the list.

   The remainder of the methodology is applied from Step 5 onwards as appropriate.

If any of your officers require further information in relation to these questions, S47F S47F @aec.gov.au) and S47F @aec.gov.au) from the AEC Legal Team would be happy to assist.

Yours sincerely

S47F

Tom Rogers

22 June 2023 S47F

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

BRIEFING PAPER 30 June 2023

To:	David Gruen	**Date Due:**	30 June 2023
		Purpose:	For action: ☑
Through:	Anders Holmberg		For information: ☐
		Contact Officer:	Anders Holmberg, MDSD

This brief responds to the questions raised by the Commissioner Tom Rogers in a letter from 22 June, (see Attachment A). The letter is about the party testing methodology and the Australian Electoral Commission's (the AEC's) routines when they discover cross-party members on the member lists supplied for party registration.

Background facts:

S47E(d) and 47C

Summary and Recommendation

S47E(d) and 47C

- Q2: The ABS do not have any statistical concern with the AEC's proposed update to Step 4. (See Key Points 3-5 below)
- The problem of cross-party members is likely to have little or no practical significance. Instead of the proposed update to Step 4, the AEC could remove this risk by including the cross-party members on the list. If a cross-party member is randomly selected, they could then have a chance to confirm or deny membership. This would reduce the cross-party members that would need to be checked, without introducing a risk that their presence or absence will influence the results. Another, consideration is to use a threshold when to apply the suggested update. It appears slow (and costly?) for the registration process to perform validation cross-party of duplicates when this number is very low.
-

Key Points

1. Just as in previous cases, this is a matter of the quality (and size) of the provided party membership list, and how this interacts with the procedures and the resources available to the AEC. This time the question is whether automatically treating identified cross-party members as non-members before doing the testing affect the outcome of AECs decision.
2. If the number of cross-party members on the list is high (i.e. a poor quality list), and a high proportion of those cross-party members are loyal to the party behind the application; then there is an increased risk of falsely rejecting a party which has at least 1500 members using the current AEC procedures. This outcome risk depends on the quality of the party members list and not on the applied random sampling and test method suggested by the ABS.

S47E(d) and 47C

S47E(d) and 47C

4. The ABS have no statistical concerns with AEC's proposal. There are some inconsistencies between the procedure in Appendix E which talk about party members (in general) and the legislation that mention only members of "non-parliamentary" political parties in scope for the cross-party comparison. . (See Question 2 in the Commissioner's Letter). It is curious why it should not be all registered political parties in Step 4?
5. The proposed update does not require any changes to the random sampling procedures nor to the decision rules of the test procedure. This is true as long as the confirmed members in the updated Step 4 are retained on the list before the random sampling is applied. (If they are selected, they could be considered as members without having to reconfirm membership if the time expired between Step 4 and the random test is not too long.)

S47E(d) and 47C

S47E(d) and 47C

Areas consulted:

Nil

Appendix A

2023 06 22 - Letter from AEC to ABS re r

S42

S47E(d) and 47C

Appendix 2 - Membership testing

Membership testing process

When a membership list is submitted to the AEC to support either registration or a review, the following steps are taken:

1. The membership list is checked to confirm that it contains between 1,500 and 1,650 names.
2. The membership list is checked against the Electoral Roll through an automated process. Party members will fall into the following three categories: matched to one; matched to many; or no match.
3. The names in the categories 'matched to many' and 'no match' are individually checked against the Electoral Roll. These members now fall into one of four categories: matched to the Electoral Roll; deceased; not currently enrolled to vote; or not found on the roll.
4. **Unique members** – Two or more parties cannot rely on the same members for the purpose of registration or continued registration. The names of party members matched to the Electoral Roll in both stages of testing are then compared to membership lists of other registered political parties to identify any cross-party duplicates. Duplicates are removed from the membership list.
5. **Less than 1,500** – If after this verification process the membership list does not contain 1,500 names, the party will be issued with a Notice to vary or review it's application.
6. **1,500 or more** – If after this verification process is completed, the membership list contains between 1,500 and 1,650 names of electors, the second phase of testing commences.
7. **Random testing** – The membership list is now randomised using an excel function. The size of the random sample is determined by the number of members on the list after steps 2 to 4 are completed.
8. Party members are contacted starting from the top of the randomised list. In the first instance emails are sent to those members with an email address. If no response is received after 24-48 hours the member will be contacted via phone.
9. Contact is attempted on three separate occasions. If after the third attempt the member is still uncontactable they are deemed a non-response (**not a denial**) and the next consecutive person on the list is contacted. Phone contact is continued in this way until the required number of contacts is reached.

Basics

"S22 " 09/09/2024 05:33 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: Brief for a response to the AEC Letter of 22 June [SEC=OFFICIAL:Sensitive]
Protective Mark	OFFICIAL:Sensitive
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

1 attachment

230626 Briefing for David Gruen AEC Duplicates.docx

OFFICIAL: Sensitive

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, June 30, 2023 10:48 PM
To: S22 @abs.gov.au>
Subject: FW: Brief for a response to the AEC Letter of 22 June

OFFICIAL: Sensitive

FYI S22 ,

From: Anders Holmberg
Sent: Friday, June 30, 2023 6:43 PM
To: David Gruen <david.gruen@abs.gov.au>; Jenet Connell <jenet.connell@abs.gov.au>
Subject: Brief for a response to the AEC Letter of 22 June

Hi David,

Here is a brief responding to the questions that Tom Rogers sent on 22 June about party membership testing.

Jenet and I spoke to him over the phone and we agreed, as you are well aware of the background, that this would be better dealt with by yourself on your return.

The briefing summarises the facts necessary to respond to Tom's letter.

S47E(d) and 47C

S22

All the best
Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(p) S22 (e) S22 @abs.gov.au

The Australian Bureau of Statistics acknowledges the traditional custodians of country throughout Australia and recognises their continuing connection to land, waters, and community. We pay our respects to them and their cultures, and elders, both past and present.

Basics

S22 " 09/09/2024 05:36 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	S47C, S47E(d)
Protective Mark	OFFICIAL
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

1 attachment

Calculator screenshots .docx

From: S22
Sent: Friday, August 25, 2023 12:31 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47C, S47E(d)

FYI

From: S22
Sent: Friday, August 18, 2023 5:57 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47C, S47E(d)

Hi S47F

-

S47C, S47E(d)

Kind regards,
S22

From: S47F @aec.gov.au>
Sent: Wednesday, August 16, 2023 12:36 PM
To: S22 @abs.gov.au>
Cc: S47F @aec.gov.au>
Subject:

CAUTION: External email. Do not click links or open attachments unless you recognise the sender an know the content is safe.

Dear S22

S47C, S47E(d)

S47C, S47E(d)

Looking forward to discussing with you further.

Kind regards,

S47F

From: S22 @abs.gov.au>
Sent: Tuesday, August 8, 2023 11:33 AM
To: S47F @aec.gov.au>; S47F @aec.gov.au>; S47F S47F @aec.gov.au>; S47F @aec.gov.au>; S47F S47F @aec.gov.au>; S47F @aec.gov.au>; S47F S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S47F @aec.gov.au>; S4 S47F @aec.gov.au>
Subject: S47C, S47E(d)

Hi,

S22

S47C, S47E(d)

S47C, S47E(d)

[redacted]

Kind regards,

S22

S22

S22

S22

S22

From: S22
Sent: Friday, 25 August 2023 12:11 PM
To: Anders Holmberg
Subject: S47E(d) and 47C

Hi Anders,

S47E(d) and 47C

I've been chatting back and forth with the AEC staff over the past few weeks. We're pretty confident that there are some minor errors in the calculation I provided to you. This was found when the AEC tried to replicate some of the calculations, and found they couldn't do it.

The calculations don't change the overall conclusion, but the AEC staff are wanting to be very precise with the risk probabilities they report on.

The AEC also asked for a new letter from David Gruen which clarifies the issue. I think they will likely send some correspondence soon.

Might be worth a short skype call to discuss?

Cheers,
S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Tuesday, August 8, 2023 11:10 PM
To: S22 @abs.gov.au>
Subject: S47E(d) and 47C

Thank you very much for this S2 ,

Well done!

S22

From: S22 @abs.gov.au>
Sent: Tuesday, August 8, 2023 1:48:39 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47E(d) and 47C

FYI – looks like the AEC got some value from the discussion.

From: S47F @aec.gov.au>
Sent: Tuesday, August 8, 2023 11:46 AM
To: S22 @abs.gov.au>
Subject: S47E(d) and 47C

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Hi S22 ,

Just quickly, I wanted to say thanks for much for taking the time yesterday to run us through the ABS calculator (which I've had some team members note they found particularly helpful) and also for discussing the advice about the particular samples. I hope you didn't feel too much like you were put on the spot about that! That wasn't our intention and it was really helpful to discuss it with you, and very grateful for your follow-up advice just now.

I should say as well that we are incredibly grateful for your support and the support of ABS generally. Speaking personally, every interaction I've had with the ABS has been very positive. That has now included working with you, Anders Holmberg and seeing Dr David Gruen at meetings of the Electoral Commission. Your ongoing support to us in this area which involves, as we have discussed, a complex interaction of statistical and legal issues is most appreciated.

We will review and let you know if we have any further queries, but once again thank you so much!

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

From: S22 @abs.gov.au>
Sent: Tuesday, August 8, 2023 11:33 AM
To: S47F @aec.gov.au>; S47F @aec.gov.au>; S47F S47F @aec.gov.au>; S47F @aec.gov.au>; S47F @aec.gov.au>; S47F @aec.gov.au>; S47F @aec.gov.au>
Cc S47F @aec.gov.au>; S47F @aec.gov.au>; S47F S47F @aec.gov.au>
Subject: S47E(d) and 47C

Hi,

S47E(d) and 47C

S47E(d) and 47C

Kind regards,
S2

-----Original Appointment-----
From: S47F @aec.gov.au>
Sent: Friday, August 4, 2023 9:01 AM
To: S47F ; S22 ; S47F
Cc: S47F
Subject: ABS demonstration of membership testing process [SEC=OFFICIAL]
When: Monday, 7 August 2023 2:30 PM-3:00 PM (UTC+10:00) Brisbane.
Where: Microsoft Teams Meeting

CAUTION: External email. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Hi all,

S22, Assistant Director, Macroeconomic Statistics Methodology at the ABS has kindly agreed to join us for a Teams call at which he will take us through the ABS Methodology for Party Membership Testing and discuss the use of the ABS calculator. Please join and bring along any questions you may have.

Thanks very much S2, and we look forward to Monday afternoon.

S

Microsoft Teams meeting

Join on your computer, mobile app or room device

S22

S22

This meeting invitation was generated by the AEC Microsoft Teams instance

Learn more | Meeting options

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Basics

"S22 " 09/09/2024 05:38 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: S47E(d) and S47C
Protective Mark	OFFICIAL:Sensitive
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

OFFICIAL: Sensitive

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Sunday, September 17, 2023 3:06 PM
To: S22 @abs.gov.au>
Subject: S47E(d) and S47C

OFFICIAL: Sensitive

Thanks S22

S47E(d) and 47C

[redacted]

Anders

OFFICIAL: Sensitive

From: [redacted]@abs.gov.au>
Sent: Tuesday, September 5, 2023 2:57 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: [redacted]

OFFICIAL: Sensitive

Hi Anders,

[redacted]

[redacted]

Cheers,
[redacted]

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Tuesday, September 5, 2023 12:56 PM
To: [redacted]@abs.gov.au>
Subject: [redacted]

OFFICIAL: Sensitive

Hi [redacted]

[redacted]

Anders

OFFICIAL: Sensitive

From: S22 @abs.gov.au>
Sent: Wednesday, August 30, 2023 12:58 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47E(d) and S47C

OFFICIAL: Sensitive

Hi Anders,

S47E(d) and S47C

Cheers,
S22

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 6:48 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and S47C

OFFICIAL: Sensitive

Hi S47F ,

S47E(d) and S47C

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant

S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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OFFICIAL: Sensitive

From: S47F @aec.gov.au>
Sent: Friday, August 25, 2023 4:30 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47E(d) and S47C

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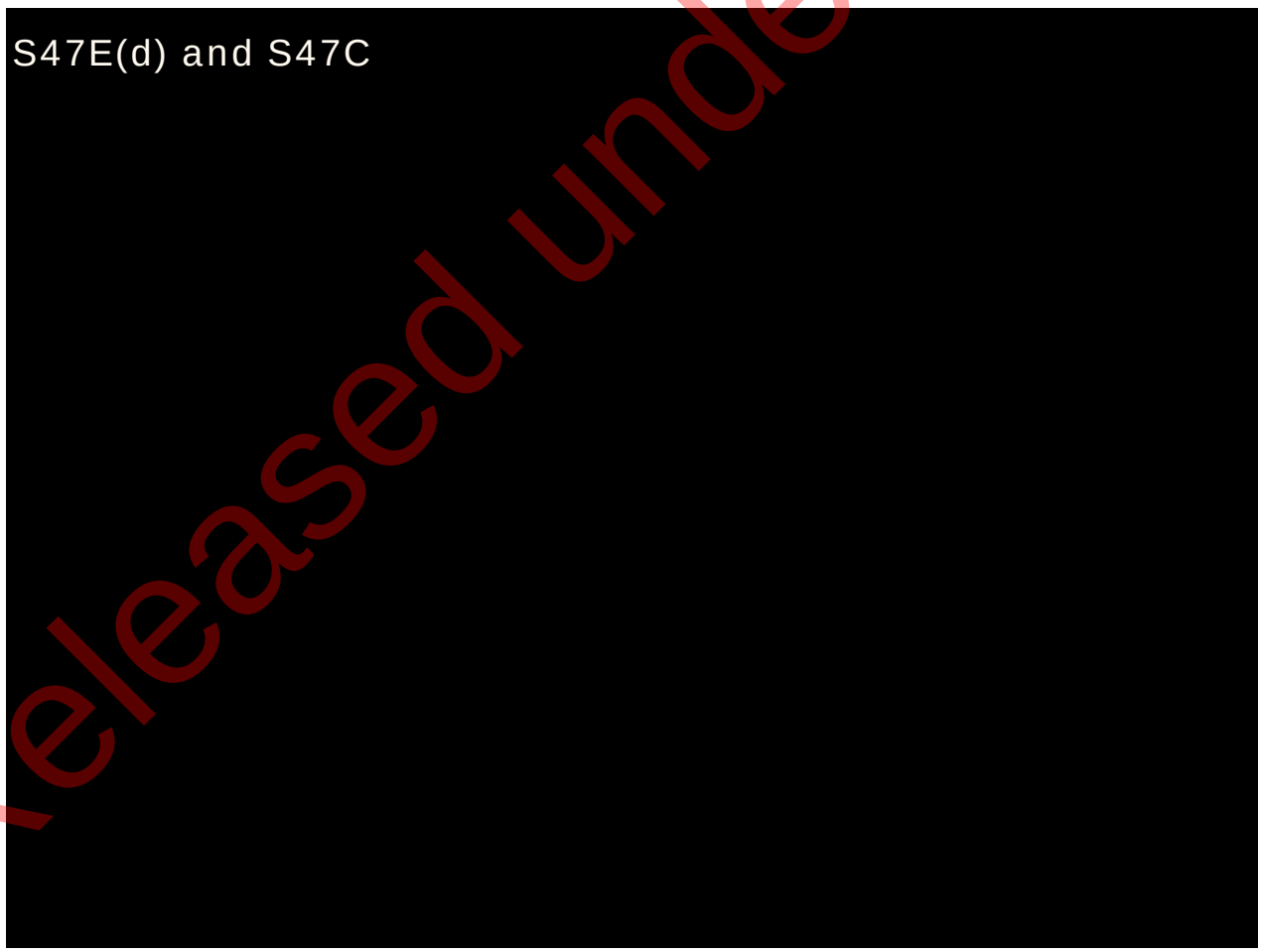
Hi Anders,



S47E(d) and S47C

S22

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 2:05 PM
To: S47F @aec.gov.au>
Subject: S47E(d) and S47C

Hi S47F

S47E(d) and S47C

S22

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

4 attachments

230626 Briefing for David Gruen AEC Duplicates.docx

s22

EC23-000237 - Leter to Commissioner Rogers regarding ABS advice on non-Parliamentary political party membership

Calculator screenshots .docx

OFFICIAL: Sensitive

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>

Sent: Monday, August 28, 2023 6:08 PM
To: S22 @abs.gov.au>
Subject: S47E(d) and 47C
[SEC=OFFICIAL:Sensitive]

OFFICIAL: Sensitive

Can you have a first go at this S2 please?

OFFICIAL: Sensitive

From: S47F @aec.gov.au>
Sent: Monday, August 28, 2023 5:05 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

CAUTION: External email. Do not click links or open attachments unless you recognise the sender an know the content is safe.

Dear Anders,

S47E(d) and 47C

S47E(d) and 47C

Kind regards,

S and S47

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 6:48 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Hi S and S47,

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

All the best

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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OFFICIAL: Sensitive

From: [redacted]@aec.gov.au>
Sent: Friday, August 25, 2023 4:30 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F [redacted]@aec.gov.au>
Subject: [redacted]

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Hi Anders,

S47E(d) and 47C

[redacted]

S47E(d) and 47C

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 2:05 PM
To: S47F @aec.gov.au>
Subject: S47E(d) and 47C

Hi S ,

S47E(d) and 47C

S22

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) @abs.gov.au (W) www.abs.gov.au

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----Message from S22 @abs.gov.au> on Fri, 18 Aug 2023 07:56:53 +0000

To: S47F @aec.gov.au>
cc: S47F @aec.gov.au>
Subject: S47E(d) and 47C

Hi S ,

S47E(d) and 47C

S47E(d) and 47C

Kind regards,

S2

From: S47F @aec.gov.au>
Sent: Wednesday, August 16, 2023 12:36 PM
To: @abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47E(d) and 47C

CAUTION: External email. Do not click links or open attachments unless you recognise the sender an know the content is safe.

Dear

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

Kind regards,

S

From: @abs.gov.au>

Sent: Tuesday, August 8, 2023 11:33 AM

To: S47F @aec.gov.au>; @aec.gov.au>; S47F S47F @aec.gov.au>; S47F @aec.gov.au>; S47F <

S47F @aec.gov.au>; S47F @aec.gov.au>; <

S47F @aec.gov.au>

Cc: S47F @aec.gov.au>; Louise Parrott <S47F @aec.gov.au>;

S47F @aec.gov.au>

Subject: S47E(d) and 47C

Hi,

S47E(d) and 47C

S47E(d) and 47C

Kind regards,
S2
-----Original Appointment-----
From: @aec.gov.au>
Sent: Friday, August 4, 2023 9:01 AM
To: S47F; S22; S47F
S47F
Cc: S47F
Subject: ABS demonstration of membership testing process [SEC=OFFICIAL]
When: Monday, 7 August 2023 2:30 PM-3:00 PM (UTC+10:00) Brisbane.
Where: Microsoft Teams Meeting

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Hi all,

S22, Assistant Director, Macroeconomic Statistics Methodology at the ABS has kindly agreed to join us for a Teams call at which he will take us through the ABS Methodology for Party Membership Testing and discuss the use of the ABS calculator. Please join and bring along any questions you may have.
Thanks very much, and we look forward to Monday afternoon.
S

Microsoft Teams meeting

Join on your computer, mobile app or room device

This meeting invitation was generated by the AEC Microsoft Teams instance
Learn more | Meeting options

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"S22 " 09/09/2024 05:39 PM
S22 @abs.gov.au

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Protective Mark	OFFICIAL:Sensitive
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

OFFICIAL: Sensitive

OFFICIAL: Sensitive

From: S47F @aec.gov.au>
Sent: Friday, September 22, 2023 2:05 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

CAUTION: External email. Do not click links or open attachments unless you recognise the sender an know the content is safe.

Hi Anders

S47E(d) and 47C

Kind regards

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, September 22, 2023 1:34 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Hi again S,

S47E(d) and 47C

Cheers,

Anders

OFFICIAL: Sensitive

From: S47F @aec.gov.au>
Sent: Friday, September 22, 2023 12:18 PM

To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

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Hi Anders and S2 ,

S47E(d) and 47C

Kind regards

S

Table in Word document

S47E(d) and 47C

S47E(d) and 47C

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Sunday, September 17, 2023 6:16 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Dear S and S47F

S47E(d) and 47C

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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From: S47F @aec.gov.au>
Sent: Monday, August 28, 2023 5:05 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47C, S47E(d)

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Dear Anders,

S47E(d) and 47C

S47E(d) and 47C

Kind regards,

S and S47F

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 6:48 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

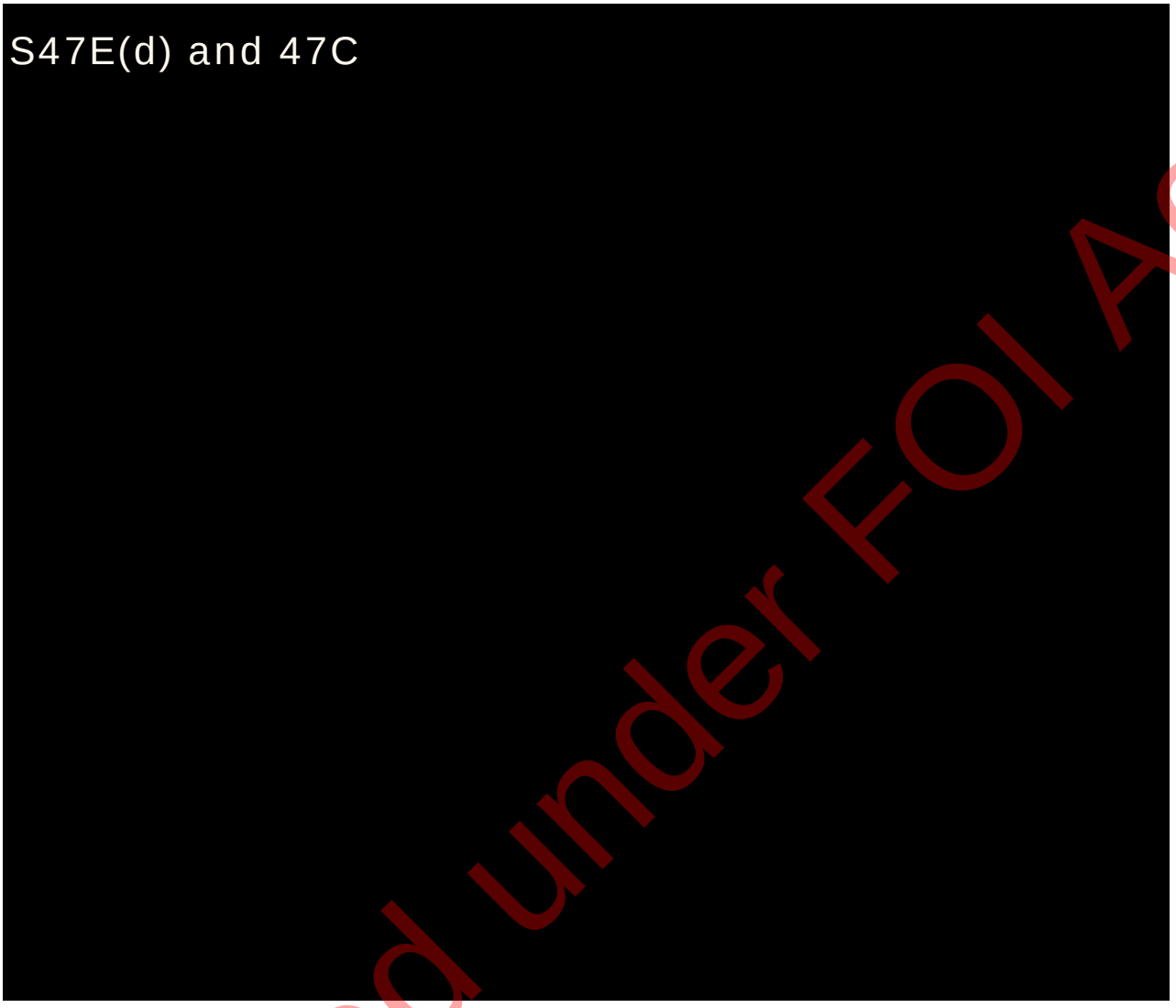
OFFICIAL: Sensitive

Hi S and S47F,

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C



All the best

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
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OFFICIAL: Sensitive

From: S47F [redacted]@aec.gov.au>
Sent: Friday, August 25, 2023 4:30 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F [redacted]@aec.gov.au>
Subject: S47E(d) and 47C [redacted]

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Hi Anders,

S47E(d) and 47C [redacted]

S47E(d) and 47C

S22

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 2:05 PM
To: S47F @aec.gov.au>
Subject: S47E(d) and 47C

Hi S ,

S47E(d) and 47C

Anders

Dr. Anders Holmberg

Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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MDMD Admin WDB "S22" 04/10/2024 05:33 PM

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Basics

"S22" 04/10/2024 05:33 PM

S22 @abs.gov.au

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Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

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OFFICIAL: Sensitive

From: S22

Sent: Tuesday, September 5, 2023 2:57 PM

To: Anders Holmberg <anders.holmberg@abs.gov.au>

Subject: S47E(d) and 47C

Hi Anders,

S47E(d) and 47C

S47E(d) and 47C

Cheers,
S2

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Tuesday, September 5, 2023 12:56 PM
To: S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Hi S2 ,

S47E(d) and 47C

Anders

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From: S22 @abs.gov.au>
Sent: Wednesday, August 30, 2023 12:58 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Hi Anders,

S47E(d) and 47C

Cheers,
S2

OFFICIAL: Sensitive

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 6:48 PM
To: S47F @aec.gov.au>
Cc: S47F @aec.gov.au>; S22 @abs.gov.au>
Subject: S47E(d) and 47C

OFFICIAL: Sensitive

Hi S and S47F,

S47E(d) and 47C

S47E(d) and 47C

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): +61 2 6252 5263
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
(P) S22 (E) S22 @abs.gov.au (W) www.abs.gov.au

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From: S47F @aec.gov.au>
Sent: Friday, August 25, 2023 4:30 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S47F @aec.gov.au>
Subject: S47E(d) and 47C

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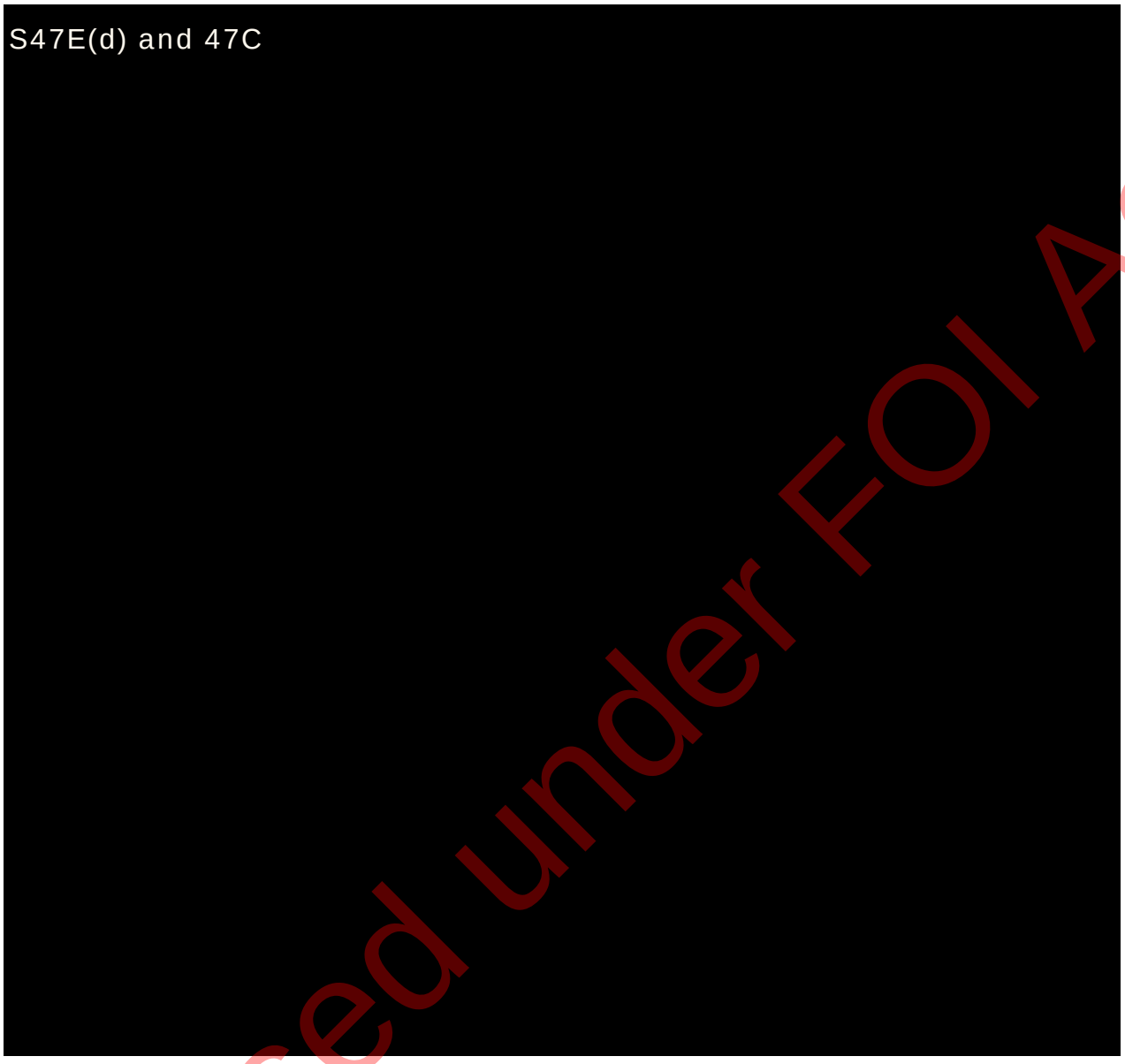
Hi Anders,

S47E(d) and 47C

S47E(d) and 47C



S22

S47F | **Senior Government Lawyer**
Electoral Law Section | Legal Services Branch
Australian Electoral Commission
M: S47F

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Friday, August 25, 2023 2:05 PM
To: S47F @aec.gov.au>
Subject: S47E(d) and 47C

Hi S ,

S47E(d) and 47C

Anders

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
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(P) S22 (E) S2 @abs.gov.au (W) www.abs.gov.au

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S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

S47E(d) and 47C

Basics

S22 09/09/2024 05:45 PM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: Draft AEC technical testing [SEC=OFFICIAL]
Protective Mark	OFFICIAL
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

S47C, S47E(d)

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Wednesday, January 10, 2024 12:39 PM
To: David Gruen <david.gruen@abs.gov.au>
Cc: S22 <S22 @abs.gov.au>
Subject: RE: Draft AEC technical testing

Thanks David,

S47C, S47E(d)

[redacted]

Anders

From: David Gruen <david.gruen@abs.gov.au>
Sent: Wednesday, January 10, 2024 12:26 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: [redacted]@abs.gov.au>
Subject: RE: Draft AEC technical testing
Importance: High

Thanks Anders

[redacted]

David

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Wednesday, January 10, 2024 11:07 AM
To: David Gruen <david.gruen@abs.gov.au>
Cc: [redacted]@abs.gov.au>
Subject: RE: Draft AEC technical testing

Hi David,

[redacted]

Please have another look, happy to have a chat if needed.

Anders

From: David Gruen <david.gruen@abs.gov.au>
Sent: Tuesday, January 9, 2024 5:06 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: S22 @abs.gov.au>
Subject: RE: Draft AEC technical testing
Importance: High

Thanks Anders.

Cheers
David

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Tuesday, January 9, 2024 11:53 AM
To: David Gruen <david.gruen@abs.gov.au>
Subject: RE: Draft AEC technical testing

Hi David,

S47C, S47E(d)

Anders

From: Anders Holmberg
Sent: Tuesday, January 9, 2024 10:43 AM
To: David Gruen <david.gruen@abs.gov.au>
Subject: Draft AEC technical testing

Dr. Anders Holmberg
Chief Methodologist and General Manager | Methodology & Data Science Division | **Australian Bureau of Statistics**
(P): **+61 2 6252 5263**
(E): Anders.Holmberg@abs.gov.au | (W): www.abs.gov.au

Executive Assistant
S22
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Basics

"S22 " 15/01/2024 11:31 AM
S22 @abs.gov.au

Send	To "MDMD Admin WDB" <mdmd.admin.wdb@abs.gov.au> cc bcc
Subject	FW: FYI FW: Political Party Membership Testing Methodology [SEC=OFFICIAL]
Protective Mark	OFFICIAL
Information management markers	☐ Personal privacy ☐ Legal privilege ☐ Legislative secrecy
Caveat	☐ ATIC
Categories	External Communication\General

1 attachment

240109 AEC Membership Testing Methodology.docx

S22

S22

From: David Gruen <david.gruen@abs.gov.au>
Sent: Wednesday, January 10, 2024 1:38 PM
To: Tom Rogers <Tom.Rogers@aec.gov.au>; Justice S47 (FCA) <S47F @fedcourt.gov.au>
Cc: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: Political Party Membership Testing Methodology

Hi Tom and S47F

Happy New Year! I hope you have both had an enjoyable and restful break.

Late last year, I promised to provide you both with a mathematical description of the membership testing methodology, for consideration as an addition to the AEC website. It is attached.

It has been written it so it can be added to the end of this document on the AEC website: party-registration-guide.pdf (aec.gov.au).

Happy to answer any questions.

I am going out on a limb with the prediction that this is the first time in either of your professional careers that you have been exposed to cumulative hypergeometric probabilities.

Cheers
David

Dr David Gruen AO
Australian Statistician
Australian Bureau of Statistics

Membership Testing Methodology: Mathematical description

A random sampling technique is used to decide whether a membership list submitted to the AEC which contains N individuals, $1500 \leq N \leq 1650$, includes at least 1500 valid members with a reasonable level of confidence.

A random sample of size n ($n < N$) is created from the membership list. As described in the membership testing process, individuals from this randomised list are contacted sequentially to determine if they are valid members of the political party. This process is continued until the required number of contacts, n, is made.

To formalise the statistical testing process, two hypotheses are set up:

- H_1: the list provided contains 1500 valid members; and
- H_2: the list provided contains 1200 valid members.

If H_1 is true, the list is valid and the political party has the required number of members. If H_2 is true, the list is invalid. The probability of falsely rejecting a valid list when H_1 is true and the list contains 1500 valid members is set to $\alpha \leq 0.06$. The probability of falsely accepting an invalid list when H_2 is true and the list contains only 1200 valid members is set to $\beta \leq 0.02$. (If the list provided contains more than 1200 but less than 1500 valid members, the probability of falsely accepting it will be greater than β in general.)

Once the process of determining the individuals in the sample as valid members has been completed, define k as the number of invalid members in the random sample. Define c as the maximum number of invalid members consistent with passing the test and accepting H_1.

For a membership list containing N individuals, the mathematical problem is to choose the parameters of the random sample, c and n, to ensure that the probability of falsely rejecting H_1 is less than or equal to α, and the probability of falsely accepting H_2 is less than or equal to β.

The exact probabilities are the cumulative hypergeometric probabilities.

$$Pr(False\ Rejection) = Pr(k > c|H_1) = 1 - Pr(k \leq c|H_1) = 1 - \sum_{k=0}^{c} \frac{\binom{N-1500}{k}\binom{1500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c, n, N - 1500, N)$$

$$Pr(False\ Acceptance) = Pr(k \leq c|H_2) = \sum_{k=0}^{c} \frac{\binom{N-1200}{k}\binom{1200}{n-k}}{\binom{N}{n}} = F(c, n, N - 1200, N)$$

With the sample size, n, chosen as small as possible, the problem is then to:

$$Choose\ c, n\ such\ that:$$

$$F(c, n, N - 1200, N) \leq \beta$$

$$1 - F(c, n, N - 1500, N) \leq \alpha$$

The Membership testing table above provides the values of c and n for a range of values of N between 1500 and 1650.

S22

From: S22
Sent: Tuesday, 9 January 2024 12:15 PM
To: Anders Holmberg
Subject: RE: Testing Political Party Membership for the AEC
Attachments: Technical appendix - Jan 2024 update - v2.docx

Hi,

As discussed, here is an updated version of the AEC paper

Cheers,
S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Wednesday, January 3, 2024 12:11 PM
To: S22 @abs.gov.au>
Subject: RE: Testing Political Party Membership for the AEC

Thanks S22

That was quick! I will have a look.

Happy New Year,

Anders

From: S22 @abs.gov.au>
Sent: Wednesday, January 3, 2024 10:28 AM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Subject: RE: Testing Political Party Membership for the AEC

Hi Anders,

S22 I put together a technical appendix as part of the previous advice.

Let me know if this is the kind of thing you were looking for.

S22

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Monday, December 18, 2023 11:49 AM
To: S22 @abs.gov.au>
Subject: FW: Testing Political Party Membership for the AEC
Importance: High

Hi S22

Please have a read of the mail trail and let me know when it is realistic to put together a summary suitable for the AEC website.

S22

Anders

From: David Gruen <david.gruen@abs.gov.au>
Sent: Thursday, December 14, 2023 6:02 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: Teresa Dickinson <teresa.dickinson@abs.gov.au>
Subject: RE: Testing Political Party Membership for the AEC
Importance: High

Thx Anders. Worth reporting the error rates even though AEC set them.

I was hoping for something before 31/12/2024 … It should be a page or two I think

From: Anders Holmberg <anders.holmberg@abs.gov.au>
Sent: Thursday, December 14, 2023 5:56 PM
To: David Gruen <david.gruen@abs.gov.au>
Cc: Teresa Dickinson <teresa.dickinson@abs.gov.au>
Subject: RE: Testing Political Party Membership for the AEC

Hi David,

We can do that w.r. to the test procedures. I think we have something from when they had the smaller requirement which can be repurposed. Just to be clear, it is the AEC that has set the two error rates. (They can choose whatever they want with the tool.)

S22 can refresh the old document since [redacted] built the tool and have given some seminars to the AEC. I assume you don't mean 31/12 2024 but that it is something he can look at when he is free to do so. I will let you know what is realistic.

All the best,

Anders

From: David Gruen <david.gruen@abs.gov.au>
Sent: Thursday, December 14, 2023 4:00 PM
To: Anders Holmberg <anders.holmberg@abs.gov.au>
Cc: Teresa Dickinson <teresa.dickinson@abs.gov.au>
Subject: Testing Political Party Membership for the AEC
Importance: High

Hi Anders

As you know, we provided the AEC with a testing methodology to determine with a high degree of confidence whether a political party has at least 1,500 valid members.

On its website, the AEC has an explanation of how this testing methodology is implemented, including the relevant table (on the final two pages of party-registration-guide.pdf (aec.gov.au)).

I have offered the Electoral Commissioner, Tom Rogers, a short document that provides a mathematical explanation of the problem being solved and the levels of confidence we have used to come up with the relevant random sample sizes and maximal denials to pass.

Tom thinks it might be valuable for them to put it on their website.

Could you please get someone to draft such an document? It should include a precise description of the statistical problem being solved, the relevant mathematical formulas, and the levels of confidence we have applied to derive the results. I imagine it should be quite short.

Sometime in the New Year will be fine!

Thx
David

Dr David Gruen AO
Australian Statistician
Australian Bureau of Statistics

Technical appendix

The paper contains the derivations used to come up with the formula applied in the advice given to the AEC.

Mathematical description of the problem

The problem is a quality control problem which has two competing hypothesis:

- H_0: the list provided contains 1500 valid members
- H_1: the list provided contains 1200 valid members

The notation used in this document is given below:

Symbol	Description
α	Maximum risk tolerance for the probability of *falsely* rejecting H_0, i.e. falsely concluding the list is invalid when it has 1500 valid members.
β	Maximum risk tolerance for the probability of *falsely* accepting H_1, i.e. falsely concluding the list is valid when it has 1200 valid members.
N	Number of members lodged that are given a chance of selection in the random sample.
n	Number of members sampled.
K	True number of invalid members lodged.
k	Number of invalid members found in the sample.
c	Maximum number of invalid members to pass the test (ie decision boundary).
μ_h	Expected number of invalid members in the sample, assuming hypothesis *h* is true (*h*=0,1).
σ_h	Standard deviation of invalid members in the sample, assuming hypothesis *h* is true (*h*=0,1).

The exact probabilities desired to perform the test are the cumulative hypergeometric probabilities.

$$Pr(False\ Acceptance) = Pr(k \le c|H_1) = \sum_{k=0}^{c} \frac{\binom{N-1200}{k}\binom{1200}{n-k}}{\binom{N}{n}} = F(c,n,N-400,N)$$

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \le c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-1500}{k}\binom{1500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c,n,N-1500,N)$$

These are the values provided in the *Calculator – Error rates* sheet in the Calculator workbook

There exist numerous functions built into various program to calculate the cumulative hypergeometric distribution. However, we want to fix these probabilities to specified values. So we actually need solve the following problem:

$$Choose\ c,n\ such\ that:$$

$$F(c,n,N-1200,N) \le \beta$$

$$1 - F(c,n,N-1500,N) \le \alpha$$

The default values are α=10% and β=2%. Also, we would like to choose the sample size to be as small as possible.

Approximate solution using the normal approximation

One way to do this is through the use of the normal approximation to the hypergeometric distribution. We have:

$$\mu_0 = n\frac{N-1500}{N} \quad \sigma_0 = \sqrt{n\frac{N-1500}{N}\frac{1500}{N}\frac{N-n}{N-1}}$$

$$\mu_1 = n\frac{N-1200}{N} \quad \sigma_1 = \sqrt{n\frac{N-1200}{N}\frac{1200}{N}\frac{N-n}{N-1}}$$

We can then use the approximations (incorporating the "continuity correction"):

$$F(c,n,N-1200,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right)$$

$$F(c,n,N-1500,N) \approx \Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right)$$

And we have functions for inverting these equations through the normal quantiles. Substituting these values in gives us:

$$\Phi\left(\frac{c+\frac{1}{2}-\mu_1}{\sigma_1}\right) \leq \beta \Rightarrow \frac{c+\frac{1}{2}-\mu_1}{\sigma_1} \leq z_\beta \Rightarrow c \geq \mu_1 - \frac{1}{2} + z_\beta\sigma_1$$

$$1-\Phi\left(\frac{c+\frac{1}{2}-\mu_0}{\sigma_0}\right) \leq \alpha \Rightarrow \frac{c+\frac{1}{2}-\mu_0}{\sigma_0} \geq z_{1-\alpha} \Rightarrow c \leq \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0$$

We can eliminate the cut-off value by setting the above inequalities to equalities, leading to an equation in 1 variable:

$$\mu_1 - \frac{1}{2} + z_\beta\sigma_1 = \mu_0 - \frac{1}{2} + z_{1-\alpha}\sigma_0 \Rightarrow A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} = 0$$

$$Where \quad A = \frac{1500-1200}{N} \qquad B = \frac{z_\beta\sqrt{(N-1200)1200} - z_{1-\alpha}\sqrt{(N-1500)1500}}{N}$$

This does not have an analytic solution, but it can be numerically solved using newton's method. An approximate solution can be obtained by assuming large N and we have

$$A\sqrt{n} + B\sqrt{\frac{N-n}{N-1}} \approx A\sqrt{n} + B = 0 \Rightarrow n^{(0)} = \left(\frac{B}{A}\right)^2$$

We know this initial solution will be too high if A>0, B<0 (with larger error for larger N). We then apply newton updates to this initial solution:

$$n^{(i+1)} = n^{(i)} - \frac{A\sqrt{n^{(i)}} + B\sqrt{\frac{N-n^{(i)}}{N-1}}}{\frac{A}{2\sqrt{n^{(i)}}} - \frac{B}{2\sqrt{(N-n^{(i)})(N-1)}}}$$

Two updates will be sufficient (firstly because the initial approximation is close, and also because the function is smooth). Once a sufficiently good solution for n is found, it is rounded up to the nearest integer:

$$n^* = \lceil n^{(2)} \rceil$$

This can then be plugged back into the formulae for μ_0, μ_1, σ_0, σ_1 to get a value for the cut-off:

$$c^* = round\left[\frac{\left(\mu_1^* - \frac{1}{2} + z_\beta \sigma_1^*\right) + \left(\mu_0^* - \frac{1}{2} + z_{1-\alpha}\sigma_0^*\right)}{2}\right]$$

The values c^* and n^* are provided in the *Calculator – Sample size* sheet in the Calculator workbook.

To see the newton updates are useful, with N=1000, α=10%, and β=2%, we get $n^{(0)}$=271 whereas $n^{(2)}$=214. Not applying the updates means that much larger sample sizes appear to be needed.

Modifying the approximate solution

The above solution will give values c^* and n^* that can be entered into the exact formula

$$F(c^*, n^*, N-1200, N) \leq \beta$$

$$1 - F(c^*, n^*, N-1500, N) \leq \alpha$$

These values should be approximately on the boundary of the inequality. The approximations used means these equalities may not be exactly satisfied. So, a small line search around the optimal sample size is used to get values that satisfy the two constraints. This is why the c and n values in the table provided does not always agree with the calculator.

Technical appendix

The paper outlines the calculations used by the AEC to decide whether a list submitted has enough valid members. The problem is a quality control problem in which the AEC takes a simple random sample without replacement from the list provided, and then classifies each member in the sample as either valid or invalid. If the number of valid and invalid members in the full list was known, then the distribution of valid members in the selected sample follows a hypergeometric distribution. However, the number of valid members is not known, so the AEC considers two competing hypotheses:

- H_0: the list provided contains 1500 valid members
- H_1: the list provided contains 1200 valid members

The AEC chooses a sample size and checks the number of valid and invalid members. If the number of invalid members is above a threshold, then the list is rejected. Otherwise, the list is accepted. These are chosen such that the two types of error are controlled, namely:

- When H_0 is true, the probability of failing the test is low (false rejection)
- When H_1 is true, the probability of passing the test is low (false acceptance)

The notation used in this document is given below:

Symbol	Description
α	Maximum risk tolerance for the probability of *falsely* rejecting H_0, i.e. falsely concluding the list is invalid when it has 1500 valid members.
β	Maximum risk tolerance for the probability of *falsely* accepting H_1, i.e. falsely concluding the list is valid when it has 1200 valid members.
N	Number of members lodged that are given a chance of selection in the random sample.
n	Number of members sampled.
K	True number of invalid members lodged.
k	Number of invalid members found in the sample.
c	Maximum number of invalid members to pass the test (ie decision boundary).
μ_h	Expected number of invalid members in the sample, assuming hypothesis *h* is true (*h*=0,1).
σ_h	Standard deviation of invalid members in the sample, assuming hypothesis *h* is true (*h*=0,1).

The exact probabilities desired to perform the test are the cumulative hypergeometric probabilities.

$$Pr(False\ Acceptance) = Pr(k \le c|H_1) = \sum_{k=0}^{c} \frac{\binom{N-1200}{k}\binom{1200}{n-k}}{\binom{N}{n}} = F(c, n, N-400, N)$$

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \le c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-1500}{k}\binom{1500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c, n, N-1500, N)$$

There exist numerous functions to calculate the cumulative hypergeometric distribution. However, we want to fix these probabilities to specified values. So we actually need solve the following problem:

$$Choose\ c, n\ such\ that:$$

$$F(c, n, N - 1200, N) \leq \beta$$

$$1 - F(c, n, N - 1500, N) \leq \alpha$$

The values chosen by the AEC are α=6% and β=2%. Additionally, the sample size should be a small as possible while maintaining these constraints.

S47E(d) and 47C

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

S47C, S47E(d)

Sheet Name	Description
Table (6% & 2%)	List of required sample sizes cut-off values for member list sizes from 1500 to 2000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 1200 valid members; - no more than a 6% chance of incorrectly rejecting a list with 1500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 1200 valid members - Probability of incorrectly rejecting a list with 1500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 1500 up to 3000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 6%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 1523 members, a sample size of 27 and max denials of 1 will give a Probability of rejecting a valid list of 6.09%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 1200 - risk	Rejecting 1500 - risk
1500	18	0	1.8%	0.0%
1501	18	0	1.7%	1.2%
1502	18	0	1.7%	2.4%
1503	18	0	1.7%	3.6%
1504	18	0	1.7%	4.7%
1505	18	0	1.7%	5.8%
1506	27	1	1.6%	0.4%
1507	27	1	1.6%	0.6%
1508	27	1	1.6%	0.8%
1509	27	1	1.6%	1.0%
1510	27	1	1.5%	1.3%
1511	27	1	1.5%	1.5%
1512	27	1	1.5%	1.8%
1513	27	1	1.5%	2.1%
1514	27	1	1.5%	2.4%
1515	27	1	1.4%	2.8%
1516	27	1	1.4%	3.1%
1517	27	1	1.4%	3.5%
1518	27	1	1.4%	3.9%
1519	27	1	1.3%	4.3%
1520	27	1	1.3%	4.7%
1521	27	1	1.3%	5.2%
1522	27	1	1.3%	5.6%
1523	33	2	1.8%	1.2%
1524	33	2	1.7%	1.4%
1525	33	2	1.7%	1.5%
1526	33	2	1.7%	1.7%
1527	33	2	1.6%	1.9%
1528	33	2	1.6%	2.1%
1529	33	2	1.6%	2.3%
1530	33	2	1.6%	2.5%
1531	33	2	1.5%	2.7%
1532	33	2	1.5%	3.0%
1533	33	2	1.5%	3.2%
1534	33	2	1.5%	3.4%
1535	33	2	1.4%	3.7%
1536	33	2	1.4%	4.0%
1537	33	2	1.4%	4.3%

1538	33	2	1.4%	4.6%
1539	33	2	1.4%	4.9%
1540	33	2	1.3%	5.2%
1541	33	2	1.3%	5.5%
1542	33	2	1.3%	5.8%
1543	38	3	1.8%	1.9%
1544	38	3	1.8%	2.1%
1545	38	3	1.7%	2.2%
1546	38	3	1.7%	2.4%
1547	38	3	1.7%	2.6%
1548	38	3	1.6%	2.8%
1549	38	3	1.6%	3.0%
1550	38	3	1.6%	3.2%
1551	38	3	1.6%	3.4%
1552	38	3	1.5%	3.6%
1553	38	3	1.5%	3.8%
1554	38	3	1.5%	4.0%
1555	38	3	1.5%	4.2%
1556	38	3	1.4%	4.5%
1557	38	3	1.4%	4.7%
1558	38	3	1.4%	5.0%
1559	38	3	1.4%	5.2%
1560	38	3	1.3%	5.5%
1561	38	3	1.3%	5.8%
1562	42	4	1.9%	2.3%
1563	42	4	1.9%	2.4%
1564	42	4	1.9%	2.6%
1565	42	4	1.8%	2.7%
1566	42	4	1.8%	2.9%
1567	42	4	1.8%	3.1%
1568	42	4	1.8%	3.2%
1569	42	4	1.7%	3.4%
1570	42	4	1.7%	3.6%
1571	42	4	1.7%	3.8%
1572	42	4	1.6%	4.0%
1573	42	4	1.6%	4.2%
1574	42	4	1.6%	4.4%
1575	42	4	1.6%	4.6%
1576	42	4	1.5%	4.8%
1577	42	4	1.5%	5.0%
1578	42	4	1.5%	5.3%
1579	42	4	1.5%	5.5%
1580	42	4	1.4%	5.7%
1581	42	4	1.4%	6.0%
1582	46	5	1.9%	2.9%
1583	46	5	1.9%	3.0%
1584	46	5	1.8%	3.2%
1585	46	5	1.8%	3.3%
1586	46	5	1.8%	3.5%
1587	46	5	1.7%	3.6%

1588	46	5	1.7%	3.8%
1589	46	5	1.7%	4.0%
1590	46	5	1.7%	4.2%
1591	46	5	1.6%	4.4%
1592	46	5	1.6%	4.6%
1593	46	5	1.6%	4.7%
1594	46	5	1.5%	5.0%
1595	46	5	1.5%	5.2%
1596	46	5	1.5%	5.4%
1597	46	5	1.5%	5.6%
1598	46	5	1.4%	5.8%
1599	50	6	1.8%	3.1%
1600	50	6	1.8%	3.3%
1601	50	6	1.8%	3.4%
1602	50	6	1.7%	3.6%
1603	50	6	1.7%	3.7%
1604	50	6	1.7%	3.9%
1605	50	6	1.6%	4.1%
1606	50	6	1.6%	4.2%
1607	50	6	1.6%	4.4%
1608	50	6	1.6%	4.6%
1609	50	6	1.5%	4.8%
1610	50	6	1.5%	5.0%
1611	50	6	1.5%	5.2%
1612	50	6	1.5%	5.4%
1613	50	6	1.4%	5.6%
1614	50	6	1.4%	5.8%
1615	50	6	1.4%	6.0%
1616	53	7	2.0%	3.2%
1617	53	7	2.0%	3.3%
1618	53	7	1.9%	3.5%
1619	53	7	1.9%	3.6%
1620	53	7	1.9%	3.8%
1621	53	7	1.8%	3.9%
1622	53	7	1.8%	4.1%
1623	53	7	1.8%	4.2%
1624	53	7	1.7%	4.4%
1625	53	7	1.7%	4.6%
1626	53	7	1.7%	4.7%
1627	53	7	1.6%	4.9%
1628	53	7	1.6%	5.1%
1629	53	7	1.6%	5.3%
1630	53	7	1.6%	5.5%
1631	53	7	1.5%	5.7%
1632	53	7	1.5%	5.9%
1633	57	8	1.7%	3.7%
1634	57	8	1.7%	3.9%
1635	57	8	1.7%	4.0%
1636	57	8	1.6%	4.2%
1637	57	8	1.6%	4.3%

1638	57	8	1.6%	4.5%
1639	57	8	1.6%	4.7%
1640	57	8	1.5%	4.8%
1641	57	8	1.5%	5.0%
1642	57	8	1.5%	5.2%
1643	57	8	1.4%	5.4%
1644	57	8	1.4%	5.5%
1645	57	8	1.4%	5.7%
1646	57	8	1.4%	5.9%
1647	60	9	1.8%	3.6%
1648	60	9	1.8%	3.7%
1649	60	9	1.8%	3.9%
1650	60	9	1.7%	4.0%
1651	60	9	1.7%	4.2%
1652	60	9	1.7%	4.3%
1653	60	9	1.6%	4.5%
1654	60	9	1.6%	4.6%
1655	60	9	1.6%	4.8%
1656	60	9	1.6%	4.9%
1657	60	9	1.5%	5.1%
1658	60	9	1.5%	5.3%
1659	60	9	1.5%	5.5%
1660	60	9	1.4%	5.6%
1661	60	9	1.4%	5.8%
1662	63	10	1.8%	3.7%
1663	63	10	1.8%	3.8%
1664	63	10	1.8%	4.0%
1665	63	10	1.7%	4.1%
1666	63	10	1.7%	4.3%
1667	63	10	1.7%	4.4%
1668	63	10	1.6%	4.6%
1669	63	10	1.6%	4.7%
1670	63	10	1.6%	4.9%
1671	63	10	1.6%	5.0%
1672	63	10	1.5%	5.2%
1673	63	10	1.5%	5.4%
1674	63	10	1.5%	5.5%
1675	63	10	1.4%	5.7%
1676	63	10	1.4%	5.9%
1677	66	11	1.8%	3.9%
1678	66	11	1.8%	4.0%
1679	66	11	1.7%	4.2%
1680	66	11	1.7%	4.3%
1681	66	11	1.7%	4.5%
1682	66	11	1.6%	4.6%
1683	66	11	1.6%	4.7%
1684	66	11	1.6%	4.9%
1685	66	11	1.5%	5.1%
1686	66	11	1.5%	5.2%
1687	66	11	1.5%	5.4%

1688	66	11	1.5%	5.6%
1689	66	11	1.4%	5.7%
1690	66	11	1.4%	5.9%
1691	69	12	1.7%	4.0%
1692	69	12	1.7%	4.2%
1693	69	12	1.7%	4.3%
1694	69	12	1.6%	4.5%
1695	69	12	1.6%	4.6%
1696	69	12	1.6%	4.7%
1697	69	12	1.6%	4.9%
1698	69	12	1.5%	5.0%
1699	69	12	1.5%	5.2%
1700	69	12	1.5%	5.4%
1701	69	12	1.4%	5.5%
1702	69	12	1.4%	5.7%
1703	69	12	1.4%	5.9%
1704	71	13	2.0%	3.7%
1705	71	13	2.0%	3.8%
1706	71	13	1.9%	4.0%
1707	71	13	1.9%	4.1%
1708	71	13	1.9%	4.2%
1709	71	13	1.8%	4.4%
1710	71	13	1.8%	4.5%
1711	71	13	1.8%	4.6%
1712	71	13	1.7%	4.8%
1713	71	13	1.7%	4.9%
1714	71	13	1.7%	5.1%
1715	71	13	1.6%	5.2%
1716	71	13	1.6%	5.4%
1717	71	13	1.6%	5.5%
1718	71	13	1.5%	5.7%
1719	71	13	1.5%	5.9%
1720	74	14	1.8%	4.3%
1721	74	14	1.8%	4.4%
1722	74	14	1.7%	4.5%
1723	74	14	1.7%	4.7%
1724	74	14	1.7%	4.8%
1725	74	14	1.6%	4.9%
1726	74	14	1.6%	5.1%
1727	74	14	1.6%	5.2%
1728	74	14	1.5%	5.4%
1729	74	14	1.5%	5.5%
1730	74	14	1.5%	5.7%
1731	74	14	1.5%	5.9%
1732	77	15	1.7%	4.4%
1733	77	15	1.7%	4.5%
1734	77	15	1.6%	4.6%
1735	77	15	1.6%	4.8%
1736	77	15	1.6%	4.9%
1737	77	15	1.5%	5.0%

1738	77	15	1.5%	5.2%
1739	77	15	1.5%	5.3%
1740	77	15	1.5%	5.5%
1741	77	15	1.4%	5.6%
1742	77	15	1.4%	5.8%
1743	77	15	1.4%	6.0%
1744	79	16	1.9%	4.1%
1745	79	16	1.8%	4.2%
1746	79	16	1.8%	4.3%
1747	79	16	1.8%	4.4%
1748	79	16	1.7%	4.6%
1749	79	16	1.7%	4.7%
1750	79	16	1.7%	4.8%
1751	79	16	1.7%	5.0%
1752	79	16	1.6%	5.1%
1753	79	16	1.6%	5.3%
1754	79	16	1.6%	5.4%
1755	79	16	1.5%	5.6%
1756	79	16	1.5%	5.7%
1757	79	16	1.5%	5.9%
1758	81	17	2.0%	4.1%
1759	81	17	1.9%	4.2%
1760	81	17	1.9%	4.3%
1761	81	17	1.9%	4.4%
1762	81	17	1.8%	4.6%
1763	81	17	1.8%	4.7%
1764	81	17	1.8%	4.8%
1765	81	17	1.7%	5.0%
1766	81	17	1.7%	5.1%
1767	81	17	1.7%	5.2%
1768	81	17	1.7%	5.4%
1769	81	17	1.6%	5.5%
1770	81	17	1.6%	5.7%
1771	81	17	1.6%	5.8%
1772	81	17	1.5%	6.0%
1773	84	18	1.7%	4.7%
1774	84	18	1.7%	4.9%
1775	84	18	1.6%	5.0%
1776	84	18	1.6%	5.1%
1777	84	18	1.6%	5.3%
1778	84	18	1.6%	5.4%
1779	84	18	1.5%	5.5%
1780	84	18	1.5%	5.7%
1781	84	18	1.5%	5.8%
1782	84	18	1.4%	6.0%
1783	86	19	1.9%	4.3%
1784	86	19	1.8%	4.4%
1785	86	19	1.8%	4.6%
1786	86	19	1.8%	4.7%
1787	86	19	1.7%	4.8%

1788	86	19	1.7%	4.9%
1789	86	19	1.7%	5.1%
1790	86	19	1.7%	5.2%
1791	86	19	1.6%	5.3%
1792	86	19	1.6%	5.5%
1793	86	19	1.6%	5.6%
1794	86	19	1.5%	5.8%
1795	86	19	1.5%	5.9%
1796	88	20	1.9%	4.3%
1797	88	20	1.9%	4.4%
1798	88	20	1.9%	4.6%
1799	88	20	1.8%	4.7%
1800	88	20	1.8%	4.8%
1801	88	20	1.8%	4.9%
1802	88	20	1.7%	5.1%
1803	88	20	1.7%	5.2%
1804	88	20	1.7%	5.3%
1805	88	20	1.7%	5.5%
1806	88	20	1.6%	5.6%
1807	88	20	1.6%	5.7%
1808	88	20	1.6%	5.9%
1809	90	21	2.0%	4.3%
1810	90	21	2.0%	4.5%
1811	90	21	1.9%	4.6%
1812	90	21	1.9%	4.7%
1813	90	21	1.9%	4.8%
1814	90	21	1.8%	5.0%
1815	90	21	1.8%	5.1%
1816	90	21	1.8%	5.2%
1817	90	21	1.7%	5.3%
1818	90	21	1.7%	5.5%
1819	90	21	1.7%	5.6%
1820	90	21	1.6%	5.8%
1821	90	21	1.6%	5.9%
1822	93	22	1.7%	4.9%
1823	93	22	1.7%	5.1%
1824	93	22	1.6%	5.2%
1825	93	22	1.6%	5.3%
1826	93	22	1.6%	5.5%
1827	93	22	1.5%	5.6%
1828	93	22	1.5%	5.7%
1829	93	22	1.5%	5.9%
1830	95	23	1.9%	4.4%
1831	95	23	1.8%	4.6%
1832	95	23	1.8%	4.7%
1833	95	23	1.8%	4.8%
1834	95	23	1.7%	4.9%
1835	95	23	1.7%	5.0%
1836	95	23	1.7%	5.2%
1837	95	23	1.6%	5.3%

1838	95	23	1.6%	5.4%
1839	95	23	1.6%	5.6%
1840	95	23	1.6%	5.7%
1841	95	23	1.5%	5.8%
1842	95	23	1.5%	6.0%
1843	97	24	1.9%	4.6%
1844	97	24	1.8%	4.7%
1845	97	24	1.8%	4.8%
1846	97	24	1.8%	4.9%
1847	97	24	1.7%	5.1%
1848	97	24	1.7%	5.2%
1849	97	24	1.7%	5.3%
1850	97	24	1.6%	5.4%
1851	97	24	1.6%	5.6%
1852	97	24	1.6%	5.7%
1853	97	24	1.6%	5.9%
1854	97	24	1.5%	6.0%
1855	99	25	1.9%	4.6%
1856	99	25	1.8%	4.7%
1857	99	25	1.8%	4.9%
1858	99	25	1.8%	5.0%
1859	99	25	1.7%	5.1%
1860	99	25	1.7%	5.2%
1861	99	25	1.7%	5.4%
1862	99	25	1.6%	5.5%
1863	99	25	1.6%	5.6%
1864	99	25	1.6%	5.8%
1865	99	25	1.6%	5.9%
1866	101	26	1.9%	4.6%
1867	101	26	1.9%	4.7%
1868	101	26	1.8%	4.8%
1869	101	26	1.8%	4.9%
1870	101	26	1.8%	5.1%
1871	101	26	1.7%	5.2%
1872	101	26	1.7%	5.3%
1873	101	26	1.7%	5.4%
1874	101	26	1.6%	5.6%
1875	101	26	1.6%	5.7%
1876	101	26	1.6%	5.8%
1877	101	26	1.6%	6.0%
1878	103	27	1.9%	4.7%
1879	103	27	1.9%	4.8%
1880	103	27	1.8%	4.9%
1881	103	27	1.8%	5.1%
1882	103	27	1.8%	5.2%
1883	103	27	1.7%	5.3%
1884	103	27	1.7%	5.4%
1885	103	27	1.7%	5.5%
1886	103	27	1.6%	5.7%
1887	103	27	1.6%	5.8%

1888	103	27	1.6%	5.9%
1889	105	28	1.9%	4.7%
1890	105	28	1.9%	4.8%
1891	105	28	1.8%	4.9%
1892	105	28	1.8%	5.1%
1893	105	28	1.8%	5.2%
1894	105	28	1.7%	5.3%
1895	105	28	1.7%	5.4%
1896	105	28	1.7%	5.6%
1897	105	28	1.6%	5.7%
1898	105	28	1.6%	5.8%
1899	105	28	1.6%	5.9%
1900	107	29	1.9%	4.8%
1901	107	29	1.8%	4.9%
1902	107	29	1.8%	5.0%
1903	107	29	1.8%	5.1%
1904	107	29	1.8%	5.2%
1905	107	29	1.7%	5.3%
1906	107	29	1.7%	5.5%
1907	107	29	1.7%	5.6%
1908	107	29	1.6%	5.7%
1909	107	29	1.6%	5.8%
1910	107	29	1.6%	6.0%
1911	109	30	1.9%	4.8%
1912	109	30	1.8%	4.9%
1913	109	30	1.8%	5.1%
1914	109	30	1.8%	5.2%
1915	109	30	1.7%	5.3%
1916	109	30	1.7%	5.4%
1917	109	30	1.7%	5.5%
1918	109	30	1.6%	5.7%
1919	109	30	1.6%	5.8%
1920	109	30	1.6%	5.9%
1921	111	31	1.9%	4.8%
1922	111	31	1.8%	4.9%
1923	111	31	1.8%	5.0%
1924	111	31	1.8%	5.1%
1925	111	31	1.7%	5.3%
1926	111	31	1.7%	5.4%
1927	111	31	1.7%	5.5%
1928	111	31	1.7%	5.6%
1929	111	31	1.6%	5.7%
1930	111	31	1.6%	5.9%
1931	113	32	1.9%	4.8%
1932	113	32	1.8%	4.9%
1933	113	32	1.8%	5.0%
1934	113	32	1.8%	5.1%
1935	113	32	1.7%	5.3%
1936	113	32	1.7%	5.4%
1937	113	32	1.7%	5.5%

1938	113	32	1.6%	5.6%
1939	113	32	1.6%	5.7%
1940	113	32	1.6%	5.9%
1941	113	32	1.6%	6.0%
1942	115	33	1.8%	4.9%
1943	115	33	1.8%	5.0%
1944	115	33	1.8%	5.2%
1945	115	33	1.7%	5.3%
1946	115	33	1.7%	5.4%
1947	115	33	1.7%	5.5%
1948	115	33	1.6%	5.6%
1949	115	33	1.6%	5.8%
1950	115	33	1.6%	5.9%
1951	117	34	1.8%	4.9%
1952	117	34	1.8%	5.0%
1953	117	34	1.8%	5.1%
1954	117	34	1.7%	5.2%
1955	117	34	1.7%	5.3%
1956	117	34	1.7%	5.4%
1957	117	34	1.6%	5.6%
1958	117	34	1.6%	5.7%
1959	117	34	1.6%	5.8%
1960	117	34	1.6%	5.9%
1961	119	35	1.8%	4.9%
1962	119	35	1.8%	5.0%
1963	119	35	1.7%	5.2%
1964	119	35	1.7%	5.3%
1965	119	35	1.7%	5.4%
1966	119	35	1.6%	5.5%
1967	119	35	1.6%	5.6%
1968	119	35	1.6%	5.7%
1969	119	35	1.6%	5.9%
1970	119	35	1.5%	6.0%
1971	121	36	1.7%	5.0%
1972	121	36	1.7%	5.1%
1973	121	36	1.7%	5.2%
1974	121	36	1.7%	5.4%
1975	121	36	1.6%	5.5%
1976	121	36	1.6%	5.6%
1977	121	36	1.6%	5.7%
1978	121	36	1.5%	5.8%
1979	121	36	1.5%	6.0%
1980	123	37	1.7%	5.0%
1981	123	37	1.7%	5.1%
1982	123	37	1.7%	5.2%
1983	123	37	1.6%	5.3%
1984	123	37	1.6%	5.5%
1985	123	37	1.6%	5.6%
1986	123	37	1.6%	5.7%
1987	123	37	1.5%	5.8%

1988	123	37	1.5%	5.9%
1989	125	38	1.7%	5.0%
1990	125	38	1.7%	5.1%
1991	125	38	1.6%	5.2%
1992	125	38	1.6%	5.4%
1993	125	38	1.6%	5.5%
1994	125	38	1.6%	5.6%
1995	125	38	1.5%	5.7%
1996	125	38	1.5%	5.8%
1997	125	38	1.5%	6.0%
1998	126	39	2.0%	4.5%
1999	126	39	2.0%	4.6%
2000	126	39	1.9%	4.7%
2001	126	39	1.9%	4.8%
2002	126	39	1.9%	4.9%
2003	126	39	1.8%	5.0%
2004	126	39	1.8%	5.1%
2005	126	39	1.8%	5.2%
2006	126	39	1.7%	5.3%
2007	126	39	1.7%	5.4%
2008	126	39	1.7%	5.6%
2009	126	39	1.6%	5.7%
2010	126	39	1.6%	5.8%
2011	126	39	1.6%	5.9%
2012	128	40	1.8%	5.1%
2013	128	40	1.8%	5.2%
2014	128	40	1.7%	5.3%
2015	128	40	1.7%	5.4%
2016	128	40	1.7%	5.5%
2017	128	40	1.6%	5.6%
2018	128	40	1.6%	5.7%
2019	128	40	1.6%	5.8%
2020	128	40	1.6%	6.0%
2021	130	41	1.7%	5.1%
2022	130	41	1.7%	5.2%
2023	130	41	1.7%	5.3%
2024	130	41	1.7%	5.4%
2025	130	41	1.6%	5.6%
2026	130	41	1.6%	5.7%
2027	130	41	1.6%	5.8%
2028	130	41	1.5%	5.9%
2029	132	42	1.7%	5.1%
2030	132	42	1.7%	5.2%
2031	132	42	1.7%	5.3%
2032	132	42	1.6%	5.4%
2033	132	42	1.6%	5.5%
2034	132	42	1.6%	5.6%
2035	132	42	1.6%	5.8%
2036	132	42	1.5%	5.9%
2037	132	42	1.5%	6.0%

2038	133	43	2.0%	4.6%
2039	133	43	1.9%	4.7%
2040	133	43	1.9%	4.8%
2041	133	43	1.9%	4.9%
2042	133	43	1.8%	5.0%
2043	133	43	1.8%	5.1%
2044	133	43	1.8%	5.2%
2045	133	43	1.8%	5.3%
2046	133	43	1.7%	5.4%
2047	133	43	1.7%	5.5%
2048	133	43	1.7%	5.7%
2049	133	43	1.6%	5.8%
2050	133	43	1.6%	5.9%
2051	135	44	1.8%	5.1%
2052	135	44	1.8%	5.2%
2053	135	44	1.7%	5.3%
2054	135	44	1.7%	5.4%
2055	135	44	1.7%	5.5%
2056	135	44	1.6%	5.7%
2057	135	44	1.6%	5.8%
2058	135	44	1.6%	5.9%
2059	137	45	1.7%	5.1%
2060	137	45	1.7%	5.2%
2061	137	45	1.7%	5.3%
2062	137	45	1.7%	5.5%
2063	137	45	1.6%	5.6%
2064	137	45	1.6%	5.7%
2065	137	45	1.6%	5.8%
2066	137	45	1.6%	5.9%
2067	139	46	1.7%	5.2%
2068	139	46	1.7%	5.3%
2069	139	46	1.6%	5.4%
2070	139	46	1.6%	5.5%
2071	139	46	1.6%	5.6%
2072	139	46	1.6%	5.7%
2073	139	46	1.5%	5.8%
2074	139	46	1.5%	5.9%
2075	140	47	2.0%	4.6%
2076	140	47	1.9%	4.7%
2077	140	47	1.9%	4.8%
2078	140	47	1.9%	4.9%
2079	140	47	1.8%	5.0%
2080	140	47	1.8%	5.1%
2081	140	47	1.8%	5.2%
2082	140	47	1.7%	5.3%
2083	140	47	1.7%	5.4%
2084	140	47	1.7%	5.5%
2085	140	47	1.7%	5.7%
2086	140	47	1.6%	5.8%
2087	140	47	1.6%	5.9%

2088	140	47	1.6%	6.0%
2089	142	48	1.7%	5.3%
2090	142	48	1.7%	5.4%
2091	142	48	1.7%	5.5%
2092	142	48	1.6%	5.6%
2093	142	48	1.6%	5.7%
2094	142	48	1.6%	5.8%
2095	142	48	1.6%	5.9%
2096	144	49	1.7%	5.3%
2097	144	49	1.7%	5.4%
2098	144	49	1.6%	5.5%
2099	144	49	1.6%	5.6%
2100	144	49	1.6%	5.7%
2101	144	49	1.6%	5.8%
2102	144	49	1.5%	5.9%
2103	145	50	2.0%	4.7%
2104	145	50	1.9%	4.8%
2105	145	50	1.9%	4.8%
2106	145	50	1.9%	4.9%
2107	145	50	1.8%	5.0%
2108	145	50	1.8%	5.1%
2109	145	50	1.8%	5.2%
2110	145	50	1.8%	5.3%
2111	145	50	1.7%	5.5%
2112	145	50	1.7%	5.6%
2113	145	50	1.7%	5.7%
2114	145	50	1.6%	5.8%
2115	145	50	1.6%	5.9%
2116	145	50	1.6%	6.0%
2117	147	51	1.7%	5.3%
2118	147	51	1.7%	5.4%
2119	147	51	1.7%	5.6%
2120	147	51	1.6%	5.7%
2121	147	51	1.6%	5.8%
2122	147	51	1.6%	5.9%
2123	147	51	1.6%	6.0%
2124	148	52	2.0%	4.7%
2125	148	52	2.0%	4.8%
2126	148	52	1.9%	4.9%
2127	148	52	1.9%	5.0%
2128	148	52	1.9%	5.1%
2129	148	52	1.8%	5.2%
2130	148	52	1.8%	5.3%
2131	148	52	1.8%	5.4%
2132	148	52	1.7%	5.5%
2133	148	52	1.7%	5.6%
2134	148	52	1.7%	5.8%
2135	148	52	1.7%	5.9%
2136	148	52	1.6%	6.0%
2137	150	53	1.8%	5.4%

2138	150	53	1.7%	5.5%
2139	150	53	1.7%	5.6%
2140	150	53	1.7%	5.7%
2141	150	53	1.6%	5.8%
2142	150	53	1.6%	5.9%
2143	150	53	1.6%	6.0%
2144	152	54	1.7%	5.4%
2145	152	54	1.7%	5.5%
2146	152	54	1.6%	5.6%
2147	152	54	1.6%	5.7%
2148	152	54	1.6%	5.8%
2149	152	54	1.6%	5.9%
2150	153	55	2.0%	4.7%
2151	153	55	2.0%	4.8%
2152	153	55	1.9%	4.9%
2153	153	55	1.9%	5.0%
2154	153	55	1.9%	5.1%
2155	153	55	1.8%	5.2%
2156	153	55	1.8%	5.3%
2157	153	55	1.8%	5.4%
2158	153	55	1.7%	5.5%
2159	153	55	1.7%	5.6%
2160	153	55	1.7%	5.7%
2161	153	55	1.7%	5.8%
2162	153	55	1.6%	5.9%
2163	155	56	1.7%	5.4%
2164	155	56	1.7%	5.5%
2165	155	56	1.7%	5.6%
2166	155	56	1.7%	5.7%
2167	155	56	1.6%	5.8%
2168	155	56	1.6%	5.9%
2169	155	56	1.6%	6.0%
2170	156	57	2.0%	4.8%
2171	156	57	2.0%	4.9%
2172	156	57	1.9%	5.0%
2173	156	57	1.9%	5.1%
2174	156	57	1.9%	5.2%
2175	156	57	1.8%	5.3%
2176	156	57	1.8%	5.4%
2177	156	57	1.8%	5.5%
2178	156	57	1.7%	5.6%
2179	156	57	1.7%	5.7%
2180	156	57	1.7%	5.8%
2181	156	57	1.7%	5.9%
2182	158	58	1.8%	5.4%
2183	158	58	1.7%	5.5%
2184	158	58	1.7%	5.6%
2185	158	58	1.7%	5.7%
2186	158	58	1.7%	5.8%
2187	158	58	1.6%	5.9%

2188	158	58	1.6%	6.0%
2189	160	59	1.7%	5.4%
2190	160	59	1.7%	5.6%
2191	160	59	1.6%	5.7%
2192	160	59	1.6%	5.8%
2193	160	59	1.6%	5.9%
2194	160	59	1.6%	6.0%
2195	161	60	2.0%	4.8%
2196	161	60	1.9%	4.9%
2197	161	60	1.9%	5.0%
2198	161	60	1.9%	5.1%
2199	161	60	1.8%	5.2%
2200	161	60	1.8%	5.3%
2201	161	60	1.8%	5.4%
2202	161	60	1.7%	5.5%
2203	161	60	1.7%	5.6%
2204	161	60	1.7%	5.7%
2205	161	60	1.7%	5.8%
2206	161	60	1.6%	5.9%
2207	163	61	1.7%	5.4%
2208	163	61	1.7%	5.5%
2209	163	61	1.7%	5.6%
2210	163	61	1.6%	5.7%
2211	163	61	1.6%	5.8%
2212	163	61	1.6%	5.9%
2213	164	62	2.0%	4.8%
2214	164	62	2.0%	4.9%
2215	164	62	1.9%	5.0%
2216	164	62	1.9%	5.1%
2217	164	62	1.9%	5.2%
2218	164	62	1.8%	5.3%
2219	164	62	1.8%	5.4%
2220	164	62	1.8%	5.5%
2221	164	62	1.7%	5.6%
2222	164	62	1.7%	5.7%
2223	164	62	1.7%	5.8%
2224	164	62	1.7%	5.9%
2225	164	62	1.6%	6.0%
2226	166	63	1.7%	5.5%
2227	166	63	1.7%	5.6%
2228	166	63	1.7%	5.7%
2229	166	63	1.6%	5.8%
2230	166	63	1.6%	5.9%
2231	166	63	1.6%	6.0%
2232	167	64	2.0%	4.9%
2233	167	64	1.9%	5.0%
2234	167	64	1.9%	5.1%
2235	167	64	1.9%	5.2%
2236	167	64	1.8%	5.3%
2237	167	64	1.8%	5.4%

2238	167	64	1.8%	5.5%
2239	167	64	1.8%	5.6%
2240	167	64	1.7%	5.7%
2241	167	64	1.7%	5.8%
2242	167	64	1.7%	5.9%
2243	167	64	1.7%	6.0%
2244	169	65	1.7%	5.5%
2245	169	65	1.7%	5.6%
2246	169	65	1.7%	5.7%
2247	169	65	1.6%	5.8%
2248	169	65	1.6%	5.9%
2249	171	66	1.7%	5.5%
2250	171	66	1.7%	5.6%
2251	171	66	1.6%	5.7%
2252	171	66	1.6%	5.8%
2253	171	66	1.6%	5.9%
2254	171	66	1.6%	6.0%
2255	172	67	1.9%	4.9%
2256	172	67	1.9%	5.0%
2257	172	67	1.9%	5.1%
2258	172	67	1.8%	5.2%
2259	172	67	1.8%	5.3%
2260	172	67	1.8%	5.4%
2261	172	67	1.8%	5.5%
2262	172	67	1.7%	5.6%
2263	172	67	1.7%	5.6%
2264	172	67	1.7%	5.7%
2265	172	67	1.6%	5.8%
2266	172	67	1.6%	5.9%
2267	173	68	2.0%	4.9%
2268	173	68	2.0%	5.0%
2269	173	68	1.9%	5.1%
2270	173	68	1.9%	5.2%
2271	173	68	1.9%	5.3%
2272	173	68	1.8%	5.3%
2273	173	68	1.8%	5.4%
2274	173	68	1.8%	5.5%
2275	173	68	1.8%	5.6%
2276	173	68	1.7%	5.7%
2277	173	68	1.7%	5.8%
2278	173	68	1.7%	5.9%
2279	175	69	1.7%	5.5%
2280	175	69	1.7%	5.6%
2281	175	69	1.7%	5.7%
2282	175	69	1.7%	5.8%
2283	175	69	1.6%	5.9%
2284	176	70	2.0%	4.9%
2285	176	70	2.0%	5.0%
2286	176	70	1.9%	5.1%
2287	176	70	1.9%	5.2%

2288	176	70	1.9%	5.2%
2289	176	70	1.9%	5.3%
2290	176	70	1.8%	5.4%
2291	176	70	1.8%	5.5%
2292	176	70	1.8%	5.6%
2293	176	70	1.7%	5.7%
2294	176	70	1.7%	5.8%
2295	176	70	1.7%	5.9%
2296	178	71	1.7%	5.5%
2297	178	71	1.7%	5.6%
2298	178	71	1.7%	5.7%
2299	178	71	1.7%	5.8%
2300	178	71	1.6%	5.9%
2301	179	72	2.0%	4.9%
2302	179	72	2.0%	5.0%
2303	179	72	1.9%	5.1%
2304	179	72	1.9%	5.2%
2305	179	72	1.9%	5.3%
2306	179	72	1.9%	5.4%
2307	179	72	1.8%	5.4%
2308	179	72	1.8%	5.5%
2309	179	72	1.8%	5.6%
2310	179	72	1.7%	5.7%
2311	179	72	1.7%	5.8%
2312	179	72	1.7%	5.9%
2313	181	73	1.7%	5.6%
2314	181	73	1.7%	5.7%
2315	181	73	1.7%	5.7%
2316	181	73	1.7%	5.8%
2317	181	73	1.6%	5.9%
2318	182	74	2.0%	4.9%
2319	182	74	2.0%	5.0%
2320	182	74	1.9%	5.1%
2321	182	74	1.9%	5.2%
2322	182	74	1.9%	5.3%
2323	182	74	1.8%	5.4%
2324	182	74	1.8%	5.5%
2325	182	74	1.8%	5.6%
2326	182	74	1.8%	5.7%
2327	182	74	1.7%	5.8%
2328	182	74	1.7%	5.9%
2329	182	74	1.7%	6.0%
2330	184	75	1.7%	5.6%
2331	184	75	1.7%	5.7%
2332	184	75	1.7%	5.8%
2333	184	75	1.6%	5.9%
2334	184	75	1.6%	6.0%
2335	185	76	2.0%	5.0%
2336	185	76	1.9%	5.1%
2337	185	76	1.9%	5.2%

2338	185	76	1.9%	5.3%
2339	185	76	1.8%	5.4%
2340	185	76	1.8%	5.5%
2341	185	76	1.8%	5.5%
2342	185	76	1.8%	5.6%
2343	185	76	1.7%	5.7%
2344	185	76	1.7%	5.8%
2345	185	76	1.7%	5.9%
2346	187	77	1.7%	5.6%
2347	187	77	1.7%	5.7%
2348	187	77	1.7%	5.8%
2349	187	77	1.6%	5.9%
2350	187	77	1.6%	6.0%
2351	188	78	2.0%	5.0%
2352	188	78	1.9%	5.1%
2353	188	78	1.9%	5.2%
2354	188	78	1.9%	5.3%
2355	188	78	1.8%	5.4%
2356	188	78	1.8%	5.4%
2357	188	78	1.8%	5.5%
2358	188	78	1.8%	5.6%
2359	188	78	1.7%	5.7%
2360	188	78	1.7%	5.8%
2361	188	78	1.7%	5.9%
2362	190	79	1.7%	5.6%
2363	190	79	1.7%	5.7%
2364	190	79	1.7%	5.8%
2365	190	79	1.6%	5.9%
2366	190	79	1.6%	6.0%
2367	191	80	1.9%	5.0%
2368	191	80	1.9%	5.1%
2369	191	80	1.9%	5.2%
2370	191	80	1.9%	5.3%
2371	191	80	1.8%	5.4%
2372	191	80	1.8%	5.5%
2373	191	80	1.8%	5.6%
2374	191	80	1.7%	5.6%
2375	191	80	1.7%	5.7%
2376	191	80	1.7%	5.8%
2377	191	80	1.7%	5.9%
2378	193	81	1.7%	5.6%
2379	193	81	1.7%	5.7%
2380	193	81	1.6%	5.8%
2381	193	81	1.6%	5.9%
2382	194	82	1.9%	5.0%
2383	194	82	1.9%	5.1%
2384	194	82	1.9%	5.2%
2385	194	82	1.9%	5.2%
2386	194	82	1.8%	5.3%
2387	194	82	1.8%	5.4%

2388	194	82	1.8%	5.5%
2389	194	82	1.8%	5.6%
2390	194	82	1.7%	5.7%
2391	194	82	1.7%	5.8%
2392	194	82	1.7%	5.9%
2393	194	82	1.6%	6.0%
2394	195	83	2.0%	5.0%
2395	195	83	1.9%	5.1%
2396	195	83	1.9%	5.2%
2397	195	83	1.9%	5.3%
2398	195	83	1.9%	5.4%
2399	195	83	1.8%	5.5%
2400	195	83	1.8%	5.5%
2401	195	83	1.8%	5.6%
2402	195	83	1.8%	5.7%
2403	195	83	1.7%	5.8%
2404	195	83	1.7%	5.9%
2405	197	84	1.7%	5.7%
2406	197	84	1.7%	5.7%
2407	197	84	1.7%	5.8%
2408	197	84	1.6%	5.9%
2409	198	85	2.0%	5.0%
2410	198	85	1.9%	5.1%
2411	198	85	1.9%	5.2%
2412	198	85	1.9%	5.3%
2413	198	85	1.9%	5.4%
2414	198	85	1.8%	5.4%
2415	198	85	1.8%	5.5%
2416	198	85	1.8%	5.6%
2417	198	85	1.8%	5.7%
2418	198	85	1.7%	5.8%
2419	198	85	1.7%	5.9%
2420	198	85	1.7%	6.0%
2421	200	86	1.7%	5.7%
2422	200	86	1.7%	5.8%
2423	200	86	1.6%	5.9%
2424	201	87	2.0%	5.0%
2425	201	87	1.9%	5.1%
2426	201	87	1.9%	5.2%
2427	201	87	1.9%	5.3%
2428	201	87	1.8%	5.4%
2429	201	87	1.8%	5.4%
2430	201	87	1.8%	5.5%
2431	201	87	1.8%	5.6%
2432	201	87	1.7%	5.7%
2433	201	87	1.7%	5.8%
2434	201	87	1.7%	5.9%
2435	201	87	1.7%	6.0%
2436	202	88	2.0%	5.1%
2437	202	88	2.0%	5.2%

2438	202	88	1.9%	5.2%
2439	202	88	1.9%	5.3%
2440	202	88	1.9%	5.4%
2441	202	88	1.8%	5.5%
2442	202	88	1.8%	5.6%
2443	202	88	1.8%	5.7%
2444	202	88	1.8%	5.8%
2445	202	88	1.7%	5.9%
2446	202	88	1.7%	5.9%
2447	204	89	1.7%	5.7%
2448	204	89	1.7%	5.8%
2449	204	89	1.7%	5.9%
2450	205	90	2.0%	5.0%
2451	205	90	2.0%	5.1%
2452	205	90	1.9%	5.2%
2453	205	90	1.9%	5.3%
2454	205	90	1.9%	5.4%
2455	205	90	1.8%	5.4%
2456	205	90	1.8%	5.5%
2457	205	90	1.8%	5.6%
2458	205	90	1.8%	5.7%
2459	205	90	1.7%	5.8%
2460	205	90	1.7%	5.9%
2461	205	90	1.7%	6.0%
2462	207	91	1.7%	5.8%
2463	207	91	1.7%	5.9%
2464	207	91	1.6%	5.9%
2465	208	92	1.9%	5.1%
2466	208	92	1.9%	5.2%
2467	208	92	1.9%	5.2%
2468	208	92	1.9%	5.3%
2469	208	92	1.8%	5.4%
2470	208	92	1.8%	5.5%
2471	208	92	1.8%	5.6%
2472	208	92	1.8%	5.7%
2473	208	92	1.7%	5.8%
2474	208	92	1.7%	5.8%
2475	208	92	1.7%	5.9%
2476	209	93	2.0%	5.1%
2477	209	93	2.0%	5.2%
2478	209	93	1.9%	5.2%
2479	209	93	1.9%	5.3%
2480	209	93	1.9%	5.4%
2481	209	93	1.9%	5.5%
2482	209	93	1.8%	5.6%
2483	209	93	1.8%	5.7%
2484	209	93	1.8%	5.7%
2485	209	93	1.8%	5.8%
2486	209	93	1.7%	5.9%
2487	211	94	1.7%	5.7%

2488	211	94	1.7%	5.8%
2489	211	94	1.7%	5.9%
2490	212	95	2.0%	5.1%
2491	212	95	1.9%	5.1%
2492	212	95	1.9%	5.2%
2493	212	95	1.9%	5.3%
2494	212	95	1.9%	5.4%
2495	212	95	1.8%	5.5%
2496	212	95	1.8%	5.6%
2497	212	95	1.8%	5.6%
2498	212	95	1.8%	5.7%
2499	212	95	1.7%	5.8%
2500	212	95	1.7%	5.9%
2501	212	95	1.7%	6.0%
2502	213	96	2.0%	5.1%
2503	213	96	2.0%	5.2%
2504	213	96	1.9%	5.3%
2505	213	96	1.9%	5.4%
2506	213	96	1.9%	5.5%
2507	213	96	1.9%	5.6%
2508	213	96	1.8%	5.6%
2509	213	96	1.8%	5.7%
2510	213	96	1.8%	5.8%
2511	213	96	1.8%	5.9%
2512	213	96	1.7%	6.0%
2513	215	97	1.7%	5.8%
2514	215	97	1.7%	5.9%
2515	215	97	1.7%	6.0%
2516	216	98	2.0%	5.2%
2517	216	98	1.9%	5.2%
2518	216	98	1.9%	5.3%
2519	216	98	1.9%	5.4%
2520	216	98	1.9%	5.5%
2521	216	98	1.8%	5.6%
2522	216	98	1.8%	5.6%
2523	216	98	1.8%	5.7%
2524	216	98	1.7%	5.8%
2525	216	98	1.7%	5.9%
2526	216	98	1.7%	6.0%
2527	217	99	2.0%	5.2%
2528	217	99	2.0%	5.2%
2529	217	99	1.9%	5.3%
2530	217	99	1.9%	5.4%
2531	217	99	1.9%	5.5%
2532	217	99	1.9%	5.6%
2533	217	99	1.8%	5.6%
2534	217	99	1.8%	5.7%
2535	217	99	1.8%	5.8%
2536	217	99	1.8%	5.9%
2537	217	99	1.7%	6.0%

2538	219	100	1.7%	5.9%
2539	219	100	1.7%	5.9%
2540	220	101	2.0%	5.1%
2541	220	101	2.0%	5.2%
2542	220	101	1.9%	5.3%
2543	220	101	1.9%	5.4%
2544	220	101	1.9%	5.4%
2545	220	101	1.9%	5.5%
2546	220	101	1.8%	5.6%
2547	220	101	1.8%	5.7%
2548	220	101	1.8%	5.8%
2549	220	101	1.8%	5.9%
2550	220	101	1.7%	5.9%
2551	222	102	1.7%	5.8%
2552	222	102	1.7%	5.9%
2553	222	102	1.7%	6.0%
2554	223	103	1.9%	5.2%
2555	223	103	1.9%	5.3%
2556	223	103	1.9%	5.3%
2557	223	103	1.9%	5.4%
2558	223	103	1.8%	5.5%
2559	223	103	1.8%	5.6%
2560	223	103	1.8%	5.7%
2561	223	103	1.8%	5.7%
2562	223	103	1.7%	5.8%
2563	223	103	1.7%	5.9%
2564	223	103	1.7%	6.0%
2565	224	104	2.0%	5.2%
2566	224	104	1.9%	5.3%
2567	224	104	1.9%	5.3%
2568	224	104	1.9%	5.4%
2569	224	104	1.9%	5.5%
2570	224	104	1.8%	5.6%
2571	224	104	1.8%	5.7%
2572	224	104	1.8%	5.8%
2573	224	104	1.8%	5.8%
2574	224	104	1.7%	5.9%
2575	226	105	1.7%	5.8%
2576	226	105	1.7%	5.9%
2577	226	105	1.7%	6.0%
2578	227	106	1.9%	5.2%
2579	227	106	1.9%	5.3%
2580	227	106	1.9%	5.3%
2581	227	106	1.9%	5.4%
2582	227	106	1.8%	5.5%
2583	227	106	1.8%	5.6%
2584	227	106	1.8%	5.7%
2585	227	106	1.8%	5.7%
2586	227	106	1.7%	5.8%
2587	227	106	1.7%	5.9%

2588	229	107	1.7%	5.8%
2589	229	107	1.7%	5.9%
2590	229	107	1.6%	6.0%
2591	230	108	1.9%	5.2%
2592	230	108	1.9%	5.3%
2593	230	108	1.9%	5.4%
2594	230	108	1.8%	5.4%
2595	230	108	1.8%	5.5%
2596	230	108	1.8%	5.6%
2597	230	108	1.8%	5.7%
2598	230	108	1.7%	5.8%
2599	230	108	1.7%	5.8%
2600	230	108	1.7%	5.9%
2601	231	109	2.0%	5.1%
2602	231	109	1.9%	5.2%
2603	231	109	1.9%	5.3%
2604	231	109	1.9%	5.4%
2605	231	109	1.9%	5.5%
2606	231	109	1.8%	5.5%
2607	231	109	1.8%	5.6%
2608	231	109	1.8%	5.7%
2609	231	109	1.8%	5.8%
2610	231	109	1.7%	5.9%
2611	231	109	1.7%	6.0%
2612	232	110	2.0%	5.2%
2613	232	110	2.0%	5.3%
2614	232	110	1.9%	5.3%
2615	232	110	1.9%	5.4%
2616	232	110	1.9%	5.5%
2617	232	110	1.9%	5.6%
2618	232	110	1.8%	5.6%
2619	232	110	1.8%	5.7%
2620	232	110	1.8%	5.8%
2621	232	110	1.8%	5.9%
2622	232	110	1.7%	6.0%
2623	234	111	1.7%	5.9%
2624	234	111	1.7%	6.0%
2625	235	112	1.9%	5.2%
2626	235	112	1.9%	5.3%
2627	235	112	1.9%	5.4%
2628	235	112	1.9%	5.4%
2629	235	112	1.8%	5.5%
2630	235	112	1.8%	5.6%
2631	235	112	1.8%	5.7%
2632	235	112	1.8%	5.8%
2633	235	112	1.7%	5.8%
2634	235	112	1.7%	5.9%
2635	236	113	2.0%	5.2%
2636	236	113	2.0%	5.2%
2637	236	113	1.9%	5.3%

2638	236	113	1.9%	5.4%
2639	236	113	1.9%	5.5%
2640	236	113	1.9%	5.6%
2641	236	113	1.8%	5.6%
2642	236	113	1.8%	5.7%
2643	236	113	1.8%	5.8%
2644	236	113	1.8%	5.9%
2645	236	113	1.7%	6.0%
2646	238	114	1.7%	5.9%
2647	238	114	1.7%	6.0%
2648	239	115	1.9%	5.2%
2649	239	115	1.9%	5.3%
2650	239	115	1.9%	5.4%
2651	239	115	1.9%	5.5%
2652	239	115	1.8%	5.5%
2653	239	115	1.8%	5.6%
2654	239	115	1.8%	5.7%
2655	239	115	1.8%	5.8%
2656	239	115	1.7%	5.9%
2657	239	115	1.7%	5.9%
2658	240	116	2.0%	5.2%
2659	240	116	2.0%	5.3%
2660	240	116	1.9%	5.3%
2661	240	116	1.9%	5.4%
2662	240	116	1.9%	5.5%
2663	240	116	1.9%	5.6%
2664	240	116	1.8%	5.7%
2665	240	116	1.8%	5.7%
2666	240	116	1.8%	5.8%
2667	240	116	1.8%	5.9%
2668	240	116	1.7%	6.0%
2669	242	117	1.7%	5.9%
2670	243	118	2.0%	5.2%
2671	243	118	1.9%	5.3%
2672	243	118	1.9%	5.3%
2673	243	118	1.9%	5.4%
2674	243	118	1.9%	5.5%
2675	243	118	1.8%	5.6%
2676	243	118	1.8%	5.7%
2677	243	118	1.8%	5.7%
2678	243	118	1.8%	5.8%
2679	243	118	1.7%	5.9%
2680	243	118	1.7%	6.0%
2681	244	119	2.0%	5.2%
2682	244	119	1.9%	5.3%
2683	244	119	1.9%	5.4%
2684	244	119	1.9%	5.5%
2685	244	119	1.9%	5.5%
2686	244	119	1.8%	5.6%
2687	244	119	1.8%	5.7%

2688	244	119	1.8%	5.8%
2689	244	119	1.8%	5.9%
2690	244	119	1.7%	5.9%
2691	246	120	1.7%	5.9%
2692	246	120	1.7%	6.0%
2693	247	121	1.9%	5.3%
2694	247	121	1.9%	5.3%
2695	247	121	1.9%	5.4%
2696	247	121	1.9%	5.5%
2697	247	121	1.8%	5.6%
2698	247	121	1.8%	5.6%
2699	247	121	1.8%	5.7%
2700	247	121	1.8%	5.8%
2701	247	121	1.7%	5.9%
2702	247	121	1.7%	6.0%
2703	248	122	2.0%	5.2%
2704	248	122	1.9%	5.3%
2705	248	122	1.9%	5.4%
2706	248	122	1.9%	5.5%
2707	248	122	1.9%	5.5%
2708	248	122	1.8%	5.6%
2709	248	122	1.8%	5.7%
2710	248	122	1.8%	5.8%
2711	248	122	1.8%	5.8%
2712	248	122	1.7%	5.9%
2713	250	123	1.7%	5.9%
2714	250	123	1.7%	6.0%
2715	251	124	1.9%	5.3%
2716	251	124	1.9%	5.3%
2717	251	124	1.9%	5.4%
2718	251	124	1.8%	5.5%
2719	251	124	1.8%	5.6%
2720	251	124	1.8%	5.6%
2721	251	124	1.8%	5.7%
2722	251	124	1.7%	5.8%
2723	251	124	1.7%	5.9%
2724	251	124	1.7%	6.0%
2725	252	125	2.0%	5.2%
2726	252	125	1.9%	5.3%
2727	252	125	1.9%	5.4%
2728	252	125	1.9%	5.5%
2729	252	125	1.9%	5.5%
2730	252	125	1.8%	5.6%
2731	252	125	1.8%	5.7%
2732	252	125	1.8%	5.8%
2733	252	125	1.8%	5.9%
2734	252	125	1.7%	5.9%
2735	253	126	2.0%	5.2%
2736	253	126	2.0%	5.3%
2737	253	126	1.9%	5.4%

2738	253	126	1.9%	5.4%
2739	253	126	1.9%	5.5%
2740	253	126	1.9%	5.6%
2741	253	126	1.8%	5.7%
2742	253	126	1.8%	5.8%
2743	253	126	1.8%	5.8%
2744	253	126	1.8%	5.9%
2745	253	126	1.7%	6.0%
2746	255	127	1.7%	6.0%
2747	256	128	1.9%	5.3%
2748	256	128	1.9%	5.4%
2749	256	128	1.9%	5.4%
2750	256	128	1.9%	5.5%
2751	256	128	1.8%	5.6%
2752	256	128	1.8%	5.7%
2753	256	128	1.8%	5.7%
2754	256	128	1.8%	5.8%
2755	256	128	1.7%	5.9%
2756	256	128	1.7%	6.0%
2757	257	129	2.0%	5.3%
2758	257	129	1.9%	5.3%
2759	257	129	1.9%	5.4%
2760	257	129	1.9%	5.5%
2761	257	129	1.9%	5.6%
2762	257	129	1.8%	5.6%
2763	257	129	1.8%	5.7%
2764	257	129	1.8%	5.8%
2765	257	129	1.8%	5.9%
2766	257	129	1.7%	5.9%
2767	259	130	1.7%	6.0%
2768	260	131	1.9%	5.3%
2769	260	131	1.9%	5.3%
2770	260	131	1.9%	5.4%
2771	260	131	1.9%	5.5%
2772	260	131	1.8%	5.6%
2773	260	131	1.8%	5.6%
2774	260	131	1.8%	5.7%
2775	260	131	1.8%	5.8%
2776	260	131	1.7%	5.9%
2777	260	131	1.7%	5.9%
2778	261	132	2.0%	5.3%
2779	261	132	1.9%	5.3%
2780	261	132	1.9%	5.4%
2781	261	132	1.9%	5.5%
2782	261	132	1.9%	5.6%
2783	261	132	1.8%	5.6%
2784	261	132	1.8%	5.7%
2785	261	132	1.8%	5.8%
2786	261	132	1.8%	5.9%
2787	261	132	1.7%	5.9%

2788	262	133	2.0%	5.3%
2789	262	133	2.0%	5.3%
2790	262	133	1.9%	5.4%
2791	262	133	1.9%	5.5%
2792	262	133	1.9%	5.5%
2793	262	133	1.9%	5.6%
2794	262	133	1.8%	5.7%
2795	262	133	1.8%	5.8%
2796	262	133	1.8%	5.8%
2797	262	133	1.8%	5.9%
2798	264	134	1.7%	6.0%
2799	265	135	1.9%	5.3%
2800	265	135	1.9%	5.3%
2801	265	135	1.9%	5.4%
2802	265	135	1.9%	5.5%
2803	265	135	1.8%	5.6%
2804	265	135	1.8%	5.6%
2805	265	135	1.8%	5.7%
2806	265	135	1.8%	5.8%
2807	265	135	1.7%	5.9%
2808	265	135	1.7%	5.9%
2809	266	136	2.0%	5.3%
2810	266	136	1.9%	5.3%
2811	266	136	1.9%	5.4%
2812	266	136	1.9%	5.5%
2813	266	136	1.9%	5.6%
2814	266	136	1.8%	5.6%
2815	266	136	1.8%	5.7%
2816	266	136	1.8%	5.8%
2817	266	136	1.8%	5.9%
2818	266	136	1.8%	5.9%
2819	267	137	2.0%	5.3%
2820	267	137	2.0%	5.3%
2821	267	137	1.9%	5.4%
2822	267	137	1.9%	5.5%
2823	267	137	1.9%	5.6%
2824	267	137	1.9%	5.6%
2825	267	137	1.9%	5.7%
2826	267	137	1.8%	5.8%
2827	267	137	1.8%	5.9%
2828	267	137	1.8%	5.9%
2829	269	138	1.7%	6.0%
2830	270	139	1.9%	5.3%
2831	270	139	1.9%	5.4%
2832	270	139	1.9%	5.5%
2833	270	139	1.9%	5.5%
2834	270	139	1.8%	5.6%
2835	270	139	1.8%	5.7%
2836	270	139	1.8%	5.7%
2837	270	139	1.8%	5.8%

2838	270	139	1.8%	5.9%
2839	270	139	1.7%	6.0%
2840	271	140	2.0%	5.3%
2841	271	140	1.9%	5.4%
2842	271	140	1.9%	5.5%
2843	271	140	1.9%	5.5%
2844	271	140	1.9%	5.6%
2845	271	140	1.8%	5.7%
2846	271	140	1.8%	5.7%
2847	271	140	1.8%	5.8%
2848	271	140	1.8%	5.9%
2849	271	140	1.8%	6.0%
2850	272	141	2.0%	5.3%
2851	272	141	2.0%	5.4%
2852	272	141	1.9%	5.5%
2853	272	141	1.9%	5.5%
2854	272	141	1.9%	5.6%
2855	272	141	1.9%	5.7%
2856	272	141	1.8%	5.7%
2857	272	141	1.8%	5.8%
2858	272	141	1.8%	5.9%
2859	272	141	1.8%	6.0%
2860	275	143	2.0%	5.3%
2861	275	143	1.9%	5.4%
2862	275	143	1.9%	5.4%
2863	275	143	1.9%	5.5%
2864	275	143	1.9%	5.6%
2865	275	143	1.8%	5.7%
2866	275	143	1.8%	5.7%
2867	275	143	1.8%	5.8%
2868	275	143	1.8%	5.9%
2869	275	143	1.7%	6.0%
2870	276	144	2.0%	5.3%
2871	276	144	1.9%	5.4%
2872	276	144	1.9%	5.4%
2873	276	144	1.9%	5.5%
2874	276	144	1.9%	5.6%
2875	276	144	1.9%	5.7%
2876	276	144	1.8%	5.7%
2877	276	144	1.8%	5.8%
2878	276	144	1.8%	5.9%
2879	276	144	1.8%	6.0%
2880	277	145	2.0%	5.3%
2881	277	145	2.0%	5.4%
2882	277	145	1.9%	5.5%
2883	277	145	1.9%	5.5%
2884	277	145	1.9%	5.6%
2885	277	145	1.9%	5.7%
2886	277	145	1.9%	5.7%
2887	277	145	1.8%	5.8%

2888	277	145	1.8%	5.9%
2889	277	145	1.8%	6.0%
2890	280	147	1.9%	5.3%
2891	280	147	1.9%	5.4%
2892	280	147	1.9%	5.5%
2893	280	147	1.9%	5.5%
2894	280	147	1.9%	5.6%
2895	280	147	1.8%	5.7%
2896	280	147	1.8%	5.7%
2897	280	147	1.8%	5.8%
2898	280	147	1.8%	5.9%
2899	280	147	1.7%	6.0%
2900	281	148	2.0%	5.3%
2901	281	148	1.9%	5.4%
2902	281	148	1.9%	5.5%
2903	281	148	1.9%	5.5%
2904	281	148	1.9%	5.6%
2905	281	148	1.9%	5.7%
2906	281	148	1.8%	5.8%
2907	281	148	1.8%	5.8%
2908	281	148	1.8%	5.9%
2909	281	148	1.8%	6.0%
2910	282	149	2.0%	5.3%
2911	282	149	2.0%	5.4%
2912	282	149	1.9%	5.5%
2913	282	149	1.9%	5.6%
2914	282	149	1.9%	5.6%
2915	282	149	1.9%	5.7%
2916	282	149	1.8%	5.8%
2917	282	149	1.8%	5.8%
2918	282	149	1.8%	5.9%
2919	282	149	1.8%	6.0%
2920	285	151	1.9%	5.4%
2921	285	151	1.9%	5.4%
2922	285	151	1.9%	5.5%
2923	285	151	1.9%	5.6%
2924	285	151	1.8%	5.7%
2925	285	151	1.8%	5.7%
2926	285	151	1.8%	5.8%
2927	285	151	1.8%	5.9%
2928	285	151	1.8%	5.9%
2929	286	152	2.0%	5.3%
2930	286	152	2.0%	5.4%
2931	286	152	1.9%	5.5%
2932	286	152	1.9%	5.5%
2933	286	152	1.9%	5.6%
2934	286	152	1.9%	5.7%
2935	286	152	1.8%	5.7%
2936	286	152	1.8%	5.8%
2937	286	152	1.8%	5.9%

2938	286	152	1.8%	6.0%
2939	287	153	2.0%	5.3%
2940	287	153	2.0%	5.4%
2941	287	153	1.9%	5.5%
2942	287	153	1.9%	5.5%
2943	287	153	1.9%	5.6%
2944	287	153	1.9%	5.7%
2945	287	153	1.9%	5.8%
2946	287	153	1.8%	5.8%
2947	287	153	1.8%	5.9%
2948	287	153	1.8%	6.0%
2949	290	155	1.9%	5.4%
2950	290	155	1.9%	5.4%
2951	290	155	1.9%	5.5%
2952	290	155	1.9%	5.6%
2953	290	155	1.8%	5.7%
2954	290	155	1.8%	5.7%
2955	290	155	1.8%	5.8%
2956	290	155	1.8%	5.9%
2957	290	155	1.8%	5.9%
2958	291	156	2.0%	5.3%
2959	291	156	1.9%	5.4%
2960	291	156	1.9%	5.5%
2961	291	156	1.9%	5.5%
2962	291	156	1.9%	5.6%
2963	291	156	1.9%	5.7%
2964	291	156	1.8%	5.7%
2965	291	156	1.8%	5.8%
2966	291	156	1.8%	5.9%
2967	291	156	1.8%	6.0%
2968	292	157	2.0%	5.3%
2969	292	157	2.0%	5.4%
2970	292	157	1.9%	5.5%
2971	292	157	1.9%	5.6%
2972	292	157	1.9%	5.6%
2973	292	157	1.9%	5.7%
2974	292	157	1.8%	5.8%
2975	292	157	1.8%	5.8%
2976	292	157	1.8%	5.9%
2977	292	157	1.8%	6.0%
2978	295	159	1.9%	5.4%
2979	295	159	1.9%	5.5%
2980	295	159	1.9%	5.5%
2981	295	159	1.9%	5.6%
2982	295	159	1.8%	5.7%
2983	295	159	1.8%	5.8%
2984	295	159	1.8%	5.8%
2985	295	159	1.8%	5.9%
2986	295	159	1.7%	6.0%
2987	296	160	2.0%	5.4%

2988	296	160	1.9%	5.4%
2989	296	160	1.9%	5.5%
2990	296	160	1.9%	5.6%
2991	296	160	1.9%	5.6%
2992	296	160	1.8%	5.7%
2993	296	160	1.8%	5.8%
2994	296	160	1.8%	5.8%
2995	296	160	1.8%	5.9%
2996	296	160	1.8%	6.0%
2997	297	161	2.0%	5.4%
2998	297	161	1.9%	5.5%
2999	297	161	1.9%	5.5%
3000	297	161	1.9%	5.6%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 1500 and 1200 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	1531
Cross party duplicates	12
Sample size	33
Maximum number of denials allowed	2

ASSUMPTIONS	
Valid list size	1500
Invalid list size	1200
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	6%

RESULT		
Probability of false rejection	6.27%	>6% (Not OK)
Probability of false acceptance	1.20%	<2% (OK)

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 2000, 6% and 2% the approximate value returned are 119 and 36. When these

INPUTS	
Members Lodged	2000
Desired probability of false rejection	6%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	1500
Unacceptable list	1200

RESULT	
Approximate sample size required	119
Approximate maximum number of denials	36

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.15
B	-1.67936
n0	125.3451
n1	117.9047
mu0	29.75
mu1	47.6
sig0	4.582074
sig1	5.184025
c0	36.37409
c1	36.45331

Sheet Name	Description
Table (6% & 2%)	List of required sample sizes cut-off values for member list sizes from 1500 to 2000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 1200 valid members; - no more than a 6% chance of incorrectly rejecting a list with 1500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 1200 valid members - Probability of incorrectly rejecting a list with 1500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 1500 up to 3000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 6%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 1523 members, a sample size of 27 and max denials of 1 will give a Probability of rejecting a valid list of 6.09%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 1200 - risk	Rejecting 1500 - risk
1500	18	0	1.8%	0.0%
1501	18	0	1.7%	1.2%
1502	18	0	1.7%	2.4%
1503	18	0	1.7%	3.6%
1504	18	0	1.7%	4.7%
1505	18	0	1.7%	5.8%
1506	27	1	1.6%	0.4%
1507	27	1	1.6%	0.6%
1508	27	1	1.6%	0.8%
1509	27	1	1.6%	1.0%
1510	27	1	1.5%	1.3%
1511	27	1	1.5%	1.5%
1512	27	1	1.5%	1.8%
1513	27	1	1.5%	2.1%
1514	27	1	1.5%	2.4%
1515	27	1	1.4%	2.8%
1516	27	1	1.4%	3.1%
1517	27	1	1.4%	3.5%
1518	27	1	1.4%	3.9%
1519	27	1	1.3%	4.3%
1520	27	1	1.3%	4.7%
1521	27	1	1.3%	5.2%
1522	27	1	1.3%	5.6%
1523	33	2	1.8%	1.2%
1524	33	2	1.7%	1.4%
1525	33	2	1.7%	1.5%
1526	33	2	1.7%	1.7%
1527	33	2	1.6%	1.9%
1528	33	2	1.6%	2.1%
1529	33	2	1.6%	2.3%
1530	33	2	1.6%	2.5%
1531	33	2	1.5%	2.7%
1532	33	2	1.5%	3.0%
1533	33	2	1.5%	3.2%
1534	33	2	1.5%	3.4%
1535	33	2	1.4%	3.7%
1536	33	2	1.4%	4.0%
1537	33	2	1.4%	4.3%

1538	33	2	1.4%	4.6%
1539	33	2	1.4%	4.9%
1540	33	2	1.3%	5.2%
1541	33	2	1.3%	5.5%
1542	33	2	1.3%	5.8%
1543	38	3	1.8%	1.9%
1544	38	3	1.8%	2.1%
1545	38	3	1.7%	2.2%
1546	38	3	1.7%	2.4%
1547	38	3	1.7%	2.6%
1548	38	3	1.6%	2.8%
1549	38	3	1.6%	3.0%
1550	38	3	1.6%	3.2%
1551	38	3	1.6%	3.4%
1552	38	3	1.5%	3.6%
1553	38	3	1.5%	3.8%
1554	38	3	1.5%	4.0%
1555	38	3	1.5%	4.2%
1556	38	3	1.4%	4.5%
1557	38	3	1.4%	4.7%
1558	38	3	1.4%	5.0%
1559	38	3	1.4%	5.2%
1560	38	3	1.3%	5.5%
1561	38	3	1.3%	5.8%
1562	42	4	1.9%	2.3%
1563	42	4	1.9%	2.4%
1564	42	4	1.9%	2.6%
1565	42	4	1.8%	2.7%
1566	42	4	1.8%	2.9%
1567	42	4	1.8%	3.1%
1568	42	4	1.8%	3.2%
1569	42	4	1.7%	3.4%
1570	42	4	1.7%	3.6%
1571	42	4	1.7%	3.8%
1572	42	4	1.6%	4.0%
1573	42	4	1.6%	4.2%
1574	42	4	1.6%	4.4%
1575	42	4	1.6%	4.6%
1576	42	4	1.5%	4.8%
1577	42	4	1.5%	5.0%
1578	42	4	1.5%	5.3%
1579	42	4	1.5%	5.5%
1580	42	4	1.4%	5.7%
1581	42	4	1.4%	6.0%
1582	46	5	1.9%	2.9%
1583	46	5	1.9%	3.0%
1584	46	5	1.8%	3.2%
1585	46	5	1.8%	3.3%
1586	46	5	1.8%	3.5%
1587	46	5	1.7%	3.6%

1588	46	5	1.7%	3.8%
1589	46	5	1.7%	4.0%
1590	46	5	1.7%	4.2%
1591	46	5	1.6%	4.4%
1592	46	5	1.6%	4.6%
1593	46	5	1.6%	4.7%
1594	46	5	1.5%	5.0%
1595	46	5	1.5%	5.2%
1596	46	5	1.5%	5.4%
1597	46	5	1.5%	5.6%
1598	46	5	1.4%	5.8%
1599	50	6	1.8%	3.1%
1600	50	6	1.8%	3.3%
1601	50	6	1.8%	3.4%
1602	50	6	1.7%	3.6%
1603	50	6	1.7%	3.7%
1604	50	6	1.7%	3.9%
1605	50	6	1.6%	4.1%
1606	50	6	1.6%	4.2%
1607	50	6	1.6%	4.4%
1608	50	6	1.6%	4.6%
1609	50	6	1.5%	4.8%
1610	50	6	1.5%	5.0%
1611	50	6	1.5%	5.2%
1612	50	6	1.5%	5.4%
1613	50	6	1.4%	5.6%
1614	50	6	1.4%	5.8%
1615	50	6	1.4%	6.0%
1616	53	7	2.0%	3.2%
1617	53	7	2.0%	3.3%
1618	53	7	1.9%	3.5%
1619	53	7	1.9%	3.6%
1620	53	7	1.9%	3.8%
1621	53	7	1.8%	3.9%
1622	53	7	1.8%	4.1%
1623	53	7	1.8%	4.2%
1624	53	7	1.7%	4.4%
1625	53	7	1.7%	4.6%
1626	53	7	1.7%	4.7%
1627	53	7	1.6%	4.9%
1628	53	7	1.6%	5.1%
1629	53	7	1.6%	5.3%
1630	53	7	1.6%	5.5%
1631	53	7	1.5%	5.7%
1632	53	7	1.5%	5.9%
1633	57	8	1.7%	3.7%
1634	57	8	1.7%	3.9%
1635	57	8	1.7%	4.0%
1636	57	8	1.6%	4.2%
1637	57	8	1.6%	4.3%

1638	57	8	1.6%	4.5%
1639	57	8	1.6%	4.7%
1640	57	8	1.5%	4.8%
1641	57	8	1.5%	5.0%
1642	57	8	1.5%	5.2%
1643	57	8	1.4%	5.4%
1644	57	8	1.4%	5.5%
1645	57	8	1.4%	5.7%
1646	57	8	1.4%	5.9%
1647	60	9	1.8%	3.6%
1648	60	9	1.8%	3.7%
1649	60	9	1.8%	3.9%
1650	60	9	1.7%	4.0%
1651	60	9	1.7%	4.2%
1652	60	9	1.7%	4.3%
1653	60	9	1.6%	4.5%
1654	60	9	1.6%	4.6%
1655	60	9	1.6%	4.8%
1656	60	9	1.6%	4.9%
1657	60	9	1.5%	5.1%
1658	60	9	1.5%	5.3%
1659	60	9	1.5%	5.5%
1660	60	9	1.4%	5.6%
1661	60	9	1.4%	5.8%
1662	63	10	1.8%	3.7%
1663	63	10	1.8%	3.8%
1664	63	10	1.8%	4.0%
1665	63	10	1.7%	4.1%
1666	63	10	1.7%	4.3%
1667	63	10	1.7%	4.4%
1668	63	10	1.6%	4.6%
1669	63	10	1.6%	4.7%
1670	63	10	1.6%	4.9%
1671	63	10	1.6%	5.0%
1672	63	10	1.5%	5.2%
1673	63	10	1.5%	5.4%
1674	63	10	1.5%	5.5%
1675	63	10	1.4%	5.7%
1676	63	10	1.4%	5.9%
1677	66	11	1.8%	3.9%
1678	66	11	1.8%	4.0%
1679	66	11	1.7%	4.2%
1680	66	11	1.7%	4.3%
1681	66	11	1.7%	4.5%
1682	66	11	1.6%	4.6%
1683	66	11	1.6%	4.7%
1684	66	11	1.6%	4.9%
1685	66	11	1.5%	5.1%
1686	66	11	1.5%	5.2%
1687	66	11	1.5%	5.4%

1688	66	11	1.5%	5.6%
1689	66	11	1.4%	5.7%
1690	66	11	1.4%	5.9%
1691	69	12	1.7%	4.0%
1692	69	12	1.7%	4.2%
1693	69	12	1.7%	4.3%
1694	69	12	1.6%	4.5%
1695	69	12	1.6%	4.6%
1696	69	12	1.6%	4.7%
1697	69	12	1.6%	4.9%
1698	69	12	1.5%	5.0%
1699	69	12	1.5%	5.2%
1700	69	12	1.5%	5.4%
1701	69	12	1.4%	5.5%
1702	69	12	1.4%	5.7%
1703	69	12	1.4%	5.9%
1704	71	13	2.0%	3.7%
1705	71	13	2.0%	3.8%
1706	71	13	1.9%	4.0%
1707	71	13	1.9%	4.1%
1708	71	13	1.9%	4.2%
1709	71	13	1.8%	4.4%
1710	71	13	1.8%	4.5%
1711	71	13	1.8%	4.6%
1712	71	13	1.7%	4.8%
1713	71	13	1.7%	4.9%
1714	71	13	1.7%	5.1%
1715	71	13	1.6%	5.2%
1716	71	13	1.6%	5.4%
1717	71	13	1.6%	5.5%
1718	71	13	1.5%	5.7%
1719	71	13	1.5%	5.9%
1720	74	14	1.8%	4.3%
1721	74	14	1.8%	4.4%
1722	74	14	1.7%	4.5%
1723	74	14	1.7%	4.7%
1724	74	14	1.7%	4.8%
1725	74	14	1.6%	4.9%
1726	74	14	1.6%	5.1%
1727	74	14	1.6%	5.2%
1728	74	14	1.5%	5.4%
1729	74	14	1.5%	5.5%
1730	74	14	1.5%	5.7%
1731	74	14	1.5%	5.9%
1732	77	15	1.7%	4.4%
1733	77	15	1.7%	4.5%
1734	77	15	1.6%	4.6%
1735	77	15	1.6%	4.8%
1736	77	15	1.6%	4.9%
1737	77	15	1.5%	5.0%

1738	77	15	1.5%	5.2%
1739	77	15	1.5%	5.3%
1740	77	15	1.5%	5.5%
1741	77	15	1.4%	5.6%
1742	77	15	1.4%	5.8%
1743	77	15	1.4%	6.0%
1744	79	16	1.9%	4.1%
1745	79	16	1.8%	4.2%
1746	79	16	1.8%	4.3%
1747	79	16	1.8%	4.4%
1748	79	16	1.7%	4.6%
1749	79	16	1.7%	4.7%
1750	79	16	1.7%	4.8%
1751	79	16	1.7%	5.0%
1752	79	16	1.6%	5.1%
1753	79	16	1.6%	5.3%
1754	79	16	1.6%	5.4%
1755	79	16	1.5%	5.6%
1756	79	16	1.5%	5.7%
1757	79	16	1.5%	5.9%
1758	81	17	2.0%	4.1%
1759	81	17	1.9%	4.2%
1760	81	17	1.9%	4.3%
1761	81	17	1.9%	4.4%
1762	81	17	1.8%	4.6%
1763	81	17	1.8%	4.7%
1764	81	17	1.8%	4.8%
1765	81	17	1.7%	5.0%
1766	81	17	1.7%	5.1%
1767	81	17	1.7%	5.2%
1768	81	17	1.7%	5.4%
1769	81	17	1.6%	5.5%
1770	81	17	1.6%	5.7%
1771	81	17	1.6%	5.8%
1772	81	17	1.5%	6.0%
1773	84	18	1.7%	4.7%
1774	84	18	1.7%	4.9%
1775	84	18	1.6%	5.0%
1776	84	18	1.6%	5.1%
1777	84	18	1.6%	5.3%
1778	84	18	1.6%	5.4%
1779	84	18	1.5%	5.5%
1780	84	18	1.5%	5.7%
1781	84	18	1.5%	5.8%
1782	84	18	1.4%	6.0%
1783	86	19	1.9%	4.3%
1784	86	19	1.8%	4.4%
1785	86	19	1.8%	4.6%
1786	86	19	1.8%	4.7%
1787	86	19	1.7%	4.8%

1788	86	19	1.7%	4.9%
1789	86	19	1.7%	5.1%
1790	86	19	1.7%	5.2%
1791	86	19	1.6%	5.3%
1792	86	19	1.6%	5.5%
1793	86	19	1.6%	5.6%
1794	86	19	1.5%	5.8%
1795	86	19	1.5%	5.9%
1796	88	20	1.9%	4.3%
1797	88	20	1.9%	4.4%
1798	88	20	1.9%	4.6%
1799	88	20	1.8%	4.7%
1800	88	20	1.8%	4.8%
1801	88	20	1.8%	4.9%
1802	88	20	1.7%	5.1%
1803	88	20	1.7%	5.2%
1804	88	20	1.7%	5.3%
1805	88	20	1.7%	5.5%
1806	88	20	1.6%	5.6%
1807	88	20	1.6%	5.7%
1808	88	20	1.6%	5.9%
1809	90	21	2.0%	4.3%
1810	90	21	2.0%	4.5%
1811	90	21	1.9%	4.6%
1812	90	21	1.9%	4.7%
1813	90	21	1.9%	4.8%
1814	90	21	1.8%	5.0%
1815	90	21	1.8%	5.1%
1816	90	21	1.8%	5.2%
1817	90	21	1.7%	5.3%
1818	90	21	1.7%	5.5%
1819	90	21	1.7%	5.6%
1820	90	21	1.6%	5.8%
1821	90	21	1.6%	5.9%
1822	93	22	1.7%	4.9%
1823	93	22	1.7%	5.1%
1824	93	22	1.6%	5.2%
1825	93	22	1.6%	5.3%
1826	93	22	1.6%	5.5%
1827	93	22	1.5%	5.6%
1828	93	22	1.5%	5.7%
1829	93	22	1.5%	5.9%
1830	95	23	1.9%	4.4%
1831	95	23	1.8%	4.6%
1832	95	23	1.8%	4.7%
1833	95	23	1.8%	4.8%
1834	95	23	1.7%	4.9%
1835	95	23	1.7%	5.0%
1836	95	23	1.7%	5.2%
1837	95	23	1.6%	5.3%

1838	95	23	1.6%	5.4%
1839	95	23	1.6%	5.6%
1840	95	23	1.6%	5.7%
1841	95	23	1.5%	5.8%
1842	95	23	1.5%	6.0%
1843	97	24	1.9%	4.6%
1844	97	24	1.8%	4.7%
1845	97	24	1.8%	4.8%
1846	97	24	1.8%	4.9%
1847	97	24	1.7%	5.1%
1848	97	24	1.7%	5.2%
1849	97	24	1.7%	5.3%
1850	97	24	1.6%	5.4%
1851	97	24	1.6%	5.6%
1852	97	24	1.6%	5.7%
1853	97	24	1.6%	5.9%
1854	97	24	1.5%	6.0%
1855	99	25	1.9%	4.6%
1856	99	25	1.8%	4.7%
1857	99	25	1.8%	4.9%
1858	99	25	1.8%	5.0%
1859	99	25	1.7%	5.1%
1860	99	25	1.7%	5.2%
1861	99	25	1.7%	5.4%
1862	99	25	1.6%	5.5%
1863	99	25	1.6%	5.6%
1864	99	25	1.6%	5.8%
1865	99	25	1.6%	5.9%
1866	101	26	1.9%	4.6%
1867	101	26	1.9%	4.7%
1868	101	26	1.8%	4.8%
1869	101	26	1.8%	4.9%
1870	101	26	1.8%	5.1%
1871	101	26	1.7%	5.2%
1872	101	26	1.7%	5.3%
1873	101	26	1.7%	5.4%
1874	101	26	1.6%	5.6%
1875	101	26	1.6%	5.7%
1876	101	26	1.6%	5.8%
1877	101	26	1.6%	6.0%
1878	103	27	1.9%	4.7%
1879	103	27	1.9%	4.8%
1880	103	27	1.8%	4.9%
1881	103	27	1.8%	5.1%
1882	103	27	1.8%	5.2%
1883	103	27	1.7%	5.3%
1884	103	27	1.7%	5.4%
1885	103	27	1.7%	5.5%
1886	103	27	1.6%	5.7%
1887	103	27	1.6%	5.8%

1888	103	27	1.6%	5.9%
1889	105	28	1.9%	4.7%
1890	105	28	1.9%	4.8%
1891	105	28	1.8%	4.9%
1892	105	28	1.8%	5.1%
1893	105	28	1.8%	5.2%
1894	105	28	1.7%	5.3%
1895	105	28	1.7%	5.4%
1896	105	28	1.7%	5.6%
1897	105	28	1.6%	5.7%
1898	105	28	1.6%	5.8%
1899	105	28	1.6%	5.9%
1900	107	29	1.9%	4.8%
1901	107	29	1.8%	4.9%
1902	107	29	1.8%	5.0%
1903	107	29	1.8%	5.1%
1904	107	29	1.8%	5.2%
1905	107	29	1.7%	5.3%
1906	107	29	1.7%	5.5%
1907	107	29	1.7%	5.6%
1908	107	29	1.6%	5.7%
1909	107	29	1.6%	5.8%
1910	107	29	1.6%	6.0%
1911	109	30	1.9%	4.8%
1912	109	30	1.8%	4.9%
1913	109	30	1.8%	5.1%
1914	109	30	1.8%	5.2%
1915	109	30	1.7%	5.3%
1916	109	30	1.7%	5.4%
1917	109	30	1.7%	5.5%
1918	109	30	1.6%	5.7%
1919	109	30	1.6%	5.8%
1920	109	30	1.6%	5.9%
1921	111	31	1.9%	4.8%
1922	111	31	1.8%	4.9%
1923	111	31	1.8%	5.0%
1924	111	31	1.8%	5.1%
1925	111	31	1.7%	5.3%
1926	111	31	1.7%	5.4%
1927	111	31	1.7%	5.5%
1928	111	31	1.7%	5.6%
1929	111	31	1.6%	5.7%
1930	111	31	1.6%	5.9%
1931	113	32	1.9%	4.8%
1932	113	32	1.8%	4.9%
1933	113	32	1.8%	5.0%
1934	113	32	1.8%	5.1%
1935	113	32	1.7%	5.3%
1936	113	32	1.7%	5.4%
1937	113	32	1.7%	5.5%

1938	113	32	1.6%	5.6%
1939	113	32	1.6%	5.7%
1940	113	32	1.6%	5.9%
1941	113	32	1.6%	6.0%
1942	115	33	1.8%	4.9%
1943	115	33	1.8%	5.0%
1944	115	33	1.8%	5.2%
1945	115	33	1.7%	5.3%
1946	115	33	1.7%	5.4%
1947	115	33	1.7%	5.5%
1948	115	33	1.6%	5.6%
1949	115	33	1.6%	5.8%
1950	115	33	1.6%	5.9%
1951	117	34	1.8%	4.9%
1952	117	34	1.8%	5.0%
1953	117	34	1.8%	5.1%
1954	117	34	1.7%	5.2%
1955	117	34	1.7%	5.3%
1956	117	34	1.7%	5.4%
1957	117	34	1.6%	5.6%
1958	117	34	1.6%	5.7%
1959	117	34	1.6%	5.8%
1960	117	34	1.6%	5.9%
1961	119	35	1.8%	4.9%
1962	119	35	1.8%	5.0%
1963	119	35	1.7%	5.2%
1964	119	35	1.7%	5.3%
1965	119	35	1.7%	5.4%
1966	119	35	1.6%	5.5%
1967	119	35	1.6%	5.6%
1968	119	35	1.6%	5.7%
1969	119	35	1.6%	5.9%
1970	119	35	1.5%	6.0%
1971	121	36	1.7%	5.0%
1972	121	36	1.7%	5.1%
1973	121	36	1.7%	5.2%
1974	121	36	1.7%	5.4%
1975	121	36	1.6%	5.5%
1976	121	36	1.6%	5.6%
1977	121	36	1.6%	5.7%
1978	121	36	1.5%	5.8%
1979	121	36	1.5%	6.0%
1980	123	37	1.7%	5.0%
1981	123	37	1.7%	5.1%
1982	123	37	1.7%	5.2%
1983	123	37	1.6%	5.3%
1984	123	37	1.6%	5.5%
1985	123	37	1.6%	5.6%
1986	123	37	1.6%	5.7%
1987	123	37	1.5%	5.8%

1988	123	37	1.5%	5.9%
1989	125	38	1.7%	5.0%
1990	125	38	1.7%	5.1%
1991	125	38	1.6%	5.2%
1992	125	38	1.6%	5.4%
1993	125	38	1.6%	5.5%
1994	125	38	1.6%	5.6%
1995	125	38	1.5%	5.7%
1996	125	38	1.5%	5.8%
1997	125	38	1.5%	6.0%
1998	126	39	2.0%	4.5%
1999	126	39	2.0%	4.6%
2000	126	39	1.9%	4.7%
2001	126	39	1.9%	4.8%
2002	126	39	1.9%	4.9%
2003	126	39	1.8%	5.0%
2004	126	39	1.8%	5.1%
2005	126	39	1.8%	5.2%
2006	126	39	1.7%	5.3%
2007	126	39	1.7%	5.4%
2008	126	39	1.7%	5.6%
2009	126	39	1.6%	5.7%
2010	126	39	1.6%	5.8%
2011	126	39	1.6%	5.9%
2012	128	40	1.8%	5.1%
2013	128	40	1.8%	5.2%
2014	128	40	1.7%	5.3%
2015	128	40	1.7%	5.4%
2016	128	40	1.7%	5.5%
2017	128	40	1.6%	5.6%
2018	128	40	1.6%	5.7%
2019	128	40	1.6%	5.8%
2020	128	40	1.6%	6.0%
2021	130	41	1.7%	5.1%
2022	130	41	1.7%	5.2%
2023	130	41	1.7%	5.3%
2024	130	41	1.7%	5.4%
2025	130	41	1.6%	5.6%
2026	130	41	1.6%	5.7%
2027	130	41	1.6%	5.8%
2028	130	41	1.5%	5.9%
2029	132	42	1.7%	5.1%
2030	132	42	1.7%	5.2%
2031	132	42	1.7%	5.3%
2032	132	42	1.6%	5.4%
2033	132	42	1.6%	5.5%
2034	132	42	1.6%	5.6%
2035	132	42	1.6%	5.8%
2036	132	42	1.5%	5.9%
2037	132	42	1.5%	6.0%

2038	133	43	2.0%	4.6%
2039	133	43	1.9%	4.7%
2040	133	43	1.9%	4.8%
2041	133	43	1.9%	4.9%
2042	133	43	1.8%	5.0%
2043	133	43	1.8%	5.1%
2044	133	43	1.8%	5.2%
2045	133	43	1.8%	5.3%
2046	133	43	1.7%	5.4%
2047	133	43	1.7%	5.5%
2048	133	43	1.7%	5.7%
2049	133	43	1.6%	5.8%
2050	133	43	1.6%	5.9%
2051	135	44	1.8%	5.1%
2052	135	44	1.8%	5.2%
2053	135	44	1.7%	5.3%
2054	135	44	1.7%	5.4%
2055	135	44	1.7%	5.5%
2056	135	44	1.6%	5.7%
2057	135	44	1.6%	5.8%
2058	135	44	1.6%	5.9%
2059	137	45	1.7%	5.1%
2060	137	45	1.7%	5.2%
2061	137	45	1.7%	5.3%
2062	137	45	1.7%	5.5%
2063	137	45	1.6%	5.6%
2064	137	45	1.6%	5.7%
2065	137	45	1.6%	5.8%
2066	137	45	1.6%	5.9%
2067	139	46	1.7%	5.2%
2068	139	46	1.7%	5.3%
2069	139	46	1.6%	5.4%
2070	139	46	1.6%	5.5%
2071	139	46	1.6%	5.6%
2072	139	46	1.6%	5.7%
2073	139	46	1.5%	5.8%
2074	139	46	1.5%	5.9%
2075	140	47	2.0%	4.6%
2076	140	47	1.9%	4.7%
2077	140	47	1.9%	4.8%
2078	140	47	1.9%	4.9%
2079	140	47	1.8%	5.0%
2080	140	47	1.8%	5.1%
2081	140	47	1.8%	5.2%
2082	140	47	1.7%	5.3%
2083	140	47	1.7%	5.4%
2084	140	47	1.7%	5.5%
2085	140	47	1.7%	5.7%
2086	140	47	1.6%	5.8%
2087	140	47	1.6%	5.9%

2088	140	47	1.6%	6.0%
2089	142	48	1.7%	5.3%
2090	142	48	1.7%	5.4%
2091	142	48	1.7%	5.5%
2092	142	48	1.6%	5.6%
2093	142	48	1.6%	5.7%
2094	142	48	1.6%	5.8%
2095	142	48	1.6%	5.9%
2096	144	49	1.7%	5.3%
2097	144	49	1.7%	5.4%
2098	144	49	1.6%	5.5%
2099	144	49	1.6%	5.6%
2100	144	49	1.6%	5.7%
2101	144	49	1.6%	5.8%
2102	144	49	1.5%	5.9%
2103	145	50	2.0%	4.7%
2104	145	50	1.9%	4.8%
2105	145	50	1.9%	4.8%
2106	145	50	1.9%	4.9%
2107	145	50	1.8%	5.0%
2108	145	50	1.8%	5.1%
2109	145	50	1.8%	5.2%
2110	145	50	1.8%	5.3%
2111	145	50	1.7%	5.5%
2112	145	50	1.7%	5.6%
2113	145	50	1.7%	5.7%
2114	145	50	1.6%	5.8%
2115	145	50	1.6%	5.9%
2116	145	50	1.6%	6.0%
2117	147	51	1.7%	5.3%
2118	147	51	1.7%	5.4%
2119	147	51	1.7%	5.6%
2120	147	51	1.6%	5.7%
2121	147	51	1.6%	5.8%
2122	147	51	1.6%	5.9%
2123	147	51	1.6%	6.0%
2124	148	52	2.0%	4.7%
2125	148	52	2.0%	4.8%
2126	148	52	1.9%	4.9%
2127	148	52	1.9%	5.0%
2128	148	52	1.9%	5.1%
2129	148	52	1.8%	5.2%
2130	148	52	1.8%	5.3%
2131	148	52	1.8%	5.4%
2132	148	52	1.7%	5.5%
2133	148	52	1.7%	5.6%
2134	148	52	1.7%	5.8%
2135	148	52	1.7%	5.9%
2136	148	52	1.6%	6.0%
2137	150	53	1.8%	5.4%

2138	150	53	1.7%	5.5%
2139	150	53	1.7%	5.6%
2140	150	53	1.7%	5.7%
2141	150	53	1.6%	5.8%
2142	150	53	1.6%	5.9%
2143	150	53	1.6%	6.0%
2144	152	54	1.7%	5.4%
2145	152	54	1.7%	5.5%
2146	152	54	1.6%	5.6%
2147	152	54	1.6%	5.7%
2148	152	54	1.6%	5.8%
2149	152	54	1.6%	5.9%
2150	153	55	2.0%	4.7%
2151	153	55	2.0%	4.8%
2152	153	55	1.9%	4.9%
2153	153	55	1.9%	5.0%
2154	153	55	1.9%	5.1%
2155	153	55	1.8%	5.2%
2156	153	55	1.8%	5.3%
2157	153	55	1.8%	5.4%
2158	153	55	1.7%	5.5%
2159	153	55	1.7%	5.6%
2160	153	55	1.7%	5.7%
2161	153	55	1.7%	5.8%
2162	153	55	1.6%	5.9%
2163	155	56	1.7%	5.4%
2164	155	56	1.7%	5.5%
2165	155	56	1.7%	5.6%
2166	155	56	1.7%	5.7%
2167	155	56	1.6%	5.8%
2168	155	56	1.6%	5.9%
2169	155	56	1.6%	6.0%
2170	156	57	2.0%	4.8%
2171	156	57	2.0%	4.9%
2172	156	57	1.9%	5.0%
2173	156	57	1.9%	5.1%
2174	156	57	1.9%	5.2%
2175	156	57	1.8%	5.3%
2176	156	57	1.8%	5.4%
2177	156	57	1.8%	5.5%
2178	156	57	1.7%	5.6%
2179	156	57	1.7%	5.7%
2180	156	57	1.7%	5.8%
2181	156	57	1.7%	5.9%
2182	158	58	1.8%	5.4%
2183	158	58	1.7%	5.5%
2184	158	58	1.7%	5.6%
2185	158	58	1.7%	5.7%
2186	158	58	1.7%	5.8%
2187	158	58	1.6%	5.9%

2188	158	58	1.6%	6.0%
2189	160	59	1.7%	5.4%
2190	160	59	1.7%	5.6%
2191	160	59	1.6%	5.7%
2192	160	59	1.6%	5.8%
2193	160	59	1.6%	5.9%
2194	160	59	1.6%	6.0%
2195	161	60	2.0%	4.8%
2196	161	60	1.9%	4.9%
2197	161	60	1.9%	5.0%
2198	161	60	1.9%	5.1%
2199	161	60	1.8%	5.2%
2200	161	60	1.8%	5.3%
2201	161	60	1.8%	5.4%
2202	161	60	1.7%	5.5%
2203	161	60	1.7%	5.6%
2204	161	60	1.7%	5.7%
2205	161	60	1.7%	5.8%
2206	161	60	1.6%	5.9%
2207	163	61	1.7%	5.4%
2208	163	61	1.7%	5.5%
2209	163	61	1.7%	5.6%
2210	163	61	1.6%	5.7%
2211	163	61	1.6%	5.8%
2212	163	61	1.6%	5.9%
2213	164	62	2.0%	4.8%
2214	164	62	2.0%	4.9%
2215	164	62	1.9%	5.0%
2216	164	62	1.9%	5.1%
2217	164	62	1.9%	5.2%
2218	164	62	1.8%	5.3%
2219	164	62	1.8%	5.4%
2220	164	62	1.8%	5.5%
2221	164	62	1.7%	5.6%
2222	164	62	1.7%	5.7%
2223	164	62	1.7%	5.8%
2224	164	62	1.7%	5.9%
2225	164	62	1.6%	6.0%
2226	166	63	1.7%	5.5%
2227	166	63	1.7%	5.6%
2228	166	63	1.7%	5.7%
2229	166	63	1.6%	5.8%
2230	166	63	1.6%	5.9%
2231	166	63	1.6%	6.0%
2232	167	64	2.0%	4.9%
2233	167	64	1.9%	5.0%
2234	167	64	1.9%	5.1%
2235	167	64	1.9%	5.2%
2236	167	64	1.8%	5.3%
2237	167	64	1.8%	5.4%

2238	167	64	1.8%	5.5%
2239	167	64	1.8%	5.6%
2240	167	64	1.7%	5.7%
2241	167	64	1.7%	5.8%
2242	167	64	1.7%	5.9%
2243	167	64	1.7%	6.0%
2244	169	65	1.7%	5.5%
2245	169	65	1.7%	5.6%
2246	169	65	1.7%	5.7%
2247	169	65	1.6%	5.8%
2248	169	65	1.6%	5.9%
2249	171	66	1.7%	5.5%
2250	171	66	1.7%	5.6%
2251	171	66	1.6%	5.7%
2252	171	66	1.6%	5.8%
2253	171	66	1.6%	5.9%
2254	171	66	1.6%	6.0%
2255	172	67	1.9%	4.9%
2256	172	67	1.9%	5.0%
2257	172	67	1.9%	5.1%
2258	172	67	1.8%	5.2%
2259	172	67	1.8%	5.3%
2260	172	67	1.8%	5.4%
2261	172	67	1.8%	5.5%
2262	172	67	1.7%	5.6%
2263	172	67	1.7%	5.6%
2264	172	67	1.7%	5.7%
2265	172	67	1.6%	5.8%
2266	172	67	1.6%	5.9%
2267	173	68	2.0%	4.9%
2268	173	68	2.0%	5.0%
2269	173	68	1.9%	5.1%
2270	173	68	1.9%	5.2%
2271	173	68	1.9%	5.3%
2272	173	68	1.8%	5.3%
2273	173	68	1.8%	5.4%
2274	173	68	1.8%	5.5%
2275	173	68	1.8%	5.6%
2276	173	68	1.7%	5.7%
2277	173	68	1.7%	5.8%
2278	173	68	1.7%	5.9%
2279	175	69	1.7%	5.5%
2280	175	69	1.7%	5.6%
2281	175	69	1.7%	5.7%
2282	175	69	1.7%	5.8%
2283	175	69	1.6%	5.9%
2284	176	70	2.0%	4.9%
2285	176	70	2.0%	5.0%
2286	176	70	1.9%	5.1%
2287	176	70	1.9%	5.2%

2288	176	70	1.9%	5.2%
2289	176	70	1.9%	5.3%
2290	176	70	1.8%	5.4%
2291	176	70	1.8%	5.5%
2292	176	70	1.8%	5.6%
2293	176	70	1.7%	5.7%
2294	176	70	1.7%	5.8%
2295	176	70	1.7%	5.9%
2296	178	71	1.7%	5.5%
2297	178	71	1.7%	5.6%
2298	178	71	1.7%	5.7%
2299	178	71	1.7%	5.8%
2300	178	71	1.6%	5.9%
2301	179	72	2.0%	4.9%
2302	179	72	2.0%	5.0%
2303	179	72	1.9%	5.1%
2304	179	72	1.9%	5.2%
2305	179	72	1.9%	5.3%
2306	179	72	1.9%	5.4%
2307	179	72	1.8%	5.4%
2308	179	72	1.8%	5.5%
2309	179	72	1.8%	5.6%
2310	179	72	1.7%	5.7%
2311	179	72	1.7%	5.8%
2312	179	72	1.7%	5.9%
2313	181	73	1.7%	5.6%
2314	181	73	1.7%	5.7%
2315	181	73	1.7%	5.7%
2316	181	73	1.7%	5.8%
2317	181	73	1.6%	5.9%
2318	182	74	2.0%	4.9%
2319	182	74	2.0%	5.0%
2320	182	74	1.9%	5.1%
2321	182	74	1.9%	5.2%
2322	182	74	1.9%	5.3%
2323	182	74	1.8%	5.4%
2324	182	74	1.8%	5.5%
2325	182	74	1.8%	5.6%
2326	182	74	1.8%	5.7%
2327	182	74	1.7%	5.8%
2328	182	74	1.7%	5.9%
2329	182	74	1.7%	6.0%
2330	184	75	1.7%	5.6%
2331	184	75	1.7%	5.7%
2332	184	75	1.7%	5.8%
2333	184	75	1.6%	5.9%
2334	184	75	1.6%	6.0%
2335	185	76	2.0%	5.0%
2336	185	76	1.9%	5.1%
2337	185	76	1.9%	5.2%

2338	185	76	1.9%	5.3%
2339	185	76	1.8%	5.4%
2340	185	76	1.8%	5.5%
2341	185	76	1.8%	5.5%
2342	185	76	1.8%	5.6%
2343	185	76	1.7%	5.7%
2344	185	76	1.7%	5.8%
2345	185	76	1.7%	5.9%
2346	187	77	1.7%	5.6%
2347	187	77	1.7%	5.7%
2348	187	77	1.7%	5.8%
2349	187	77	1.6%	5.9%
2350	187	77	1.6%	6.0%
2351	188	78	2.0%	5.0%
2352	188	78	1.9%	5.1%
2353	188	78	1.9%	5.2%
2354	188	78	1.9%	5.3%
2355	188	78	1.8%	5.4%
2356	188	78	1.8%	5.4%
2357	188	78	1.8%	5.5%
2358	188	78	1.8%	5.6%
2359	188	78	1.7%	5.7%
2360	188	78	1.7%	5.8%
2361	188	78	1.7%	5.9%
2362	190	79	1.7%	5.6%
2363	190	79	1.7%	5.7%
2364	190	79	1.7%	5.8%
2365	190	79	1.6%	5.9%
2366	190	79	1.6%	6.0%
2367	191	80	1.9%	5.0%
2368	191	80	1.9%	5.1%
2369	191	80	1.9%	5.2%
2370	191	80	1.9%	5.3%
2371	191	80	1.8%	5.4%
2372	191	80	1.8%	5.5%
2373	191	80	1.8%	5.6%
2374	191	80	1.7%	5.6%
2375	191	80	1.7%	5.7%
2376	191	80	1.7%	5.8%
2377	191	80	1.7%	5.9%
2378	193	81	1.7%	5.6%
2379	193	81	1.7%	5.7%
2380	193	81	1.6%	5.8%
2381	193	81	1.6%	5.9%
2382	194	82	1.9%	5.0%
2383	194	82	1.9%	5.1%
2384	194	82	1.9%	5.2%
2385	194	82	1.9%	5.2%
2386	194	82	1.8%	5.3%
2387	194	82	1.8%	5.4%

2388	194	82	1.8%	5.5%
2389	194	82	1.8%	5.6%
2390	194	82	1.7%	5.7%
2391	194	82	1.7%	5.8%
2392	194	82	1.7%	5.9%
2393	194	82	1.6%	6.0%
2394	195	83	2.0%	5.0%
2395	195	83	1.9%	5.1%
2396	195	83	1.9%	5.2%
2397	195	83	1.9%	5.3%
2398	195	83	1.9%	5.4%
2399	195	83	1.8%	5.5%
2400	195	83	1.8%	5.5%
2401	195	83	1.8%	5.6%
2402	195	83	1.8%	5.7%
2403	195	83	1.7%	5.8%
2404	195	83	1.7%	5.9%
2405	197	84	1.7%	5.7%
2406	197	84	1.7%	5.7%
2407	197	84	1.7%	5.8%
2408	197	84	1.6%	5.9%
2409	198	85	2.0%	5.0%
2410	198	85	1.9%	5.1%
2411	198	85	1.9%	5.2%
2412	198	85	1.9%	5.3%
2413	198	85	1.9%	5.4%
2414	198	85	1.8%	5.4%
2415	198	85	1.8%	5.5%
2416	198	85	1.8%	5.6%
2417	198	85	1.8%	5.7%
2418	198	85	1.7%	5.8%
2419	198	85	1.7%	5.9%
2420	198	85	1.7%	6.0%
2421	200	86	1.7%	5.7%
2422	200	86	1.7%	5.8%
2423	200	86	1.6%	5.9%
2424	201	87	2.0%	5.0%
2425	201	87	1.9%	5.1%
2426	201	87	1.9%	5.2%
2427	201	87	1.9%	5.3%
2428	201	87	1.8%	5.4%
2429	201	87	1.8%	5.4%
2430	201	87	1.8%	5.5%
2431	201	87	1.8%	5.6%
2432	201	87	1.7%	5.7%
2433	201	87	1.7%	5.8%
2434	201	87	1.7%	5.9%
2435	201	87	1.7%	6.0%
2436	202	88	2.0%	5.1%
2437	202	88	2.0%	5.2%

2438	202	88	1.9%	5.2%
2439	202	88	1.9%	5.3%
2440	202	88	1.9%	5.4%
2441	202	88	1.8%	5.5%
2442	202	88	1.8%	5.6%
2443	202	88	1.8%	5.7%
2444	202	88	1.8%	5.8%
2445	202	88	1.7%	5.9%
2446	202	88	1.7%	5.9%
2447	204	89	1.7%	5.7%
2448	204	89	1.7%	5.8%
2449	204	89	1.7%	5.9%
2450	205	90	2.0%	5.0%
2451	205	90	2.0%	5.1%
2452	205	90	1.9%	5.2%
2453	205	90	1.9%	5.3%
2454	205	90	1.9%	5.4%
2455	205	90	1.8%	5.4%
2456	205	90	1.8%	5.5%
2457	205	90	1.8%	5.6%
2458	205	90	1.8%	5.7%
2459	205	90	1.7%	5.8%
2460	205	90	1.7%	5.9%
2461	205	90	1.7%	6.0%
2462	207	91	1.7%	5.8%
2463	207	91	1.7%	5.9%
2464	207	91	1.6%	5.9%
2465	208	92	1.9%	5.1%
2466	208	92	1.9%	5.2%
2467	208	92	1.9%	5.2%
2468	208	92	1.9%	5.3%
2469	208	92	1.8%	5.4%
2470	208	92	1.8%	5.5%
2471	208	92	1.8%	5.6%
2472	208	92	1.8%	5.7%
2473	208	92	1.7%	5.8%
2474	208	92	1.7%	5.8%
2475	208	92	1.7%	5.9%
2476	209	93	2.0%	5.1%
2477	209	93	2.0%	5.2%
2478	209	93	1.9%	5.2%
2479	209	93	1.9%	5.3%
2480	209	93	1.9%	5.4%
2481	209	93	1.9%	5.5%
2482	209	93	1.8%	5.6%
2483	209	93	1.8%	5.7%
2484	209	93	1.8%	5.7%
2485	209	93	1.8%	5.8%
2486	209	93	1.7%	5.9%
2487	211	94	1.7%	5.7%

2488	211	94	1.7%	5.8%
2489	211	94	1.7%	5.9%
2490	212	95	2.0%	5.1%
2491	212	95	1.9%	5.1%
2492	212	95	1.9%	5.2%
2493	212	95	1.9%	5.3%
2494	212	95	1.9%	5.4%
2495	212	95	1.8%	5.5%
2496	212	95	1.8%	5.6%
2497	212	95	1.8%	5.6%
2498	212	95	1.8%	5.7%
2499	212	95	1.7%	5.8%
2500	212	95	1.7%	5.9%
2501	212	95	1.7%	6.0%
2502	213	96	2.0%	5.1%
2503	213	96	2.0%	5.2%
2504	213	96	1.9%	5.3%
2505	213	96	1.9%	5.4%
2506	213	96	1.9%	5.5%
2507	213	96	1.9%	5.6%
2508	213	96	1.8%	5.6%
2509	213	96	1.8%	5.7%
2510	213	96	1.8%	5.8%
2511	213	96	1.8%	5.9%
2512	213	96	1.7%	6.0%
2513	215	97	1.7%	5.8%
2514	215	97	1.7%	5.9%
2515	215	97	1.7%	6.0%
2516	216	98	2.0%	5.2%
2517	216	98	1.9%	5.2%
2518	216	98	1.9%	5.3%
2519	216	98	1.9%	5.4%
2520	216	98	1.9%	5.5%
2521	216	98	1.8%	5.6%
2522	216	98	1.8%	5.6%
2523	216	98	1.8%	5.7%
2524	216	98	1.7%	5.8%
2525	216	98	1.7%	5.9%
2526	216	98	1.7%	6.0%
2527	217	99	2.0%	5.2%
2528	217	99	2.0%	5.2%
2529	217	99	1.9%	5.3%
2530	217	99	1.9%	5.4%
2531	217	99	1.9%	5.5%
2532	217	99	1.9%	5.6%
2533	217	99	1.8%	5.6%
2534	217	99	1.8%	5.7%
2535	217	99	1.8%	5.8%
2536	217	99	1.8%	5.9%
2537	217	99	1.7%	6.0%

2538	219	100	1.7%	5.9%
2539	219	100	1.7%	5.9%
2540	220	101	2.0%	5.1%
2541	220	101	2.0%	5.2%
2542	220	101	1.9%	5.3%
2543	220	101	1.9%	5.4%
2544	220	101	1.9%	5.4%
2545	220	101	1.9%	5.5%
2546	220	101	1.8%	5.6%
2547	220	101	1.8%	5.7%
2548	220	101	1.8%	5.8%
2549	220	101	1.8%	5.9%
2550	220	101	1.7%	5.9%
2551	222	102	1.7%	5.8%
2552	222	102	1.7%	5.9%
2553	222	102	1.7%	6.0%
2554	223	103	1.9%	5.2%
2555	223	103	1.9%	5.3%
2556	223	103	1.9%	5.3%
2557	223	103	1.9%	5.4%
2558	223	103	1.8%	5.5%
2559	223	103	1.8%	5.6%
2560	223	103	1.8%	5.7%
2561	223	103	1.8%	5.7%
2562	223	103	1.7%	5.8%
2563	223	103	1.7%	5.9%
2564	223	103	1.7%	6.0%
2565	224	104	2.0%	5.2%
2566	224	104	1.9%	5.3%
2567	224	104	1.9%	5.3%
2568	224	104	1.9%	5.4%
2569	224	104	1.9%	5.5%
2570	224	104	1.8%	5.6%
2571	224	104	1.8%	5.7%
2572	224	104	1.8%	5.8%
2573	224	104	1.8%	5.8%
2574	224	104	1.7%	5.9%
2575	226	105	1.7%	5.8%
2576	226	105	1.7%	5.9%
2577	226	105	1.7%	6.0%
2578	227	106	1.9%	5.2%
2579	227	106	1.9%	5.3%
2580	227	106	1.9%	5.3%
2581	227	106	1.9%	5.4%
2582	227	106	1.8%	5.5%
2583	227	106	1.8%	5.6%
2584	227	106	1.8%	5.7%
2585	227	106	1.8%	5.7%
2586	227	106	1.7%	5.8%
2587	227	106	1.7%	5.9%

2588	229	107	1.7%	5.8%
2589	229	107	1.7%	5.9%
2590	229	107	1.6%	6.0%
2591	230	108	1.9%	5.2%
2592	230	108	1.9%	5.3%
2593	230	108	1.9%	5.4%
2594	230	108	1.8%	5.4%
2595	230	108	1.8%	5.5%
2596	230	108	1.8%	5.6%
2597	230	108	1.8%	5.7%
2598	230	108	1.7%	5.8%
2599	230	108	1.7%	5.8%
2600	230	108	1.7%	5.9%
2601	231	109	2.0%	5.1%
2602	231	109	1.9%	5.2%
2603	231	109	1.9%	5.3%
2604	231	109	1.9%	5.4%
2605	231	109	1.9%	5.5%
2606	231	109	1.8%	5.5%
2607	231	109	1.8%	5.6%
2608	231	109	1.8%	5.7%
2609	231	109	1.8%	5.8%
2610	231	109	1.7%	5.9%
2611	231	109	1.7%	6.0%
2612	232	110	2.0%	5.2%
2613	232	110	2.0%	5.3%
2614	232	110	1.9%	5.3%
2615	232	110	1.9%	5.4%
2616	232	110	1.9%	5.5%
2617	232	110	1.9%	5.6%
2618	232	110	1.8%	5.6%
2619	232	110	1.8%	5.7%
2620	232	110	1.8%	5.8%
2621	232	110	1.8%	5.9%
2622	232	110	1.7%	6.0%
2623	234	111	1.7%	5.9%
2624	234	111	1.7%	6.0%
2625	235	112	1.9%	5.2%
2626	235	112	1.9%	5.3%
2627	235	112	1.9%	5.4%
2628	235	112	1.9%	5.4%
2629	235	112	1.8%	5.5%
2630	235	112	1.8%	5.6%
2631	235	112	1.8%	5.7%
2632	235	112	1.8%	5.8%
2633	235	112	1.7%	5.8%
2634	235	112	1.7%	5.9%
2635	236	113	2.0%	5.2%
2636	236	113	2.0%	5.2%
2637	236	113	1.9%	5.3%

2638	236	113	1.9%	5.4%
2639	236	113	1.9%	5.5%
2640	236	113	1.9%	5.6%
2641	236	113	1.8%	5.6%
2642	236	113	1.8%	5.7%
2643	236	113	1.8%	5.8%
2644	236	113	1.8%	5.9%
2645	236	113	1.7%	6.0%
2646	238	114	1.7%	5.9%
2647	238	114	1.7%	6.0%
2648	239	115	1.9%	5.2%
2649	239	115	1.9%	5.3%
2650	239	115	1.9%	5.4%
2651	239	115	1.9%	5.5%
2652	239	115	1.8%	5.5%
2653	239	115	1.8%	5.6%
2654	239	115	1.8%	5.7%
2655	239	115	1.8%	5.8%
2656	239	115	1.7%	5.9%
2657	239	115	1.7%	5.9%
2658	240	116	2.0%	5.2%
2659	240	116	2.0%	5.3%
2660	240	116	1.9%	5.3%
2661	240	116	1.9%	5.4%
2662	240	116	1.9%	5.5%
2663	240	116	1.9%	5.6%
2664	240	116	1.8%	5.7%
2665	240	116	1.8%	5.7%
2666	240	116	1.8%	5.8%
2667	240	116	1.8%	5.9%
2668	240	116	1.7%	6.0%
2669	242	117	1.7%	5.9%
2670	243	118	2.0%	5.2%
2671	243	118	1.9%	5.3%
2672	243	118	1.9%	5.3%
2673	243	118	1.9%	5.4%
2674	243	118	1.9%	5.5%
2675	243	118	1.8%	5.6%
2676	243	118	1.8%	5.7%
2677	243	118	1.8%	5.7%
2678	243	118	1.8%	5.8%
2679	243	118	1.7%	5.9%
2680	243	118	1.7%	6.0%
2681	244	119	2.0%	5.2%
2682	244	119	1.9%	5.3%
2683	244	119	1.9%	5.4%
2684	244	119	1.9%	5.5%
2685	244	119	1.9%	5.5%
2686	244	119	1.8%	5.6%
2687	244	119	1.8%	5.7%

2688	244	119	1.8%	5.8%
2689	244	119	1.8%	5.9%
2690	244	119	1.7%	5.9%
2691	246	120	1.7%	5.9%
2692	246	120	1.7%	6.0%
2693	247	121	1.9%	5.3%
2694	247	121	1.9%	5.3%
2695	247	121	1.9%	5.4%
2696	247	121	1.9%	5.5%
2697	247	121	1.8%	5.6%
2698	247	121	1.8%	5.6%
2699	247	121	1.8%	5.7%
2700	247	121	1.8%	5.8%
2701	247	121	1.7%	5.9%
2702	247	121	1.7%	6.0%
2703	248	122	2.0%	5.2%
2704	248	122	1.9%	5.3%
2705	248	122	1.9%	5.4%
2706	248	122	1.9%	5.5%
2707	248	122	1.9%	5.5%
2708	248	122	1.8%	5.6%
2709	248	122	1.8%	5.7%
2710	248	122	1.8%	5.8%
2711	248	122	1.8%	5.8%
2712	248	122	1.7%	5.9%
2713	250	123	1.7%	5.9%
2714	250	123	1.7%	6.0%
2715	251	124	1.9%	5.3%
2716	251	124	1.9%	5.3%
2717	251	124	1.9%	5.4%
2718	251	124	1.8%	5.5%
2719	251	124	1.8%	5.6%
2720	251	124	1.8%	5.6%
2721	251	124	1.8%	5.7%
2722	251	124	1.7%	5.8%
2723	251	124	1.7%	5.9%
2724	251	124	1.7%	6.0%
2725	252	125	2.0%	5.2%
2726	252	125	1.9%	5.3%
2727	252	125	1.9%	5.4%
2728	252	125	1.9%	5.5%
2729	252	125	1.9%	5.5%
2730	252	125	1.8%	5.6%
2731	252	125	1.8%	5.7%
2732	252	125	1.8%	5.8%
2733	252	125	1.8%	5.9%
2734	252	125	1.7%	5.9%
2735	253	126	2.0%	5.2%
2736	253	126	2.0%	5.3%
2737	253	126	1.9%	5.4%

2738	253	126	1.9%	5.4%
2739	253	126	1.9%	5.5%
2740	253	126	1.9%	5.6%
2741	253	126	1.8%	5.7%
2742	253	126	1.8%	5.8%
2743	253	126	1.8%	5.8%
2744	253	126	1.8%	5.9%
2745	253	126	1.7%	6.0%
2746	255	127	1.7%	6.0%
2747	256	128	1.9%	5.3%
2748	256	128	1.9%	5.4%
2749	256	128	1.9%	5.4%
2750	256	128	1.9%	5.5%
2751	256	128	1.8%	5.6%
2752	256	128	1.8%	5.7%
2753	256	128	1.8%	5.7%
2754	256	128	1.8%	5.8%
2755	256	128	1.7%	5.9%
2756	256	128	1.7%	6.0%
2757	257	129	2.0%	5.3%
2758	257	129	1.9%	5.3%
2759	257	129	1.9%	5.4%
2760	257	129	1.9%	5.5%
2761	257	129	1.9%	5.6%
2762	257	129	1.8%	5.6%
2763	257	129	1.8%	5.7%
2764	257	129	1.8%	5.8%
2765	257	129	1.8%	5.9%
2766	257	129	1.7%	5.9%
2767	259	130	1.7%	6.0%
2768	260	131	1.9%	5.3%
2769	260	131	1.9%	5.3%
2770	260	131	1.9%	5.4%
2771	260	131	1.9%	5.5%
2772	260	131	1.8%	5.6%
2773	260	131	1.8%	5.6%
2774	260	131	1.8%	5.7%
2775	260	131	1.8%	5.8%
2776	260	131	1.7%	5.9%
2777	260	131	1.7%	5.9%
2778	261	132	2.0%	5.3%
2779	261	132	1.9%	5.3%
2780	261	132	1.9%	5.4%
2781	261	132	1.9%	5.5%
2782	261	132	1.9%	5.6%
2783	261	132	1.8%	5.6%
2784	261	132	1.8%	5.7%
2785	261	132	1.8%	5.8%
2786	261	132	1.8%	5.9%
2787	261	132	1.7%	5.9%

2788	262	133	2.0%	5.3%
2789	262	133	2.0%	5.3%
2790	262	133	1.9%	5.4%
2791	262	133	1.9%	5.5%
2792	262	133	1.9%	5.5%
2793	262	133	1.9%	5.6%
2794	262	133	1.8%	5.7%
2795	262	133	1.8%	5.8%
2796	262	133	1.8%	5.8%
2797	262	133	1.8%	5.9%
2798	264	134	1.7%	6.0%
2799	265	135	1.9%	5.3%
2800	265	135	1.9%	5.3%
2801	265	135	1.9%	5.4%
2802	265	135	1.9%	5.5%
2803	265	135	1.8%	5.6%
2804	265	135	1.8%	5.6%
2805	265	135	1.8%	5.7%
2806	265	135	1.8%	5.8%
2807	265	135	1.7%	5.9%
2808	265	135	1.7%	5.9%
2809	266	136	2.0%	5.3%
2810	266	136	1.9%	5.3%
2811	266	136	1.9%	5.4%
2812	266	136	1.9%	5.5%
2813	266	136	1.9%	5.6%
2814	266	136	1.8%	5.6%
2815	266	136	1.8%	5.7%
2816	266	136	1.8%	5.8%
2817	266	136	1.8%	5.9%
2818	266	136	1.8%	5.9%
2819	267	137	2.0%	5.3%
2820	267	137	2.0%	5.3%
2821	267	137	1.9%	5.4%
2822	267	137	1.9%	5.5%
2823	267	137	1.9%	5.6%
2824	267	137	1.9%	5.6%
2825	267	137	1.9%	5.7%
2826	267	137	1.8%	5.8%
2827	267	137	1.8%	5.9%
2828	267	137	1.8%	5.9%
2829	269	138	1.7%	6.0%
2830	270	139	1.9%	5.3%
2831	270	139	1.9%	5.4%
2832	270	139	1.9%	5.5%
2833	270	139	1.9%	5.5%
2834	270	139	1.8%	5.6%
2835	270	139	1.8%	5.7%
2836	270	139	1.8%	5.7%
2837	270	139	1.8%	5.8%

2838	270	139	1.8%	5.9%
2839	270	139	1.7%	6.0%
2840	271	140	2.0%	5.3%
2841	271	140	1.9%	5.4%
2842	271	140	1.9%	5.5%
2843	271	140	1.9%	5.5%
2844	271	140	1.9%	5.6%
2845	271	140	1.8%	5.7%
2846	271	140	1.8%	5.7%
2847	271	140	1.8%	5.8%
2848	271	140	1.8%	5.9%
2849	271	140	1.8%	6.0%
2850	272	141	2.0%	5.3%
2851	272	141	2.0%	5.4%
2852	272	141	1.9%	5.5%
2853	272	141	1.9%	5.5%
2854	272	141	1.9%	5.6%
2855	272	141	1.9%	5.7%
2856	272	141	1.8%	5.7%
2857	272	141	1.8%	5.8%
2858	272	141	1.8%	5.9%
2859	272	141	1.8%	6.0%
2860	275	143	2.0%	5.3%
2861	275	143	1.9%	5.4%
2862	275	143	1.9%	5.4%
2863	275	143	1.9%	5.5%
2864	275	143	1.9%	5.6%
2865	275	143	1.8%	5.7%
2866	275	143	1.8%	5.7%
2867	275	143	1.8%	5.8%
2868	275	143	1.8%	5.9%
2869	275	143	1.7%	6.0%
2870	276	144	2.0%	5.3%
2871	276	144	1.9%	5.4%
2872	276	144	1.9%	5.4%
2873	276	144	1.9%	5.5%
2874	276	144	1.9%	5.6%
2875	276	144	1.9%	5.7%
2876	276	144	1.8%	5.7%
2877	276	144	1.8%	5.8%
2878	276	144	1.8%	5.9%
2879	276	144	1.8%	6.0%
2880	277	145	2.0%	5.3%
2881	277	145	2.0%	5.4%
2882	277	145	1.9%	5.5%
2883	277	145	1.9%	5.5%
2884	277	145	1.9%	5.6%
2885	277	145	1.9%	5.7%
2886	277	145	1.9%	5.7%
2887	277	145	1.8%	5.8%

2888	277	145	1.8%	5.9%
2889	277	145	1.8%	6.0%
2890	280	147	1.9%	5.3%
2891	280	147	1.9%	5.4%
2892	280	147	1.9%	5.5%
2893	280	147	1.9%	5.5%
2894	280	147	1.9%	5.6%
2895	280	147	1.8%	5.7%
2896	280	147	1.8%	5.7%
2897	280	147	1.8%	5.8%
2898	280	147	1.8%	5.9%
2899	280	147	1.7%	6.0%
2900	281	148	2.0%	5.3%
2901	281	148	1.9%	5.4%
2902	281	148	1.9%	5.5%
2903	281	148	1.9%	5.5%
2904	281	148	1.9%	5.6%
2905	281	148	1.9%	5.7%
2906	281	148	1.8%	5.8%
2907	281	148	1.8%	5.8%
2908	281	148	1.8%	5.9%
2909	281	148	1.8%	6.0%
2910	282	149	2.0%	5.3%
2911	282	149	2.0%	5.4%
2912	282	149	1.9%	5.5%
2913	282	149	1.9%	5.6%
2914	282	149	1.9%	5.6%
2915	282	149	1.9%	5.7%
2916	282	149	1.8%	5.8%
2917	282	149	1.8%	5.8%
2918	282	149	1.8%	5.9%
2919	282	149	1.8%	6.0%
2920	285	151	1.9%	5.4%
2921	285	151	1.9%	5.4%
2922	285	151	1.9%	5.5%
2923	285	151	1.9%	5.6%
2924	285	151	1.8%	5.7%
2925	285	151	1.8%	5.7%
2926	285	151	1.8%	5.8%
2927	285	151	1.8%	5.9%
2928	285	151	1.8%	5.9%
2929	286	152	2.0%	5.3%
2930	286	152	2.0%	5.4%
2931	286	152	1.9%	5.5%
2932	286	152	1.9%	5.5%
2933	286	152	1.9%	5.6%
2934	286	152	1.9%	5.7%
2935	286	152	1.8%	5.7%
2936	286	152	1.8%	5.8%
2937	286	152	1.8%	5.9%

2938	286	152	1.8%	6.0%
2939	287	153	2.0%	5.3%
2940	287	153	2.0%	5.4%
2941	287	153	1.9%	5.5%
2942	287	153	1.9%	5.5%
2943	287	153	1.9%	5.6%
2944	287	153	1.9%	5.7%
2945	287	153	1.9%	5.8%
2946	287	153	1.8%	5.8%
2947	287	153	1.8%	5.9%
2948	287	153	1.8%	6.0%
2949	290	155	1.9%	5.4%
2950	290	155	1.9%	5.4%
2951	290	155	1.9%	5.5%
2952	290	155	1.9%	5.6%
2953	290	155	1.8%	5.7%
2954	290	155	1.8%	5.7%
2955	290	155	1.8%	5.8%
2956	290	155	1.8%	5.9%
2957	290	155	1.8%	5.9%
2958	291	156	2.0%	5.3%
2959	291	156	1.9%	5.4%
2960	291	156	1.9%	5.5%
2961	291	156	1.9%	5.5%
2962	291	156	1.9%	5.6%
2963	291	156	1.9%	5.7%
2964	291	156	1.8%	5.7%
2965	291	156	1.8%	5.8%
2966	291	156	1.8%	5.9%
2967	291	156	1.8%	6.0%
2968	292	157	2.0%	5.3%
2969	292	157	2.0%	5.4%
2970	292	157	1.9%	5.5%
2971	292	157	1.9%	5.6%
2972	292	157	1.9%	5.6%
2973	292	157	1.9%	5.7%
2974	292	157	1.8%	5.8%
2975	292	157	1.8%	5.8%
2976	292	157	1.8%	5.9%
2977	292	157	1.8%	6.0%
2978	295	159	1.9%	5.4%
2979	295	159	1.9%	5.5%
2980	295	159	1.9%	5.5%
2981	295	159	1.9%	5.6%
2982	295	159	1.8%	5.7%
2983	295	159	1.8%	5.8%
2984	295	159	1.8%	5.8%
2985	295	159	1.8%	5.9%
2986	295	159	1.7%	6.0%
2987	296	160	2.0%	5.4%

2988	296	160	1.9%	5.4%
2989	296	160	1.9%	5.5%
2990	296	160	1.9%	5.6%
2991	296	160	1.9%	5.6%
2992	296	160	1.8%	5.7%
2993	296	160	1.8%	5.8%
2994	296	160	1.8%	5.8%
2995	296	160	1.8%	5.9%
2996	296	160	1.8%	6.0%
2997	297	161	2.0%	5.4%
2998	297	161	1.9%	5.5%
2999	297	161	1.9%	5.5%
3000	297	161	1.9%	5.6%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 1500 and 1200 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	1531
Sample size	33
Maximum number of denials allowed	2

ASSUMPTIONS	
Valid list size	1489
Invalid list size	1189
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	6%

RESULT		
Probability of false rejection	5.92%	<6% (OK)
Probability of false acceptance	1.22%	<2% (OK)

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 2000, 6% and 2% the approximate value returned are 119 and 36. When these

INPUTS	
Members Lodged	2000
Desired probability of false rejection	6%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	1500
Unacceptable list	1200

RESULT	
Approximate sample size required	119
Approximate maximum number of denials	36

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.15
B	-1.67936
n0	125.3451
n1	117.9047
mu0	29.75
mu1	47.6
sig0	4.582074
sig1	5.184025
c0	36.37409
c1	36.45331

Sheet Name	Description
Table (10% & 2%)	List of required sample sizes cut-off values for member list sizes from 500 to 1000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 400 valid members; - no more than a 10% chance of incorrectly rejecting a list with 500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 400 valid members - Probability of incorrectly rejecting a list with 500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 500 up to 1000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 10%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 550 members, a sample size of 45 and max denials of 6 will give a Probability of rejecting a valid list of 10.11%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 400 - risk	Rejecting 500 - risk
500	18	0	1.7%	0.0%
501	18	0	1.6%	3.6%
502	18	0	1.5%	7.0%
503	26	1	1.8%	0.7%
504	26	1	1.7%	1.4%
505	26	1	1.6%	2.3%
506	26	1	1.6%	3.4%
507	26	1	1.5%	4.5%
508	26	1	1.4%	5.8%
509	26	1	1.4%	7.2%
510	26	1	1.3%	8.7%
511	32	2	1.6%	2.6%
512	32	2	1.6%	3.3%
513	32	2	1.5%	4.1%
514	32	2	1.4%	5.0%
515	32	2	1.3%	6.0%
516	32	2	1.3%	7.0%
517	32	2	1.2%	8.1%
518	32	2	1.2%	9.3%
519	37	3	1.5%	3.9%
520	37	3	1.4%	4.6%
521	37	3	1.4%	5.4%
522	37	3	1.3%	6.2%
523	37	3	1.2%	7.1%
524	37	3	1.2%	8.0%
525	37	3	1.1%	9.0%
526	41	4	1.6%	4.3%
527	41	4	1.5%	5.0%
528	41	4	1.4%	5.7%
529	41	4	1.3%	6.4%
530	41	4	1.3%	7.2%
531	41	4	1.2%	8.1%
532	41	4	1.1%	9.0%
533	41	4	1.1%	9.9%
534	44	5	1.7%	5.1%
535	44	5	1.6%	5.7%
536	44	5	1.5%	6.4%
537	44	5	1.5%	7.1%

538	44	5	1.4%	7.9%
539	44	5	1.3%	8.7%
540	44	5	1.3%	9.5%
541	47	6	1.8%	5.4%
542	47	6	1.7%	6.0%
543	47	6	1.6%	6.6%
544	47	6	1.6%	7.3%
545	47	6	1.5%	8.0%
546	47	6	1.4%	8.8%
547	47	6	1.3%	9.6%
548	50	7	1.8%	5.9%
549	50	7	1.7%	6.4%
550	50	7	1.6%	7.1%
551	50	7	1.6%	7.7%
552	50	7	1.5%	8.4%
553	50	7	1.4%	9.2%
554	50	7	1.3%	9.9%
555	53	8	1.7%	6.5%
556	53	8	1.7%	7.1%
557	53	8	1.6%	7.7%
558	53	8	1.5%	8.4%
559	53	8	1.4%	9.1%
560	53	8	1.4%	9.8%
561	56	9	1.7%	6.7%
562	56	9	1.6%	7.3%
563	56	9	1.5%	8.0%
564	56	9	1.5%	8.6%
565	56	9	1.4%	9.3%
566	59	10	1.7%	6.6%
567	59	10	1.6%	7.2%
568	59	10	1.5%	7.8%
569	59	10	1.4%	8.4%
570	59	10	1.4%	9.1%
571	59	10	1.3%	9.8%
572	61	11	1.9%	6.5%
573	61	11	1.8%	7.0%
574	61	11	1.7%	7.6%
575	61	11	1.6%	8.2%
576	61	11	1.5%	8.8%
577	61	11	1.4%	9.4%
578	64	12	1.7%	7.2%
579	64	12	1.6%	7.7%
580	64	12	1.5%	8.3%
581	64	12	1.4%	8.9%
582	64	12	1.3%	9.6%
583	66	13	1.8%	6.7%
584	66	13	1.7%	7.2%
585	66	13	1.7%	7.8%
586	66	13	1.6%	8.3%
587	66	13	1.5%	8.9%

588	66	13	1.4%	9.6%
589	68	14	1.9%	6.8%
590	68	14	1.8%	7.4%
591	68	14	1.7%	7.9%
592	68	14	1.6%	8.5%
593	68	14	1.6%	9.0%
594	68	14	1.5%	9.6%
595	70	15	1.9%	7.1%
596	70	15	1.9%	7.6%
597	70	15	1.8%	8.1%
598	70	15	1.7%	8.6%
599	70	15	1.6%	9.2%
600	70	15	1.5%	9.8%
601	72	16	2.0%	7.3%
602	72	16	1.9%	7.8%
603	72	16	1.8%	8.4%
604	72	16	1.7%	8.9%
605	72	16	1.6%	9.5%
606	75	17	1.7%	8.1%
607	75	17	1.6%	8.6%
608	75	17	1.5%	9.2%
609	75	17	1.4%	9.7%
610	77	18	1.8%	7.5%
611	77	18	1.7%	8.0%
612	77	18	1.6%	8.5%
613	77	18	1.6%	9.1%
614	77	18	1.5%	9.6%
615	79	19	1.8%	7.5%
616	79	19	1.7%	8.0%
617	79	19	1.7%	8.5%
618	79	19	1.6%	9.1%
619	79	19	1.5%	9.6%
620	81	20	1.8%	7.6%
621	81	20	1.7%	8.1%
622	81	20	1.7%	8.6%
623	81	20	1.6%	9.1%
624	81	20	1.5%	9.7%
625	83	21	1.8%	7.7%
626	83	21	1.7%	8.2%
627	83	21	1.6%	8.7%
628	83	21	1.6%	9.2%
629	83	21	1.5%	9.8%
630	85	22	1.8%	7.9%
631	85	22	1.7%	8.4%
632	85	22	1.6%	8.9%
633	85	22	1.5%	9.4%
634	85	22	1.5%	10.0%
635	87	23	1.7%	8.1%
636	87	23	1.7%	8.6%
637	87	23	1.6%	9.1%

638	87	23	1.5%	9.7%
639	89	24	1.8%	8.0%
640	89	24	1.7%	8.4%
641	89	24	1.6%	8.9%
642	89	24	1.5%	9.5%
643	89	24	1.4%	10.0%
644	91	25	1.7%	8.3%
645	91	25	1.6%	8.8%
646	91	25	1.5%	9.3%
647	91	25	1.5%	9.8%
648	93	26	1.7%	8.2%
649	93	26	1.6%	8.7%
650	93	26	1.5%	9.2%
651	93	26	1.5%	9.7%
652	95	27	1.7%	8.2%
653	95	27	1.6%	8.7%
654	95	27	1.5%	9.2%
655	95	27	1.4%	9.7%
656	97	28	1.6%	8.2%
657	97	28	1.6%	8.7%
658	97	28	1.5%	9.2%
659	97	28	1.4%	9.7%
660	98	29	2.0%	7.3%
661	98	29	1.9%	7.8%
662	98	29	1.8%	8.2%
663	98	29	1.7%	8.7%
664	98	29	1.6%	9.1%
665	98	29	1.5%	9.6%
666	100	30	1.7%	8.3%
667	100	30	1.6%	8.7%
668	100	30	1.6%	9.2%
669	100	30	1.5%	9.7%
670	102	31	1.7%	8.4%
671	102	31	1.6%	8.9%
672	102	31	1.5%	9.4%
673	102	31	1.4%	9.8%
674	103	32	2.0%	7.6%
675	103	32	1.9%	8.0%
676	103	32	1.8%	8.5%
677	103	32	1.7%	8.9%
678	103	32	1.6%	9.4%
679	103	32	1.5%	9.8%
680	105	33	1.7%	8.6%
681	105	33	1.6%	9.1%
682	105	33	1.5%	9.6%
683	107	34	1.7%	8.4%
684	107	34	1.6%	8.9%
685	107	34	1.5%	9.3%
686	107	34	1.5%	9.8%
687	108	35	2.0%	7.7%

688	108	35	1.9%	8.1%
689	108	35	1.8%	8.5%
690	108	35	1.7%	9.0%
691	108	35	1.6%	9.4%
692	108	35	1.6%	9.9%
693	110	36	1.7%	8.8%
694	110	36	1.6%	9.3%
695	110	36	1.5%	9.7%
696	112	37	1.7%	8.7%
697	112	37	1.6%	9.2%
698	112	37	1.5%	9.6%
699	113	38	2.0%	7.6%
700	113	38	1.9%	8.0%
701	113	38	1.8%	8.4%
702	113	38	1.7%	8.9%
703	113	38	1.7%	9.3%
704	113	38	1.6%	9.7%
705	115	39	1.7%	8.8%
706	115	39	1.6%	9.2%
707	115	39	1.5%	9.7%
708	117	40	1.6%	8.8%
709	117	40	1.6%	9.2%
710	117	40	1.5%	9.7%
711	118	41	1.9%	7.8%
712	118	41	1.8%	8.2%
713	118	41	1.8%	8.6%
714	118	41	1.7%	9.0%
715	118	41	1.6%	9.4%
716	118	41	1.5%	9.9%
717	119	42	2.0%	8.0%
718	119	42	1.9%	8.3%
719	119	42	1.8%	8.7%
720	119	42	1.7%	9.2%
721	119	42	1.7%	9.6%
722	121	43	1.7%	8.8%
723	121	43	1.7%	9.2%
724	121	43	1.6%	9.7%
725	123	44	1.7%	8.9%
726	123	44	1.6%	9.3%
727	123	44	1.5%	9.8%
728	124	45	1.9%	7.9%
729	124	45	1.9%	8.3%
730	124	45	1.8%	8.7%
731	124	45	1.7%	9.1%
732	124	45	1.6%	9.6%
733	124	45	1.6%	10.0%
734	125	46	2.0%	8.2%
735	125	46	1.9%	8.5%
736	125	46	1.8%	8.9%
737	125	46	1.7%	9.4%

738	125	46	1.7%	9.8%
739	127	47	1.7%	9.1%
740	127	47	1.6%	9.5%
741	127	47	1.6%	9.9%
742	128	48	2.0%	8.2%
743	128	48	1.9%	8.6%
744	128	48	1.8%	9.0%
745	128	48	1.8%	9.4%
746	128	48	1.7%	9.8%
747	130	49	1.7%	9.2%
748	130	49	1.6%	9.6%
749	130	49	1.6%	10.0%
750	131	50	2.0%	8.3%
751	131	50	1.9%	8.6%
752	131	50	1.8%	9.0%
753	131	50	1.7%	9.4%
754	131	50	1.7%	9.8%
755	133	51	1.7%	9.3%
756	133	51	1.6%	9.7%
757	135	52	1.7%	9.1%
758	135	52	1.6%	9.5%
759	135	52	1.5%	10.0%
760	136	53	1.9%	8.3%
761	136	53	1.8%	8.7%
762	136	53	1.7%	9.1%
763	136	53	1.7%	9.4%
764	136	53	1.6%	9.9%
765	137	54	2.0%	8.2%
766	137	54	1.9%	8.6%
767	137	54	1.8%	9.0%
768	137	54	1.7%	9.4%
769	137	54	1.7%	9.8%
770	139	55	1.7%	9.3%
771	139	55	1.6%	9.7%
772	140	56	2.0%	8.1%
773	140	56	1.9%	8.5%
774	140	56	1.8%	8.8%
775	140	56	1.8%	9.2%
776	140	56	1.7%	9.6%
777	142	57	1.7%	9.2%
778	142	57	1.6%	9.6%
779	142	57	1.6%	10.0%
780	143	58	1.9%	8.4%
781	143	58	1.8%	8.8%
782	143	58	1.8%	9.1%
783	143	58	1.7%	9.5%
784	143	58	1.6%	9.9%
785	144	59	2.0%	8.4%
786	144	59	1.9%	8.7%
787	144	59	1.8%	9.1%

788	144	59	1.8%	9.5%
789	144	59	1.7%	9.9%
790	146	60	1.7%	9.5%
791	146	60	1.6%	9.9%
792	147	61	2.0%	8.4%
793	147	61	1.9%	8.7%
794	147	61	1.8%	9.1%
795	147	61	1.7%	9.5%
796	147	61	1.7%	9.9%
797	149	62	1.6%	9.5%
798	149	62	1.6%	9.9%
799	150	63	1.9%	8.5%
800	150	63	1.8%	8.8%
801	150	63	1.8%	9.2%
802	150	63	1.7%	9.5%
803	150	63	1.6%	9.9%
804	151	64	2.0%	8.5%
805	151	64	1.9%	8.8%
806	151	64	1.8%	9.2%
807	151	64	1.8%	9.5%
808	151	64	1.7%	9.9%
809	153	65	1.7%	9.6%
810	155	66	1.6%	9.4%
811	155	66	1.6%	9.8%
812	156	67	1.9%	8.4%
813	156	67	1.8%	8.7%
814	156	67	1.7%	9.1%
815	156	67	1.7%	9.4%
816	156	67	1.6%	9.8%
817	157	68	1.9%	8.4%
818	157	68	1.9%	8.7%
819	157	68	1.8%	9.1%
820	157	68	1.7%	9.5%
821	157	68	1.6%	9.8%
822	158	69	2.0%	8.4%
823	158	69	1.9%	8.8%
824	158	69	1.8%	9.1%
825	158	69	1.8%	9.5%
826	158	69	1.7%	9.8%
827	160	70	1.6%	9.7%
828	161	71	2.0%	8.3%
829	161	71	1.9%	8.7%
830	161	71	1.8%	9.0%
831	161	71	1.7%	9.4%
832	161	71	1.7%	9.7%
833	163	72	1.6%	9.6%
834	163	72	1.6%	9.9%
835	164	73	1.9%	8.6%
836	164	73	1.8%	8.9%
837	164	73	1.7%	9.3%

838	164	73	1.7%	9.6%
839	164	73	1.6%	10.0%
840	165	74	1.9%	8.7%
841	165	74	1.8%	9.0%
842	165	74	1.8%	9.3%
843	165	74	1.7%	9.7%
844	167	75	1.6%	9.6%
845	167	75	1.6%	10.0%
846	168	76	1.9%	8.6%
847	168	76	1.8%	9.0%
848	168	76	1.7%	9.3%
849	168	76	1.7%	9.7%
850	169	77	2.0%	8.4%
851	169	77	1.9%	8.7%
852	169	77	1.8%	9.0%
853	169	77	1.8%	9.4%
854	169	77	1.7%	9.7%
855	170	78	2.0%	8.5%
856	170	78	1.9%	8.8%
857	170	78	1.9%	9.1%
858	170	78	1.8%	9.5%
859	170	78	1.7%	9.8%
860	172	79	1.6%	9.8%
861	173	80	1.9%	8.5%
862	173	80	1.9%	8.8%
863	173	80	1.8%	9.2%
864	173	80	1.7%	9.5%
865	173	80	1.7%	9.9%
866	174	81	2.0%	8.6%
867	174	81	1.9%	8.9%
868	174	81	1.8%	9.3%
869	174	81	1.8%	9.6%
870	174	81	1.7%	9.9%
871	175	82	2.0%	8.7%
872	175	82	1.9%	9.0%
873	175	82	1.8%	9.4%
874	175	82	1.8%	9.7%
875	177	83	1.7%	9.7%
876	178	84	2.0%	8.5%
877	178	84	1.9%	8.8%
878	178	84	1.8%	9.1%
879	178	84	1.8%	9.5%
880	178	84	1.7%	9.8%
881	180	85	1.6%	9.8%
882	181	86	1.9%	8.6%
883	181	86	1.8%	9.0%
884	181	86	1.8%	9.3%
885	181	86	1.7%	9.6%
886	181	86	1.6%	10.0%
887	182	87	1.9%	8.8%

888	182	87	1.8%	9.1%
889	182	87	1.8%	9.4%
890	182	87	1.7%	9.7%
891	183	88	2.0%	8.6%
892	183	88	1.9%	8.9%
893	183	88	1.9%	9.2%
894	183	88	1.8%	9.5%
895	183	88	1.7%	9.9%
896	185	89	1.6%	9.9%
897	186	90	1.9%	8.8%
898	186	90	1.8%	9.1%
899	186	90	1.8%	9.4%
900	186	90	1.7%	9.7%
901	187	91	2.0%	8.6%
902	187	91	1.9%	8.9%
903	187	91	1.8%	9.2%
904	187	91	1.8%	9.5%
905	187	91	1.7%	9.9%
906	188	92	2.0%	8.7%
907	188	92	1.9%	9.0%
908	188	92	1.8%	9.3%
909	188	92	1.8%	9.7%
910	188	92	1.7%	10.0%
911	189	93	2.0%	8.8%
912	189	93	1.9%	9.1%
913	189	93	1.9%	9.5%
914	189	93	1.8%	9.8%
915	191	94	1.7%	9.9%
916	192	95	1.9%	8.8%
917	192	95	1.9%	9.1%
918	192	95	1.8%	9.4%
919	192	95	1.7%	9.7%
920	194	96	1.6%	9.9%
921	195	97	1.9%	8.8%
922	195	97	1.8%	9.1%
923	195	97	1.7%	9.4%
924	195	97	1.7%	9.7%
925	196	98	1.9%	8.6%
926	196	98	1.9%	8.9%
927	196	98	1.8%	9.3%
928	196	98	1.7%	9.6%
929	196	98	1.7%	9.9%
930	197	99	1.9%	8.8%
931	197	99	1.9%	9.1%
932	197	99	1.8%	9.4%
933	197	99	1.8%	9.7%
934	199	100	1.6%	9.9%
935	200	101	1.9%	8.8%
936	200	101	1.8%	9.1%
937	200	101	1.7%	9.4%

938	200	101	1.7%	9.8%
939	201	102	1.9%	8.7%
940	201	102	1.9%	9.0%
941	201	102	1.8%	9.3%
942	201	102	1.7%	9.6%
943	201	102	1.7%	9.9%
944	202	103	1.9%	8.9%
945	202	103	1.9%	9.2%
946	202	103	1.8%	9.5%
947	202	103	1.7%	9.8%
948	205	105	1.9%	8.7%
949	205	105	1.9%	8.9%
950	205	105	1.8%	9.2%
951	205	105	1.7%	9.6%
952	205	105	1.7%	9.9%
953	206	106	1.9%	8.8%
954	206	106	1.8%	9.1%
955	206	106	1.8%	9.4%
956	206	106	1.7%	9.7%
957	207	107	2.0%	8.7%
958	207	107	1.9%	9.0%
959	207	107	1.8%	9.3%
960	207	107	1.8%	9.6%
961	207	107	1.7%	9.9%
962	208	108	2.0%	8.9%
963	208	108	1.9%	9.2%
964	208	108	1.8%	9.4%
965	208	108	1.8%	9.8%
966	211	110	1.9%	8.7%
967	211	110	1.9%	9.0%
968	211	110	1.8%	9.3%
969	211	110	1.7%	9.6%
970	211	110	1.7%	9.9%
971	212	111	1.9%	8.9%
972	212	111	1.9%	9.2%
973	212	111	1.8%	9.5%
974	212	111	1.7%	9.8%
975	213	112	2.0%	8.8%
976	213	112	1.9%	9.1%
977	213	112	1.8%	9.4%
978	213	112	1.8%	9.7%
979	213	112	1.7%	10.0%
980	214	113	2.0%	9.0%
981	214	113	1.9%	9.2%
982	214	113	1.8%	9.5%
983	214	113	1.8%	9.8%
984	217	115	1.9%	8.9%
985	217	115	1.8%	9.2%
986	217	115	1.8%	9.5%
987	217	115	1.7%	9.8%

988	218	116	2.0%	8.8%
989	218	116	1.9%	9.1%
990	218	116	1.8%	9.3%
991	218	116	1.8%	9.6%
992	218	116	1.7%	9.9%
993	219	117	1.9%	9.0%
994	219	117	1.9%	9.2%
995	219	117	1.8%	9.5%
996	219	117	1.8%	9.8%
997	220	118	2.0%	8.9%
998	220	118	1.9%	9.1%
999	220	118	1.9%	9.4%
1000	220	118	1.8%	9.7%

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 500 and 400 respectively
There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified
There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	539
Sample size	35
Maximum number of denials allowed	9

ASSUMPTIONS	
Valid list size	500
Invalid list size	400
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	10%

RESULT		
Probability of false rejection	0.01%	<10% (OK)
Probability of false acceptance	58.56%	>2% (Not OK)

Prop	7.9%	K	1000
Est invalid	49	p0	7.2%
SE	7		
Est valid	490		
add 1SE	497		
Pr(valid ≥ 500)	8.1%		

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 1000, 10% and 2% the approximate value returned are 214 and 115.

INPUTS	
Members Lodged	550
Desired probability of false rejection	10%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	500
Unacceptable list	450

RESULT	
Approximate sample size required	126
Approximate maximum number of denials	15

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.090909
B	-1.16054
n0	162.9692
n1	124.351
mu0	11.45455
mu1	22.90909
sig0	2.83589
sig1	3.804745
c0	14.58888
c1	14.5951

INPUTS	Scenario1	Scenario2	Scenario3	Scenario4
Members Lodged	550	550	550	550
Sample size	50	25	100	200
Maximum number of denials allowed	7	3	15	22

Valid members in the list	Probability of Passing the test			
	Scenario1 (n=50,	nario2 (n=25,	ario3 (n=100,	io4 (n=200, c=22)
1	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%
3	0.0%	0.0%	0.0%	0.0%
4	0.0%	0.0%	0.0%	0.0%
5	0.0%	0.0%	0.0%	0.0%
6	0.0%	0.0%	0.0%	0.0%
7	0.0%	0.0%	0.0%	0.0%
8	0.0%	0.0%	0.0%	0.0%
9	0.0%	0.0%	0.0%	0.0%
10	0.0%	0.0%	0.0%	0.0%
11	0.0%	0.0%	0.0%	0.0%
12	0.0%	0.0%	0.0%	0.0%
13	0.0%	0.0%	0.0%	0.0%
14	0.0%	0.0%	0.0%	0.0%
15	0.0%	0.0%	0.0%	0.0%
16	0.0%	0.0%	0.0%	0.0%
17	0.0%	0.0%	0.0%	0.0%
18	0.0%	0.0%	0.0%	0.0%
19	0.0%	0.0%	0.0%	0.0%
20	0.0%	0.0%	0.0%	0.0%
21	0.0%	0.0%	0.0%	0.0%
22	0.0%	0.0%	0.0%	0.0%
23	0.0%	0.0%	0.0%	0.0%
24	0.0%	0.0%	0.0%	0.0%
25	0.0%	0.0%	0.0%	0.0%
26	0.0%	0.0%	0.0%	0.0%
27	0.0%	0.0%	0.0%	0.0%
28	0.0%	0.0%	0.0%	0.0%
29	0.0%	0.0%	0.0%	0.0%
30	0.0%	0.0%	0.0%	0.0%
31	0.0%	0.0%	0.0%	0.0%
32	0.0%	0.0%	0.0%	0.0%
33	0.0%	0.0%	0.0%	0.0%
34	0.0%	0.0%	0.0%	0.0%
35	0.0%	0.0%	0.0%	0.0%
36	0.0%	0.0%	0.0%	0.0%
37	0.0%	0.0%	0.0%	0.0%
38	0.0%	0.0%	0.0%	0.0%
39	0.0%	0.0%	0.0%	0.0%
40	0.0%	0.0%	0.0%	0.0%
41	0.0%	0.0%	0.0%	0.0%
42	0.0%	0.0%	0.0%	0.0%

43	0.0%	0.0%	0.0%	0.0%
44	0.0%	0.0%	0.0%	0.0%
45	0.0%	0.0%	0.0%	0.0%
46	0.0%	0.0%	0.0%	0.0%
47	0.0%	0.0%	0.0%	0.0%
48	0.0%	0.0%	0.0%	0.0%
49	0.0%	0.0%	0.0%	0.0%
50	0.0%	0.0%	0.0%	0.0%
51	0.0%	0.0%	0.0%	0.0%
52	0.0%	0.0%	0.0%	0.0%
53	0.0%	0.0%	0.0%	0.0%
54	0.0%	0.0%	0.0%	0.0%
55	0.0%	0.0%	0.0%	0.0%
56	0.0%	0.0%	0.0%	0.0%
57	0.0%	0.0%	0.0%	0.0%
58	0.0%	0.0%	0.0%	0.0%
59	0.0%	0.0%	0.0%	0.0%
60	0.0%	0.0%	0.0%	0.0%
61	0.0%	0.0%	0.0%	0.0%
62	0.0%	0.0%	0.0%	0.0%
63	0.0%	0.0%	0.0%	0.0%
64	0.0%	0.0%	0.0%	0.0%
65	0.0%	0.0%	0.0%	0.0%
66	0.0%	0.0%	0.0%	0.0%
67	0.0%	0.0%	0.0%	0.0%
68	0.0%	0.0%	0.0%	0.0%
69	0.0%	0.0%	0.0%	0.0%
70	0.0%	0.0%	0.0%	0.0%
71	0.0%	0.0%	0.0%	0.0%
72	0.0%	0.0%	0.0%	0.0%
73	0.0%	0.0%	0.0%	0.0%
74	0.0%	0.0%	0.0%	0.0%
75	0.0%	0.0%	0.0%	0.0%
76	0.0%	0.0%	0.0%	0.0%
77	0.0%	0.0%	0.0%	0.0%
78	0.0%	0.0%	0.0%	0.0%
79	0.0%	0.0%	0.0%	0.0%
80	0.0%	0.0%	0.0%	0.0%
81	0.0%	0.0%	0.0%	0.0%
82	0.0%	0.0%	0.0%	0.0%
83	0.0%	0.0%	0.0%	0.0%
84	0.0%	0.0%	0.0%	0.0%
85	0.0%	0.0%	0.0%	0.0%
86	0.0%	0.0%	0.0%	0.0%
87	0.0%	0.0%	0.0%	0.0%
88	0.0%	0.0%	0.0%	0.0%
89	0.0%	0.0%	0.0%	0.0%
90	0.0%	0.0%	0.0%	0.0%
91	0.0%	0.0%	0.0%	0.0%
92	0.0%	0.0%	0.0%	0.0%

93	0.0%	0.0%	0.0%	0.0%
94	0.0%	0.0%	0.0%	0.0%
95	0.0%	0.0%	0.0%	0.0%
96	0.0%	0.0%	0.0%	0.0%
97	0.0%	0.0%	0.0%	0.0%
98	0.0%	0.0%	0.0%	0.0%
99	0.0%	0.0%	0.0%	0.0%
100	0.0%	0.0%	0.0%	0.0%
101	0.0%	0.0%	0.0%	0.0%
102	0.0%	0.0%	0.0%	0.0%
103	0.0%	0.0%	0.0%	0.0%
104	0.0%	0.0%	0.0%	0.0%
105	0.0%	0.0%	0.0%	0.0%
106	0.0%	0.0%	0.0%	0.0%
107	0.0%	0.0%	0.0%	0.0%
108	0.0%	0.0%	0.0%	0.0%
109	0.0%	0.0%	0.0%	0.0%
110	0.0%	0.0%	0.0%	0.0%
111	0.0%	0.0%	0.0%	0.0%
112	0.0%	0.0%	0.0%	0.0%
113	0.0%	0.0%	0.0%	0.0%
114	0.0%	0.0%	0.0%	0.0%
115	0.0%	0.0%	0.0%	0.0%
116	0.0%	0.0%	0.0%	0.0%
117	0.0%	0.0%	0.0%	0.0%
118	0.0%	0.0%	0.0%	0.0%
119	0.0%	0.0%	0.0%	0.0%
120	0.0%	0.0%	0.0%	0.0%
121	0.0%	0.0%	0.0%	0.0%
122	0.0%	0.0%	0.0%	0.0%
123	0.0%	0.0%	0.0%	0.0%
124	0.0%	0.0%	0.0%	0.0%
125	0.0%	0.0%	0.0%	0.0%
126	0.0%	0.0%	0.0%	0.0%
127	0.0%	0.0%	0.0%	0.0%
128	0.0%	0.0%	0.0%	0.0%
129	0.0%	0.0%	0.0%	0.0%
130	0.0%	0.0%	0.0%	0.0%
131	0.0%	0.0%	0.0%	0.0%
132	0.0%	0.0%	0.0%	0.0%
133	0.0%	0.0%	0.0%	0.0%
134	0.0%	0.0%	0.0%	0.0%
135	0.0%	0.0%	0.0%	0.0%
136	0.0%	0.0%	0.0%	0.0%
137	0.0%	0.0%	0.0%	0.0%
138	0.0%	0.0%	0.0%	0.0%
139	0.0%	0.0%	0.0%	0.0%
140	0.0%	0.0%	0.0%	0.0%
141	0.0%	0.0%	0.0%	0.0%
142	0.0%	0.0%	0.0%	0.0%

143	0.0%	0.0%	0.0%	0.0%
144	0.0%	0.0%	0.0%	0.0%
145	0.0%	0.0%	0.0%	0.0%
146	0.0%	0.0%	0.0%	0.0%
147	0.0%	0.0%	0.0%	0.0%
148	0.0%	0.0%	0.0%	0.0%
149	0.0%	0.0%	0.0%	0.0%
150	0.0%	0.0%	0.0%	0.0%
151	0.0%	0.0%	0.0%	0.0%
152	0.0%	0.0%	0.0%	0.0%
153	0.0%	0.0%	0.0%	0.0%
154	0.0%	0.0%	0.0%	0.0%
155	0.0%	0.0%	0.0%	0.0%
156	0.0%	0.0%	0.0%	0.0%
157	0.0%	0.0%	0.0%	0.0%
158	0.0%	0.0%	0.0%	0.0%
159	0.0%	0.0%	0.0%	0.0%
160	0.0%	0.0%	0.0%	0.0%
161	0.0%	0.0%	0.0%	0.0%
162	0.0%	0.0%	0.0%	0.0%
163	0.0%	0.0%	0.0%	0.0%
164	0.0%	0.0%	0.0%	0.0%
165	0.0%	0.0%	0.0%	0.0%
166	0.0%	0.0%	0.0%	0.0%
167	0.0%	0.0%	0.0%	0.0%
168	0.0%	0.0%	0.0%	0.0%
169	0.0%	0.0%	0.0%	0.0%
170	0.0%	0.0%	0.0%	0.0%
171	0.0%	0.0%	0.0%	0.0%
172	0.0%	0.0%	0.0%	0.0%
173	0.0%	0.0%	0.0%	0.0%
174	0.0%	0.0%	0.0%	0.0%
175	0.0%	0.0%	0.0%	0.0%
176	0.0%	0.0%	0.0%	0.0%
177	0.0%	0.0%	0.0%	0.0%
178	0.0%	0.0%	0.0%	0.0%
179	0.0%	0.0%	0.0%	0.0%
180	0.0%	0.0%	0.0%	0.0%
181	0.0%	0.0%	0.0%	0.0%
182	0.0%	0.0%	0.0%	0.0%
183	0.0%	0.0%	0.0%	0.0%
184	0.0%	0.0%	0.0%	0.0%
185	0.0%	0.0%	0.0%	0.0%
186	0.0%	0.0%	0.0%	0.0%
187	0.0%	0.0%	0.0%	0.0%
188	0.0%	0.0%	0.0%	0.0%
189	0.0%	0.0%	0.0%	0.0%
190	0.0%	0.0%	0.0%	0.0%
191	0.0%	0.0%	0.0%	0.0%
192	0.0%	0.0%	0.0%	0.0%

193	0.0%	0.0%	0.0%	0.0%
194	0.0%	0.0%	0.0%	0.0%
195	0.0%	0.0%	0.0%	0.0%
196	0.0%	0.0%	0.0%	0.0%
197	0.0%	0.0%	0.0%	0.0%
198	0.0%	0.0%	0.0%	0.0%
199	0.0%	0.0%	0.0%	0.0%
200	0.0%	0.0%	0.0%	0.0%
201	0.0%	0.0%	0.0%	0.0%
202	0.0%	0.0%	0.0%	0.0%
203	0.0%	0.0%	0.0%	0.0%
204	0.0%	0.0%	0.0%	0.0%
205	0.0%	0.0%	0.0%	0.0%
206	0.0%	0.0%	0.0%	0.0%
207	0.0%	0.0%	0.0%	0.0%
208	0.0%	0.0%	0.0%	0.0%
209	0.0%	0.0%	0.0%	0.0%
210	0.0%	0.0%	0.0%	0.0%
211	0.0%	0.0%	0.0%	0.0%
212	0.0%	0.0%	0.0%	0.0%
213	0.0%	0.0%	0.0%	0.0%
214	0.0%	0.0%	0.0%	0.0%
215	0.0%	0.0%	0.0%	0.0%
216	0.0%	0.0%	0.0%	0.0%
217	0.0%	0.0%	0.0%	0.0%
218	0.0%	0.0%	0.0%	0.0%
219	0.0%	0.0%	0.0%	0.0%
220	0.0%	0.0%	0.0%	0.0%
221	0.0%	0.0%	0.0%	0.0%
222	0.0%	0.0%	0.0%	0.0%
223	0.0%	0.0%	0.0%	0.0%
224	0.0%	0.0%	0.0%	0.0%
225	0.0%	0.0%	0.0%	0.0%
226	0.0%	0.0%	0.0%	0.0%
227	0.0%	0.0%	0.0%	0.0%
228	0.0%	0.0%	0.0%	0.0%
229	0.0%	0.0%	0.0%	0.0%
230	0.0%	0.0%	0.0%	0.0%
231	0.0%	0.0%	0.0%	0.0%
232	0.0%	0.0%	0.0%	0.0%
233	0.0%	0.0%	0.0%	0.0%
234	0.0%	0.0%	0.0%	0.0%
235	0.0%	0.0%	0.0%	0.0%
236	0.0%	0.0%	0.0%	0.0%
237	0.0%	0.0%	0.0%	0.0%
238	0.0%	0.0%	0.0%	0.0%
239	0.0%	0.0%	0.0%	0.0%
240	0.0%	0.0%	0.0%	0.0%
241	0.0%	0.0%	0.0%	0.0%
242	0.0%	0.0%	0.0%	0.0%

243	0.0%	0.0%	0.0%	0.0%
244	0.0%	0.0%	0.0%	0.0%
245	0.0%	0.0%	0.0%	0.0%
246	0.0%	0.0%	0.0%	0.0%
247	0.0%	0.0%	0.0%	0.0%
248	0.0%	0.0%	0.0%	0.0%
249	0.0%	0.0%	0.0%	0.0%
250	0.0%	0.0%	0.0%	0.0%
251	0.0%	0.0%	0.0%	0.0%
252	0.0%	0.0%	0.0%	0.0%
253	0.0%	0.0%	0.0%	0.0%
254	0.0%	0.0%	0.0%	0.0%
255	0.0%	0.0%	0.0%	0.0%
256	0.0%	0.0%	0.0%	0.0%
257	0.0%	0.0%	0.0%	0.0%
258	0.0%	0.0%	0.0%	0.0%
259	0.0%	0.0%	0.0%	0.0%
260	0.0%	0.0%	0.0%	0.0%
261	0.0%	0.0%	0.0%	0.0%
262	0.0%	0.0%	0.0%	0.0%
263	0.0%	0.0%	0.0%	0.0%
264	0.0%	0.0%	0.0%	0.0%
265	0.0%	0.0%	0.0%	0.0%
266	0.0%	0.0%	0.0%	0.0%
267	0.0%	0.0%	0.0%	0.0%
268	0.0%	0.0%	0.0%	0.0%
269	0.0%	0.0%	0.0%	0.0%
270	0.0%	0.0%	0.0%	0.0%
271	0.0%	0.0%	0.0%	0.0%
272	0.0%	0.0%	0.0%	0.0%
273	0.0%	0.0%	0.0%	0.0%
274	0.0%	0.0%	0.0%	0.0%
275	0.0%	0.0%	0.0%	0.0%
276	0.0%	0.0%	0.0%	0.0%
277	0.0%	0.0%	0.0%	0.0%
278	0.0%	0.0%	0.0%	0.0%
279	0.0%	0.0%	0.0%	0.0%
280	0.0%	0.0%	0.0%	0.0%
281	0.0%	0.0%	0.0%	0.0%
282	0.0%	0.0%	0.0%	0.0%
283	0.0%	0.0%	0.0%	0.0%
284	0.0%	0.0%	0.0%	0.0%
285	0.0%	0.0%	0.0%	0.0%
286	0.0%	0.0%	0.0%	0.0%
287	0.0%	0.0%	0.0%	0.0%
288	0.0%	0.0%	0.0%	0.0%
289	0.0%	0.0%	0.0%	0.0%
290	0.0%	0.0%	0.0%	0.0%
291	0.0%	0.0%	0.0%	0.0%
292	0.0%	0.0%	0.0%	0.0%

293	0.0%	0.0%	0.0%	0.0%
294	0.0%	0.0%	0.0%	0.0%
295	0.0%	0.0%	0.0%	0.0%
296	0.0%	0.0%	0.0%	0.0%
297	0.0%	0.0%	0.0%	0.0%
298	0.0%	0.0%	0.0%	0.0%
299	0.0%	0.0%	0.0%	0.0%
300	0.0%	0.0%	0.0%	0.0%
301	0.0%	0.0%	0.0%	0.0%
302	0.0%	0.0%	0.0%	0.0%
303	0.0%	0.0%	0.0%	0.0%
304	0.0%	0.0%	0.0%	0.0%
305	0.0%	0.0%	0.0%	0.0%
306	0.0%	0.0%	0.0%	0.0%
307	0.0%	0.0%	0.0%	0.0%
308	0.0%	0.1%	0.0%	0.0%
309	0.0%	0.1%	0.0%	0.0%
310	0.0%	0.1%	0.0%	0.0%
311	0.0%	0.1%	0.0%	0.0%
312	0.0%	0.1%	0.0%	0.0%
313	0.0%	0.1%	0.0%	0.0%
314	0.0%	0.1%	0.0%	0.0%
315	0.0%	0.1%	0.0%	0.0%
316	0.0%	0.1%	0.0%	0.0%
317	0.0%	0.1%	0.0%	0.0%
318	0.0%	0.1%	0.0%	0.0%
319	0.0%	0.1%	0.0%	0.0%
320	0.0%	0.1%	0.0%	0.0%
321	0.0%	0.1%	0.0%	0.0%
322	0.0%	0.1%	0.0%	0.0%
323	0.0%	0.1%	0.0%	0.0%
324	0.0%	0.1%	0.0%	0.0%
325	0.0%	0.1%	0.0%	0.0%
326	0.0%	0.2%	0.0%	0.0%
327	0.0%	0.2%	0.0%	0.0%
328	0.0%	0.2%	0.0%	0.0%
329	0.0%	0.2%	0.0%	0.0%
330	0.0%	0.2%	0.0%	0.0%
331	0.0%	0.2%	0.0%	0.0%
332	0.0%	0.2%	0.0%	0.0%
333	0.0%	0.2%	0.0%	0.0%
334	0.0%	0.2%	0.0%	0.0%
335	0.0%	0.3%	0.0%	0.0%
336	0.0%	0.3%	0.0%	0.0%
337	0.0%	0.3%	0.0%	0.0%
338	0.0%	0.3%	0.0%	0.0%
339	0.0%	0.3%	0.0%	0.0%
340	0.0%	0.3%	0.0%	0.0%
341	0.0%	0.4%	0.0%	0.0%
342	0.0%	0.4%	0.0%	0.0%

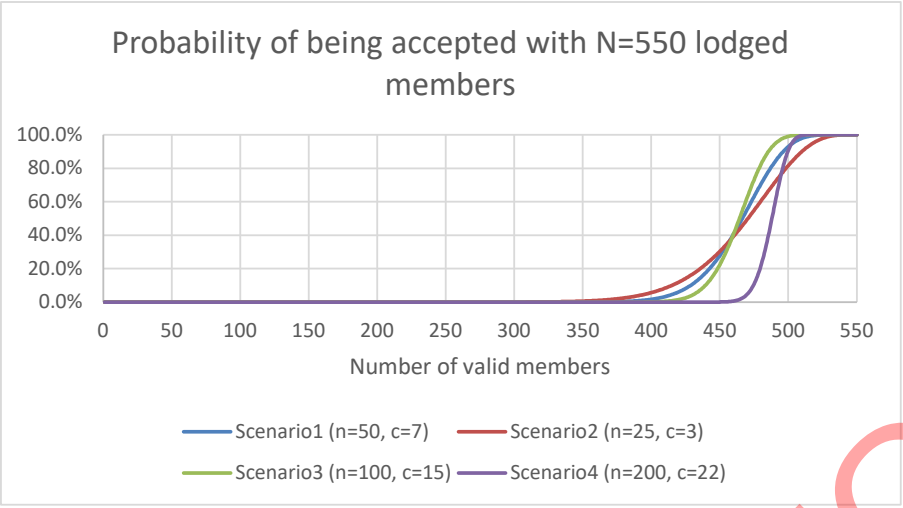
343	0.0%	0.4%	0.0%	0.0%
344	0.0%	0.4%	0.0%	0.0%
345	0.0%	0.4%	0.0%	0.0%
346	0.0%	0.5%	0.0%	0.0%
347	0.0%	0.5%	0.0%	0.0%
348	0.0%	0.5%	0.0%	0.0%
349	0.0%	0.5%	0.0%	0.0%
350	0.0%	0.6%	0.0%	0.0%
351	0.0%	0.6%	0.0%	0.0%
352	0.0%	0.6%	0.0%	0.0%
353	0.0%	0.7%	0.0%	0.0%
354	0.0%	0.7%	0.0%	0.0%
355	0.0%	0.7%	0.0%	0.0%
356	0.0%	0.8%	0.0%	0.0%
357	0.0%	0.8%	0.0%	0.0%
358	0.1%	0.9%	0.0%	0.0%
359	0.1%	0.9%	0.0%	0.0%
360	0.1%	1.0%	0.0%	0.0%
361	0.1%	1.0%	0.0%	0.0%
362	0.1%	1.1%	0.0%	0.0%
363	0.1%	1.1%	0.0%	0.0%
364	0.1%	1.2%	0.0%	0.0%
365	0.1%	1.2%	0.0%	0.0%
366	0.1%	1.3%	0.0%	0.0%
367	0.1%	1.3%	0.0%	0.0%
368	0.1%	1.4%	0.0%	0.0%
369	0.1%	1.5%	0.0%	0.0%
370	0.2%	1.5%	0.0%	0.0%
371	0.2%	1.6%	0.0%	0.0%
372	0.2%	1.7%	0.0%	0.0%
373	0.2%	1.8%	0.0%	0.0%
374	0.2%	1.9%	0.0%	0.0%
375	0.2%	1.9%	0.0%	0.0%
376	0.3%	2.0%	0.0%	0.0%
377	0.3%	2.1%	0.0%	0.0%
378	0.3%	2.2%	0.0%	0.0%
379	0.3%	2.3%	0.0%	0.0%
380	0.4%	2.4%	0.0%	0.0%
381	0.4%	2.5%	0.0%	0.0%
382	0.4%	2.7%	0.0%	0.0%
383	0.5%	2.8%	0.0%	0.0%
384	0.5%	2.9%	0.0%	0.0%
385	0.5%	3.0%	0.0%	0.0%
386	0.6%	3.2%	0.0%	0.0%
387	0.6%	3.3%	0.0%	0.0%
388	0.7%	3.5%	0.0%	0.0%
389	0.7%	3.6%	0.0%	0.0%
390	0.8%	3.8%	0.0%	0.0%
391	0.9%	3.9%	0.0%	0.0%
392	0.9%	4.1%	0.0%	0.0%

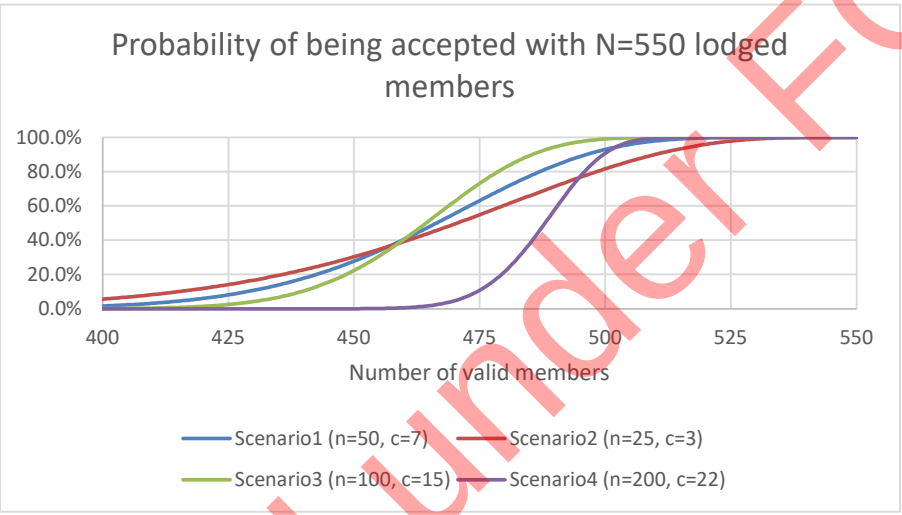
393	1.0%	4.3%	0.0%	0.0%
394	1.1%	4.4%	0.0%	0.0%
395	1.1%	4.6%	0.1%	0.0%
396	1.2%	4.8%	0.1%	0.0%
397	1.3%	5.0%	0.1%	0.0%
398	1.4%	5.2%	0.1%	0.0%
399	1.5%	5.4%	0.1%	0.0%
400	1.6%	5.6%	0.1%	0.0%
401	1.8%	5.9%	0.1%	0.0%
402	1.9%	6.1%	0.2%	0.0%
403	2.0%	6.4%	0.2%	0.0%
404	2.2%	6.6%	0.2%	0.0%
405	2.3%	6.9%	0.2%	0.0%
406	2.5%	7.1%	0.3%	0.0%
407	2.7%	7.4%	0.3%	0.0%
408	2.8%	7.7%	0.3%	0.0%
409	3.0%	8.0%	0.4%	0.0%
410	3.3%	8.3%	0.4%	0.0%
411	3.5%	8.6%	0.5%	0.0%
412	3.7%	8.9%	0.6%	0.0%
413	3.9%	9.3%	0.6%	0.0%
414	4.2%	9.6%	0.7%	0.0%
415	4.5%	10.0%	0.8%	0.0%
416	4.8%	10.3%	0.9%	0.0%
417	5.1%	10.7%	1.0%	0.0%
418	5.4%	11.1%	1.2%	0.0%
419	5.7%	11.5%	1.3%	0.0%
420	6.1%	11.9%	1.5%	0.0%
421	6.4%	12.3%	1.6%	0.0%
422	6.8%	12.8%	1.8%	0.0%
423	7.2%	13.2%	2.0%	0.0%
424	7.7%	13.7%	2.3%	0.0%
425	8.1%	14.1%	2.5%	0.0%
426	8.6%	14.6%	2.8%	0.0%
427	9.1%	15.1%	3.1%	0.0%
428	9.6%	15.6%	3.4%	0.0%
429	10.1%	16.1%	3.8%	0.0%
430	10.7%	16.7%	4.2%	0.0%
431	11.3%	17.2%	4.6%	0.0%
432	11.9%	17.8%	5.1%	0.0%
433	12.6%	18.4%	5.6%	0.0%
434	13.2%	18.9%	6.2%	0.0%
435	13.9%	19.5%	6.8%	0.0%
436	14.6%	20.2%	7.4%	0.0%
437	15.4%	20.8%	8.1%	0.0%
438	16.2%	21.4%	8.8%	0.0%
439	17.0%	22.1%	9.6%	0.0%
440	17.8%	22.8%	10.5%	0.0%
441	18.7%	23.5%	11.4%	0.0%
442	19.6%	24.2%	12.3%	0.0%

443	20.5%	24.9%	13.4%	0.0%
444	21.4%	25.6%	14.5%	0.0%
445	22.4%	26.4%	15.6%	0.0%
446	23.4%	27.1%	16.8%	0.0%
447	24.5%	27.9%	18.1%	0.0%
448	25.5%	28.7%	19.5%	0.0%
449	26.6%	29.5%	20.9%	0.0%
450	27.8%	30.3%	22.4%	0.1%
451	28.9%	31.1%	23.9%	0.1%
452	30.1%	32.0%	25.5%	0.1%
453	31.3%	32.9%	27.2%	0.1%
454	32.6%	33.7%	28.9%	0.1%
455	33.9%	34.6%	30.8%	0.2%
456	35.2%	35.5%	32.6%	0.2%
457	36.5%	36.4%	34.5%	0.3%
458	37.8%	37.4%	36.5%	0.4%
459	39.2%	38.3%	38.5%	0.5%
460	40.6%	39.3%	40.6%	0.6%
461	42.0%	40.2%	42.7%	0.8%
462	43.4%	41.2%	44.9%	1.0%
463	44.9%	42.2%	47.0%	1.2%
464	46.4%	43.2%	49.2%	1.5%
465	47.9%	44.2%	51.5%	1.8%
466	49.3%	45.2%	53.7%	2.2%
467	50.9%	46.3%	55.9%	2.7%
468	52.4%	47.3%	58.1%	3.3%
469	53.9%	48.4%	60.4%	3.9%
470	55.4%	49.4%	62.6%	4.7%
471	57.0%	50.5%	64.8%	5.6%
472	58.5%	51.6%	66.9%	6.7%
473	60.0%	52.7%	69.0%	7.9%
474	61.5%	53.8%	71.1%	9.2%
475	63.1%	54.8%	73.1%	10.8%
476	64.6%	55.9%	75.1%	12.5%
477	66.1%	57.0%	77.0%	14.5%
478	67.6%	58.2%	78.8%	16.7%
479	69.1%	59.3%	80.6%	19.1%
480	70.5%	60.4%	82.2%	21.7%
481	71.9%	61.5%	83.8%	24.6%
482	73.4%	62.6%	85.4%	27.6%
483	74.8%	63.7%	86.8%	30.9%
484	76.1%	64.8%	88.1%	34.4%
485	77.4%	65.9%	89.4%	38.1%
486	78.8%	67.0%	90.6%	41.9%
487	80.0%	68.1%	91.7%	45.9%
488	81.3%	69.2%	92.7%	49.9%
489	82.5%	70.3%	93.6%	54.0%
490	83.6%	71.4%	94.4%	58.1%
491	84.7%	72.5%	95.2%	62.1%
492	85.8%	73.5%	95.8%	66.1%

493	86.9%	74.6%	96.4%	69.9%
494	87.9%	75.6%	97.0%	73.6%
495	88.8%	76.7%	97.5%	77.1%
496	89.7%	77.7%	97.9%	80.4%
497	90.6%	78.7%	98.2%	83.4%
498	91.4%	79.7%	98.5%	86.1%
499	92.2%	80.7%	98.8%	88.6%
500	92.9%	81.6%	99.0%	90.7%
501	93.6%	82.6%	99.2%	92.6%
502	94.3%	83.5%	99.4%	94.2%
503	94.9%	84.4%	99.5%	95.5%
504	95.4%	85.3%	99.6%	96.6%
505	95.9%	86.1%	99.7%	97.5%
506	96.4%	86.9%	99.8%	98.2%
507	96.8%	87.8%	99.8%	98.7%
508	97.2%	88.5%	99.9%	99.1%
509	97.6%	89.3%	99.9%	99.4%
510	97.9%	90.0%	99.9%	99.6%
511	98.2%	90.8%	100.0%	99.8%
512	98.5%	91.4%	100.0%	99.9%
513	98.7%	92.1%	100.0%	99.9%
514	98.9%	92.7%	100.0%	100.0%
515	99.1%	93.3%	100.0%	100.0%
516	99.2%	93.9%	100.0%	100.0%
517	99.4%	94.5%	100.0%	100.0%
518	99.5%	95.0%	100.0%	100.0%
519	99.6%	95.5%	100.0%	100.0%
520	99.7%	95.9%	100.0%	100.0%
521	99.7%	96.4%	100.0%	100.0%
522	99.8%	96.8%	100.0%	100.0%
523	99.8%	97.1%	100.0%	100.0%
524	99.9%	97.5%	100.0%	100.0%
525	99.9%	97.8%	100.0%	100.0%
526	99.9%	98.1%	100.0%	100.0%
527	100.0%	98.4%	100.0%	100.0%
528	100.0%	98.6%	100.0%	100.0%
529	100.0%	98.8%	100.0%	100.0%
530	100.0%	99.0%	100.0%	100.0%
531	100.0%	99.2%	100.0%	100.0%
532	100.0%	99.3%	100.0%	100.0%
533	100.0%	99.5%	100.0%	100.0%
534	100.0%	99.6%	100.0%	100.0%
535	100.0%	99.7%	100.0%	100.0%
536	100.0%	99.8%	100.0%	100.0%
537	100.0%	99.8%	100.0%	100.0%
538	100.0%	99.9%	100.0%	100.0%
539	100.0%	99.9%	100.0%	100.0%
540	100.0%	99.9%	100.0%	100.0%
541	100.0%	100.0%	100.0%	100.0%
542	100.0%	100.0%	100.0%	100.0%

543	100.0%	100.0%	100.0%	100.0%
544	100.0%	100.0%	100.0%	100.0%
545	100.0%	100.0%	100.0%	100.0%
546	100.0%	100.0%	100.0%	100.0%
547	100.0%	100.0%	100.0%	100.0%
548	100.0%	100.0%	100.0%	100.0%
549	100.0%	100.0%	100.0%	100.0%
550	100.0%	100.0%	100.0%	100.0%

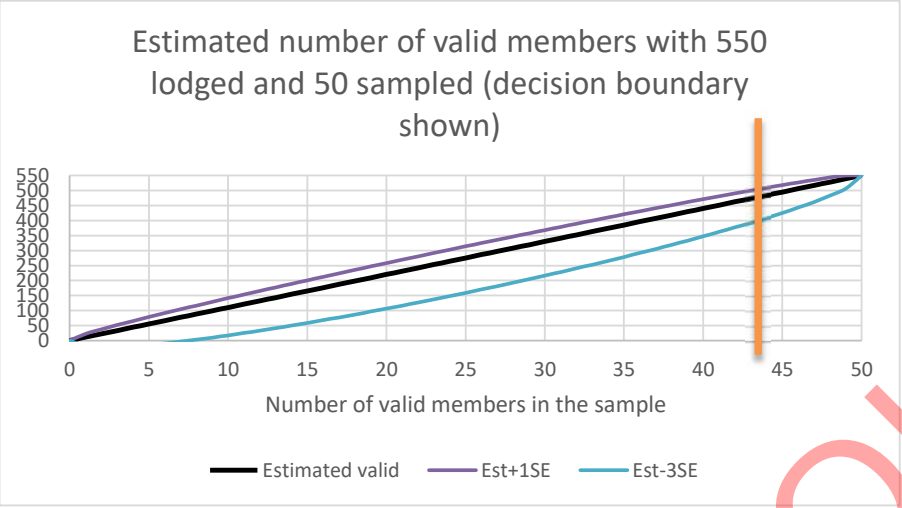


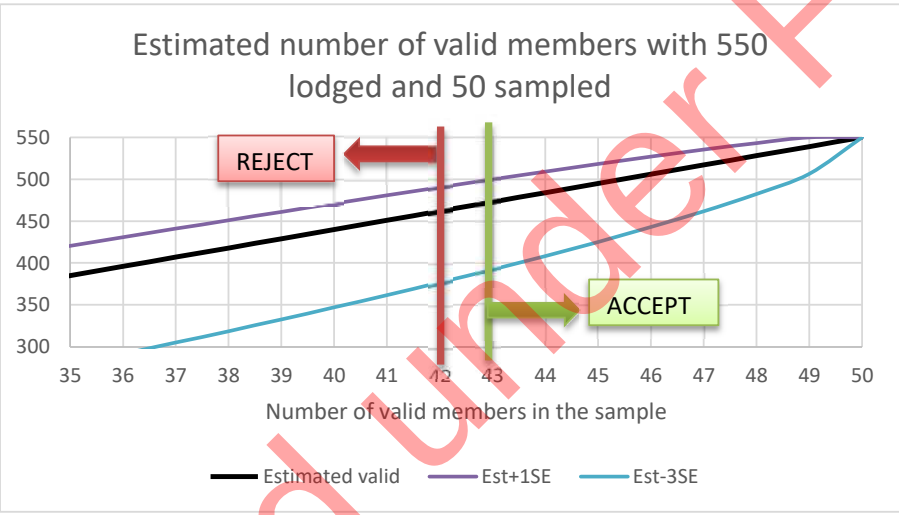


INPUTS	Scenario1
Members Lodged	550
Sample size	50
Maximum number of denials allowed	7

Valid members in the sample	Proportion	Estimated	SE	Est+1SE	Est-3SE
0	0	0	0	0	0
1	0.02	11	11	22	-22
2	0.04	22	15	37	-24
3	0.06	33	18	51	-22
4	0.08	44	21	65	-19
5	0.1	55	23	78	-15
6	0.12	66	25	91	-10
7	0.14	77	27	104	-4
8	0.16	88	28	116	3
9	0.18	99	30	129	10
10	0.2	110	31	141	17
11	0.22	121	32	153	25
12	0.24	132	33	165	33
13	0.26	143	34	177	41
14	0.28	154	35	189	50
15	0.3	165	35	200	59
16	0.32	176	36	212	68
17	0.34	187	37	224	77
18	0.36	198	37	235	86
19	0.38	209	38	247	96
20	0.4	220	38	258	106
21	0.42	231	38	269	116
22	0.44	242	38	280	127
23	0.46	253	39	292	137
24	0.48	264	39	303	148
25	0.5	275	39	314	159
26	0.52	286	39	325	170
27	0.54	297	39	336	181
28	0.56	308	38	346	193
29	0.58	319	38	357	204
30	0.6	330	38	368	216
31	0.62	341	38	379	228
32	0.64	352	37	389	240
33	0.66	363	37	400	253
34	0.68	374	36	410	266
35	0.7	385	35	420	279
36	0.72	396	35	431	292
37	0.74	407	34	441	305
38	0.76	418	33	451	319
39	0.78	429	32	461	333
40	0.8	440	31	471	347
41	0.82	451	30	481	362
42	0.84	462	28	490	377

43	0.86	473	27	500	392
44	0.88	484	25	509	408
45	0.9	495	23	518	425
46	0.92	506	21	527	443
47	0.94	517	18	535	462
48	0.96	528	15	543	482
49	0.98	539	11	550	506
50	1	550	0	550	550





Sheet Name	Description
Table (10% & 2%)	List of required sample sizes cut-off values for member list sizes from 500 to 1000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 400 valid members; - no more than a 10% chance of incorrectly rejecting a list with 500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 400 valid members - Probability of incorrectly rejecting a list with 500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size fror 500 up to 1000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 10%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combination that can achieve close to the desired error rates with smaller sample size. For example, with 550 members, a sample size of 45 and max denials of 6 will give a Probability of rejecting a valid list of 10.11%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 400 - risk	Rejecting 500 - risk
500	18	0	1.7%	0.0%
501	18	0	1.6%	3.6%
502	18	0	1.5%	7.0%
503	26	1	1.8%	0.7%
504	26	1	1.7%	1.4%
505	26	1	1.6%	2.3%
506	26	1	1.6%	3.4%
507	26	1	1.5%	4.5%
508	26	1	1.4%	5.8%
509	26	1	1.4%	7.2%
510	26	1	1.3%	8.7%
511	32	2	1.6%	2.6%
512	32	2	1.6%	3.3%
513	32	2	1.5%	4.1%
514	32	2	1.4%	5.0%
515	32	2	1.3%	6.0%
516	32	2	1.3%	7.0%
517	32	2	1.2%	8.1%
518	32	2	1.2%	9.3%
519	37	3	1.5%	3.9%
520	37	3	1.4%	4.6%
521	37	3	1.4%	5.4%
522	37	3	1.3%	6.2%
523	37	3	1.2%	7.1%
524	37	3	1.2%	8.0%
525	37	3	1.1%	9.0%
526	41	4	1.6%	4.3%
527	41	4	1.5%	5.0%
528	41	4	1.4%	5.7%
529	41	4	1.3%	6.4%
530	41	4	1.3%	7.2%
531	41	4	1.2%	8.1%
532	41	4	1.1%	9.0%
533	41	4	1.1%	9.9%
534	44	5	1.7%	5.1%
535	44	5	1.6%	5.7%
536	44	5	1.5%	6.4%
537	44	5	1.5%	7.1%

538	44	5	1.4%	7.9%
539	44	5	1.3%	8.7%
540	44	5	1.3%	9.5%
541	47	6	1.8%	5.4%
542	47	6	1.7%	6.0%
543	47	6	1.6%	6.6%
544	47	6	1.6%	7.3%
545	47	6	1.5%	8.0%
546	47	6	1.4%	8.8%
547	47	6	1.3%	9.6%
548	50	7	1.8%	5.9%
549	50	7	1.7%	6.4%
550	50	7	1.6%	7.1%
551	50	7	1.6%	7.7%
552	50	7	1.5%	8.4%
553	50	7	1.4%	9.2%
554	50	7	1.3%	9.9%
555	53	8	1.7%	6.5%
556	53	8	1.7%	7.1%
557	53	8	1.6%	7.7%
558	53	8	1.5%	8.4%
559	53	8	1.4%	9.1%
560	53	8	1.4%	9.8%
561	56	9	1.7%	6.7%
562	56	9	1.6%	7.3%
563	56	9	1.5%	8.0%
564	56	9	1.5%	8.6%
565	56	9	1.4%	9.3%
566	59	10	1.7%	6.6%
567	59	10	1.6%	7.2%
568	59	10	1.5%	7.8%
569	59	10	1.4%	8.4%
570	59	10	1.4%	9.1%
571	59	10	1.3%	9.8%
572	61	11	1.9%	6.5%
573	61	11	1.8%	7.0%
574	61	11	1.7%	7.6%
575	61	11	1.6%	8.2%
576	61	11	1.5%	8.8%
577	61	11	1.4%	9.4%
578	64	12	1.7%	7.2%
579	64	12	1.6%	7.7%
580	64	12	1.5%	8.3%
581	64	12	1.4%	8.9%
582	64	12	1.3%	9.6%
583	66	13	1.8%	6.7%
584	66	13	1.7%	7.2%
585	66	13	1.7%	7.8%
586	66	13	1.6%	8.3%
587	66	13	1.5%	8.9%

588	66	13	1.4%	9.6%
589	68	14	1.9%	6.8%
590	68	14	1.8%	7.4%
591	68	14	1.7%	7.9%
592	68	14	1.6%	8.5%
593	68	14	1.6%	9.0%
594	68	14	1.5%	9.6%
595	70	15	1.9%	7.1%
596	70	15	1.9%	7.6%
597	70	15	1.8%	8.1%
598	70	15	1.7%	8.6%
599	70	15	1.6%	9.2%
600	70	15	1.5%	9.8%
601	72	16	2.0%	7.3%
602	72	16	1.9%	7.8%
603	72	16	1.8%	8.4%
604	72	16	1.7%	8.9%
605	72	16	1.6%	9.5%
606	75	17	1.7%	8.1%
607	75	17	1.6%	8.6%
608	75	17	1.5%	9.2%
609	75	17	1.4%	9.7%
610	77	18	1.8%	7.5%
611	77	18	1.7%	8.0%
612	77	18	1.6%	8.5%
613	77	18	1.6%	9.1%
614	77	18	1.5%	9.6%
615	79	19	1.8%	7.5%
616	79	19	1.7%	8.0%
617	79	19	1.7%	8.5%
618	79	19	1.6%	9.1%
619	79	19	1.5%	9.6%
620	81	20	1.8%	7.6%
621	81	20	1.7%	8.1%
622	81	20	1.7%	8.6%
623	81	20	1.6%	9.1%
624	81	20	1.5%	9.7%
625	83	21	1.8%	7.7%
626	83	21	1.7%	8.2%
627	83	21	1.6%	8.7%
628	83	21	1.6%	9.2%
629	83	21	1.5%	9.8%
630	85	22	1.8%	7.9%
631	85	22	1.7%	8.4%
632	85	22	1.6%	8.9%
633	85	22	1.5%	9.4%
634	85	22	1.5%	10.0%
635	87	23	1.7%	8.1%
636	87	23	1.7%	8.6%
637	87	23	1.6%	9.1%

638	87	23	1.5%	9.7%
639	89	24	1.8%	8.0%
640	89	24	1.7%	8.4%
641	89	24	1.6%	8.9%
642	89	24	1.5%	9.5%
643	89	24	1.4%	10.0%
644	91	25	1.7%	8.3%
645	91	25	1.6%	8.8%
646	91	25	1.5%	9.3%
647	91	25	1.5%	9.8%
648	93	26	1.7%	8.2%
649	93	26	1.6%	8.7%
650	93	26	1.5%	9.2%
651	93	26	1.5%	9.7%
652	95	27	1.7%	8.2%
653	95	27	1.6%	8.7%
654	95	27	1.5%	9.2%
655	95	27	1.4%	9.7%
656	97	28	1.6%	8.2%
657	97	28	1.6%	8.7%
658	97	28	1.5%	9.2%
659	97	28	1.4%	9.7%
660	98	29	2.0%	7.3%
661	98	29	1.9%	7.8%
662	98	29	1.8%	8.2%
663	98	29	1.7%	8.7%
664	98	29	1.6%	9.1%
665	98	29	1.5%	9.6%
666	100	30	1.7%	8.3%
667	100	30	1.6%	8.7%
668	100	30	1.6%	9.2%
669	100	30	1.5%	9.7%
670	102	31	1.7%	8.4%
671	102	31	1.6%	8.9%
672	102	31	1.5%	9.4%
673	102	31	1.4%	9.8%
674	103	32	2.0%	7.6%
675	103	32	1.9%	8.0%
676	103	32	1.8%	8.5%
677	103	32	1.7%	8.9%
678	103	32	1.6%	9.4%
679	103	32	1.5%	9.8%
680	105	33	1.7%	8.6%
681	105	33	1.6%	9.1%
682	105	33	1.5%	9.6%
683	107	34	1.7%	8.4%
684	107	34	1.6%	8.9%
685	107	34	1.5%	9.3%
686	107	34	1.5%	9.8%
687	108	35	2.0%	7.7%

688	108	35	1.9%	8.1%
689	108	35	1.8%	8.5%
690	108	35	1.7%	9.0%
691	108	35	1.6%	9.4%
692	108	35	1.6%	9.9%
693	110	36	1.7%	8.8%
694	110	36	1.6%	9.3%
695	110	36	1.5%	9.7%
696	112	37	1.7%	8.7%
697	112	37	1.6%	9.2%
698	112	37	1.5%	9.6%
699	113	38	2.0%	7.6%
700	113	38	1.9%	8.0%
701	113	38	1.8%	8.4%
702	113	38	1.7%	8.9%
703	113	38	1.7%	9.3%
704	113	38	1.6%	9.7%
705	115	39	1.7%	8.8%
706	115	39	1.6%	9.2%
707	115	39	1.5%	9.7%
708	117	40	1.6%	8.8%
709	117	40	1.6%	9.2%
710	117	40	1.5%	9.7%
711	118	41	1.9%	7.8%
712	118	41	1.8%	8.2%
713	118	41	1.8%	8.6%
714	118	41	1.7%	9.0%
715	118	41	1.6%	9.4%
716	118	41	1.5%	9.9%
717	119	42	2.0%	8.0%
718	119	42	1.9%	8.3%
719	119	42	1.8%	8.7%
720	119	42	1.7%	9.2%
721	119	42	1.7%	9.6%
722	121	43	1.7%	8.8%
723	121	43	1.7%	9.2%
724	121	43	1.6%	9.7%
725	123	44	1.7%	8.9%
726	123	44	1.6%	9.3%
727	123	44	1.5%	9.8%
728	124	45	1.9%	7.9%
729	124	45	1.9%	8.3%
730	124	45	1.8%	8.7%
731	124	45	1.7%	9.1%
732	124	45	1.6%	9.6%
733	124	45	1.6%	10.0%
734	125	46	2.0%	8.2%
735	125	46	1.9%	8.5%
736	125	46	1.8%	8.9%
737	125	46	1.7%	9.4%

738	125	46	1.7%	9.8%
739	127	47	1.7%	9.1%
740	127	47	1.6%	9.5%
741	127	47	1.6%	9.9%
742	128	48	2.0%	8.2%
743	128	48	1.9%	8.6%
744	128	48	1.8%	9.0%
745	128	48	1.8%	9.4%
746	128	48	1.7%	9.8%
747	130	49	1.7%	9.2%
748	130	49	1.6%	9.6%
749	130	49	1.6%	10.0%
750	131	50	2.0%	8.3%
751	131	50	1.9%	8.6%
752	131	50	1.8%	9.0%
753	131	50	1.7%	9.4%
754	131	50	1.7%	9.8%
755	133	51	1.7%	9.3%
756	133	51	1.6%	9.7%
757	135	52	1.7%	9.1%
758	135	52	1.6%	9.5%
759	135	52	1.5%	10.0%
760	136	53	1.9%	8.3%
761	136	53	1.8%	8.7%
762	136	53	1.7%	9.1%
763	136	53	1.7%	9.4%
764	136	53	1.6%	9.9%
765	137	54	2.0%	8.2%
766	137	54	1.9%	8.6%
767	137	54	1.8%	9.0%
768	137	54	1.7%	9.4%
769	137	54	1.7%	9.8%
770	139	55	1.7%	9.3%
771	139	55	1.6%	9.7%
772	140	56	2.0%	8.1%
773	140	56	1.9%	8.5%
774	140	56	1.8%	8.8%
775	140	56	1.8%	9.2%
776	140	56	1.7%	9.6%
777	142	57	1.7%	9.2%
778	142	57	1.6%	9.6%
779	142	57	1.6%	10.0%
780	143	58	1.9%	8.4%
781	143	58	1.8%	8.8%
782	143	58	1.8%	9.1%
783	143	58	1.7%	9.5%
784	143	58	1.6%	9.9%
785	144	59	2.0%	8.4%
786	144	59	1.9%	8.7%
787	144	59	1.8%	9.1%

788	144	59	1.8%	9.5%
789	144	59	1.7%	9.9%
790	146	60	1.7%	9.5%
791	146	60	1.6%	9.9%
792	147	61	2.0%	8.4%
793	147	61	1.9%	8.7%
794	147	61	1.8%	9.1%
795	147	61	1.7%	9.5%
796	147	61	1.7%	9.9%
797	149	62	1.6%	9.5%
798	149	62	1.6%	9.9%
799	150	63	1.9%	8.5%
800	150	63	1.8%	8.8%
801	150	63	1.8%	9.2%
802	150	63	1.7%	9.5%
803	150	63	1.6%	9.9%
804	151	64	2.0%	8.5%
805	151	64	1.9%	8.8%
806	151	64	1.8%	9.2%
807	151	64	1.8%	9.5%
808	151	64	1.7%	9.9%
809	153	65	1.7%	9.6%
810	155	66	1.6%	9.4%
811	155	66	1.6%	9.8%
812	156	67	1.9%	8.4%
813	156	67	1.8%	8.7%
814	156	67	1.7%	9.1%
815	156	67	1.7%	9.4%
816	156	67	1.6%	9.8%
817	157	68	1.9%	8.4%
818	157	68	1.9%	8.7%
819	157	68	1.8%	9.1%
820	157	68	1.7%	9.5%
821	157	68	1.6%	9.8%
822	158	69	2.0%	8.4%
823	158	69	1.9%	8.8%
824	158	69	1.8%	9.1%
825	158	69	1.8%	9.5%
826	158	69	1.7%	9.8%
827	160	70	1.6%	9.7%
828	161	71	2.0%	8.3%
829	161	71	1.9%	8.7%
830	161	71	1.8%	9.0%
831	161	71	1.7%	9.4%
832	161	71	1.7%	9.7%
833	163	72	1.6%	9.6%
834	163	72	1.6%	9.9%
835	164	73	1.9%	8.6%
836	164	73	1.8%	8.9%
837	164	73	1.7%	9.3%

838	164	73	1.7%	9.6%
839	164	73	1.6%	10.0%
840	165	74	1.9%	8.7%
841	165	74	1.8%	9.0%
842	165	74	1.8%	9.3%
843	165	74	1.7%	9.7%
844	167	75	1.6%	9.6%
845	167	75	1.6%	10.0%
846	168	76	1.9%	8.6%
847	168	76	1.8%	9.0%
848	168	76	1.7%	9.3%
849	168	76	1.7%	9.7%
850	169	77	2.0%	8.4%
851	169	77	1.9%	8.7%
852	169	77	1.8%	9.0%
853	169	77	1.8%	9.4%
854	169	77	1.7%	9.7%
855	170	78	2.0%	8.5%
856	170	78	1.9%	8.8%
857	170	78	1.9%	9.1%
858	170	78	1.8%	9.5%
859	170	78	1.7%	9.8%
860	172	79	1.6%	9.8%
861	173	80	1.9%	8.5%
862	173	80	1.9%	8.8%
863	173	80	1.8%	9.2%
864	173	80	1.7%	9.5%
865	173	80	1.7%	9.9%
866	174	81	2.0%	8.6%
867	174	81	1.9%	8.9%
868	174	81	1.8%	9.3%
869	174	81	1.8%	9.6%
870	174	81	1.7%	9.9%
871	175	82	2.0%	8.7%
872	175	82	1.9%	9.0%
873	175	82	1.8%	9.4%
874	175	82	1.8%	9.7%
875	177	83	1.7%	9.7%
876	178	84	2.0%	8.5%
877	178	84	1.9%	8.8%
878	178	84	1.8%	9.1%
879	178	84	1.8%	9.5%
880	178	84	1.7%	9.8%
881	180	85	1.6%	9.8%
882	181	86	1.9%	8.6%
883	181	86	1.8%	9.0%
884	181	86	1.8%	9.3%
885	181	86	1.7%	9.6%
886	181	86	1.6%	10.0%
887	182	87	1.9%	8.8%

888	182	87	1.8%	9.1%
889	182	87	1.8%	9.4%
890	182	87	1.7%	9.7%
891	183	88	2.0%	8.6%
892	183	88	1.9%	8.9%
893	183	88	1.9%	9.2%
894	183	88	1.8%	9.5%
895	183	88	1.7%	9.9%
896	185	89	1.6%	9.9%
897	186	90	1.9%	8.8%
898	186	90	1.8%	9.1%
899	186	90	1.8%	9.4%
900	186	90	1.7%	9.7%
901	187	91	2.0%	8.6%
902	187	91	1.9%	8.9%
903	187	91	1.8%	9.2%
904	187	91	1.8%	9.5%
905	187	91	1.7%	9.9%
906	188	92	2.0%	8.7%
907	188	92	1.9%	9.0%
908	188	92	1.8%	9.3%
909	188	92	1.8%	9.7%
910	188	92	1.7%	10.0%
911	189	93	2.0%	8.8%
912	189	93	1.9%	9.1%
913	189	93	1.9%	9.5%
914	189	93	1.8%	9.8%
915	191	94	1.7%	9.9%
916	192	95	1.9%	8.8%
917	192	95	1.9%	9.1%
918	192	95	1.8%	9.4%
919	192	95	1.7%	9.7%
920	194	96	1.6%	9.9%
921	195	97	1.9%	8.8%
922	195	97	1.8%	9.1%
923	195	97	1.7%	9.4%
924	195	97	1.7%	9.7%
925	196	98	1.9%	8.6%
926	196	98	1.9%	8.9%
927	196	98	1.8%	9.3%
928	196	98	1.7%	9.6%
929	196	98	1.7%	9.9%
930	197	99	1.9%	8.8%
931	197	99	1.9%	9.1%
932	197	99	1.8%	9.4%
933	197	99	1.8%	9.7%
934	199	100	1.6%	9.9%
935	200	101	1.9%	8.8%
936	200	101	1.8%	9.1%
937	200	101	1.7%	9.4%

938	200	101	1.7%	9.8%
939	201	102	1.9%	8.7%
940	201	102	1.9%	9.0%
941	201	102	1.8%	9.3%
942	201	102	1.7%	9.6%
943	201	102	1.7%	9.9%
944	202	103	1.9%	8.9%
945	202	103	1.9%	9.2%
946	202	103	1.8%	9.5%
947	202	103	1.7%	9.8%
948	205	105	1.9%	8.7%
949	205	105	1.9%	8.9%
950	205	105	1.8%	9.2%
951	205	105	1.7%	9.6%
952	205	105	1.7%	9.9%
953	206	106	1.9%	8.8%
954	206	106	1.8%	9.1%
955	206	106	1.8%	9.4%
956	206	106	1.7%	9.7%
957	207	107	2.0%	8.7%
958	207	107	1.9%	9.0%
959	207	107	1.8%	9.3%
960	207	107	1.8%	9.6%
961	207	107	1.7%	9.9%
962	208	108	2.0%	8.9%
963	208	108	1.9%	9.2%
964	208	108	1.8%	9.4%
965	208	108	1.8%	9.8%
966	211	110	1.9%	8.7%
967	211	110	1.9%	9.0%
968	211	110	1.8%	9.3%
969	211	110	1.7%	9.6%
970	211	110	1.7%	9.9%
971	212	111	1.9%	8.9%
972	212	111	1.9%	9.2%
973	212	111	1.8%	9.5%
974	212	111	1.7%	9.8%
975	213	112	2.0%	8.8%
976	213	112	1.9%	9.1%
977	213	112	1.8%	9.4%
978	213	112	1.8%	9.7%
979	213	112	1.7%	10.0%
980	214	113	2.0%	9.0%
981	214	113	1.9%	9.2%
982	214	113	1.8%	9.5%
983	214	113	1.8%	9.8%
984	217	115	1.9%	8.9%
985	217	115	1.8%	9.2%
986	217	115	1.8%	9.5%
987	217	115	1.7%	9.8%

988	218	116	2.0%	8.8%
989	218	116	1.9%	9.1%
990	218	116	1.8%	9.3%
991	218	116	1.8%	9.6%
992	218	116	1.7%	9.9%
993	219	117	1.9%	9.0%
994	219	117	1.9%	9.2%
995	219	117	1.8%	9.5%
996	219	117	1.8%	9.8%
997	220	118	2.0%	8.9%
998	220	118	1.9%	9.1%
999	220	118	1.9%	9.4%
1000	220	118	1.8%	9.7%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 500 and 400 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	540
Sample size	68
Maximum number of denials allowed	11
Number of non-responding units	4

ASSUMPTIONS	
Valid list size	500
Invalid list size	400
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	10%

RESULT		
Expected # of responding members	510	
Expected # of responding valid (valid list)	472	
Expected # of responding valid (invalid list)	377	
Probability of false rejection	0.19%	<10% (OK)
Probability of false acceptance	2.85%	>2% (Not OK)

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

NOTE: this calculator is approximate, and should be used as a guide to assist with searching for an ideal sample size. For example, when the inputs are 1000, 10% and 2% the approximate value returned are 214 and 115.

INPUTS	
Members Lodged	550
Desired probability of false rejection	10%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	500
Unacceptable list	400

RESULT	
Approximate sample size required	46
Approximate maximum number of denials	6

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.181818
B	-1.28308
n0	49.80051
n1	45.66387
mu0	4.181818
mu1	12.54545
sig0	1.868165
sig1	2.894149
c0	6.075968
c1	6.101598

Sheet Name	Description
Table (6% & 2%)	List of required sample sizes cut-off values for member list sizes from 1500 to 2000. This table is based on achieving: - no more than a 2% chance of incorrectly accepting a list with only 1200 valid members; - no more than a 6% chance of incorrectly rejecting a list with 1500 valid members.
Calculator - error rates	For a given member list size, random sample size, and maximum number of denials this will calculate two probabilities: - Probability of incorrectly accepting a list with only 1200 valid members - Probability of incorrectly rejecting a list with 1500 valid members
Calculator - sample size	For a given member list size, probability of incorrect rejection, and probability of incorrect acceptance this will calculate: - the sample size required to achieve both probabilities - the maximum number of denials that should be allowed

The table below shows the desired sample size and maximum number of denials for each list size from 1500 up to 3000
The error probabilities for these have been set to:
- Probability of rejecting a valid list = 6%
- Probability of accepting an invalid list = 2%

NOTE: the error probabilities have been adhered to as strict constraints. There are some combinations that can achieve close to the desired error rates with smaller sample size. For example, with 1523 members, a sample size of 27 and max denials of 1 will give a Probability of rejecting a valid list of 6.09%. As this is above the constraint value it is not included

Members Lodged	Random Sample Size	Maximum denials to pass	Accepting 1200 - risk	Rejecting 1500 - risk
1500	18	0	1.8%	0.0%
1501	18	0	1.7%	1.2%
1502	18	0	1.7%	2.4%
1503	18	0	1.7%	3.6%
1504	18	0	1.7%	4.7%
1505	18	0	1.7%	5.8%
1506	27	1	1.6%	0.4%
1507	27	1	1.6%	0.6%
1508	27	1	1.6%	0.8%
1509	27	1	1.6%	1.0%
1510	27	1	1.5%	1.3%
1511	27	1	1.5%	1.5%
1512	27	1	1.5%	1.8%
1513	27	1	1.5%	2.1%
1514	27	1	1.5%	2.4%
1515	27	1	1.4%	2.8%
1516	27	1	1.4%	3.1%
1517	27	1	1.4%	3.5%
1518	27	1	1.4%	3.9%
1519	27	1	1.3%	4.3%
1520	27	1	1.3%	4.7%
1521	27	1	1.3%	5.2%
1522	27	1	1.3%	5.6%
1523	33	2	1.8%	1.2%
1524	33	2	1.7%	1.4%
1525	33	2	1.7%	1.5%
1526	33	2	1.7%	1.7%
1527	33	2	1.6%	1.9%
1528	33	2	1.6%	2.1%
1529	33	2	1.6%	2.3%
1530	33	2	1.6%	2.5%
1531	33	2	1.5%	2.7%
1532	33	2	1.5%	3.0%
1533	33	2	1.5%	3.2%
1534	33	2	1.5%	3.4%
1535	33	2	1.4%	3.7%
1536	33	2	1.4%	4.0%
1537	33	2	1.4%	4.3%

1538	33	2	1.4%	4.6%
1539	33	2	1.4%	4.9%
1540	33	2	1.3%	5.2%
1541	33	2	1.3%	5.5%
1542	33	2	1.3%	5.8%
1543	38	3	1.8%	1.9%
1544	38	3	1.8%	2.1%
1545	38	3	1.7%	2.2%
1546	38	3	1.7%	2.4%
1547	38	3	1.7%	2.6%
1548	38	3	1.6%	2.8%
1549	38	3	1.6%	3.0%
1550	38	3	1.6%	3.2%
1551	38	3	1.6%	3.4%
1552	38	3	1.5%	3.6%
1553	38	3	1.5%	3.8%
1554	38	3	1.5%	4.0%
1555	38	3	1.5%	4.2%
1556	38	3	1.4%	4.5%
1557	38	3	1.4%	4.7%
1558	38	3	1.4%	5.0%
1559	38	3	1.4%	5.2%
1560	38	3	1.3%	5.5%
1561	38	3	1.3%	5.8%
1562	42	4	1.9%	2.3%
1563	42	4	1.9%	2.4%
1564	42	4	1.9%	2.6%
1565	42	4	1.8%	2.7%
1566	42	4	1.8%	2.9%
1567	42	4	1.8%	3.1%
1568	42	4	1.8%	3.2%
1569	42	4	1.7%	3.4%
1570	42	4	1.7%	3.6%
1571	42	4	1.7%	3.8%
1572	42	4	1.6%	4.0%
1573	42	4	1.6%	4.2%
1574	42	4	1.6%	4.4%
1575	42	4	1.6%	4.6%
1576	42	4	1.5%	4.8%
1577	42	4	1.5%	5.0%
1578	42	4	1.5%	5.3%
1579	42	4	1.5%	5.5%
1580	42	4	1.4%	5.7%
1581	42	4	1.4%	6.0%
1582	46	5	1.9%	2.9%
1583	46	5	1.9%	3.0%
1584	46	5	1.8%	3.2%
1585	46	5	1.8%	3.3%
1586	46	5	1.8%	3.5%
1587	46	5	1.7%	3.6%

1588	46	5	1.7%	3.8%
1589	46	5	1.7%	4.0%
1590	46	5	1.7%	4.2%
1591	46	5	1.6%	4.4%
1592	46	5	1.6%	4.6%
1593	46	5	1.6%	4.7%
1594	46	5	1.5%	5.0%
1595	46	5	1.5%	5.2%
1596	46	5	1.5%	5.4%
1597	46	5	1.5%	5.6%
1598	46	5	1.4%	5.8%
1599	50	6	1.8%	3.1%
1600	50	6	1.8%	3.3%
1601	50	6	1.8%	3.4%
1602	50	6	1.7%	3.6%
1603	50	6	1.7%	3.7%
1604	50	6	1.7%	3.9%
1605	50	6	1.6%	4.1%
1606	50	6	1.6%	4.2%
1607	50	6	1.6%	4.4%
1608	50	6	1.6%	4.6%
1609	50	6	1.5%	4.8%
1610	50	6	1.5%	5.0%
1611	50	6	1.5%	5.2%
1612	50	6	1.5%	5.4%
1613	50	6	1.4%	5.6%
1614	50	6	1.4%	5.8%
1615	50	6	1.4%	6.0%
1616	53	7	2.0%	3.2%
1617	53	7	2.0%	3.3%
1618	53	7	1.9%	3.5%
1619	53	7	1.9%	3.6%
1620	53	7	1.9%	3.8%
1621	53	7	1.8%	3.9%
1622	53	7	1.8%	4.1%
1623	53	7	1.8%	4.2%
1624	53	7	1.7%	4.4%
1625	53	7	1.7%	4.6%
1626	53	7	1.7%	4.7%
1627	53	7	1.6%	4.9%
1628	53	7	1.6%	5.1%
1629	53	7	1.6%	5.3%
1630	53	7	1.6%	5.5%
1631	53	7	1.5%	5.7%
1632	53	7	1.5%	5.9%
1633	57	8	1.7%	3.7%
1634	57	8	1.7%	3.9%
1635	57	8	1.7%	4.0%
1636	57	8	1.6%	4.2%
1637	57	8	1.6%	4.3%

1638	57	8	1.6%	4.5%
1639	57	8	1.6%	4.7%
1640	57	8	1.5%	4.8%
1641	57	8	1.5%	5.0%
1642	57	8	1.5%	5.2%
1643	57	8	1.4%	5.4%
1644	57	8	1.4%	5.5%
1645	57	8	1.4%	5.7%
1646	57	8	1.4%	5.9%
1647	60	9	1.8%	3.6%
1648	60	9	1.8%	3.7%
1649	60	9	1.8%	3.9%
1650	60	9	1.7%	4.0%
1651	60	9	1.7%	4.2%
1652	60	9	1.7%	4.3%
1653	60	9	1.6%	4.5%
1654	60	9	1.6%	4.6%
1655	60	9	1.6%	4.8%
1656	60	9	1.6%	4.9%
1657	60	9	1.5%	5.1%
1658	60	9	1.5%	5.3%
1659	60	9	1.5%	5.5%
1660	60	9	1.4%	5.6%
1661	60	9	1.4%	5.8%
1662	63	10	1.8%	3.7%
1663	63	10	1.8%	3.8%
1664	63	10	1.8%	4.0%
1665	63	10	1.7%	4.1%
1666	63	10	1.7%	4.3%
1667	63	10	1.7%	4.4%
1668	63	10	1.6%	4.6%
1669	63	10	1.6%	4.7%
1670	63	10	1.6%	4.9%
1671	63	10	1.6%	5.0%
1672	63	10	1.5%	5.2%
1673	63	10	1.5%	5.4%
1674	63	10	1.5%	5.5%
1675	63	10	1.4%	5.7%
1676	63	10	1.4%	5.9%
1677	66	11	1.8%	3.9%
1678	66	11	1.8%	4.0%
1679	66	11	1.7%	4.2%
1680	66	11	1.7%	4.3%
1681	66	11	1.7%	4.5%
1682	66	11	1.6%	4.6%
1683	66	11	1.6%	4.7%
1684	66	11	1.6%	4.9%
1685	66	11	1.5%	5.1%
1686	66	11	1.5%	5.2%
1687	66	11	1.5%	5.4%

1688	66	11	1.5%	5.6%
1689	66	11	1.4%	5.7%
1690	66	11	1.4%	5.9%
1691	69	12	1.7%	4.0%
1692	69	12	1.7%	4.2%
1693	69	12	1.7%	4.3%
1694	69	12	1.6%	4.5%
1695	69	12	1.6%	4.6%
1696	69	12	1.6%	4.7%
1697	69	12	1.6%	4.9%
1698	69	12	1.5%	5.0%
1699	69	12	1.5%	5.2%
1700	69	12	1.5%	5.4%
1701	69	12	1.4%	5.5%
1702	69	12	1.4%	5.7%
1703	69	12	1.4%	5.9%
1704	71	13	2.0%	3.7%
1705	71	13	2.0%	3.8%
1706	71	13	1.9%	4.0%
1707	71	13	1.9%	4.1%
1708	71	13	1.9%	4.2%
1709	71	13	1.8%	4.4%
1710	71	13	1.8%	4.5%
1711	71	13	1.8%	4.6%
1712	71	13	1.7%	4.8%
1713	71	13	1.7%	4.9%
1714	71	13	1.7%	5.1%
1715	71	13	1.6%	5.2%
1716	71	13	1.6%	5.4%
1717	71	13	1.6%	5.5%
1718	71	13	1.5%	5.7%
1719	71	13	1.5%	5.9%
1720	74	14	1.8%	4.3%
1721	74	14	1.8%	4.4%
1722	74	14	1.7%	4.5%
1723	74	14	1.7%	4.7%
1724	74	14	1.7%	4.8%
1725	74	14	1.6%	4.9%
1726	74	14	1.6%	5.1%
1727	74	14	1.6%	5.2%
1728	74	14	1.5%	5.4%
1729	74	14	1.5%	5.5%
1730	74	14	1.5%	5.7%
1731	74	14	1.5%	5.9%
1732	77	15	1.7%	4.4%
1733	77	15	1.7%	4.5%
1734	77	15	1.6%	4.6%
1735	77	15	1.6%	4.8%
1736	77	15	1.6%	4.9%
1737	77	15	1.5%	5.0%

1738	77	15	1.5%	5.2%
1739	77	15	1.5%	5.3%
1740	77	15	1.5%	5.5%
1741	77	15	1.4%	5.6%
1742	77	15	1.4%	5.8%
1743	77	15	1.4%	6.0%
1744	79	16	1.9%	4.1%
1745	79	16	1.8%	4.2%
1746	79	16	1.8%	4.3%
1747	79	16	1.8%	4.4%
1748	79	16	1.7%	4.6%
1749	79	16	1.7%	4.7%
1750	79	16	1.7%	4.8%
1751	79	16	1.7%	5.0%
1752	79	16	1.6%	5.1%
1753	79	16	1.6%	5.3%
1754	79	16	1.6%	5.4%
1755	79	16	1.5%	5.6%
1756	79	16	1.5%	5.7%
1757	79	16	1.5%	5.9%
1758	81	17	2.0%	4.1%
1759	81	17	1.9%	4.2%
1760	81	17	1.9%	4.3%
1761	81	17	1.9%	4.4%
1762	81	17	1.8%	4.6%
1763	81	17	1.8%	4.7%
1764	81	17	1.8%	4.8%
1765	81	17	1.7%	5.0%
1766	81	17	1.7%	5.1%
1767	81	17	1.7%	5.2%
1768	81	17	1.7%	5.4%
1769	81	17	1.6%	5.5%
1770	81	17	1.6%	5.7%
1771	81	17	1.6%	5.8%
1772	81	17	1.5%	6.0%
1773	84	18	1.7%	4.7%
1774	84	18	1.7%	4.9%
1775	84	18	1.6%	5.0%
1776	84	18	1.6%	5.1%
1777	84	18	1.6%	5.3%
1778	84	18	1.6%	5.4%
1779	84	18	1.5%	5.5%
1780	84	18	1.5%	5.7%
1781	84	18	1.5%	5.8%
1782	84	18	1.4%	6.0%
1783	86	19	1.9%	4.3%
1784	86	19	1.8%	4.4%
1785	86	19	1.8%	4.6%
1786	86	19	1.8%	4.7%
1787	86	19	1.7%	4.8%

1788	86	19	1.7%	4.9%
1789	86	19	1.7%	5.1%
1790	86	19	1.7%	5.2%
1791	86	19	1.6%	5.3%
1792	86	19	1.6%	5.5%
1793	86	19	1.6%	5.6%
1794	86	19	1.5%	5.8%
1795	86	19	1.5%	5.9%
1796	88	20	1.9%	4.3%
1797	88	20	1.9%	4.4%
1798	88	20	1.9%	4.6%
1799	88	20	1.8%	4.7%
1800	88	20	1.8%	4.8%
1801	88	20	1.8%	4.9%
1802	88	20	1.7%	5.1%
1803	88	20	1.7%	5.2%
1804	88	20	1.7%	5.3%
1805	88	20	1.7%	5.5%
1806	88	20	1.6%	5.6%
1807	88	20	1.6%	5.7%
1808	88	20	1.6%	5.9%
1809	90	21	2.0%	4.3%
1810	90	21	2.0%	4.5%
1811	90	21	1.9%	4.6%
1812	90	21	1.9%	4.7%
1813	90	21	1.9%	4.8%
1814	90	21	1.8%	5.0%
1815	90	21	1.8%	5.1%
1816	90	21	1.8%	5.2%
1817	90	21	1.7%	5.3%
1818	90	21	1.7%	5.5%
1819	90	21	1.7%	5.6%
1820	90	21	1.6%	5.8%
1821	90	21	1.6%	5.9%
1822	93	22	1.7%	4.9%
1823	93	22	1.7%	5.1%
1824	93	22	1.6%	5.2%
1825	93	22	1.6%	5.3%
1826	93	22	1.6%	5.5%
1827	93	22	1.5%	5.6%
1828	93	22	1.5%	5.7%
1829	93	22	1.5%	5.9%
1830	95	23	1.9%	4.4%
1831	95	23	1.8%	4.6%
1832	95	23	1.8%	4.7%
1833	95	23	1.8%	4.8%
1834	95	23	1.7%	4.9%
1835	95	23	1.7%	5.0%
1836	95	23	1.7%	5.2%
1837	95	23	1.6%	5.3%

1838	95	23	1.6%	5.4%
1839	95	23	1.6%	5.6%
1840	95	23	1.6%	5.7%
1841	95	23	1.5%	5.8%
1842	95	23	1.5%	6.0%
1843	97	24	1.9%	4.6%
1844	97	24	1.8%	4.7%
1845	97	24	1.8%	4.8%
1846	97	24	1.8%	4.9%
1847	97	24	1.7%	5.1%
1848	97	24	1.7%	5.2%
1849	97	24	1.7%	5.3%
1850	97	24	1.6%	5.4%
1851	97	24	1.6%	5.6%
1852	97	24	1.6%	5.7%
1853	97	24	1.6%	5.9%
1854	97	24	1.5%	6.0%
1855	99	25	1.9%	4.6%
1856	99	25	1.8%	4.7%
1857	99	25	1.8%	4.9%
1858	99	25	1.8%	5.0%
1859	99	25	1.7%	5.1%
1860	99	25	1.7%	5.2%
1861	99	25	1.7%	5.4%
1862	99	25	1.6%	5.5%
1863	99	25	1.6%	5.6%
1864	99	25	1.6%	5.8%
1865	99	25	1.6%	5.9%
1866	101	26	1.9%	4.6%
1867	101	26	1.9%	4.7%
1868	101	26	1.8%	4.8%
1869	101	26	1.8%	4.9%
1870	101	26	1.8%	5.1%
1871	101	26	1.7%	5.2%
1872	101	26	1.7%	5.3%
1873	101	26	1.7%	5.4%
1874	101	26	1.6%	5.6%
1875	101	26	1.6%	5.7%
1876	101	26	1.6%	5.8%
1877	101	26	1.6%	6.0%
1878	103	27	1.9%	4.7%
1879	103	27	1.9%	4.8%
1880	103	27	1.8%	4.9%
1881	103	27	1.8%	5.1%
1882	103	27	1.8%	5.2%
1883	103	27	1.7%	5.3%
1884	103	27	1.7%	5.4%
1885	103	27	1.7%	5.5%
1886	103	27	1.6%	5.7%
1887	103	27	1.6%	5.8%

1888	103	27	1.6%	5.9%
1889	105	28	1.9%	4.7%
1890	105	28	1.9%	4.8%
1891	105	28	1.8%	4.9%
1892	105	28	1.8%	5.1%
1893	105	28	1.8%	5.2%
1894	105	28	1.7%	5.3%
1895	105	28	1.7%	5.4%
1896	105	28	1.7%	5.6%
1897	105	28	1.6%	5.7%
1898	105	28	1.6%	5.8%
1899	105	28	1.6%	5.9%
1900	107	29	1.9%	4.8%
1901	107	29	1.8%	4.9%
1902	107	29	1.8%	5.0%
1903	107	29	1.8%	5.1%
1904	107	29	1.8%	5.2%
1905	107	29	1.7%	5.3%
1906	107	29	1.7%	5.5%
1907	107	29	1.7%	5.6%
1908	107	29	1.6%	5.7%
1909	107	29	1.6%	5.8%
1910	107	29	1.6%	6.0%
1911	109	30	1.9%	4.8%
1912	109	30	1.8%	4.9%
1913	109	30	1.8%	5.1%
1914	109	30	1.8%	5.2%
1915	109	30	1.7%	5.3%
1916	109	30	1.7%	5.4%
1917	109	30	1.7%	5.5%
1918	109	30	1.6%	5.7%
1919	109	30	1.6%	5.8%
1920	109	30	1.6%	5.9%
1921	111	31	1.9%	4.8%
1922	111	31	1.8%	4.9%
1923	111	31	1.8%	5.0%
1924	111	31	1.8%	5.1%
1925	111	31	1.7%	5.3%
1926	111	31	1.7%	5.4%
1927	111	31	1.7%	5.5%
1928	111	31	1.7%	5.6%
1929	111	31	1.6%	5.7%
1930	111	31	1.6%	5.9%
1931	113	32	1.9%	4.8%
1932	113	32	1.8%	4.9%
1933	113	32	1.8%	5.0%
1934	113	32	1.8%	5.1%
1935	113	32	1.7%	5.3%
1936	113	32	1.7%	5.4%
1937	113	32	1.7%	5.5%

1938	113	32	1.6%	5.6%
1939	113	32	1.6%	5.7%
1940	113	32	1.6%	5.9%
1941	113	32	1.6%	6.0%
1942	115	33	1.8%	4.9%
1943	115	33	1.8%	5.0%
1944	115	33	1.8%	5.2%
1945	115	33	1.7%	5.3%
1946	115	33	1.7%	5.4%
1947	115	33	1.7%	5.5%
1948	115	33	1.6%	5.6%
1949	115	33	1.6%	5.8%
1950	115	33	1.6%	5.9%
1951	117	34	1.8%	4.9%
1952	117	34	1.8%	5.0%
1953	117	34	1.8%	5.1%
1954	117	34	1.7%	5.2%
1955	117	34	1.7%	5.3%
1956	117	34	1.7%	5.4%
1957	117	34	1.6%	5.6%
1958	117	34	1.6%	5.7%
1959	117	34	1.6%	5.8%
1960	117	34	1.6%	5.9%
1961	119	35	1.8%	4.9%
1962	119	35	1.8%	5.0%
1963	119	35	1.7%	5.2%
1964	119	35	1.7%	5.3%
1965	119	35	1.7%	5.4%
1966	119	35	1.6%	5.5%
1967	119	35	1.6%	5.6%
1968	119	35	1.6%	5.7%
1969	119	35	1.6%	5.9%
1970	119	35	1.5%	6.0%
1971	121	36	1.7%	5.0%
1972	121	36	1.7%	5.1%
1973	121	36	1.7%	5.2%
1974	121	36	1.7%	5.4%
1975	121	36	1.6%	5.5%
1976	121	36	1.6%	5.6%
1977	121	36	1.6%	5.7%
1978	121	36	1.5%	5.8%
1979	121	36	1.5%	6.0%
1980	123	37	1.7%	5.0%
1981	123	37	1.7%	5.1%
1982	123	37	1.7%	5.2%
1983	123	37	1.6%	5.3%
1984	123	37	1.6%	5.5%
1985	123	37	1.6%	5.6%
1986	123	37	1.6%	5.7%
1987	123	37	1.5%	5.8%

1988	123	37	1.5%	5.9%
1989	125	38	1.7%	5.0%
1990	125	38	1.7%	5.1%
1991	125	38	1.6%	5.2%
1992	125	38	1.6%	5.4%
1993	125	38	1.6%	5.5%
1994	125	38	1.6%	5.6%
1995	125	38	1.5%	5.7%
1996	125	38	1.5%	5.8%
1997	125	38	1.5%	6.0%
1998	126	39	2.0%	4.5%
1999	126	39	2.0%	4.6%
2000	126	39	1.9%	4.7%
2001	126	39	1.9%	4.8%
2002	126	39	1.9%	4.9%
2003	126	39	1.8%	5.0%
2004	126	39	1.8%	5.1%
2005	126	39	1.8%	5.2%
2006	126	39	1.7%	5.3%
2007	126	39	1.7%	5.4%
2008	126	39	1.7%	5.6%
2009	126	39	1.6%	5.7%
2010	126	39	1.6%	5.8%
2011	126	39	1.6%	5.9%
2012	128	40	1.8%	5.1%
2013	128	40	1.8%	5.2%
2014	128	40	1.7%	5.3%
2015	128	40	1.7%	5.4%
2016	128	40	1.7%	5.5%
2017	128	40	1.6%	5.6%
2018	128	40	1.6%	5.7%
2019	128	40	1.6%	5.8%
2020	128	40	1.6%	6.0%
2021	130	41	1.7%	5.1%
2022	130	41	1.7%	5.2%
2023	130	41	1.7%	5.3%
2024	130	41	1.7%	5.4%
2025	130	41	1.6%	5.6%
2026	130	41	1.6%	5.7%
2027	130	41	1.6%	5.8%
2028	130	41	1.5%	5.9%
2029	132	42	1.7%	5.1%
2030	132	42	1.7%	5.2%
2031	132	42	1.7%	5.3%
2032	132	42	1.6%	5.4%
2033	132	42	1.6%	5.5%
2034	132	42	1.6%	5.6%
2035	132	42	1.6%	5.8%
2036	132	42	1.5%	5.9%
2037	132	42	1.5%	6.0%

2038	133	43	2.0%	4.6%
2039	133	43	1.9%	4.7%
2040	133	43	1.9%	4.8%
2041	133	43	1.9%	4.9%
2042	133	43	1.8%	5.0%
2043	133	43	1.8%	5.1%
2044	133	43	1.8%	5.2%
2045	133	43	1.8%	5.3%
2046	133	43	1.7%	5.4%
2047	133	43	1.7%	5.5%
2048	133	43	1.7%	5.7%
2049	133	43	1.6%	5.8%
2050	133	43	1.6%	5.9%
2051	135	44	1.8%	5.1%
2052	135	44	1.8%	5.2%
2053	135	44	1.7%	5.3%
2054	135	44	1.7%	5.4%
2055	135	44	1.7%	5.5%
2056	135	44	1.6%	5.7%
2057	135	44	1.6%	5.8%
2058	135	44	1.6%	5.9%
2059	137	45	1.7%	5.1%
2060	137	45	1.7%	5.2%
2061	137	45	1.7%	5.3%
2062	137	45	1.7%	5.5%
2063	137	45	1.6%	5.6%
2064	137	45	1.6%	5.7%
2065	137	45	1.6%	5.8%
2066	137	45	1.6%	5.9%
2067	139	46	1.7%	5.2%
2068	139	46	1.7%	5.3%
2069	139	46	1.6%	5.4%
2070	139	46	1.6%	5.5%
2071	139	46	1.6%	5.6%
2072	139	46	1.6%	5.7%
2073	139	46	1.5%	5.8%
2074	139	46	1.5%	5.9%
2075	140	47	2.0%	4.6%
2076	140	47	1.9%	4.7%
2077	140	47	1.9%	4.8%
2078	140	47	1.9%	4.9%
2079	140	47	1.8%	5.0%
2080	140	47	1.8%	5.1%
2081	140	47	1.8%	5.2%
2082	140	47	1.7%	5.3%
2083	140	47	1.7%	5.4%
2084	140	47	1.7%	5.5%
2085	140	47	1.7%	5.7%
2086	140	47	1.6%	5.8%
2087	140	47	1.6%	5.9%

2088	140	47	1.6%	6.0%
2089	142	48	1.7%	5.3%
2090	142	48	1.7%	5.4%
2091	142	48	1.7%	5.5%
2092	142	48	1.6%	5.6%
2093	142	48	1.6%	5.7%
2094	142	48	1.6%	5.8%
2095	142	48	1.6%	5.9%
2096	144	49	1.7%	5.3%
2097	144	49	1.7%	5.4%
2098	144	49	1.6%	5.5%
2099	144	49	1.6%	5.6%
2100	144	49	1.6%	5.7%
2101	144	49	1.6%	5.8%
2102	144	49	1.5%	5.9%
2103	145	50	2.0%	4.7%
2104	145	50	1.9%	4.8%
2105	145	50	1.9%	4.8%
2106	145	50	1.9%	4.9%
2107	145	50	1.8%	5.0%
2108	145	50	1.8%	5.1%
2109	145	50	1.8%	5.2%
2110	145	50	1.8%	5.3%
2111	145	50	1.7%	5.5%
2112	145	50	1.7%	5.6%
2113	145	50	1.7%	5.7%
2114	145	50	1.6%	5.8%
2115	145	50	1.6%	5.9%
2116	145	50	1.6%	6.0%
2117	147	51	1.7%	5.3%
2118	147	51	1.7%	5.4%
2119	147	51	1.7%	5.6%
2120	147	51	1.6%	5.7%
2121	147	51	1.6%	5.8%
2122	147	51	1.6%	5.9%
2123	147	51	1.6%	6.0%
2124	148	52	2.0%	4.7%
2125	148	52	2.0%	4.8%
2126	148	52	1.9%	4.9%
2127	148	52	1.9%	5.0%
2128	148	52	1.9%	5.1%
2129	148	52	1.8%	5.2%
2130	148	52	1.8%	5.3%
2131	148	52	1.8%	5.4%
2132	148	52	1.7%	5.5%
2133	148	52	1.7%	5.6%
2134	148	52	1.7%	5.8%
2135	148	52	1.7%	5.9%
2136	148	52	1.6%	6.0%
2137	150	53	1.8%	5.4%

2138	150	53	1.7%	5.5%
2139	150	53	1.7%	5.6%
2140	150	53	1.7%	5.7%
2141	150	53	1.6%	5.8%
2142	150	53	1.6%	5.9%
2143	150	53	1.6%	6.0%
2144	152	54	1.7%	5.4%
2145	152	54	1.7%	5.5%
2146	152	54	1.6%	5.6%
2147	152	54	1.6%	5.7%
2148	152	54	1.6%	5.8%
2149	152	54	1.6%	5.9%
2150	153	55	2.0%	4.7%
2151	153	55	2.0%	4.8%
2152	153	55	1.9%	4.9%
2153	153	55	1.9%	5.0%
2154	153	55	1.9%	5.1%
2155	153	55	1.8%	5.2%
2156	153	55	1.8%	5.3%
2157	153	55	1.8%	5.4%
2158	153	55	1.7%	5.5%
2159	153	55	1.7%	5.6%
2160	153	55	1.7%	5.7%
2161	153	55	1.7%	5.8%
2162	153	55	1.6%	5.9%
2163	155	56	1.7%	5.4%
2164	155	56	1.7%	5.5%
2165	155	56	1.7%	5.6%
2166	155	56	1.7%	5.7%
2167	155	56	1.6%	5.8%
2168	155	56	1.6%	5.9%
2169	155	56	1.6%	6.0%
2170	156	57	2.0%	4.8%
2171	156	57	2.0%	4.9%
2172	156	57	1.9%	5.0%
2173	156	57	1.9%	5.1%
2174	156	57	1.9%	5.2%
2175	156	57	1.8%	5.3%
2176	156	57	1.8%	5.4%
2177	156	57	1.8%	5.5%
2178	156	57	1.7%	5.6%
2179	156	57	1.7%	5.7%
2180	156	57	1.7%	5.8%
2181	156	57	1.7%	5.9%
2182	158	58	1.8%	5.4%
2183	158	58	1.7%	5.5%
2184	158	58	1.7%	5.6%
2185	158	58	1.7%	5.7%
2186	158	58	1.7%	5.8%
2187	158	58	1.6%	5.9%

2188	158	58	1.6%	6.0%
2189	160	59	1.7%	5.4%
2190	160	59	1.7%	5.6%
2191	160	59	1.6%	5.7%
2192	160	59	1.6%	5.8%
2193	160	59	1.6%	5.9%
2194	160	59	1.6%	6.0%
2195	161	60	2.0%	4.8%
2196	161	60	1.9%	4.9%
2197	161	60	1.9%	5.0%
2198	161	60	1.9%	5.1%
2199	161	60	1.8%	5.2%
2200	161	60	1.8%	5.3%
2201	161	60	1.8%	5.4%
2202	161	60	1.7%	5.5%
2203	161	60	1.7%	5.6%
2204	161	60	1.7%	5.7%
2205	161	60	1.7%	5.8%
2206	161	60	1.6%	5.9%
2207	163	61	1.7%	5.4%
2208	163	61	1.7%	5.5%
2209	163	61	1.7%	5.6%
2210	163	61	1.6%	5.7%
2211	163	61	1.6%	5.8%
2212	163	61	1.6%	5.9%
2213	164	62	2.0%	4.8%
2214	164	62	2.0%	4.9%
2215	164	62	1.9%	5.0%
2216	164	62	1.9%	5.1%
2217	164	62	1.9%	5.2%
2218	164	62	1.8%	5.3%
2219	164	62	1.8%	5.4%
2220	164	62	1.8%	5.5%
2221	164	62	1.7%	5.6%
2222	164	62	1.7%	5.7%
2223	164	62	1.7%	5.8%
2224	164	62	1.7%	5.9%
2225	164	62	1.6%	6.0%
2226	166	63	1.7%	5.5%
2227	166	63	1.7%	5.6%
2228	166	63	1.7%	5.7%
2229	166	63	1.6%	5.8%
2230	166	63	1.6%	5.9%
2231	166	63	1.6%	6.0%
2232	167	64	2.0%	4.9%
2233	167	64	1.9%	5.0%
2234	167	64	1.9%	5.1%
2235	167	64	1.9%	5.2%
2236	167	64	1.8%	5.3%
2237	167	64	1.8%	5.4%

2238	167	64	1.8%	5.5%
2239	167	64	1.8%	5.6%
2240	167	64	1.7%	5.7%
2241	167	64	1.7%	5.8%
2242	167	64	1.7%	5.9%
2243	167	64	1.7%	6.0%
2244	169	65	1.7%	5.5%
2245	169	65	1.7%	5.6%
2246	169	65	1.7%	5.7%
2247	169	65	1.6%	5.8%
2248	169	65	1.6%	5.9%
2249	171	66	1.7%	5.5%
2250	171	66	1.7%	5.6%
2251	171	66	1.6%	5.7%
2252	171	66	1.6%	5.8%
2253	171	66	1.6%	5.9%
2254	171	66	1.6%	6.0%
2255	172	67	1.9%	4.9%
2256	172	67	1.9%	5.0%
2257	172	67	1.9%	5.1%
2258	172	67	1.8%	5.2%
2259	172	67	1.8%	5.3%
2260	172	67	1.8%	5.4%
2261	172	67	1.8%	5.5%
2262	172	67	1.7%	5.6%
2263	172	67	1.7%	5.6%
2264	172	67	1.7%	5.7%
2265	172	67	1.6%	5.8%
2266	172	67	1.6%	5.9%
2267	173	68	2.0%	4.9%
2268	173	68	2.0%	5.0%
2269	173	68	1.9%	5.1%
2270	173	68	1.9%	5.2%
2271	173	68	1.9%	5.3%
2272	173	68	1.8%	5.3%
2273	173	68	1.8%	5.4%
2274	173	68	1.8%	5.5%
2275	173	68	1.8%	5.6%
2276	173	68	1.7%	5.7%
2277	173	68	1.7%	5.8%
2278	173	68	1.7%	5.9%
2279	175	69	1.7%	5.5%
2280	175	69	1.7%	5.6%
2281	175	69	1.7%	5.7%
2282	175	69	1.7%	5.8%
2283	175	69	1.6%	5.9%
2284	176	70	2.0%	4.9%
2285	176	70	2.0%	5.0%
2286	176	70	1.9%	5.1%
2287	176	70	1.9%	5.2%

2288	176	70	1.9%	5.2%
2289	176	70	1.9%	5.3%
2290	176	70	1.8%	5.4%
2291	176	70	1.8%	5.5%
2292	176	70	1.8%	5.6%
2293	176	70	1.7%	5.7%
2294	176	70	1.7%	5.8%
2295	176	70	1.7%	5.9%
2296	178	71	1.7%	5.5%
2297	178	71	1.7%	5.6%
2298	178	71	1.7%	5.7%
2299	178	71	1.7%	5.8%
2300	178	71	1.6%	5.9%
2301	179	72	2.0%	4.9%
2302	179	72	2.0%	5.0%
2303	179	72	1.9%	5.1%
2304	179	72	1.9%	5.2%
2305	179	72	1.9%	5.3%
2306	179	72	1.9%	5.4%
2307	179	72	1.8%	5.4%
2308	179	72	1.8%	5.5%
2309	179	72	1.8%	5.6%
2310	179	72	1.7%	5.7%
2311	179	72	1.7%	5.8%
2312	179	72	1.7%	5.9%
2313	181	73	1.7%	5.6%
2314	181	73	1.7%	5.7%
2315	181	73	1.7%	5.7%
2316	181	73	1.7%	5.8%
2317	181	73	1.6%	5.9%
2318	182	74	2.0%	4.9%
2319	182	74	2.0%	5.0%
2320	182	74	1.9%	5.1%
2321	182	74	1.9%	5.2%
2322	182	74	1.9%	5.3%
2323	182	74	1.8%	5.4%
2324	182	74	1.8%	5.5%
2325	182	74	1.8%	5.6%
2326	182	74	1.8%	5.7%
2327	182	74	1.7%	5.8%
2328	182	74	1.7%	5.9%
2329	182	74	1.7%	6.0%
2330	184	75	1.7%	5.6%
2331	184	75	1.7%	5.7%
2332	184	75	1.7%	5.8%
2333	184	75	1.6%	5.9%
2334	184	75	1.6%	6.0%
2335	185	76	2.0%	5.0%
2336	185	76	1.9%	5.1%
2337	185	76	1.9%	5.2%

2338	185	76	1.9%	5.3%
2339	185	76	1.8%	5.4%
2340	185	76	1.8%	5.5%
2341	185	76	1.8%	5.5%
2342	185	76	1.8%	5.6%
2343	185	76	1.7%	5.7%
2344	185	76	1.7%	5.8%
2345	185	76	1.7%	5.9%
2346	187	77	1.7%	5.6%
2347	187	77	1.7%	5.7%
2348	187	77	1.7%	5.8%
2349	187	77	1.6%	5.9%
2350	187	77	1.6%	6.0%
2351	188	78	2.0%	5.0%
2352	188	78	1.9%	5.1%
2353	188	78	1.9%	5.2%
2354	188	78	1.9%	5.3%
2355	188	78	1.8%	5.4%
2356	188	78	1.8%	5.4%
2357	188	78	1.8%	5.5%
2358	188	78	1.8%	5.6%
2359	188	78	1.7%	5.7%
2360	188	78	1.7%	5.8%
2361	188	78	1.7%	5.9%
2362	190	79	1.7%	5.6%
2363	190	79	1.7%	5.7%
2364	190	79	1.7%	5.8%
2365	190	79	1.6%	5.9%
2366	190	79	1.6%	6.0%
2367	191	80	1.9%	5.0%
2368	191	80	1.9%	5.1%
2369	191	80	1.9%	5.2%
2370	191	80	1.9%	5.3%
2371	191	80	1.8%	5.4%
2372	191	80	1.8%	5.5%
2373	191	80	1.8%	5.6%
2374	191	80	1.7%	5.6%
2375	191	80	1.7%	5.7%
2376	191	80	1.7%	5.8%
2377	191	80	1.7%	5.9%
2378	193	81	1.7%	5.6%
2379	193	81	1.7%	5.7%
2380	193	81	1.6%	5.8%
2381	193	81	1.6%	5.9%
2382	194	82	1.9%	5.0%
2383	194	82	1.9%	5.1%
2384	194	82	1.9%	5.2%
2385	194	82	1.9%	5.2%
2386	194	82	1.8%	5.3%
2387	194	82	1.8%	5.4%

2388	194	82	1.8%	5.5%
2389	194	82	1.8%	5.6%
2390	194	82	1.7%	5.7%
2391	194	82	1.7%	5.8%
2392	194	82	1.7%	5.9%
2393	194	82	1.6%	6.0%
2394	195	83	2.0%	5.0%
2395	195	83	1.9%	5.1%
2396	195	83	1.9%	5.2%
2397	195	83	1.9%	5.3%
2398	195	83	1.9%	5.4%
2399	195	83	1.8%	5.5%
2400	195	83	1.8%	5.5%
2401	195	83	1.8%	5.6%
2402	195	83	1.8%	5.7%
2403	195	83	1.7%	5.8%
2404	195	83	1.7%	5.9%
2405	197	84	1.7%	5.7%
2406	197	84	1.7%	5.7%
2407	197	84	1.7%	5.8%
2408	197	84	1.6%	5.9%
2409	198	85	2.0%	5.0%
2410	198	85	1.9%	5.1%
2411	198	85	1.9%	5.2%
2412	198	85	1.9%	5.3%
2413	198	85	1.9%	5.4%
2414	198	85	1.8%	5.4%
2415	198	85	1.8%	5.5%
2416	198	85	1.8%	5.6%
2417	198	85	1.8%	5.7%
2418	198	85	1.7%	5.8%
2419	198	85	1.7%	5.9%
2420	198	85	1.7%	6.0%
2421	200	86	1.7%	5.7%
2422	200	86	1.7%	5.8%
2423	200	86	1.6%	5.9%
2424	201	87	2.0%	5.0%
2425	201	87	1.9%	5.1%
2426	201	87	1.9%	5.2%
2427	201	87	1.9%	5.3%
2428	201	87	1.8%	5.4%
2429	201	87	1.8%	5.4%
2430	201	87	1.8%	5.5%
2431	201	87	1.8%	5.6%
2432	201	87	1.7%	5.7%
2433	201	87	1.7%	5.8%
2434	201	87	1.7%	5.9%
2435	201	87	1.7%	6.0%
2436	202	88	2.0%	5.1%
2437	202	88	2.0%	5.2%

2438	202	88	1.9%	5.2%
2439	202	88	1.9%	5.3%
2440	202	88	1.9%	5.4%
2441	202	88	1.8%	5.5%
2442	202	88	1.8%	5.6%
2443	202	88	1.8%	5.7%
2444	202	88	1.8%	5.8%
2445	202	88	1.7%	5.9%
2446	202	88	1.7%	5.9%
2447	204	89	1.7%	5.7%
2448	204	89	1.7%	5.8%
2449	204	89	1.7%	5.9%
2450	205	90	2.0%	5.0%
2451	205	90	2.0%	5.1%
2452	205	90	1.9%	5.2%
2453	205	90	1.9%	5.3%
2454	205	90	1.9%	5.4%
2455	205	90	1.8%	5.4%
2456	205	90	1.8%	5.5%
2457	205	90	1.8%	5.6%
2458	205	90	1.8%	5.7%
2459	205	90	1.7%	5.8%
2460	205	90	1.7%	5.9%
2461	205	90	1.7%	6.0%
2462	207	91	1.7%	5.8%
2463	207	91	1.7%	5.9%
2464	207	91	1.6%	5.9%
2465	208	92	1.9%	5.1%
2466	208	92	1.9%	5.2%
2467	208	92	1.9%	5.2%
2468	208	92	1.9%	5.3%
2469	208	92	1.8%	5.4%
2470	208	92	1.8%	5.5%
2471	208	92	1.8%	5.6%
2472	208	92	1.8%	5.7%
2473	208	92	1.7%	5.8%
2474	208	92	1.7%	5.8%
2475	208	92	1.7%	5.9%
2476	209	93	2.0%	5.1%
2477	209	93	2.0%	5.2%
2478	209	93	1.9%	5.2%
2479	209	93	1.9%	5.3%
2480	209	93	1.9%	5.4%
2481	209	93	1.9%	5.5%
2482	209	93	1.8%	5.6%
2483	209	93	1.8%	5.7%
2484	209	93	1.8%	5.7%
2485	209	93	1.8%	5.8%
2486	209	93	1.7%	5.9%
2487	211	94	1.7%	5.7%

2488	211	94	1.7%	5.8%
2489	211	94	1.7%	5.9%
2490	212	95	2.0%	5.1%
2491	212	95	1.9%	5.1%
2492	212	95	1.9%	5.2%
2493	212	95	1.9%	5.3%
2494	212	95	1.9%	5.4%
2495	212	95	1.8%	5.5%
2496	212	95	1.8%	5.6%
2497	212	95	1.8%	5.6%
2498	212	95	1.8%	5.7%
2499	212	95	1.7%	5.8%
2500	212	95	1.7%	5.9%
2501	212	95	1.7%	6.0%
2502	213	96	2.0%	5.1%
2503	213	96	2.0%	5.2%
2504	213	96	1.9%	5.3%
2505	213	96	1.9%	5.4%
2506	213	96	1.9%	5.5%
2507	213	96	1.9%	5.6%
2508	213	96	1.8%	5.6%
2509	213	96	1.8%	5.7%
2510	213	96	1.8%	5.8%
2511	213	96	1.8%	5.9%
2512	213	96	1.7%	6.0%
2513	215	97	1.7%	5.8%
2514	215	97	1.7%	5.9%
2515	215	97	1.7%	6.0%
2516	216	98	2.0%	5.2%
2517	216	98	1.9%	5.2%
2518	216	98	1.9%	5.3%
2519	216	98	1.9%	5.4%
2520	216	98	1.9%	5.5%
2521	216	98	1.8%	5.6%
2522	216	98	1.8%	5.6%
2523	216	98	1.8%	5.7%
2524	216	98	1.7%	5.8%
2525	216	98	1.7%	5.9%
2526	216	98	1.7%	6.0%
2527	217	99	2.0%	5.2%
2528	217	99	2.0%	5.2%
2529	217	99	1.9%	5.3%
2530	217	99	1.9%	5.4%
2531	217	99	1.9%	5.5%
2532	217	99	1.9%	5.6%
2533	217	99	1.8%	5.6%
2534	217	99	1.8%	5.7%
2535	217	99	1.8%	5.8%
2536	217	99	1.8%	5.9%
2537	217	99	1.7%	6.0%

2538	219	100	1.7%	5.9%
2539	219	100	1.7%	5.9%
2540	220	101	2.0%	5.1%
2541	220	101	2.0%	5.2%
2542	220	101	1.9%	5.3%
2543	220	101	1.9%	5.4%
2544	220	101	1.9%	5.4%
2545	220	101	1.9%	5.5%
2546	220	101	1.8%	5.6%
2547	220	101	1.8%	5.7%
2548	220	101	1.8%	5.8%
2549	220	101	1.8%	5.9%
2550	220	101	1.7%	5.9%
2551	222	102	1.7%	5.8%
2552	222	102	1.7%	5.9%
2553	222	102	1.7%	6.0%
2554	223	103	1.9%	5.2%
2555	223	103	1.9%	5.3%
2556	223	103	1.9%	5.3%
2557	223	103	1.9%	5.4%
2558	223	103	1.8%	5.5%
2559	223	103	1.8%	5.6%
2560	223	103	1.8%	5.7%
2561	223	103	1.8%	5.7%
2562	223	103	1.7%	5.8%
2563	223	103	1.7%	5.9%
2564	223	103	1.7%	6.0%
2565	224	104	2.0%	5.2%
2566	224	104	1.9%	5.3%
2567	224	104	1.9%	5.3%
2568	224	104	1.9%	5.4%
2569	224	104	1.9%	5.5%
2570	224	104	1.8%	5.6%
2571	224	104	1.8%	5.7%
2572	224	104	1.8%	5.8%
2573	224	104	1.8%	5.8%
2574	224	104	1.7%	5.9%
2575	226	105	1.7%	5.8%
2576	226	105	1.7%	5.9%
2577	226	105	1.7%	6.0%
2578	227	106	1.9%	5.2%
2579	227	106	1.9%	5.3%
2580	227	106	1.9%	5.3%
2581	227	106	1.9%	5.4%
2582	227	106	1.8%	5.5%
2583	227	106	1.8%	5.6%
2584	227	106	1.8%	5.7%
2585	227	106	1.8%	5.7%
2586	227	106	1.7%	5.8%
2587	227	106	1.7%	5.9%

2588	229	107	1.7%	5.8%
2589	229	107	1.7%	5.9%
2590	229	107	1.6%	6.0%
2591	230	108	1.9%	5.2%
2592	230	108	1.9%	5.3%
2593	230	108	1.9%	5.4%
2594	230	108	1.8%	5.4%
2595	230	108	1.8%	5.5%
2596	230	108	1.8%	5.6%
2597	230	108	1.8%	5.7%
2598	230	108	1.7%	5.8%
2599	230	108	1.7%	5.8%
2600	230	108	1.7%	5.9%
2601	231	109	2.0%	5.1%
2602	231	109	1.9%	5.2%
2603	231	109	1.9%	5.3%
2604	231	109	1.9%	5.4%
2605	231	109	1.9%	5.5%
2606	231	109	1.8%	5.5%
2607	231	109	1.8%	5.6%
2608	231	109	1.8%	5.7%
2609	231	109	1.8%	5.8%
2610	231	109	1.7%	5.9%
2611	231	109	1.7%	6.0%
2612	232	110	2.0%	5.2%
2613	232	110	2.0%	5.3%
2614	232	110	1.9%	5.3%
2615	232	110	1.9%	5.4%
2616	232	110	1.9%	5.5%
2617	232	110	1.9%	5.6%
2618	232	110	1.8%	5.6%
2619	232	110	1.8%	5.7%
2620	232	110	1.8%	5.8%
2621	232	110	1.8%	5.9%
2622	232	110	1.7%	6.0%
2623	234	111	1.7%	5.9%
2624	234	111	1.7%	6.0%
2625	235	112	1.9%	5.2%
2626	235	112	1.9%	5.3%
2627	235	112	1.9%	5.4%
2628	235	112	1.9%	5.4%
2629	235	112	1.8%	5.5%
2630	235	112	1.8%	5.6%
2631	235	112	1.8%	5.7%
2632	235	112	1.8%	5.8%
2633	235	112	1.7%	5.8%
2634	235	112	1.7%	5.9%
2635	236	113	2.0%	5.2%
2636	236	113	2.0%	5.2%
2637	236	113	1.9%	5.3%

2638	236	113	1.9%	5.4%
2639	236	113	1.9%	5.5%
2640	236	113	1.9%	5.6%
2641	236	113	1.8%	5.6%
2642	236	113	1.8%	5.7%
2643	236	113	1.8%	5.8%
2644	236	113	1.8%	5.9%
2645	236	113	1.7%	6.0%
2646	238	114	1.7%	5.9%
2647	238	114	1.7%	6.0%
2648	239	115	1.9%	5.2%
2649	239	115	1.9%	5.3%
2650	239	115	1.9%	5.4%
2651	239	115	1.9%	5.5%
2652	239	115	1.8%	5.5%
2653	239	115	1.8%	5.6%
2654	239	115	1.8%	5.7%
2655	239	115	1.8%	5.8%
2656	239	115	1.7%	5.9%
2657	239	115	1.7%	5.9%
2658	240	116	2.0%	5.2%
2659	240	116	2.0%	5.3%
2660	240	116	1.9%	5.3%
2661	240	116	1.9%	5.4%
2662	240	116	1.9%	5.5%
2663	240	116	1.9%	5.6%
2664	240	116	1.8%	5.7%
2665	240	116	1.8%	5.7%
2666	240	116	1.8%	5.8%
2667	240	116	1.8%	5.9%
2668	240	116	1.7%	6.0%
2669	242	117	1.7%	5.9%
2670	243	118	2.0%	5.2%
2671	243	118	1.9%	5.3%
2672	243	118	1.9%	5.3%
2673	243	118	1.9%	5.4%
2674	243	118	1.9%	5.5%
2675	243	118	1.8%	5.6%
2676	243	118	1.8%	5.7%
2677	243	118	1.8%	5.7%
2678	243	118	1.8%	5.8%
2679	243	118	1.7%	5.9%
2680	243	118	1.7%	6.0%
2681	244	119	2.0%	5.2%
2682	244	119	1.9%	5.3%
2683	244	119	1.9%	5.4%
2684	244	119	1.9%	5.5%
2685	244	119	1.9%	5.5%
2686	244	119	1.8%	5.6%
2687	244	119	1.8%	5.7%

2688	244	119	1.8%	5.8%
2689	244	119	1.8%	5.9%
2690	244	119	1.7%	5.9%
2691	246	120	1.7%	5.9%
2692	246	120	1.7%	6.0%
2693	247	121	1.9%	5.3%
2694	247	121	1.9%	5.3%
2695	247	121	1.9%	5.4%
2696	247	121	1.9%	5.5%
2697	247	121	1.8%	5.6%
2698	247	121	1.8%	5.6%
2699	247	121	1.8%	5.7%
2700	247	121	1.8%	5.8%
2701	247	121	1.7%	5.9%
2702	247	121	1.7%	6.0%
2703	248	122	2.0%	5.2%
2704	248	122	1.9%	5.3%
2705	248	122	1.9%	5.4%
2706	248	122	1.9%	5.5%
2707	248	122	1.9%	5.5%
2708	248	122	1.8%	5.6%
2709	248	122	1.8%	5.7%
2710	248	122	1.8%	5.8%
2711	248	122	1.8%	5.8%
2712	248	122	1.7%	5.9%
2713	250	123	1.7%	5.9%
2714	250	123	1.7%	6.0%
2715	251	124	1.9%	5.3%
2716	251	124	1.9%	5.3%
2717	251	124	1.9%	5.4%
2718	251	124	1.8%	5.5%
2719	251	124	1.8%	5.6%
2720	251	124	1.8%	5.6%
2721	251	124	1.8%	5.7%
2722	251	124	1.7%	5.8%
2723	251	124	1.7%	5.9%
2724	251	124	1.7%	6.0%
2725	252	125	2.0%	5.2%
2726	252	125	1.9%	5.3%
2727	252	125	1.9%	5.4%
2728	252	125	1.9%	5.5%
2729	252	125	1.9%	5.5%
2730	252	125	1.8%	5.6%
2731	252	125	1.8%	5.7%
2732	252	125	1.8%	5.8%
2733	252	125	1.8%	5.9%
2734	252	125	1.7%	5.9%
2735	253	126	2.0%	5.2%
2736	253	126	2.0%	5.3%
2737	253	126	1.9%	5.4%

2738	253	126	1.9%	5.4%
2739	253	126	1.9%	5.5%
2740	253	126	1.9%	5.6%
2741	253	126	1.8%	5.7%
2742	253	126	1.8%	5.8%
2743	253	126	1.8%	5.8%
2744	253	126	1.8%	5.9%
2745	253	126	1.7%	6.0%
2746	255	127	1.7%	6.0%
2747	256	128	1.9%	5.3%
2748	256	128	1.9%	5.4%
2749	256	128	1.9%	5.4%
2750	256	128	1.9%	5.5%
2751	256	128	1.8%	5.6%
2752	256	128	1.8%	5.7%
2753	256	128	1.8%	5.7%
2754	256	128	1.8%	5.8%
2755	256	128	1.7%	5.9%
2756	256	128	1.7%	6.0%
2757	257	129	2.0%	5.3%
2758	257	129	1.9%	5.3%
2759	257	129	1.9%	5.4%
2760	257	129	1.9%	5.5%
2761	257	129	1.9%	5.6%
2762	257	129	1.8%	5.6%
2763	257	129	1.8%	5.7%
2764	257	129	1.8%	5.8%
2765	257	129	1.8%	5.9%
2766	257	129	1.7%	5.9%
2767	259	130	1.7%	6.0%
2768	260	131	1.9%	5.3%
2769	260	131	1.9%	5.3%
2770	260	131	1.9%	5.4%
2771	260	131	1.9%	5.5%
2772	260	131	1.8%	5.6%
2773	260	131	1.8%	5.6%
2774	260	131	1.8%	5.7%
2775	260	131	1.8%	5.8%
2776	260	131	1.7%	5.9%
2777	260	131	1.7%	5.9%
2778	261	132	2.0%	5.3%
2779	261	132	1.9%	5.3%
2780	261	132	1.9%	5.4%
2781	261	132	1.9%	5.5%
2782	261	132	1.9%	5.6%
2783	261	132	1.8%	5.6%
2784	261	132	1.8%	5.7%
2785	261	132	1.8%	5.8%
2786	261	132	1.8%	5.9%
2787	261	132	1.7%	5.9%

2788	262	133	2.0%	5.3%
2789	262	133	2.0%	5.3%
2790	262	133	1.9%	5.4%
2791	262	133	1.9%	5.5%
2792	262	133	1.9%	5.5%
2793	262	133	1.9%	5.6%
2794	262	133	1.8%	5.7%
2795	262	133	1.8%	5.8%
2796	262	133	1.8%	5.8%
2797	262	133	1.8%	5.9%
2798	264	134	1.7%	6.0%
2799	265	135	1.9%	5.3%
2800	265	135	1.9%	5.3%
2801	265	135	1.9%	5.4%
2802	265	135	1.9%	5.5%
2803	265	135	1.8%	5.6%
2804	265	135	1.8%	5.6%
2805	265	135	1.8%	5.7%
2806	265	135	1.8%	5.8%
2807	265	135	1.7%	5.9%
2808	265	135	1.7%	5.9%
2809	266	136	2.0%	5.3%
2810	266	136	1.9%	5.3%
2811	266	136	1.9%	5.4%
2812	266	136	1.9%	5.5%
2813	266	136	1.9%	5.6%
2814	266	136	1.8%	5.6%
2815	266	136	1.8%	5.7%
2816	266	136	1.8%	5.8%
2817	266	136	1.8%	5.9%
2818	266	136	1.8%	5.9%
2819	267	137	2.0%	5.3%
2820	267	137	2.0%	5.3%
2821	267	137	1.9%	5.4%
2822	267	137	1.9%	5.5%
2823	267	137	1.9%	5.6%
2824	267	137	1.9%	5.6%
2825	267	137	1.9%	5.7%
2826	267	137	1.8%	5.8%
2827	267	137	1.8%	5.9%
2828	267	137	1.8%	5.9%
2829	269	138	1.7%	6.0%
2830	270	139	1.9%	5.3%
2831	270	139	1.9%	5.4%
2832	270	139	1.9%	5.5%
2833	270	139	1.9%	5.5%
2834	270	139	1.8%	5.6%
2835	270	139	1.8%	5.7%
2836	270	139	1.8%	5.7%
2837	270	139	1.8%	5.8%

2838	270	139	1.8%	5.9%
2839	270	139	1.7%	6.0%
2840	271	140	2.0%	5.3%
2841	271	140	1.9%	5.4%
2842	271	140	1.9%	5.5%
2843	271	140	1.9%	5.5%
2844	271	140	1.9%	5.6%
2845	271	140	1.8%	5.7%
2846	271	140	1.8%	5.7%
2847	271	140	1.8%	5.8%
2848	271	140	1.8%	5.9%
2849	271	140	1.8%	6.0%
2850	272	141	2.0%	5.3%
2851	272	141	2.0%	5.4%
2852	272	141	1.9%	5.5%
2853	272	141	1.9%	5.5%
2854	272	141	1.9%	5.6%
2855	272	141	1.9%	5.7%
2856	272	141	1.8%	5.7%
2857	272	141	1.8%	5.8%
2858	272	141	1.8%	5.9%
2859	272	141	1.8%	6.0%
2860	275	143	2.0%	5.3%
2861	275	143	1.9%	5.4%
2862	275	143	1.9%	5.4%
2863	275	143	1.9%	5.5%
2864	275	143	1.9%	5.6%
2865	275	143	1.8%	5.7%
2866	275	143	1.8%	5.7%
2867	275	143	1.8%	5.8%
2868	275	143	1.8%	5.9%
2869	275	143	1.7%	6.0%
2870	276	144	2.0%	5.3%
2871	276	144	1.9%	5.4%
2872	276	144	1.9%	5.4%
2873	276	144	1.9%	5.5%
2874	276	144	1.9%	5.6%
2875	276	144	1.9%	5.7%
2876	276	144	1.8%	5.7%
2877	276	144	1.8%	5.8%
2878	276	144	1.8%	5.9%
2879	276	144	1.8%	6.0%
2880	277	145	2.0%	5.3%
2881	277	145	2.0%	5.4%
2882	277	145	1.9%	5.5%
2883	277	145	1.9%	5.5%
2884	277	145	1.9%	5.6%
2885	277	145	1.9%	5.7%
2886	277	145	1.9%	5.7%
2887	277	145	1.8%	5.8%

2888	277	145	1.8%	5.9%
2889	277	145	1.8%	6.0%
2890	280	147	1.9%	5.3%
2891	280	147	1.9%	5.4%
2892	280	147	1.9%	5.5%
2893	280	147	1.9%	5.5%
2894	280	147	1.9%	5.6%
2895	280	147	1.8%	5.7%
2896	280	147	1.8%	5.7%
2897	280	147	1.8%	5.8%
2898	280	147	1.8%	5.9%
2899	280	147	1.7%	6.0%
2900	281	148	2.0%	5.3%
2901	281	148	1.9%	5.4%
2902	281	148	1.9%	5.5%
2903	281	148	1.9%	5.5%
2904	281	148	1.9%	5.6%
2905	281	148	1.9%	5.7%
2906	281	148	1.8%	5.8%
2907	281	148	1.8%	5.8%
2908	281	148	1.8%	5.9%
2909	281	148	1.8%	6.0%
2910	282	149	2.0%	5.3%
2911	282	149	2.0%	5.4%
2912	282	149	1.9%	5.5%
2913	282	149	1.9%	5.6%
2914	282	149	1.9%	5.6%
2915	282	149	1.9%	5.7%
2916	282	149	1.8%	5.8%
2917	282	149	1.8%	5.8%
2918	282	149	1.8%	5.9%
2919	282	149	1.8%	6.0%
2920	285	151	1.9%	5.4%
2921	285	151	1.9%	5.4%
2922	285	151	1.9%	5.5%
2923	285	151	1.9%	5.6%
2924	285	151	1.8%	5.7%
2925	285	151	1.8%	5.7%
2926	285	151	1.8%	5.8%
2927	285	151	1.8%	5.9%
2928	285	151	1.8%	5.9%
2929	286	152	2.0%	5.3%
2930	286	152	2.0%	5.4%
2931	286	152	1.9%	5.5%
2932	286	152	1.9%	5.5%
2933	286	152	1.9%	5.6%
2934	286	152	1.9%	5.7%
2935	286	152	1.8%	5.7%
2936	286	152	1.8%	5.8%
2937	286	152	1.8%	5.9%

2938	286	152	1.8%	6.0%
2939	287	153	2.0%	5.3%
2940	287	153	2.0%	5.4%
2941	287	153	1.9%	5.5%
2942	287	153	1.9%	5.5%
2943	287	153	1.9%	5.6%
2944	287	153	1.9%	5.7%
2945	287	153	1.9%	5.8%
2946	287	153	1.8%	5.8%
2947	287	153	1.8%	5.9%
2948	287	153	1.8%	6.0%
2949	290	155	1.9%	5.4%
2950	290	155	1.9%	5.4%
2951	290	155	1.9%	5.5%
2952	290	155	1.9%	5.6%
2953	290	155	1.8%	5.7%
2954	290	155	1.8%	5.7%
2955	290	155	1.8%	5.8%
2956	290	155	1.8%	5.9%
2957	290	155	1.8%	5.9%
2958	291	156	2.0%	5.3%
2959	291	156	1.9%	5.4%
2960	291	156	1.9%	5.5%
2961	291	156	1.9%	5.5%
2962	291	156	1.9%	5.6%
2963	291	156	1.9%	5.7%
2964	291	156	1.8%	5.7%
2965	291	156	1.8%	5.8%
2966	291	156	1.8%	5.9%
2967	291	156	1.8%	6.0%
2968	292	157	2.0%	5.3%
2969	292	157	2.0%	5.4%
2970	292	157	1.9%	5.5%
2971	292	157	1.9%	5.6%
2972	292	157	1.9%	5.6%
2973	292	157	1.9%	5.7%
2974	292	157	1.8%	5.8%
2975	292	157	1.8%	5.8%
2976	292	157	1.8%	5.9%
2977	292	157	1.8%	6.0%
2978	295	159	1.9%	5.4%
2979	295	159	1.9%	5.5%
2980	295	159	1.9%	5.5%
2981	295	159	1.9%	5.6%
2982	295	159	1.8%	5.7%
2983	295	159	1.8%	5.8%
2984	295	159	1.8%	5.8%
2985	295	159	1.8%	5.9%
2986	295	159	1.7%	6.0%
2987	296	160	2.0%	5.4%

2988	296	160	1.9%	5.4%
2989	296	160	1.9%	5.5%
2990	296	160	1.9%	5.6%
2991	296	160	1.9%	5.6%
2992	296	160	1.8%	5.7%
2993	296	160	1.8%	5.8%
2994	296	160	1.8%	5.8%
2995	296	160	1.8%	5.9%
2996	296	160	1.8%	6.0%
2997	297	161	2.0%	5.4%
2998	297	161	1.9%	5.5%
2999	297	161	1.9%	5.5%
3000	297	161	1.9%	5.6%

HOW TO USE THIS CALCULATOR:

There are three inputs to this calculator:

- members lodged
- sample size
- maximum number of denials allowed

The calculator will then give the probabilities of false acceptance and false rejection using these inputs. The size of the acceptable and unacceptable lists have been set to 1500 and 1200 respectively

There is also a cell next to the each error rate indicating whether it is within the tolerance bounds specified

There are some adjustable assumptions made listed below

INPUTS	
Members Lodged	1550
Sample size	37
Maximum number of denials allowed	3

ASSUMPTIONS	
Valid list size	1500
Invalid list size	1200
Probability of accepting an invalid list	2%
Probability of rejecting a valid list	6%

RESULT		
Probability of false rejection	2.89%	<6% (OK)
Probability of false acceptance	1.91%	<2% (OK)

HOW TO USE THIS CALCULATOR:
There are three inputs to this calculator:
- members lodged
- desired probability of false rejection
- desired probability of false acceptance

The calculator will then give an approximate sample size and maximum number of denials needed to achieve both the desired probabilities

INPUTS	
Members Lodged	1650
Desired probability of false rejection	6%
Desired probability of false acceptance	2%

ASSUMPTIONS	
Acceptable list	1500
Unacceptable list	1200

RESULT	
Approximate sample size required	55
Approximate maximum number of denials	8

WARNING!!

This sheet is used to store intermediate calculations for the sample size calculator

Do not change the cells in this sheet or the calculator may not work properly

A	0.181818
B	-1.36163
n0	56.08437
n1	54.25815

mu0	5
mu1	15
sig0	2.096808
sig1	3.248361
c0	7.760062
c1	7.828682

Step	Description
1	decrease sample size until FRR<6%
2	increase denial by 1
3	increase sample size until FAR<2%

operation	description
1	decrease sample
2	increase sample
3	decrease denials
4	increase denials

n	c	p1	p2	p1_crit	p2_crit	next step	next operation
55	8	0.05568	0.018318	1	1	1	1
54	8	0.050348	0.02193	1	0	3	2
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0

55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0

55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0
55	8	0.05568	0.018318	1	1	0	0

Algorithm for deriving sampling plan for AEC membership testing

Outline

This document provides the mathematical algorithm used to create the sampling plans for the AEC for list sizes up to 3000

We consider taking a sample of size n from a population of size N and decide whether to reject or accept the list based on how many invalid members are found in the sample x. If there are too many invalid members in the sample, then the list is rejected as not having enough valid members.

The algorithm determines the sample size and maximum denials as outputs (n, m). It takes the population size N as an input, and the probability of two alternative scenarios

A. The probability that a list of size N containing V_A valid members will pass the test $(1 - \alpha)$
B. The probability that a list of size N containing V_B valid members will pass the test (β)

The goal of the algorithm is to choose (n, m) such that

$$\Pr(A|N, n, m) \geq 1 - \alpha$$

$$\Pr(B|N, n, m) \leq \beta$$

Both of these probabilities are calculated using the hypergeometric distribution

$$\Pr(A|N, n, m) = \sum_{x \leq m} \frac{\binom{N - V_A}{x}\binom{V_A}{n - x}}{\binom{N}{n}} \geq 1 - \alpha$$

$$\Pr(B|N, n, m) = \sum_{x \leq m} \frac{\binom{N - V_B}{x}\binom{V_B}{n - x}}{\binom{N}{n}} \leq \beta$$

There are some special properties of the hypergeometric distribution that can be used to efficiently search the space of (n, m)

We know for a fixed sample size and population size, the more denials allowed the higher the probability of passing the test.

$$\Pr(A|N, n, m) \leq \Pr(A|N, n, m + 1)$$

$$\Pr(B|N, n, m) \leq \Pr(B|N, n, m + 1)$$

Additionally, we also can show that for a fixed sample size and maximum denials, increasing the population size will decrease the probability of passing the test under certain conditions.

$$V_A < (N + 1)\left(1 - \frac{m}{n}\right) \Rightarrow \Pr(A|N, n, m) \leq \Pr(A|N + 1, n, m)$$

$$V_B < (N + 1)\left(1 - \frac{m}{n}\right) \Rightarrow \Pr(B|N, n, m) \leq \Pr(B|N + 1, n, m)$$

This condition is sufficient, but not necessary. Note that the quantity $(N+1)\left(1-\frac{m}{n}\right)$ is a simple estimator of the number of valid members in the population based on a sample sized n with m denials. As the basis of the test is to accept when this is V_A and reject when this is V_B we should roughly expect the following in the optimal region of denials for a given sample size to satisfy

$$V_B < (N+1)\left(1-\frac{m}{n}\right) < V_A$$

This means we should expect the false rejection rate to increase, and the false acceptance rate to decrease when the population size is increased. Note that as the number of valid members is staying fixed, this scenario is essentially adding 1 invalid member to the list.

And finally, for a fixed population size and maximum denials, increasing the sample size by 1 will decrease the probability of passing the test under certain conditions.

$$V_A < N\left(1-\frac{m}{n+1}\right)+\frac{m}{n+1} \Rightarrow \Pr(A|N,n,m) \leq \Pr(A|N,n+1,m)$$

$$V_B < N\left(1-\frac{m}{n+1}\right)+\frac{m}{n+1} \Rightarrow \Pr(B|N,n,m) \leq \Pr(B|N,n+1,m)$$

This condition is sufficient, but not necessary. Note that the quantity $N\left(1-\frac{m}{n+1}\right)+\frac{m}{n+1}$ is very close to the estimated number of valid members in the population based on a sample sized $n+1$ with m denials. Similar to the other condition, we should expect that in the optimal region we should see

$$V_B < N\left(1-\frac{m}{n+1}\right)+\frac{m}{n+1} < V_A$$

This means we should expect the false rejection rate to increase, and the false acceptance rate to decrease when the sample size is increased. Note that this scenario is essentially requiring an extra valid member to accept the list.

To apply these heuristics, we need to find a solution that is optimal that we can start from. The point $N = V_A$ is a good choice, as we know that the false rejection rate for $m = 0$ denials is 0% as there are no invalid members.

$$\Pr(A|N = V_A, n, 0) = 1 \geq 1-\alpha$$

Further, the probability for false acceptance simplifies to

$$\Pr(B|X_A, n, 0) = \frac{\binom{V_A - V_B}{0}\binom{V_B}{n}}{\binom{V_A}{n}} = \frac{\binom{V_B}{n}}{\binom{V_A}{n}} = \prod_{j=0}^{n-1}\frac{V_B - j}{V_A - j} \approx \left(\frac{V_B}{V_A}\right)^n$$

So, we only require the sample size require to ensure that $\Pr(B|X_A, n, 0) \leq \beta$.

If we use the notation $n(N)$ as the minimum sample size required to satisfy both constraints when the population is size N, we can proceed as follows.

- We can find $n(X_A)$ by a simple line search such that $\Pr(B|X_A, n(X_A), 0) \leq \beta$ and $\Pr(B|X_A, n(X_A)+1, 0) > \beta$. Solving the approximation can be used to give an initial value that should be close to the boundary, which is $n \approx \frac{\log\beta}{\log\left(\frac{V_B}{V_A}\right)}$
- We can check if this sampling plan will also apply to larger populations. As $\Pr(B|X_A + c, n(X_A), 0) < \Pr(B|X_A, n(X_A), 0)$ we only need to consider the false rejection

probability. We will denote the population size $N^{(0)}$ as the quantity which satisfies $\Pr\left(A\middle|N^{(0)}, n(X_A), 0\right) \geq 1-\alpha$ and $\Pr\left(A\middle|N^{(0)}+1, n(X_A), 0\right) < 1-\alpha$

- We now have $n(N) = n(X_A)$ for $X_A \leq N \leq N^{(0)}$
- There is no feasible sample size for $N > N^{(0)}$ when $m = 0$

Then, for the next case, where $N = N^{(0)} + 1$ we need to increase the number of denials to be $m = 1$. We know this will increase the probability in both scenarios. This means that we can write

$$\Pr\left(A\middle|N^{(0)}+1, n(X_A), 1\right) > \Pr\left(A\middle|N^{(0)}+1, n(X_A), 0\right)$$

$$\Pr\left(B\middle|N^{(0)}+1, n(X_A), 1\right) > \Pr\left(B\middle|N^{(0)}+1, n(X_A), 0\right)$$

This change pushes the first probability in the "right direction" but pushes the second in the "wrong direction". This may mean that the one or both inequality constraints could be violated.

In any event, we should be able to increase the sample size until the false acceptance rate is achieved. That is we choose an integer $\boldsymbol{c} > 0$ such that the following two conditions hold

$$\Pr\left(B\middle|N^{(0)}+1, n(X_A)+\boldsymbol{c}, 1\right) \leq \beta$$

$$\Pr\left(B\middle|N^{(0)}+1, n(X_A)+\boldsymbol{c}-1, 1\right) > \beta$$

We can call this sample size $n\left(N^{(0)}+1\right) = n(X_A) + \boldsymbol{c}$.

Now, when we increase the population size, while we know that $n\left(N^{(0)}+1+k\right)$ must be larger than $n(X_A)$, it may not need to be larger than $n\left(N^{(0)}+1\right)$ due to the discrete nature of the parameters. So we can proceed as follows:

1. Set $k = 1$ and $N^{(1)} = N^{(0)}$
2. Set $n^{(0)} = n\left(N^{(1)}\right)$
3. If both constraints are satisfied, then do the following:
    a. Decrease $n^{(1)} = n^{(0)} - c$ such that at least one of the constraints are violated
    $$\left\{\Pr\left(A\middle|N^{(0)}+k, n^{(1)}, 1\right) < 1-\alpha \quad OR \quad \Pr\left(B\middle|N^{(0)}+k, n^{(1)}, 1\right) > \beta\right\}$$
    $$AND$$
    $$\left\{\Pr\left(A\middle|N^{(0)}+k, n^{(1)}+1, 1\right) \geq 1-\alpha \quad AND \quad \Pr\left(B\middle|N^{(0)}+k, n^{(1)}+1, 1\right) \leq \beta\right\}$$
    b. Set $n\left(N^{(0)}+k\right) = n^{(1)} + 1$.
4. If $\Pr\left(B\middle|N^{(0)}+k, n^{(0)}, 1\right) > \beta$ then do the following:
    a. set $n^{(1)} = n^{(0)} + c$ such that
    $$\Pr\left(B\middle|N^{(0)}+k, n^{(1)}, 1\right) \leq \beta \quad AND \quad \Pr\left(B\middle|N^{(0)}+k, n^{(1)}-1, 1\right) > \beta$$
    b. If $\Pr\left(A\middle|N^{(0)}+k, n^{(1)}, 1\right) \geq 1-\alpha$ then set $n\left(N^{(0)}+k\right) = n^{(1)}$. Otherwise, we say there is no sample size with only 1 denial that can satisfy the error constraints for the population size $N^{(0)}+k$.
5. If a sample size was created, then set $N^{(1)} = n\left(N^{(0)}+k\right)$, set $k = k+1$ and return to step 2. Otherwise, stop the algorithm.

We can further expand this by including the number of denials into the algorithm as follows:

1. Set $m = 1$ and determine $N^{(0)}$
2. Set $k = 1$ and $N^{(m)} = N^{(m-1)}$
3. Set $n^{(0)} = n\left(N^{(m)}\right)$

4. If both constraints are satisfied, then do the following:
    a. Decrease $n^{(1)} = n^{(0)} - c$ such that at least one of the constraints are violated
    $\{\Pr(A|N^{(m-1)} + k, n^{(1)}, 1) < 1 - \alpha \quad OR \quad \Pr(B|N^{(m-1)} + k, n^{(1)}, 1) > \beta\}$
    AND
    $\{\Pr(A|N^{(m-1)} + k, n^{(1)} + 1, 1) \geq 1 - \alpha \quad AND \quad \Pr(B|N^{(m-1)} + k, n^{(1)} + 1, 1) \leq \beta\}$
    b. Set $n(N^{(m-1)} + k) = n^{(1)} + 1$.
5. If $\Pr(B|N^{(0)} + k, n^{(0)}, 1) > \beta$ then do the following:
    a. set $n^{(1)} = n^{(0)} + c$ such that
    $$\Pr(B|N^{(m-1)} + k, n^{(1)}, 1) \leq \beta \quad AND \quad \Pr(B|N^{(m-1)} + k, n^{(1)} - 1, 1) > \beta$$
    b. If $\Pr(A|N^{(m-1)} + k, n^{(1)}, 1) \geq 1 - \alpha$ then set $n(N^{(m-1)} + k) = n^{(1)}$. Otherwise, we say there is no sample size with only m denial that can satisfy the error constraints for the population size $N^{(m-1)} + k$.
6. If a sample size was created, then set $N^{(1)} = n(N^{(0)} + k)$, set $k = k + 1$ and return to step 3. Otherwise, set $m = m + 1$ and return to step 2.

Proofs

The first inequality is obvious as a property of the cumulative distribution function. There is one additional term in the summation for $m + 1$ denials compared to that for m denials.

For the second proof, if we can show conditions when

$$\frac{\binom{N+1-V}{x}\binom{V}{n-x}}{\binom{N+1}{n}} \leq \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

Then we can substitute this into the expression for the probability to obtain

$$\sum_{x \leq m} \frac{\binom{N+1-V}{x}\binom{V}{n-x}}{\binom{N+1}{n}} \leq \sum_{x \leq m} \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

Then we have a proof. We start by noting that we can remove most of the combinatorical functions as follows.

$$\frac{\binom{N+1-V}{x}\binom{V}{n-x}}{\binom{N+1}{n}} = \frac{\binom{N-V}{x}\frac{N+1-V}{N+1-V-x}\binom{V}{n-x}}{\binom{N}{n}\frac{N+1}{N+1-n}}$$

So, for the inequality to be true we require

$$\frac{\frac{N+1-V}{N+1-V-x}}{\frac{N+1}{N+1-n}} \leq 1$$

Which can be re-arranged as follows

$$\frac{\frac{N+1-V}{N+1-V-x}}{\frac{N+1}{N+1-n}} \leq 1 \Leftrightarrow \frac{N+1-V}{N+1-V-x} \leq \frac{N+1}{N+1-n}$$

$$\Leftrightarrow 1+\frac{x}{N+1-V-x} \leq 1+\frac{n}{N+1-n}$$

$$\Leftrightarrow \frac{x}{N+1-V-x} \leq \frac{n}{N+1-n}$$

$$\Leftrightarrow \frac{x}{n} \leq \frac{N+1-V-x}{N+1-n}$$

$$\Leftrightarrow \frac{x}{n}(N+1-n) \leq N+1-V-x$$

$$\Leftrightarrow V \leq N+1-x-\frac{x}{n}(N+1-n)$$

$$\Leftrightarrow V \leq N+1-\frac{x}{n}(N+1)$$

$$\Leftrightarrow V \leq (N+1)\left(1-\frac{x}{n}\right)$$

$$\Leftrightarrow V \leq (N+1)\left(1-\frac{m}{n}\right) \quad \forall x \leq m$$

This completes the proof.

For the third proof, we need to show that

$$V < (n-m)+(N-n)\left(1-\frac{m}{n+1}\right)$$

Will decrease the probability of passing the test. We start by noting that the RHS increases as m decreases so we have

$$V < (n-m)+(N-n)\left(1-\frac{m}{n+1}\right) \Rightarrow V < (n-x)+(N-n)\left(1-\frac{x}{n+1}\right) \quad \forall x \leq m$$

We can then re-arrange this expression as follows:

$$V < (n-x)+(N-n)\left(1-\frac{x}{n+1}\right)$$

$$\Leftrightarrow V-(n-x) < (N-n)\left(1-\frac{x}{n+1}\right)$$

$$\Leftrightarrow \frac{V-(n-x)}{N-n} < \frac{n-x+1}{n+1}$$

$$\Leftrightarrow \left(\frac{n+1}{n+1-x}\right)\left(\frac{V-(n-x)}{N-n}\right) < 1$$

$$\Leftrightarrow \left(\frac{n+1}{N-n}\right)\left(\frac{V-(n-x)}{n+1-x}\right) < 1$$

$$\Leftrightarrow \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}\left(\frac{n+1}{N-n}\right)\left(\frac{V-(n-x)}{n+1-x}\right) < \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

$$\Leftrightarrow \frac{\binom{N-V}{x}\binom{V}{n-x}\left(\frac{V-(n-x)}{n+1-x}\right)}{\binom{N}{n}\left(\frac{N-n}{n+1}\right)} < \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

$$\Leftrightarrow \frac{\binom{N-V}{x}\binom{V}{n+1-x}}{\binom{N}{n+1}} < \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

$$\Rightarrow \sum_{x\le m} \frac{\binom{N-V}{x}\binom{V}{n+1-x}}{\binom{N}{n+1}} \le \sum_{x\le m} \frac{\binom{N-V}{x}\binom{V}{n-x}}{\binom{N}{n}}$$

$$\binom{A}{a}\frac{(A-a)}{(a+1)}$$

$$\frac{m}{n+1} < \frac{X_B-m}{N-n} \Rightarrow \Pr(B|N,n+1,m) < \Pr(B|N,n,m)$$

We start by considering the scenario $\frac{m}{n+1} < \frac{X_B-m}{N-n}$ then this means that, for $x \le m$ we have

$$\frac{x}{n+1} \le \frac{m}{n+1} < \frac{X_B-m}{N-n} \le \frac{X_B-x}{N-n}$$

This shows that $\frac{m}{n+1} < \frac{X-m}{N-n} \Rightarrow \frac{x}{n+1} < \frac{X-x}{N-n}$ for $x \le m$

We can prove the result with the following steps.

$$\frac{x}{n+1} < \frac{X_B-x}{N-n}$$

$$\Leftrightarrow 1-\frac{X_B-x}{N-n} < 1-\frac{x}{n+1}$$

$$\Leftrightarrow 1-\frac{X_B-x}{N-n} < \frac{n-x+1}{n+1}$$

$$\Leftrightarrow \left(\frac{n+1}{n+1-x}\right)\left(1-\frac{X_B-x}{N-n}\right) < 1$$

$$\Leftrightarrow \left(\frac{n+1}{n+1-x}\right)\left(\frac{N-n-(X_B-x)}{N-n}\right) < 1$$

$$\Leftrightarrow \left(\frac{n+1}{N-n}\right)\left(\frac{N-X_B-(n-x)}{n+1-x}\right) < 1$$

$$\Leftrightarrow \frac{\binom{X_B}{x}\binom{N-X_B}{n-x}}{\binom{N}{n}}\left(\frac{n+1}{N-n}\right)\left(\frac{N-X_B-(n-x)}{n+1-x}\right) < \frac{\binom{X_B}{x}\binom{N-X_B}{n-x}}{\binom{N}{n}}$$

$$\Leftrightarrow \frac{\binom{X_B}{x}\binom{N-X_B}{n-x}\left(\frac{N-X-(n-x)}{n+1-x}\right)}{\binom{N}{n}\left(\frac{N-n}{n+1}\right)} < \frac{\binom{X_B}{x}\binom{N-X_B}{n-x}}{\binom{N}{n}}$$

$$\Leftrightarrow \frac{\binom{X_B}{x}\binom{N-X_B}{n+1-x}}{\binom{N}{n+1}} < \frac{\binom{X_B}{x}\binom{N-X_B}{n-x}}{\binom{N}{n}}$$

$$\Rightarrow \sum_{x\le m} \frac{\binom{X}{x}\binom{N-X}{n+1-x}}{\binom{N}{n+1}} < \sum_{x\le m} \frac{\binom{X}{x}\binom{N-X}{n-x}}{\binom{N}{n}}$$

$$\Leftrightarrow \Pr(B|N,n+1,m) < \Pr(B|N,n,m)$$

This completes the proof.

$$\Pr(A|N,n,m) = \sum_{x\le m} \frac{\binom{N-X_A}{x}\binom{X_A}{n-x}}{\binom{N}{n}} < 1-\alpha$$

$$\Pr(A|N,n,m+1) = \sum_{x\le m} \frac{\binom{N-X_A}{x}\binom{X_A}{n-x}}{\binom{N}{n}} + \frac{\binom{N-X_A}{m+1}\binom{X_A}{n-m-1}}{\binom{N}{n}} \ge 1-\alpha$$

Start with $m = 0$

$$\frac{\binom{N-X_A}{0}\binom{X_A}{n}}{\binom{N}{n}} = \prod_{j=0}^{n-1} \frac{X_A - j}{N-j}$$

$$\frac{\binom{N-X_A}{1}\binom{X_A}{n-1}}{\binom{N}{n}} = n\frac{\left(\prod_{j=0}^{0}(N-X_A-j)\right)\left(\prod_{j=0}^{n-2}(X_A-j)\right)}{\prod_{j=0}^{n-1}(N-j)}$$

$$\frac{\binom{N-X_A}{x}\binom{X_A}{n-x}}{\binom{N}{n}} = \binom{n}{x}\frac{\left(\prod_{j=0}^{x-1}(N-X_A-j)\right)\left(\prod_{j=0}^{n-x-1}(X_A-j)\right)}{\prod_{j=0}^{n-1}(N-j)}$$

Bayesian approach

The notation used in this document is given below:

Symbol	Description
N	Number of members lodged
n	Number of members sampled
K	True number of invalid members
k	Number of invalid members found in the sample
c	Maximum number of invalid members allowed
μ	Expected number of invalid members in the sample
σ	Standard deviation of invalid members in the sample

We want to calculate the posterior distribution of the true number of invalid members. Using a uniform prior, we can easily determine this to be:

$$\Pr(K = K_0 | N, n, k) = \frac{\binom{K_0}{k}\binom{N-K_0}{n-k}}{\binom{N+1}{n+1}}$$

This has a mean and standard deviation of:

$$\mu = k + (N-n)p \quad where \quad p = \frac{k+1}{n+2}$$

$$\sigma = \sqrt{\frac{p(1-p)}{n+3}(N+2)(N-n)}$$

We can also calculate the probability that the list is valid:

$$\Pr(K \leq K_0 | N, n, k) = \begin{cases} 0 & K_0 < k \\ \frac{\sum_{K=k}^{K_0}\binom{K}{k}\binom{N-K}{n-k}}{\binom{N+1}{n+1}} & k \leq K_0 \leq N-n+k \\ 1 & K_0 > N-n+k \end{cases}$$

Decision making

Suppose we have a loss function as follows:

$$Loss = \begin{cases} L_a \max(K-N+500, 0) & Accept\ List \\ L_r \max(N-499-K, 0) & Reject\ List \end{cases}$$

This indicates that accepting would only give a loss when there are less than 500 valid values, and rejecting would only give a loss when there are 500 or more valid values

Then the expected loss when the list is accepted and rejected can be calculated as:

$$E(Loss|N,n,k,Accept) = L_a \frac{\sum_{K=k}^{N-n+k} \max(K-N+500,0)\binom{K}{k}\binom{N-K}{n-k}}{\binom{N+1}{n+1}}$$

$$E(Loss|N,n,k,Reject) = L_r \frac{\sum_{K=k}^{N-n+k} \max(N-499-K,0)\binom{K}{k}\binom{N-K}{n-k}}{\binom{N+1}{n+1}}$$

For any given sample we calculate the expected loss under each scenario and choose the decision with the smaller expected loss.

Choice of prior probability

The use of uniform prior above is probably inappropriate here. To see this, note that without checking any members (i.e. k=n=0), we have a probability of having a valid list of

$$\Pr(K \le K_0|N,n=0,k=0) = \begin{cases} 0 & K_0 < 0 \\ \dfrac{K_0+1}{N+1} & 0 \le K_0 \le N \\ 1 & K_0 > N \end{cases}$$

So, for a list of N=550 members, with a uniform prior, we would only give the list a 51/551=9.3% chance of having 500 or more valid members. A more appropriate assumption might be instead to assume a prior probability distribution that has more concentration around the valid list requirements. Suppose instead that we assume there are at least 400 valid members in the prior, so we have:

$$\Pr(K = K_0) = \begin{cases} 0 & K_0 < 0 \\ \dfrac{1}{N-400+1} & 0 \le K_0 \le N-400 \\ 1 & K_0 > N-400 \end{cases}$$

The posterior probability changes to:

$$\Pr(K \le K_0|N,n,k) = \begin{cases} 0 & K_0 < k \\ \dfrac{\sum_{K=k}^{K_0}\binom{K}{k}\binom{N-K}{n-k}}{\sum_{K=k}^{\min(N-n+k,N-400)}\binom{K}{k}\binom{N-K}{n-k}} & k \le K_0 \le \min(N-n+k,N-400) \\ 1 & K_0 > \min(N-n+k,N-400) \end{cases}$$

The (simplified) problem is a quality control problem which has two competing hypothesis:

- H_0: the list provided contains 500 valid members
- H_1: the list provided contains 400 valid members

The notation for tolerance risks are; α the probability of *falsely* rejecting H_0, i.e. falsely concluding we have <500 members, and β the probability of *falsely* concluding there are 500 members or more although the true number is 400, i.e. false acceptance of the invalid list in H_1.

The notation used in this document is given below:

Symbol	Description
N	Number of members lodged
N	Number of members sampled
K	True number of invalid members lodged
K	Number of invalid members found in the sample
C	Maximum number of invalid members to pass the test (ie decision boundary)
μ_h	Expected number of invalid members in the sample, assuming hypothesis *h* is true
σ_h	Standard deviation of invalid members in the sample, assuming hypothesis *h* is true

The exact probabilities desired to perform the test are the cumulative hypergeometric probabilities.

$$Pr(False\ Acceptance) = Pr(k \le c|H_1) = \sum_{k=0}^{c} \frac{\binom{N-400}{k}\binom{400}{n-k}}{\binom{N}{n}} = F(c,n,N-400,N)$$

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \le c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-500}{k}\binom{500}{n-k}}{\binom{N}{n}}$$

$$= 1 - F(c,n,N-500,N)$$

These are the values provided in the *Calculator – Error rates* sheet in the Calculator workbook

There exist numerous functions built into various program to calculate the cumulative hypergeometric distribution. However, we want to fix these probabilities to specified values. So we actually need solve the following problem:

$$Choose\ c,n\ such\ that:$$

$$F(c,n,N-400,N) \le \beta$$

$$1 - F(c,n,N-500,N) \le \alpha$$

The default values are α=10% and β=2%. Also, we would like to choose the sample size to be as small as possible.

Suppose we expand the decision space is as follows…

We have d decision points where there are 3 options…

1. Reject the population if $k_d > c_d$
2. Accept the population $k_d = 0$
3. Take another sample of size m_{d+1} if $0 < k_d \le c_d$

The final decision point does not have option 3, and we must decide after $n = m_1 + m_2 + \cdots + m_d$ units have been sampled to accept or reject. Obviously, the first decision point will almost certainly be to take another sample, because we have no data at that point!

Now, we consider the probability of a list being accepted…it becomes more complicated, because there are multiple ways a list can be accepted. Define the symbol A_d, R_d, S_d to indicate accept/reject/sample more as the decision at point d. Then we have d components to the probability

$$\Pr(accepted) = \Pr(A_1) + \Pr(S_1)\Pr(A_2|S_1)$$
$$+ \Pr(S_1)\Pr(S_2|S_1)\Pr(A_3|S_2, S_1)$$
$$+ \cdots + \Pr(S_1)\Pr(S_2|S_1) \ldots \Pr(S_d|S_{d-1}, \ldots, S_2, S_1)\Pr(A_d|S_d, \ldots, S_2, S_1)$$

In words, we can say this as to accept at step d we need to have decided to sample more at all previous steps. This suggests we

In order to make this a more efficient way to use the sample, we need to use the extremes in order to control one of the risks. For example, it should be clear that in a sample of size m if we have $k = 0$ invalid members, then we should really only be considering if m is sufficiently large that the false acceptance risk is low

$$Pr(k_1 \leq 0|H_1) = \frac{\binom{N-400}{0}\binom{400}{m_1}}{\binom{N}{m_1}} = \frac{400(399)\ldots(400-m_1+1)}{N(N-1)\ldots(N-m_1+1)} \approx \left(\frac{400}{N}\right)^{m_1} \leq \beta$$

$$\Rightarrow m_1 \geq \frac{\log \beta}{\log \frac{400}{N}}$$

This suggests that a value of $m_1 = 13$ is sufficient for a risk $\beta = 0.02$ and population size $N = 550$.

So we could devise the start of a decision rule as set $m_1 = 13$ and if you find no denials, then accept the sample. We can then choose c_1 such that

$$1 - F(c_1, m_1, N - 500, N) \leq \alpha$$

This suggests that a value of $c_1 = 3$ would satisfy a risk of $\alpha = 0.1$ and population size $N = 550$. It almost satisfies it for $c_1 = 2$ where the risk is $\alpha = 0.1055$.

So, we have the start of the first step which is, take a sample of size $m_1 = 13$. Then count the number of invalid members, k_1.

- If $k_1 = 0$ then accept the list as valid
- If $k_1 > 3$ then reject the list as invalid
- If $k_1 \in \{1,2,3\}$ then get a larger sample

We can repeat the same idea again here. Suppose we take an additional m_2 samples, and we consider the scenario where all are valid members, so $k_2 = 0$. How large does the additional sample need to be in order to accept the list? We can do this by simply solving the following inequality for m_2

$$Choose\ m_2\ such\ that\ \ F(k_1, m_1 + m_2, N - 400, N) \leq \beta$$

This gives the following values for m_2

$$k_1 = 1 \rightarrow m_2 = 6 \quad k_1 = 2 \rightarrow m_2 = 12 \quad k_1 = 3 \rightarrow m_2 = 17$$

Or roughly…$m_2 = 6k_1$

Now, we need to set the cutoff values such that we reject

$$Choose\ m_2\ such\ that\ \ F(0, m_2, N - 400 - k_1, N - m_1) \leq \beta$$

This gives a value for $m_2 = 12$ when $k_1 \in \{1,2\}$ and $m_2 = 13$ when $k_1 = 3$ for $\beta = 0.02$ and $N = 550$. The idea behind this inequality is we have adjusted the hypothesis to account for the sample already selected, and started again. So instead of the invalid list having 400 valid members, it has $400 - m_1 + k_1$ valid members, and the total list size is now $N - m_1$ instead of N.

We now need to set the upper bound, such that the chance of false rejection is sufficiently low with the given value of $m_2 = 12$.

$$Choose\ c_2\ such\ that\ \ 1 - F(c_2, m_2, N - 500 - k_1, N - m_1) \leq \alpha$$

This gives a value of $c_2 = 2$ when $k_1 = 1$ and $k_1 = 2$ for $\alpha = 0.1$ and $N = 550$. Hence we have

Take a sample of size $m_2 = 13$. Then count the number of invalid members, k_2.

- If $k_2 = 0$ then accept the list as valid
- If $k_2 \geq 2$ then reject the list as invalid
- If $k_2 \in \{1,2\}$ then get a larger sample

$$Pr(False\ Rejection) = Pr(k > c|H_0) = 1 - Pr(k \leq c|H_0) = 1 - \sum_{k=0}^{c} \frac{\binom{N-500}{k}\binom{500}{m-k}}{\binom{N}{n}}$$

The population can be thought of as consisting of 3 groups

- People who do not respond (J)
- People who respond as not a member of the party (K)
- People who respond as a member of the party (L)

With a total population of J+K+L = N. The sampling and decision process works as follows:

- Keep sampling without replacement until $n = k + l$ positive responding units are found
- Non-responding people cannot be distinguished
- Reject the list if there are too many responding units which are not a member of a political party (i.e. reject if $k > c$ for some appropriately chosen cut-off value c)

This means the joint probability of observing the k out of the n responding people as invalid, and j non-responding is given by:

$$\Pr(k, j) = \frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j}$$

This is a multivariate hypergeometric distribution for 3 groups multiplied by a factor. The factor in the equation is accounting for the stopping rule – that n responding units are needed. The stopping rule reduces the total number of possible samples of $n + j$ units to be selected at random from N units.

Ignoring the information from the non-responding units

This joint distribution can be marginalised over the non-responding units to obtain a distribution for the number of invalid members:

$$\Pr(k) = \sum_{j=0}^{J} \frac{\binom{K}{k}\binom{L}{n-k}\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j} = \binom{K}{k}\binom{L}{n-k}\sum_{j=0}^{J}\frac{\binom{J}{j}}{\binom{N}{n+j}}\frac{n}{n+j} = \frac{\binom{K}{k}\binom{L}{n-k}}{\binom{K+L}{n}}$$

This distribution is almost identical with the original distribution underlying the previous calculations. The only exception is we now have $K + L < N$ due to the presence of J non-responding units.

The calculations in the spreadsheet provided are assuming that $K + L = N$. This means the "population" in the spreadsheets provided is referring to the responding list size, not the full list size. In terms of deductive evidence, we merely require $N - j \geq 500$ to ensure that ignoring non-response can still be consistent with a list having 500 valid members.

We also need to consider using the observed response rate in an ad-hoc fashion by using it to convert the K and L parameters from the old version to their "responding" version. We can get an unbiased estimate of the response rate as:

$$r = \frac{n-1}{n-1+j} \quad and \quad K^* = rK \quad L^* = rL$$

Using information from the non-responding units

If the number of non-responding people in the sample becomes too large, then we would begin to doubt the validity of the list. This is particularly true if political parties discover the sampling strategy used and provides inaccurate contact information for the invalid members. So, it would be useful to include a cut-off for the number of non-responding people allowed.

Bayesian approach

Want to infer J, K, and L from the data. Calculate the following probabilities:

$$\Pr(L \geq 500 | k, j, l, N)$$

$$\Pr(L \leq 400 | k, j, l, N)$$

Likelihood is as given previously

$$\Pr(k, j | l, K, J, N) = \frac{\binom{K}{k}\binom{L}{l}\binom{J}{j}}{\binom{N}{k+l+j}} \frac{l}{k+l+j}$$

Using a conjugate prior of

$$\Pr(K, L, J | N, \alpha, q_K, q_L, I) \propto \binom{K + \alpha q_K - 1}{K}\binom{L + \alpha q_L - 1}{L}\binom{J + \alpha q_J - 1}{J}$$

We obtain

$$\Pr(K, L, J | j, k, l, N) \propto \binom{K + \alpha q_K - 1}{K - k}\binom{L + \alpha q_L - 1}{L - l}\binom{J + \alpha q_J - 1}{J - j}$$

This is a well-known distribution sometimes referred to as Polya's urn, on the three numbers

$$\Pr(K, L, J | j, k, n, N) = \frac{\binom{K + \alpha q_K - 1}{K - k}\binom{L + \alpha q_L - 1}{L - l}\binom{J + \alpha q_J - 1}{J - j}}{\binom{N + \alpha - 1}{N - n}}$$

$$K \geq k, L \geq l, J \geq j \quad K + L + J = N$$

This distribution has mean ± standard deviations for each parameter of:

$$\hat{K} = k + (N - n)\hat{p}_K \quad SD(\hat{K}) = \sqrt{\frac{\hat{p}_K(1 - \hat{p}_K)}{n + \alpha + 1}(N - n)(N + \alpha)} \quad where \quad \hat{p}_K = \frac{k + \alpha q_K}{n + \alpha}$$

$$\hat{L} = l + (N-n)\hat{p}_L \quad SD(\hat{L}) = \sqrt{\frac{\hat{p}_L(1-\hat{p}_L)}{n+\alpha+1}(N-n)(N+\alpha)} \quad where \quad \hat{p}_L = \frac{l+\alpha q_L}{k+l+j+\alpha}$$

$$\hat{J} = j + (N-n)\hat{p}_J \quad SD(\hat{J}) = \sqrt{\frac{\hat{p}_J(1-\hat{p}_J)}{n+\alpha+1}(N-n)(N+\alpha)} \quad where \quad \hat{p}_J = \frac{j+\alpha q_J}{k+l+j+\alpha}$$

We can use a normal approximation to calculate the probabilities as:

$$\Pr(L \geq 500|k,j,n,N) \approx 1 - \Phi\left(\frac{500-\hat{L}}{SD(\hat{L})}\right)$$

$$\Pr(L \leq 400|k,j,n,N) \approx \Phi\left(\frac{400-\hat{L}}{SD(\hat{L})}\right)$$

Loss function….

$$Loss(\delta = 1, L) = \begin{Bmatrix} 0 & L \geq 500 \\ V_{FP1} & 400 \leq L < 500 \\ V_{FP1} + V_{FP2} & L < 400 \end{Bmatrix}$$

$$Loss(\delta = 0, L) = \begin{Bmatrix} V_{FN1} + V_{FN2} & L \geq 500 \\ V_{FN1} & 400 \leq L < 500 \\ 0 & L < 400 \end{Bmatrix}$$

Expected loss….

$$E[Loss(\delta = 1)] = V_{FP2}\Phi\left(\frac{400-\hat{L}}{SD(\hat{L})}\right) + V_{FP1}\Phi\left(\frac{500-\hat{L}}{SD(\hat{L})}\right)$$

$$E[Loss(\delta = 0)] = V_{FN2}\left[1 - \Phi\left(\frac{500-\hat{L}}{SD(\hat{L})}\right)\right] + V_{FN1}\left[1 - \Phi\left(\frac{400-\hat{L}}{SD(\hat{L})}\right)\right]$$

Accept the list….

$$E[Loss(\delta = 1)] < E[Loss(\delta = 0)]$$

$$(V_{FP2} + V_{FN1})\Phi\left(\frac{400-\hat{L}}{SD(\hat{L})}\right) + (V_{FP1} + V_{FN2})\Phi\left(\frac{500-\hat{L}}{SD(\hat{L})}\right) < V_{FN2} + V_{FN1}$$

Simpler scenario….

$$V_{FP2} = V_{FN1} = 0$$

$$(V_{FP1} + V_{FN2})\Phi\left(\frac{500-\hat{L}}{SD(\hat{L})}\right) < V_{FN2}$$

$$\hat{L} > 500 - SD(\hat{L})\Phi^{-1}\left(\frac{V_{FN2}}{V_{FP1} + V_{FN2}}\right)$$