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1. INTRODUCTION

1 This is added to get the section numbers right in section 2.

2. EXPERT ISSUES AND SUMMARY OF OPINIONS

2 In this summary and in the body of our report we have grouped the 15 Horizon issues into four groups of related issues, so that our opinions can be expressed as concisely as possible. The groups have minor overlaps with each other and therefore require some cross-referencing between groups. In what follows, for each group, we will first state the Horizon issues, and then give a summary of our opinions. In section 2.5 we summarise where our opinions differ from Mr Coyne's opinions, as expressed in his report.

2.1 Bugs in Horizon

3 The first group of issues includes the Horizon issues 1, 3, 4, and 6. These issues concern bugs in Horizon which might have had an impact on branch accounts. The issues are:

4 **Issue 1**: To what extent was it possible or likely for bugs, errors or defects of the nature alleged at §§23 and 24 of the GPOC and referred to in §§ 49 to 56 of the Generic Defence to have the potential to (a) cause apparent or alleged discrepancies or shortfalls relating to Subpostmasters' branch accounts or transactions, or (b) undermine the reliability of Horizon accurately to process and to record transactions as alleged at §24.1 GPOC?

5 **Issue 3**: To what extent and in what respects is the Horizon System "robust" and extremely unlikely to be the cause of shortfalls in branches?

6 **Issue 4**: To what extent has there been potential for errors in data recorded within Horizon to arise in (a) data entry, (b) transfer or (c) processing of data in Horizon?

7 **Issue 6**: To what extent did measures and/or controls that existed in Horizon prevent, detect, identify, report or reduce to an extremely low level the risk of the following:

a) data entry errors;

b) data packet or system level errors (including data processing, effecting, and recording the same);

c) a failure to detect, correct and remedy software coding errors or bugs;

d) errors in the transmission, replication and storage of transaction record data; and

e) the data stored in the central data centre not being an accurate record of transactions entered on branch terminals?

8 Issues 1 and 3 are restricted in scope to those errors which might have an impact on branch accounts, whereas issues 4 and 6 are not explicitly restricted to that scope. We have chosen to interpret issues 4 and 6 generally - in the sense of asking what general measures are built into Horizon - while at the same time focussing them largely on the scope of issues 1 and 3 - addressing mainly those effects with possible impact on branch accounts. Issues 4 and 6 then

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ask about specific dimensions of those effects. The overall question - of how much effect bugs in Horizon might have had on the claimant's branch accounts - remains as stated in issue 1.

2.1.1 Robustness of Horizon

9 We first summarise our opinion on Issue 3, the robustness of Horizon. In our opinion the design, implementation and support of Horizon achieved a very high degree of robustness. It is necessary to spell out in more specific terms what that means.

10 Horizon's main purpose is to support the financial transactions and management of PO branch accounts - through from the point of sale in the branches, to PO's annual financial accounts (although aspects of his are outside the scope of the Horizon trial). To meet this requirement, Horizon and related systems must provide a very high degree of confidence to subpostmasters and to PO management that the resulting accounts are robust against:

a) Failures in Horizon hardware, software, or communications

b) Errors in business processes made outside Horizon

c) User errors made on Horizon in the branches

d) Deliberate errors of any kind - i.e. fraud

11 To be robust against all these kinds of errors is a very demanding requirement. Large parts of our report are devoted to describing how Horizon, its supporting hardware and software, and surrounding IT systems have been designed to achieve this - and to what extent those design objectives were achieved [the last requires additions to the Foundation report, summarising test results]. We conclude that the resulting system has had a high degree of robustness against all four categories of effect, at all stages of its service life.

12 In this summary we focus particularly on the corrective measures built into Horizon, to ensure that errors in categories (b) - (d) would not have any permanent effect on branch accounts. These measures rely on the fact that for every business transaction entered into Horizon, Horizon itself is not the only record of what happened. Other records include the physical cash and stock within each branch, and the electronic records of the PO clients on whose behalf PO branches carry out customer transactions. It is possible to compare the record on Horizon with these other records, and if there is any discrepancy, to correct the record on Horizon. This comparison and correction of Horizon is frequently done, in:

- Periodic checks of physical cash and stock in the branches
- Periodic checks of PO records against the electronic records of clients

13 The result of these checks is that for nearly all errors in categories (b) (c) and (d), while they may produce a temporary anomaly in branch accounts on Horizon, any such anomaly will be corrected after a period of weeks or occasionally months, depending on PO clients' business processes.

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14 There are large classes of errors of type (a), arising from software bugs in Horizon, whose only effect is to mimic, or possibly to increase the chances of, some error in types (b) - (d). So while these software bugs may produce temporary anomalies in branch accounts, the same correction processes will remove those errors before long, and there will be no permanent effect on branch accounts..

15 This is the most important way in which, in our opinion, Horizon is robust. A clear understanding of these robust error correction processes will enable the court to understand, for any bug in Horizon, whether or not it can have any permanent effect on branch accounts.

16 Horizon also has built into it a large number of fairly standard measures to achieve robustness against hardware errors, communication failures, and failures of the supporting software. In our opinion, these robustness measures have been professionally designed, implemented and tested.

2.1.2 Macro Analysis of Bugs in Horizon

17 In addressing Horizon issue 1, we have taken several different approaches. The first of these, which we have called the Macro analysis, does not rely on information about individual parts of Horizon, or specific bugs in Horizon. It enables us to make an overall estimate of the impact of all Horizon bugs, detected or undetected, on the accounts of a typical branch - and therefore, to estimate the net financial impact of bugs on all claimants' branches.

18 The problem of estimating the net effect of all bugs in Horizon, on a typical set of branch accounts, is a problem of engineering measurement. We need to estimate a signal (the net effect of all bugs in Horizon), in the presence of a noise (the effects of human errors and business process errors in the branches).

19 In order to measure any signal in the presence of noise, the accepted engineering approach is to measure the signal plus the noise, using a sample which has the lowest possible level of noise - thus to produce an upper limit on the size of the signal. The choice of a sample with the smallest noise produces the tightest possible upper limit on the signal. We can reasonably assume that the level of the signal (effects of bugs and back-office errors) is uniformly distributed across all branches, and for each branch is approximately proportional to its number of stock units; or for the smaller branches, its monthly revenue. Therefore it is valid to measure the signal on a set of branches with an expected low level of noise (i.e. those which are well run and produce the most reliable accounts), and then to use that measure of the level of the signal for any branch, including those managed by the claimants.

20 Our Macro approach is to do this. For any branch, the branch discrepancy at the end of any trading period is the sum of three terms: (a) the discrepancy in cash and stock found by manual checking; (b) the sum of transaction corrections from errors discovered in reconciliation; and (c) an amount caused by bugs in Horizon (which will usually consist of amounts not understood by the SPM).

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21 The main comparison we wish to make it to compare the typical levels of branch discrepancy at a group of well managed branches, with the levels of discrepancy claimed by the claimants. As the well run branches were equally prone to bugs in Horizon as the claimant's branches, the well run branches give an estimate of the impact of Horizon bugs on the claimant's branches. As we shall see, this estimate is very much smaller than the net discrepancy claimed by the claimants - showing that no significant part of the discrepancy could have been caused by Horizon bugs.

22 This broad conclusion will be evident from the figures. However, we wish to establish this conclusion with a high degree of confidence, and to show that it cannot be cast into doubt by any possible random effects between branches , or between different factors which can affect branch accounts. To do this, some elementary statistics will be required. These will be fully explained in the relevant chapters of the report; here we summarise the approach:

- We assume that certain types of effect on branch accounts (such as manual errors in a branch, and bugs in Horizon) are statistically uncorrelated with one another - that is, the occurrence of one effect in a branch and trading period does not affect the probability of the other effect occurring; and furthermore, that they may occur with different signs, positive and negative.
- The correct statistical way to account for such uncorrelated additive components is to calculate a root mean square (RMS) of their sum over a long enough period. This provides an upper limit on the effect of any component, such as bugs in Horizon, with a computable statistical accuracy.
- We further assume that the impact of Horizon bugs is on average the same for well managed branches as for the claimants' branches.
- We use standard statistical methods to estimate what sample size of well run branches and trading periods is necessary to get a reliable upper limit on the impact of Horizon bugs on claimants' branches
- We test all our assumptions by trying to devise counter-examples to them

23 If we assume that the three terms (a) (cash and stock discrepancies) (b) (errors found in reconciliation) and (c) (effects of Horizon bugs) are statistically uncorrelated, we can show mathematically that for any set of branches and trading periods, the sum of squares of the branch discrepancies ($d^2 = (a + b + c)^2$) is an upper limit on the sum of squares of term (c) (that caused by bugs in Horizon)- which , we can assume, is independent of branches. We can measure an upper limit on term (c) using any set of branches we choose, using a large enough sample to get a statistically reliable answer. To get the tightest possible upper limit, we need to choose the best run branches. For instance, for a perfectly run branch, with no manual errors in

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checking stock or in customer transactions, the terms (a) and (b) will be zero, and the branch discrepancies would be an accurate measure of term (c). For a well run branch, it will be a tight upper limit on (c).

24 [Nearly all the figures which follow are illustrative guesses. We urgently need to replace them by real measured figures.]

25 We have done this for a selection of 50 branches, which on the basis of their monthly branch discrepancies appear to be well run branches, over a period of 24 months for each branch - with the periods randomly distributed over the period of the dispute, approximately matching the distribution of periods where the claimants suffered discrepancies [we need to measure this distribution] For those branches, we may expect the sums of terms (a) and (b) to be the smallest, so to give the tightest upper limit on term (c). We can show statistically that this is a large enough sample to give an answer accurate to within better than 10%.

26 From this calculation, we find that an upper limit on the root mean square monthly correction to any branch accounts caused by any bugs in Horizon is £X per month per stock unit. As a first guess, X = £80? [We urgently need to measure this figure for 50 good branches] Since Horizon bugs are expected to affect all branches equally, we can apply this figure to all branches, including the claimants' branches.

27 [to avert the criticism that , by choosing the branches with low branch discrepancy, we have chosen just those branches which 'got lucky' in being subject to few Horizon bugs, whereas the claimants were less lucky, I intend to take two approaches: (a) statistical analysis to show that this lucky fluke has very low probability of occurring, and (b) do the same analysis not using the best branches, but using a randomly chosen set of branches]

28 There are 560 claimants, with approximately 1000 stock units between them [may not be possible to count?], and the number of months over which they were in post, in which discrepancies could have arisen from Horizon bugs is 10,000 stock unit months [need to count]. Applying the upper limit (c) to this set, the upper limit on the amount of discrepancy which could have been caused by bugs in Horizon is £ZM - compared with a total claimed discrepancy over those branches of £13M. So we find that the total effect of all Horizon bugs cannot have been more than U% of the claimed discrepancy.

29 [WBD/PO/Fujitsu could prepare a spreadsheet of the raw information - claimants' branches, number of SUs, and their discrepancy for each month where they declare any. We can then compute. For the calculation of 'good' branches, we need a spreadsheet analogous to the claimants' spreadsheet - 50 good branches, their numbers of SUs, and monthly balancing amounts for 12-month periods.]

30 However, this figure is only an upper limit on the amount arising from Horizon bugs. In practice, when a postmaster with a well-run branch discovers at the end of a Trading Period that he has a branch discrepancy - particularly when it is a large one - he usually investigates its

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causes to try to understand them. In this way he may understand a large part of the discrepancy as arising from some errors by himself or his staff. It is only the remaining amount, which the SPM cannot understand, which could possibly have arisen from Horizon bugs.

31 [This needs to be done] PO have conducted a number of interviews with the SPMs of well run branches, to discover what proportion of their larger branch discrepancies they typically do not understand after investigation. It appears that this proportion is approximately Z%. [we need the real figure]. Although detailed factual information pertaining to individual SPMs is out of scope for the Horizon trial, WBD [will] have submitted a witness statement confirming the overall average figure.

32 Using this figure, the root mean square monthly discrepancy arising in branch accounts from bugs in Horizon cannot be more than £X per SU per month. Applying this figure to the claimant's branches, the total discrepancy arising from Horizon bugs cannot be more than Y% of the total claimed discrepancy.

33 This result shows that bugs in Horizon cannot possibly have given rise to a large proportion of the financial discrepancies claimed. This is in effect the central question to be answered in the Horizon trial, and the macro analysis provides the answer. This answer stands, independent of any analysis or discussion of specific parts of Horizon, or of specific bugs observed in Horizon.

2.1.3 Statistical Micro Analysis

34 We have made a second analysis, which is independent of the macro analysis above, but which only estimates the effect on branch accounts of Horizon bugs which were detected in live use and recorded in the KEL and Peak systems.

35 The Peak system (and its predecessor, the PinICL system) is used, among other things, to record all issues found in Horizon either in test or live use, which require corrective action. Those Peak entries which arise in test and are corrected before live use have no impact on branch accounts. All Peaks which arise in live use, or have not been not corrected before live use, and which are judged to have any possible effect on operations in the branches (including branch accounts), and so may give rise to the need for some instructions or workarounds in the branches, should be used to create or update an entry in the KEL system, so that the Help desk is able to provide the required support to SPMs.

36 Therefore any Horizon bug, which is discovered in live use and which has potential impact on branch accounts, should give rise to a KEL. It is then possible , by analysing all the KELs, to estimate the net effect on branch accounts of all such Horizon bugs. For the great majority of KELs, it is possible to establish fairly easily, from the content of the KEL and any related Peaks, that there is no possible permanent impact on branch accounts.

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37 There are approximately 8000 KELs, and it is not possible within the constraints of the Horizon trial to analyse all of them. However, it is possible to take a statistical approach, using only a random sample of KELs, provided we ensure that the sample size is large enough to give a reliable answer. In this way, it is possible to estimate both the number of discovered bugs in Horizon which could have had any impact on branch accounts, and their expected net financial impact on claimants' branches. The latter figure is the more important one for the purposes of the Horizon trial - because a bug which might have a financial impact, but an impact measured only in pennies, would not be significant.

38 We have analysed a sample of 200 randomly selected KELs. We present the analysis of all these in a table in the Appendix. For the great majority of these KELs, either there is no underlying bug in Horizon, or it is possible to establish by further investigation that any underlying bug can have no impact on branch accounts. For these, we have included in a table a brief summary of the investigation by which we established this.

39 For the remaining 20 KELs, there is an underlying bug in Horizon, with some possible impact on branch accounts. For these, we need to establish quantitatively the scale of the possible impact. For this, there are a variety of possible sources of information, including:

a) The length of the time period between when the bug was introduced in Horizon, and when it was corrected

b) The types of transaction which could be affected by the bug, and the typical monthly volume of those transactions and their typical monetary amounts

c) The circumstances in which the bug might occur, leading to an approximate estimate of the probability with which it might occur, for each transaction of the affected type

d) For some bugs, there is other more direct evidence about the branches affected and the monetary amounts involved

40 From these sources of information, it is possible to estimate, for each such bug in Horizon, the order of magnitude of its likely effect on the branch accounts of the 560 claimants. Because of the approximate nature of some of the sources of information, this estimate usually has a large uncertainty , relative to its magnitude. However, in most or all cases, the expected magnitude of the effect is so small, that even large relative errors in the number are not important.

41 We then scale up the magnitude of the net effect of all bugs, to account for the fact that we have actually analysed only 200 KELs out of the full set of 8000. We have also estimated statistically the range of errors in the scaled up result. This range of errors arises as a sampling error, from taking only a limited sample, and we have used the established statistical techniques for estimating sampling errors.

42 [The following numbers are only placeholders, and we need to replace them by the results of calculations when we can]

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43 The total amount of all discrepancies in their branch accounts, claimed by all the claimants, is a figure of £13M. [this figure is now real].

44 For the 20 KELs we found that might have an effect on claimants' branch accounts, the typical scale of the their possible impact on all claimants is in the region of £500 or less - or £10,000 for all 20 KELs with any impact taken together. For each KEL, the estimate is made to be a fairly conservative upper bound on the effect of the bug. The figure is as small as it is because there are only 560 claimant branches out of 11,000 branches in total, and any bug in Horizon is expected to affect all branches equally.

45 Scaling this up from 200 KELs to 8000 KELs (i.e. by a factor 40) leads to an overall impact of £800,000, with a statistical uncertainty of approximately 20% - i.e. not more than £ZM, out of the total claimed discrepancy of £13M.

46 We therefore find that the total expected impact of all detected bugs in Horizon, on the branch accounts of all claimants, is not more than X% of their total claimed discrepancy.

47 Because this figure is a conservative upper bound on the effects of detected bugs, it is consistent with the figure for the total effects of all bugs, detected and undetected, coming out of the macro analysis. The analyses agree with one another, and they both show independently that bugs in Horizon cannot account for any significant part of the claimed discrepancy.

2.2 Reconciliation and Transaction Corrections

48 The second group of issues includes the Horizon issues 5 and 15, concerning the related topics of reconciliation with external parties, and transaction corrections (which often arise from reconciliation). These have been treated as a group because they belong so closely together. However, as they are an important part of the way Horizon is made robust against a variety of user errors, they relate to issue 3 in the first group. The issues are:

49 **Issue 5**: How, if at all, does the Horizon system itself compare transaction data recorded by Horizon against transaction data from sources outside of Horizon?

50 **Issue 15**: How did Horizon process and/or record Transaction Corrections?

51 These are both fairly descriptive issues, being 'how' questions and requiring a detailed 'how' answer. In bare summary, our opinion on issue 5 is:

- For every client organisation which uses PO branches as agents for its financial transactions, both the PO and the client organisation keep an electronic record of every transaction
- These records are periodically compared, or reconciled, to check that they match, down to the level of individual transactions.
- This reconciliation process is done by a range of IT systems, some of which are part of Horizon, and some of which are not.

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- Whenever a mismatch is discovered, the contract between PO and the client organisation defines how it is to be investigated and handled.
- If it is decided that PO are responsible for the discrepancy (which happens in the majority of cases, because PO branches do manual processes, whereas client IT systems are generally fully automated) then PO makes up the difference, and this leads to an entry in PO accounts on POLSAP.

52 Our opinion on issue 15 (transaction corrections) can be summarised:

- If, following a new accounting entry in POLSAP resulting from a reconciliation discrepancy, PO believes that the branch was responsible for an error, a Transaction Correction (TC) is created on POLSAP.
- The TC is passed to BRDB, but does not at that point affect the branch accounts.
- From BRDB, information about the transaction correction is passed overnight to the branch, so the SPM sees it the next morning.
- If, at that point , the SPM accepts that the correction arose from an error in his branch, he accepts the TC, and it then affects his branch accounts. Usually this correction makes the accounts correct, after an error.
- If the SPM does not accept this, there are processes for investigating the possible cause of the TC.

53 The two issues relate to points raised in the claim and defence in the sense that, provided Horizon and the systems it interacts with perform reconciliation and transaction corrections accurately, and in a way that sub-postmasters can understand, there is no detrimental impact on branch accounts; but if those functions are not accurate, there may be unintended effects on branch accounts.

54 Our analysis of reconciliation and transaction corrections is that they are carried out accurately, and the results communicated correctly to sub-postmasters; so that they are not responsible for shortfalls in branch accounts.

55 [We have seen overall statistics on the number of TCs - about 1 per branch per month. We need to find out what proportion of these TCs are contested by the SPM, for what reasons, how they are investigated, and what proportion of the contested TCs are resolved in favour of the SPM].

2.3 Facilities available to Subpostmasters

56 The third group of issues includes the Horizon issues 2, 9, and 14, because these all relate to the Horizon facilities available to sub-postmasters when running their branches. The issues are:

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57 **Issue 2**: Did the Horizon IT system itself alert Subpostmasters of such bugs, errors or defects as described in (1) above and if so how

58 **Issue 9**: At all material times, what transaction data and reporting functions (if any) were available through Horizon to Subpostmasters for:

a) identifying apparent or alleged discrepancies and shortfalls and/or the causes of the same; and

b) accessing and identifying transactions recorded on Horizon?

59 **Issue 14**: How (if at all) does the Horizon system and its functionality:

a) enable Subpostmasters to compare the stock and cash in a branch against the stock and cash indicated on Horizon?

b) enable or require Subpostmasters to decide how to deal with, dispute, accept or make good an alleged discrepancy by (i) providing his or her own personal funds or (ii) settling centrally?

c) record and reflect the consequence of raising a dispute on an alleged discrepancy, on Horizon Branch account data and, in particular:

i. does raising a dispute with the Helpline cause a block to be placed on the value of an alleged shortfall; and

ii. is that recorded on the Horizon system as a debt due to Post Office?

d) enable Subpostmasters to produce (i) Cash Account before 2005 and (ii) Branch Trading Statement after 2005?

e) enable or require Subpostmasters to continue to trade if they did not complete a Branch Trading Statement; and, if so, on what basis and with what consequences on the Horizon system?

60 These issues are addressed as a group because they all relate to facilities available to subpostmasters, so our opinions all follow from a description of those facilities.

61 These are all descriptive issues - 'how' and 'what' questions - so the answer to each question emerges from a detailed description of the Horizon facilities, and cannot be easily summarised here.

62 They are related in several ways to allegations in the pleadings, and we summarise our opinions on those relations:

63 TBD.

2.4 Facilities available to Post Office

64 The fourth group of issues includes the Horizon issues 7, 8, 10, 11, 12, and 13, which all relate to facilities available to the Post Office centrally or to Fujitsu, rather than to subpostmasters. The issues are:

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65 **Issue 7**: Were Post Office and/or Fujitsu able to access transaction data recorded by Horizon remotely (i.e. not from within a branch)?

66 **Issue 8**: What transaction data and reporting functions were available through Horizon to Post Office for identifying the occurrence of alleged shortfalls and the causes of alleged shortfalls in branches, including whether they were caused by bugs, errors and/or defects in the Horizon system?

67 **Issue 10**: Whether the Defendant and/or Fujitsu have had the ability/facility to: (i) insert, inject, edit or delete transaction data or data in branch accounts; (ii) implement fixes in Horizon that had the potential to affect transaction data or data in branch accounts; or (iii) rebuild branch transaction data:

a) at all;

b) without the knowledge of the Subpostmaster in question; and

c) without the consent of the Subpostmaster in question.

68 **Issue 11**: if they did, did the Horizon system have any permission controls upon the use of the above facility, and did the system maintain a log of such actions and such permission controls?

69 **Issue 12**: If the Defendant and/or Fujitsu did have such ability, how often was that used, if at all?

70 **Issue 13**: To what extent did use of any such facility have the potential to affect the reliability of Branches' accounting positions?

71 In issue 7, if the word 'access' is interpreted as 'access to read' (a common interpretation in IT), then the answer is trivial; both PO and Fujitsu regularly needed to access the data to read it. If 'access' is interpreted as 'change or update' the answer is also yes, but under tightly controlled conditions which will not be described in this summary. In our opinion, these conditions were so tightly controlled that adverse effects on the accounts of a branch were very unlikely.

72 Issues 8, 10 and 11 are descriptive questions with detailed answers (including 9 parts, in the answer to issue 10), which will not be summarised here. Issue 12 is a factual question, and we have been advised that the ability was used on only one occasion, which we describe in chapter X of this report.

73 Issue 13 draws out the impact of issues 8 and 10 on branch accounts. In our opinion, any such effect was either zero or very small indeed, and could only account for at most about 0.01% of the discrepancies alleged by the claimants.

2.5 Mr Coyne's opinions

74 It will probably not be possible briefly to summarise all our responses to Mr Coyne's opinions, and we will not attempt to do so. Most responses will be in the body of our report.

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75 One response will be summarised here. JC will probably list a number of bugs in Horizon, derived largely from Peaks and KELs. In response, we intend to show that some of them can have had no effect on branch accounts; and for the rest, to estimate quantitatively the likely effect on the accounts of the claimants, using the same methods for each bug as we used for our statistical micro analysis - presenting the results in a table (not in this summary, which will only have the summed number).

76 In this way we intend to show that the net effect on the branch accounts of the claimants, of all bugs listed by Mr Coyne, is very small compared to their total claimed discrepancy, and therefore cannot account for it. We will also compare this figure with the results of our macro and micro analyses.

77 Other aspects of Mr Coyne's report cannot yet be anticipated.