



BOARD FOR ACTUARIAL STANDARDS

EXPOSURE DRAFT: MODELLING

MAY 2009

CONTENTS

	<i>Page</i>
Analysis of Responses and Invitation to Comment	3
Introduction	4
2 Responses to consultation questions	7
3 Proposals	20
4 Invitation to comment	22
Exposure Draft	23
Appendices	35
A Members of the Board and of Working Groups	35
B List of respondents	37

ANALYSIS OF RESPONSES

AND

INVITATION TO COMMENT

1 INTRODUCTION

CONSULTATION AND RESPONSES

- 1.1 The Board for Actuarial Standards (BAS) is responsible for setting technical actuarial standards in the UK: it is an operating body of the Financial Reporting Council (the FRC)¹. In November 2008, it published a consultation paper on its Generic Technical Actuarial Standard (Generic TAS)² on *Modelling* (TAS M).
- 1.2 The consultation period ended on 23 February 2009. A total of 27 public responses³ were received (see Appendix B). A number of meetings with practitioners and other stakeholders were held and the proposals were discussed with the FRC's Actuarial Stakeholder Interests Working Group. During the preparation of the consultation paper we were assisted by a Working Group and an Advisory Group,⁴ and they also provided valuable input as we considered the responses and drafted the proposed text of TAS M. We thank all those who contributed.

SUMMARY

- 1.3 In drafting the proposed text of TAS M we have taken account of the comments we received in response to the consultation paper, as well as other comments that have been made to us in meetings. We have also considered the responses to other consultations, especially those on *Reporting Actuarial Information* and *Data*. As a result, some changes have been made to the principles proposed in the consultation paper. The proposed text is consistent with the exposure drafts of TAS R (on *Reporting Actuarial Information*) and TAS D (on *Data*).
- 1.4 Respondents to the consultation paper generally supported the direction of the consultation paper and the principles proposed in it. A number of respondents welcomed the proposed principles as means to promoting good modelling that would help to maintain and improve the quality of actuarial work.
- 1.5 A number of comments indicated some uncertainty about how judgement, materiality and proportionality would work in the context of TAS M (and indeed of other BAS standards).
- 1.6 It was also suggested that the BAS should issue guidance on what would constitute compliance with some of the proposed requirements. The BAS believes that it is in the nature of principles-based standards that they require judgement to be exercised by those complying with them, and we believe that actuaries and others who seek to comply with our standards are responsible professionals who are capable of exercising judgement.

¹ The Financial Reporting Council is the UK's independent regulator responsible for promoting confidence in governance and corporate reporting.

² Generic TASs apply to all work specified in the Schedule to the BAS's *Scope & Authority of Technical Standards*. Specific TASs are limited to a specific, defined context.

³ The responses are available at <http://www.frc.org.uk/bas/publications/pub1795.html>.

⁴ Members of both groups are listed in Appendix A.

- 1.7 A significant theme that emerged from the responses was a concern that the proposed requirements for documentation would be too onerous. Some of this concern may have reflected a belief that documentation should be disclosed to the user (see paragraphs 2.20 to 2.21).
- 1.8 Overall the principles in the proposed text of TAS M are substantially those discussed in the consultation paper.
- 1.9 Section 2 summarises the comments that we received in answer to the specific questions that were posed in the consultation paper, and describes how we have responded to them. Section 3 summarises the other comments we received, and describes further proposals. Section 4 contains our invitation to comment on the exposure draft of TAS M. The second part of this document contains the proposed text.

EXPECTED EFFECTS AND IMPACT ASSESSMENT

- 1.10 The BAS believes that many practitioners currently comply with most or all of the proposed requirements of TAS M. However, TAS M is, we believe, likely to result in a greater emphasis by practitioners on the ways in which models meet users' needs and on the limitations of models. Users will gain a greater understanding of these issues, and of the assumptions and judgements on which models depend. These effects will be driven by the requirements for documentation as well as those for reporting, which will complement the requirements in TAS R. TAS M and TAS R together will result in a greater emphasis on the uncertainties inherent in the use of models. These changed emphases will provide better support to those who rely on actuarial information as they make decisions.
- 1.11 An area in which TAS M will produce significant change is the extent to which models are documented. It is widely accepted that current levels of documentation are inadequate. We believe that good documentation provides a number of benefits, including:
- better understanding of the models by model developers, which feeds through into better communication to users;
 - higher quality model implementations, as problems are discovered earlier during the development process; and
 - more reliable use of models by those other than the original developers, or by the original developers after some time has elapsed.
- 1.12 Overall, we believe that TAS M will contribute to two of the drivers of actuarial quality that were identified in the FRC's *Actuarial Quality Framework*. It will promote the reliability and usefulness of actuarial methods, through encouraging the effective use of well documented models with due recognition of the power and limitations of the models used, and through encouraging robust criteria for the selection of assumptions and the recognition and exploration of risk and uncertainty. Together with TAS R it will also promote the communication of actuarial information and advice, by encouraging the inclusion of sufficient information to enable the reader to judge the appropriateness and implications of any recommendations, as well as information about uncertainty.
- 1.13 We recognise that the introduction of TAS M is likely to result in transitional costs as the documentation of existing models is upgraded in order to comply with the standard, and as checks are constructed and performed on them in

order to determine whether they are fit for purpose. These costs will, of course, be greater if the original developers are no longer available or are no longer familiar with how the models operate. However, the use of poorly documented and poorly understood models, or models that are not known to be fit for purpose, is a significant threat to the production of reliable actuarial information and to actuarial quality. The greatest costs are likely to be incurred in documenting and checking models that are poorly understood, and which therefore present the greatest risks. The documentation and checking of existing models may result in the identification of hitherto unsuspected problems, and thus an increase in the reliability of the information based on the models. We believe that the short term costs will be more than offset by substantial benefits in the short, medium and long terms.

- 1.14 We believe that the additional costs of documenting and checking models as they are developed are unlikely to be significant. Several modelling specialists have commented that documenting and checking models during development assists the development process by providing earlier identification of problems and clarifying thought processes.
- 1.15 Overall, we believe that the benefits to users of TAS M will outweigh any extra costs.
- 1.16 We would be interested in the views of respondents on the transitional costs that are likely to be incurred as a result of the introduction of TAS M. Respondents should consider the costs in the context of ensuring that actuarial information that is based on models meets the needs of users.

RESPONSES TO THIS EXPOSURE DRAFT

- 1.17 Details of how to respond to this paper are set out in Section 4. Comments should reach the BAS by **28 August 2009**.

2 RESPONSES TO CONSULTATION QUESTIONS

INTRODUCTION

2.1 In this section we summarise the comments that we received in answer to the specific questions that were posed in the consultation paper, and our reactions to them. In brief, we are proposing that:

- the purpose of the TAS and the definition of a model will be essentially those that were proposed in the consultation paper (paragraphs 2.4 to 2.18);
- TAS M will contain requirements for documentation (paragraphs 2.20 to 2.21);
- models should cover all materially relevant phenomena (paragraphs 2.35 to 2.39);
- some of the requirements that were proposed in the consultation paper concerning data will be included in TAS D rather than TAS M (paragraphs 2.45 to 2.48 and 2.76);
- quantification of the effects of grouping the data used for the models will not be required, but the rationale behind the grouping should be explained to the user (paragraphs 2.49 to 2.51)
- definitions of estimates need not always be statistical in nature (paragraph 2.55);
- best estimates need not always be presented alongside prudent estimates, but the level of prudence in estimates should be explained to the user (paragraphs 2.59 to 2.63);
- ranges need not always be presented alongside point estimates, but the uncertainty inherent in point estimates should be explained to the user (paragraphs 2.64 to 2.66);
- back testing need not always be performed, but the checks that are performed should address the predictive properties of models (paragraphs 2.74 to 2.75);
- if outliers are removed from the data, the rationale for doing so should be documented and the implications should be explained to the user (paragraphs 2.77 to 2.79)
- TAS M will not contain requirements for reasonableness or robustness (paragraphs 2.82 to 2.84); and
- TAS M will not contain explicit requirements concerning sensitivity testing (paragraphs 2.86 to 2.88).

2.2 Comments on the consultation paper that were not addressed to the specific questions that were asked are discussed in section 3.

2.3 The remainder of this section discusses comments that were made on specific parts of the consultation paper, and the responses to the questions that were

posed. It covers the issues in the order that they were discussed in the consultation paper.

PURPOSE AND SCOPE

1 Will the proposed purpose of the modelling TAS as set out in paragraph 2.9 help to ensure that users of actuarial information can place a high degree of reliance on its relevance, transparency of assumptions, completeness and comprehensibility?

2.4 Respondents were generally happy with the proposed purpose of the TAS, although some drafting changes were suggested.

2.5 We have made no substantial changes to the purpose, which is in paragraph A.1.2 of the proposed text.

2 Will the definition of a model given in paragraph 2.13 encompass the full range of models that contribute to actuarial information?

2.6 A number of respondents expressed strong opposition to the proposed definition because they felt that it was too wide-ranging. They considered that complying with the proposed requirements would be too onerous for many of the calculations performed in day to day actuarial work. This especially applied to the risk and uncertainty aspects of TAS M (and indeed of TAS R), and to the requirements for documentation.

2.7 A few respondents thought that the definition was too narrow and were concerned that the proposed definition was inconsistent with the concept of an internal model that is used in Solvency II.

Breadth of definition

2.8 It is possible that some of the concerns about the breadth of the definition were based on a misunderstanding of the proposed scope of TAS M. It will not automatically apply to all actuarial work. As a Generic TAS its scope is defined in the Schedule to the *Scope & Authority*⁵. We are currently consulting⁶ on proposals to amend the Schedule. Under the proposals, Generic TASs would apply to Reserved Work and work that is presented as complying with TASs as well as to any work within the scope of a Specific TAS. Reserved Work is itself defined in the *Scope & Authority*. By no means all work that is performed by actuaries is Reserved Work, especially work that consists mainly of performing calculations using predetermined formulae and assumptions (such as the calculation of transfer values or surrender values).

2.9 We have looked at a simple case study: the calculation of transfer values for members of defined benefit pension schemes. Most of the respondents who expressed concerns had a pensions background, and the calculation of transfer values was mentioned as a particular area that they would not like to see covered by TAS M.

2.10 Since October 2008, it has been the (statutory) responsibility of the trustees to set the assumptions that underlie the transfer values. It is a statutory

⁵ *Scope & Authority of Technical Standards*, July 2008.

⁶ *Exposure Draft: Reporting Actuarial Information*, March 2009. The consultation period ends on 29 May 2009.

requirement for the trustees to receive advice from an actuary in setting the assumptions, including the discount rate or rates and life expectancies to be used. Advising on the assumptions to be used is thus Reserved Work (the work has to be done, and has to be done by an actuary) and under the current proposals any modelling work involved would be covered by TAS M. We believe that this is desirable, and that it was not this aspect of transfer value calculations that respondents were concerned about.

- 2.11 The trustees then determine the assumptions to be used in the calculations. They are under no obligation to accept the recommendations of the actuary (and the actuary may not have presented recommendations, but may simply have presented relevant information).
- 2.12 Finally, the actual transfer values for individual members are calculated using the assumptions set by the trustees. In some cases, the Scheme documents may specify that the calculations must be performed by an actuary. Depending on the precise wording, this may then be Reserved Work. In other cases, there is no obligation for the calculations to be performed by an actuary. In practice, the calculations are performed either by actuaries or by scheme administrators. In the latter case, actuaries usually provide the administrators with instructions and factors (which may, for example, take the form of a spreadsheet).
- 2.13 Regardless of whether actuaries are performing the calculations themselves, or telling others how to do so, we believe that it is important that the calculations are performed accurately and documented sufficiently. We do not believe that these aspects of TAS M, if they apply, would be too onerous. As our Specific TAS on Pensions is developed, we will consider whether it should include a requirement that such calculations and instructions should be subject to checks and should be documented.
- 2.14 In many cases, it is trustees or insurance companies who are responsible for communicating the results of simple calculations such as transfer values or surrender values to scheme members or policyholders. It is the reporting of the results by actuaries to trustees or insurance companies that would fall within scope of TASs, not the communication to the end user. Any explanations included with instructions for performing the calculations, or presented as a covering document in advance of the calculations being performed, would contribute to compliance with TAS R.
- 2.15 We believe that it is not the method or complexity of a calculation that is important, but its significance in supporting decisions made by the users of the resulting actuarial information. If the calculation is material (its results would influence the decisions) it is important that it is performed correctly, that the assumptions on which it is based are appropriate, and that the relevant checks are performed. If it is not material, then a failure to comply with the requirements in a TAS does not constitute a departure from the TAS.
- 2.16 Paragraph B.1.3 in the proposed text addresses this point.

Solvency II internal models

- 2.17 Some respondents were concerned that the proposed definition was too narrow and was inconsistent with the concept of an internal model that is used in Solvency II. Solvency II avoids an explicit definition of internal models, but it is clear that they include management processes as well as calculation engines. Our definition covers only calculation engines.

- 2.18 The BAS does not believe that the BAS should be setting standards for the management processes included in Solvency II internal models, except insofar as those processes affect the development and maintenance of the calculation engine.

GENERAL CONCEPTS AND PRINCIPLES

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| 3. | Do respondents have any comments on the proposals in section 3, especially those in paragraphs 3.15, 3.22 and 3.27? |
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- 2.19 The proposals in paragraphs 3.15, 3.22 and 3.27 of the consultation paper addressed documentation, proportionality and judgement respectively.

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| 4. | Do respondents have any views on the definition of materiality that is proposed in paragraph 3.5? |
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| 5. | Should the modelling TAS include principles concerning the need for documentation as discussed in paragraphs 3.9 to 3.18? |
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Documentation

- 2.20 Nearly all the respondents agreed that the proposed principle for documentation in paragraph 3.15 of the consultation paper was acceptable. One respondent believed that there should be no standards for the documentation of models used only for internal purposes.

- 2.21 A few respondents were concerned that the proposed documentation requirements would be either too onerous or disproportionate for some simple models. Some also believed that the requirements could inundate the user with too much information. It is clear that those who expressed the latter concern had not understood that documentation does not have to be disclosed to the user – that we distinguish between documentation and reporting. The revised definition of documentation (in Part B of the proposed text) makes the distinction clear. These points are covered in section C.4 of the proposed text.

Materiality

- 2.22 Many respondents agreed with the definition proposed in paragraph 3.5 of the consultation paper. However, a number of respondents, including some who were happy with the definition, expressed concerns about how difficult it would be to apply the definition in practice, and the extent of judgement required in order to do so. Other respondents thought that the definition was too long, confusing, and internally inconsistent – it appeared to define materiality in different ways for departures from the TAS and for other matters such as assumptions and documentation.

- 2.23 Paragraph 23 of the *Scope & Authority* defines materiality in the context of departures from TASs, but does not define it in the context of other matters. There are a number of aspects of models and modelling which might be material (or immaterial) and so it is important that the term is defined consistently for all the contexts in which it might be used. We believe that the definition in Part B of the proposed text extends the definition to cover the relevant aspects, while remaining consistent with the definition in the *Scope & Authority*.

- 2.24 Some concern has been expressed that it will be possible to argue that no documentation is material according to the proposed definition, as

documentation (which need not be disclosed to users) cannot influence the decisions that users take. We believe that this argument fails to allow for the fact that documentation assists the preparation of information that is reported to users.

- 2.25 Some concerns have been expressed to the BAS about the use of the phrase “could influence the decisions ...”, on the grounds that it extends the concept of materiality too broadly. It has been suggested that a better definition would use “is likely to influence ...” or “could reasonably influence ...”. We believe that “is likely to influence” would be much too narrow a definition, as its most obvious meaning would cover only those matters that were more likely than not to influence the decision. The use of the word “reasonably” would also present problems of interpretation.
- 2.26 The BAS’s definition of materiality is consistent with that in international accounting standards:
- Omissions or misstatements of items are material if they could, individually or collectively, influence the economic decisions of users taken on the basis of the financial statements.⁷
- 2.27 The BAS is therefore not currently proposing to change the definition of materiality in the *Scope & Authority*, which underwent consultation in 2008.
- 2.28 The definition of materiality in the proposed text is consistent with the definition in the *Scope & Authority*, which applies only to departures from the standard. The other definitions in Part B of the proposed text are the same as definitions used in the *Scope & Authority* or in other TASs.

Proportionality

- 2.29 We have received many comments on our proposed principle on proportionality, in response both to the modelling consultation paper and to other consultations.
- 2.30 The BAS believes that it is extremely important that actuaries (and others complying with its standards) do not act disproportionately, and in particular that they do not use BAS standards as an excuse for doing so. It believes that the best way of ensuring this is to explain that BAS standards should not be interpreted disproportionately.
- 2.31 This point is addressed in paragraph B.1.4 of the proposed text. In due course we expect that this will be covered in the *Scope & Authority* (as it applies equally to all our TASs) but we are expecting not to amend the *Scope & Authority* until we are closer to completing work on the initial set of TASs.

Judgement

- 2.32 Our suggested proposal on applying judgement in a reasoned and justifiable manner was generally welcomed, although a few respondents were concerned about the proposed requirement to document judgements.
- 2.33 We believe that the documentation of all judgements would be disproportionate, and we are therefore not intending to require it. These points are covered in paragraphs C.2.2 to C.2.4 of the proposed text.

⁷ IAS 1.

REPRESENTING THE REAL WORLD

6 Do respondents have any comments on the proposals concerning relevance and parsimony that are presented in section 4, especially those in paragraphs 4.12 and 4.17?

2.34 The proposals in paragraphs 4.12 and 4.17 of the consultation paper addressed the phenomena that should be modelled and the desirability of making models no more complex than necessary (often known as the principle of parsimony) respectively.

Phenomena to be modelled

2.35 Paragraph 4.12 of the consultation paper proposed that “models should cover all materially relevant phenomena, taking into account the purpose and structure of the model or models in question.”

2.36 Many respondents felt that this requirement was impossible to comply with in practice. Several suggested such variations as “should aim to cover all materially relevant phenomena ...” or “... all phenomena believed at the time of performing the work to be materially relevant...”.

2.37 It was also thought by some that it was not clear that “relevant” was not intended to mean “anything remotely connected with the problem at hand”. In fact, the second part of the proposed principle was intended to cover that point.

2.38 There are two main difficulties with all the revised wordings that were suggested. (The two examples given above are representative of all the suggestions.) First, the BAS believes that it cannot mandate the achievement of a mental state, so its TASs cannot require that actuaries (or others) aim or intend to do anything. Second, the definition of materiality already includes “... if, at the time the work is performed, the effect ... could influence the decisions to be taken ...”. Including a phrase such as “believed at the time of performing the work” in the principle would therefore not add anything new.

2.39 The BAS believes that this principle is an important foundation of good modelling. Therefore we have decided to make no substantial changes to the proposed text. These points are covered in paragraphs C.5.1 to C.5.3 of the proposed text.

Parsimony

2.40 Although most respondents agreed with the proposed principle in paragraph 4.17 of the consultation paper, some questioned the practicality of demonstrating that the criteria were achieved.

2.41 An example mentioned several times was the situation in which an existing complex model is used for a new purpose where the purpose would not require the same level of complexity. We do not believe that this issue would contradict the proposed principle, which addresses the introduction of complexity rather than the overall level. However, if a model is much too complex for a use to which it is being put, there may be a need to consider whether the model is in fact fit for that purpose.

2.42 A few other respondents were concerned that the proposed principle would inhibit the development of new models and methods of modelling. They

pointed out that in some cases it is not obvious before making changes whether the outputs would change significantly or not. In other cases, a complexity introduced to the model might not necessarily cause a material change in the outputs but might improve the quality of the outputs. In the light of these comments, we have amended the proposed principle to require that models should be no more complex than can be justified, rather than requiring that complexity be introduced if and only if it results in material differences to the outputs or to the limitations of the model in question. Justifications could be based on material differences to the outputs or limitations, or could be based on other factors. We are not proposing to require that the justifications be documented.

2.43 These points are covered in paragraphs C.5.4 to C.5.6 of the proposed text.

MODEL INPUTS AND OUTPUTS

7 Do respondents have any comments on the proposals concerning inputs and outputs that are presented in section 5, especially those in paragraphs 5.17, 5.28, 5.29, 5.35, 5.42 and 5.51?

2.44 The proposals in paragraphs 5.17, 5.28 and 5.29 of the consultation paper concerned data. Those in paragraphs 5.35, 5.42 and 5.51 of the consultation paper concerned the consistency of assumptions, definitions of estimates and the derivation of best estimates respectively.

Data

2.45 Paragraph 5.17 of the consultation paper proposed that the TAS should include a principle about the completeness, accuracy and relevance of data.

8 Should the modelling TAS include:

- a) any requirements relating to the disclosure of known or suspected shortcomings in data, over and above those expected to be included in the reporting TAS?
- b) requirements to provide an estimate of the effects of any data shortcomings, and that any compensating adjustments should avoid bias?

2.46 Most respondents felt that the disclosure requirements concerning data shortcomings should be covered in TAS R or TAS D.

2.47 Respondents understood the need to communicate the material shortcomings of data to the user but questioned the practicality of providing an estimate of the effects in all cases. Respondents agreed that any compensating adjustments should avoid bias.

2.48 These requirements are covered in TAS R, and we are not proposing to include a specific requirement in TAS M.

9. Should the modelling TAS include a requirement that, if data is grouped, the effects of the grouping should be quantified?

2.49 Paragraphs 5.28 and 5.29 of the consultation paper proposed the inclusion of principles concerning what should be reported about the grouping of data.

2.50 The respondents' views were mixed, although most were against a requirement for the quantification of the effects of the grouping. In most cases, it was thought, the reason for grouping data is to improve statistical

credibility or to increase computational tractability. Requiring the models to be run on both sets of data would defeat the purpose of grouping.

- 2.51 We accept the point that quantifying the effects of grouping data is not always possible. However, we believe that it is important that users understand the material effects of any grouping that has been performed. These points are covered in paragraphs C.6.1 to C.6.3 of the proposed text.

Consistency of assumptions

- 2.52 Paragraph 5.35 of the consultation paper contained a proposal that the assumptions used in a model, or in a suite of models that operate in conjunction, should be consistent, taking into account the purpose of the model or models in question.
- 2.53 Respondents found this principle a sensible one. A few respondents thought that the principle should also include appropriateness of the assumptions chosen.
- 2.54 Paragraphs C.6.7 to C.6.8 of the proposed text require the assumptions used in a model to be documented. Paragraphs C.6.9 to C.6.11 cover the consistency of assumptions.

Estimates

- 2.55 Paragraph 5.42 of the consultation paper contained a proposal that statistical definitions of estimates should be required. The responses we received indicated that such definitions are not always possible and so the proposed text requires a statistical or other definition (in paragraphs C.6.12 to C.6.14). The requirement that estimates be explained to users (also in paragraph 5.42 of the consultation paper) is covered in TAS R and so is not included in our proposals for TAS M.

10. Do respondents agree that best estimates (and other similar estimates) should be independent of the use to which they will be put?
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- 2.56 Paragraph 5.51 of the consultation paper contained a proposal that best estimates should be derived using methods that are independent of the purpose of the model. Respondents generally agreed with this proposal, which is covered in paragraphs C.6.15 to C.6.17 of the proposed text.

11. Do respondents have any views on: <ul style="list-style-type: none"> a) whether biased estimates such as those concerning prudence depend on context? b) the practicality or otherwise of requiring that the equivalent best estimate be presented alongside every prudent estimate, and the benefits to users of actuarial information of doing so?
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- 2.57 Respondents generally agreed that biased estimates depend on context, but thought that the TAS should make this clear. Paragraph C.6.17 of the proposed text addresses this point.

- 2.58 However, there was a divergence of opinion over the use of the word “bias”. Some respondents thought that it was a useful way of distinguishing between those estimates that should be independent of the purpose and other estimates, while others felt that its strict statistical sense was inconsistent with this use of it. We have therefore decided not to use the term in this context.

- 2.59 There was widespread agreement that a requirement that best estimates should be presented alongside all prudent estimates would be impractical, and some respondents thought that it would not help users.
- 2.60 It was pointed out that in some cases prudent estimates (or other estimates that depend on the purpose, such as optimistic estimates) are produced precisely because it is impossible to come up with a best estimate. In other cases, there could be practical difficulties in arriving at best estimates – for example, if prudence is inherent in methodology rather than an input, such as by zeroising negative technical provisions. In other cases, producing both prudent and best estimates would be extremely onerous, requiring nearly twice as much work as producing a single estimate.
- 2.61 It was also thought that in some cases the additional information might confuse users rather than helping them.
- 2.62 The proposed text therefore does not include a requirement that best estimates be presented alongside prudent estimates. However, prudent estimates will of course have to be defined (paragraph C.6.12 of the proposed text) and TAS R will require the meaning of “prudent” to be explained to users. As we develop Specific TASs we will consider whether there are particular circumstances in which prudent estimates should be accompanied by best estimates.
- 2.63 In addition, the BAS believes that it is important that users understand the level of prudence (or other similar qualities) in estimates. The requirement in paragraphs C.6.18 to C.6.19 of the proposed text addresses this point.

The use of ranges

12. Do respondents have any views on the practicality or otherwise of requiring the use of a range in conjunction with every single point estimate?

- 2.64 Most respondents thought that such a requirement would be impractical and undesirable. It was thought, for example, that a plethora of ranges could create confusion, and could obscure the main message. For a model with many outputs, it would be infeasible to produce a range for each one. For some types of output it would be difficult to produce ranges at all; for example, a range around an aggregate estimate might require complex assumptions about correlations and copulas.
- 2.65 On the other hand, some respondents expressed strong support for the proposal. However, they did not address the practicalities of doing so, and it appears that many of them were considering only “significant” point estimates.
- 2.66 We accept that requiring ranges in all cases would indeed be impractical. It is important that users get a clear picture of the uncertainty surrounding estimates, but a range is not the only method by which that might be achieved, and may not always be the best method. TAS R will require that uncertainty is communicated and we do not believe that any extra requirement is needed in TAS M. However, paragraph C.6.21 of the proposed text emphasises the need for effective communication of the uncertainty in point estimates.

FIT FOR PURPOSE

13	Do respondents have any comments on the proposals concerning the fitness for purpose of models that are presented in section 6, especially those in paragraphs 6.8, 6.12, 6.20, 6.28 and 6.33?
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2.67 Paragraphs 6.8, 6.12 and 6.20 of the consultation paper proposed principles concerning reproducibility and checks that should be performed. Paragraphs 6.28 and 6.33 of the consultation paper proposed principles concerning data.

Reproducibility

14	Are there any types of model that cannot be implemented in such a way that they exhibit reproducibility?
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2.68 Most respondents confirmed that they had not come across any actuarial models for which reproducibility was impossible. A few respondents thought that it may not always be possible for stochastic models to exhibit reproducibility because of software version updates.

2.69 We understand that the demonstration of reproducibility in its strict sense may not be always practical for stochastic models but the use of enough simulations to demonstrate stability in the statistical distributions of the outputs could be an alternative in such cases. Paragraphs C.7.1 to C.7.3 of the proposed text cover these points.

Checks on models

2.70 Paragraph 6.8 of the consultation paper contained a proposed principle concerning the checks that should be performed and how they should be documented. Paragraph 6.20 of the consultation paper contained a proposed principle concerning the documentation of the reasons for believing that models are satisfactory representations of reality.

2.71 Most respondents agreed on the necessity of performing and documenting checks as suggested in paragraph 6.8 of the consultation paper. Some had concerns that the requirement could be disproportionate in some cases. A few respondents thought that the requirement to state the purpose of checks would be disproportionate.

2.72 The opinions of the respondents were divided on the requirement to document the reasons for believing that the theoretical construct of a model was a satisfactory representation of reality. Amongst those who agreed with the proposal, there were concerns about the requirement potentially being disproportionate for certain cases. Amongst those who disagreed with the proposal, the concerns were mainly on the subjectivity of the reality to be represented; that it would change over time and that in quite a number of cases the actuarial model would be intended to represent the future and therefore there would be an inevitable subjectivity attached to the reality. We have amended the proposed principle (which appears in paragraph C.7.7 of the proposed text) to make it clear that it is necessary only to explain the ways in which the model reflects reality.

2.73 These points are addressed in paragraphs C.7.4 to C.7.10 of the proposed text.

Back testing

- 15 Should the modelling TAS include a principle concerning back testing?
- a) Are there any models for which back testing is impossible?
- b) Are there any practical difficulties that might arise if back testing were to be a requirement?

2.74 There was general agreement on the benefits of back testing but some significant problems were identified with requiring it in all cases. Most of these problems were connected with data in some way. For instance:

- If there is only very limited data, reserving some of it for use in back testing would mean that the remainder was not sufficient to produce any statistically credible results.
- In some cases, such as if new classes of business are being modelled, there is no relevant experience against which back testing could take place.
- Where the time horizon being back tested is long relative to the available history of calibration data, back-testing does not give statistically meaningful results.

2.75 We accept that it is impractical to require back testing for all models. There will be a requirement that checks are performed on models in order to determine their fitness for purpose, and in many (but not all) cases back testing would be an obvious way of doing this. Paragraphs C.7.4 to C.7.10 of the proposed text address this point.

Data

2.76 Paragraph 6.28 of the consultation paper contained a proposed principle that the definitions of all items of data should be documented. We are now proposing to include this requirement in TAS D.

2.77 Paragraph 6.33 of the consultation paper contained a proposed principle concerning the removal of outliers in data.

2.78 Most respondents agreed on the desirability of documenting the decision behind the removal of outliers. A few respondents thought it would be onerous if the standard was applied to justify each removal of outliers. Some believed that the effect of the removal of the outliers should be part of disclosure to the end user and hence part of TAS R. One respondent believed that such information should also contain the results that would be obtained if the outlier was not removed.

2.79 Paragraphs C.6.4 to C.6.5 of the proposed text cover this point.

External models

- 16 Would it be desirable and practical for users of external models to document the judgements they make, the checks that they perform and other relevant matters, and include explanations of the inputs, outputs and limitations in the same way as they would for models that they themselves have developed? Respondents who believe that this would not be practical should suggest alternative ways in which the objective set out in paragraph 2.9 could be met by users of external models.

- 2.80 Respondents generally agreed on the necessity of understanding and challenging the outputs of external models in the same way as those of internal models. However, some respondents raised concerns that the related documentation requirements would be disproportionate. The concerns extended to the issues around the checks that can be applied in practice by the practitioners using these models and the risk of them trying to give blunt judgements without fully appreciating the features of these models. If practitioners need to rely on the information provided by the developers of the external models, they will need to consider whether the checks performed by the external providers meet the users' needs.
- 2.81 The BAS believes that it is important that TAS M applies to all models within its scope, regardless of who has developed them. It recognises that it may not be possible (or even desirable) to perform exactly the same checks on externally developed models as would be performed on internally developed models, but the overall goal should be the same: to check that the models are fit for purpose and to ensure that their limitations are understood. Paragraph C.7.10 in the proposed text addresses this point.

Robustness and reasonableness

- | | |
|-----|--|
| 17. | Do respondents agree that requirements for robustness and reasonableness would not be enforceable and could have undesirable consequences? |
|-----|--|
- 2.82 Respondents generally agreed that requirements for robustness and reasonableness would not be enforceable and could have undesirable consequences, although a few thought that TAS M should include such requirements.
- 2.83 There were a number of comments to the effect that it is important that TAS M does nothing to discourage innovative thinking about possible events and phenomena. Recent events have shown that trends do not always continue, and that assumptions about the likelihood of extreme outcomes are very difficult.
- 2.84 We agree with these points. Models are inevitably strongly influenced by the experience and expectations of those developing them, and it is important that model developers recognise those limitations and try to overcome them.

LIMITATIONS OF MODELS

- | | |
|-----|---|
| 18. | Do respondents have any comments on the proposals concerning the limitations of models that are presented in section 7, especially those in paragraphs 7.29 and 7.41? |
|-----|---|
- 2.85 Paragraph 7.29 of the consultation paper contained proposals concerning sensitivity tests, and paragraph 7.41 of the consultation paper proposed that both model limitations and the ways in models meet users' needs should be reported to users.

Sensitivity tests

- 2.86 Many respondents expressed concerns that the requirements proposed in paragraph 7.29 of the consultation paper would be too onerous, especially the requirement to document the reasoning behind not performing sensitivity tests on some of the assumptions. The number of assumptions in some models runs into thousands.

- 2.87 Sensitivity testing may serve (at least) three purposes. First, it may be used to check the fitness for purpose of models – more sensitivity than expected to a particular assumption may indicate an implementation error. Second, it may be used to determine which assumptions are more significant than others. And third, it may be used to investigate the limitations of models, by indicating the degree of reliance that can be placed on the outputs.
- 2.88 However, sensitivity testing is by no means the only technique available for any of these purposes and so the proposed text does not include a separate principle addressing it (but see paragraphs C.7.9 and C.8.2 of the proposed text).

Model limitations

- | | |
|----|---|
| 19 | Does the discussion in paragraphs 7.7 to 7.24 include all the major sources of limitations in models? |
| 20 | Do respondents have any comments on the advantages and disadvantages of the options set out in paragraphs 7.38 to 7.42? |
| 21 | Should the modelling TAS identify specific types of limitation that should be explained in actuarial information? |
- 2.89 Most respondents thought that paragraphs 7.7 to 7.24 of the consultation paper were reasonably comprehensive. A few felt that there were some that had been omitted and that should be covered by TAS M. These included potential communication gaps between the provider of the model outputs and the users receiving the actuarial information and operational errors where the models were being used inadequately due to human errors.
- 2.90 Paragraphs 7.38 to 7.42 of the consultation paper compare three options for how TAS M could address limitations of models. Most respondents preferred the balanced approach suggested in paragraph 7.42 of the consultation paper, which would require the disclosure of limitations to users together with an explanation of how the models met the users' needs.
- 2.91 Most respondents believed that TAS M should not include a list of limitations that should be disclosed, since the situations would vary widely amongst different types of models and practice areas, but many thought that a check list would be useful as guidance.
- 2.92 Paragraph C.8.2 of the proposed text includes a list of examples of limitations of models and their implications. It is by no means an exhaustive list, but gives some idea of the types of matters that should be considered. The identification of phenomena that have not been modelled is often difficult, as it requires imagination to realise that hitherto completely unexpected events or circumstances may arise and may be relevant to the problems being addressed. However, recent events have demonstrated that limitations of this type can significantly undermine the reliability of models.
- 2.93 Paragraphs C.8.1 to C.8.3 of the proposed text address these points.

3 PROPOSALS

INTRODUCTION

- 3.1 In addition to the comments in answer to the specific questions posed in our consultation paper, we received a number of more general comments. Some of the comments which we have received on other consultations or in other contexts are also relevant to the development of TAS M.
- 3.2 In this section we discuss the following:
- a proposal that documentation should include a statement of the assumptions that have been used (paragraph 3.3); and
 - the proposal that TAS M should apply to all models used in aggregate reports completed on or after 1 April 2010 (paragraphs 3.4 to 3.11);

STATEMENT OF ASSUMPTIONS

- 3.3 TAS R will require that the material assumptions be reported to users, but does not impose any documentation requirements. TAS D is likely to require that the definitions of all data items be documented. We believe that it is important that there is a full record of the assumptions on which a model is based, and therefore are proposing to require that documentation includes statements of the assumptions that have been used (in paragraphs C.6.7 to C.6.8 of the proposed text).

COMMENCEMENT OF TAS M

- 3.4 We are proposing that TAS M will apply to models used in the preparation of all aggregate reports completed on or after 1 April 2010. This is consistent with the proposal that TAS R will apply to aggregate reports completed on or after 1 April 2010.
- 3.5 In order to encourage early adoption, we are proposing that all aggregate reports completed on or after 1 November 2009 will be required to state whether the models used in their preparation comply with TAS M.
- 3.6 For some pieces of work there is a large gap between the effective date and the date of the report. For example, Scheme Funding exercises for defined benefit pension schemes generally have to be completed within 15 months of the effective date, and in many cases are not completed until near the end of that period. In such cases it is possible that TAS M will apply to exercises for which the work on models has already started. However, we believe that in many cases the work being carried out is already compliant with TAS M or can be compliant with little additional work.
- 3.7 From its commencement date, TAS M will apply to all models that are used to produce actuarial information for work that is specified in the Schedule to the *Scope & Authority*, regardless of when those models were developed. It will not, of course apply to models that are no longer used. In particular, if a report quotes information from a previous report, the models used to produce the information in the previous report need not comply unless they are used to produce new outputs.

- 3.8 Some practitioners have expressed concerns about the amount of work that will be required in order to make existing models comply with TAS M, especially in the area of documentation.
- 3.9 The requirements of TAS M fall into three main groups: those concerning the models themselves (what phenomena they represent and their structure), those concerning the reporting of matters concerning models, and those concerning documentation. We believe that most existing models already comply with the first group of requirements. If they do not, we believe that they should not be used in the production of actuarial information. Compliance with the second group of requirements does not require any changes to the models themselves, but may require a better understanding of them on the part of those who prepare information based on them. Again, we believe that they should not be used without this understanding. We recognise that a significant amount of work may be required in order to comply with the third group of requirements, on documentation.
- 3.10 We are concerned that models whose documentation would not comply with TAS M are poorly understood and are not fit for purpose. We believe that if a model is well understood it would not be difficult to produce the documentation required by TAS M. Moreover, we believe that it may be difficult for information that is based on undocumented models to meet our overall Reliability Objective, that the users for whom a piece of actuarial information was created should be able to place a high degree of reliance on the information's relevance, transparency of assumptions, completeness and comprehensibility, including the communication of any uncertainty inherent in the information.
- 3.11 We would be interested in respondents' views on the practicality of the proposed commencement date. If respondents are in favour of a later commencement date they should explain how the needs of users will be met.

4 INVITATION TO COMMENT

QUESTIONS

- 4.1 The BAS invites the views of those stakeholders and other parties interested in actuarial information who wish to comment on the content of this document.
- 4.2 This consultation is not intended as an opportunity to revisit those issues that have already been exposed for comment in previous consultation documents. Respondents are therefore asked to focus on the policy decisions that were not articulated in the November 2008 consultation paper. In particular the BAS would welcome views on the following matters:
- 1 the proposed commencement date for TAS M (see paragraphs 3.4 to 3.11);
 - 2 the effects that the introduction of TAS M is likely to have on actuarial information based on models and our impact assessment (see paragraphs 1.10 to 1.16); and
 - 3 the text of the exposure draft as a means of implementing the policy proposals presented in this document.

RESPONSES

- 4.3 For ease of handling, we prefer comments to be sent electronically to **basmodelling@frc.org.uk**, with any attachments in Word format.

Comments may also be sent in hard copy form to:

The Director
Board for Actuarial Standards
5th Floor, Aldwych House
71-91 Aldwych
London
WC2B 4HN

- 4.4 Comments should reach the BAS by **28 August 2009**.
- 4.5 All responses will be regarded as being on the public record unless confidentiality is expressly requested by the respondent. A standard confidentiality statement in an e-mail message will not be regarded as a request for non disclosure. We do not edit personal information (such as telephone numbers or email addresses) from submissions; therefore only information that you wish to publish should be submitted. If you are sending a confidential response by e-mail, please include the word “confidential” in the subject line of your e-mail.
- 4.6 We aim to publish non-confidential responses on our web site within ten working days of receipt. We will publish a summary of the consultation responses, either as a separate document or as part of, or alongside, any decision.

DRAFT OF
TECHNICAL ACTUARIAL STANDARD M:
MODELLING

MODELLING (TAS M)

Status

This standard (TAS M) is a Generic Technical Actuarial Standard (Generic TAS), as defined in the *Scope & Authority of Technical Standards (Scope & Authority)* of the Board for Actuarial Standards (BAS).

This standard should be read in the context of the *Scope & Authority*.

The *Scope & Authority* sets out circumstances in which material departures from this standard are permitted or required and the disclosures which are required in respect of them.

Appendix I 'The development of TAS M' reviews considerations and arguments that were thought significant by the BAS in reaching the conclusions on the document. [Note: Appendix I is not included in this exposure draft.]

Scope

This standard, as a Generic TAS, applies to the work specified in the Schedule to the *Scope & Authority*. The scope of this standard will be affected by any amendments to the Schedule to the *Scope & Authority*.

Specific TASs may include provisions that include or exclude particular categories of work from the scope of this standard or other Generic TASs.

Wider adoption is encouraged.

Commencement

This standard applies to models used in the preparation of aggregate reports completed on or after 1 April 2010.

All aggregate reports completed on or after 1 November 2009 must include a statement of whether the models used in their preparation comply with TAS M.

Earlier adoption is encouraged.

Relationship with other TASs and with Guidance Notes

This standard sets out principles to be adopted across the range of work to which it applies, as described above. Other Generic and Specific TASs may apply to work that is within the scope of this standard, setting out additional principles that should be adopted.

In the event of a conflict between this standard and a Guidance Note adopted by the BAS (as described in the *Scope & Authority*), this standard shall prevail.

CONTENTS [OF TAS M EXPOSURE DRAFT]

<i>Part</i>		<i>Page</i>
A	Purpose of TAS M	26
	A.1 Purpose	26
B	Interpretation	27
	B.1 Interpretation of the text	27
	B.2 Definitions	27
C	Modelling	29
	C.1 Introduction	29
	C.2 Application	29
	C.3 Reporting	29
	C.4 Documentation	30
	C.5 Representation of the real world	30
	C.6 Model inputs and outputs	31
	C.7 Fitness for purpose	32
	C.8 Limitations	34

A PURPOSE OF TAS M

A.1 PURPOSE

A.1.1 The BAS's Reliability Objective is that the **users**¹ for whom a piece of actuarial information was created should be able to place a high degree of reliance on the information's relevance, transparency of assumptions, completeness and comprehensibility, including the communication of any uncertainty inherent in the information.

A.1.2 The purpose of this standard is to assist the achievement of the Reliability Objective by ensuring that if actuarial information is based on **models** it:

- includes explanations of the purpose the **models** are intended to serve, how the inputs to the **models** are derived and what the outputs from the **models** are intended to represent; and
- includes explanations of the significant limitations of the **models**;

and the **models**:

- sufficiently represent those aspects of the world that are relevant to the decisions for which the actuarial information will be used; and
- are fit for purpose both in theory and in practice.

¹ Terms appearing in **bold** in the text are explained in the Definitions set out in Part B.

B INTERPRETATION

B.1 INTERPRETATION OF THE TEXT

- B.1.1 All text in this standard has equal status unless stated otherwise. Paragraphs setting out explicit principles are emphasised with boxes for convenience.
- B.1.2 The **Scope & Authority** states that a failure to follow the principles in this standard need not be considered a departure if it does not have a **material** effect. The contents of this standard should be read in that context, even where the term **material** is not explicitly used or where the word “shall” is used.
- B.1.3 The definition of **model** covers a wide range of calculations of varying degrees of complexity performed in many different ways, electronic or otherwise. The **materiality** of outputs, assumptions, checks, documentation and other matters relating to **models** depends on their influence on the decisions that they support, not on the complexity of the calculations or how they are performed.
- B.1.4 Nothing in this standard should be interpreted as requiring work to be performed that is not proportionate to the scope of the decision or assignment to which it relates and the benefit that **users** would be expected to obtain from the work.
- B.1.5 The form that is taken by any explanations, rationales, descriptions, indications or other analyses required by this standard will need to depend on the scope of the work being performed and the benefit to the **users**. Unless stated otherwise, analyses may be quantitative or qualitative.
- B.1.6 This standard should be interpreted in the light of the purpose set out in Part A.

B.2 DEFINITIONS

- B.2.1 Terms appearing in **bold** in the text are used with the meanings set out below.

aggregate report For each decision taken by a **user** in connection with work within the scope of this standard, the set of all **component reports** received by the **user** containing information **material** to that decision. The **aggregate report** for a piece of work is the set of all **component reports** relating to that piece of work.

component report Information which relates to work within the scope of this standard and which is given to a **user** in permanent form. A **component report** may be given to the **user** in hard copy or electronically. Examples of **component reports** include formal written **reports**, draft **reports**, emails and copies of presentations. Possible contents of **component reports** include tables, charts and other diagrammatic presentations as well as or instead of text. It is possible for a **component report** to form part of one or more **aggregate reports**.

data	A collection of facts or information usually collected from records or as the result of experience or observation. Examples include membership or policyholder data, claims data, asset and investment data, operating data (such as expenses), benefit definitions and policy terms and conditions.
documentation	Records and explanations of judgements, assumptions and other matters. Documentation may be paper or electronic based. It is not necessarily provided to users . Documentation is material if it concerns a material matter.
Generic TAS	A Technical Actuarial Standard which applies to all work specified in the Schedule to the Scope & Authority .
implementation	The formulae and algorithms of the theoretical construct in a form that will accept inputs and will generate outputs. In many cases the implementation is a computer program, but other types of implementation are possible – for instance, pen and paper are often used for simple models .
material	A matter is material if, at the time the work is performed, it (or information resulting from it) could influence the decisions to be taken by users . A matter that is immaterial when considered in isolation may be material when considered in conjunction with others.
model	An abstract and simplified representation, based on assumptions, of some aspect of the world which consists of a set of mathematical formulae and algorithms that calculate outputs from inputs in the form of data and estimated parameters.
realisation	An implementation together with a set of inputs. For an implementation that is a computer program, a realisation is a run of the program. Runs with different data or parameters are different realisations even if the program itself has not changed.
report	An aggregate report or a component report .
Scope & Authority	The BAS's <i>Scope & Authority of Technical Standards</i> .
Specific TAS	A Technical Actuarial Standard that is not designated by the BAS as a Generic TAS .
theoretical construct	The set of mathematical formulae and algorithms comprising the model .
users	Those people whose decisions a report is intended (at the time of writing) to assist. Examples of possible users include those to whom the report is addressed, regulators and third parties for whose benefit a report is written.

C MODELLING

C.1 INTRODUCTION

- C.1.1 This Part contains principles that support the purpose of this standard set out in Part A. It should be interpreted as described in Part B.
- C.1.2 Work that is within the scope of this standard may also be within the scope of other BAS standards. In particular, other **Generic TASs**, including those on *Reporting Actuarial Information* and *Data*, apply to all such work.
- C.1.3 Other principles concerning **models** may be contained in **Specific TASs**.
- C.1.4 Section C.2 describes how this standard should be applied. Sections C.3 to C.8 contain principles that contribute to the achievement of the purpose set out in Part A.

C.2 APPLICATION

C.2.1 All **models** relating to work within the scope of this standard shall comply with this standard.

Judgement

C.2.2 Judgements concerning the application of this standard shall be exercised in a reasoned and justifiable manner.

- C.2.3 Examples of matters on which judgement might be needed include applicability of the **model** to the purpose, the suitability of the assumptions and **data** to be used, the relevance of the outputs and the form that indications or explanations might take.
- C.2.4 Judgements might need to be reconsidered when, for example:
- a significant period of time has elapsed since the **model** was developed or last used;
 - a previously unexpected event has occurred; or
 - the **model** is being used for purposes other than those originally intended.

C.3 REPORTING

- C.3.1 Principles for other matters that should be reported to **users** in respect of **models** are contained in the **Generic TAS** on *Reporting Actuarial Information*.
- C.3.2 Principles for matters that should be reported to **users** in respect of **models** may also be contained in **Specific TASs**.

C.4 DOCUMENTATION

C.4.1 **Documentation** shall:

- a) contain enough detail for a technically competent person with no previous knowledge of the **model** being **documented** to understand the matters involved and assess the judgements made;
- b) include a statement of its purpose; and
- c) be clear, unambiguous and complete for its purpose.

C.4.2 **Documentation** might take many forms, including separate physical or electronic documents, comments in the code of an **implementation** or annotations to the output of a **realisation**.

C.4.3 Principles regarding specific **documentation** requirements are contained in other sections of this standard.

C.5 REPRESENTATION OF THE REAL WORLD

Phenomena to be modelled

C.5.1 **Models** shall represent all phenomena that are relevant to their purpose, taking into account their structure.

C.5.2 The relevance and **materiality** of a phenomenon are matters for judgement at the time the work is performed.

C.5.3 A phenomenon that is relevant to the purpose of one **model** might be irrelevant to that of another similar **model**. For example, a decrease in deaths due to circulatory diseases might be relevant to a causal **model** of future mortality but not to a **model** based on time-series extrapolation of overall mortality rates.

Parsimony

C.5.4 **Models** shall be no more complex than can be justified.

C.5.5 Examples of possible justifications include a **material** difference to the outputs of the **model** or a **material** reduction in its limitations.

C.5.6 The presence of irrelevant assumptions might indicate that the **model** structure is more complex than necessary.

C.6 MODEL INPUTS AND OUTPUTS

Data

C.6.1 If heterogeneous **data** has been grouped:

- a) **documentation** shall include the reasons for the grouping and the criteria used to determine the groups; and
- b) the **aggregate report** shall include an explanation of the rationale underlying the grouping if it is not possible to demonstrate that the grouping has no **material** effect.

C.6.2 Examples of reasons for grouping heterogeneous **data** and criteria for determining the groups include improving statistical credibility, increasing computational tractability and changing the level of uncertainty surrounding the results.

C.6.3 An explanation of the rationale underlying **data** grouping will need to cover both the advantages and the disadvantages of doing so, including the effects on uncertainty. The explanation may include a quantification of the effects of grouping or may take some other form.

C.6.4 If any outliers are removed from the **data** used for a **realisation** other than because they are erroneous:

- a) **documentation** shall include the rationale for their removal; and
- b) the **aggregate report** shall include an explanation of the implications of their removal.

C.6.5 An outlier is a **data** point that is significantly different from other **data** points.

C.6.6 Principles for other matters that relate to **data** are contained in the **Generic TAS on Data**.

Assumptions

C.6.7 **Documentation** shall include statements of the assumptions used in a **model**.

C.6.8 Examples of assumptions include numerical values that form inputs to an **implementation** or **realisation**, implicit qualitative assumptions about the relationships between phenomena and prior beliefs about the future behaviour of the phenomena being modelled (such as assumptions about the mean reversion of equity returns).

C.6.9 The assumptions used in a **model**, or in a suite of **models** that operate in conjunction, shall be consistent, taking into account the purpose of the **model** or **models** in question.

C.6.10 An example of the need to avoid inconsistencies is when the changes to assumptions that are required in order to investigate the effects of a scenario, such as high inflation, need to be made in all parts of the suite of **models** and to all related assumptions (such as future expense levels).

C.6.11 Different assumptions are not always inconsistent. For example, if several independent **models** are used in conjunction to provide better estimates than any one **model** could provide on its own, different assumptions might be chosen deliberately.

Estimates

C.6.12 **Documentation** shall include statistical or other definitions of any estimates derived from **model** outputs or used as assumptions in **models**.

C.6.13 Examples of estimates that might require definitions include “best estimate”, “central estimate” and “prudent estimate”. Definitions might be statistical or mathematical descriptions of how the estimates have been derived, or might take other forms. Definitions may need to be consistent with any regulatory use of the term in question.

C.6.14 The **Generic TAS** on *Reporting Actuarial Information* requires that descriptions of the intended meanings of such terms are included in **aggregate reports**.

C.6.15 The terms “best estimate”, “central estimate” and other similar terms shall be applied only to estimates that have been derived using methods, assumptions and judgements that are independent of the purpose of the **model**.

C.6.16 For example, an independent estimate of future mortality rates for a given group of lives would be the same regardless of whether the estimate was to be used to calculate term insurance premiums or annuity rates.

C.6.17 Terms such as “prudent”, “not excessive” or “optimistic” may be used to describe other types of estimate.

C.6.18 An **aggregate report** shall include an indication of the extent to which estimates have been influenced by the purpose of the **model**. If the extent of influence is based on a comparison with a corresponding estimate that is independent of the purpose of the **model**, the **aggregate report** shall include an explanation of the relationship between the two estimates.

C.6.19 For example, the indication of the extent to which estimates have been influenced by the purpose of the **model** might take the form of an indication of the level of prudence or optimism in the estimate, or might take some other form.

C.6.20 Paragraphs C.6.15 to C.6.19 apply to estimates derived from **model** outputs or used as assumptions in **models**.

C.6.21 The **Generic TAS** on *Reporting Actuarial Information* requires an indication of the nature and extent of any **material** uncertainty inherent in the information contained in an **aggregate report**. The uncertainty inherent in point estimates might be indicated through the use of ranges, sensitivity analyses or other means.

C.7 FITNESS FOR PURPOSE

Reproducibility

C.7.1 **Implementations** and **realisations** of **models** shall be reproducible.

- C.7.2 A reproducible **implementation** is one that produces the same outputs from identical inputs. A reproducible **realisation** is one that produces the same outputs each time it is run.
- C.7.3 For Monte Carlo simulations, methods by which reproducibility can be demonstrated include:
- the use of a random number generator that can be seeded in order to generate the same sequence of pseudo-random numbers on demand; and
 - the production of enough simulations to demonstrate stability in the statistical distributions of the outputs, for instance by comparing the outputs from two sets of simulations.

Checks

C.7.4 A set of checks shall be constructed and performed in order to determine the fitness for purpose of the **theoretical construct, implementation and realisations**.

C.7.5 **Documentation** shall include:

- a) the objectives of the checks that have been performed; and
- b) records of the outcomes of the checks.

C.7.6 Some checks might need to be performed when any changes are made to the **model**. Other checks might need to be performed less frequently.

C.7.7 **Documentation** shall include:

- a) explanations of the ways in which the **theoretical construct and implementation** are satisfactory representations of reality; and
- b) a quantitative analysis of the predictive properties of any **models** that are intended to be used for prediction.

C.7.8 Explanations of the ways in which the **theoretical construct and implementation** are satisfactory representations of reality may need to include the rationales for fundamental qualitative assumptions and prior beliefs.

C.7.9 Examples of techniques that can be used to support such explanations or analyses include:

- comparing the predictions given by the **model** outputs with the actual experience (sometimes known as back testing);
- comparing the inputs and parameters of **models** with actual experience;
- analysis of movements; and
- sensitivity testing.

C.7.10 Paragraphs C.7.4 to C.7.9 apply to all **models**, regardless of who has developed them. The extent and nature of the checks that are performed will need to take into account the provenance of the **model** in question and the reliability of any checks that have been performed by others.

C.8 LIMITATIONS

C.8.1 If an **aggregate report** includes information based on **models**, it shall include explanations of:

- a) any **material** limitations of the **models** and their implications; and
- b) how the **models** on which it is based address the **users'** needs.

C.8.2 Examples of limitations of **models** and the implications of those limitations include:

- phenomena that have not been modelled;
- how sensitive the outputs are to key assumptions (both quantitative and qualitative);
- how suitable the outputs are for purposes other than those intended;
- the extent to which the system-wide effects of individual actions and other systemic risks have been taken into account;
- significant simplifying assumptions that have been made; and
- the degree of reliance that can be placed on the outputs.

C.8.3 Explanations of how the **models** address the **users'** needs will need to cover the relevance of the **model** outputs to those needs and their completeness with respect to them.

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