



BOARD FOR ACTUARIAL STANDARDS

**EXPOSURE DRAFT:
MODELLING**

DECEMBER 2009

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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 May 2009, it published an exposure draft of its Generic Technical Actuarial Standard (Generic TAS)² on *Modelling* (TAS M).
- 1.2 The consultation period ended on 28 August 2009. We received 25 public responses³ (see Appendix B), and several confidential responses. We held a number of meetings with practitioners and other stakeholders and discussed the proposals with the FRC's Actuarial Stakeholder Interests Working Group. We thank all those who contributed.

SUMMARY

- 1.3 The largest proportion of responses came from pensions practitioners, with fewer from practitioners in life and non-life insurance. Some respondents represented the views of two or three practice areas. There were no responses from the users of actuarial information, but the FRC's Stakeholder Interests Working Group considered the matter from a user perspective and gave useful input.
- 1.4 Respondents to the exposure draft generally supported the direction of the draft and the principles proposed in it. However, some respondents expressed significant concerns about the practical application of the standard while others found some sections difficult to understand. There were also some concerns about particular principles that were included.
- 1.5 From discussions with a number of respondents and others it appears that many of the concerns arose because of misunderstandings and because the proposed text was not being interpreted as we had intended. As a result of these comments we have redrafted the TAS, changing the structure and some of the terminology but retaining the essential content of the previous draft.
- 1.6 We have also made some changes to the principles. Some have been dropped or combined with others, while some have been added in order to make explicit requirements that were implicit in the previous draft.
- 1.7 Section 2 discusses the proposed commencement date of TAS M. Section 3 discusses the comments that were made on the proposed text, and explains the changes that we have made.
- 1.8 Because of the extent and nature of the changes, we are issuing a further exposure draft of the proposed text of TAS M. Section 4 contains our invitation to comment on the revised draft and the second part of this document contains the proposed text.

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

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 public responses are available at <http://www.frc.org.uk/bas/publications/pub2055.html>.

EXPECTED EFFECTS

- 1.9 In paragraphs 1.11 to 1.16 of the exposure draft we discussed the expected effects of TAS M and asked for respondents' views on them, and outlined our assessment that any long term costs associated with the implementation of TAS M would be justified by the resultant benefits to users of actuarial information.
- 1.10 Some respondents felt that TAS M would help to formalise current best practice. Many agreed that the greatest impact would be to the documentation of models, some feeling that the benefits of better documentation would not be visible to users other than in very rare cases where its production uncovered errors.
- 1.11 One respondent was concerned that the text could be interpreted differently by different actuaries and without consistent interpretation the TAS would not give users confidence in actuarial information.
- 1.12 Other practitioners felt that the application of materiality and proportionality would be difficult but was the key to the standard being practical and excessive costs not being incurred.
- 1.13 Most respondents agreed that the long term benefits of applying TAS M would exceed the costs but emphasised that the initial costs could be significant, particular for older or externally developed models. Some respondents felt that we had underestimated the initial costs. We consider that some of the high assessments of likely costs are due to misinterpretations of the exposure draft, as described in paragraphs 3.7 and 3.8.
- 1.14 Some insurance practitioners argued that for models with a limited future life, such as those due to be replaced on the introduction of Solvency II, the costs would not be proportionate to the benefits to users. Some pensions practitioners were concerned that the costs would be disproportionate for small schemes.
- 1.15 No convincing arguments were presented that the overall long term costs of compliance with TAS M would outweigh the benefits. However, for some practitioners the short term costs of reviewing and possibly updating their models and associated documentation might be significant.

RESPONSES TO THIS EXPOSURE DRAFT

- 1.16 Details of how to respond to this paper are set out in section 4. Comments should reach the BAS by **1 February 2010**.

2 COMMENCEMENT DATE

INTRODUCTION

- 2.1 In the May exposure draft we proposed that TAS M should apply to models used in the preparation of aggregate reports completed on or after 1 April 2010, and that any aggregate report completed from 1 November 2009 should include a statement of whether it complies with TAS M. Paragraphs 3.4 to 3.11 of the analysis of responses in the May exposure draft explained our reasoning, and discussed how compliance might work in some cases.

STATEMENT OF COMPLIANCE

- 2.2 There was no support from respondents for a mandatory statement of compliance before the commencement date, and we have not pursued this idea.

PHASED INTRODUCTION

- 2.3 Most practitioners expressed concern over the proposed commencement date: they thought that 1 April 2010 was too early and that it did not allow sufficient time for models to be reviewed and for any necessary work to ensure compliance to be completed. Some respondents suggested that there should be a transitional period, during which compliance with TAS M should be on a “comply or explain” basis or during which TAS M should be recommended practice but not mandatory.
- 2.4 A number of respondents from both insurance and pensions proposed that separate commencement dates should apply to new and existing models. While new models would need to comply with the TAS from April 2010 delays of up to one or two years were suggested to give time for the review and amendment of existing models.

INSURANCE

- 2.5 Several insurance practitioners considered that an April 2010 commencement date for TAS M would interact badly with the introduction of Solvency II, which is placing significant pressure on resources. It was thought likely that many insurers would be unable to review and amend their existing models within the proposed time scale.
- 2.6 It was also argued that the introduction of Solvency II will result in a number of existing models being discarded within the next two or three years, and that they should not be subject to the requirements of TAS M as users’ long-term interests would be better met by the development of the models that would replace them. It was thought that many of the models that will be discarded are used only for calculating some of the formulaic capital requirements under Solvency I, which are in most cases overridden by the more risk based results of the Individual Capital Adequacy Standards (ICAS) process. It was suggested that the commencement date for TAS M for all models or existing models should be aligned with the introduction of the Solvency II regime in 2012. Some insurers (in confidential responses or individual meetings) argued that they would be unable to comply with TAS M for all their models before the introduction of Solvency II.

PENSIONS

- 2.7 A number of pensions practitioners also expressed a preference for a later commencement date. They were concerned that the proposed timing would lead to the retrospective application of the standard. Scheme Funding exercises can take up to 15 months from their effective date and are usually performed triennially, so that exercises finishing in April 2010 could have effective dates as early as January 2009. Moreover, other reports issued between Scheme Funding exercises are often based on reports from the previous exercise, which could have an effective date in 2007 or 2008. It was argued that the modelling used for such reports would have to be revisited in order to comply with TAS M.
- 2.8 Other pensions practitioners thought that a commencement date related to the effective date of Scheme Funding exercises, or other projects, would be more practical.

PROPOSED COMMENCEMENT DATE

- 2.9 We considered several options for the commencement date of TAS M, including separate dates for new and old models, or for simple and complex models. We also considered expressing the date in terms of when a piece of work was started, instead of in terms of the completion of an aggregate report. However, we, and those with whom we discussed the matter, were unable to find a definition that provided a satisfactory distinction between new and old models or between simple and complex ones. In addition, we thought that it would be helpful to users to express the commencement dates for our different TASs consistently, in terms of the completion of aggregate reports.
- 2.10 We recognise that existing models and processes will have to be reviewed and possibly changed during the coming months to ensure that models used in the preparation of aggregate reports completed after the commencement date comply with TAS M. However, TAS M formalises the requirement for models to be fit for purpose. Less reliance can be placed on the outputs produced by a model that is not fit for purpose, so we consider that it would not further our Reliability Objective to delay the introduction of TAS M unduly. Models that are currently fit for purpose are likely to comply with TAS M in most respects already, so that practitioners will need to make few changes to their processes, especially as existing documentation and checks that have already been performed contribute to compliance. Some of the concerns expressed by practitioners about the difficulty of complying with TAS M were due to a misunderstanding of its requirements, as discussed in paragraphs 3.7 and 3.8.
- 2.11 It is likely that TAS M will be issued in Spring 2010, and we are therefore proposing that it should apply to models used in the preparation of aggregate reports completed on or after 1 January 2011, which will in our view give practitioners sufficient notice to allow them to review their models and processes.

3 CHANGES TO THE TEXT

INTRODUCTION

3.1 As a result of the responses we received to the exposure draft and meetings with practitioners and other stakeholders, we have made significant changes to the structure and wording of the proposed text of TAS M. The changes are described in this section. In brief:

- The text has been extensively revised in order to better express our intentions, including changes to a number of definitions.
- We have brought the definition of materiality in TAS M into line with its definition in the *Scope & Authority* and TAS R (both of which were amended in November 2009) and TAS D.
- The principle that all relevant phenomena should be modelled has been dropped, as we accept that this may be impossible in some cases.
- The principles requiring the use of neutral methods to calculate best estimates and requiring the disclosure of the degree of prudence (or other non-neutral methodology) have been rewritten using revised terminology.
- The principles requiring the documentation of definitions of estimates and quantitative analyses of the predictive properties of models have been dropped.
- Principles have been added that require that the data used in realisations is suitable for the purpose of the model and the data that has been used is recorded.
- The principle requiring the removal of outliers from data to be documented has been extended to cover the removal of all non-erroneous data points, and a principle requiring the recording and reporting of such removals has been added.

3.2 Unless indicated otherwise, all references in this section to paragraph numbers are to the proposed text of TAS M in the second part of this document.

INTERPRETATION

3.3 Several respondents identified particular paragraphs in the proposed text that they felt needed clarification. In some cases, they suggested adding text to make it clear that requirements were to be interpreted in a proportionate way, or that they applied only to material matters.

3.4 We do not consider that the clarity of TAS M would be enhanced by using the words “proportionate” or “material” widely. Paragraph B.1.2 explains clearly that materiality should be understood, even where the term “material” is not explicitly used. Paragraph B.1.4 explains that all requirements are to be interpreted proportionately.

3.5 We have added an explanation (paragraph B.1.5) that lists of examples are not intended to be exhaustive.

- 3.6 A number of respondents were concerned that, in order to comply with TAS M, models would have to be very elaborate and undergo extensive checking. It would become impossible to use simple models to give approximate answers that were required by users in a short time. It is certainly not our intention that TAS M should have this effect. In our view, such models serve users' needs, although they necessarily have significant limitations. Paragraphs C.3.7, C.5.8 and C.5.9 address this point explicitly.
- 3.7 Some responses indicated to us that the respondents were not interpreting TAS M in the way we had intended. We gained this impression from comments that were made about the effort required to comply with some of the principles, and confirmed it through meetings with respondents at which we explored the issue. Some practitioners considered that TAS M would introduce a need for a control environment which would require a major exercise to implement but which would not reduce the number of errors in models. We have revised the text to place a greater emphasis on the fitness for purpose of models, focusing on whether the right aspects of the world are modelled in the right way.
- 3.8 It appears that some of the misinterpretation may have occurred because respondents thought that, if taken at face value, the principles would be so easy to comply with that they would have little effect on the quality of their actuarial work, and that this could not be what we intended. We consider this is an effect of the extent to which TAS M is a truly generic standard, capable of being applied to a broad range of work. Current practice varies by area of work, and a principle that is observed in current practice in one area may well result in significant changes of practice in another. The introduction of TAS M will, we hope, result in more consistent practice across all areas of work to which it applies. We do indeed intend the principles in our standards to be taken at face value. We hope that the revised exposure draft makes our intentions clearer.

MATERIALITY

- 3.9 The definition of materiality in Part B of the revised exposure draft is the same as the definition in the *Scope & Authority* and TAS R (both of which were amended in November 2009) and TAS D. The reasons for the change in the definition are given in *Technical Actuarial Standard D: Data – Analysis of responses to the May 2009 exposure draft*⁴.
- 3.10 In brief, our definition now makes it clear that the judgement of materiality must take place within the context in which the work is performed and reported. The context includes the time at which the activities take place, so there is no element of hindsight, but does not limit it to either the time at which the work is performed or the time at which it is reported (which are not always the same). The definition also introduces an element of reasonableness into the judgement. It remains close to that used in international accounting standards.

APPLICATION

- 3.11 Several respondents, predominantly pensions practitioners, expressed concerns that the definition of a model was too wide and included simple actuarial functions and routine calculation work. They thought that it could

⁴ Available at <http://www.frc.org.uk/bas/publications/pub2168.html>.

be interpreted as applying to almost all types of calculations undertaken by actuaries. There was also felt to be a lack of clarity about which principles applied to the theoretical construct (or specification), implementation or realisation, or a combination of the three.

- 3.12 TAS M is a generic standard and will apply to models of widely differing natures regardless of their size, complexity or origins. The text has been expanded to make this explicit. It also gives examples of simple and complex models and notes the difference between a model as a whole and its component parts.
- 3.13 The definition of “model” has been changed to make it clear that it includes the theoretical concept of how some aspect of the world will be represented through to the calculation of results for a particular purpose. The definitions of the different aspects of a model – specification, implementation and realisation - have been revised to make them clearer. “Specification” replaces “theoretical construct”.
- 3.14 Concerns were expressed about the application of the standard to externally sourced models. We consider that those using a model to provide actuarial information should be able to demonstrate it is fit for purpose, use it appropriately and understand and communicate its limitations regardless of whether it was developed internally or externally; TAS M therefore applies equally to all models. The revised text makes it clear that documentation provided and checks performed by an external provider may contribute to compliance with the standard.

Documentation

- 3.15 Some respondents felt that requiring documentation to be suitable for a person with no previous knowledge of the particular model being documented was unnecessarily onerous and could be interpreted as referring to a person with no previous knowledge of, for example, the products and system in question. As existing documents, such as user manuals or policy documents, can contribute to compliance we do not accept this concern.
- 3.16 It was suggested that there is no merit in the requirement for documentation to state its purpose (paragraph C.2.8). As documentation, like a report, may be intended for a wide range of purposes (for example, to assist the user of the model or to assist future developers of the model), we consider that it is helpful for the purpose to be stated, so that any limitations in the documentation arising from a limited purpose can be understood.
- 3.17 Paragraph C.2.8 has been amended to make it clear that it applies to documentation that is required by TAS M, but not necessarily to all documentation produced for any purpose.
- 3.18 Paragraph C.2.9 has been amended to make it clear that documentation need not be prepared especially for the purpose of complying with TAS M, may take many forms (including computer files) and may have been prepared by others, including the providers of an externally built model. Paragraph C.2.10 has been added to emphasise that the level of detail required is a matter of judgement. It notes factors that will need to be taken account of in that judgement.
- 3.19 It was suggested that TAS M should address the length of time for which documentation should be retained. In our view there is no single retention period which would be appropriate in all contexts. We consider that

requiring a minimum retention period is more an ethical and conduct matter than a technical actuarial matter.

FITNESS FOR PURPOSE

Satisfactory representation

- 3.20 Some practitioners presented strong arguments supporting their contention that it is not always possible to represent all material phenomena in a model, or that there may be good reasons for not doing so. In the latter case, they suggested, reporting the resulting limitations of the model would meet the Reliability Objective.
- 3.21 We accept these arguments, and have removed the principle (paragraph C.5.1 in the May exposure draft) from the revised text. Paragraph C.3.1 now requires that the model is a satisfactory representation of some aspect of the world, replacing part of paragraph C.7.7 in the May exposure draft. In paragraph C.3.2 we make it clear that the extent to which relevant phenomena are modelled is a contributory factor.

Checks

- 3.22 Many respondents expressed concerns about the requirement for a quantitative analysis of the predictive properties of models in paragraph C.7.7 of the May exposure draft, and argued that it added little to the requirements that models are satisfactory representations of reality and that they are checked. We agree with these arguments, and there is no such requirement in the revised text. However, paragraph C.3.9 clarifies that checks of predictive properties may be needed for some models.

Choice of methods

- 3.23 Paragraphs C.3.10 to C.3.13 replace paragraphs C.6.15 to C.6.17 of the May exposure draft. The intent and underlying principles have not changed but have been expressed using different terminology. We now define the term “neutral” to refer to methods, assumptions and judgements that are not affected by the desired outcomes. Paragraph C.3.10 requires that best estimates, and other similar estimates, are neutral.
- 3.24 Paragraph C.3.12 recognises that legislation or other legal requirements may describe an estimate as a “best estimate” and specify methods and assumptions which are not neutral. In these circumstances users should be made aware that the term “best estimate” might be misleading. There is, of course, no requirement that any specific terms, such as “neutral”, are used in the explanation given to users.

Parsimony

- 3.25 Some respondents were concerned that the parsimony principle would prevent the use of complex models to address simple issues. We do not consider that the use of such a model would contradict the principle unless the model is much too complex for the use to which it is being put. In such a situation there may be a need to consider if the model is in fact fit for purpose. The revised text clarifies this point.

MODEL INPUTS**Data**

- 3.26 Paragraphs C.4.3 to C.4.6 require the data used to be suitable for the purpose, and that records are kept of the data that has been used.
- 3.27 Several respondents pointed out that data items may be removed from the data set other than because they are outliers, and saw no reason why the principle in paragraph C.4.11 should be limited to outliers. We agree. We have also accepted suggestions that the data points in question should be recorded and reported to users.

Assumptions

- 3.28 It was suggested that the requirement in paragraph C.4.16 that assumptions are documented was too onerous, and that it would mean, for example, producing a list of all the inputs to every single spreadsheet used in a large complex model. This is not our intention. Paragraph C.2.3 now makes it clear that the requirements of TAS M apply to a model as a whole, not the individual components. Paragraph C.2.9 explains that electronic files can constitute documentation. For example, the input files for a modelling system, if they include text labels, would form documentation of the parameters they contain.
- 3.29 Paragraph C.4.19 replaces paragraphs C.6.12 to C.6.14 of the May exposure draft.

REPORTING

- 3.30 Paragraphs C.5.4 to C.5.6 replace paragraphs C.6.18 to C.6.20 of the May exposure draft. They use the same terminology as paragraphs C.3.10 to C.3.12, and require that the extent of any subjective adjustments to estimates is disclosed.

Limitations and users' needs

- 3.31 Paragraphs C.5.8 to C.5.9 now make it clear that the needs of users and the limitations of the models used are often closely connected. A very simple model used to give an approximate answer might meet the user's need for a quick response, but will necessarily have more limitations than one that is used for a more detailed study. However, the level of detail needed in a description of the limitations does not depend on their extent. A broad-brush explanation that there are many significant limitations may be sufficient in some circumstances.

4 INVITATION TO COMMENT

QUESTIONS

- 4.1 We invite 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. Those wishing to comment at this stage should bear in mind that we have already consulted on most of the policy decisions underlying TAS M.
- 4.3 Respondents are therefore asked to focus on the policy decisions that were not articulated in the May 2009 Exposure Draft and accompanying consultation document. In particular we would welcome views on the following matters:
- 1 The proposed commencement date for TAS M (see paragraphs 2.1 to 2.11);
 - 2 The requirements that the data used should be suitable for the purpose of the model and should be documented (see paragraph 3.26);
 - 3 The requirements surrounding the removal of data points from the data that is used (see paragraph 3.27); and
 - 4 The text of the exposure draft as a means of implementing the policy proposals presented in this document.

RESPONSES

- 4.4 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
- 4.5 Comments should reach the BAS by **1 February 2010**.
- 4.6 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.
- 4.7 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.

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.

Wider adoption is encouraged.

Commencement

This standard applies to models used in the preparation of aggregate reports completed on or after 1 January 2011.

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.

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A PURPOSE OF TAS M

A.1 PURPOSE

A.1.1 The BAS's Reliability Objective is 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.

A.1.2 Actuarial information often depends crucially on the results of **models**¹, which are inevitably simplifications of reality, and whose **specifications**, **implementations** and **realisations** must be fit for purpose for the information to be relied on. The purpose of this standard is therefore to assist the achievement of the Reliability Objective by ensuring that **models**:

- sufficiently represent the matters that are relevant to the decisions for which the actuarial information based on them will be used; and
- are fit for purpose both in theory and in practice;

and that the actuarial information based on them:

- includes explanations of the purposes 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**.

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**² 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**. The level of detail required is a matter for judgement. Unless stated otherwise, analyses may be quantitative or qualitative.
- B.1.6 Lists of examples are not intended to be exhaustive.
- B.1.7 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. Some of the definitions are taken from the **Scope & Authority**. The definitions are used consistently in the **Scope & Authority** and other BAS standards.

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

² Paragraph 23 of the **Scope & Authority**.

component report	A document given to a user in permanent form containing material information which relates to work within the scope of this standard. Formal written reports , draft reports , emails and presentations are examples of component reports . Possible contents of component reports include tables, charts and other diagrammatic presentations as well as or instead of text. A component report may form part of one or more aggregate reports .
data	Facts or information usually collected from records or from experience or observation. Examples include membership or policyholder data, claims data, asset and investment data, operating data (such as administrative or running costs), benefit definitions and policy terms and conditions.
document	To record in documentation .
documentation	Records of facts, opinions, explanations of judgements 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 a model in a form that will perform the calculations required by the specification . In many cases an implementation is a computer program, but other types of implementation are possible – for instance, manual calculations are often used for simple models .
material	Matters are material if they could, individually or collectively, influence the decisions to be taken by users of the related actuarial information. Assessing materiality is a matter of reasonable judgement which requires consideration of the users and the context in which the work is performed and reported.
model	A representation of some aspect of the world which is based on simplifying assumptions. A model is specified by describing the matters that should be represented and the relationships between them, implemented through a set of mathematical formulae and algorithms, and realised by using the implementation to produce a set of outputs from inputs in the form of data and parameters.
neutral	A neutral method, assumption or judgement is one that is not deliberately either optimistic or pessimistic and does not incorporate adjustments to reflect the desired outcome. A neutral estimate is one that is derived using neutral methods, assumptions and judgements. There may be a range of neutral estimates, reflecting inherent uncertainty.

realisation	<p>An implementation together with a set of inputs and the corresponding outputs.</p> <p>For an implementation that is a conventional computer program, a realisation is a run of the program, together with the inputs used and the outputs produced. Runs with different data or parameters are different realisations even if the program itself has not changed.</p>
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 . A Specific TAS is limited to a specific, defined context.
specification	A description of a model that describes the matters to be represented, the inputs and their interactions with each other, and the outputs to be produced.
users	Those people whose decisions a report is intended (at the time of writing) to assist. Those to whom the report is addressed, regulators and third parties for whose benefit a report is written are examples of possible users .

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 modelling may be contained in **Specific TASs**.
- C.1.4 Section C.2~ describes how this standard should be applied.
- C.1.5 Sections C.3~ to C.5~ contain principles that contribute to the achievement of the purpose set out in Part A, addressing the fitness for purpose of **models** (section C.3~), their inputs (section C.4~) and how they and their results are reported to **users** (section C.5~).

C.2 APPLICATION

C.2.1 This standard shall apply to all **models** used in preparing actuarial information which is presented in a **report**.

- C.2.2 This standard applies to all **models** regardless of their provenance. The extent and nature of the **documentation** required and the checks that are performed for externally developed **models** will need to depend on the reliability of any **documentation** that has been supplied or checks that have been performed by others.
- C.2.3 This standard applies to all **models** regardless of their size or complexity. It applies to each **model** as a whole, rather than to individual components of a **model**. The judgement whether a collection of computer programs (such as modelling packages or spreadsheets) together constitute the **implementation** of a single **model** or a suite of separate **models** will need to take into account the purpose being served and the **materiality** of the individual components.
- C.2.4 Examples of **models** include:
- a spreadsheet used to calculate a policy surrender value;
 - a **model** used to project the liabilities and assets of a pension scheme from one date to a later date;
 - a **model** used to calculate the value of the liabilities in a Scheme Funding exercise; and
 - **models** used to investigate the capital requirements of an insurer.

Judgement

C.2.5 Judgements concerning the application of this standard shall be exercised in a reasoned and justifiable manner.

- C.2.6 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 **materiality** and relevance of the outputs and the form that indications or explanations might take.
- C.2.7 Judgements will need to be kept under review. Judgements might need to be reconsidered when, for example:
- a significant period of time has elapsed since the **specification** was developed or the **implementation** last used;
 - a previously unexpected event has occurred; or
 - a **model** is being used for purposes other than those originally intended.

Documentation

- C.2.8 All **documentation** required by this standard shall:
- a) contain enough detail for a technically competent person with no previous knowledge of the particular **model** being **documented** to understand the matters involved and assess the judgements made;
 - b) include a statement of the purpose of the **documentation**; and
 - c) be clear, unambiguous and complete for that purpose.

- C.2.9 **Documentation** might take many forms, including separate physical or electronic documents (such as files or collections of files produced by modelling packages), comments in the code of an **implementation** or annotations to the output of a **realisation**. **Documentation** might consist of or include documents prepared by others, such as documents provided by systems developers and policy documents, pension scheme deeds or booklets. **Documentation** might serve a variety of purposes, including forming part of an institution's risk management structure.
- C.2.10 The level of detail of **documentation** is a matter for judgement, and will need to depend on matters such as the size and complexity of the **model** and the context in which it is being used.
- C.2.11 Principles regarding specific requirements for matters to be **documented** are contained in other sections of this standard.

C.3 FITNESS FOR PURPOSE

Satisfactory representation

- C.3.1 The **model** shall be a satisfactory representation of some aspect of the world in the context of the purpose for which it is being used. The explanation of how it is a satisfactory representation shall be **documented**.

C.3.2 The explanation of how the **model** is a satisfactory representation might need to include factors such as:

- the relevance of the aspect of the world that is modelled to the purpose for which the **model** is being used;
- the extent to which all phenomena relevant to the purpose and structure of the **model** have been modelled;
- the compliance of the **model** with regulatory requirements;
- the rationales for fundamental qualitative assumptions and prior beliefs; and
- records of calibrations for quantitative assumptions.

C.3.3 The relevance and **materiality** of a phenomenon, and other aspects of whether a **model** is a satisfactory representation, are matters for judgement at the time the work is performed. For example, a phenomenon that is relevant to the purpose of a **model** that is intended to provide a detailed analysis of an issue might be irrelevant to that of a **model** that is intended to provide an overview or rough estimate. A phenomenon that is relevant to the purpose of one **model** might be irrelevant to that of another **model** serving the same purpose but with a different structure. 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.

C.3.4 The explanation of how the **model** is a satisfactory representation can be supported by techniques such as:

- comparing the inputs and outputs of **implementations** or **realisations** with actual experience;
- quantitative analysis of the predictive properties of the **model** using back-testing;
- analysis of movements; and
- sensitivity testing.

Checks

C.3.5 A set of checks shall be constructed and performed in order to determine the fitness for purpose of the **model** as a whole and its **specification, implementation and realisations**.

C.3.6 The checks that have been performed shall be **documented**.

C.3.7 The nature and level of detail of the checks that are performed will need to reflect the purpose for which the **model** is being used. For example, a **model** being used to perform a detailed analysis might require more thorough checking than one being used to provide an approximate result.

- C.3.8 Some checks might need to be performed when any changes are made to the **specification** or **implementation**. Other checks might need to be performed less frequently, or for specific **realisations**.
- C.3.9 The fitness for purpose of the **model** can be assessed through the use of checks such as:
- checking that a **specification** accounts for a specific aspect of the world;
 - checking that an **implementation** accurately meets the **specification**;
 - checking that an **implementation** accepts all possible valid inputs and handles invalid inputs appropriately;
 - checking that a **realisation** uses the intended inputs;
 - performing a quantitative analysis of the predictive properties of the **model**; and
 - comparing the outputs of the **model** with those of a different **model**.

Choice of methods

C.3.10 **Neutral** methods, assumptions and judgements shall be used to derive any estimates described as “best estimate”, “central estimate” or other similar terms.

C.3.11 Estimates described as “prudent”, “not excessive”, “pessimistic”, “optimistic” or other similar terms will need to be derived using methods, assumptions and judgements that are not **neutral**.

C.3.12 If legislation, regulation or another legal obligation specifies that an estimate described as a “best estimate” or other similar term should be derived using methods, assumptions and judgements that are not **neutral**, paragraph C.3.10~ shall not apply but the **aggregate report** will need to explain that the estimate includes elements of pessimism, optimism or other subjective adjustments as the case may be.

C.3.13 The **Generic TAS** on *Reporting Actuarial Information* includes a principle requiring the disclosure of the intended meaning of terms that are not uniquely defined, such as “best estimate” and “prudent”.

Parsimony

C.3.14 **Models** shall be no more complex than can be justified.

C.3.15 Examples of possible justifications include a **material** difference to the outputs of the **model**, a **material** reduction in its limitations and the availability of an **implementation** that, although more complex than necessary, will serve the purpose at hand.

C.3.16 The presence of irrelevant assumptions might indicate that the structure of the **model** is more complex than necessary.

Reproducibility

C.3.17 **Implementations and realisations** shall be reproducible.

C.3.18 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. Reproducibility enables the checking of **implementations and realisations**.

C.3.19 For Monte Carlo simulations, reproducibility can be demonstrated by methods such as:

- the use of a random number generator that can be seeded in order to generate the same sequence of 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.

C.4 MODEL INPUTS

Data

C.4.1 The **Generic TAS** on *Data* contains principles concerning the preparation and checking of **data**.

C.4.2 The **Generic TAS** on *Reporting Actuarial Information* contains principles concerning the reporting of the source and shortcomings of **data**.

C.4.3 The **data** used for any **realisation** shall be suitable for the purpose of the **model**.

C.4.4 The **data** used for each **realisation** shall be **documented**.

C.4.5 **Data** might be unsuitable for the purpose of the **model** for reasons such as:

- the **data** is inconsistent with assumptions that form part of the **specification**;
- the **data** definitions are inconsistent with those assumed in the **specification**; or
- the **data** is insufficient to be statistically credible.

C.4.6 Possible methods of **documenting** the **data** used for a **realisation** might include recording the name and location of the input file or files for a computer program and listing the values used for a manual calculation.

C.4.7 Grouped **data** shall be clearly identified and:

- a) the reasons for the grouping and the criteria used to determine the groups shall be **documented**; 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.4.8 Possible reasons for grouping heterogeneous **data** and criteria for determining the groups include improving statistical credibility, increasing computational tractability and reducing the level of uncertainty surrounding the results.
- C.4.9 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.4.10 The extent to which **data** grouping is **material**, and the level of detail required in **documentation** or **reports**, are matters for judgement.
- C.4.11 If any **data** points are removed from the **data** used for a **realisation** other than because they are erroneous:

 - a) the rationale for their removal shall be **documented**; and
 - b) the **aggregate report** shall explain the implications of their removal.
- C.4.12 Paragraph C.4.11~ applies to all **data** points, including outliers (**data** points that differ significantly from other **data** points).
- C.4.13 The **data** points that have been removed will need to be **documented** and the **aggregate report** will need to describe them.
- C.4.14 **Data** points might be removed for reasons such as:
- analysing claims other than those relating to catastrophes;
 - analysing only administrative or running costs that are expected to recur; and
 - analysing mortality only for ages for which there is credible **data**.
- C.4.15 The extent to which the removal of **data** points is **material**, and the level of detail required in **documentation** and **reports**, are matters for judgement.

Assumptions

- C.4.16 The assumptions used in a **specification**, its **implementation** and **realisations** shall be **documented**.
- C.4.17 Examples of assumptions used in **specifications**, which may be implicit or explicit, include 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.4.18 Examples of assumptions used in **implementations** and **realisations** include numerical and other parameters. **Documentation** will need to include records of the assumptions that were used for each **implementation** and **realisation**.

C.4.19 If an assumption has a description that is not uniquely defined, such as “best estimate” or “prudent”, a statistical or other definition of the term in question will need to be **documented**. The **Generic TAS** on *Reporting Actuarial Information* requires descriptions of the intended meanings of such terms to be included in **aggregate reports**.

C.4.20 The assumptions used in a **model** or in a suite of **models** that operate in conjunction shall be consistent with each other, taking into account the purpose of the **model** or **models** in question.

C.4.21 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 **implementations** and to all related assumptions (such as future levels of administrative or running costs).

C.4.22 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.

C.4.23 If the purpose of a **model** is to calculate outputs in accordance with regulation, and the assumptions that are required to be used are inconsistent with other assumptions, the reasons for the inconsistency will need to be explained to the **user**.

C.4.24 The **Generic TAS** on *Reporting Actuarial Information* requires a statement of any differences between the assumptions used or recommended in different parts of the work.

C.5 REPORTING

C.5.1 Principles for matters that should be reported to **users** in respect of modelling are contained in the **Generic TAS** on *Reporting Actuarial Information*.

C.5.2 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.5.3 Principles for matters that should be reported to **users** in respect of modelling may also be contained in **Specific TASs**.

Non neutral estimates

C.5.4 An **aggregate report** that includes estimates that are not **neutral** shall indicate their relationship to **neutral** estimates.

C.5.5 Paragraph C.5.4~ applies to both estimates derived from outputs and estimates used as assumptions.

C.5.6 The relationship between an estimate that is not **neutral** and a **neutral** estimate might be indicated using methods such as:

- describing the level of pessimism or optimism in the estimate;
- explaining how the derivation of the estimate differs from that of a **neutral** estimate;
- comparing the estimate with a **neutral** estimate and explaining the differences; and
- quantifying the probability of the estimate being exceeded.

Limitations and users' needs

C.5.7 If an **aggregate report** includes information derived from **models**, it shall include explanations of:

- a) any **material** limitations of the **models** that have been used and the implications of those limitations; and
- b) how the **users'** needs are addressed by the **models** that have been used.

C.5.8 The limitations of the **model** might be closely related to its purpose and the needs of the **users**. For example, if a **user** has asked for an approximate answer to be prepared in a short period of time, the **model** that is used might be less detailed and have undergone less thorough checks (and therefore have more limitations) than one that is used for a more detailed study.

C.5.9 The level of detail at which limitations are explained is a matter for judgement, and will need to depend on matters such as the purpose for which the **model** is being used. An explanation of the limitations of a **model** used to provide approximate answers might be less detailed than for one used for a more detailed study.

C.5.10 Possible limitations of **models** and the implications of those limitations include:

- phenomena that have not been modelled;
- simplifying assumptions that have been made;
- the extent to which the **implementation** meets the **specification**;
- the sensitivity or otherwise of the outputs to key assumptions (both quantitative and qualitative);
- the suitability or otherwise of the outputs 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;
- the number and variety of **realisations** that have been used; and
- the amount of checking that has been performed and the degree of reliance that can be placed on the outputs of the **model**.

- C.5.11 Explanations of how the **models** address the **users'** needs will need to cover the relevance of the outputs to those needs and their completeness with respect to them.

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