



BOARD FOR ACTUARIAL STANDARDS

**TECHNICAL ACTUARIAL STANDARD M:
MODELLING**

**ANALYSIS OF RESPONSES TO THE DECEMBER 2009
EXPOSURE DRAFT**

APRIL 2010

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PART I

ANALYSIS OF RESPONSES TO THE DECEMBER 2009 EXPOSURE DRAFT OF

TECHNICAL ACTUARIAL STANDARD M: MODELLING

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 December 2009, it published a second exposure draft of its Generic Technical Actuarial Standard (Generic TAS)² on *Modelling* (TAS M).
- 1.2 The consultation period ended on 1 February 2010. A total of 20 public responses³ were received (see Appendix B). We thank all those who contributed.

SUMMARY

- 1.3 In finalising the text of TAS M we have taken account of the comments we received in response to the exposure draft, 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 the consultation papers on *Insurance* and *Pensions*.
- 1.4 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 users of actuarial information.
- 1.5 Respondents to the exposure draft generally supported the direction of the draft and the principles proposed in it.
- 1.6 The principles in TAS M are substantially the same as those that appeared in the exposure draft, although the text has been amended in places in order to improve clarity.
- 1.7 Section 2 summarises the comments that we received in answer to the specific questions that were posed in the second exposure draft. Section 3 explains the changes that we have made to the text that appeared in the exposure draft.
- 1.8 Part II of this document contains the final version of TAS M, marked up to show changes from the exposure draft.

REVIEW OF TAS M

- 1.9 We recognise that our TASs may need amendment after they have been in operation for a period. We will develop mechanisms to obtain feedback from practitioners and users of actuarial information, and will conduct a formal review of each TAS at least every four years. At least every two years we will consider whether immediate changes are required.

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 responses are available at <http://www.frc.org.uk/bas/publications/pub2222.html>.

2 RESPONSES TO THE EXPOSURE DRAFT

INTRODUCTION

- 2.1 In this section we summarise the comments that we received on the exposure draft, and our reactions to them. In brief:
- TAS M will apply to models used in the preparation of aggregate reports completed on or after 1 April 2011.
 - We have explained that, if data ideally suited to the model is not available, alternative data can be used.
 - We have clarified the requirements relating to removal of data points, explaining that where a number of data points are removed it is not necessary to document each point individually.

COMMENCEMENT DATE

- 2.2 In the exposure draft we proposed that TAS M should apply to models used in the preparation of aggregate reports completed on or after 1 January 2011. Paragraphs 2.9 to 2.11 of the exposure draft explained our reasoning.
- 2.3 Several respondents from insurers considered that a January 2011 commencement date for TAS M would interact badly with the introduction of Solvency II, which, they argued, is placing significant pressure on resources. They 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 these models should not be subject to the requirements of TAS M. They suggested that the commencement date for TAS M should be aligned with the introduction of Solvency II in 2012, or that existing models which are expected to be discarded following the implementation of Solvency II should be excluded from the scope of the TAS.
- 2.4 Other respondents from insurers commented that the same pressure on resources would hamper their ability to ensure the compliance of existing models which appear to be working effectively. They proposed that there should be a different commencement date for all existing models.
- 2.5 A number of pensions practitioners also expressed a preference for a later commencement date. Their concern was that the proposed timing would lead to the retrospective application of the standard. Scheme Funding exercises can take up to 15 months from the valuation date and are usually performed triennially, so that exercises finishing in January 2011 could have effective dates as early as October 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 models used in such reports would have to be revisited in order to ensure that they complied with TAS M.
- 2.6 Some pensions practitioners commented that, while the draft implied no significant change in practice or procedure, there would be work involved in confirming that this was the case. Some proposed that application should be limited to models with an effective date of 1 January 2011 or later.
- 2.7 We considered several options for the commencement date of TAS M, including a commencement date expressed in terms of the issue of

component reports, the effective date of calculations and the date at which the work using data is performed. However, all the suggested alternative methods of defining the commencement date posed problems of their own, and we decided not to change our proposal to express the commencement date in terms of the issuing of aggregate reports.

- 2.8 We recognise that existing processes and internal standards would have to be reviewed over the next few months to ensure that models used in the preparation of aggregate reports completed after 1 January 2011 comply with TAS M.
- 2.9 However, TAS M formalises the checking and documentation of models. If models are currently undocumented, or there is no checking process in place, we consider the principles in TAS M should apply sooner rather than later. If documentation and checking are currently occurring, then practitioners will have to make few changes to their procedures in order to comply with TAS M. TAS M does not stipulate that the documentation and checking it requires must be prepared or performed after the commencement date. Existing documentation, and checks that have already been performed and documented, can contribute to compliance.
- 2.10 We appreciate that the use of models to support work for year end 31 December 2010 will be underway very shortly after issue of the standard, and that a commencement date affecting year end reporting might impose a significant burden on practitioners.
- 2.11 Taking all these factors into consideration we have decided that TAS M will apply to models used in the preparation of aggregate reports completed on or after 1 April 2011.

USE OF DATA WHICH IS NOT IDEAL

- 2.12 We asked respondents for their views on the requirement that the data used should be suitable for the purpose of the model and should be documented.
- 2.13 Several respondents commented that circumstances arise in which suitable and credible data is not available for a variety of reasons. For instance, the event on which data is sought may be sufficiently uncommon that there is only limited data, or the scale of the entity may be too small, or the data may be too heterogeneous. They recommended that in such circumstances it should be possible for the best available data to be used as long as there is documentation explaining why it is less than ideal and the implications for the results.
- 2.14 We agree with this argument, and have introduced appropriate wording to clarify this point in paragraphs C.4.5 and C.4.7.

REMOVAL OF DATA POINTS

- 2.15 We sought respondents' views on our proposed requirements about the removal of data points from the data that is used for a realisation.
- 2.16 Many respondents felt that the requirements of paragraph C.4.13 could be incorporated into the requirements of paragraph C.4.11 (both references are to paragraph numbers in the exposure draft). We agree: revised wording appears as paragraph C.4.13.
- 2.17 One respondent suggested that if a substantial number of data points were removed for the same reason it should not be necessary to state the reason for

removal for each of these points, but simply to state how many data points fall under this heading. We agree: this is covered by additional text in paragraph C.4.15.

TEXT AS A MEANS OF IMPLEMENTATION

- 2.18 We asked respondents for their views on the text of the exposure draft as a means of implementing our policy proposals.
- 2.19 One respondent suggested that principles should carry more weight than other paragraphs. We disagree. All text in TAS M is of equal status. The style we have adopted in all TASs is to set out principles within the boxed paragraphs, and these are intentionally kept succinct. The following paragraphs clarify the circumstances in which the principles apply. In some cases they contain a short (non-exhaustive) list of examples. These clarifying paragraphs are not subservient to the principles, but sit alongside them to assist users in understanding the application of the principles.
- 2.20 One respondent suggested that the proportionality argument expounded in paragraph B.1.4 would be more effective if couched in positive form. Instead of stating that disproportionate work is not required, the TAS should suggest that only proportionate work should be performed. We consider that this does not change the interpretation and, in order to maintain consistency with other TASs, have not adopted this suggestion.

Interpretation

- 2.21 Several respondents identified particular paragraphs that they felt needed clarification. In many cases, they suggested adding text to make it clear that requirements were to be interpreted in a proportionate way, or that they only applied to material matters. In other cases they requested that we offer examples to illustrate points.
- 2.22 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.
- 2.23 We have not introduced further examples into the text beyond those already in the exposure draft. Practitioners will have to exercise judgement on matters of materiality and proportionality, and we consider that the examples we have given will help them to do this. The examples we give are not exhaustive, and are not intended to cover all possible situations.

Definitions

- 2.24 It was suggested that the unqualified use of the word “could” in the definition of material was unhelpful and extends the concept of materiality too broadly. However, we believe this is addressed by the second sentence of the definition which clarifies that judgement is essential in assessing materiality. We note that this second sentence is also included in other TASs and in our *Scope & Authority*.
- 2.25 Another suggestion was that judgements about materiality should be based on the impact on the business entity, as opposed to materiality to users. An example given was the pricing of a single reinsurance contract when the user’s decision whether to proceed or not would have no material impact on

the insurance company. We disagree, because materiality is defined from the perspective of the user. However, arguments about proportionality might reduce the effort needed to comply for actuarial work if the user's decision is immaterial to the business.

- 2.26 There were a number of comments on the definition of a model. Some respondents suggested that simple calculation formulae should be excluded from the definition, and therefore from the scope of the TAS. However, most of the examples given in support of this view incorporate assumptions about future claims patterns and cash flows. We consider that such calculations (including the assumptions on which they are based) should be checked and documented, and have decided therefore that they should be within the scope of the TAS.
- 2.27 Some respondents sought clarification of the definition of user. One asked if individual recipients of advice, such as pension scheme members given a transfer value or policyholders given a surrender value, should be considered to be users. We note that paragraph 2.14 of the May 2009 exposure draft explained that it is the reporting of simple calculations such as transfer values or surrender values to trustees or insurance companies that falls within the TASs, rather than the onward communication to scheme members or policyholders. Another respondent asked whether users of a computer program were included in this definition. The reference to receipt of a report makes clear that users should not be interpreted as computer users, except for the purposes of reliance on the outputs.

Documentation

- 2.28 Two respondents raised the difficulty of complying with paragraph C.2.8 a) in the absence of a definition of a technically competent person, and the judgements required in order to meet such a user's needs in terms of understanding the matters involved and assessing the judgements made. We believe that practitioners should be able to exercise judgement in complying with this, but the intention behind referring to a technically competent person was to allow practitioners to limit their explanations to those required for someone familiar with the principles of modelling. There are many levels of detail at which documentation can be written, and this term is used to describe the type of reader for whom documentation should be written.
- 2.29 It was suggested that there is no merit in the requirement in paragraph C.2.8 b) for documentation to state its purpose. As documentation, like a report, may be intended for a wide range of purposes (for example, to assist the user of the data or to assist somebody preparing similar data in the future), 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.
- 2.30 The question of compliance for externally produced models or parts of models arose in a number of contexts, usually with a plea for their exclusion from scope. We think that it is not unreasonable for practitioners to ensure that they have adequate documentation and evidence of checks from their suppliers to meet the TAS requirements. If not they should carry out such checks themselves and document the work accordingly. However, we do have sympathy with the respondent who noted that received documentation may not meet the requirement that all documentation be clear, unambiguous and complete for that purpose. We do not require rewriting suppliers' documentation, so long as total documentation is compliant. We consider that paragraph C.2.3 provides for adequate documentation for the model as a

whole although in some cases, documentation of individual components may be the best way of achieving this, as is clarified in paragraph C.2.11.

FITNESS FOR PURPOSE

Checks

- 2.31 Paragraph C.3.5 requires checks to be constructed and performed in order to determine the fitness for purpose of both the model as a whole and the elements of the models. One respondent suggested that it was excessive to require checks on the fitness for purpose of the specification, implementation and realisation as well as the model as a whole. We consider that not only should the model as a whole be appropriate, but a particular specification, implementation and realisation should be appropriate for the problem at hand.

Parsimony

- 2.32 Paragraph C.3.15 clarifies the principle in paragraph C.3.14, giving an example of a case in which a complex model might be used to address a simple issue. One respondent argued that this paragraph renders the whole principle redundant. We introduced this clarification to allay concerns that an existing complex model could not be used even if it did the job, but that a new simplified model would have to be built. We have added further clarification, explaining that it is the disproportionate work involved which justifies this exception.

Reproducibility

- 2.33 One respondent commented that, since a reproducible realisation is impossible without a reproducible implementation, the reference to the latter is unnecessary. We acknowledge this argument, but consider it to be clearer if both requirements are stated in the principle.
- 2.34 The question was raised whether by reproducible implementations we intended only that running an identical computer program twice with the same inputs should produce the same result. This was indeed our intention. This is a fundamental requirement of a model. In particular this requirement applies to implementations which use random numbers when the use of a seeded random number generator can be used to check reproducibility.

MODEL INPUTS

Data

- 2.35 The requirement to document the data used for each realisation (paragraph C.4.4) differs from the requirement in TAS D which requires documentation of the *definition* of all items of data. One respondent requested that we clarify that documentation is not needed for each output of a stochastic model. We consider that such clarification is unnecessary.
- 2.36 As indicated in paragraphs 2.12 to 2.14, we have clarified the approach to be taken where ideally suited data is not available. We have also clarified the approach to be taken to the removal of data points (see paragraphs 2.15 to 2.17).

Assumptions

- 2.37 Paragraph C.4.18 requires that the assumptions used in a specification, its implementation and realisations should be documented. Paragraph C.4.22 requires that if assumptions are used in a model or suite of models they should be consistent with each other.
- 2.38 Two respondents sought a distinction between different types of assumptions for the purposes of documentation. One suggested that there is an important distinction between numerical or qualitative assumptions and beliefs implicit in the construction of the model. Paragraph C.4.19 addresses this point. The other suggested that data which has been calculated using assumptions selected on the basis of a previous compliant aggregate report should be excluded. We consider that, in this event, a better response would be to refer to that aggregate report.

Non-neutral estimates

- 2.39 Paragraph C.5.4 requires that if an aggregate report includes estimates that are not neutral, an indication of their relationship to neutral estimates should be given.
- 2.40 One respondent noted that it is possible to have a neutral (or non-neutral) estimate of a prudent measure – for example an estimate of the likely cost of buying out pension schemes liabilities may deliberately contain margins to ensure that it does not underestimate the market rate that would be charged if a pension scheme was to be wound up in this way. We accept this point, and have clarified this with the addition of paragraph C.5.6.

Limitations and users' needs

- 2.41 Several respondents expressed unease with the principle in paragraph C.5.8 which requires an explanation of how the users' needs are addressed by the model. They argued that it is unhelpful without an example to illustrate how this would be achieved in practice.
- 2.42 In general, a model should be used only if it meets the user's needs, usually because it produces outputs that provide useful information at a cost proportionate to the value to the user. Users might have other needs as well: for example, if deadlines are paramount, a user might require a simple model which can be produced quickly, even though a more precise answer could be obtained from a more complex model in a longer timeframe. In this situation, the explanation might include a statement that a simple approximate model meets the user's specific need for a rapid response.

3 CHANGES TO THE TEXT

INTRODUCTION

- 3.1 As a result of the responses we received to the exposure draft, and comments we have received in other contexts, we have made a number of changes to the text in the exposure draft. They are described in this section. Part II contains a version of the final text that shows the changes from the text in the exposure draft. Changes to paragraph numbering are not shown. All references in this section are to the final version of TAS M, unless stated otherwise.
- 3.2 In the exposure draft we indicated our intention that TAS M would include an appendix reviewing considerations and arguments that were thought significant by the BAS in reaching its conclusions. In line with the publications of the other Generic TASs, we have decided not to include this appendix in the final document, but are publishing a separate document explaining the development of TAS M, including the significant considerations underlying the principles.
- 3.3 A number of minor changes have been made throughout the text in order to add clarity. They are not described individually in this section.

PART B: INTERPRETATION

Definitions

- 3.4 Definitions of **measure** and **method** have been added. They are the same definitions that are used, and that we expect to use, in other TASs.
- 3.5 The definition of **model** has been amended slightly to address concerns raised by respondents (see paragraph 2.26). We have also modified the definition of **neutral** which is consistent with the Exposure Draft on *Pensions*.

PART C: MODELLING

- 3.6 Paragraph C.2.4 has been amended to remove a perceived circular use of the term **model**.

Documentation

- 3.7 Paragraph C.2.11 has been added to make it clear that the documentation requirements apply to the model as a whole but that alternatively individual components of a model might need to be documented.

Checks

- 3.8 Paragraph C.3.5 has been amended to make it clear that the checks that are constructed and performed in order to determine fitness for purpose apply to the model as a whole, including its specification, implementation and realisations.
- 3.9 Paragraph C.3.7 has been amended for clarity.

Choice of methods

- 3.10 Paragraphs C.3.10 and C.3.11 have been amended to reflect the change to the definition of neutral.

Parsimony

- 3.11 Paragraph C.3.16 has been amended to clarify that excessive data requirements may be a further indication of an unnecessarily complex model.

Data

- 3.12 Paragraph C.4.5 has been added to make it clear that, in situations where insufficient directly relevant data is available for a realisation, alternative data may be used provided the implications of using the alternative data are documented.
- 3.13 Paragraph C.4.7 has been added to give examples of scenarios where sufficient directly relevant data may not be available.
- 3.14 Paragraph C.4.10 has been amended for clarity.
- 3.15 In line with many respondents' suggestions the original C.4.13 has been incorporated into the original C.4.11, the text of which now appears as C.4.13.
- 3.16 Paragraph C.4.14 clarifies the position regarding the exclusion of data points used for previous realisations on the grounds that they are no longer relevant.
- 3.17 Paragraph C.4.15 provides clarification that separate individual documentation of the removal of a number of points for the same reason is not required.
- 3.18 Paragraph C.4.25 has been reworded for consistency with paragraph C.4.22.

Non neutral estimates

- 3.19 Paragraph C.5.6 has been added to clarify that the principle regarding estimates that are not neutral applies to prudent measures.
- 3.20 Paragraph C.5.7 includes additional wording for clarity (second bullet).
- 3.21 Paragraph C.5.11 has been modified to clarify that it contains a list of possible ways of explaining limitations and implications.

PART II

TRACKED CHANGES FROM THE DECEMBER 2009
EXPOSURE DRAFT OF

TECHNICAL ACTUARIAL STANDARD M:
MODELLING

BOARD FOR ACTUARIAL STANDARDS

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~~ April 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.
<u>measure</u>	<u>The approach that is used to define how an (uncertain) asset or liability amount is quantified. Two different measures of the same asset or liability may produce different results.</u>
<u>method</u>	<u>The mechanism that is used to quantify an (uncertain) asset or liability amount. Two different methods of calculating the same asset or liability measures should produce similar results.</u>

model	<p>A representation of some aspect of the world which is based on simplifying assumptions.</p> <p>A model is specified <u>defined by a specification by describing that describes</u> the matters that should be represented and <u>the inputs and</u> the relationships between them, implemented through a set of mathematical formulae and algorithms, and realised by using the <u>an</u> implementation to produce a set of outputs from inputs in the form of data and parameters.</p>
neutral	<p>A neutral <u>method measure</u>, 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 <u>methods measures</u>, assumptions and judgements. There may be a range of neutral estimates, reflecting inherent uncertainty.</p>
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~~ and 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~~ Models might be used for purposes such as:

- ~~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 estimate~~ 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** ~~and~~ 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 ~~and~~ 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 In some cases, documentation required by this standard might need to describe individual components instead of the **model** as a whole.

C.2.12 Principles ~~regarding~~ concerning 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 of 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 and the complexity of the model. 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 [methodsmeasures](#)**, 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 **[methodsmeasures](#)**, 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 ~~which that~~**, although more complex than necessary, will serve the purpose at hand.

C.3.16 The presence of irrelevant **~~assumptions–inputs~~** 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 is suitable for the purpose of the model if it is both directly relevant to the purpose of the model and available. If insufficient directly relevant data is available, alternative data will need to be used. In this event, an explanation of why this data has been used and the implications of its use will need to be documented

C.4.6 **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 or set out in the **specification**; and/or
- the **data** is insufficient to be statistically useful ~~reliable~~.

C.4.7 Sufficient statistically useful **data** may be unavailable for the **implementation** for reasons such as:

- the volume of business in-force or the size of the pension scheme is too small for statistically useful **data** to become available; or
- the incidence of the event being measured is too infrequent for statistically useful **data** to become available.

C.4.8 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.4.9 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.4.10 Possible reasons for grouping heterogeneous **data** and criteria for determining the groups include improving statistical usefulness~~credibility~~, increasing computational tractability~~simplifying computation~~ and reducing the level of uncertainty surrounding the results.

C.4.11 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.4.12 The extent to which **data** grouping is **material**, and the level of detail required in **documentation** or **reports**, are matters for judgement.

C.4.13 If any **data** points are removed from the **data** used for a **realisation** other than because they are erroneous:

- a) the **data** points that have been removed shall be **documented** and the **aggregate report** shall describe them;
- b) the rationale for their removal shall be **documented**; and
- c) the **aggregate report** shall explain the implications of their removal.

C.4.14 Paragraph C.4.13 applies to all **data** points, including outliers (**data** points that differ significantly from other **data** points) and **data** points used in previous **realisations** but now excluded on the grounds that they are no longer representative of the current state of the phenomenon being modelled.

C.4.15 Paragraph C.4.13 ~~The **data** points that have been removed will need to be **documented** and the **aggregate report** will need to describe them.~~ does not require separate **documentation** of each of a number of **data** points removed for the same reason.

C.4.16 **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 [statistically usefuledeedible](#) data.

C.4.17 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.4.18 The assumptions used in a **specification**, its **implementation** and **realisations** shall be **documented**.

C.4.19 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.4.20 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.4.21 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.4.22 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.4.23 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.4.24 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.4.25 If the purpose of a **model** is to calculate [estimatesoutputs](#) in accordance with regulation, and the assumptions that are required to be used [in the model or in a suite of models of which it is one](#) are inconsistent with [each](#) other [assumptions](#), the reasons for the inconsistency will need to be explained to the **user**.

C.4.26 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 [Paragraph C.5.4 applies to estimates using both **neutral** and **prudent measures**. For example the cost of buying out pension scheme liabilities might be a **prudent measure** for an ongoing scheme. An estimate of this cost ~~may~~ might itself be **neutral** or ~~may~~ might deliberately include a margin for prudence. In the latter case paragraph C.5.4 applies.](#)

C.5.7 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, [for example by including a specific margin for prudence](#);
- 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.5.8 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.5.9 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.5.10 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.5.11 Explanations of the Possible limitations of **models** and the implications of those limitations might include descriptions of:
- the exclusion of relevant phenomena from the specification~~that have not been modelled;~~
 - simplifying assumptions that have been made;
 - the extent to which the **implementation** might not fully 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.5.12 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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