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## Tracked changes from the exposure draft of TAS M

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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). In December 2009, it published a second exposure draft of its Generic Technical Actuarial Standard (Generic TAS) on Modelling (TAS M).

1.2 The consultation period ended on 1 February 2010. A total of 20 public responses 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.

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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
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, 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.

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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.

**measure**  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.

**method**  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.
model A representation of some aspect of the world which is based on simplifying assumptions.

A model is specified defined by a specification by describing that describes the matters that should be represented and the inputs and the relationships between them, implemented through a set of mathematical formulae and algorithms, and realised by using the an implementation to produce a set of outputs from inputs in the form of data and parameters.

neutral A neutral method measure, 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 measures, assumptions and judgements. There may be a range of neutral estimates, reflecting inherent uncertainty.

realisation An implementation together with a set of inputs and the corresponding outputs.

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.

report An aggregate report or a component report.

Scope & Authority The BAS's Scope & Authority of Technical Standards.

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 MODELING

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 might be used for purposes such as:

- a spreadsheet used to calculating a policy surrender value;
- a model used to projecting the liabilities and assets of a pension scheme from one date to a later date;
- a model used to calculating the value of the liabilities in a Scheme Funding exercise; and
- models used to estimating 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 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 methods measures, 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 measures, 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
- the data is insufficient to be statistically useful and 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, 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 useful credible 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 estimates outputs 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**

<table>
<thead>
<tr>
<th>C.5.4</th>
<th>An <strong>aggregate report</strong> that includes estimates that are not <strong>neutral</strong> shall indicate their relationship to <strong>neutral</strong> estimates.</th>
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<tr>
<th>C.5.5</th>
<th>Paragraph C.5.4 applies to both estimates derived from outputs and estimates used as assumptions.</th>
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<tr>
<th>C.5.6</th>
<th>Paragraph C.5.4 applies to estimates using both <strong>neutral</strong> and <strong>prudent measures</strong>. For example the cost of buying out pension scheme liabilities might be a <strong>prudent measure</strong> for an ongoing scheme. An estimate of this cost may itself be <strong>neutral</strong> or may deliberately include a <strong>margin for prudence</strong>. In the latter case paragraph C.5.4 applies.</th>
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<th>C.5.7</th>
<th>The relationship between an estimate that is not <strong>neutral</strong> and a <strong>neutral</strong> estimate might be indicated using methods such as:</th>
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<td>• describing the level of pessimism or optimism in the estimate;</td>
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<td>• explaining how the derivation of the estimate differs from that of a <strong>neutral</strong> estimate, for example by including a specific margin for prudence;</td>
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<td>• comparing the estimate with a <strong>neutral</strong> estimate and explaining the differences; and</td>
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<td>• quantifying the probability of the estimate being exceeded.</td>
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**Limitations and users’ needs**

<table>
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<th>C.5.8</th>
<th>If an <strong>aggregate report</strong> includes information derived from <strong>models</strong>, it shall include explanations of:</th>
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<td>a) any <strong>material</strong> limitations of the <strong>models</strong> that have been used and the implications of those limitations; and</td>
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<td></td>
<td>b) how the <strong>users’ needs</strong> are addressed by the <strong>models</strong> that have been used.</td>
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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 meet 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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“A” denotes a Fellow of the Institute of Actuaries or the Faculty of Actuaries
### B LIST OF RESPONDENTS TO THE DECEMBER 2009 EXPOSURE DRAFT

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<td>Legal &amp; General</td>
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