



**BOARD FOR ACTUARIAL STANDARDS**

**TECHNICAL ACTUARIAL STANDARD M:  
MODELLING**

**SIGNIFICANT CONSIDERATIONS**

**APRIL 2010**

# CONTENTS

<i>Section</i>	<i>Page</i>
1 Introduction	3
2 Structure and style	5
3 Purpose of TAS M	7
4 Interpretation of TAS M	9
5 Principles	14
 <i>Appendix</i>	 <i>Page</i>
A Members of the Board for Actuarial Standards	22

# 1 INTRODUCTION

## PURPOSE

- 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)<sup>1</sup>.
- 1.2 In April 2010, after a process of consultation, the BAS published its Generic Technical Actuarial Standard (Generic TAS)<sup>2</sup> on *Modelling* (TAS M).
- 1.3 This document reviews the considerations and arguments that were thought significant by the BAS in developing TAS M.

## BACKGROUND

- 1.4 In our consultation paper *Towards a Conceptual Framework*, which was published in November 2007<sup>3</sup>, we proposed that our standards would be of two types: generic, applying to a wide range of actuarial work, and specific, limited to a defined context. Generic standards would help to provide coherence and consistency across the range of actuarial work.
- 1.5 That document also set out our proposals that standards be principles-based rather than rules-based, and that they address outputs and responsibilities, with output-based standards focusing on the users of actuarial services and their needs as decision makers.
- 1.6 In April 2008 we published a consultation paper on the *Structure of the new BAS Standards*, in which we set out our proposals to develop a suite of eight or nine TASs, of which three would be Generic TASs on *Data*, *Modelling* and *Reporting Actuarial Information*. The responses to the consultation were generally positive, and we decided to proceed with our proposals.
- 1.7 In November 2008 we published a consultation paper on *Modelling*, followed by an exposure draft of TAS M in May 2009, and a second exposure draft in December 2009.
- 1.8 We published exposure drafts of our Generic TAS on *Reporting Actuarial Information* (TAS R) in April 2008 and March 2009, followed by TAS R in September 2009, and a revised version in November 2009. We published an exposure draft of our Generic TAS on *Data* (TAS D) in May 2009, followed by TAS D in September 2009.
- 1.9 We aim to ensure that our standards are consistent with the wider strategic aims established by the FRC including its *Actuarial Quality Framework*, which was issued in January 2009 following a discussion paper in May 2008.

---

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

<sup>2</sup> 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.

<sup>3</sup> All BAS publications are available from <http://www.frc.org.uk/bas/publications/>.

## **TAS M**

- 1.10 In developing TAS M, we considered the responses to all the consultations mentioned above, and to the discussion paper on *Mortality* that we published in March 2008. We also considered responses to informal consultations with the FRC's Actuarial Stakeholder Interests Working Group and a number of other individual stakeholders.
- 1.11 TAS M is the third standard to be developed by the BAS. The overall structure and style to be used for our TASs were established in the development of our first two standards, TAS R and TAS D, and are reviewed in section 2. Sections 3 to 5 review the development of the content.

## 2 STRUCTURE AND STYLE

### INTRODUCTION

- 2.1 The structure and style of TAS M (and all Generic TASs) reflect the objectives and characteristics of our standards that are set out in our *Conceptual Framework*<sup>4</sup>. In particular, our TASs are written in a way which favours principles over prescriptive rules, and each TAS has its own specific objectives.
- 2.2 As set out in our *Scope & Authority*<sup>5</sup>, compliance with our TASs is mandatory for actuaries performing work within their scope. However, actuaries performing other work may choose to comply with them and so may those who are not actuaries. The purpose of TASs is to set out requirements that must be met in order to comply with them, not to explain best practice or recommend good practice.

### STRUCTURE

- 2.3 TAS M has three parts. The first two parts cover its purpose and how it should be interpreted. The third sets out its requirements. Further information about the status and scope of the TAS, when it commences and its relationship with other TASs and with Guidance Notes is included in a rubric that precedes the content of the TAS.
- 2.4 All principles in TAS M are of equal status. Labelling some principles, but not all of them, as “overriding” would imply that there was a hierarchy of principles; but it is not clear how such a hierarchy, if intended, would work. For example, it might be intended to suggest that in some circumstances the non-overriding principles could be in conflict with the overriding principles and, in such cases, the overriding principles should prevail. Alternatively, it might be intended to suggest that the non-overriding principles were extensions of the overriding principles, adding detail but no new requirements. All text in TAS M therefore has equal status.
- 2.5 We considered whether TAS M should include an appendix setting out the considerations that had been found important in the development of the standard. We decided that, although a summary of the underlying rationale should be published, it should be a separate document rather than part of TAS M. This is that document.

### STYLE

- 2.6 In drafting TAS M, we have tried to tread the fine line between being clear about the requirements of the TAS and being unnecessarily prescriptive. We consider that, for writing standards, clarity of expression and the substance of the text are more important than the tone in which the text is written. We therefore use the word “shall” to express requirements, and “will need to” to describe the implications of those requirements, in order to provide clarity about what TAS M requires. The use of these words is consistent with TAS M’s mandatory nature.

---

<sup>4</sup> The *Conceptual Framework for Technical Actuarial Standards*, published in July 2008.

<sup>5</sup> The *Scope & Authority of Technical Standards*, published in July 2008, and subsequently revised.

- 2.7 Some of the requirements in TAS M are for indications or explanations. These terms were chosen because they can be interpreted quite broadly, and therefore the level of detail that they require is a matter for judgement. Explicit principles are set out using the word “shall”: for example, that the checks that have been performed shall be documented.
- 2.8 TAS M is focused on outcomes, and therefore primarily imposes requirements on the suitability, effectiveness and documentation of models and their realisations rather than on those using the models. It is written in a way that allows compliance by those who are not actuaries as well as by actuaries.
- 2.9 The whole of TAS M is subject to the provision in the *Scope & Authority* that it is only material departures that need be disclosed. There is an explicit statement to this effect in Part B of TAS M, and the word “material” is therefore used sparingly throughout part C. Similarly, Part B states that the requirements should be interpreted proportionately, and the word “proportionate” is not used in the remainder of the text.

### 3 PURPOSE OF TAS M

#### PURPOSE

- 3.1 All our standards serve the overall purpose set out in our Reliability Objective, that the users for whom a piece of actuarial information was created should be able to place a high degree of reliance on the information's relevance, transparency of assumptions, completeness and comprehensibility, including the communication of any uncertainty inherent in the information.<sup>6</sup>
- 3.2 Our standards are intended to ensure the quality of actuarial work that the users receive, whoever performs the work. Actuaries performing work that is not designated as being within their scope may choose to comply with them, and people doing actuarial work who are not actuaries may well be required by others to meet the same standards. The purpose of TASs is to set out requirements that must be met in order to comply with them, not to explain best practice or recommend good practice.
- 3.3 We determined that the purpose of TAS M should be to assist the achievement of the Reliability Objective insofar as the quality of actuarial information depends on the models that are used to produce it. TAS M therefore focuses on two aspects of the use of models: their suitability for the purpose, and documentation, including limitations. The purpose of TAS M, in paragraph A.1.2, makes this explicit.
- 3.4 TAS M will help to promote actuarial quality by addressing two of the indicators of quality identified in the FRC's *Actuarial Quality Framework*. The *Framework* notes that actuarial methods provide a positive contribution to actuarial quality where they make effective use of models, with due recognition of the power and limitations of the models used, where they incorporate full and clear model documentation, and where they incorporate robust criteria for analysing model outputs against expectations. TAS M supports all these aspects of actuarial methods directly. The *Framework* also notes that the communication of actuarial information provides a positive contribution to actuarial quality where it includes sufficient information to enable the reader to judge the appropriateness and implications of any recommendations. Although TAS M does not directly address reporting, compliance with its principles will support this driver.
- 3.5 We consider that actuaries (and others complying with our standards) should not act disproportionately, and in particular that they should not use BAS standards as an excuse for doing so. We consider that the best way of ensuring this is to explain that BAS standards should not be interpreted disproportionately (paragraph B.1.4). Proportionality already underlies all the FRC's work, along with the other better regulation principles: accountability, transparency, consistency and targeting. We therefore do not consider that it would be helpful to identify proportionality as a specific objective that compliance with our TASs should be intended to achieve.
- 3.6 There is an important distinction to be made between materiality and proportionality. If a piece of actuarial information is not material, there is no requirement to follow the principles set out in the standard. If work is

---

<sup>6</sup> *Scope & Authority*, paragraph 8.

material, the principles must be complied with proportionately. For example, in some cases a required explanation might be comparatively brief, or an indication might consist of a short description, while in others a detailed explanation or full quantitative analysis might be appropriate. A departure from compliance on the grounds of proportionality does nevertheless constitute a departure.

- 3.7 As stated in paragraph B.1.7, the interpretation of TAS M is governed by its purpose. If it appears that any provision in TAS M conflicts with its purpose, then that provision is being misinterpreted.
- 3.8 We are aware of the Model Validation Policy requirements proposed under Solvency II. The requirements of TAS M are sufficiently broadly based and general that we do not expect any inconsistencies. We will continue to monitor this issue during the development of Solvency II.

### **IMPLICATIONS**

- 3.9 Both our Reliability Objective and the purpose of TAS M address the fitness for purpose of models used to produce actuarial information and the reliance its users can place on the underlying models. We consider that appropriate use of models is integral to ensuring the quality of actuarial information that is based on those models.
- 3.10 TAS M therefore specifies requirements to be met by checks on the fitness for purpose of models, and by documentation of their purpose, assumptions, and the data used. In addition it requires explanation of models' limitations.

## 4 INTERPRETATION OF TAS M

### INTRODUCTION

- 4.1 Part B of TAS M consists of two sections. The first describes how the TAS should be interpreted and the second defines a number of terms that are used in the remainder of the TAS.

### INTERPRETATION

- 4.2 The text in section B.1 of TAS M is intended to assist practitioners to make judgements about how to comply with the standard. All our TASs are principles-based: they are not intended to foster a tick-box mentality. Awareness of the objectives and spirit of the standard should help practitioners make judgements about compliance.
- 4.3 Many of the responses to our consultations and the discussions we have had with practitioners indicate that there is a tendency to interpret our standards as requiring more work and more detailed work than is our intention. In section B.1 we have therefore emphasised:
- the provision in the *Scope & Authority* for immaterial departures;
  - that the standard should not be interpreted disproportionately; and
  - the scope for interpretation in the details of the principles.
- 4.4 TAS M is intended to be a truly generic standard, capable of being applied to a broad range of actuarial work. Current practice varies by area of work, and a principle that is consistent with current practice in one area may well require significant changes of practice in another area. The introduction of TAS M will, we hope, result in more consistent practice across all areas of work to which it applies. Practitioners might consider that some principles are so easy to comply with that they must require more than the words state; however, the wording is deliberate, and what may appear obvious and easy to some will not necessarily appear the same way to others. Practitioners should therefore interpret the principles as written.
- 4.5 We do not consider that it would improve the clarity of TAS M to repeat the word “material” in every principle. We have therefore explicitly reminded its readers that the standard should be read in the context of paragraph 23 of the *Scope & Authority*, which permits immaterial departures (paragraph B.1.2).
- 4.6 We consider that the materiality of the model and its constituent elements depends on its outcomes and how these are used. Paragraph B.1.3 emphasises that it is not the method or complexity of a calculation that is important, but its significance in supporting decisions made by the users of the resulting actuarial information. If the calculation is material (its results would influence the decision), it should be performed correctly, the assumptions on which it is based should be appropriate, and the relevant checks should be performed. If it is not material, then a failure to comply with the requirements in a TAS does not constitute a departure from the TAS.
- 4.7 We consider that actuaries (and others complying with our standards) should not act disproportionately, and in particular they should not use BAS standards as an excuse for doing so. We have taken care to ensure that it is not necessary to perform work that is disproportionate to the needs of the

users in order to comply with TAS M, and have explicitly reminded readers of the standard that it should not be interpreted disproportionately (paragraph B.1.4).

- 4.8 Throughout TAS M we have used words such as “indicate” and “explain” in order to avoid being prescriptive about the type of analysis or level of detail that is required. In paragraph B.1.5 we have emphasised that these are matters for judgement. In complying with the standard, practitioners need to look at the level of documentation and analysis from the perspective of the user, and consider what will enable the user to better appreciate the implications and limitations of the model. In some circumstances they might conclude that alternative realisations are essential: in others, a description of the critical assumptions and their effect might be more useful.
- 4.9 Where possible, we have illustrated the principles in TAS M with examples, in order to better convey the intention behind the principle. However, the range of work which falls within the definition of a model makes it impractical to provide exhaustive lists, so any examples in TAS M are only indicative.

## **DEFINITIONS**

- 4.10 Section B.2 defines a number of terms used within the text of the standard. Many of the definitions will appear in other TASs.

## **Reports**

- 4.11 The definitions of “aggregate report”, “component report” and “report” give effect to our intention that our standards should apply to the totality of information on which users base their decisions.
- 4.12 In particular TAS M will apply to all models used to produce actuarial information which is presented to a user in either a component report or an aggregate report.

## **Documentation**

- 4.13 The definition of documentation expressly notes that it is not necessarily provided to users. We recognise that the level of detailed documentation of a model needed for a practitioner to be able to exercise judgement about its fitness for purpose and limitations might not be suitable for the users of a report containing actuarial information derived from the use of a model. Documentation is therefore distinct from disclosure. In many cases the main purpose of documentation is to establish an audit trail for future practitioners looking at the same model. The documentation is therefore likely to record how the model was described and the checks carried out. Disclosures to users are more likely to concern the limitations and interpretation of the actuarial information derived from the model.

## **Materiality**

- 4.14 The definition of materiality in our standards is consistent with that in international accounting standards, which is:

Omissions or misstatements of items are material if they could, individually or collectively, influence the economic decisions of users taken on the basis of the financial statements. Materiality depends on the size and nature of the omission or misstatement judged in the

surrounding circumstances. The size or nature of the item, or a combination of both, could be the determining factor.

Assessing whether a matter could influence the decisions to be taken by users and so be material requires the consideration of the characteristics of those users. The Framework for the Preparation and Presentation of Financial Statements states in paragraph 25 that ‘users are assumed to have a reasonable knowledge of business and economic activities and accounting and a willingness to study the information with reasonable diligence.’ Therefore, the assessment will need to take into account how users could reasonably be expected to be influenced in making decisions.<sup>7</sup>

- 4.15 Our definition makes it clear that the judgement of materiality must take place within the context in which the work is performed and reported. The context includes the time at which the activities take place, so there is no element of hindsight, but does not limit it to either the time at which the work is performed or the time at which it is reported (which are not always the same). The definition also introduces an element of reasonableness into the judgement.
- 4.16 We have adopted the same definition of materiality in all our TASs and in our *Scope & Authority of Technical Standards*.

### Models

- 4.17 Models have three aspects. The first aspect, the specification, consists of the set of mathematical formulae and algorithms, and sets out how some aspect of the world will be represented. The specification will typically identify the particular measure of liabilities that the model will be used to estimate.
- 4.18 The second aspect, the practical implementation, embodies those formulae and algorithms in a form that will accept inputs and will generate outputs. In many cases the implementation is a computer program, but other types of implementation are possible – for instance, pen and paper are often used for simple models. TAS M covers implementations of all types. The implementation will use a particular method to determine the value of the liability measure identified in the specification.
- 4.19 The third aspect, a specific realisation, consists of an implementation together with a set of inputs. In other words, for a model implemented using a computer program, a realisation is a run of the program which calculates results for a particular purpose. Different runs, with different data or parameters, are different realisations even if the program itself has not changed. It is only a specific realisation that can actually generate model outputs, and different realisations might generate different outputs.
- 4.20 The word model may be used to describe any of these three aspects. To avoid confusion, TAS M identifies which of the three is meant.
- 4.21 TAS M applies to all models used in preparing actuarial information within the defined scope of the TAS. As currently specified in the Schedule to our *Scope & Authority of Technical Standards*, TAS M, as a generic standard, applies to all work that is covered by any specific TAS. To avoid repetition, this is not stated explicitly in the proposed principles. Nevertheless it should be understood when reading this paper.

---

<sup>7</sup> IAS 1.

- 4.22 The assumptions used in models are themselves often derived from other models. For example, models that are used to investigate the capital requirements of insurance companies often take their economic assumptions from other models, such as economic scenario generators. The mortality assumptions used in models of pension scheme funding, and in models of many aspects of long term insurance business, may also be generated by dedicated models.
- 4.23 In some circumstances the outputs of several models may be combined to comprise the final outputs that form the basis of actuarial information. For instance, an internal model used by an insurance firm under the provisions of Solvency II is likely to be composed of many smaller models whose outputs are combined to give estimates of quantities relating to the firm as a whole. In other contexts, several independent models, of different types and using different assumptions, may be used to estimate economic variables. In both these cases the combination or aggregation of results is itself performed by a model.
- 4.24 All models used in the production of actuarial information, whether their outputs are used directly or mediated through other models, are included in the scope of TAS M. The information depends on the models and so the users of the information should be able to rely on them.

### **Neutral**

- 4.25 We considered a number of possible descriptions to use for the concept that we are terming “neutrality”, including “best estimate”, “unbiased” and “not skewed”. They all had problems associated with them. Many of those we consulted felt that there can only be one “best estimate”: in addition, there is no consensus on what it means, with the possibilities including median, probability weighted average, and the practitioner’s honest belief. Any terms involving the words “bias” or “skew” are open to being confused with the technical statistical meanings of those words. We decided that the term “neutral” best conveys our intended meaning, that no subjective influences are present. A neutral estimate need not be a best estimate, but all best estimates are neutral estimates. There might be many possible neutral estimates.
- 4.26 An estimate that builds in margins against adverse deviation is not neutral, as it has been deliberately adjusted in one direction. Likewise, an estimate that is deliberately optimistic is not neutral. In both cases, the potential adverse deviation or optimism is judged in the context of a desired outcome. Generalising this notion leads to the definition of a neutral estimate as one which does not incorporate adjustments to reflect the desired outcome.
- 4.27 This terminology is consistent with that used in the exposure draft of the Pensions TAS and will be adopted in the exposure draft of the Insurance TAS and in other TASs.

### **Users**

- 4.28 In many cases the use of and reliance on actuarial information are not confined to those paying for its preparation. We believe that all the intended users, regardless of their commercial relationship with those responsible for preparing the report, should be able to rely on the information.
- 4.29 In many cases, it is trustees or insurance companies who are responsible for communicating the results of simple calculations such as transfer values or

surrender values to scheme members or policy holders. It is the reporting of the results by actuaries to trustees or insurance companies that falls within scope of TASs, not the communication to the end user.

- 4.30 The definition of “users” deliberately refers to those who are intended to be assisted by the actuarial information. Those who may have access to the information are not necessarily users. For example some reports are addressed to and intended for a limited group of people, such as pension scheme trustees, but are available to (but not addressed to) a wider group of stakeholders. It is only those for whom the report is specifically intended who are users of the information it contains.
- 4.31 For avoidance of doubt, the term user is not intended to refer to somebody who merely implements instructions to run a computer program.

## 5 PRINCIPLES

### INTRODUCTION

- 5.1 Part C forms the body of TAS M and contains the principles that work that complies with TAS M must satisfy.

### APPLICATION

- 5.2 Section C.2 of TAS M sets out some principles concerning the application of the standard.
- 5.3 As described in section 3, it is our objective that the models used in the preparation of actuarial information presented in a report should comply with TAS M, and the principle in paragraph C.2.1 gives effect to this objective.
- 5.4 We consider that those using a model to provide actuarial information should be able to demonstrate it is fit for purpose, use it appropriately and understand and communicate its limitations regardless of whether it was developed internally or externally: TAS M therefore applies equally to all models. We recognise that it might not be possible (or even desirable) to perform exactly the same checks on externally developed models as would be performed on internally developed models, but the overall goal should be the same: to check that the models are fit for purpose and to ensure that their limitations are understood. Paragraph C.2.2 addresses this point, and makes it clear that documentation provided and checks performed by an external provider may contribute to compliance with the standard.
- 5.5 We consider that the materiality of a model need not be related to its complexity. Simple models may be relied on as much as complex models, and consequently should be as reliable. TAS M is a generic standard and will apply to models of widely differing natures regardless of their size, complexity or origins. Paragraph C.2.3 makes this explicit and notes the difference between a model as a whole and its component parts. Paragraph C.2.4 gives examples of how models might be used, including both simple and complex models.

### Judgement

- 5.6 Because TAS M is principles-based, judgement will be required in order to apply it. We consider that such judgement should be reasoned and justifiable (paragraph C.2.5). We accept that requiring a justification of all judgements would be unduly onerous, and so require only that justification should be possible.

### Documentation

- 5.7 Paragraph C.2.8 of TAS M sets out the requirements for all documentation that is required by other principles in TAS M, and does not itself impose any requirements for any matters to be documented.
- 5.8 The definition of documentation (in part B) makes it clear that documentation need not be provided to the users of actuarial information. However, we consider that the existence and preparation of documentation affect the quality of the information that is provided to users, and that requirements that some matters be documented are therefore desirable and proportionate.

- 5.9 Documentation may be prepared for many purposes, such as recording the provenance of a model, checks that were carried out or judgements that were made which might assist others who use the model in future. Documentation that serves one purpose might be inadequate for another, so paragraph C.2.8 b) requires that documentation should include a statement of its purpose.
- 5.10 Similarly, there are many levels of detail at which documentation can be written. Paragraph C.2.8 a) therefore describes the type of reader for whom documentation should be written. The phrase “technically competent person” is used to indicate that documentation need not explain the principles of modelling but should provide sufficient detail for someone familiar with the principles of modelling to understand the key considerations involved in the development of the model and the particular realisations used to produce actuarial information.
- 5.11 We agree with many of those who we consulted who suggested that it would be unduly onerous to require the individual documentation of each input to every spreadsheet that is part of a large model. Paragraphs C.2.9 to C.2.11 apply to this documentation, as they do to all documentation required by TAS M. They explain that documentation may take any form, including electronic files, and that the level of detail is a matter for judgement. For example, the input files for a modelling system, if they include text labels, could form documentation of the parameters they contain. In addition, TAS M does not require that documentation be prepared especially for a given exercise – as long as the documentation exists it does not matter when or why it was prepared.
- 5.12 Some models might comprise a number of components from different sources, and with differing levels of documentation. Provided that documentation for the whole model meets the requirements of TAS M, we do not require that each component complies on a stand-alone basis. In some cases, however, this might be a more efficient approach, particularly if those component parts might be used within other models. This point is made in paragraph C.2.11.

## **FITNESS FOR PURPOSE**

### **Satisfactory representation**

- 5.13 The purpose of any model is to provide a simplified representation of some aspect of the world in order to investigate the effect certain phenomena might have. Different models will involve greater or lesser complexity both in the number and type of phenomena they represent, and in the level of detail to which they attempt to represent each such phenomenon. Paragraph C.3.1 requires that an explanation be provided of the aspects covered and the level of detail used, and of why this is considered to be appropriate to the needs of the users of the actuarial information produced by the model.
- 5.14 The needs of users should drive the selection of the model. A relatively simple model may be appropriate if users need an approximate indication in a short time frame, whereas a more complex detailed model will be needed if precision and responsiveness to small changes will influence the users’ decisions. Paragraph C.3.3 explains this point and provides an example.
- 5.15 Paragraph C.3.1 requires an explanation of how the model used represents real world phenomena satisfactorily, since this is a key aspect of fitness for purpose. There are many ways in which such an explanation can be given,

and many types of evidence that might be adduced in support. Paragraph C.3.4, which is by no means an exhaustive list, suggests some of them.

- 5.16 We considered whether to include a principle that models should represent all material phenomena. However, respondents presented strong arguments that it is not always possible to represent all material phenomena in a model, or that there may be good reasons for not doing so. In the latter case, they suggested, reporting the resulting limitations of the model would meet the Reliability Objective. We accepted their arguments, and so TAS M includes no such principle.

### Checks

- 5.17 We consider it to be essential that some checks are carried out on models before placing reliance on their outputs, even if they have been used extensively beforehand. In particular, checks are required to ensure that the particular realisation is relevant to the specific context in which it is being used. Paragraph C.3.5 therefore requires that some checks are performed.
- 5.18 Paragraph C.3.6 requires that the checks that are performed should be documented. Documentation will ensure there is a record for future reference, and will serve as a basis for the explanation to users of the reliability and limitations of actuarial work produced using the model.
- 5.19 Since the nature of the checks required will depend on the circumstances, we do not mandate what checks should be carried out. Paragraphs C.3.7 to C.3.9 note that they should be proportionate to the purpose and complexity of the model and give examples of the types of checks that might be needed. In particular, we considered whether back testing should be required of all models as a means of assessing their predictive properties. There was general agreement from those we consulted on the benefits of back testing but some significant problems were identified with requiring it in all cases. We therefore decided against including such a principle, but consulted on whether TAS M should include a principle requiring some form of quantitative analysis of the predictive properties of models. Many of those we consulted argued that this would add little to the requirements that models are satisfactory representations of reality and that they are checked. We agreed with these arguments, but have suggested analysis of predictive properties as an example of the type of check that might be needed.
- 5.20 For the avoidance of doubt, TAS M does not require that all possible checks are performed every time a model is used. A model that has been used many times over a long period is likely to require less checking than one that has not been used before. Similarly, TAS M does not require all checks that have ever been performed on a model to be documented. It requires only those checks that are performed in compliance with TAS M to be documented.

### Choice of methods

- 5.21 There are a number of terms in use pertaining to the degree of prudence or bias in estimates. Paragraph C.3.10 requires that if models are used to produce actuarial information which is described as being unbiased, the underlying methodology, assumptions and measures should be neutral, as defined in TAS M, and discussed in paragraphs 4.25 to 4.27 above.
- 5.22 By extension of this reasoning, any estimate which is deliberately towards one end of a spectrum of results should not be derived from neutral measures, assumptions or judgements, as explained in paragraph C.3.11.

- 5.23 Paragraph C.3.12 recognises that legislation or other legal requirements may describe an estimate as a “best estimate” and specify methods and assumptions which are not neutral. In these circumstances users should be made aware that the term “best estimate” might be misleading. There is no requirement that any specific terms, such as “neutral”, are used in the explanation given to users.
- 5.24 The existence of so many different terms means that users need to understand the underlying message. Paragraph C.3.13 reminds practitioners of the principle in TAS R that requires them to explain what they mean when using terminology which is not uniquely defined.

### **Parsimony**

- 5.25 The idea that models should be as simple as possible, but no simpler, is an old one, dating back at least to the 14th century.<sup>8</sup> The advantages of simplicity are well known. A simple model is easier than a complex model to understand and to check. It is also more likely to avoid over-fitting – such as conforming to the details of data rather than identifying trends. A more complex model might give better insights into the underlying drivers, while an over-simplified model might omit vital characteristics of the phenomena under investigation. A more complex model will usually require more, or more detailed assumptions to be made. This might be difficult if limited information is available. In addition, the outputs may not be reliable if assumptions are based on insufficient data.
- 5.26 Paragraph C.3.14 therefore requires that models should not be unnecessarily complex. Some of those we consulted were concerned that a requirement for parsimony would inhibit the development of new models and methods of modelling. They pointed out that in some cases it is not obvious before making changes whether the outputs would change significantly or not. In other cases, a complexity introduced to the model might not necessarily cause a material change in the outputs but might improve the quality of the outputs. We accepted these concerns, so the principle requires that complexity should be justifiable, rather than requiring that complexity be introduced if and only if it results in material differences to the outputs or to the limitations of the model in question. In particular, we recognise that it is often reasonable to use a more complex model that already exists and which is capable of meeting the required purpose (paragraph C.3.15).

### **Reproducibility**

- 5.27 A reproducible model is one that can reproduce exactly the same outputs from strictly identical inputs. An implementation or realisation that is not reproducible cannot be checked. Another aim of reproducibility is to ensure that the model in question is stable. It may be impossible to determine how the outputs change, if at all, with any change in the inputs if the model is not reproducible. Paragraph C.3.17 therefore requires that implementations and realisations are reproducible.
- 5.28 In many cases this reproducibility will be self-evident, and it has been suggested that paragraph C.3.18 must refer to a more complicated requirement. This is not the case.

---

<sup>8</sup> William of Ockham expressed it as “*entia non sunt multiplicanda praeter necessitatem*” – entities must not be multiplied beyond necessity.

- 5.29 We consider that all types of models, including those that use Monte Carlo simulation, can be reproducible. For instance, a way of ensuring reproducibility for Monte Carlo simulations is to use a random number generator that can be seeded in order to generate the same sequence of pseudo-random numbers on demand. If for any reason random numbers cannot be reproduced, reproducibility can be achieved through the ability to run the model on a deterministic basis, to check whether the calculations are correct for a given set of random numbers. Combined with the use of enough simulations to provide stability in the overall outputs, it is then possible to say that the overall realisation (ie the outputs generated by analysing all simulations in the set) is reproducible.

## MODEL INPUTS

- 5.30 Section C.4 of TAS M sets out a number of principles concerning the provenance of the inputs to the model, their suitability to the particular task, and their limitations.

### Data

- 5.31 Paragraph C.4.3 requires the use of suitable data. In an ideal world, complete and accurate data would always be available in precisely the form needed for any realisation of the model being used. In practice, that is rarely the case. Suitability therefore encompasses both relevance and availability.
- 5.32 Shortcomings in the data that is used might significantly influence the extent to which specific realisations are fit for purpose. Incompleteness of data can have a number of adverse effects on modelling. Most obviously, it might result in the misstatement of modelled quantities – for instance, missing records for deferred pensioners would lead to an understatement of pension scheme liabilities. It might also exhibit biases that would not be present if the data were complete. In life insurance, for example, lapsing policies may have different characteristics from those that remain in force. Omitting data for lapsed policies might therefore be misleading in any analysis of the take up of options. Similarly, incomplete data might provide misleading estimates of statistical quantities such as variance or skewness. Shortcomings in the available data thus affect its suitability.
- 5.33 The outputs of a realisation depend crucially on its inputs. Paragraph C.4.4 therefore requires that the data used for each realisation be documented, so that a record is kept of what the outputs represent. Paragraph C.4.8 notes that it is not necessary to document each item of data separately. Paragraphs C.2.9 to C.2.11 apply to this documentation, as they do to all documentation required by TAS M. They explain that documentation may take any form, including electronic files, and that the level of detail is a matter for judgement.

### *Data grouping*

- 5.34 Policy or membership data is frequently grouped for the purposes of actuarial work – that is, instead of carrying out individual calculations on each policy (or each member), the calculations are performed on the aggregate data for groups of similar policies (or similar members). Grouping the data might shorten the time taken to run an actuarial model, or it might lower the cost of carrying out the work. Sometimes grouped data is used because it is all that is available.

- 5.35 In some cases grouping data might increase the reliability of the outputs (for example, if it increases the volume of data, and hence statistical credibility, without increasing its heterogeneity), while in others it might have an adverse effect (for example, if it introduces significant bias). It might be difficult to quantify the effects of grouping without running the model on both grouped and ungrouped data, which could well be prohibitive in terms of both cost and time. However, in some cases it is possible to demonstrate that grouping has no material effect, while in other cases the process that is used to determine the groups that are used may provide useful information on the effects.
- 5.36 Paragraph C.4.9 requires documentation of the basis on which any data grouping is performed. If the grouping might have a material effect, it also requires that the rationale underlying the grouping is explained to users. If it can be demonstrated that there is no material effect, no such explanation is required.
- 5.37 The removal of data points for any reason might affect the outputs, so paragraph C.4.13 requires documentation of the data points that have been removed. It also requires the points to be described to users, and the implications of their removal to be explained. The level of detail of the description and explanation may vary. In particular, there is no requirement to list every point that has been removed either in documentation or to users.

### **Assumptions**

- 5.38 Assumptions vary widely in both the matters they concern and their source. They may be fundamental to the structure of the model – for example, an assumption that both the direction and magnitude of changes in stock prices are random (ie that prices move in a random walk) is fundamental to the Black-Scholes model for pricing equity options. Assumptions like this are not represented by any single model input or parameter. Other assumptions are more detailed, and may be represented by a single input or set of inputs. In the Black-Scholes model, the implied volatility and risk free rate of return are assumptions of this type.
- 5.39 Assumptions of all types may be derived from any or all of data (possibly through the use of further models), other information and judgement. More fundamental assumptions, especially, may be either explicit or implicit, quantitative or qualitative.
- 5.40 The outputs of a realisation depend crucially on its inputs. Paragraph C.4.18 therefore requires that the assumptions used for each realisation be documented, so that a record is kept of what the outputs represent. Paragraph C.4.19 explains that the assumptions that should be documented include both explicit and implicit assumptions.

### *Consistency*

- 5.41 A single model may require a large number of assumptions, all interacting with each other, and with data to produce the model outputs. In some circumstances, several different models are used in conjunction with the outputs of one being used as inputs in another. The total number of assumptions in such a system may be enormous.
- 5.42 Consistency of assumptions is vital if reliance is to be placed on the outputs of a model or suite of models. It is important for both qualitative and quantitative assumptions. For instance, if one model in the suite assumes that

stock prices follow a random walk, so should the others. If one model assumes that pay will increase at the same rate as price inflation, consistency demands that the other models do too. Consistency is especially easy to overlook when performing scenario testing. It may happen that a very high inflation rate is assumed in one model in the suite, for example, but that the concomitant changes are not made in other models.

- 5.43 Sometimes, several independent models are used in conjunction to provide better estimates than any one model could provide on its own. In such cases, inconsistent assumptions may be chosen deliberately. This inconsistency is a result of the purpose for which the models are being used. Consistency is therefore not desirable in all circumstances.
- 5.44 Paragraphs C.4.22 to C.4.26 address these points.

## REPORTING

- 5.45 Section C.5 of TAS M sets out a number of principles concerning matters that should be reported to users in connection with modelling. TAS R also contains such principles, and Specific TASs may also do so.

### Non-neutral estimates

- 5.46 On occasion actuarial information might include estimates that are optimistic, pessimistic, prudent, or dependent in some other way on the context (including the desired outcomes) in which they are presented. Such estimates are only possible where there is some uncertainty about the actual outcome. In some cases, they are required by regulation – in this case, they are usually required to be prudent.
- 5.47 We have used the term “neutral” to describe estimates that do not depend on the desired outcome (see paragraphs 4.25 to 4.27). We consider that it will increase users’ understanding of actuarial information if they are given an explanation of how non-neutral estimates differ from neutral estimates – for example, if they are given some idea of the degree of prudence in a prudent estimate. Paragraphs C.5.4 to C.5.7 cover this point.
- 5.48 Some of those we consulted argued that this principle would not assist users to understand the risk and uncertainty in estimates. We agree; however, that is not why we have included it in TAS M. We have included the principle in order to assist users to understand the degree of prudence, optimism, or other bias that is incorporated in estimates.
- 5.49 It was suggested to us that it would be impractical to require the presentation of a neutral estimate alongside all non neutral estimates: in some cases, for instance, prudence is inherent in methodology rather than an input (for example if negative technical provisions are zeroised). Producing both prudent and neutral estimates could be onerous, requiring nearly twice as much work as producing a single estimate. The principle in C.5.4 therefore does not require a neutral estimate to be produced, although doing so would be one way of indicating the relationship between it and the non-neutral estimate.
- 5.50 However, there may be contexts in which the production of a neutral estimate would be both possible and desirable, and Specific TASs may include such principles.

**Limitations and users' needs**

- 5.51 Models are invariably simplifications of the real world, with a variety of limitations. For their outputs to be used effectively, the limitations should be clearly understood. Many limitations are very general in nature, applying to all models; others are specific to the individual model in question.
- 5.52 The limitations of models depend crucially on the purposes for which those models are being used. A feature that is a virtue in one context may be a significant limitation in another.
- 5.53 The existence of limitations, often extremely significant ones, should not undermine the use of models and the presentation of their outputs. Despite their problems, models provide useful information which cannot be obtained in any other manner. However, it is important that those making decisions based on the outputs of models realise what those outputs are intended to represent.
- 5.54 We consider that, despite their inevitable limitations, models are valuable, even vital, tools in the provision of actuarial information. Indeed, as presented in the FRC's *Actuarial Quality Framework*, we consider that the use and interpretation of mathematical models are underlying features of actuarial work. It is therefore important that those making decisions based on the outputs of models understand how the models serve their needs.
- 5.55 Users may have a wide spectrum of needs, including some concerning the information that will support decisions and others concerning the time at which the information is received. A model might therefore meet their needs by giving an appropriate trade off between speed and levels of uncertainty in the outputs. In some cases, users' needs may be very simple, such as requiring the output of calculations. The explanation of how those needs are met is likely to be concomitantly simple.
- 5.56 Paragraphs C.5.8 to C.5.12 cover these points.

## A MEMBERS OF THE BOARD FOR ACTUARIAL STANDARDS

### Members

Jim Sutcliffe (A)	Chair
David Blackwood	Group Finance Director, Yule Catto & Co plc
Lawrence Churchill	Chairman of the Pension Protection Fund
Harold Clarke (A)	Director, European Actuarial Services, Ernst & Young
Christopher Daws	Chairman, Action for Children Pension Fund
Steven Haberman (A)	Professor of Actuarial Science and Deputy Dean of Cass Business School, City University
David Hare (A)	Chief Actuary UK & Europe, Standard Life Assurance Limited
Dianne Hayter	Chair of the Property Standards Board
Julian Lowe (A)	Consultant
Oonagh McDonald	Director, Oonagh McDonald Consulting Ltd
Mukesh Mittal (A)	Insurance executive
Jerome Nollet	Corporate finance advisor in risk and capital management for the insurance industry
Louise Pryor (A)	Director, Board for Actuarial Standards
Sir Derek Wanless	Chairman, Northumbrian Water Group plc
Martin Weale	Director, National Institute of Economic and Social Research

### Observers

Jon-Paul Brett	Department for Work and Pensions
Seamus Creedon (A)	Groupe Consultatif Actuariel Européen
Richard Maconachie	The Actuarial Profession
Will Price	The Pensions Regulator
Paul Sharma	Financial Services Authority
James Templeton	H M Treasury

“A” denotes a Fellow of the Institute of Actuaries or the Faculty of Actuaries



**FINANCIAL REPORTING COUNCIL**  
**5TH FLOOR**  
**ALDWYCH HOUSE**  
**71-91 ALDWYCH**  
**LONDON WC2B 4HN**  
**TEL: +44 (0)20 7492 2300**  
**FAX: +44 (0)20 7492 2301**  
**WEBSITE: [www.frc.org.uk](http://www.frc.org.uk)**

© The Financial Reporting Council Limited 2010

The Financial Reporting Council Limited is a company limited by guarantee. Registered in England number 2486368.  
Registered Office: 5th Floor, Aldwych House, 71-91 Aldwych, London WC2B 4HN.