Version 7.2

Best Practice
Spreadsheet Modeling Standards

Commentary & Examples

SSRB
Spreadsheet Standards Review Board

BEST PRACTICE SPREADSHEET MODELING STANDARDS - VERSION 7.2

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These standards are the subject of ongoing development with updates being made available at www.ssrb.org.

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SPREADSHEET STANDARDS REVIEW BOARD

The Spreadsheet Standards Review Board ('SSRB') is the body that develops and maintains the Best Practice Spreadsheet Modeling Standards. The SSRB was established during 2002 to bring together the best spreadsheet modeling skills from around the world in order to develop and gain general acceptance for comprehensive and universally applicable Best Practice Spreadsheet Modeling Standards. The SSRB can be contacted as follows:

Website: www.ssrb.org
Email: info@ssrb.org

IMPORTANT NOTICES

These Best Practice Spreadsheet Modeling Standards have been written based on spreadsheet modeling using Microsoft Excel® and are universally applicable to all forms of spreadsheet modeling within that application. The SSRB is of the opinion that Microsoft Excel is the most commonly used spreadsheet application available for spreadsheet modeling. Therefore, the commentary and examples provided are based on Microsoft Excel. However, most of these standards and conventions are generally applicable.

Many of the examples provided throughout this commentary and examples book have been created within Microsoft Excel using Modano® – a best practice content management and sharing add-in available from Modano (www.modano.com). The SSRB is of the opinion that the use of Modano within Microsoft Excel is the most efficient and effective means of implementing the Best Practice Spreadsheet Modeling Standards. The free Community Edition of Modano may be downloaded from the Modano website at www.modano.com.

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Introduction

Defining Spreadsheet Modeling

The term 'spreadsheet modeling' is a generic term that is used to describe any form of analysis which is undertaken using spreadsheets. Spreadsheet modeling is also commonly referred to within the business world as 'financial modeling' or simply 'modeling'.

A **spreadsheet** can be defined as:

> *A program for organizing numerical data in tabular formats allowing rapid calculations with changing variables.*

A **spreadsheet model** can be defined as:

> *A theoretical construct in a spreadsheet that represents numerical processes by a set of variables and a set of logical and quantitative relationships between them.*

The Evolution of Spreadsheet Modeling

Whilst spreadsheet applications have been around for over 20 years, spreadsheet modeling is a relatively new area of expertise within the business world.

Functional spreadsheet applications were first developed in the 1980s with the release of Lotus 1-2-3®, which was based on VisiCalc®; the first ever computer spreadsheet program which was developed by Dan Bricklin and Bob Frankston. Microsoft Excel® for Windows® was released in 1987 but it was not until the release of Microsoft Excel 95® that spreadsheet applications became widely used within the business world. Since the release of Microsoft Excel 95®, spreadsheet application functionality has improved at an exponential rate, providing spreadsheet model developers with the tools to construct increasingly sophisticated spreadsheet models.

With the rise of spreadsheet application technology, both simple and complex spreadsheet models have become more prevalent throughout the business world. Spreadsheets are now generally accepted as being the primary vehicle for modeling in business.

The demand for spreadsheet modeling continues to rise, with decision makers relying more intensively on spreadsheet modeling analysis as the basis for their decisions. In order to meet the increasingly complex demands of model users, model developers have had to significantly improve their spreadsheet modeling skills. As such, spreadsheet model development has become a highly skilled area of expertise within the business community.

Model Developers vs. Model Users

The people who come into contact with spreadsheet models can be universally categorized as being either *model developers* or *model users*. To explain the Best Practice Spreadsheet Modeling Standards, it is important to clearly distinguish between model developers and model users.

- **Model Developers** are involved in the physical construction of a spreadsheet model and the derivation of the underlying calculations.
- **Model Users** rely upon outputs from a spreadsheet model for various purposes, often to analyze or gain an understanding of the area being modeled or to provide them with assistance in decision making.

A model developer can act as a model user following the completion of a spreadsheet model. Conversely, a model user can act as a model developer when making changes to the construction of a spreadsheet model. Most people, including model auditors or model reviewers, will be considered to be model users unless they are making changes to the construction of a spreadsheet model. The important difference between a model developer and a model user is the purpose of their involvement in the spreadsheet model, being to either construct or use the spreadsheet model respectively.

The Need for Standards & Conventions

As spreadsheet modeling activities and underlying organizations grow and become more complex, the need for universal spreadsheet modeling standards and accountability behind decision-making processes also grows.

Traditionally, a lack of generally accepted principles governing the model development process has resulted in model developers constructing models according to individual tastes and preferences. This lack of standardization has often resulted in unnecessary frustration and confusion as model developers have difficulty understanding and utilising models developed by others and model users have been forced to adapt to models on a case by case basis. In the absence of universal spreadsheet modeling standards, the spreadsheet modeling sector would continue to become more complex, disjointed and difficult for management and decision makers to control, unnecessarily creating significant costs and risks for business organizations.

Standards currently govern many areas of the business world. Some of the more prominent examples include accounting standards and auditing standards. In general, there is considerable standardization of reporting and analysis in relation to historical results, but very little standardization in relation to forecasted results. Prior to the first release of these Best Practice Spreadsheet Modeling Standards, there was little or no standardization within the spreadsheet modeling sector. Despite this lack of standardization, spreadsheet models have still been used as a fundamental component of the quantitative analysis which is undertaken in relation to almost every major business decision.

Objectives of the Standards & Conventions

The Best Practice Spreadsheet Modeling Standards and Conventions aim to provide the model development and business communities with:

- Freely-available, universally-applicable and definitive principles against which the quality of spreadsheet models can be assessed; and
- A platform for the standardization of spreadsheet model development processes.

Importantly, these Standards and Conventions provide a comprehensive and detailed set of guidelines relating to every stage of the spreadsheet model development process, but do not limit the customizability of spreadsheet-based analysis in any way. Put simply, these standards and conventions explain **how** to develop best practice spreadsheet models, not **what** to include in spreadsheet models.

The Best Practice Spreadsheet Modeling Standards and Conventions empower both model developers and model users with the knowledge to improve the quality and efficiency of spreadsheet modeling activities. In this regard, the primary spreadsheet modeling benefits of adopting these standards and conventions are:

a. Improved quality and transparency;

b. Decreased development time and costs;

c. Minimization of error risk;

d. Facilitation of efficient sharing of model development methodologies;

e. Prevention of model redundancy; and

f. Alignment of the needs of model developers and model users.

The Best Practice Spreadsheet Modelling Standards and Conventions do not currently address the file management environment in which spreadsheets exist. On the basis that there are often multiple (subsequent) versions of a model, commentary is provided on approaches to version control. Modellers using the Standards and Conventions are also encouraged to consider other important aspects of the business environment (backups, model sign-off processes, etc.) when constructing and distributing models.

Classification of the Standards & Conventions

The following definitions govern the categorization of the Best Practice Modeling Standards and Conventions:

Best Practice Modeling Standard (BPMS):

- A methodology or approach that is **required** to implement best practice spreadsheet modeling.

  The standards are universally applicable and are the **best way** to develop best practice spreadsheet models. Standards must be exhaustive and must be recognized as being the only methodology or approach that is best practice.

Best Practice Modeling Convention (BPMC):

- A methodology or approach that is **recommended** to implement best practice spreadsheet modeling.

The conventions are universally applicable and are **recommended** by the Spreadsheet Standards Review Board.

There are typically three types of Conventions:

1. Where there is **more than one 'best practice'**, none of which are necessarily better or worse than the others (e.g. when aesthetics or personal preference cannot be avoided);

2. Where a basis for consistency is required and there is **no generally accepted methodology** or approach in existence, the SSRB may recommend a convention to establish a basis for further standardization; or

3. Where a methodology or approach is **almost always 'best practice'**, but when certain rare circumstances are introduced may not be best practice (i.e. where the SSRB believes that the benefits of introducing the convention for most spreadsheets considerably outweigh the lack of universal applicability).

The Spreadsheet Standards Review Board

SSRB and the Best Practice Spreadsheet Modeling Standards

The Spreadsheet Standards Review Board ('**SSRB**') is the body that develops and maintains the Best Practice Spreadsheet Modeling Standards. The SSRB has invested significant resources in comprehensively analyzing every aspect of spreadsheet modeling in order to establish these comprehensive and universally applicable Standards.

The SSRB was established in 2002 in Australia to bring together the best spreadsheet modeling skills in order to develop and gain general acceptance for comprehensive and universally applicable Best Practice Spreadsheet Modeling Standards.

The Best Practice Spreadsheet Modeling Standards, being the highest professional spreadsheet modeling standards publicly available in the world, were first published in July 2003 and have been progressively gaining general market acceptance.

Role of the SSRB

The SSRB is responsible for:

- Promoting the general acceptance of the Best Practice Spreadsheet Modeling Standards to ensure that the Best Practice Spreadsheet Modeling Standards are recognized, used and accepted as the highest professional spreadsheet modeling standards in the world;
- Developing and maintaining the Best Practice Spreadsheet Modeling Standards;
- Facilitating and managing public participation in the Best Practice Spreadsheet Modeling Standards via written proposals to the SSRB;
- Evaluating proposals to modify the Best Practice Spreadsheet Modeling Standards; and
- Providing free copies of the Best Practice Spreadsheet Modeling Standards to the public.

The SSRB meets periodically to evaluate and consider proposals to add, delete or modify the Standards that are submitted to the SSRB by any party. The SSRB also invests significant resources into comprehensively analyzing every aspect of spreadsheet development, maintenance and usage in order to establish new universally applicable standards and conventions for spreadsheet modeling activities.

Changes to the Standards & Conventions – Process

The Best Practice Spreadsheet Modeling Standards and Conventions are maintained by the SSRB in accordance with the Open Licence Agreement which is annexed to these standards.

Any party may propose an addition, deletion or modification to the standards by submitting a 'Best Practice Spreadsheet Modeling Standards - Proposal Form' to the SSRB. Each proposal is subject to the same approval process. The process for approving a proposal is as follows:

1. Completion and submission of a 'Best Practice Spreadsheet Modeling Standards Proposal Form' to the SSRB via proposals@ssrb.org which requires the following categories of information including (see 'Changes to the Standards and Conventions – Approval Criteria' for more details in relation to these categories):
    a. Submitting Party contact details;
    b. Submitting Party qualifications and experience;
    c. Type of proposal (addition, deletion or modification);
    d. Overview of proposal;
    e. Exact wording of Standard or Convention to be added, deleted or modified;
    f. Exact wording of new Standard or Convention to be added or modified;
    g. Summary of primary spreadsheet issues addressed by the proposal;
    h. Description of how the proposal complies with each of the eight 'Criteria for Approval'; and
    i. Description of how the proposal meets the criteria for Standard or Convention Classification.
2. Preliminary review of submission by SSRB Proposal Committee;
3. Provision of Clarification Questions by SSRB Proposal Committee to Submitting Party (if required);
4. Preparation of final submission by Submitting Party to SSRB;
5. Dissemination of final submission to SSRB members (four weeks in advance of formal SSRB Meeting or decision making vote);
6. Consideration and discussion of final submission at formal SSRB meeting; and
7. Vote to approve submission proposal by SSRB members:
8. If approved by 75% of members - the Standard or Convention is added, deleted or modified for inclusion into the next version of the Best Practice Spreadsheet Modeling Standards; or
9. If not approved by 75% of members - the proposal is not approved, and in certain cases a report may be prepared by the SSRB Proposal Committee to the Submitting Party with suggested areas to address to gain future approval and/or summary of the reasons why the proposal was not approved.

Changes to the Standards & Conventions – Approval Criteria

In order for a proposed standard or convention to qualify for inclusion in the Best Practice Spreadsheet Modeling Standards it must be approved by the Spreadsheet Standards Review Board. In evaluating proposals, the SSRB focuses on eight fundamental criteria. In order to be approved by the SSRB the standard or convention proposal must:

1. Be a methodology or approach for developing, maintaining or using spreadsheets;

   In order to be a standard or convention, the proposal under consideration must be a 'methodology or approach', and it must be such for the purposes of 'developing, maintaining or using spreadsheets'. This ensures that proposals that are unrelated to best practice spreadsheet modeling are not included in the standards.

2. Have universal applicability;

   When it is relevant, a standard or convention must be capable of being applied to every Microsoft Excel® spreadsheet (i.e. universally applicable).

3. Address **how** to model (not **what** to model);

   All standards and conventions must be universally applicable methodologies or approaches to spreadsheet development, maintenance and use. Hence, the methodologies or approaches that are adopted to develop, maintain or use specific spreadsheet content will not be considered to be standards or conventions.

4. Be in the interests of improving communication between model developers and model users;

   This criterion is directed at ensuring that the standards are developed in the interest of improving communication, rather than reducing spreadsheet development time. This is due to the imperative that the standards articulate best practices in order to encourage the spreadsheet market to develop the appropriate tools to assist them with implementing the standards.

5. Reduce the likelihood of errors or mistakes in spreadsheets;

   One of the primary objectives of the standards is to encourage practices that reduce the likelihood of errors occurring in the development, maintenance or use of spreadsheets. As such, it is important that new standards seek to reduce or at least not increase the likelihood of errors in spreadsheets.

6. Increase spreadsheet transparency and user-friendliness for model users;

   By increasing transparency and user-friendliness, the ultimate end-users of spreadsheets can achieve their goals in a more efficient, clear and logical manner.

7. Be consistent with the definitions of words and terms contained in the standards; and

   There is an extensive list of definitions for words and terms used within the standards and conventions that must be read in conjunction with the standards and conventions. As such any new standard must be written such that it is consistent with the definitions contained within the existing standards.

8. Be the best practice that is known, where 'best practice' is defined as 'a set of operations achieving world class results in quality, flexibility, timeliness, cost and competitiveness, especially from the cooperation of model developers and model users'.

   The methodology or approach must be generally accepted as being the best practice that is available or known at any point in time. In certain circumstances, particularly where a methodology or approach involves the inclusion of aesthetics, there may be more than one 'best practice'. In these circumstances a Convention may be established.

Using the Standards & Conventions

Best Practice Utilization

The Best Practice Spreadsheet Modeling Standards should be used in every material spreadsheet model development process, particularly when multiple model developers are involved and/or the model is to be used by model users not involved in the model development process.

An important foundation for implementing 'best practice' is an understanding of the 16 Spreadsheet Modeling Areas which comprise the standards and conventions and an understanding of the notation which is used to classify related standards and conventions. A detailed discussion and examples of these concepts is provided in this Commentary & Examples version of the Best Practice Spreadsheet Modeling Standards which can be downloaded from the SSRB website (www.ssrb.org).

Finally, it is important to understand how the standards and conventions can be efficiently and effectively implemented, taking into account potential issues resulting from working in teams to develop best practice models. There are tools, such as Modano (available from www.modano.com), which have been developed specifically to facilitate best practice implementation and review, and these should be considered before undertaking any significant best practice modeling exercise.

Spreadsheet Modeling Areas

The Best Practice Spreadsheet Modeling Standards and Conventions have been separated into 16 'Spreadsheet Modeling Areas'. Each Spreadsheet Modeling Area represents a distinct area of the spreadsheet model development process.

The 16 Spreadsheet Modeling Areas are listed below:

Spreadsheet Modeling Area	Description
1) General Concepts	Fundamental concepts including workbook, sheet and cell purpose and content.
2) Workbook Structure	Workbook structure, sections, table of contents and navigation.
3) Sheet Structure	Sheet types, structure, consistency, titles and content.
4) Formats & Styles	Format and style purpose, consistency, identification, explanation and appearance.
5) Assumptions Entry Interfaces	Assumptions entry interface structure, rules, consistency, location and formats.
6) Sensitivity Analysis	Sensitivity analysis structure, location, rules and identification.
7) Outputs & Presentations	Outputs links, rules, separation and sections.
8) Calculation Formulas	Calculation formulas consistency, rules, diagrams and complexities.
9) Naming Principles	Workbook, sheet and range naming consistency, identification, rules and application.
10) Time Series Analysis	Time series analysis, assumptions, consistency, structure, periodicity, rules and outputs.
11) Checks	Error checks, Sensitivity checks and Alert checks structure, rules, location, formats and identification.
12) Printing & Viewing	Printing and viewing consistency, rules, margins, page numbers and information.
13) Multiple Workbooks	Multiple workbook links, structure, location, rules and diagrams.
14) Security & Protection	Workbook, sheet and cell protection and control.
15) Visual Basic Programming	The use of visual basic programming in spreadsheet models.
16) Miscellaneous	Various other areas.

Structure of the Standards & Conventions

The following diagram provides an overview of the content of the Standards and Conventions within each of the 16 Spreadsheet Modeling Standards Areas.

SMA 1 – General Concepts

BPMS 1-1	Workbook Purpose	**BPMC 1-1**	Sheet Types
BPMS 1-2	Sheet Classification	**BPMC 1-2**	Sheet Purpose Identification
BPMS 1-3	Sheet Content	**BPMC 1-3**	Cell Content Identification
BPMS 1-4	Sheet Purpose	**BPMC 1-4**	Cell Purpose Identification
BPMS 1-5	Cell Classification	**BPMC 1-5**	Mixed Cell Exceptions
BPMS 1-6	Cell Content		
BPMS 1-7	Cell Purpose		
BPMS 1-8	Assumption Classification		
BPMS 1-9	Assumption Cell Content		

SMA 2 – Workbook Structure

BPMS 2-1	Workbook Cover Sheet	**BPMC 2-1**	Workbook Section Structure
BPMS 2-2	Workbook Sections		
BPMS 2-3	Section Cover Sheets		
BPMS 2-4	Table of Contents		
BPMS 2-5	Table of Contents Information		
BPMS 2-6	Workbook Navigation		

SMA 3 – Sheet Structure

BPMS 3-1	Sheet Titles	**BPMC 3-1**	Sheet Content Consistency
BPMS 3-2	Sheet Type Consistency	**BPMC 3-2**	Hyperlinks in Worksheets
BPMS 3-3	Grouping Rows or Columns	**BPMC 3-3**	No Chart Sheets
		BPMC 3-4	Workbook Cover Sheet Content
		BPMC 3-5	Workbook Cover Sheet Notes
		BPMC 3-6	Section Cover Sheet Content
		BPMC 3-7	Section Cover Sheet Notes
		BPMC 3-8	Limiting Worksheet Depth
		BPMC 3-9	Freezing Panes
		BPMC 3-10	Grouping Levels
		BPMC 3-11	Heading Indentation

SMA 4 – Formats & Styles

BPMS 4-1	Formats & Styles Key	**BPMC 4-1**	Use of Purpose-Based Styles
BPMS 4-2	Worksheet Data Alignment	**BPMC 4-2**	Cell Data Alignment
BPMS 4-3	Denomination Identification	**BPMC 4-3**	Work In Progress Identification
BPMS 4-4	Workbook Denomination	**BPMC 4-4**	Hyperlink Formats
BPMS 4-5	Hyperlink Consistency		
BPMS 4-6	Work In Progress		

SMA 5 – Assumptions Entry Interfaces

BPMS 5-1	Assumptions Location	**BPMC 5-1**	Preventing Invalid Assumption Entries
BPMS 5-2	No Assumption Repetition	**BPMC 5-2**	Assumptions Entry Interfaces
BPMS 5-3	Control Cell Link Placement	**BPMC 5-3**	Controlling Assumptions Entry Interfaces
BPMS 5-4	Control Lookup Data	**BPMC 5-4**	No Heading Title Label Repetition
BPMS 5-5	In Cell Drop Down List	**BPMC 5-5**	Control Cell Link Range Names
		BPMC 5-6	Use of Check Box Controls
		BPMC 5-7	Use of Button Controls
		BPMC 5-8	Use of Drop Down Box or List Box Controls
		BPMC 5-9	Use of Spin Button or Scroll Bar Controls
		BPMC 5-10	Data Validation
		BPMC 5-11	Conditional Formatting of Assumption Cells
		BPMC 5-12	Visual Identification of Inactive Assumptions

SMA 6 – Sensitivity Analysis

BPMS 6-1	Separate Sensitivity Assumptions Section	**BPMC 6-1**	Sensitivity Assumptions Entry Interface Structure
BPMS 6-2	Sheet Type for Sensitivity Assumptions Entry Interfaces		
BPMS 6-3	Separate Sensitivity Assumptions Entry Interfaces		

SMA 7 – Outputs & Presentations

BPMS 7-1	Segregation of Outputs	**BPMC 7-1**	Separate Outputs Workbooks
BPMS 7-2	Presentation Sheets	**BPMC 7-2**	Outputs Section Structure
BPMS 7-3	Presentation Sheet Usage	**BPMC 7-3**	Outputs Worksheet Summaries

SMA 8 – Calculation Formulas

BPMS 8-1	Consistent Formulas	**BPMC 8-1**	Avoid Complex Formulas
BPMS 8-2	No Assumptions In Mixed Cell Content	**BPMC 8-2**	Complex Formula schematics
BPMS 8-3	Circular References	**BPMC 8-3**	Multiple Function Formulas
		BPMC 8-4	No Repeated Calculations

SMA 9 – Naming Principles

BPMS 9-1	Workbook Naming	**BPMC 9-1**	Workbook Name Display
BPMS 9-2	Sheet Naming	**BPMC 9-2**	File Name Visibility
BPMS 9-3	Range Naming	**BPMC 9-3**	Sheet Type Naming Suffixes
BPMS 9-4	Standardized Naming Prefixes	**BPMC 9-4**	Secondary Sheet Naming Suffixes
		BPMC 9-5	Sheet Naming Key
		BPMC 9-6	Range Naming Prefixes
		BPMC 9-7	Range Naming Key
		BPMC 9-8	Range Naming Conflicts

SMA 10 – Time Series Analysis

BPMS 10-1	Time Series Assumptions	**BPMC 10-1**	Time Series Constants
BPMS 10-2	Time Series Period Labels	**BPMC 10-2**	No Mixing Of Periodicities
BPMS 10-3	Time Series Period End Dates	**BPMC 10-3**	Multiple Periodicities In One Workbook
BPMS 10-4	Time Series Periodicity Identification	**BPMC 10-4**	Time Series Data Direction
BPMS 10-5	Time Series Number Of Periods		
BPMS 10-6	Time Series Sheet Consistency		

SMA 11 – Checks

BPMS 11-1	Checks Classification	**BPMC 11-1**	Linking Checks to Model Name Entry Cell
BPMS 11-2	Error Checks	**BPMC 11-2**	Check Cell Conditional Formatting
BPMS 11-3	Sensitivity Checks	**BPMC 11-3**	Check Calculation Location
BPMS 11-4	Alert Checks	**BPMC 11-4**	Check Type Summary Cell
BPMS 11-5	Error Checks Summary		
BPMS 11-6	Sensitivity Checks Summary		
BPMS 11-7	Alert Checks Summary		
BPMS 11-8	Check Indicator Flag		
BPMS 11-9	Check Cell Formatting		
BPMS 11-10	Dedicated Checks Summaries		

SMA 12 – Printing & Viewing

BPMS 12-1	Table Of Contents Page Numbers	**BPMC 12-1**	Workbook Print Scaling
BPMS 12-2	Sheet Page Numbers	**BPMC 12-2**	Printed Information
BPMS 12-3	Page Margin Consistency		
BPMS 12-4	Print View Consistency		
BPMS 12-5	Page View Consistency		
BPMS 12-6	Worksheet View Consistency		

SMA 13 – Multiple Workbooks

BPMS 13-1	External Workbook Imports	**BPMC 13-1**	Workbook-Specific Import And Export Sheets
BPMS 13-2	External Workbook Exports	**BPMC 13-2**	Import And Export Sheet Consistency
BPMS 13-3	Workbook Outputs Links	**BPMC 13-3**	No Complex Formulas On Import Sheets
		BPMC 13-4	Import And Export Sections
		BPMC 13-5	Linked Workbook Diagrams

SMA 14 – Security & Protection

	[No Standards]	**BPMC 14-1**	Workbook Protection
		BPMC 14-2	Protection of Non Assumptions
		BPMC 14-3	Sheet and Cell Protection
		BPMC 14-4	No Unnecessary Passwords
		BPMC 14-5	Storing Passwords

SMA 15 – Visual Basic Programming

	[No Standards]	**BPMC 15-1**	Recording Macros

SMA 16 – Miscellaneous

BPMS 16-1	Automatic Calculation Setting	**BPMC 16-1**	Model Developer Identification
		BPMC 16-2	Emphasizing Information
		BPMC 16-3	Help Files and Instructions

Reading the Standards & Conventions

The Best Practice Spreadsheet Modeling Standards are provided in both list form (see pages 25 – 39 for the Standards listing and pages 40 – 57 for the Conventions listing) and with detailed commentary and examples for each standard and convention by Spreadsheet Modeling Area (see chapters 1 – 16).

Each Best Practice Spreadsheet Modeling Standard has a numbered identifier that includes a '**BPMS**' prefix (indicating that it is a Standard) and a two part number representing the 'Spreadsheet Modeling Area' and 'number' of the standard.

Similarly, each Best Practice Spreadsheet Modeling Convention also has a numbered identifier that includes a '**BPMC**' prefix (indicating that it is a Convention) and a two part number representing the 'Spreadsheet Modeling Area' and 'number' of the convention. See the following two numbered identifier examples:

Type	Numbered Identifier	Number Component Meanings	
Standard	**BPMS 1-9**	**1** = Spreadsheet Modeling Area Number 1 (General Concepts)	**9** = Standard number 9 within Spreadsheet Modeling Area Number 1
Convention	**BPMC 3-2**	**3** = Spreadsheet Modeling Area Number 3 (Sheet Structure)	**2** = Convention number 2 within Spreadsheet Modeling Area Number 3

There are many defined words and terms contained within the text of many Standards and Conventions, and definitions of each are contained in Appendix 1. These defined words and terms are highlighted within Standards and Conventions using *italic font*. An example is shown in the Standard below, with the italic font representing defined terms for 'workbook', 'format', 'style' and 'cells':

BPMS 4-1 Formats & Styles Key

Every *workbook* should contain a key or legend that explains the purpose of each *format* and *style* that has been applied to the *cells* in the *workbook*.

The Best Practice Spreadsheet Modeling Standards (without commentary or examples) containing all of the Standards and Conventions within the 16 Spreadsheet Modeling Areas have been provided on pages 23 to 59 of this book.

How to use the Standards & Conventions

A best practice spreadsheet model developer should always apply the Best Practice Spreadsheet Modeling Standards whenever they build a spreadsheet model. Aside from implementing best practice, model developers will find that applying the standards and conventions will greatly reduce the amount of time required to develop, explain and modify their spreadsheet models - especially if the parties with whom they are communicating are also aware of the standards and conventions being applied.

Further, a best practice spreadsheet model user should require that their spreadsheet models are developed in accordance with these standards and conventions. This will ensure that model users derive maximum value from their spreadsheet models in the most efficient manner, whilst maintaining control over approach and quality.

Not every standard or convention will be applicable to every spreadsheet model being developed. This can be thought of in the same way as when applying accounting standards - i.e. only the standards and conventions relevant to the particular area being modeled need to be considered at any point in time.

It is therefore important that a best practice spreadsheet model developer be familiar with all of the standards and conventions, and knows when each standard and convention is relevant to the spreadsheet model being built.

Practical Implementation

The Best Practice Spreadsheet Modeling Standards and Conventions can be implemented by simply using any spreadsheet application with discipline and consistency. However, this approach creates risks of non-best practice issues, particularly as models become larger and more complex.

The standardization and consistency which create the foundation for the standards also make it possible to use standardization software to ensure that best practice is being implemented efficiently and accurately. The best software available for this purpose is Modano® - a comprehensive best practice content creation, management and sharing system for Microsoft Excel® developed and maintained by Modano. Modano makes it possible to implement the Standards in less time than non-best practice modeling, and also allows for the creation and maintenance of personal and/or corporate themes which can be applied collectively by multiple spreadsheet model developers. The software also includes a full range of best practice auditing tools which verify that spreadsheets are in fact best practice.

For more information on Modano and other best practice modeling resources, visit the Modano website at www.modano.com. Modano also offers a free Community Edition and forums which ensures that best practice modelers are kept up to date with changes to the standards and the ongoing development of improved best practice modeling tools and techniques.

More Information

This book contains detailed commentary and examples in relation to each of the Best Practice Spreadsheet Modeling Standards and Conventions. For more information on the standards and conventions or any queries regarding any spreadsheet modeling area you can contact the SSRB via the following details:

Website:	www.ssrb.org
Email:	info@ssrb.org

The Best Practice Spreadsheet Modeling Standards are maintained by the Spreadsheet Standards Review Board ('SSRB'). For further information regarding the Best Practice Spreadsheet Modeling Standards or the SSRB, please contact the SSRB at www.ssrb.org/contact.

Fundamental Terms

There are several basic and fundamental terms that are used throughout the Standards and Conventions. In addition to the basic terms outlined below, there is a detailed Appendix of defined words and terms on page 243 of this book.

Term	Definition
Assumption	Anything within a workbook that the model developer intends to be manipulated by model users to affect the workbook calculations.
Base Assumption	A base entry into a workbook that drives base outputs (outputs that do not include the impacts of sensitivity assumptions).
Cell (Range)	One (or more) of the entry boxes that make up worksheets within a workbook.
Column	A single vertical group of cells which is 1 cell in width, and is the height of an entire worksheet.
Constant(s)	A numerical value, text, macro generated value, control generated value (cell link) or any other entry contained within a cell that is not a formula and does not contain a formula. Also referred to as a hard-code.
Convention	A methodology or approach that is recommended to implement best practice spreadsheet modeling. This methodology or approach is universally applicable and is recommended by the Spreadsheet Standards Review Board.
Entry Interface	A cell, range of cells or control for entering base or sensitivity assumptions.
Fill Color	The background color of a cell or range of cells. Used to indicate cell purpose.
Font Color	The color of any character within a cell or range of cells. Used to indicate cell content.
Format	A single property of a cell or other object that affects its outward appearance.
Formula	An equation that performs calculations, including a function or mathematical operator that does not include a constant.
Hyperlink	A link located within a workbook which, when activated, moves the active cell to another worksheet in the same workbook, a different workbook, or another area on the same worksheet
Link	A reference within a formula that refers to a cell or range of cells that is located on another worksheet or in another workbook
Location	A cell reference or named position within a worksheet. Also referred to as Position.
Model Developer	A person involved in the construction of a spreadsheet model and the derivation of the underlying calculations.
Model User	A person who relies upon outputs from a spreadsheet model for various purposes, often to analyze or gain an understanding of the area being modeled or to provide them with assistance in decision making
Output(s)	Any component within a workbook that is not an assumption.
Row	A single horizontal group of cells which is a worksheet width wide and 1 cell long.
Section	Sheets within a workbook that have been grouped (located) together.
Sensitivity Analysis	The analysis of the sensitivity of the outputs from a spreadsheet model to changes in its base assumptions (using sensitivity assumptions).
Sensitivity Assumption	An entry into a workbook that drives running case outputs (outputs that include the impacts of both base assumptions and sensitivity assumptions).
Sheet	A worksheet or chart sheet in a workbook.
Spreadsheet Model	A theoretical construct in a spreadsheet that represents numerical processes by a set of variables and a set of logical and quantitative relationships between them. A spreadsheet model may be a workbook or group of linked workbooks.

Term	Definition
Standard	A methodology or approach that is required to implement Best Practice spreadsheet modeling. This methodology or approach is universally applicable and is the best way to develop Best Practice spreadsheet models.
Style	A collection of pre-determined formats consistently applied to cells or other objects.
Time Series Model	A workbook or group of linked workbooks that analyzes numbers over more than one sequential period of time. A Time Series Model includes more than one period and as such requires date and time assumptions and period labels.
Workbook	A file that contains one or more sheets.
Worksheet	A sheet which consists of rows and columns, and therefore contains cells.

Standards & Conventions

Overview

This chapter lists each of the Best Practice Spreadsheet Modeling Standards and Conventions in order of Spreadsheet Modeling Area. Each Best Practice Spreadsheet Modeling Standard and Convention has been stated, without commentary, in the following pages, numbered and listed within each of the 16 different Spreadsheet Modeling Areas.

For more detailed information, commentary and examples relating to each Standard & Convention refer to chapters 1 – 16 of this book on pages 59 - 241, which correspond with the 16 Spreadsheet Modeling Areas.

Best Practice Spreadsheet Modeling Standards

There are currently 68 universally applicable Best Practice Spreadsheet Modeling Standards and 72 Conventions, grouping into the following Spreadsheet Modeling Areas:

Number	Spreadsheet Modeling Area
1	General Concepts
2	Workbook Structure
3	Sheet Structure
4	Formats and Styles
5	Assumptions Entry Interfaces
6	Sensitivity Analysis
7	Outputs and Presentations
8	Calculation Formulas
9	Naming Principles
10	Time Series Analysis
11	Checks
12	Printing and Viewing
13	Multiple Workbooks
14	Security and Protection
15	Visual Basic Programming
16	Miscellaneous

The following pages detail each Best Practice Spreadsheet Modeling Standard.

1. General Concepts

BPMS 1-1 Workbook Purpose

The purpose of a *workbook* should be the primary consideration of a *model developer* during every stage of a *workbook's* development. The purpose of a *workbook* can be universally segregated into three levels as follows:

a. The purpose of the *workbook*;

b. The purpose of each *sheet*; and

c. The purpose of each component within each *sheet*.

Related Standards:	*BPMS 1-4*	*Sheet Purpose, Page 27.*
	BPMS 1-7	*Cell Purpose, Page 27.*

BPMS 1-2 Sheet Classification

The *sheet content* and *sheet purpose* of every *sheet* in a *workbook* should be visually identifiable at all times.

Related Standards:	*BPMS 1-3*	*Sheet Content, Page 26.*
	BPMS 1-4	*Sheet Purpose, Page 27.*
Related Conventions:	*BPMC 1-1*	*Sheet Types, Page 41.*
	BPMC 1-2	*Sheet Purpose Identification, Page 41.*

BPMS 1-3 Sheet Content

Every *sheet* in a *workbook* should be visually identifiable as being one of the following *sheet types*:

a. Cover sheet

b. Contents sheet

c. Section cover sheet

d. Schematics sheet

e. Time series sheet

f. Blank sheet

g. Lookups sheet

h. Chart sheet

Related Standards:	*BPMS 1-4*	*Sheet Purpose, Page 27.*
	BPMS 3-2	*Sheet Type Consistency, Page 30.*
Related Conventions:	*BPMC 1-1*	*Sheet Types, Page 41.*

BPMS 1-4 Sheet Purpose

Every *sheet* in a *workbook* should have the purpose of either collecting *assumptions* or not collecting *assumptions*.

Hence, every *sheet* in a *workbook* should be visually identifiable as having one of the following *sheet* purposes:

a. *Assumptions sheet; or*

b. *Outputs sheet.*

Related Conventions:	*BPMC 1-2*	*Sheet Purpose Identification, Page 41.*

BPMS 1-5 Cell Classification

The *cell content* and *cell purpose* of every *cell* in every *worksheet* should be visually identifiable at all times.

Related Standards:	*BPMS 1-6*	*Cell Content, Page 27.*
	BPMS 1-7	*Cell Purpose, Page 27.*
Related Conventions:	*BPMC 1-3*	*Cell Content Identification, Page 42.*
	BPMC 1-4	*Cell Purpose Identification, Page 42.*

BPMS 1-6 Cell Content

Every *cell* in every *worksheet* should be visually identifiable as containing one of the following content types:

a. *Constant;*

b. *Formula;* or

c. *Mixed* (combination of constant and formula).

Related Conventions:	*BPMC 1-3*	*Cell Content Identification, Page 42.*
	BPMC 1-5	*Mixed Cell Exceptions, Page 42.*

BPMS 1-7 Cell Purpose

Every *cell* in every *worksheet* should have the purpose of either collecting *assumptions* or not collecting *assumptions*.

Hence, every *cell* in every *worksheet* should be visually identifiable as having one of the following *cell* purposes:

a. *Assumption cell;* or

b. *Output cell.*

Related Conventions:	*BPMC 1-4*	*Cell Purpose Identification, Page 42.*

BPMS 1-8 Assumption Classification

An *assumption* is defined as anything within a *workbook* that is intended to be manipulated by *model users* to affect *outputs*.

Every *assumption* in a *workbook* must be classified as one of the following types:

a. *Base assumption;* or

b. Sensitivity assumption.

Related Standards:	*BPMS 1-4*	*Sheet Purpose, Page 27.*
	BPMS 1-7	*Cell Purpose, Page 27.*

BPMS 1-9 Assumption Cell Content

Every *assumption cell* in every *worksheet* should contain *constant* cell content.

Related Standards:	*BPMS 1-5*	*Cell Classification, Page 27.*
	BPMS 1-6	*Cell Content, Page 27.*
	BPMS 1-7	*Cell Purpose, Page 27.*
Related Conventions:	*BPMC 1-3*	*Cell Content Identification, Page 42.*

2. Workbook Structure

BPMS 2-1 Workbook Cover Sheet

Every *workbook* that contains more than one *sheet* should contain a separate *cover sheet* as the first *sheet* in the *workbook*.

Related Conventions:	*BPMC 2-1*	*Workbook Section Structure, Page 43.*
	BPMC 3-4	*Workbook Cover Sheet Content, Page 44.*
	BPMC 3-5	*Workbook Cover Sheet Notes, Page 45.*

BPMS 2-2 Workbook Sections

Every *workbook* that contains multiple categories or similar types of information should be separated into *sections*. A separate *section* should be created in a *workbook* for each *sheet* or group of *sheets* containing similar types of information.

Related Conventions:	*BPMC 2-1*	*Workbook Section Structure, Page 43.*

BPMS 2-3 Section Cover Covers

A *section cover sheet* should be used at the start of each *section* in a *workbook* to indicate the commencement of each new *section*.

Related Conventions:	*BPMC 3-6*	*Section Cover Sheet Content, Page 45.*
	BPMC 3-7	*Section Cover Sheet Notes, Page 45.*

BPMS 2-4 Table of Contents

Every *workbook* with more than one *sheet* should contain a *table of contents* outlining the structure and composition of the underlying *workbook*.

Related Standards:	*BPMS 12-1*	*Table of Contents Page Numbers, Page 37.*
	BPMS 12-2	*Sheet Page Numbers, Page 37.*

BPMS 2-5 Table of Contents Information

A *Table of Contents* should:

a. Show the *sections* of the *workbook* (if any *sections* have been created);

b. Reference the *sheet title* of each *sheet* in the *model*;

c. Clearly number each *section* and *sheet*; and

d. Be located near the front of the *workbook* (generally the second *sheet* in the workbook).

Related Standards:	*BPMS 12-1*	*Table of Contents Page Numbers, Page 37.*

BPMS 2-6 Workbook Navigation

Every *workbook* with more than one *sheet* should contain:

a. a *table of contents* sheet outlining the *sections* and *sheets* in the *workbook*;

b. *hyperlinks* from the *table of contents* to every *sheet* in the *workbook*; and

c. a *hyperlink* to the *table of contents* always in view on every *sheet* in the *workbook*.

Related Standards:	*BPMS 3-3*	*Grouping Rows or Columns, Page 30.*
	BPMS 3-3	*Grouping Rows or Columns, Page 30.*
Related Conventions:	*BPMC 3-2*	*Hyperlinks in Worksheets, Page 44.*

3. Sheet Structure

BPMS 3-1 Sheet Titles

Every *sheet* in a *workbook* should contain a clearly highlighted *sheet title* that is:

a. Consistently formatted on every *sheet*;

b. Consistently *located* on every *sheet type*; and

c. Always in view on the screen when that *sheet* is active.

Related Standards:	*BPMS 1-3*	*Sheet Content, Page 26.*
Related Conventions:	*BPMC 1-1*	*Sheet Types, Page 41.*
	BPMC 3-1	*Sheet Content Consistency, Page 43.*

BPMS 3-2 Sheet Type Consistency

Sheets of the same *sheet type* within a *workbook* should be consistently structured and formatted.

This standard applies to:

a. Sheet title, styles and positioning;

b. Heading *styles* and spacing;

c. *Column* and *row* dimensions;

d. *Data* entry points;

e. *Hyperlink* positioning;

f. Visibility of gridlines;

g. *Grouping levels*;

h. Zoom and viewing properties;

i. Window panes and splits; and

j. *Formats* and colors.

Related Conventions:	*BPMC 3-1*	*Sheet Content Consistency, Page 43.*
	BPMC 3-2	*Hyperlinks in Worksheets, Page 44.*
	BPMC 3-4	*Workbook Cover Sheet Content, Page 44.*
	BPMC 3-6	*Section Cover Sheet Content, Page 45.*

BPMS 3-3 Grouping Rows or Columns

When hiding *rows* or *columns* in a *worksheet*, the *rows* or *columns* should always be *grouped*, not hidden.

Related Conventions:	*BPMC 3-8*	*Limiting Worksheet Depth, Page 46.*
	BPMC 3-9	*Freezing Panes, Page 46.*
	BPMC 3-10	*Grouping Levels, Page 46.*

4. Formats & Styles

BPMS 4-1 Formats and Styles Key

Every *workbook* should contain a key or legend that explains the purpose of each *format* and *style* that has been applied to the *cells* in the *workbook*.

Related Conventions: *BPMC 4-1* *Use of Purpose-Based Styles, Page 47.*
BPMC 4-3 *Work in Progress Identification, Page 47.*

BPMS 4-2 Worksheet Data Alignment

All *data* of the same type on a *worksheet* should be consistently aligned down *rows* or across *columns*.

Related Conventions: *BPMC 4-2* *Cell Data Alignment, Page 47.*

BPMS 4-3 Denomination Identification

Every number in a *workbook* should clearly indicate what type of *denomination* it is by either:

a. Stating the *denomination* of a number in an appropriate corresponding *heading*, *title column, row* or *label*; or

b. Formatting the number such that it is displayed as its *denominator* (e.g. $20, 20 tonnes, 20% or 20.0x).

Related Standards: *BPMS 4-4* *Workbook Denomination, Page 31.*

BPMS 4-4 Workbook Denomination

There should be a primary *denomination* that is used consistently throughout the *workbook*.

Where *denominations* differ from the primary *denomination*, they should be clearly *labelled* to inform other *model developers* and *model users*.

Related Standards: *BPMS 4-3* *Denomination Identification, Page 31.*

BPMS 4-5 Hyperlink Consistency

All *hyperlinks* within a *workbook* should use a consistent, dedicated *style* or *format* so that they are visually identifiable as being *hyperlinks*.

Related Conventions: *BPMC 4-4* *Hyperlink Formats , Page 47.*

BPMS 4-6 Work in Progress

Any *cell* within a *workbook* that is subject to further work or not finalized should be visually identifiable as being *work in progress*.

Related Conventions: *BPMC 4-3* *Work in Progress Identification , Page 47.*

5. Assumptions Entry Interfaces

BPMS 5-1 Assumptions Location

All *assumptions* contained in a *workbook* should be located on dedicated and visually identifiable *assumptions sheets*.

Assumptions should never be *located* on *outputs sheets*.

BPMS 5-2 No Assumption Repetition

Any single *assumption* should never be entered more than once into a *workbook*.

BPMS 5-3 Control Cell Link Placement

Every *cell link* that is attached to a *control* in a *workbook* should be located in the top left cell of the range over which its control is placed.

Related Conventions:	*BPMC 5-5*	*Control Cell Link Range Names, Page 48.*
	BPMC 9-5	*Sheet Naming Key, Page 52.*

BPMS 5-4 Control Lookup Data

When using a *control* in a *workbook* that requires an input *range* (*lookup data*), the *lookup data* should always be located on a separate *lookups sheet*.

BPMS 5-5 In-Cell Drop Down Lists

A *cell* in which *data validation* is used to create *in cell drop down lists.* The *range* in which the drop down list is inserted should always be *formatted* as an *assumption cell*.

6. Sensitivity Analysis

BPMS 6-1 Separate Sensitivity Assumptions Section

Every *workbook* that contains *sensitivity analysis* functionality should contain a dedicated *sensitivity assumptions section* (which is separate to the *base assumptions section*).

Related Conventions:	*BPMC 6-1*	*Sensitivity Assumptions Entry Interface Structure, Page 50.*

BPMS 6-2 Sheet Type for Sensitivity Assumptions Entry Interfaces

All *sensitivity assumptions* in a *workbook* should be *located* on *assumptions sheets*.

BPMS 6-3 Separate Sensitivity Assumptions Entry Interfaces

Sensitivity assumptions should always be *located* on a dedicated *sensitivity assumptions sheet* which is separate to its corresponding *base assumptions sheet*.

7. Outputs & Presentations

BPMS 7-1 Segregation of Outputs

Outputs sheets and *presentations*, which may take the form of tables, graphs, diagrams or pictures, amongst other forms, should always be *located* in either:

a. a separate, clearly labelled section of a *workbook*; or

b. a separate dedicated *outputs workbook*.

Related Conventions:	*BPMC 7-1*	*Separate Output Workbooks, Page 50.*
	BPMC 7-2	*Output Section Structure, Page 50.*

BPMS 7-2 Presentation Sheets

A *workbook* may contain sheets which do not comply with the *standards* and *conventions*, but these sheets must be *presentation sheets*.

A *presentation sheet* is a *sheet* that is included in a *workbook* in order to present *outputs* which are necessarily exempt from the *standards* and *conventions* in order to meet aesthetic or corporate requirements.

BPMS 7-3 Presentation Sheet Usage

Presentation sheets should only be included in a *workbook* where it is not possible to use non-presentation sheets to achieve the same objective.

8. Calculation Formulas

BPMS 8-1 Consistent Formulas

When more than one adjacent *cell* contains a similar type of *output* the structure and components of the *formulas* within the *cells* should always be consistent, so that the *cell* can be copied across / down the relevant range without needing to make changes.

BPMS 8-2 No Assumptions in Mixed Cell Content

Assumptions should not be embedded in cells containing *mixed cell content* – i.e. cells containing content with a combination of *constant* and *formula*.

BPMS 8-3 Circular References

A *workbook* or group of *linked workbooks* should never contain a *circular reference*.

9. Naming Principles

BPMS 9-1 Workbook Naming

Each *workbook* should be named such that the name:

a. Allows for different versions of the *workbook*;

b. Remains consistent between versions of the *workbook*; and

c. Differentiates the *workbook* from other *workbooks*.

Related Conventions: *BPMC 9-1* *Workbook Name Display, Page 51.*

BPMS 9-2 Sheet Naming

Every *sheet* name in a *workbook* should indicate the *sheet* type.

Related Conventions: *BPMC 9-3* *Sheet Type Naming Suffixes, Page 52.*
BPMC 9-4 *Secondary Sheet Naming Suffixes, Page 52.*

BPMS 9-3 Range Naming

Every *range name* in a *workbook* should describe the content or use of the *range* being named.

Related Conventions: *BPMC 9-5* *Sheet Naming Key, Page 52.*
BPMC 9-6 *Range Naming Prefixes, Page 53.*
BPMC 9-7 *Range Naming Key, Page 53.*

BPMS 9-4 Standardized Naming Prefixes

Every *range name* in a *workbook* should have a standardized *prefix* to identify what type of *range* the name refers to or the purpose of that *range*.

10. Time Series Analysis

BPMS 10-1 Time Series Assumptions

Every *workbook* that undertakes *time series analysis* should clearly state, for each distinct *time series*:

a. the *time series* start date; and

b. the *time series periodicity*.

Related Conventions: *BPMC 10-2* *No Mixing of Periodicities, Page 54.*

BPMS 10-2 Time Series Period Labels

A *time series* should always contain a consistent set of *periodicity* labels and counters that are located in the same *position* on every relevant *worksheet* in the *workbook*.

The *periodicity labels* and counters that should appear in every *time series sheet* are:

a. *Period* start date;

b. *Period* end date; and

c. *Period* number (counter).

Related Standards: BPMS 10-3Time Series Period End Dates, Page 35

BPMS 10-3 Time Series Period End Dates

The *period* end date *label* for each *period* in a *time series sheet* should always be in view on the screen.

Related Standards: BPMS 10-2 Time Series Period Labels, Page 35

BPMS 10-4 Time Series Periodicity Identification

The *periodicity* of each *time series sheet* should be clearly identified and always in view on each *time series sheet*.

BPMS 10-5 Time Series Number of Periods

A *workbook* that undertakes time series analysis should always include a *cell* or *cell range* that indicates the number of *periods* in each distinct *time series*.

BPMS 10-6 Time Series Sheet Consistency

Time series sheets for each distinct *time series* within a *workbook* should always:

a. Contain the same number of *periods*; and

b. Have the first *period* starting in the same *column* (or more rarely, *row*).

11. Checks

BPMS 11-1 Checks Classification

All *checks* in a *workbook* should be classified as being one of the following *check types*:

a. Error check;

b. Sensitivity check; or

c. Alert check.

Related Standards:
BPMS 11-2 Error Checks, Page 36.
BPMS 11-3 Sensitivity Checks, Page 36.
BPMS 11-4 Alert Checks, Page 36.

BPMS 11-2 Error Checks

Every *workbook* should contain appropriate *error checks* to assist in identifying *errors* in the *workbook*.

Related Standards:	*BPMS 11-1*	*Checks Classification , Page 35.*
	BPMS 11-5	*Error Checks Summary , Page 36.*

BPMS 11-3 Sensitivity Checks

Every *workbook* that contains one or more *sensitivity assumptions* should contain *sensitivity checks* to identify when there is an *operative sensitivity assumption*.

Related Standards:	*BPMS 11-1*	*Checks Classification, Page 35.*
	BPMS 11-6	*Sensitivity Checks Summary , Page 36.*

BPMS 11-4 Alert Checks

Every *workbook* that requires *checks* that are not classified as *error checks* or *sensitivity checks* should contain *alert checks* to identify when such a check has been triggered.

Related Standards:	*BPMS 11-1*	*Checks Classification, Page 35.*
	BPMS 11-7	*Alert Checks Summary , Page 36.*

BPMS 11-5 Error Checks Summary

The outcome of every *error check* in a *workbook* should be displayed in a dedicated and separate *error checks summary*.

Related Standards:	*BPMS 11-2*	*Error Checks, Page 36.*
	BPMS 11-10	*Dedicated Checks Summaries , Page 37.*

BPMS 11-6 Sensitivity Checks Summary

The outcome of every *sensitivity check* in a *workbook* should be displayed in a dedicated and separate *sensitivity checks summary*.

Related Standards:	*BPMS 11-3*	*Sensitivity Checks , Page 36.*
	BPMS 11-10	*Dedicated Checks Summaries , Page 37.*

BPMS 11-7 Alert Checks Summary

The outcome of every *alert check* in a *workbook* should be displayed in a dedicated and separate *alert checks summary*.

Related Standards:	*BPMS 11-4*	*Alert Checks , Page 36.*
	BPMS 11-10	*Dedicated Checks Summaries , Page 37.*

BPMS 11-8 Check Indicator Flag

A message or indicator that clearly notifies the *model developer* or *user* that a *check* has been triggered in a *workbook* should always be in view on every *worksheet* in a *workbook*.

Related Conventions:	*BPMC 11-1*	*Linking Checks to Model Name Entry Cell, Page 54.*

BPMS 11-9 Check Cell Formatting

Each *check cell* in a *workbook* should be *formatted* in such a way that it will visually indicate when an *error*, *sensitivity* or *alert check* has been triggered.

Related Conventions:	*BPMC 11-2*	*Check Cell Conditional Formatting, Page 54.*

BPMS 11-10 Dedicated Checks Summaries

A *workbook* should not contain more than one of each of the following types of *check summaries*:

a. Error checks summary;

b. Sensitivity checks summary; and/or

c. Alert checks summary.

Related Standards:	*BPMS 11-5*	*Error Checks Summary, Page 36.*
	BPMS 11-6	*Sensitivity Checks Summary, Page 36.*
	BPMS 11-7	*Alert Checks Summary, Page 36.*

12. Printing & Viewing

BPMS 12-1 Table of Contents Page Numbers

Every *workbook* with more than one *sheet* should contain a *table of contents* that displays the corresponding printed page numbers for each *sheet*. As such a *workbook* should always print with a *Table of Contents* that is consistent with any page numbers printed on the individual *sheet* pages.

Related Standards:	*BPMS 2-4*	*Table of Contents, Page 29.*
	BPMS 12-2	*Sheet Page Numbers, Page 37.*

BPMS 12-2 Sheet Page Numbers

Every *sheet* within a *workbook* should contain page numbers that correspond with the printed page numbers stated in the *workbook table of contents*, when printing the entire *workbook*.

Related Standards:	*BPMS 2-4*	*Table of Contents, Page 29.*
	BPMS 12-1	*Table of Contents Page Numbers, Page 37.*

BPMS 12-3 Page Margin Consistency

The page margins on every *sheet* in a *workbook* should be consistent.

BPMS 12-4 Print View Consistency

The *print scaling* setting and hence the size of the content on each printed page in a *workbook* should, where feasible, be consistent for each *sheet*.

Related Standards:	*BPMS 12-5*	*Page View Consistency, Page 38.*
	BPMS 12-6	*Worksheet View Consistency, Page 38.*

BPMS 12-5 Page View Consistency

The *view type* should be the same for each *sheet* in a *workbook*.

Related Standards:	*BPMS 12-4*	*Print View Consistency, Page 38.*
	BPMS 12-6	*Worksheet View Consistency, Page 38.*

BPMS 12-6 Worksheet View Consistency

Prior to providing a *workbook* to a *model user*, the view of every *worksheet* in the *workbook* should be set such that the top-left corner of the *worksheet* is in view (i.e. *cell* A1 is selected).

Related Standards:	*BPMS 12-4*	*Print View Consistency, Page 38.*
	BPMS 12-5	*Page View Consistency, Page 38.*

13. Multiple Workbooks

BPMS 13-1 External Workbook Imports

All *links* from an external *workbook* into a *workbook* should be made via dedicated and separate *import sheets*.

Related Standards:	*BPMS 13-2*	*External Workbook Exports, Page 39.*
	BPMS 13-3	*Workbook Output Links, Page 39.*
Related Conventions:	*BPMC 13-1*	*Workbook-Specific Import and Export Sheets, Page 55.*
	BPMC 13-2	*Import and Export Sheet Consistency, Page 55.*
	BPMC 13-3	*No Complex Formulas on Import Sheets, Page 56.*
	BPMC 13-4	*Import and Export Sections, Page 56.*
	BPMC 13-5	*Multiple Workbook Diagrams, Page 56.*

BPMS 13-2 External Workbook Exports

All *links* to an external *workbook* from a *workbook* should be made via dedicated and separate *export sheets*.

Related Standards:	*BPMS 13-1*	*External Workbook Imports, Page 38.*
	BPMS 13-3	*Workbook Output Links, Page 39.*
Related Conventions:	*BPMC 13-1*	*Workbook-Specific Import and Export Sheets, Page 55.*
	BPMC 13-2	*Import and Export Sheet Consistency, Page 55.*
	BPMC 13-3	*No Complex Formulas on Import Sheets, Page 56.*
	BPMC 13-4	*Import and Export Sections, Page 56.*
	BPMC 13-5	*Multiple Workbook Diagrams, Page 56.*

BPMS 13-3 Workbook Outputs Links

All *formulas* on an *export worksheet* should always be linked directly to the *workbook* calculations.

Content on an *export worksheet* should never be moved from one *workbook* to another *workbook* in a manner (e.g. copied and pasted as values) which creates static data that will not change when changes are made to the *workbook* from which the *data* originated.

Related Standards:	*BPMS 13-1*	*External Workbook Imports, Page 38.*
	BPMS 13-2	*External Workbook Exports, Page 39.*

14. Security and Protection

Related Conventions:	*BPMC 14-3*	*Sheet and Cell Protection, Page 56.*

15. Visual Basic Programming

Related Conventions:	*BPMC 15-1*	*Recording Macros, Page 57.*

16. Miscellaneous

BPMS 16-1 Automatic Calculation Setting

A *workbook* should, where feasible, be set to calculate automatically.

Best Practice Spreadsheet Modeling Conventions

There are currently 68 universally applicable Best Practice Spreadsheet Modeling Standards and 72 Conventions, grouping into the following Spreadsheet Modeling Areas:

Number	Spreadsheet Modeling Area
1	General Concepts
2	Workbook Structure
3	Sheet Structure
4	Formats and Styles
5	Assumptions Entry Interfaces
6	Sensitivity Analysis
7	Outputs and Presentations
8	Calculation Formulas
9	Naming Principles
10	Time Series Analysis
11	Checks
12	Printing and Viewing
13	Multiple Workbooks
14	Security and Protection
15	Visual Basic Programming
16	Miscellaneous

The following pages detail each Best Practice Spreadsheet Modeling Convention.

1. General Concepts

BPMC 1-1 Sheet Types

It is recommended that the eight basic *sheet types* stated in BPMS 1-3 Sheet Content, be further sub-divided into 10 different *sheet types* as follows:

a. Cover sheet

b. Contents sheet

c. Section cover sheet

d. Schematics sheet

e. Time series sheet

   i) Time series assumptions sheet

   ii) Time series outputs sheet

f. Blank sheet

   i) Blank assumptions sheet

   ii) Blank outputs sheet

g. Lookups sheet

h. Chart sheet

These categories are exhaustive, and should be the only *sheet* types required to develop any form of *workbook*.

Related Standards:	*BPMS 1-2*	*Sheet Classification, Page 26.*
	BPMS 1-3	*Sheet Content, Page 26.*
	BPMS 1-4	*Sheet Purpose, Page 27.*

BPMC 1-2 Sheet Purpose Identification

It is recommended that the purpose of every *sheet* in a *workbook* be identified using its *fill color* property as follows:

a. Light grey *fill color* for *assumptions sheets*; and

b. White / No *fill color* for *outputs sheets*.

Related Standards:	*BPMS 1-4*	*Sheet Purpose, Page 27.*
Related Conventions:	*BPMC 1-1*	*Sheet Types, Page 41.*

BPMC 1-3 Cell Content Identification

It is recommended that the content of every *cell* in a *worksheet* be identified using its *font color* property as follows:

a. Blue *font color* for *constants*;

b. Black *font color* for *formula*; and

c. Green *font color* for mixed (combination of *constant* and *formula*).

Related Standards:	*BPMS 1-6*	*Cell Content, Page 27.*
Related Conventions:	*BPMC 1-4*	*Cell Purpose Identification, Page 42.*

BPMC 1-4 Cell Purpose Identification

It is recommended that the purpose of every *cell* in a *worksheet* be identified using its *fill color* property as follows:

a. White / No *fill color* for *assumption cells* on (grey *fill color*) *assumptions sheets*; and

b. *Fill color* the same as the *fill color* of the applicable *worksheet* for *output cells*.

Related Standards:	*BPMS 1-7*	*Cell Purpose, Page 27.*
Related Conventions:	*BPMC 1-3*	*Cell Content Identification, Page 42.*

BPMC 1-5 Mixed Cell Exceptions

It is recommended that the following *constants* be disregarded for the purposes of classifying a *cell* as having *mixed* content:

a. '1';

b. '0';

c. 'TRUE'; and

d. 'FALSE'.

Related Standards:	*BPMS 1-6*	*Cell Content, Page 27.*
Related Conventions:	*BPMC 1-3*	*Cell Content Identification, Page 42.*

2. Workbook Structure

BPMC 2-1 Workbook Section Structure

It is recommended that every *workbook* be structured consistently to at least include the following *sections*:

a. *Cover* and Contents;

b. Model Documentation and Diagrams (where relevant);

c. *Assumptions*;

d. *Outputs*;

e. *Presentations* (where relevant); and

f. *Appendices* (where relevant).

Related Standards:	*BPMS 2-2*	*Workbook Sections, Page 28.*
	BPMS 2-3	*Section Cover Covers, Page 28.*

3. Sheet Structure

BPMC 3-1 Sheet Content Consistency

It is recommended that every *sheet* of the same *sheet type* in a *workbook* consistently apply the following properties:

a. Sheet title style and *position*;

b. *Heading styles* and spacing;

c. Purpose-based *formats* and *styles*;

d. *Hyperlink positions* and *styles*;

e. Zoom/scaling percentage of the visible and printed *sheets*;

f. Visibility of gridlines;

g. *Grouping levels*; and

h. Window panes/splits.

Related Standards:	*BPMS 3-1*	*Sheet Titles, Page 30.*
	BPMS 3-2	*Sheet Type Consistency, Page 30.*
	BPMS 3-3	*Grouping Rows or Columns, Page 30.*

BPMC 3-2 Hyperlinks in Worksheets

It is recommended that every *worksheet*, where relevant, contain the following *hyperlinks*:

a. Sheet left *hyperlink* (to move to the *worksheet* to the left);

b. Sheet right *hyperlink* (to move to the *worksheet* to the right);

c. Sheet top *hyperlink* (to move to the top of the *worksheet*);

d. Error check *hyperlink* (to move to the workbook *error checks summary*);

e. Sensitivity check *hyperlink* (to move to the workbook *sensitivity checks summary*);

f. Alert check *hyperlink* (to move to the workbook *alert checks summary*).

It is recommended that all of these *hyperlinks* be in view on the screen at all times.

Related Standards:	*BPMS 2-6*	*Workbook Navigation, Page 29.*
	BPMS 3-2	*Sheet Type Consistency, Page 30.*

BPMC 3-3 No Chart Sheets

To ensure *hyperlink* access to all the *sheets* within a *workbook*, it is recommended that charts be placed within *worksheets* rather than using *chart sheets*.

This convention does not apply to spreadsheet applications which allow chart sheets to contain hyperlinks and to be specified as the target of hyperlinks.

Related Standards:	*BPMS 2-6*	*Workbook Navigation, Page 29.*

BPMC 3-4 Workbook Cover Sheet Content

It is recommended that the *cover sheet* of a *workbook* contain the following information:

a. The model name;

b. The model developer's name and contact details (if appropriate); and

c. Workbook cover sheet notes.

Related Standards:	*BPMS 2-1*	*Workbook Cover Sheet, Page 28.*
Related Conventions:	*BPMC 3-5*	*Workbook Cover Sheet Notes, Page 45.*

BPMC 3-5 Workbook Cover Sheet Notes

It is recommended that the *cover sheet* of a *workbook* include provision for *notes* that are in view and in a consistent *location*.

Cover sheet notes should include:

a. A description of the contents of the underlying *workbook*;

b. Instructions for *model users* or *developers*; and/or

c. Warnings for *model users* or *developers*.

Related Standards:	*BPMS 2-1*	*Workbook Cover Sheet, Page 28.*
Related Conventions:	*BPMC 3-4*	*Workbook Cover Sheet Content, Page 44.*

BPMC 3-6 Section Cover Sheet Content

It is recommended that every *section cover sheet* in a *workbook* contain the following information:

a. A *title* for the following section;

b. The section number for the following *section*;

c. *Section cover sheet notes*; and

d. The *model name*.

This information should be consistently *formatted* and *positioned* on all *section cover sheets* in the *workbook*.

Related Standards:	*BPMS 2-2*	*Workbook Sections, Page 28.*
Related Conventions:	*BPMC 3-7*	*Section Cover Sheet Notes, Page 45.*

BPMC 3-7 Section Cover Sheet Notes

It is recommended that *section cover sheets* within a *workbook* include provision for *notes* that are in view and in a consistent *location*.

Section cover sheet notes should include:

a. A description of the contents of the underlying *section*;

b. Instructions for *model users* or *developers*; and/or

c. Warnings for *model users* or *developers*.

Related Standards:	*BPMS 2-3*	*Section Cover Covers, Page 28.*
Related Conventions:	*BPMC 3-6*	*Section Cover Sheet Content, Page 45.*

BPMC 3-8 Limiting Worksheet Depth

It is recommended that the number of *rows* utilized on any worksheet be limited, where feasible, to what can be seen on the screen without vertical scrolling.

It is recommended that the number of *rows* utilized on any one *worksheet* be limited to the minimum possible. To reduce the depth of a *worksheet* where there is an unavoidably large amount of information it is recommended that:

a. *Rows* are grouped and collapsed; or

b. Different types of information be moved to new *worksheets* (splitting the *worksheet* information).

BPMC 3-9 Freezing Panes

It is recommended that *frozen panes* be used on every *worksheet* in a *workbook* (excluding *cover sheets*) to ensure that the *sheet title*, any *hyperlinks*, check indicator flags or periodicity and time titles are always in view.

Related Standards:	*BPMS 2-6*	*Workbook Navigation, Page 29.*
	BPMS 3-1	*Sheet Titles, Page 30.*
	BPMS 3-2	*Sheet Type Consistency, Page 30.*

BPMC 3-10 Grouping Levels

It is recommended that *rows* and *columns* within the *worksheets* in a *workbook* be grouped consistently across all *worksheets* to create the following three views:

a. *Summary view* (compacted);

b. *Print view* (semi-compacted, if required); and

c. *Expanded view* (un-compacted).

Related Standards:	*BPMS 3-2*	*Sheet Type Consistency, Page 30.*
	BPMS 3-3	*Grouping Rows or Columns, Page 30.*

BPMC 3-11 Heading Indentation

It is recommended that headings within a *workbook* are consistently indented using different columns that visually communicate the appropriate level of emphasis or importance that should be attached to each *heading*.

Related Standards:	*BPMS 3-2*	*Sheet Type Consistency, Page 30.*
Related Conventions:	*BPMC 3-1*	*Sheet Content Consistency, Page 43.*

4. Formats & Styles

BPMC 4-1 Use of Purpose-Based Styles

It is recommended that standardized, purpose based *styles* be applied in order to adopt the most efficient method of applying different combinations of *formats* and consistently identify and differentiate *cell purpose* and *cell content*.

Related Standards: *BPMS 4-1* *Formats and Styles Key, Page 31.*

BPMC 4-2 Cell Data Alignment

It is recommended that all *data* within *cells* or *ranges* of *cells* be aligned such that different number *formats*, including any relevant symbols are perfectly aligned to the right of the *cell* or *cell range* (different number *formats* might include positive numbers, negative numbers, currency, percentages and multiples).

Related Standards: *BPMS 4-2* *Worksheet Data Alignment, Page 31.*

BPMC 4-3 Work in Progress Identification

It is recommended that any *cells* in a *workbook* which have not been finalized be colored in light yellow *fill color* to visually identify these cells as being work in progress.

Related Standards: *BPMS 4-6* *Work in Progress, Page 31.*

BPMC 4-4 Hyperlink Formats

It is recommended that all *hyperlinks* in a *workbook* be consistently *formatted* as follows:

a. Bold and underlined font; and

b. Plum *font color*.

Related Standards: *BPMS 4-5* *Hyperlink Consistency, Page 31.*

5. Assumptions Entry Interfaces

BPMC 5-1 Preventing Invalid Assumption Entries

It is recommended that *controls*, *data validation* and *sheet protection* be used to limit the scope for *model users* to enter invalid *assumptions* into *assumptions sheets*.

Related Conventions: *BPMC 5-2* *Assumptions Entry Interfaces, Page 48.*
BPMC 5-6 *Use of Check Box Controls, Page 49.*
BPMC 5-7 *Use of Button Controls, Page 49.*
BPMC 5-8 *Use of Drop Down Box or List Box Controls, Page 49.*
BPMC 5-9 *Use of Spin Button or Scroll Bar Controls, Page 49.*
BPMC 5-10 *Data Validation, Page 49.*

BPMC 5-2 Assumptions Entry Interfaces

It is recommended that every *assumption* in a *workbook* that has a finite number of entry possibilities should use an *assumptions entry interface* that limits the *model user* to only those finite entry possibilities.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*
	BPMC 5-10	*Data Validation, Page 49.*

BPMC 5-3 Controlling Assumptions Entry Interfaces

It is recommended that combinations of the following tools be used to limit *assumptions entry interfaces* to finite possibilities:

a. *Controls;*

b. *Data validation;*

c. *Error checking;*

d. *Conditional formatting*; and

e. *Sheet protection*.

Related Conventions:	*BPMC 5-2*	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-6	*Use of Check Box Controls, Page 49.*
	BPMC 5-7	*Use of Button Controls, Page 49.*
	BPMC 5-8	*Use of Drop Down Box or List Box Controls, Page 49.*
	BPMC 5-9	*Use of Spin Button or Scroll Bar Controls, Page 49.*
	BPMC 5-10	*Data Validation, Page 49.*

BPMC 5-4 No Heading, Title or Label Repetition

It is recommended that, where feasible, no *heading, title* or *label* that is inserted into a *workbook* be entered more than once. All identical *headings, titles* and *labels* that are contained in a *workbook* should be linked to the base *heading, title* or *label* that was entered.

BPMC 5-5 Control Cell Link Range Names

It is recommended that control *cell link* ranges be named to indicate the type of control to which the cell link relates.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-6 Use of Check Box Controls

It is recommended that a *check box* be used in a *workbook* when the *assumption* entry is *binary* (or *Boolean*).

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-7 Use of Button Controls

It is recommended that a *button* be used in a *workbook* only when a *macro* needs to be assigned to a *control*.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-8 Use of Drop Down Box or List Box Controls

It is recommended that a *drop down box* or *list box* be used in a *workbook* when there are a definite and limited number of possible *assumption* entries.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-9 Use of Spin Button or Scroll Bar Controls

It is recommended that a *spin button* or *scroll bar* be used in a *workbook* when an *assumption* entry is in the form of a numbered sequence that has upper and lower bounds.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-10 Data Validation

It is recommended that *data validation* be used to:

a. Inform *model users* about the *assumption* entries required;

b. Control the type of *data* being entered into *assumption cells*; and/or

c. Set the minimum and maximum bounds of the *assumptions* that are entered.

Data validation should be used when the type of *assumption* entry is known, but the use of *controls* is not suitable.

Related Conventions:	*BPMC 5-1*	*Preventing Invalid Assumption Entries, Page 47.*
	BPMC 5-2	*Assumptions Entry Interfaces, Page 48.*
	BPMC 5-3	*Controlling Assumptions Entry Interfaces, Page 48.*

BPMC 5-11 Conditional Formatting of Assumption Cells

It is recommended that *conditional formatting* be used to indicate to model users which *assumption cells* are inactive at any point in time – i.e. not relevant to output calculations.

BPMC 5-12 Visual Identification of Inactive Assumptions

It is recommended that an *assumption cell* that is currently irrelevant for *outputs* as a consequence of a prevailing *assumption* in another *assumptions entry interface* be visually identifiable as being an *inactive assumption cell* using grey *fill color* and white *font color*.

6. Sensitivity Analysis

BPMC 6-1 Sensitivity Assumptions Entry Interface Structure

It is recommended that, to the extent that it is practical, any *sensitivity assumptions entry interface* in a *workbook* be structured consistently with its corresponding *base assumptions entry interface*.

Related Standards: *BPMS 6-1* *Separate Sensitivity Assumptions Sheets, Page 32.*

7. Outputs & Presentations

BPMC 7-1 Separate Outputs Workbooks

It is recommended that separate, dedicated *outputs workbooks* be created for medium to large *workbooks* or where the *model developer* does not want to divulge certain *workbook content* to certain *model users*.

Related Standards: *BPMS 7-1* *Segregation of Outputs, Page 33.*

BPMC 7-2 Outputs Section Structure

It is recommended that, where feasible, the *outputs sections* within a *workbook* be structured consistently with their corresponding *assumptions sections*.

Related Standards: *BPMS 7-1* *Segregation of Outputs, Page 33*

BPMC 7-3 Outputs Worksheet Summaries

It is recommended that, where feasible, a summary of the primary *outputs* on each *outputs worksheet* be provided at the top of the *outputs worksheet*.

It is recommended that an *outputs worksheet* is structured in the following order, going down or across the worksheet:

a. *Outputs* summary (primary *outputs* only); then

b. *Outputs* calculations (including details).

8. Calculation Formulas

BPMC 8-1 Avoid Complex Formulas

It is recommended, where feasible, that *complex formulas* not be used within a *workbook*.

BPMC 8-2 Complex Formula schematics

It is recommended, where feasible, that complex *formulas* within a *workbook* be explained through the creation of *Formula schematics* (diagrams representing *formula* logic) that are placed in a separate *schematics section* of the *workbook*.

BPMC 8-3 Multiple Function Formulas

It is recommended that *formulas* within a *workbook* that contain more than one *function* be separated within the *formula* such that each new *function* is displayed on a separate line of the formula bar.

BPMC 8-4 No Repeated Calculations

It is recommended that, where feasible, a calculation should be performed only once, with dependent calculations referring back to this single instance.

9. Naming Principles

BPMC 9-1 Workbook Name Display

It is recommended that every *workbook* has a name and that the name correspond with the file name.

It is recommended that every *worksheet* in the *workbook* displays the *model name* (in addition to the *sheet title*) and that the *model name* is consistently *formatted* and located.

Related Standards: BPMS 9-1 Workbook Naming, Page 34.

BPMC 9-2 File Name Visibility

It is recommended that the file name for every *workbook* is contained within the header or footer of each *sheet* in the *workbook*.

BPMC 9-3 Sheet Type Naming Suffixes

It is recommended that the following *suffixes* be appended to *sheet tab* names to indicate the type of *sheet* that is being named:

Sheet Type	Suffix
a) Cover sheet	Cover
b) *Contents sheet*	Contents
c) *Section cover sheet*	SC
d) *Schematics sheet*	MS
e) Time series sheet	
i) *Time series assumptions sheet*	TA
ii) *Time series outputs sheet*	TO
f) *Blank sheet*	
i) *Blank assumptions sheet*	BA
ii) *Blank outputs sheet*	BO
g) *Lookups sheet*	LU
h) *Chart sheet*	CHT

These *suffixes* are exhaustive and, other than *secondary sheet naming suffixes*, should be the only *sheet* naming *suffixes* required when naming *sheets*.

BPMC 9-4 Secondary Sheet Naming Suffixes

In addition *sheet type naming suffixes*, it is recommended that the following suffixes be appended to any *sheet tab* names to indicate any of the following sub-classifications of the *sheet*:

Sheet Sub-Classification	Secondary Suffix
a) Import	MI
b) *Export*	ME
c) *Presentation*	P

These secondary sheet naming suffixes should be appended prior to appending the applicable *sheet type naming suffix*.

BPMC 9-5 Sheet Naming Key

Where the *sheet* naming *prefixes* or *suffixes* are used in a *workbook*, it is recommended that a key or legend that explains the *sheet* naming *prefixes* or *suffixes* also be included in the *workbook*.

Related Conventions: *BPMC 9-3* *Sheet Type Naming Suffixes, Page 52.*
BPMC 9-7 *Range Naming Key, Page 53.*

BPMC 9-6 Range Naming Prefixes

It is recommended that the following *prefixes* be used when naming *ranges* to indicate the type of *range* that is being named or the purpose of that *range*:

Range Type	Naming Prefix	Range Description / Purpose
Row Array	RA_	Single *row*, multiple *column*, single area array
Column Array	CA_	Single *column*, multiple *row*, single area array
Block Array	BA_	Single area, multiple *cell*, non-*row*, non-*column* array
Multiple Area Array	MAA_	Multiple area (includes areas of any type)
Base Cell	BC_	Single *cell* base *cell* (for OFFSET *function* reference, etc)
Lookup Array	LU_	Names a *Lookup Table Array* on a *Lookups Sheet*
Hyperlink Cell Reference	HL_	*Hyperlink cell reference*
Check Box Cell Link	CB_	*Check box cell link*
Drop Down Box Cell Link	DD_	*Drop down box cell link*
List Box Cell Link	LB_	*List box cell link*
Option Button Cell Link	OB_	*Option button cell link*
Spin Button Cell Link	S_	*Spin button cell link*
Scroll Bar Cell Link	SB_	*Scroll bar cell link*
Residual	N/A	Residual category (i.e. single *cell* non-base *cells*, etc.)

This list of *range* naming *prefixes* is exhaustive, and should be the only *range* naming *prefixes* required when naming *cells*, *cell ranges* or *control cell links*.

BPMC 9-7 Range Naming Key

Where *range* naming *prefixes* are used in a *workbook*, it is recommended that a key or legend that explains the *range* naming *prefixes* also be included in the *workbook*.

Related Conventions: *BPMC 9-5* *Sheet Naming Key, Pageon page 52.*

BPMC 9-8 Range Naming Conflicts

Where a *worksheet range* qualifies for more than one *range* naming *prefix* under BPMC 9-6, the *prefix* derived from the purpose of the *range* should be used when naming the *range*, not the *prefix* derived from its type.

Related Conventions: *BPMC 9-6* *Range Naming Prefixes, Page 52.*

10. Time Series Analysis

BPMC 10-1 Time Series Constants

It is recommended that every *workbook* that undertakes *time series analysis* contains time constants (e.g. months in year, days in week, weeks in year).

Related Standards: *BPMS 10-1* *Time Series Assumptions, Page 34.*

BPMC 10-2 No Mixing of Periodicities

It is recommended that, where feasible, a *time series sheet* never contains *assumptions* or *outputs* for more than one *periodicity*.

Related Standards: *BPMS 10-1* *Time Series Assumptions, Page 34.*

BPMC 10-3 Multiple Periodicities in One Workbook

It is recommended that no *section* in a *time series workbook* contains more than one *periodicity*.

BPMC 10-4 Time Series Data Direction

It is recommended, that where feasible, *periodicity* labels be *positioned* across *rows*, not down *columns*.

11. Checks

BPMC 11-1 Linking Checks to Model Name Entry Cell

It is recommended, that where relevant, the outcome of the *check type* summary cell referred to in BPMC 11-4 be linked to the *model name* entry *cell* on the *workbook cover sheet*.

Related Standards: *BPMS 11-8* *Check Indicator Flag, Page 37.*

BPMC 11-2 Check Cell Conditional Formatting

It is recommended that every *check cell* in a *workbook* be consistently *formatted* such that, when triggered, they appear formatted as follows:

a. Bold font; and

b. Red *font color*.

Related Standards: *BPMS 11-9* *Check Cell Formatting, Page 37.*

BPMC 11-3 Check Calculation Location

It is recommended that the calculations for *checks* be *located* on the *sheet* to which the *check* is relevant and not on the associated *check sheet*.

BPMC 11-4 Check Type Summary Cell

It is recommended that the outcome of all *checks* of each *check type* be summarized into a single *check cell* for each *check type* contained within a *workbook*.

Related Conventions: *BPMC 11-1* *Linking Checks to Model Name Entry Cell, Page 54.*

12. Printing & Viewing

BPMC 12-1 Workbook Print Scaling

It is recommended that, where feasible, the *print scaling* for every *sheet* in a *workbook* should be set to 100%, where possible, to ensure clarity and consistency when printing and viewing a printed copy of the *workbook*.

Related Standards: *BPMS 12-4* *Print View Consistency, Page 38.*

BPMC 12-2 Printed Information

It is recommended that every printed page include the following information:

a. The date and time that the page was printed;

b. The name of the *workbook*;

c. The name of the *sheet;* and

d. The page number.

13. Multiple Workbooks

BPMC 13-1 Workbook-Specific Import and Export Sheets

It is recommended that, where feasible, a separate *import* and *export sheet* be created for each external *workbook* that a *workbook links* from and to.

Related Standards: *BPMS 13-1* *External Workbook Imports, Page 38.*
BPMS 13-2 *External Workbook Exports, Page 39.*

BPMC 13-2 Import and Export Sheet Consistency

It is recommended that the *import sheet* in one *workbook* be structured in exactly the same way as the corresponding *export sheet* in the relevant linked *workbook*.

Related Standards: *BPMS 13-1* *External Workbook Imports, Page 38.*
BPMS 13-2 *External Workbook Exports, Page 39.*

BPMC 13-3 No Complex Formulas on Import Sheets

It is recommended that, where feasible, *functions* not be included within *formulas* that contain *links* to external *workbooks*.

Related Standards:	*BPMS 13-1*	*External Workbook Imports, Page 38.*
	BPMS 13-2	*External Workbook Exports, Page 39.*

BPMC 13-4 Import and Export Sections

It is recommended that *import* and *export sheets* be placed in separate, dedicated *sections* of a *workbook*.

Related Standards:	*BPMS 13-1*	*External Workbook Imports, Page 38*
	BPMS 13-2	*External Workbook Exports, Page 39*

BPMC 13-5 Linked Workbook Diagrams

It is recommended that whenever there are more than two *workbooks linked* to each other in a *workbook* group, that a diagram be created within each *workbook* showing the *links* between the group of *linked workbooks*.

Related Standards:	*BPMS 13-1*	*External Workbook Imports, Page 38.*
	BPMS 13-2	*External Workbook Exports, Page 39.*

14. Security & Protection

BPMC 14-1 Workbook Protection

It is recommended that *workbook protection* be used whenever a *model developer* is required to:

a. Control access to a *workbook*;

b. Control access to designated *sheets* within a *workbook*; and/or

c. Prevent structural changes being made to a *workbook*.

BPMC 14-2 Protection of Non-Assumptions

Security and *protection* tools should be used to ensure that only the *assumptions* components of a *workbook* are capable of manipulation by *model users*.

BPMC 14-3 Sheet and Cell Protection

It is recommended that every *cell* in a *workbook* that is not an *assumption cell* be *protected* (locked) prior to distribution of the *workbook* to *model users*.

For this *cell protection* to operate effectively, every *sheet* in the *workbook* must be *protected*.

BPMC 14-4 No Unnecessary Passwords

It is recommended that unless the *model developer* does not want *model users* to access certain areas of a *workbook* when *protecting* a *worksheet* or *workbook*, that no password be applied.

BPMC 14-5 Storing Passwords

It is recommended that when applying *workbook* or *worksheet protection* using passwords, that a password list be printed and stored in a safe location for future reference.

15. Visual Basic Programming

BPMC 15-1 Recording Macros

It is recommended that only extremely simple *macros* be created using the *macro* recorder. *Macros* created using the *macro* recorder should not be relied upon by *model developers* who are not familiar with the resulting source code.

Macros should only be written by experienced VBE programmers.

16. Miscellaneous

BPMC 16-1 Model Developer Identification

It is recommended that the name of the *model developer* is entered into the *workbook* (normally on the *cover sheet,* if applicable).

BPMC 16-2 Emphasizing Information

It is recommended that you create and consistently apply various levels of *headings* in a *workbook* that visually communicate the appropriate level of emphasis or importance that should be attached to each *cell* or *range* of *cells*.

BPMC 16-3 Help Files and Instructions

It is recommended that every *workbook* be accompanied by instructions that explain the following for both *model users* and future *model developers*:

a. What the primary *outputs* are;

b. What the primary *assumptions* are;

c. How to use the *workbook* or group of *workbooks*; and

d. Any other relevant *notes* or commentary.

Chapter 1

General Concepts

1.1 Clarity of Purpose

Best practice spreadsheet modeling centers around purposed-based spreadsheet model development. Purpose-based spreadsheet model development refers to the development of a spreadsheet model with a clear understanding of its underlying purpose at all times, and ensuring that this purpose is clearly communicated to any party who comes into contact with the spreadsheet model.

Clarity of purpose should be the underlying consideration at every stage of the spreadsheet model development process, and should therefore be taken into account even before the spreadsheet model construction process commences. In this regard, the model developer must consider:

a. The ultimate purpose of the workbook (or group of linked workbooks);

b. The purpose of each sheet; and

c. The purpose of each component within each sheet.

Once understood, the spreadsheet model must then be constructed in a way that clearly communicates this purpose to other model developers and users of the model.

BPMS 1-1 Workbook Purpose

The purpose of a *workbook* should be the primary consideration of a *model developer* during every stage of a *workbook*'s development. The purpose of a workbook can be universally segregated into three levels as follows:

a) The purpose of the *workbook*;

b) The purpose of each *sheet*; and

c) The purpose of each component within each *sheet*.

Purpose should always be ascertained from a model user's perspective, not a model developer's perspective. It is the model users that will enter assumptions into the spreadsheet model and analyze the resulting outputs, not the model developer.

For larger spreadsheet models, many workbook construction decisions will need to be made by the model developer before and during the model development process. When making these decisions, it is important that the purpose(s) of the spreadsheet model remain the primary consideration.

These decisions are many and varied and may include areas such as:

a. The separation of different model components into several workbooks;

b. The layout of sheets within a workbook; and

c. The structure of an assumptions entry interface on a worksheet.

The amalgamation of the many factors that are often involved in developing spreadsheet models can become overwhelming for model developers. This can result in spreadsheet models that lack focus and clarity of purpose. By focusing on purpose at each stage of the development process, the model developer will develop spreadsheet models that fulfil the needs of both model users and other model developers.

The following diagram shows how a model developer may be required to communicate workbook purpose to a large number of other model developers and model users.

The importance and benefits of clarity of purpose increase exponentially with the number of parties expected to come into contact with the spreadsheet model.

1.2 Purpose-Based Formatting

The nature of spreadsheets is such that it is possible to represent very large amounts of information of many different types within a small space (i.e. sheets within a workbook). As such, there is considerable scope for both model developers and model users to lose track of all of the information that can be contained within a spreadsheet model. It is therefore important that model developers construct spreadsheet models so that the information contained within them is efficiently communicated to model users (particularly with large spreadsheet models).

Best practice spreadsheet modeling seeks to ensure that model developers and model users can interpret and use the information within a workbook in the most efficient manner possible. This is best achieved through the use of purpose-based formatting.

Purpose-based formatting of workbooks involves the consistent use of distinct formats to clearly and logically distinguish the different components of a workbook and its worksheet ranges by purpose (and often also by content). Hence, there are two main objectives of purpose-based formatting:

a. To distinguish sheet types; and

b. To distinguish worksheet cell ranges.

Before discussing the standards and conventions relating to the application of purpose-based formatting to sheets and worksheet ranges, it is important to understand the concept of *assumptions* versus *non-assumptions*.

1.3 Assumption Classification

The difference between *assumptions* and *non-assumptions* is the most critical concept when distinguishing between sheet types and classifying cells within worksheets.

The term 'assumption' is commonly used throughout the spreadsheet modeling community to refer to the numbers or data that are entered into a workbook to form the basis for the workbook calculations. However, assumptions can take any number of forms within a workbook. An assumption could be a number in a cell, a control, a macro-based dialog box entry, a date or even text such as headings, labels or names. Furthermore, there are many hard-coded headings, labels, numbers or data that are entered into a workbook that the model developer does not intend model users to modify and would therefore not be considered to be assumptions. Hence it is necessary to define the term assumption to more accurately reflect its purpose-based nature.

Because assumptions are commonly understood to be the driving force behind the workbook calculations that result in the outputs that are required by model users, the definition of assumptions should be based on model users manipulating the 'driving force' behind the outputs of a workbook. Therefore an *assumption* is defined as being:

- Anything within a workbook that the model developer intends to be manipulated by model users to affect the workbook calculations.

This definition allows for the idea of there being two types of entry into a workbook, as follows:

a. Entries that are intended to be manipulated by model users (Assumptions); and

b. Entries that are not intended to be manipulated by model users (Non-Assumptions).

Hence, this definition of *assumptions* creates two exhaustive types of entry into a workbook:

a. Assumptions; and

b. Non-Assumptions.

Every component of a spreadsheet model can be categorized as either an *assumption* or a *non-assumption*, with non-assumptions commonly being referred to as simply 'Outputs'.

Base Assumptions vs. Sensitivity Assumptions

A further consideration in defining assumptions is that the model developer should differentiate assumptions that are used to derive the *base case outputs* from assumptions that are entered for the purposes of *sensitivity analysis* (discussed in detail in Spreadsheet Modeling Area 6. Sensitivity Analysis).

In accordance with the above definition of *assumptions*, both forms of entry (base and sensitivity) into a workbook are assumptions, but it is important that model developers and model users can clearly differentiate between these two types of assumptions.

These two types of assumptions are defined as follows:

- *Base Assumptions* are assumptions that are used as a basis for calculating base case outputs (i.e. outputs that do not include the impacts of sensitivity assumptions); and

- *Sensitivity Assumptions* are assumptions that supplement or over-write base case assumptions to calculate sensitivity case outputs (i.e. outputs that include the impacts of both base assumptions and sensitivity assumptions).

As such, the terms *base assumptions* and *sensitivity assumptions* should be used to clearly distinguish between these two types of assumptions. This classification is exhaustive – i.e. all assumptions must be classified as either base or sensitivity in nature. A more detailed commentary in relation to sensitivity analysis is provided in Chapter 6. Sensitivity Analysis on page 151.

Assumptions Classification Summary

It can now be seen that the assumptions classification process involves 2 steps with the second step requiring the sub-classification of assumptions into *base assumptions* and *sensitivity assumptions*. This classification process is summarized below in BPMS 1-5.

BPMS 1-8 Assumption Classification

An *assumption* is defined as anything within a *workbook* that is intended to be manipulated by *model users* to affect *outputs*.

Every *assumption* in a *workbook* must be classified as one of the following types:

a. *Base assumption*; or

b. *Sensitivity assumption*.

This classification process should be applied to every component of every spreadsheet model.

1.4 Sheet Classification

In the same way as cells are classified and identified so that model developers and users are provided with visual information as to their purpose and content (see page 67, Cell Classification), each sheet within a workbook should also be classified and identified as having a distinct purpose and content.

The sheet classification is summarized below:

- *Sheet Content* relates to the type of information that is contained within the sheet;
- *Sheet Purpose* relates to whether or not assumptions will be entered into the sheet. As such, every sheet in the workbook can be classified as having one of two mutually exclusive and exhaustive *purposes*:

  1. Contains assumptions (Assumptions Sheet); or

  2. Does not contain assumptions (Outputs Sheet).

The sheet classification process is required by BPMS 1-2, as stated below:

BPMS 1-2 Sheet Classification

The *sheet content* and *sheet purpose* of every *sheet* in a *workbook* should be visually identifiable at all times.

The primary difference between cell classification and sheet classification is the content-based categorization. Although both cells and sheets are classified as *assumptions* or *outputs* (non-assumptions), sheet types are not classified as constant, formula or mixed according to content. Instead, the sheet content classification process results in the creation of a finite number of sheet types (differentiated by content) which should allow for every possible spreadsheet model.

Sheet Content

The first step in the sheet classification process is the determination of the *content* of the sheet. The content of a sheet refers to the type of information that it contains, with an exhaustive list provided below in BPMS 1-3:

BPMS 1-3 Sheet Content

Every *sheet* in a *workbook* should be visually identifiable as being one of the following *sheet types*:

a) Cover sheet
b) Contents sheet
c) Section cover sheet
d) Schematics sheet
e) Time series sheet
f) Blank sheet
g) Lookups sheet
h) *Chart sheet*

At the most basic level, any sheet in a workbook can only contain a finite number of different types of information, from both a model developer and model user's perspective. The following table contains an exhaustive list of sheet types designed to match any basic content identified during the first step of the sheet classification process.

Sheet Type	Content / Description
Cover	The workbook cover sheet (see Chapter 2, Workbook Structure).
Contents	Contains the workbook Table of Contents.
Section Cover	Divides workbook sections – e.g. Assumptions and Outputs sections.
Schematics	Contains model diagrams and flow charts.
Time Series	Contains time series titles for analyzing data over multiple time series periods (see Chapter 10, Time Series Analysis).
Blank	Residual category.
Lookups	Contains lookup data for use in controls/forms and in worksheet formulas.
Chart	Contains a single chart as a standalone sheet.

Note that the *blank* sheet type has been included as a residual category to ensure that every sheet in every workbook falls within one of these sheet types, thereby making the above categories exhaustive. For more information on structuring different sheet types, see Chapter 3, Sheet Structure.

Sheet Purpose

Following the determination of the content of a sheet, the model developer must then determine the *purpose* of the sheet. In this regard, sheet purpose refers to whether or not the sheet is an *assumptions sheet* or a *non-assumptions sheet* (also referred to as an *outputs sheet*).

BPMS 1-4 Sheet Purpose

Every *sheet* in a *workbook* should have the purpose of either collecting *assumptions* or not collecting *assumptions*.

Hence, every *sheet* in a *workbook* should be visually identifiable as having one of the following *sheet* purposes:

a) *Assumptions sheet*; or

b) *Outputs sheet.*

Hence, every sheet in a workbook can be classified as either an *assumptions sheet* or *non-assumptions sheet* (i.e. *outputs sheet*). In the same way as each cell is classified as either an *assumption cell* or *non-assumption cell*, assumptions sheets are sheets that contain one or more assumptions, while all other sheets are by default non-assumption/outputs sheets.

In this way, assumptions should always be located on visually identifiable assumptions sheets and non-assumptions/outputs should always be located on visually identifiable non-assumption/outputs sheets. By clearly segregating these two types of sheets, the assumptions and non-assumptions within a workbook will always be clearly separated and distinguishable to model users.

Assumptions sheets should not contain unnecessary output cells (i.e. other than simple totals and calculations required to assist in the assumption entry process) and outputs sheets should never contain any assumption cells.

Defined Sheet Types

After taking into account the *content* and *purpose* of a sheet, BPMC 1-1 recommends that each sheet in a workbook should be classified as one of the following defined sheet types which take into account both of these considerations:

BPMC 1-1 Sheet Types

It is recommended that the 8 basic *sheet types* stated in BPMS 1-3 Sheet Content, be further sub-divided into 10 different *sheet types* as follows:

a) Cover sheet

b) Contents sheet

c) Section cover sheet

d) Schematics sheet

e) Time series assumptions sheet

f) Time series outputs sheet

g) *Blank assumptions sheet*

h) Blank outputs sheet

i) Lookups sheet

j) Chart sheet

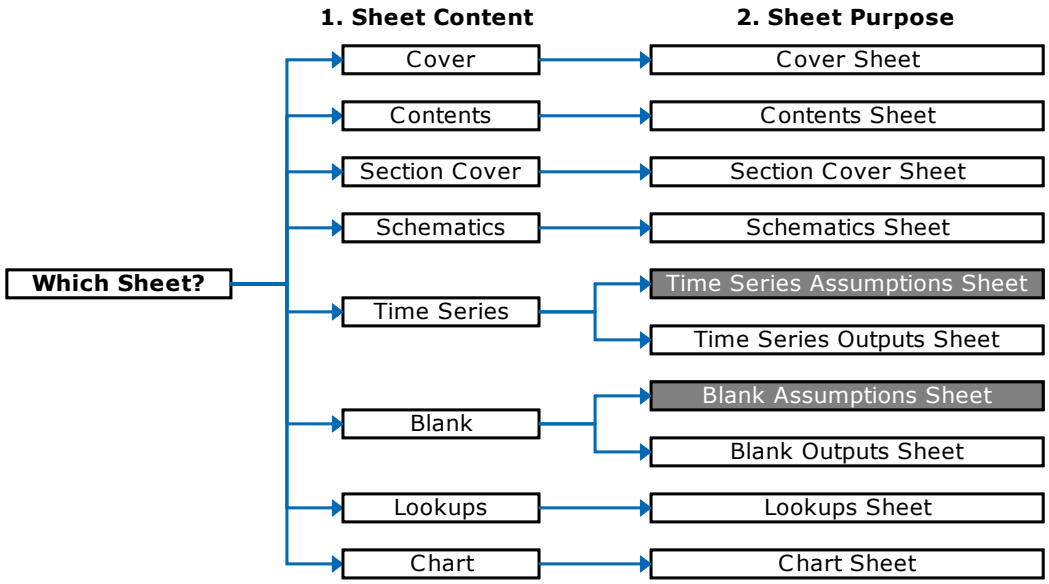
These categories are exhaustive, and should be the only *sheet* types required to develop any form of *workbook*.

Note that this convention allows for the sub-division of time series sheets and blank sheets (required by BPMS 1-3) into *assumptions* and *outputs* versions of each of these sheet types, but this is not the case for other sheet types which do not support the entering of assumptions. The ultimate result of the sheet type categorization process is summarized in the table below:

Sheet Type	Assumptions	Non-Assumptions (Outputs)
Cover	N/A	Cover Sheet
Contents	N/A	Contents Sheet
Section Cover	N/A	Section Cover Sheet
Schematics	N/A	Schematics Sheet
Time Series	Time Series Assumptions Sheet	Time Series Outputs Sheet
Blank	Blank Assumptions Sheet	Blank Outputs Sheet
Lookups	N/A	Lookups Sheet
Chart	N/A	Chart Sheet

Sheet Classification - Summary

A summary of the sheet classification process is provided in the diagram below:



This two step process should be undertaken every time a new sheet is added to a workbook, with the appropriate purpose-based formatting then applied to the sheet to indicate the classification that has been made (see 1.5 Sheet Identification).

1.5 Sheet Identification

Following the completion of the sheet classification process, the model developer must then communicate this information about the sheet to other model developers and model users. This is done through the consistent use of *purpose-based sheet formatting*.

Identifying Sheet Purpose – Fill Colors

Purpose-based sheet formatting is achieved through the use of color-coding to communicate the purpose of each sheet in a workbook. For sheet identification, it is recommended that color-coding is applied to the *fill color* (i.e. the *background color)* of sheets to clearly distinguish assumptions sheets from outputs sheets. There are two main reasons for the recommended use of fill coloring in this way:

1. Assumptions sheets and outputs sheets can immediately be distinguished; and
2. Assumption cells can immediately be distinguished on assumptions sheets because they will have a different fill color than the fill color of the sheet itself.

Color-coding of sheets based on purpose needs to be used in conjunction with the color-coding of cells within those sheets in order to achieve effective purpose-based formatting. Failing to use both of these systems together will not result in a best practice spreadsheet model because assumptions sheets and cells will not clearly be differentiated from outputs sheets and non-assumption cells.

The recommended colors to be used to differentiating assumption and non-assumptions sheets are stated in BPMC 1-2 below:

BPMC 1-2 Sheet Purpose Identification

It is recommended that the purpose of every *sheet* in a *workbook* be identified using its *fill color* property as follows:

a) Light grey *fill color* for *assumptions sheets*; and

b) White / No *fill color* for *outputs sheets*.

Although there are eight different potential sheet types listed in BPMS 1-3 (although it is recommended that this be sub-divided into 10 sheet types in BPMC 1-1, Sheet Types), only the *purpose* of each sheet needs to be distinguished using fill colors when applying purpose-based formatting – i.e. only the *assumption* or *output* purpose of the sheet need be identified. This is because from a model user's perspective, assumptions sheets require data to be entered whilst outputs (i.e. all other) sheets provide calculations and outputs analysis from the model and therefore this fundamental difference in sheet purpose must be clearly communicated.

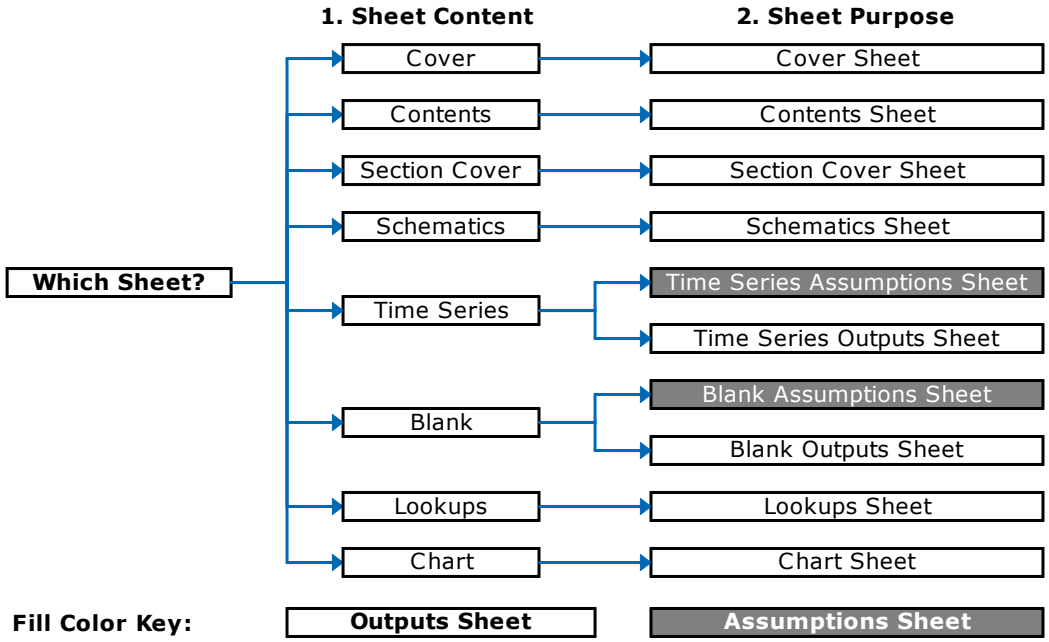
As stated above in BPMC 1-2, the following colors are recommended to distinguish assumptions sheets from outputs (non-assumption) sheets:

Sheet Purpose	Recommended Fill Color	Color Name
Assumption	Light Grey	Assumption Grey
Output	White / No Fill	N/A (None)

Hence, it is recommended that outputs sheets (including chart sheets) always have a white background/fill color (usually the default fill color of newly inserted sheets) while assumptions sheets always have a light grey (grey-25% with an RGB combination of 192 192 192 is recommended) background/fill color.

Bringing together the cell and sheet classification Standards and Conventions, creates a visual dictionary for spreadsheet models. As such, both model developers and model users will be able to efficiently interpret and understand fundamental information regarding spreadsheet model content and purpose.

A summary of the sheet content and purpose categorization process based on the recommended modeling colors is provided below. Note that the only difference between the assumptions and outputs version of each sheet type is the application of assumption grey fill / background color to the assumption version:



For more information and examples of the structuring and presentation of the different sheet types, see Chapter 3, Sheet Structure.

1.6 Cell Classification

Worksheet ranges and the cells which constitute them are the heart and soul of a spreadsheet model. They collect assumptions, perform detailed calculations and present structured outputs to model users. However, due to the fact that the values displayed in the cells of a worksheet do not always indicate the contents of the underlying cells (i.e. a large formula may simply return the value '100.0'), worksheet ranges are the also the most common source of confusion and errors on behalf of both model developers and model users.

The best way to minimize the potential confusion created by worksheet ranges is to logically classify each cell within each non-empty worksheet range according to its *content* and *purpose* (see below) and ensure that the outcome of this classification process is communicated to other model developers and model users. As discussed below in 1.7 Cell Identification, the communication of the outcome of this classification process is achieved through the use of specific *purpose-based formatting*.

Cell classification is a 2-step process involving the examination of the *content* and *purpose* of each cell. When undertaking this process, understanding the difference between the content and the purpose of a cell is fundamental. These concepts have been summarized below:

- **Cell Content** relates to the type of information or data that is contained within a cell (or range of cells). As such, every cell in a workbook can be classified as having one of three mutually-exclusive types of *cell content*:

1. *Constant* – hard-coded data;
2. *Formula* – pure formula (output calculations); or
3. *Mixed* – a combination of formula (output) and hard-coded data (constant).

- **Cell Purpose** relates to whether or not the model developer intends model users to modify the cell. As such, every cell in the workbook can be classified as having one of two mutually exclusive *cell purposes*:

  1. *Assumption* – intended to be changed by model users; or
  2. *Non-Assumption* – not intended to be changed by model users.

The cell classification standard is articulated below in BPMS 1-5:

BPMS 1-5 Cell Classification

The *cell content* and *cell purpose* of every *cell* in every *worksheet* should be visually identifiable at all times.

Understanding the difference between *cell content* and *cell purpose* and the communication of this understanding to other model developers and users is fundamental to purpose-based modeling.

Cell Content

The first step in the cell classification process is the determination of the content of the cell. The content of a cell refers to the type of data that it contains, where the term 'type' can be defined in many different ways. For spreadsheet modeling purposes, the most important information that both a model developer and model user require in terms of the 'type' of data contained within a cell is whether or not the cell contains a *constant* (i.e. a hard-coded text or value) or a *formula*. This information provides model developers and model users with the ability to identify where hard-coded entries have been made and where calculations are producing outputs within a workbook, and should be made visually identifiable as per BPMS 1-6 below:

BPMS 1-6 Cell Content

Every *cell* in every *worksheet* should be visually identifiable as containing one of the following content types:

a) *Constant*;

b) *Formula*; or

c) *Mixed* (combination of *constant* and *formula*).

As stated above in BPMS 1-6, every non-empty cell in a workbook must contain *constant*, *formula* or *mixed* content. The following table further explains these three exhaustive cell content types and provides some simple examples:

Cell	Contents	Examples	
Constant	Hard-coded, non-formula text or values of any data type.	100	Operating Costs
Formula	Formulas purely referencing other worksheet ranges / names.	= A1 + A2	=Range_Name*A1
Mixed Cell	A mixture of constants and formulas.	="Case"&A1	=IF(A1=1,"Debt","Equity")

The only discretion which the model developer may be required to use when categorizing a cell by its content is in relation to the *mixed* content type. While most content which cannot be classified as non-constant or non-formula content is clearly mixed content (such as the examples in the above table, which demonstrate string constants being concatenated with precedent range references), some content will be so close to being pure formula that mixed categorization may seem unnecessary – e.g. where the formula in the cell refers to a counter (i.e. "=IF(A1=1,A2,A3)"). In this example, the number '1' is constant content while the remainder of the cell content is pure formula cell content. In such a case, the model developer should assess the potential risks involved in not identifying the cell as containing mixed content and categorize the cell accordingly. Generally, erring on the side of conservatism is recommended – i.e. if the constant component of the cell content embedded within a formula content appears to be a non-generic reference, a *mixed* classification should be made.

Hence, BPMC 1-5 provides some recommended mixed cell exceptions which are designed to prevent the over-use of mixed content formatting (discussed below in Cell Identification):

BPMC 1-5 Mixed Cell Exceptions

It is recommended that the following *constants* be disregarded for the purposes of classifying a *cell* as having *mixed* content:

a) '1';

b) '0';

c) 'TRUE'; and

d) 'FALSE'.

Cell Purpose

Following the determination of the content of a cell, the model developer must then determine the purpose of the cell. The purpose of a cell refers to whether or not the cell is an *assumption cell* or a *non-assumptions cell*, as stated in BPMS 1-7:

BPMS 1-7 Cell Purpose

Every *cell* in every *worksheet* should have the purpose of either collecting *assumptions* or not collecting *assumptions*.

Hence, every *cell* in every *worksheet* should be visually identifiable as having one of the following *cell* purposes:

a) *Assumption cell*; or

b) *Output cell*.

As discussed in 1.3 Assumption Classification, the classification of a cell is determined by whether it is intended to be manipulated by model users. Hence, every non-empty cell in a workbook can be categorized as one of the following two alternatives:

- *Assumption cells* are intended to be manipulated/changed by model users when using the model; and
- *Non-assumption cells* are not intended to be manipulated/changed by model users when using the model.

The sub-categorization of assumptions cells into base assumption cells and sensitivity assumptions cells may also be required (as discussed in 1.3 Assumption Classification), but this sub-categorization is only relevant when segregating assumptions (see 2.1 Purpose-Based Workbook Structure) because all assumptions should be formatted consistently throughout a workbook.

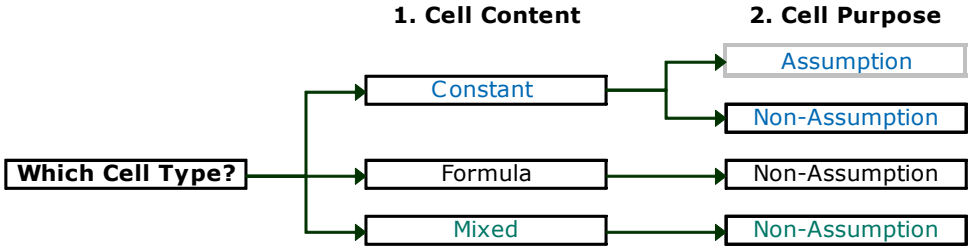
Note that as a result of the fact that assumption cells are intended to be manipulated by model users, assumption cells should always contain *constant* cell content – i.e. a model user should never be allowed to manipulate formulas within cells. This requirement is stated in BPMS 1-9 below:

BPMS 1-9 Assumption Cell Content

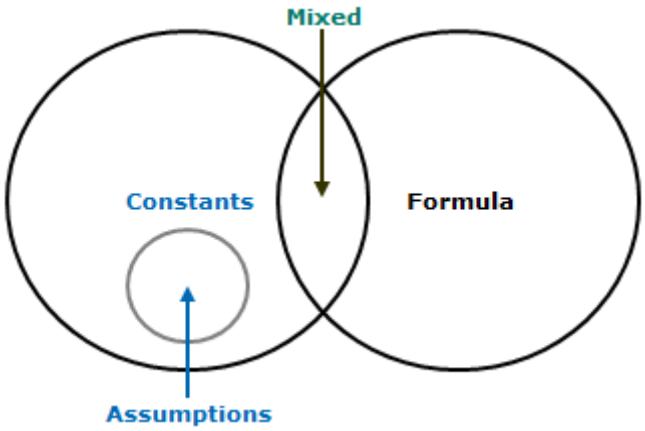
Every *assumption cell* in every *worksheet* should contain *constant* cell content.

Cell Classification - Summary

A summary of the cell classification process is provided in the diagram below:



This two-step process should be undertaken every time an entry is made into a worksheet range, with the appropriate purpose-based formatting then applied to the range to indicate the classification made (see 1.7 Cell Identification below). The following Venn diagram shows every possible cell type that can exist in a workbook, allowing for both cell content and cell purpose:



There are two important points to note in the above diagram:

a. *Assumption cells* must have *constant* cell content; and

b. Cells with *mixed* or *formula* cell content cannot be *assumptions*.

The concepts of constant, formula, and mixed cell content and assumptions versus non-assumptions are critical for a model developer to understand because they form the basis for purpose-based workbook development. It is for this reason that they are referred to extensively throughout these standards and conventions.

1.7 Cell Identification

Following the completion of the cell classification process, the model developer must then communicate this information about the cell to other model developers and model users. This is done through the consistent use of *purpose-based cell formatting*.

Purpose-based cell formatting is achieved primarily through the controlled and consistent use of colors (referred to as 'color-coding') to communicate the *content* and *purpose* of each non-empty cell in a workbook. For cell identification, color-coding is applied to both the font and fill color properties of each cell.

The colors recommended in these standards are based upon the extensive experience of the spreadsheet model developers and users that sit on the Spreadsheet Standards Review Board and a review of many spreadsheet models in the business community. As such, the color-coding conventions in these standards take into account existing common practices within the spreadsheet modeling community. Although it is not necessary to follow the color coding-rules recommended in these conventions, doing so prevents the need to explain a customized approach to other model developers and users who are familiar with these standards, and will therefore often result in significant reductions in model development and explanation time.

It is important to note that purpose-based formatting does not govern the construction of presentation outputs (such as charts and schematic diagrams) which will normally be formatted according to personal or corporate preferences. This can be contrasted with the construction of the non-presentation components of the spreadsheet model, where it is fundamental to best practice that purpose-based formatting be applied to visibly communicate information about the spreadsheet model that is fundamental to the spreadsheet model's underlying purpose.

Identifying Cell Content – Font Colors

It is recommended that the identification of the *content* of each cell in a workbook be achieved through the consistent use of defined *font colors* to distinguish constant, formula and mixed cells. The colors recommended by standards are set out in BPMC 1-3 below:

BPMC 1-3 Cell Content Identification

It is recommended that the content of every *cell* in a *worksheet* be identified using its *font color* property as follows:

a) Blue font color for constants;

b) Black font color for formula; and

c) Green font color for mixed (combination of constant and formula).

In addition to the three main recommended cell content colors, the standards recommend the consistent use of font coloring for other recommended structural content such as hyperlinks (discussed in Chapter 2 Workbook Structure) and checks (discussed in Chapter 11 Checks).

The following table summarizes all of the recommended font colors to be used for identifying the content of each cell type within a workbook, including references to hyperlinks and checks:

Cell Type	Recommended Font Color
Constant	Blue
Formula	Black / Automatic
Mixed	Green
Hyperlink	Plum
Check	Red

These colors are referenced throughout the commentary in these standards and conventions, often by cell type rather than color – e.g. *constant font color*, *check cell color*, etc.

Hyperlink has been included as a separate font color that can be used to identify hyperlinks throughout a workbook. As discussed in 2.4 Workbook Navigation / Hyperlinks, hyperlinks are critical to the user-friendliness of a large spreadsheet model. The ease of identification of hyperlinks is also very important to ensure the efficient navigation around the workbook. For this reason, it is recommended that an entirely different color (i.e. Hyperlink Plum) be used to clearly identify all hyperlinks in a workbook.

The second additional font color, *check*, has been included in the table as a result of the importance of using a stand-out font color to indicate to model users and other model developers when errors, sensitivities and alerts have been detected in a spreadsheet model. This font color has not been included in BPMC 1-3 above because it will normally be applied to a cell as a *conditional format* rather than a full time font color – i.e. the font color of a cell will only become *check red* when an error is detected within the cell. Using *check red* font color in this way is a fundamental part of a best practice robust checks system, which is discussed in detail in Chapter 11 Error Checks.

The following table shows the application of the recommended modeling colors to cells on an outputs sheet, showing both the normal screen view and the contents of the cells (with gridlines shown to highlight the cells):

Normal View		Showing Cell Contents	
100.0	Output	100	=M10
Mixed	1	=IF(M10=N10,"Mixed","")	=IF(ROUND(M10-N10,5)<>0,1,0)
Hyperlink		Hyperlink	

Note the check cell returning '1' in the above example, formatted with check red font color and bold font. This cell would actually be formatted in mixed font color (because it contains the constant '5' within its formula), but appears as bold check red as a result of the application of conditional formatting which has been triggered by the non-zero value within this check cell resulting from the IF statement shown on the right. This is a classic example of a check flag cell, which are discussed in detail in Chapter 11 Error Checks.

Identifying Cell Purpose – Fill Colors

It is recommended that the identification of the *purpose* of each cell in a workbook be achieved through the consistent use of defined *fill colors* to distinguish assumption cells from non-assumption cells. This should be done in conjunction with the sheet purpose identification principles enunciated in BPMC 1-2, with the recommended colors being provided by BPMC 1-4 below:

BPMC 1-4 Cell Purpose Identification

It is recommended that the purpose of every *cell* in a *worksheet* be identified using its *fill color* property as follows:

a) White / No *fill color* for *assumption cells* on (grey *fill color*) *assumptions sheets*; and

b) *Fill color* the same as the *fill color* of the applicable *worksheet* for *output cells*.

By utilizing this convention to govern the identification of cell purpose, every cell in a workbook will be immediately identifiable as being either an assumption cell or a non-assumption Cell. Note that base assumption cells and sensitivity assumption cells are not formatted differently because according to BPMS 6-3, these cells will always be placed in separate assumptions entry interfaces within a workbook and will therefore never be confused.

Non-assumptions cells will be referred to throughout these standards as 'outputs cells', because the purpose of these cells is to provide model users with outputs information. This terminology should not be confused with the 'output' cell content type although it is consistent because assumptions cells should never contain outputs or mixed cell content.

In addition to the two primary fill colors articulated in BPMC 1-4 above, it is also recommended that a 'work in progress' fill color be used to identify cells that have not yet been finalized. This fill color is not included in this convention because a completed workbook would not contain any work in progress cells. For more information regarding this fill type, see page 129 of the Formats and Styles Chapter of this book.

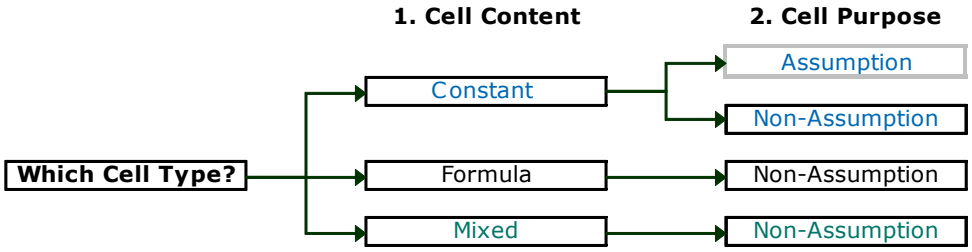
The following table summarises all of the recommended *fill colors* to be used for identifying the purpose of each cell within a workbook:

Cell Type	Recommended Fill Color
Assumption	White
Output (Non-Assumption)	No Fill
Work in Progress	Yellow

Hence, assumptions cells should always have a white background which, when formatted in this way on an assumptions sheet (which are recommended to have a grey background by BPMC 1-1 – see page 89, Sheet Types, for the relevant sheet standards) will ensure that assumptions cells are clearly distinguishable from non-assumptions cells at all times.

Note importantly that work in progress ranges colored in Work In Progress (yellow) fill color will be distinguishable on both assumptions sheets (grey background) and outputs sheets (white background).

A summary of the cell content and purpose categorization process based on the recommended modeling colors (excluding the recommended check font color, which is discussed in detail in the Chapter 11 Error Checks on page 202) is provided below. Note that a grey border has been included around the assumption cell to indicate that this cell would appear white on a grey (assumptions sheet) background:



Cell Identification Examples

The following image shows the application of the recommended modeling colors to both assumption cells and non-assumptions cells on an assumptions sheet (note the grey background / fill color applied to the assumptions sheets - see page 89 for the relevant Sheet Type Standards):

Cell Identification

Constant (Non-Assumption)

Constant (Assumption)

Output

Mixed

Error (Non-Assumption)

Error! (Assumption)

Work In Progress (Non-Assumption)

Work In Progress (Assumption)

Hyperlink

Note that no example has been provided of output or mixed assumption cells, because assumption cells should always be constants (see BPMS 1-9 Assumption Cell Content). Note also the inclusion of check, work in progress and hyperlink cells to demonstrate how these cells appear in contract to normal assumption and non-assumption cells. These concepts are discussed further later in this book.

The following example shows a more meaningful application of the recommended modeling colors to an assumptions sheet (top left) and a related outputs sheet (bottom right) – this time with the outputs sheet gridlines hidden to improve the clarity of the presentation:

Assumptions Sheet

Business Name:	My Business P/L
2013 Sales:	$100.0
Annual Growth Rate (%):	2.50%

(Time Series) Outputs Sheet

Sales Projections for My Business P/L

Year Ending 31 December	**2013**	**2014**	**2015**
Sales ($)	$100.0	$102.5	$105.1
Annual Growth Rate (%):		*2.50%*	*2.50%*

Note in this simple example:

- The assumptions sheet fill color (grey) compared with the outputs sheet fill color (white);
- Assumption cells are clearly distinguished by their white fill color on the assumptions sheet grey background;
- The use of mixed (green) font color to indicate that cells contain mixed content – i.e. the cell reading 'Sales Projections for My Business P/L' contains a formula which concatenates the text 'Sales Projections for ' with the 'Business Name' assumption from the assumptions sheet (i.e. 'My Business P/L').

Although the above example is very simple, it can be used as a basis for understanding the color-coding of cell font and fill colors that is required to effectively implement purpose-based modeling. These concepts should be applied without compromise to every cell of every worksheet in every best practice spreadsheet model.

Chapter 2

Workbook Structure

2.1 Purpose-Based Workbook Structure

Best practice workbook structuring centers around developing *purpose-based workbooks*. Purpose-based workbook development refers to the development of a workbook with a clear understanding of its underlying purpose and the underlying purpose of each component within the workbook. Similar to the use of purpose-based formatting to identify sheets and cells, this understanding must be clearly communicated to model users and other model developers.

In structuring a workbook a model developer will make many decisions which may include:

a. How to structure and segregate the overall content of the workbook;

b. How to break the workbook into logical sections;

c. How to order the sheets in the workbook;

d. How to lay out the contents of each sheet; and

e. How to navigate the workbook.

By focusing on the purpose of the workbook when making these decisions and any other decision associated with the workbook structure, the model developer can construct a workbook that meets the needs of both model users and other model developers.

The standards and conventions contained within this chapter are designed to assist the model developer in creating best practice workbooks. For more information relating to the structuring of specific sheet types, see Chapter 3, Sheet Structure.

2.2 Cover Sheets

Cover sheets are worksheets that are included in a spreadsheet model for two primary reasons:

a. To provide a workbook cover; and

b. To segregate the sections (and possibly sub-sections) within the workbook (See 2.3 Workbook Sections for further information on sectionalizing).

Cover sheets should never contain assumptions or detailed output calculations. They are intended to be used to create and support a clear workbook structure and convey information about the underlying spreadsheet model (or section or sub-section) which is too important to leave embedded within the non-cover sheet detail. They are also used to convey information about the underlying model (for a workbook cover sheet) or section (for a section cover sheet) to model users.

Workbook Cover Sheet

As discussed in Chapter 1, a workbook cover sheet is a sheet which, if included in a spreadsheet model, will be the first sheet in the workbook and contain information relevant to the entire model – i.e. *workbook* information.

A workbook cover sheet should be included in every multi-sheet spreadsheet model and should always be in view when the model is first presented to other model developers or model users – i.e. when the workbook is first opened. Just like a book may only have one cover, a workbook may only ever have one workbook cover sheet.

BPMS 2-1 Workbook Cover Sheet

Every *workbook* that contains more than one *sheet* should contain a separate *cover sheet* as the first *sheet* in the *workbook*.

As well as providing a printer-friendly cover page to the spreadsheet model, the workbook cover sheet is the ideal sheet on which to include important information about the model for other model developers and users. This general information (e.g. the model name, model developer contact details, a disclaimer, etc) can then be referenced by formula from any other worksheet in the spreadsheet model to ensure consistency.

Including a dedicated workbook cover sheet in every workbook provides:

a. A central interface to enter a clear model name and title;

b. A location to enter the subject and purpose of the workbook;

c. A focal point to enter general notes or comments;

d. Model users with clarity regarding the purpose of the workbook; and

e. A 'book style' cover page for model printing and viewing purposes.

The workbook cover sheet provides the model developer with an interface through which general information about the underlying spreadsheet model can be conveyed to other model developers and model users in a user-friendly way. Because every party who comes in contact with the model will view the workbook cover sheet, it is a much safer place to convey this information than within the workbook file name or properties, which some parties may not view or understand properly. An example of a workbook cover sheet has been provided at 3.7 Sample Sheet Layouts.

2.3 Workbook Sections

The existence of section cover sheets (and potentially sub-section cover sheets) makes it very easy to segregate the areas of a spreadsheet model into sections and sub-sections and clearly distinguish these areas. Best practice workbook structure requires that a spreadsheet model be sectionalized such that each area of the spreadsheet model (categorized by purpose) is segregated and contains all the sheets relating to that particular area.

BPMS 2-2 Workbook Sections

Every *workbook* that contains multiple categories or similar types of information should be separated into *sections*. A separate *section* should be created in a *workbook* for each *sheet* or group of *sheets* containing similar types of information.

As a result, every multiple-sheet workbook should contain at least one section, with each section prefaced with a section cover sheet. A workbook cover sheet should preface the entire workbook, while section cover sheets (and potentially sub-section cover sheets) should be used to preface each included section (and potentially sub-section).

BPMS 2-3 Section Cover Sheets

A *section cover sheet* should be used at the start of each *section* in a *workbook* to indicate the commencement of each new *section*.

The process of creating sections in a spreadsheet model can be thought of in the same way as creating chapters in a book. The structured and divisible nature of most spreadsheet models means that the process of dividing and sub-dividing a workbook into more digestible sections is usually quite simple and intuitive. Examples of section cover sheets have been provided at 3.7 Sample Sheet Layouts.

Workbook Section Structure

Whilst the standards require the use of sections in workbooks which contain multiple categories or similar types of information, the standards are silent with regards to the manner in which the data within a workbook is sectionalized. This is because, like creating chapters within a book, there are no generic rules which can be applied to this process. However, based on the experience of the members of the Spreadsheet Standards Review Board, BPMC 2-1 has been included within the standards as a guide for creating a commonly-recognized section structure within a best practice spreadsheet:

BPMC 2-1 Workbook Section Structure

It is recommended that every *workbook* be structured consistently to at least include the following *sections*:

a) *Cover* and Contents;
b) Model Documentation and Diagrams (where relevant);
c) *Assumptions*;
d) *Outputs*;
e) *Presentations* (where relevant); and
f) *Appendices* (where relevant).

The table of contents of a best practice model that utilizes this structure is shown below:

Workbook Section Structure Example – Table of Contents

Table of Contents

Best Practice Model

Go to Cover Sheet

Section & Sheet Titles

Note in this example:

- The clarity of structure created by the use of sections and sub-sections;
- The presentation of this structure within a single workbook table of contents (discussed below in 2.4 Workbook Navigation / Hyperlinks);
- The inclusion of a 'Model Documentation' section which provides notes, diagrams and other information about the model to model users and other model developers;
- The separation of assumptions and outputs into two distinct sections; and
- The inclusion of an 'Appendices' section, with multiple sub-sections, to house structural components of the workbook including lookup tables (discussed in Chapter 3 Sheet Structure) and checks (discussed in Chapter 11 Checks).

Assumptions Sections vs. Outputs Sections

One of the most common sources of both errors and confusion in spreadsheet models is the inconsistent placement of assumptions. As discussed in BPMS 5-1 Assumptions Location, all assumptions within a workbook should be placed on dedicated and visually identifiable assumptions sheets. Furthermore, BPMC 2-1 recommends that these assumptions sheets should always be placed within dedicated and visually identifiable assumption sections (with sub-sections if necessary). In this way both model developers and users will know where all of the assumptions within a spreadsheet model are located and will therefore be confident that no changes to the model will be being driven by assumptions embedded within outputs sheets.

In addition to differentiating workbook sections by area, the model developer should always determine whether each section is an assumption section or an outputs section. As discussed in BPMS 1-8 Assumptions Classification, this determination rests on the intended ability of the model user to manipulate entries within each particular section:

- *Assumptions Sections* exclusively contain sheets that contain assumption cells which can therefore be changed by the model user (i.e. assumptions sheets); while
- *Outputs Sections* exclusively contain sheets that contain non-assumption cells which therefore cannot be changed by model users (i.e. non-assumption/outputs sheets).

These sections should never be confused or mixed, such that assumptions sheets should never be contained in an outputs section, and outputs sheets should never be contained in an assumption section. As a result, no assumptions should ever be located within the outputs section(s) of a spreadsheet model.

The following table shows the assumptions / outputs categorization of the detailed workbook section classifications listed in BPMC 2-1 Workbook Section Structure:

Section Type	Component Sheet Type
Cover and Contents	Outputs
Model Documentation & Diagrams	Outputs
Assumptions	Assumptions
Outputs	Outputs
Presentations	Outputs
Appendices	Outputs

Note that multiple assumption sections or sub-sections may be required in a model which contains both base and sensitivity assumptions (as discussed in BPMS 1-8 Assumption Classification). In such a case, the use of sections and/or sub-sections in this way is the key to preventing the confusion of model users and other model developers as a result of failing to differentiate between base and sensitivity assumptions.

Inter-Sheet Consistency

Apart from selecting the appropriate section and sheet types to properly structure the workbook, the order and layout of the sheets within (and between) sections should be consistent to avoid confusion.

For example, if a sheet entitled *Taxation Assumptions* was the first sheet in assumption section of a workbook, its corresponding *Taxation Outputs* sheet should be the first sheet in the corresponding outputs section of the workbook. Additionally, the layout and presentation of these related sheets should be as consistent as possible such that model users and other model developers do not have to re-familiarize themselves with outputs sheets after becoming familiar with assumptions sheets. This consistency is even more important when related base and sensitivity assumptions are included within a workbook.

For more information on sheet structuring, see Chapter 3, Sheet Structure.

2.4 Workbook Navigation / Hyperlinks

Following the creation of a well-structured spreadsheet model, it is then important to ensure that model users and other model developers are able to efficiently navigate their way around the workbook. Ease of navigation is achieved through the use of two methods:

1. A central *table of contents* which summarizes the sections, sub-sections and sheets in the underlying workbook; and

2. *Hyperlinks* which link each worksheet to the table of contents and other anticipated destinations in the workbook.

These two methods, when used together, should enable a model developer or user to easily navigate around the entire workbook using the mouse without the need for any inefficient scrolling of sheet windows and minimal use of the sheet tabs.

As discussed below, these two methods are inseparable because most hyperlinks rely on the table of contents as a central hub while the table of contents can only be efficiently used for navigational purposes when used in conjunction with hyperlinks to all destination worksheets.

Table of Contents

The inclusion of a well-structured table of contents in every spreadsheet model is one of the most fundamental workbook structuring principles contained in these standards and conventions. Nonetheless many workbooks do not include a table of contents, thereby making it very difficult for model users (and model developers themselves) to understand the contents and location of the contents within a workbook.

BPMS 2-4 Table of Contents

Every *workbook* with more than one *sheet* should contain a *Table of Contents* outlining the structure and composition of the underlying *workbook*.

As such, it is best practice to include a content sheet with a table of contents in every workbook with more than one sheet. In doing so the model developer:

a. is provided with a summary of the outcome of the workbook structuring decisions that have been made during the model development process;

b. provides model users with a succinct summary of the structure and content of the underlying model;

c. provides model users with an understanding of the location of components within the workbook;

d. is encouraged to structure the components of the workbook such that it appears presentable in a table of contents; and

e. significantly improves the structure of the workbook.

Even the most well-structured workbook is still likely to confuse model users and other model developers if a table of contents is not used to provide a structural summary and content guidance. Hence, with the exception of simple, single sheet workbooks, a table of contents should be incorporated into every spreadsheet model.

There will generally only be a requirement to have one table of contents within any one workbook, so it should be placed near the front of the workbook for easy access. When you have created a table of contents in a spreadsheet model, it will become the focus for all model developers and users as a means of obtaining an overview of the workbook content, as well as providing a means to navigate around the workbook.

A table of contents should therefore serve three purposes:

1. Provide a structural overview of the workbook, including a list of each constituent section and its sheets;

2. Provide hyperlink access to every worksheet in the workbook (see below for more information on using hyperlinks as navigation tools); and

3. Provide a printed page numbers list (if the workbook is intended to be printed for physical presentation).

Model developers should aim to present the table of contents in a manner similar to the home page of an internet web page – i.e. users of the model should be able to return to the table of contents from any worksheet and immediately regain an understanding of their relative position within the workbook.

BPMS 2-5 Table of Contents Information provides a summary of the information that should be included within a table of contents. Visual examples of contents sheets containing tables of contents constructed in accordance with this standard are provided within the discussion on the following pages.

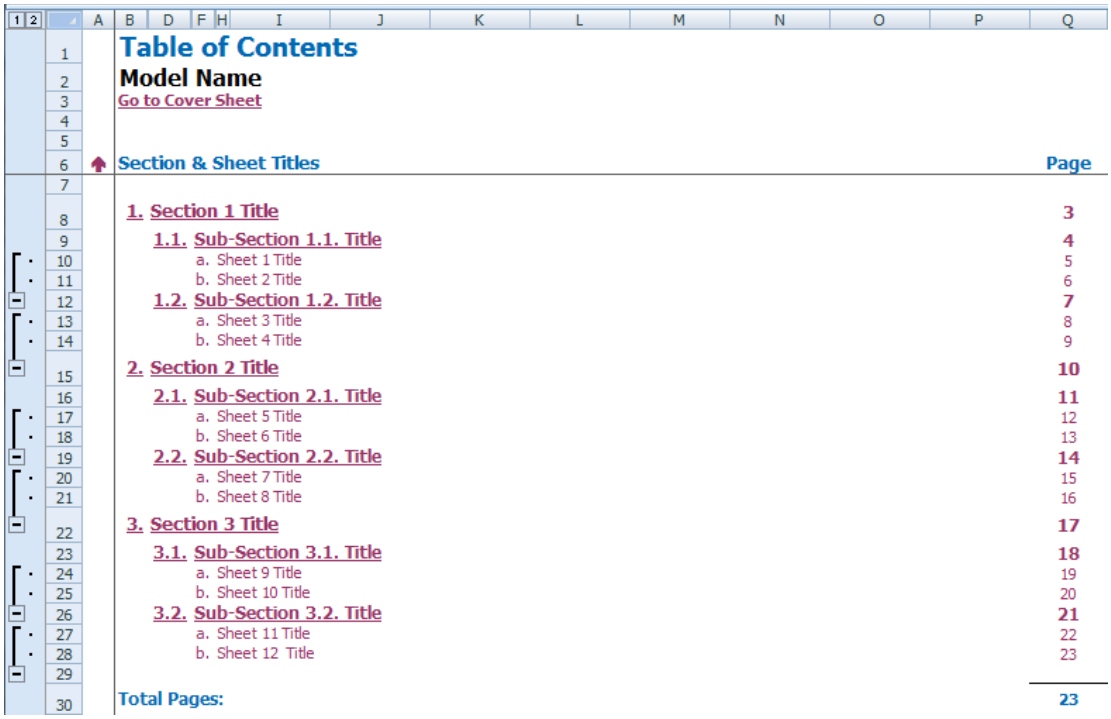
BPMS 2-5 Table of Contents Information

A Table of Contents should:

a) Show the sections of the workbook (if any sections have been created);
b) Reference the sheet title of each sheet in the model;
c) Clearly number each section and sheet; and
d) Be located near the front of the workbook (generally the second sheet in the workbook).

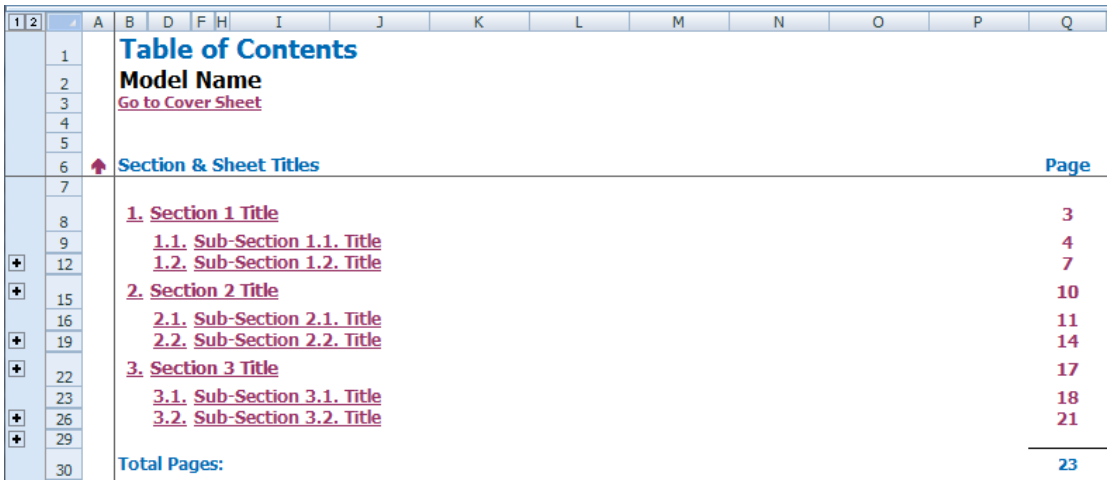
Where a table of contents becomes so large that it extends off the bottom of the screen when in view, grouping should be used where possible (see BPMS 3-2 Sheet Titles) to allow the table to be compacted to list only section or sub-section sheets.

The following figure shows a window containing a table of contents constructed according to these standards. In this example, the underlying workbook contains three sections, each with two sub-sections, each containing two blank outputs sheets:



The grouping of rows in the above table of contents creates the ability to view the table on an expanded basis (as shown above) or compacted basis. For more information on grouping, see BPMC 3-7 Grouping Levels.

The figure below shows the same table of contents with the rows compacted to show only the section and sub-section sheets in the workbook:



Note also that the above table of contents includes a hyperlink reference to the workbook cover sheet in cell B3. This hyperlink ensures that the person navigating around the model can click through to the workbook cover sheet, even though the workbook cover sheet is before the contents sheet and therefore not listed in the table of contents itself.

Another hyperlink in the shape of an up arrow is also included in the above table of contents. This hyperlink has been added in this example to move the user to the top of the contents sheet in the event that worksheets are added to the underlying workbook and the table of contents extends below the bottom of the viewable screen content. The use of hyperlinks is discussed in more detail below.

Hyperlinks as Navigation Tools

If used appropriately, hyperlinks are capable of transforming a large spreadsheet model into a virtual internet web site within which a model user can navigate around using nothing more than mouse button clicks.

BPMS 2-6 Workbook Navigation

Every *workbook* with more than one *sheet* should contain:

a) a table of contents sheet outlining the sections and sheets in the workbook;

b) hyperlinks from the table of contents to every sheet in the workbook; and

c) a hyperlink to the table of contents always in view on every sheet in the workbook.

Hyperlinks should be included in any circumstance where the next move of the model user is predictable. For example, hyperlinks can be used to direct users:

- from the table of contents to any worksheet in the workbook;
- to the top of the active worksheet;
- to the worksheet immediately left / right of the active worksheet;
- from an assumptions sheet to the corresponding outputs worksheet; or
- to another range in a large worksheet.

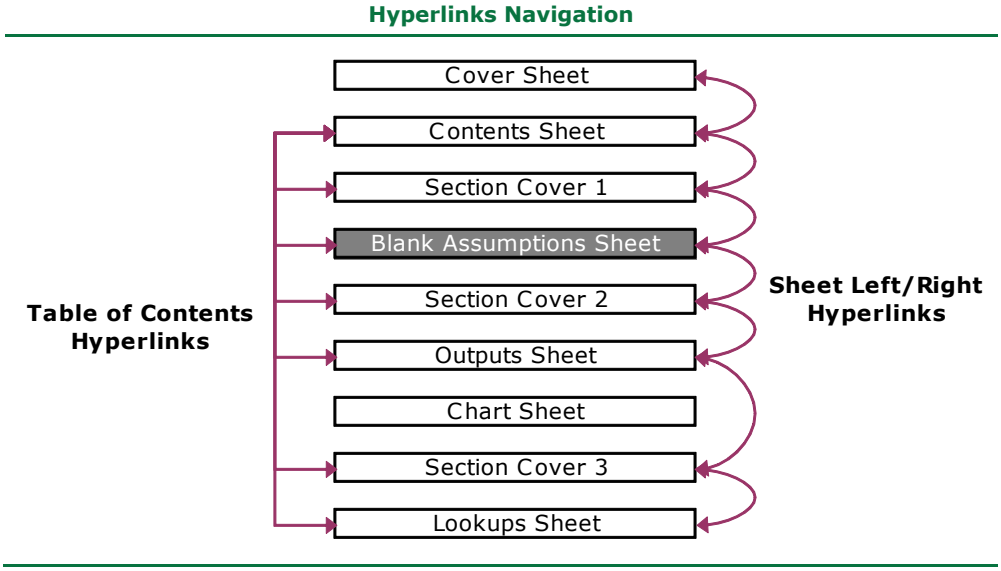
A hyperlink in a spreadsheet model needs to be visually identifiable so that both the model developer and model users can identify where hyperlinks exist. Similar to the identification of cell content as either constant, formula or mixed cell content (see BPMS 1-6 Cell Content), this is achieved through the consistent use of purpose-based formatting. Normal internet formatting of hyperlinks includes underlining and as a result this approach has been adopted for all examples throughout these standards.

The text displayed by a hyperlink should provide the model user with a clear indication of the destination of the hyperlink. In this regard, if the destination cell contains a heading or other descriptive text, it is often best to link the hyperlink cell by formula to the destination cell such that both cells always contain the same value (i.e. the value of the destination cell).

Hyperlinks can be displayed on a worksheet with any word or character in view. This means that arrows and other symbols can be used to provide user-friendly navigation guidance to model users. However, if this approach is taken, the number of different symbols should be limited and applied consistently to prevent confusing model users.

The only common limitation on hyperlinks is that they are most commonly used to direct the user to a worksheet range. Hence, hyperlinks cannot easily be used to take users from the table of contents to a chart or other non-range object directly. Furthermore, hyperlinks are usually anchored to a worksheet range, meaning that it may be difficult or impossible in some spreadsheet applications to place them on chart sheets to click through to the table of contents. It is for this reason that the inclusion of chart sheets (instead of embedding charts within worksheets) generally detracts from the navigation user-friendliness of a spreadsheet model.

The following figure shows how hyperlinks might be used to support the structure of a simple model (which includes a chart sheet) and thereby allow for easy workbook navigation:



Note that although the chart sheet in the workbook represented in the above diagram should still be listed on the table of contents, hyperlinks cannot be linked to it because it does not contain worksheet ranges. It is for this reason that BPMC 3-3 (see Chapter 3) recommends that no chart sheets should be included in a workbook.

2.5 Workbook Consistency

Model developers should extensively use consistency as the basis for delivering clarity in their spreadsheet models. In constructing a workbook a model developer makes many decisions regarding:

a. Sheet titles, positioning and formats;

b. Sheet structure;

c. Data positioning;

d. Information visibility;

e. Workbook navigation; and

f. Sheet view and print properties.

By standardizing these decisions throughout a workbook, a model developer can create workbooks that model users will find easy and efficient to interpret, understand, view, print and navigate. As such, model developers should always use a standardized and consistently applied approach to all of these factors within a workbook. Further, good model developers should seek to develop and consistently apply these factors to all of the workbooks that they develop. In this way, a model developer's workbooks will become familiar to model users and more readily useable, particularly when the same model users are using these different workbooks developed by a single model developer.

Chapter 3

Sheet Structure

3.1 Purpose-Based Sheet Structure

Best practice sheet structure centres around developing purpose-based sheets. Purpose-based sheet development refers to the development of a sheet with a clear understanding of its content and underlying purpose. In structuring a sheet a model developer will make many decisions which may include:

a. Which sheet type to use to hold the desired information;

b. How to structure and segregate the content of the sheet;

c. How the sheet should be printed and viewed on screen;

d. How the layout of a worksheet can be best simplified;

e. How to navigate around a worksheet;

f. What information needs to be in view; and

g. How to position the components within sheets.

By focusing on the purpose of the underlying sheet when making these decisions, the model developer can construct sheets that meet the needs of model users. The standards and conventions contained in this chapter aim to assist the model developer in constructing purpose-based sheets.

3.2 Sheet Consistency

The primary consideration when structuring sheets in a spreadsheet model is ensuring sheet consistency. Sheet consistency should be considered on two levels:

1. *General sheet consistency* involves the consistent use and application of components common to all sheets in a workbook; and

2. *Sheet type consistency* involves the consistent use and application of components common to sheets of the same type in a workbook.

While the general sheet consistency principles are applicable to all sheets of all types, the sheet type consistency principles are only relevant to sheets classified by the model developer as being of the same type (see BPMS 1-3, BPMS 1-4 and BPMC 1-1 for more information on sheet type classification).

Sheet consistency on both levels is fundamental to ensure the development of purpose-based spreadsheet models with a clearly communicated logical structure. The result is improved user-friendliness, workbook navigation and understanding on behalf of both model users and other model developers.

General Sheet Consistency

Ensuring general sheet consistency involves maintaining the consistent layout and presentation of every component that is common to every worksheet in a workbook. These components include:

- Sheet heading and title positions and styles;
- Hyperlinks to the Contents Sheet and neighbouring sheets;
- The zoom % of the visible and printed sheets;
- The visibility of gridlines on worksheets;
- Window panes / splits (see 3.4 Window Panes and Splits below); and
- Grouping levels (see 3.5 Grouping Levels below).

Consistency of sheet layouts, both within sheet types and between sheet types, extends to every component of sheet formatting and structuring. Many developers often fail to address many of these issues when constructing a spreadsheet model, and as a result are required to retrospectively adjust everything from worksheet structures to styles to page setup properties – often never achieving strict consistency.

BPMS 3-1 specifically relates to the consistent layout and presentation of sheet titles:

BPMS 3-1 Sheet Titles

Every *sheet* in a *workbook* should contain a clearly highlighted *sheet title* that is:

a) Consistently formatted on every *sheet*;

b) Consistently *located* on every *sheet type*; and

c) Always in view on the screen when that *sheet* is active.

When entering sheet titles, the model developer should consider the fact that in many cases the table of contents will by hyperlinked to the sheet title of each worksheet (see BPMS 2-5 Table of Contents Information). Hence, the entered sheet title should be short enough to fit on the table of contents yet descriptive enough to provide model users and other model developers with enough information as to the contents of the sheet when reading down the table of contents.

Additionally, the model user should consider the entered sheet title in the context of the table of contents – i.e. if the sheet is clearly placed within the *Assumptions* section of the workbook and represented as such in the table of contents, it may be acceptable to shorten a sheet title such as 'Revenue - Assumptions' to 'Revenue'. This simplification of the sheet title is made possible primarily as a result of assumptions sheets being clearly differentiated from outputs sheets using color-coding (see BPMC 1-2 Sheet Purpose Identification).

The consistent formatting of sheet titles is most efficiently achieved via the use of a purpose-based 'Sheet Title' style. This will prevent the model developer having to remember to re-apply the same combination of formats to each sheet title following the insertion of a new worksheet. For more information on creating purpose-based styles, see 4.2 Styles.

Sheet titles should be placed in the same cell for each sheet type within a spreadsheet model – i.e. the sheet title cell on all *section cover* sheets should be identical. This cell, along with the cells containing hyperlink references to the table of contents and other worksheets, should always remain in view regardless of whether or not the model user scrolls down or across the worksheet. This is achieved through the use of window panes and is discussed below in BPMC 3-7.

The consistent use of sheet titles, and many other components common to all sheet types, is recommended by the sheet content consistency recommendations within BPMC 3-1:

BPMC 3-1 Sheet Content Consistency

It is recommended that every *sheet* of the same *sheet type* in a *workbook* consistently apply the following properties:

a) Sheet title style and *position*;
b) *Heading styles* and spacing;
c) Purpose-based *formats* and *styles*;
d) *Hyperlink positions* and *styles*;
e) Zoom/scaling percentage of the visible and printed *sheets*;
f) Visibility of gridlines;
g) *Grouping levels*; and
h) Window panes/splits.

BPMC 3-1 recommends the consistent positioning and styling of hyperlinks within every worksheet. This recommendation is not referring to all hyperlinks, which will differ in many cases between different sheets, but instead to the position and presentation of the hyperlinks that are common to all worksheets. These hyperlinks are the subject of BPMC 3-2:

BPMC 3-2 Hyperlinks in Worksheets

It is recommended that every *worksheet*, where relevant, contain the following *hyperlinks*:

a) Sheet left *hyperlink* (to move to the *worksheet* to the left);
b) Sheet right *hyperlink* (to move to the *worksheet* to the right);
c) Sheet top *hyperlink* (to move to the top of the *worksheet*);
d) Error check *hyperlink* (to move to the workbook *error checks summary*);
e) Sensitivity check *hyperlink* (to move to the workbook *sensitivity checks summary*);
f) Alert check *hyperlink* (to move to the workbook *alert checks summary*).

It is recommended that all of these *hyperlinks* be in view on the screen at all times.

Note that sheet left and sheet right hyperlinks will only be included in a worksheet where there is a visible worksheet to the left or right or the active worksheet, and the error, sensitivity and alert check hyperlinks will only be required if their corresponding checks summaries have been included in the underlying workbook (for more information on checks see Chapter 11 Checks).

Additionally, because many spreadsheet applications do not easily allow hyperlinks to reference chart sheets, these sheets will be skipped by sheet left and sheet right hyperlinks, thereby neagatively impacting the ease with which a workbook can be navigated. For this reason, BPMC 3-3 recommends that chart sheets not be used within best practice models:

BPMC 3-3 No Chart Sheets

To ensure *hyperlink* access to all the *sheets* within a *workbook*, it is recommended that charts be placed within *worksheets* rather than using *chart sheets*.

This convention does not apply to spreadsheet applications which allow chart sheets to contain hyperlinks and to be specified as the target of hyperlinks.

Finally, the existence of sheet top hyperlinks is only made possible through the use of window panes in conjunction with hyperlinks. More information on the use of window panes (and splits) in this way is provided in 3.4 Window Panes and Splits below.

Sheet Type Consistency

Ensuring *sheet type consistency* involves strictly maintaining the consistent layout and presentation of every component that is common to sheets of the same type within a workbook. The primary objective of the model developer when applying sheet type consistency should be to ensure that model users and other model developers are quickly able to both recognise sheets of the same type and distinguish between sheets of different types. Sheet type consistency is governed by BPMS 3-2:

BPMS 3-2 Sheet Type Consistency

Sheets of the same *sheet type* within a *workbook* should be consistently structured and formatted.

This standard applies to:

a) Sheet title, styles and positioning;
b) Heading *styles* and spacing;
c) *Column* and *row* dimensions;
d) *Data* entry points;
e) *Hyperlink* positioning;
f) Visibility of gridlines;
g) *Grouping levels*;
h) Zoom and viewing properties;
i) Window panes and splits; and
j) *Formats* and colors.

Ensuring sheet type consistency requires a clear understanding of the components of each sheet type and how each of these components can differ from other sheet types. Only after a model developer understands these concepts can these components be laid out and presented consistently to distinguish each sheet type.

The following steps have been provided as an indication of the steps that can be taken to distinguish sheet types based on the sheet types listed in BPMS 1-3 Sheet Content:

- Column widths of the same sheet type should be identical – i.e. all *time series sheets* or *section cover sheets* should always appear on screen and print in exactly the same way;
- Headings, titles, hyperlinks and other common sheet infrastructure should be formatted and positioned consistently;
- Time series period titles should always be presented and positioned in the same way – i.e. the first time series period column should always be the same; and
- Sheet naming suffixes should be used to immediately differentiate sheets by type (see BPMC 9-3 Sheet Type Naming Suffixes).

For examples of consistent sheet layouts in accordance with BPMS 3-2 see 3.7 Sample Sheet Layouts.

Workbook Cover Sheet Content

The workbook cover sheet was introduced in Chapter 1 when discussing the sheet types required by BPMS 1-3 and recommended by BPMC 1-1. The recommended content for inclusion within a workbook cover sheet is specified in BPMC 3-4, as stated below:

BPMC 3-4 Workbook Cover Sheet Content

It is recommended that the *cover sheet* of a *workbook* contain the following information:

a) The model name;

b) The model developer's name and contact details (if appropriate); and

c) Workbook cover sheet notes.

Workbook Cover Sheet Notes

A large amount of model redundancy results from the lack of effective communication of workbook issues and instructions to other model developers and model users. The workbook cover sheet provides a point of focus in the workbook where model developers should enter such instructions or notes for model users. It is recommended that this information be provided via the use of cover sheet notes.

BPMC 3-5 Workbook Cover Sheet Notes

It is recommended that the *cover sheet* of a *workbook* include provision for *notes* that are in view and in a consistent *location*.

Cover sheet notes should include:

a) A description of the contents of the underlying *workbook*;

b) Instructions for *model users* or *developers*; and/or

c) Warnings for *model users* or *developers*.

Model developers should enter cover sheet notes assuming that they will be read by other model developers and model users who know nothing about the underlying spreadsheet model. Hence, the instructions and comments should be simple enough to provide these parties with comfort about their ability to use and/or make changes to the workbook.

Cover sheet notes should indicate the purpose of the workbook and provide warnings regarding any areas of potential confusion or concern for both model developers and model users. Cover sheet notes can address any number of potential uses, including:

- A summary of the purpose of the model;
- The current version of the model;
- A summary of any remaining Work In Progress areas in the model (See BPMC 4-3 Work in Progress Identification);
- An indication of any planned amendments or additions to the model; and
- The existence of any links to external workbooks (see Chapter 13 Multiple Workbooks).

When entering cover sheet notes, the model developer should bear in mind that the excessive use of these notes can cause more concern than comfort. In the event that a large number of general model issues remain outstanding, it may be more reasonable to list these issues on a blank outputs sheet within an appendix section of the spreadsheet model rather than crowding the workbook cover sheet.

Section Cover Sheet Content

Section cover sheets were introduced in Chapter 1 when discussing the sheet types required by BPMS 1-3 and recommended by BPMC 1-1, and also discussed in Chapter 2 when discussing the workbook sectionalization requirements of BPMS 2-2. Section cover sheets, like all sheet types which may be included multiple times within a workbook, should be consistently structured to ensure that model users and other model developers quickly distinguish section cover sheets after first viewing one. In addition to this sheet type consistency requirement, BPMC 3-6 recommends the inclusion of the following content on all section cover sheets:

BPMC 3-6 Section Cover Sheet Content

It is recommended that every *section cover sheet* in a *workbook* contain the following information:

a) A *title* for the following section;

b) The section number for the following *section*;

c) *Cover sheet notes*; and

d) The *model name*.

This information should be consistently *formatted* and *positioned* on all *section cover sheets* in the *workbook*.

Complete consistency of section cover sheets is recommended because the primary purpose of any section cover sheet in a workbook is to indicate to model users and other model developers that the following sheets contain a separate topic or type of information to the sheets prior to the section cover sheet.

Section Cover Sheet Notes

In the same way that it is recommended that cover sheet notes be used on the workbook cover sheet, it is recommended that section cover sheet notes be used on section cover sheets to convey information to model users and other model developers about the content and purpose of the underlying section (or sub-section).

BPMC 3-7 Section Cover Sheet Notes

It is recommended that the *cover sheet* of a *workbook* include provision for *notes* that are in view and in a consistent *location*.

Cover sheet notes should include:

a) A description of the contents of the underlying *workbook*;

b) Instructions for *model users* or *developers*; and/or

c) Warnings for *model users* or *developers*.

For more information and examples demonstrating the representation of the different sheet types in a workbook table, see BPMS 2-5 Table of Contents Information.

3.3 Limiting Worksheet Depth

When using a purpose-based approach to workbook structuring (see Chapter 2), model developers should always avoid the temptation to include excessive amounts of information on any one worksheet. While this may be unavoidable when analyzing data over a large number of time series periods (columns), it can generally be controlled in relation to the number of rows used (or 'depth' of the worksheet). Limiting worksheet depth is recommended by BPMC 3-8:

BPMC 3-8 Limiting Worksheet Depth

It is recommended that the number of *rows* utilized on any worksheet be limited, where feasible, to what can be seen on the screen without vertical scrolling.

It is recommended that the number of *rows* utilized on any one *worksheet* be limited to the minimum possible. To reduce the depth of a *worksheet* where there is an unavoidably large amount of information it is recommended that:

a) *Rows* are grouped and collapsed; or

b) Different types of information be moved to new *worksheets* (splitting the *worksheet* information).

In fact, as a general rule model developers should aim to ensure that most of the information on a worksheet is visible without the need for any vertical scrolling – i.e. the number of rows used should be limited to approximately the number of rows visible in the sheet window when the sheet is in the top position. Where this cannot be achieved without grouping, grouping of rows should be used to offer model users a 'compacted' summary of the detail in the worksheet before they choose to look into the compacted detail (see 3.5 Grouping Levels below).

The benefits of limiting the depth of the worksheets in a spreadsheet model include:

- Forcing model developers to separate the assumptions and outputs areas of the model into distinct, digestible pieces;
- Allowing for efficient workbook navigation via a table of contents;
- Ensuring that the table of contents provides a thorough summary of the different areas in the model which can then be immediately accessed via hyperlinks to these sheets; and
- Preventing disorientation on behalf of model users who are unable to gain an understanding of the purpose or relevance of each section within a worksheet.

The use of a larger number of smaller worksheets (as opposed to a smaller number of larger worksheets) is only made viable by the inclusion of a fully hyperlinked table of contents and the extensive use of hyperlinks throughout the workbook to guide model users. For more information on purpose-based workbook structuring and navigation techniques see Chapter 2, Workbook Structure.

3.4 Window Panes and Splits

The consistent and logical use of window panes and splits on worksheets is strongly recommended. In fact, when developing large spreadsheet models, the effective use of a logical workbook structure with hyperlink navigation will not be possible without the utilization of at least some window panes.

BPMC 3-9 Freezing Panes

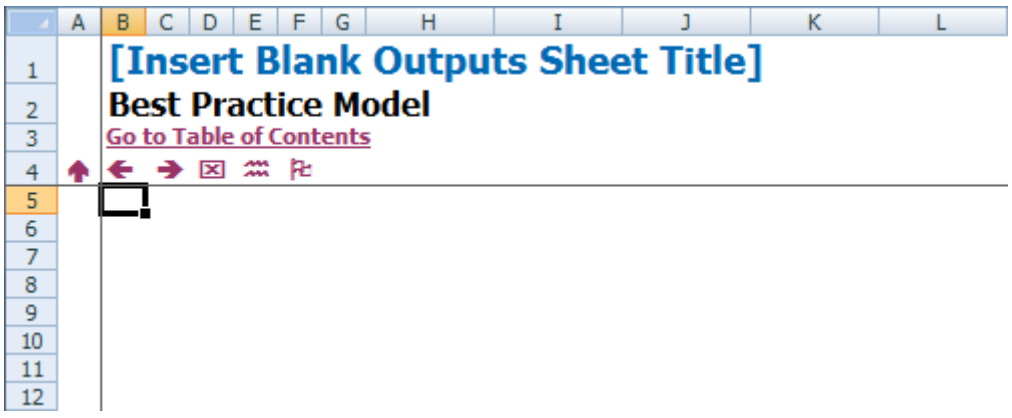
It is recommended that *frozen panes* be used on every *worksheet* in a *workbook* (excluding *cover sheets*) to ensure that the *sheet title*, any *hyperlinks*, error flags or date and time titles are always in view.

The decision concerning the use of splits versus panes is a personal one for each model developer. However, many model users have difficultly navigating around a worksheet when window splits have been put in place, and therefore panes have become the more commonly accepted (and therefore recommended) means of controlling window components.

The following factors should be considered when using window splits and panes in spreadsheet models:

- The primary use of splits and panes should be to ensure that the top level sheet titles, headings and hyperlinks remain in view even when a user scrolls down (or across) the worksheet;
- Splits and panes should be used on every time series sheet to ensure that time series period titles remain in view when a user scrolls down the worksheet;
- The use of hyperlinks in conjunction with panes can enable model users to rapidly reset the position of the active window to the top of the active worksheet with one click. The following example demonstrates this method:

Combining Hyperlinks & Frozen Panes



In this example, panes have been frozen around cell B5. This will ensure that rows 1 – 4 and column A is always visible on this worksheet. A hyperlink has then been inserted in cell A4 (and formatted as an up arrow to indicate to model users that clicking on this hyperlink will move them to the top of the sheet) which references cell B5. As a result, regardless of where the model developer has scrolled within the worksheet, clicking on the up arrow hyperlink will always make cell B5 the active cell, and in doing so reset the worksheet view to the top of the page (as it currently appears above).

This method prevents the need for the model user to perform multiple up and left scrolls to reach the top of the worksheet. Note however, that this method will not work with window splits, which create 4 independent areas within the same window.

- The use of checks hyperlinks in conjunction with panes ensures that model users are always only 1 click away from activating checks summaries in the event that an error, sensitivity or alert is detected in the workbook (for more information on checks see Chapter 11 Checks); and

- Using splits and panes effectively (as demonstrated in the previous example) should ensure that a hyperlink to the table of contents is always in view. As a result, the model user should never be more than 1 click away from the Table of Contents and 2 clicks away from any other worksheet in the active workbook.

Hence it can be seen that the use of window splits and (in particular) panes can play a fundamental role in controlling sheet structure and ensuring the easy navigation of a spreadsheet model.

3.5 Grouping Levels

Many worksheets in a spreadsheet model will contain intermediary calculations and detail which are not required to be scrutinized by model users. However, hiding this information by hiding rows or columns can be dangerous as it is often easy for such hidden data to be ignored or even deleted by other model developers. Hence, to prevent confusion, rows and columns should be 'grouped' wherever necessary to temporarily hide unnecessary detail.

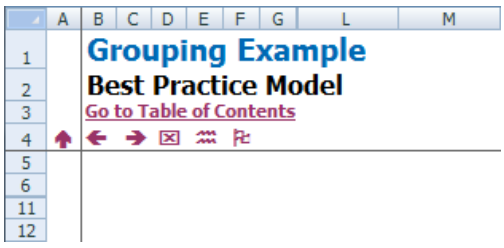
BPMS 3-3 Grouping Rows or Columns

When hiding *rows* or *columns* in a *worksheet*, the *rows* or *columns* should always be *grouped*, not hidden.

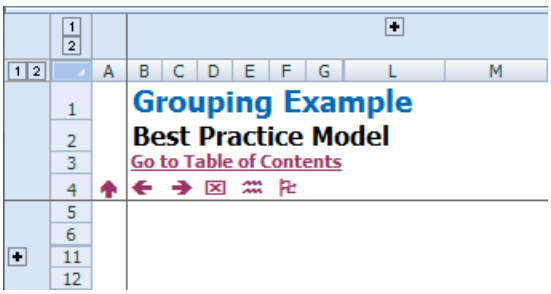
When used properly, grouping can significantly simplify the structure and appearance of worksheets without permanently hiding information or misleading model users. This is largely because group levels are always displayed to the left of and above the row and column headers respectively.

The following table shows the same worksheet – firstly with rows 7 – 10 and columns H – K *hidden*, and then with the same rows and columns *grouped*:

Hidden Rows and Columns



Grouped Rows and Columns



Although the hidden rows and columns do not reduce the visible worksheet area (which occurs when grouping levels are indicated to the left of and above the row and column headers), they are almost impossible to detect without closely examining the row and column headers. Additionally, unhiding and re-hiding rows and columns is a much slower process than switching group levels in and out of view, and something many model users will not have the knowledge to do.

Group Level Views

Grouping principles should be applied consistently throughout a spreadsheet model. By doing this, the model developer effectively creates *views* in which the model can be analysed, with each view differing depending on the level of detail. BPMC 3-10 recommends the consistent use of grouping to create three views in every workbook:

BPMC 3-10 Grouping Levels

It is recommended that *rows* and *columns* within the *worksheets* in a *workbook* be grouped consistently across all *worksheets* to create the following three views:

Summary view (compacted);

Print view (semi-compacted, if required); and

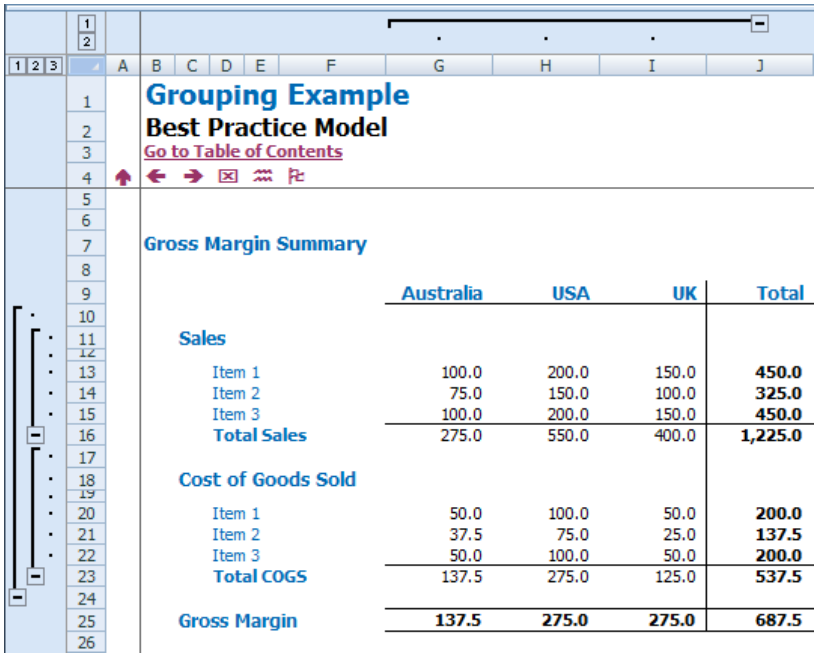
Expanded view (un-compacted).

Having these views can be very useful when printing, viewing or protecting a workbook, because the model developer can effectively control the level of detail that is provided to model users. Generally, the views recommended in BPMC 3-10 will exist only in the first 3 levels of grouping because grouping beyond level 3 often results in the worksheet area on the screen becoming unacceptably small. The following 3 views are recommended:

View Name	Group Levels Hidden	Purpose
Compacted View	All	Hides all detail except for headings, titles and selected other information which will never be hidden
Print View	1	Shows all information which will be visible when the workbook is printed or viewed on screen
Expanded View	None	Shows all information in the worksheet – primarily used during model development stage

An example of the application of these three views is provided below, where the same information is displayed in three levels of detail depending on the group levels in view:

Grouping Example – Expanded View (Showing All Group Levels)



Grouping Example

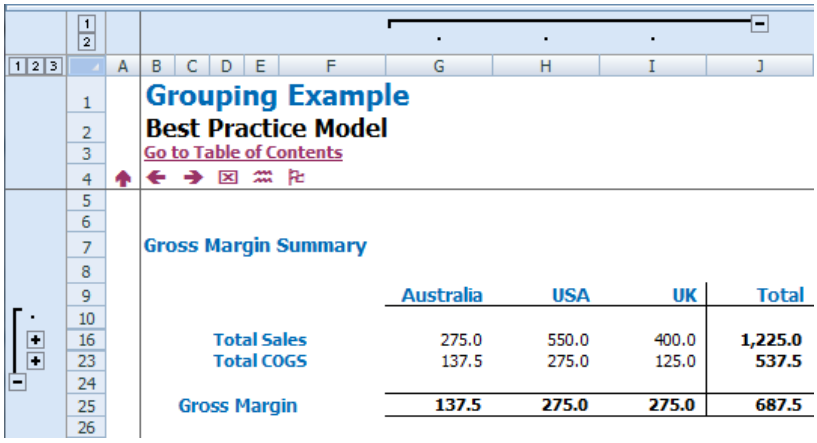
Best Practice Model

Go to Table of Contents

Gross Margin Summary

	Australia	USA	UK	Total
Sales				
Item 1	100.0	200.0	150.0	**450.0**
Item 2	75.0	150.0	100.0	**325.0**
Item 3	100.0	200.0	150.0	**450.0**
Total Sales	275.0	550.0	400.0	**1,225.0**
Cost of Goods Sold				
Item 1	50.0	100.0	50.0	**200.0**
Item 2	37.5	75.0	25.0	**137.5**
Item 3	50.0	100.0	50.0	**200.0**
Total COGS	137.5	275.0	125.0	**537.5**
Gross Margin	**137.5**	**275.0**	**275.0**	**687.5**

Grouping Example – Print View (Hiding Group Level 1)



Grouping Example

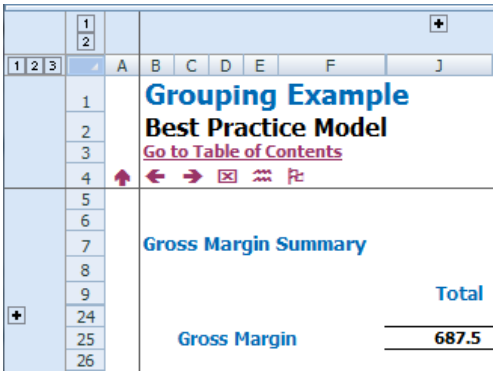
Best Practice Model

Go to Table of Contents

Gross Margin Summary

	Australia	USA	UK	Total
Total Sales	275.0	550.0	400.0	**1,225.0**
Total COGS	137.5	275.0	125.0	**537.5**
Gross Margin	**137.5**	**275.0**	**275.0**	**687.5**

Grouping Example – Compacted View (Hiding All Group Levels)



Grouping Example

Best Practice Model

Go to Table of Contents

Gross Margin Summary

	Total
Gross Margin	**687.5**

Although these standards do not require the use of grouping in spreadsheet models, it is strongly recommended for any worksheet with content that extends significantly beyond the visible area on the screen or contains a large amount of detail not relevant to model users.

3.6 Heading Indentation

Another element to consider when implementing *general sheet consistency* is the consistent use of heading styles (discussed in detail in Chapter 4 Formats & Styles) and the indentation of headings using these styles. Whilst not required by the standards, BPMC 3-11 recommends the consistent use of hierarchical heading styles throughout the worksheets within a best practice model in order to assist model users and other model developers when understanding the content and purpose of the workbook:

BPMC 3-11 Heading Indentation

It is recommended that headings within a *workbook* are consistently indented using different columns that visually communicate the appropriate level of emphasis or importance that should be attached to each *heading*.

Because spreadsheet applications do not have the same tab indent functionalities that are provided with most word processing applications, the following steps are recommended to be taken to reliably implement consistent heading indentation within a best practice model:

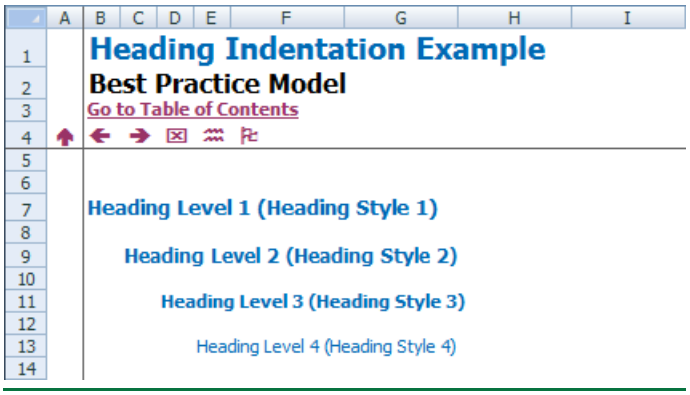
1. Create a number of hierarchical heading styles – e.g. Heading 1 – Heading 4 (styles are discussed in detail in Chapter 4 Formats & Styles);

2. Adjust the column width of the first four columns within which you intend to use these heading levels on each sheet type (see BPMS 1-3 Sheet Content for more information on sheet types); and

3. Apply consistently each style to headings within their corresponding column within each worksheet.

An example of this process is provided below:

Heading Indentation – Example 1



A more realistic example, showing the consistent use of headings within a Balance Sheet, is shown below:

Heading Indentation – Example 2

1		**Balance Sheet**									
2		**Best Practice Model**									
3		Go to Table of Contents									
4		← →									
5											
6											
7		Year Ending 31 December								2013 (F)	2014 (F)
14											
15											
16		**Balance Sheet**							Opening		
17									1-Jan-13		
18		**Current Assets**									
19											
22		Cash at Bank							5.0	33.8	46.3
23		Accounts Receivable							65.0	124.8	126.9
24		Other Current Assets							3.0	3.0	4.0
25		**Total Current Assets**							**73.0**	**161.6**	**177.2**
26											
27		**Non-Current Assets**									
28											
29		Assets							1,550.0	1,484.0	1,408.3
30		Intangibles							80.0	127.1	165.1
31		Deferred Tax Assets							-	-	-
32		Other Current Liabilities							4.0	4.0	5.0
33		**Total Non-Current Assets**							**1,634.0**	**1,615.1**	**1,578.4**
34											
35		**Total Assets**							**1,707.0**	**1,776.7**	**1,755.6**
36											

Note that it will often not be possible to use perfect consistency when using heading indentation – e.g. even in the above example the 'Cash at Bank' heading and 'Total Current Assets' heading are in the same column, even though they have been formatted in Heading Style 4 and Heading Style 3 respectively. This is not bad practice, because in this instance it would be more confusing to indent the 'Cash at Bank' heading than to place it in the same column as the 'Total Current Assets' heading.

Hence, it can be seen from this simple example that heading level indentation, whilst fundamentally important to achieving *general sheet consistency*, is not a perfect science but rather a 'best endeavours' recommendation of the standards and conventions.

3.7 Sample Sheet Layouts

Other than purpose-based workbook structuring and formatting and ensuring consistency between workbook sheet types, the general layout of the different sheet types remains largely at the discretion of the model developer. However, if model developers clearly segregate the presentation outputs sections of their spreadsheet models (see BPMS 7-1 Segregation of Outputs) the body of the spreadsheet model should be primarily functional rather than aesthetically appealing.

The sample sheet type layouts in this section of the standards have been provided as examples of the way in which the different sheet types can be laid out distinctively yet consistently to ensure the effective implementation of a purpose-based workbook structure. The sheets provide a base starting point for the addition of any new sheet to a spreadsheet model.

The following common elements should be inserted with every worksheet, regardless of sheet type:

1. *Sheet Title* – used as the basis for the table of contents hyperlink reference. Should be the first and largest title on each worksheet;

2. *Model Name* – should appear near the sheet title. Should be entered on the workbook cover sheet and referenced by formula on all other worksheets; and

3. *Table of Contents Hyperlink* – provides immediate access to the workbook table of contents at the click of the mouse.

The remainder of this section is dedicated to a discussion of the elements relevant to each specific sheet type and the provision of visual examples of these basic sheet types. Note that all visual examples of these basic sheet types have been provided in Print Preview View in order to demonstrate the consistent use of page setup properties (i.e. headers and footers, etc.).

Workbook Cover Sheet

BPMC 3-4 recommends that the following content be included in the workbook cover sheet:

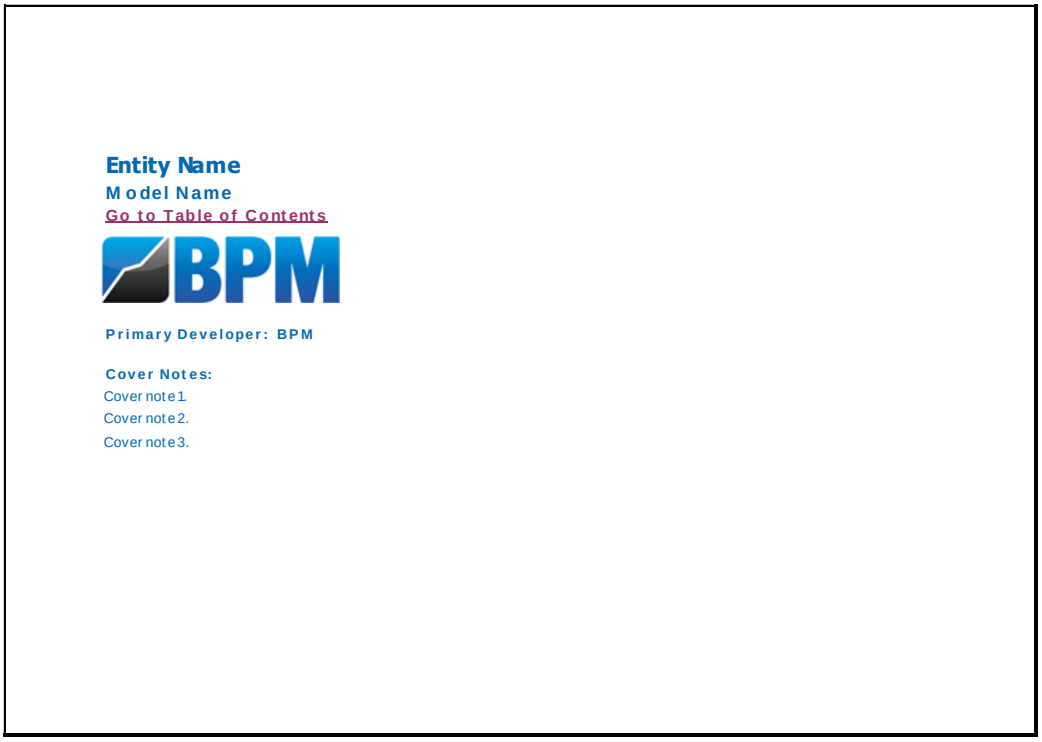
a. The model name;

b. The model developer's name and contact details (if appropriate); and

c. Workbook cover sheet notes.

An example of a workbook cover sheet that implements these recommendations is provided below:

Workbook Cover Sheet Example



Note from this sample workbook cover sheet:

- The *entity name* and *model name* are entered (in this example as constant) onto this sheet;
- A table of contents hyperlink allows model users to click through to the table of contents;
- The name of the primary model developer is displayed;
- Cover notes are clearly displayed; and
- No headers or footers have been used because the details of the model are stated above and page numbers are not required (because the workbook cover sheet should always be the first sheet in a workbook).

Section Cover Sheets

BPMC 3-6 recommends that the following content be included in section cover sheets:

a. A title for the following section;

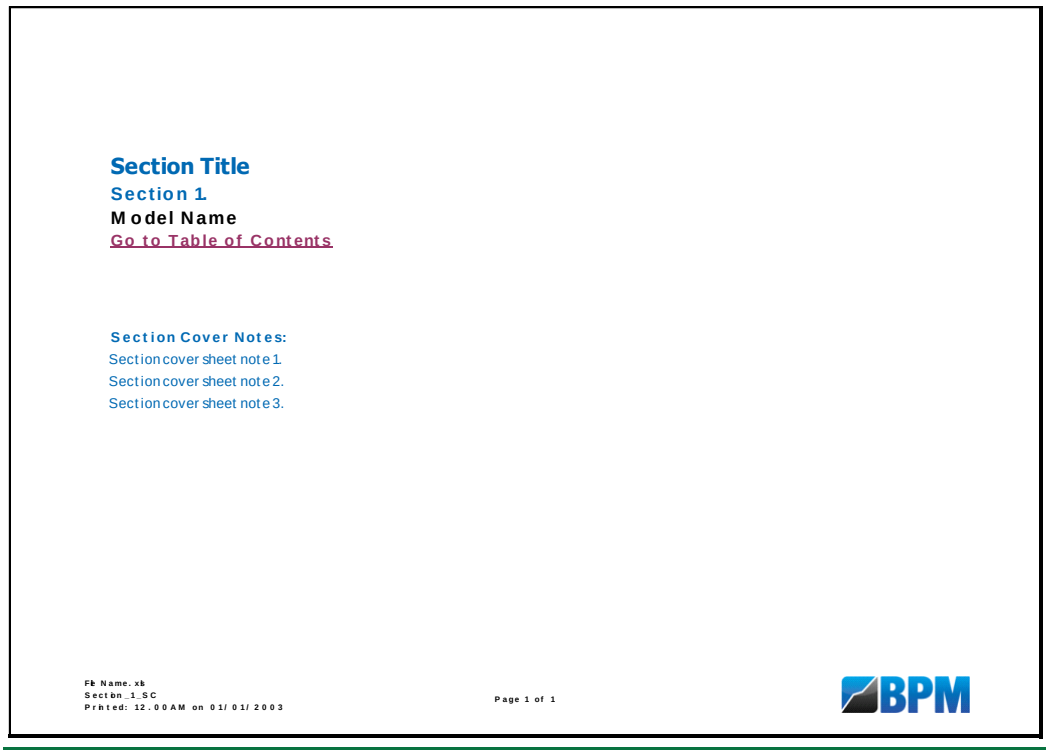
b. The section number for the following section;

c. Section cover sheet notes; and

d. The model name.

An example of a workbook cover sheet that implements these recommendations is provided below:

Workbook Cover Sheet Example



Note from this sample section cover sheet:

- The *section title and section number* are clearly entered at the top of the sheet;
- The *model name* reference is linked to the workbook cover sheet (and hence formatted in formula black to indicate the formula content of this cell);
- A table of contents hyperlink allows model users to click through to the table of contents;
- Section cover notes are clearly displayed;
- Footers have been included to communicate the file name, sheet name, time of printing and page number to model users when they print the sheet; and
- The use of the Section Cover Sheet naming suffix ('SC') (see BPMC 9-3 Sheet Naming - Suffixes) in the sheet name (which can be viewed in the left footer).

Note the intentional similarity in the layouts of the example workbook cover sheet (in the prior section) and the example section cover sheet. This consistency should be used for all cover sheets, including potential sub-section cover sheets, as it ensures that model users will immediately recognise cover sheets when they activate any of these sheets.

The primary difference between the workbook cover sheet, section cover sheets and sub-section cover sheets is their treatment within the table of contents. As shown in the sample contents sheet below, the table of contents structure should clearly highlight the different section and sub-section levels created by these cover sheets using appropriate indentation and numbering.

Contents Sheet

The contents sheet is the central navigational hub of a well-structured spreadsheet model. In addition to providing rapid hyperlink access to every worksheet in the underlying workbook, a well-constructed table of contents attests to the reasonableness and logic of the structure that has been built into the workbook.

The following sample contents sheet should be analyzed in conjunction with BPMS 2-5 Table of Contents Information. The example shows how two sections, each with two sub-sections (each with 2 sheets) should be laid out in a table of contents:

Contents Sheet Example

Table of Contents
Model Name
Cover Sheet

Section & Sheet Titles	Page
1. Section 1 Title	3
Sub-Section 1.1 Title	4
a. Sheet 1 Title	5
a. Sheet 2 Title	6
Sub-Section 1.1 Title	7
a. Sheet 3 Title	8
a. Sheet 4 Title	9
2. Section 2 Title	10
Sub-Section 2.1 Title	11
a. Sheet 5 Title	12
a. Sheet 6 Title	13
Sub-Section 2.2 Title	14
a. Sheet 7 Title	15
a. Sheet 8 Title	16
Total Pages	16

File Name.xls
Contents
Printed: 12.00AM on 01/01/2003

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BPM

Note from this sample contents sheet:

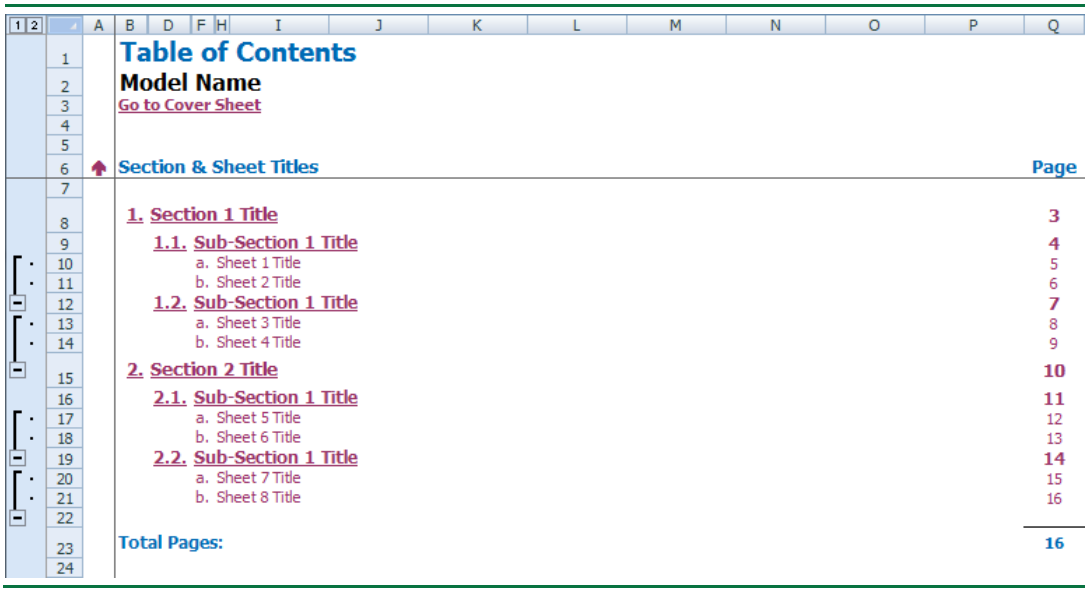
- The workbook cover sheet does not appear in the table of contents because it should always be before the content sheet. However, a hyperlink to the workbook cover sheet has been included at the top of the worksheet to ensure that model users can access every worksheet in the model from the contents sheet;

- The workbook sheet type hierarchy is represented using indent levels – i.e. section cover sheets are the highest level indenting to non-cover sheets as the lowest level. This approach visually communicates to model users and other developers the structure of the underlying model; and

- The inclusion of a printed page numbers column to enable the user-friendly printing of the workbook.

There are important elements of the previous sample contents sheet which cannot be seen in Print Preview mode. The following screen view of the same sample Contents Sheet has been provided to demonstrate these elements:

Contents Sheet Example – Screen View



Note from this screen view of the sample contents sheet:

- The grouping of all non-cover sheet rows in the table of contents to enable the detail to be compacted and expanded as the underlying workbook becomes larger;

- The use of a sheet top hyperlink in cell A6 to enable model users to rapidly reset to worksheet to the top position (as per the example provided in 3.4 Window Panes and Splits); and

- The freezing of window panes around cell B7 to ensure that all the important information above row 7 is kept in view even after a model user scrolls down the worksheet. This also ensures that the sheet top hyperlink in cell A6 is always in view.

The manner in which rows and columns are sized to accommodate the table of contents is up to the model developer. However, once the structure is set up to handle all cover sheet and non-cover sheet sheet types, it should not change thereafter.

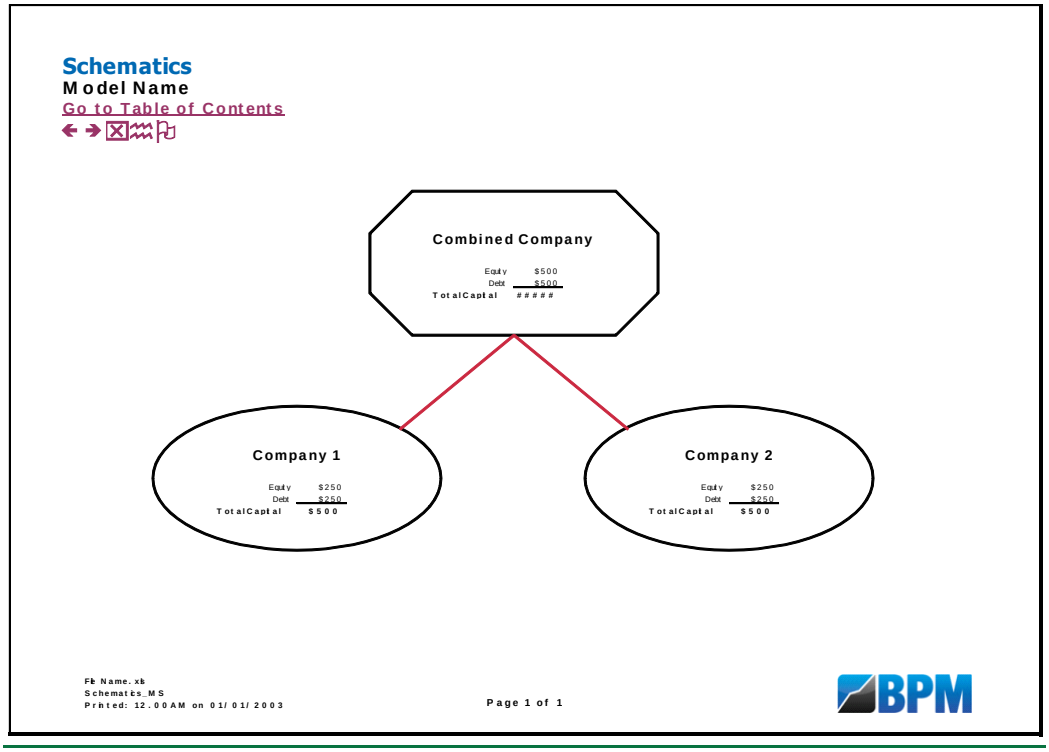
Schematics Sheets

The schematics sheet type is not differentiated from the other sheet types listed in BPMS 1-3 and BPMC 1-1 purely because it houses diagrams, flowcharts, drawing objects, etc. In fact, the primary distinguishing feature of a schematics sheet is its grid structure which is used to accurately position objects over and around its worksheet ranges.

This grid structure, as the following example will demonstrate, is achieved through the adjustment of the row height and column widths of all rows and columns on each schematics sheet (other than the sheet title and headings rows) to create a grid of perfect squares. Because these squares are worksheet ranges, all worksheet formula functionalities are retained for use alongside and within the objects inserted within the worksheet.

The following example shows a simple schematics sheet in print preview. The diagram inserted on the worksheet depicts the simple conglomeration of two companies; Company 1 and Company 2.

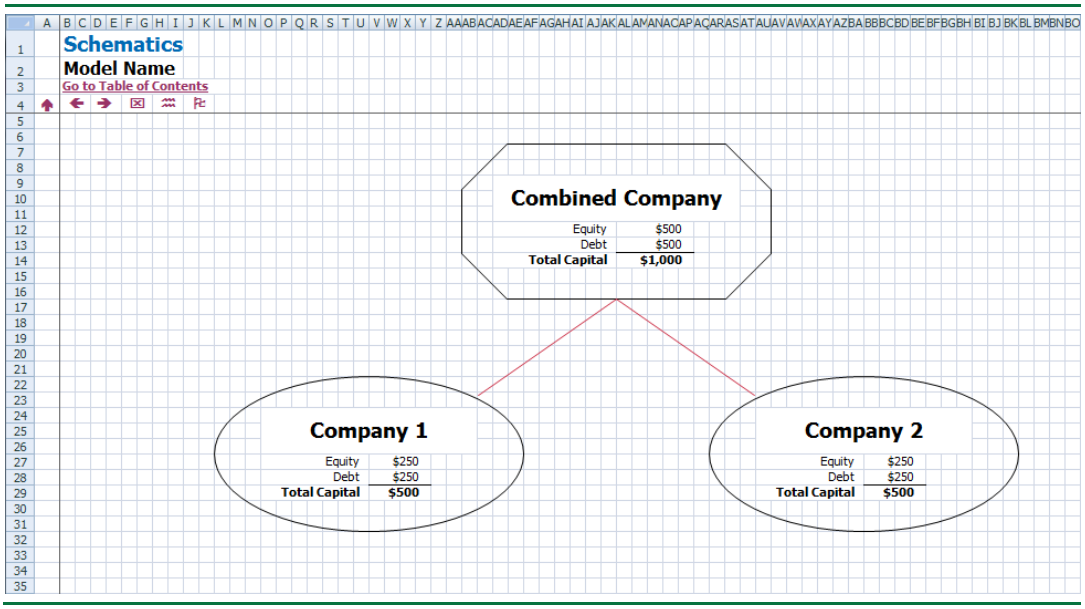
Schematics Sheet Example



Because the above example schematics sheet is shown in print preview, it is not possible to view the underlying grid structure which has made the perfect layout of the diagram very simple.

To demonstrate this grid structure, the screen view of the same schematics sheet is shown below:

Schematics Sheet Example – Screen View



Note from this screen view:

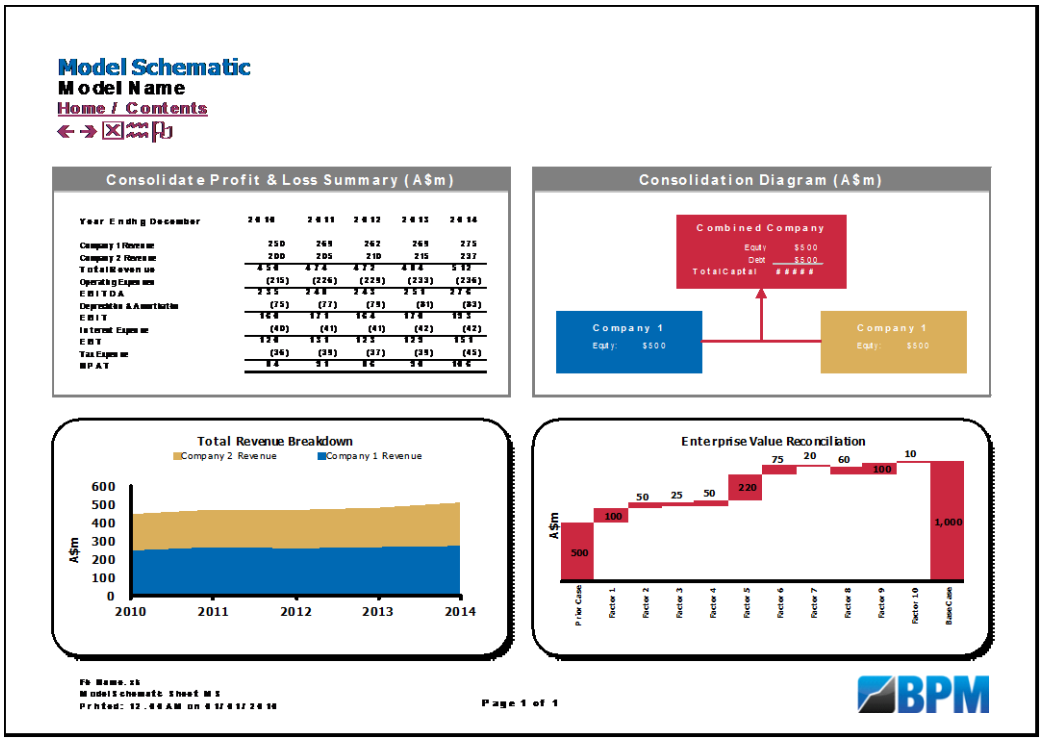
- The grid of squares created by equating all row heights and column widths;
- The use of merging to ensure that data inserted in the worksheet ranges fits within the merged ranges and does not re-size rows or columns to auto fit;
- The placement of shapes (with no fill color in this example) aligned with worksheet ranges to ensure perfect alignment and positioning; and
- The use of visible gridlines and page breaks (the dotted lines along the right hand and bottom edges of the screen) to ensure the perfect alignment of the diagram within the schematics sheet.

From this simple example it can be seen that the use of the grid structure in a schematics sheet creates the maximum level of layout and design control for schematic diagrams. However, the main advantage of the approach is that it allows complex worksheet calculations to be included in conjunction with diagrams (and even charts) that can be easily positioned and aligned.

The development of clear, informative and impressive schematics sheets (and the diagrams within them) is something which becomes quicker and easier with practice. Model schematic sheets can be constructed to represent anything from simple flow charts or structure diagrams to detailed schematics breaking out the logic behind complex model formulas.

The following example shows how a schematics sheet can be used to house tables and charts – a layout often referred to as a *Dashboard*:

Schematics Sheet – Dashboard Example



Note that schematics sheets are by nature always outputs sheets – i.e. assumptions should never be entered on schematics sheets. It is for this reason that it is important that most of the information included on a schematics sheet be linked to the outputs of the underlying model by formula to ensure that it remains live as the calculations in the model change the outputs data.

Additionally, model developers may want to present information in ways which is not possible without breaching the purpose-based formatting requirements of the standards – e.g. in the above example where white font color has been used for the headings on the top two tiles in the dashboard. This should be done via the use of *presentation sheets* and *presentation styles*, which are by nature exempt from the standards and conventions. See Chapter 7 for a detailed discussion of presentation sheets.

Time Series Sheets

The distinguishing characteristic of all time series sheets is the inclusion of time series period titles which state the periods over which data is being analysed. For more information on Time Series Analysis, see Chapter 10.

The following example shows a time series outputs sheet containing some sample revenue forecasts for a hypothetical company, Company 1:

Time Series Outputs Sheet Example

Company 1 - Revenue Projections

Model Name

Home / Contents

Year Endng 31 December	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Revenue Summary - A$m														
Revenue Stream 1	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 2	25.0	26.9	27.1	27.8	28.5	29.2	30.0	30.7	31.5	32.3	33.1	33.9	34.7	35.6
Revenue Stream 3	7.5	8.1	8.1	8.3	8.6	8.8	9.0	9.2	9.4	9.7	9.9	10.2	10.4	10.7
Revenue Stream 4	52.5	56.4	57.0	58.4	59.9	61.4	62.9	64.5	66.1	67.8	69.5	71.2	73.0	74.8
Revenue Stream 5	10.0	10.8	10.9	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2	13.6	13.9	14.2
Revenue Stream 6	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Revenue Stream 7	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 8	30.0	32.3	32.6	33.4	34.2	35.1	36.0	36.9	37.8	38.7	39.7	40.7	41.7	42.7
Revenue Stream 9	15.0	16.1	16.3	16.7	17.1	17.5	18.0	18.4	18.9	19.4	19.8	20.3	20.8	21.4
Revenue Stream 10	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Total Revenue	250.0	268.8	271.4	278.2	285.2	292.3	299.6	307.1	314.8	322.7	330.7	339.0	347.5	356.1
Revenue Growth Summary - %p.a.														
Revenue Stream 1		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 2		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 3		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 4		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 5		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 6		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 7		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 8		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 9		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 10		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%

File Name. xls
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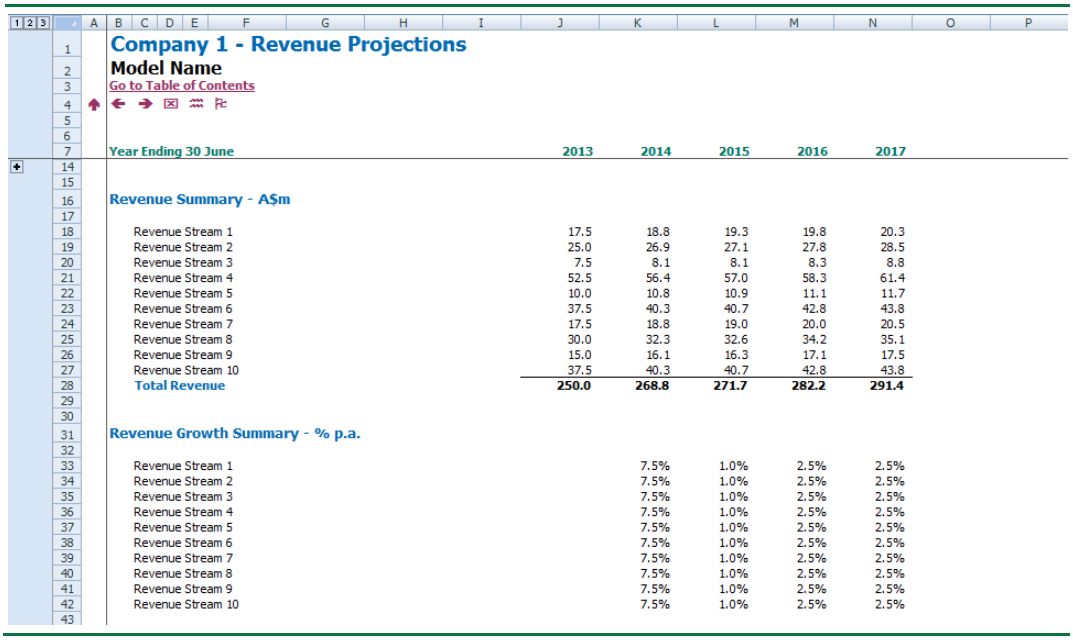
Note from this sample time series outputs sheet:

- The inclusion and consistent layout and placement of time series period titles – in this case annual periods starting from 2013; and
- The perfect alignment of the decimal places for both numbers and percentages (as recommended by BPMC 4-2 Cell Data Alignment).

One of the most important elements of time series sheets is the use of window panes to ensure that the time series period titles remain in view even when model users scroll down the worksheet. The following screen view of the same time series outputs sheet demonstrates how this technique is used:

Time Series Outputs Sheet Example – Screen View



Company 1 - Revenue Projections

Model Name

Go to Table of Contents

Year Ending 30 June	2013	2014	2015	2016	2017
Revenue Summary - A$m					
Revenue Stream 1	17.5	18.8	19.3	19.8	20.3
Revenue Stream 2	25.0	26.9	27.1	27.8	28.5
Revenue Stream 3	7.5	8.1	8.1	8.3	8.8
Revenue Stream 4	52.5	56.4	57.0	58.3	61.4
Revenue Stream 5	10.0	10.8	10.9	11.1	11.7
Revenue Stream 6	37.5	40.3	40.7	42.8	43.8
Revenue Stream 7	17.5	18.8	19.0	20.0	20.5
Revenue Stream 8	30.0	32.3	32.6	34.2	35.1
Revenue Stream 9	15.0	16.1	16.3	17.1	17.5
Revenue Stream 10	37.5	40.3	40.7	42.8	43.8
Total Revenue	**250.0**	**268.8**	**271.7**	**282.2**	**291.4**
Revenue Growth Summary - % p.a.					
Revenue Stream 1		7.5%	1.0%	2.5%	2.5%
Revenue Stream 2		7.5%	1.0%	2.5%	2.5%
Revenue Stream 3		7.5%	1.0%	2.5%	2.5%
Revenue Stream 4		7.5%	1.0%	2.5%	2.5%
Revenue Stream 5		7.5%	1.0%	2.5%	2.5%
Revenue Stream 6		7.5%	1.0%	2.5%	2.5%
Revenue Stream 7		7.5%	1.0%	2.5%	2.5%
Revenue Stream 8		7.5%	1.0%	2.5%	2.5%
Revenue Stream 9		7.5%	1.0%	2.5%	2.5%
Revenue Stream 10		7.5%	1.0%	2.5%	2.5%

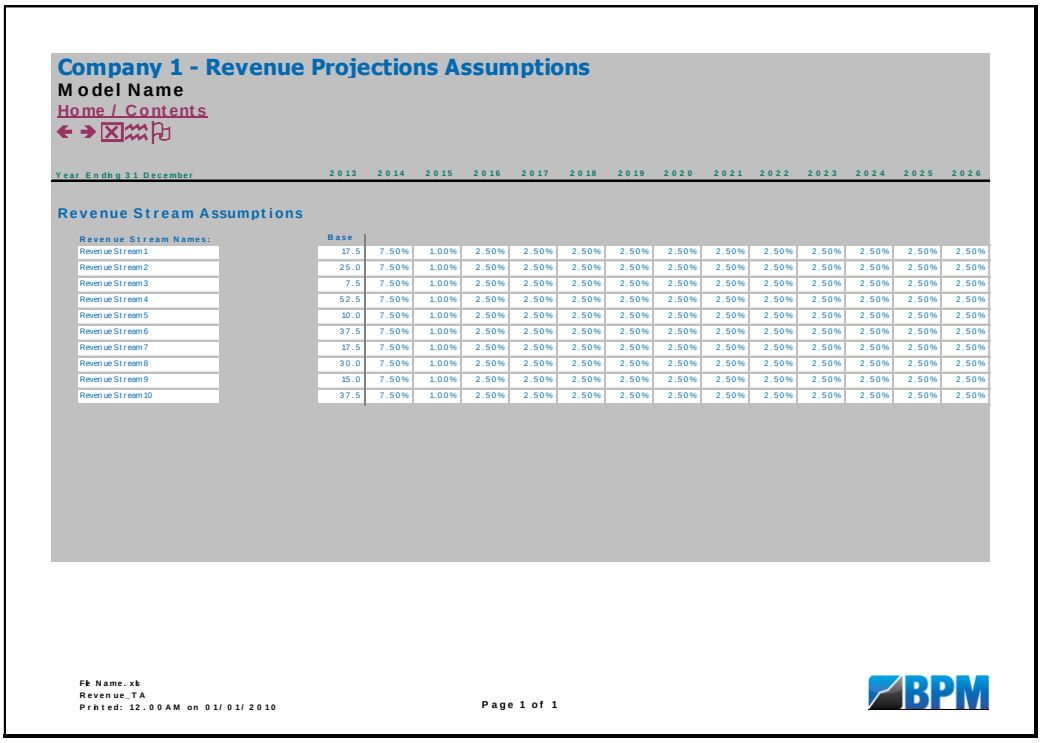
Note from this screen view:

- Calculations supporting the time series period titles (in rows 8 – 13) have been grouped and therefore hidden from view to simplify the sheet layout; and
- The window panes have been frozen around cell B14 (as per BPMC 3-9) to ensure that the time series period titles in row 7 remain in view when model users scroll down the worksheet.

This example also demonstrates the consistent and logical application of purpose-based styles and formats as discussed in Chapter 1, General Concepts and Chapter 4, Formats and Styles.

Note that the only difference between the layout and presentation of time series outputs sheets and time series assumptions sheets is the fill color property of the sheet (see BPMC 1-2 Sheet Purpose Identification). If the sheet consistency principles discussed in 3.2 Sheet Consistency are correctly followed, the sheets should be visually reconcilable but for the detailed content within the sheet - i.e. the following time series assumptions sheet could correspond with the time series outputs sheet example provided above:

Time Series Assumptions Sheet Example – Screen View



Company 1 - Revenue Projections Assumptions

Model Name

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Year Ending 31 December

Revenue Stream Assumptions

Revenue Stream Names:	Base	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Revenue Stream 1	17.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 2	25.0	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 3	7.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 4	52.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 5	10.0	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 6	37.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 7	17.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 8	30.0	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 9	15.0	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 10	37.5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%

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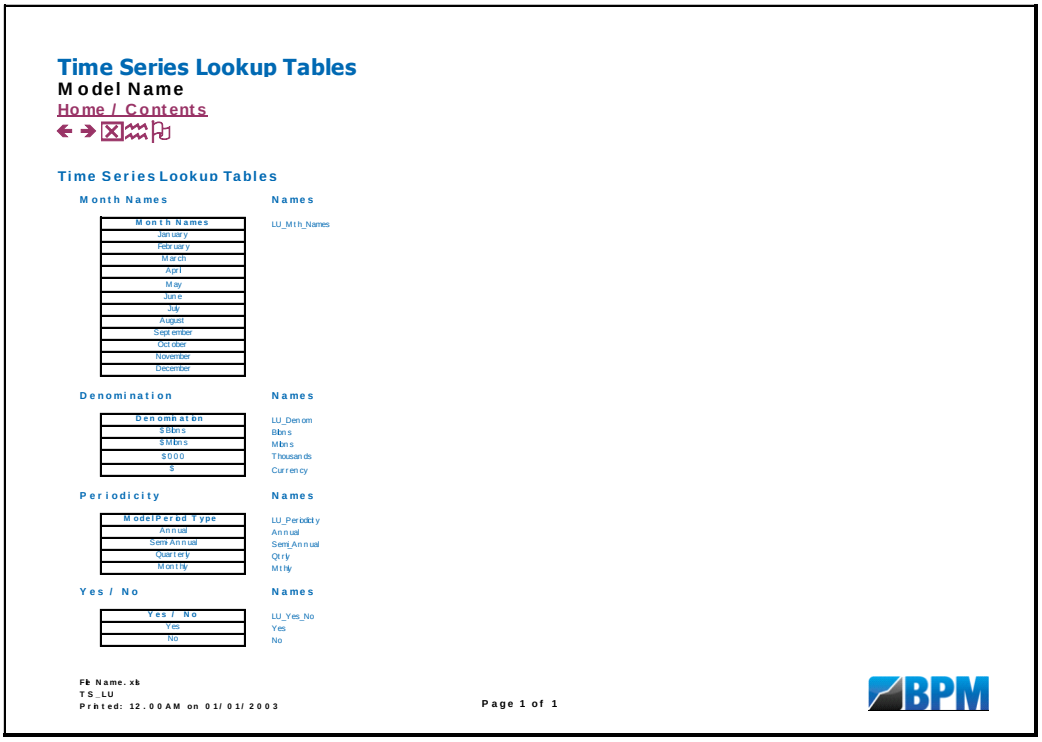
Note that no controls have been inserted on this time series assumptions sheet to ensure that the example remains simple. In reality, controls should always almost be used when developing assumptions entry interfaces to minimize potential errors during the assumption entry process. This concept is discussed in detail in Chapter 5, Assumptions Entry Interfaces.

Lookups Sheets

When inserting certain controls into a spreadsheet model (particularly drop down boxes and list boxes) ranges must be specified which contain the data that will be used in these controls. This reference data is referred to as 'lookup data' and should always be placed on lookup tables on lookups sheets (see BPMS 5-4 Control Lookup Data). In this way, the lookup data for all controls in a spreadsheet model will be centrally located in a known position, and can be easily accessed or updated.

The following example shows a lookups sheet containing some sample lookup tables for use in controls and formulas throughout the surrounding workbook:

Lookups Sheet Example



Time Series Lookup Tables
Model Name
Home / Contents

Time Series Lookup Tables

Month Names — **Names**

Month Names
January
February
March
April
May
June
July
August
September
October
November
December

LU_Mth_Names

Denomination — **Names**

Denomination
$Bbns
$Mbns
$'000
$

LU_Denom
Bbns
Mbns
Thousands
Currency

Periodicity — **Names**

ModelPerbd Type
Annual
Semi Annual
Quarterly
Monthly

LU_Periodcty
Annual
Semi Annual
Qtrly
Mthly

Yes / No — **Names**

Yes / No
Yes
No

LU_Yes_No
Yes
No

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Note from this sample lookups sheet:

- The clear and consistent layout and formatting of all the lookup tables within the lookups sheet;
- A single column of lookup tables has been included within the lookups sheet, making the addition and removal of lookup tables easy without concern for other lookup tables which might otherwise have been inserted in a second or third column of lookup tables;
- The naming of each lookup table in accordance with the range naming principles recommended in BPMC 9-5 Range Naming – Prefixes – e.g the first lookup table provides a list of month names and has accordingly been named 'LU_Mth_Names'; and
- The communication of the range names applied in a names column next to each lookup table, including the range names applied to lookup table items – e.g. 'Yes' and 'No' in the bottom lookup table.

Lookup tables should be placed on their corresponding lookups sheets dividing logically by area. Different lookups sheets should be created for each area within a model that utilizes lookup ranges. Lookups sheets containing lookup data that will be used in controls and formulas throughout the model (such as the lookups sheet in the above example) should be titled in a way which indicates this general applicability and placed at the start of the lookups section within a workbook.

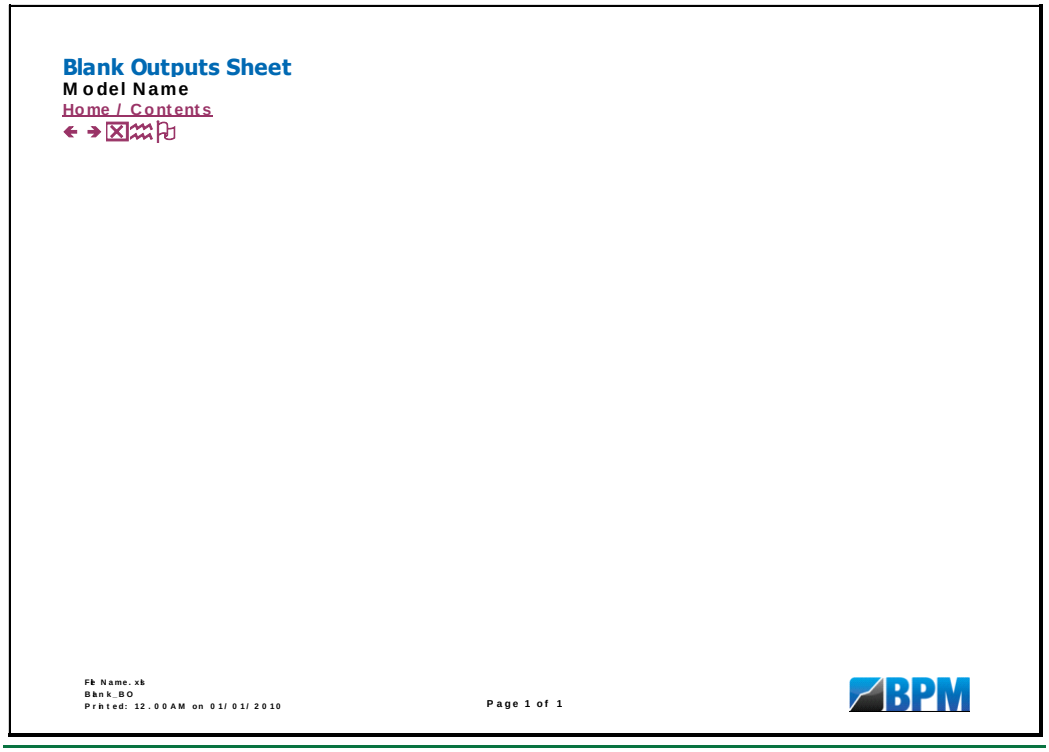
Importantly, lookups sheets are purely *functional* – i.e. their sole purpose is to provide a dedicated area to house lookup data. As a result, the entire lookups section of a workbook is often hidden after the model is completed. Hence, a strict application of sheet consistency and structuring rules should be applied when developing lookups sheets and inserting lookup tables.

Note that similarly to schematics sheets, lookups sheets should never contain assumptions and should therefore never be assumptions sheets. Although the lookup table data is data that is entered into the model by the model developer during the model construction process, it should never be intended to be changed by model users and is therefore by implication *non-assumption* in purpose.

Blank Sheets

As discussed in Chapter 1, the blank sheet type is a residual sheet type – i.e. it is designed to facilitate any type of sheet content that does not fall within one of the other sheet types listed in BPMS 1-3 Sheet Content and BPMC 1-1 Sheet Types. The following example shows the Print Preview of an empty blank outputs sheet:

Blank Outputs Sheet Example



Note the consistency of the layout of the blank outputs sheet with the other sheet type examples previously provided. Although the content of blank sheets will be of varying types, the general sheet consistency principles stated in BPMS 3-1 Sheet Titles and BPMC 3-1 Sheet Content Consistency should be strictly followed to prevent blank sheets from breaking down the consistency and flow of the surrounding spreadsheet model.

For completeness, the print preview of an empty blank assumptions sheet is shown below:

Blank Assumptions Sheet Example

Note that although the assumption grey fill color of the assumptions sheets in the previous examples fills the entire screen when working on screen, only the print area of each worksheet will be printed grey.

Chart Sheets

As stated in BPMC 3-3, chart sheets should not be used in the development of best practice spreadsheet models because they reduce the navigational user-friendliness of the underlying workbook.

In addition to causing workbook navigational problems, chart sheets are difficult to structure and present in a consistent and logical way. Experienced model developers will know how to place text boxes and other objects within a chart sheet to mimic the structure of neighbouring worksheets, but these techniques are complicated, imperfect and generally troublesome, let alone confusing to average model users.

For these reasons, and because it is simply not possible to perfectly standardize all chart sheets within a spreadsheet model, a chart sheet example is not provided in these standards.

3.8 Sheet Type Component Summaries

The following table provides a summary of the basic components common to each sheet type, taking into account titles, headings, hyperlinks and other components which together distinguish each sheet type from one another. The non-generic information included within some sheet types has been highlighted in italics.

Sheet Type	Common Components
Workbook Cover	• Model name entry (constant) • Entity entry (constant) • Go to Table of Contents hyperlink • Workbook cover sheet notes
Section Cover	• Section title • Section number • Model name reference (formula link) • Go to Table of Contents hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Section cover sheet notes
Sub-Section Cover	• Sub-section title • Sub-section number • Model name reference (formula link) • Go to Table of Contents hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Sub-section cover sheet notes
Contents	• Title (e.g. 'Table of Contents') • Model name reference (formula link) • Go to Table of Contents hyperlink • Sheet top hyperlink • Sheet left / right hyperlinks (if applicable) • Frozen panes • *Table of Contents*
Schematics	• Sheet title • Model name reference (formula link) • Go to Table of Contents hyperlink • Sheet top hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Frozen panes • *Row heights and column widths set to square grid* • *Schematic diagrams*

Sheet Type	Common Components
Time Series	• Sheet title • Model name reference (formula link) • Go to Table of Contents hyperlink • Sheet top hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Frozen panes • *Time series period titles* • *Data analyzed over multiple time series periods*
Lookups	• Sheet title • Model Name reference (formula link) • Go to Table of Contents hyperlink • Sheet top hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Frozen panes • *Lookup tables*
Blank	• Sheet title • Model Name reference (formula link) • Go to Table of Contents hyperlink • Sheet top hyperlink • Sheet left / right hyperlinks (if applicable) • Error / sensitivity / alert check hyperlinks (if applicable) • Frozen panes • *Residual category information*
Chart	• Sheet title • Model name reference (formula link)

Note that many of the components common to each sheet type are also common to all sheet types. This table indicates the different components that should be laid out and presented consistently to achieve both general sheet consistency and sheet type consistency as discussed earlier in 3.2 Sheet Consistency.

Chapter 4

Formats and Styles

4.1 Purpose-Based Formatting

The concept of purpose-based formatting was introduced in Chapter 1, General Concepts. As discussed in that chapter, purpose-based formatting is used for two primary purposes:

1. Cell identification (see BPMC 1-3 Cell Content Identification and BPMC 1-4 Cell Purpose Identification); and

2. Sheet identification (see BPMC 1-2 Sheet Purpose Identification).

This chapter further discusses cell identification techniques in more detail and introduces the use of styles as a means of efficiently applying purpose-based formats.

Formats and Styles

While the word 'format' is used generally to refer to the outward appearance of something, its definition is far narrower for the purposes of best practice spreadsheet modeling. For the purpose of these standards, a *format* may be thought of as a single property of an object which affects its appearance. For example, in many spreadsheet applications, the following formats may be applied to the font component of a cell:

a. Name;

b. Size;

c. Bold;

d. Italic;

e. Underline;

f. Color;

g. Strikethrough;

h. Superscript; and

i. Subscript.

While each of these formats affects the appearance of the underlying cell (or more accurately the appearance of the font of the underlying cell), not one of them can alone be correctly described as the format of the cell. This is because the appearance of a cell is determined by the combination of its format properties, which together form the *style* of that cell.

The terms 'format' and 'style' are often used interchangeably, which has resulted in many model developers assuming that formats and styles are the same thing. In fact, a style is a collection of pre-determined formats which are applied to a cell in one action rather than independently. Hence, the use of well-prepared purpose-based styles is strongly recommended to ensure consistent formatting and efficient model construction.

Hence, before discussing the basic creation and application of styles, it is important to understand the difference between a format and a style. The following definitions have been provided for use within these Standards:

a. **Format:** A single property of a cell or other object that affects its outward appearance; and

b. **Style:** A collection of pre-determined formats consistently applied to cells or other objects.

It can be seen from these definitions how the creation and application of styles, as opposed to the ongoing application of individual formats, can greatly reduce model development time.

Formats and Styles Key

The key to best practice cell identification is the consistent application of a set of formats (often through a pre-determined set of styles) to the cells within the workbook to efficiently communicate to model users and other model developers the content and purpose of each cell.

This process is done via two steps:

1. Determine the formats (and styles) to be used to indicate cell content and purpose; then

2. Communicate the purpose of each format (and style) to model users and other model developers.

The first of these steps can be done at the discretion of the model developer or in accordance with the recommended sheet and cell classification color-coding principles enunciated in BPMC 1-2 – BPMC 1-4. The second step is governed by BPMS 4-1 and is achieved through the inclusion of a centralized Formats and Styles Key:

BPMS 4-1 Formats and Styles Key

Every *workbook* should contain a key or legend that explains the purpose of each *format* and *style* that has been applied to the *cells* in the *workbook*.

The Formats and Styles Key should contain examples of each standardized format and style that has been applied in the workbook with an associated definition. Additionally, if the color-coding principles recommended in these standards have been adopted as the basis for deriving purpose-based formats and styles, a reference to these standards could be included in the workbook.

If the color-coding principles recommended by the sheet and cell identification conventions in BPMC 1-2 – BPMC 1-4 have been utilized, the Formats and Styles Key should appear something like the following (placed within a blank outputs sheet):

Color Name	Color Description / Purpose	Example
Font Colors		
Constant	Indicates ranges contain 100% constant (e.g. text/numbers).	**Constant**
Formula	Indicates ranges contain pure formulas / output calculations.	**Formula**
Mixed	Indicates ranges contain a mixture of formulas and constants (e.g. formulas that contain embedded text or numbers).	**Mixed**
Check	Indicates operative checks – normally used as a conditional format.	**Check**
Hyperlink	Indicates ranges contain hyperlinks to other ranges within the workbook or to other linked models.	**Hyperlink**
Fill Colors		
Assumptions Sheet	Distinguishes assumptions sheets.	
Work in Progress (WIP)	Indicates ranges contain data or formulas that remain uncertain or are subject to change	
Assumption Cell	Distinguishes assumption cells.	

This Formats and Styles Key could also include a summary of the hyperlinks used throughout the workbook to further communicate to model users and other model developers the systems utilized in the spreadsheet model.

If the hyperlinks recommended in BPMC 4-4 (discussed below) are followed, the hyperlinks section of the Formats and Styles Key should appear something like the following:

Hyperlink Type	Description / Purpose	Example
Cover Hyperlink	• Links Contents Sheet to Cover Sheet	Go to Cover Sheet
Home Hyperlink	• Links worksheets to Contents Sheet	Go to Table of Contents
Custom Hyperlink	• Links worksheet ranges to other worksheet ranges in the model	Linked Cell Text
Sheet Top Hyperlink	• Scrolls worksheet to the upper-most viewable section	
Sheet Left Hyperlink	• Links active worksheet to the previous visible worksheet	
Sheet Right Hyperlink	• Links active worksheet to the next visible worksheet	
Error Check Hyperlink	• Links worksheet ranges to the workbook error checks summary (if included).	
Sensitivity Check Hyperlink	• Links worksheet ranges to the workbook sensitivity checks summary (if included).	
Alert Check Hyperlink	• Links worksheet ranges to the workbook alert checks summary (if included).	

The inclusion of a Formats and Styles Key becomes more important as the number of expected model users increases and as the level of familiarity that these model users will be expected to have with the spreadsheet model increases. Generally, it is recommended that every workbook contain a Formats and Styles Key to prevent any potential confusion in understanding the purpose of the formats and styles used in the workbook.

4.2 Styles

The implementation of purpose-based formatting and the required color-coding of each worksheet cell can become extremely tedious when constructing large and complex spreadsheet models. This process can be made far more efficient via the use of a number of pre-set purpose-based styles that can be repeatedly applied on command and ensure that all the purpose-based formatting requirements are met for each cell in each worksheet.

BPMC 4-1 Use of Purpose Based Styles

It is recommended that standardized, purpose based *styles* be applied in order to adopt the most efficient method of applying different combinations of *formats* and consistently identify and differentiate *cell purpose* and *cell content*.

Although the use of styles is not strictly necessary to effect purpose-based formatting (because formats could be applied individually to achieve the same outcome), an overview of the concepts has been included in these standards due to the significant time savings they can create.

A Note on the Cell Protection Format

Although explained in more detail in Chapter 14, Security and Protection, it is important to note the relevance of *cell protection* before discussing the creation of purpose-based styles. For a full explanation of the concepts of workbook and worksheet security and protection, see the Security and Protection chapter starting on page 231.

When adopting purposed-based formatting, the model developer should ensure that all *assumption cells are always unlocked* and all *non-assumption cells are always locked*. This will ensure that when the workbook and its component sheets are protected, model users will be prevented from inadvertently changing non-assumptions cells, such as output formulas, headings or other worksheet infrastructure.

By default, most spreadsheet applications will assume the model developer wants to lock all of the cells in each worksheet. This is a safe default, but will result in models being unusable (if formats and styles are not used correctly) if the worksheets are protected because model users will not be able to change any assumptions. Hence, assumption cells will need to be unlocked each time they are created to ensure the correct operation of a protected spreadsheet model.

Note as an additional consideration that a special type of assumption cell may exist in the form of a control cell link. In the event that control cell links are not unlocked and their parent worksheet is locked, model users will not be able to change the value in the control (which itself is an assumptions entry interface – see Chapter 5). Hence, cell links need to have their cell protection property unlocked (or a special unlocked style applied to them) when controls are linked to them to prevent this problem from arising.

Cell protection is an important component of controlling assumptions entry interfaces (see Chapter 5) and becomes more important with the likelihood of the final spreadsheet model being used by model users independently of the model developer. As a result, ensuring the correctness of the cell protection property of each style is fundamental to their correct operation.

Basic Purpose-Based Use of Styles

Although styles may contain many different components, there are only three critical components. The following style components *must* be correctly pre-determined if styles are to be used to efficiently effect purpose-based formatting:

Style Component	Purposes
Font Color	Indicates the *content* of a cell (i.e. constant, formula or mixed).
Fill Color	Indicates the *purpose* of a cell (assumption versus non-assumption) when used on an assumptions sheet.
Locked	Allows or prevents a cell from being changed when its worksheet is protected.

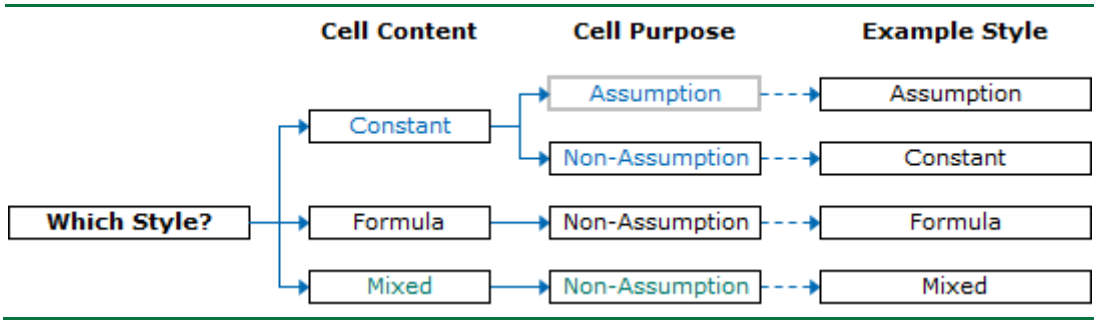
Note that the style components relate directly to the cell *content* and *purpose* identification requirements of BPMC 1-3 Cell Content Identification and BPMC 1-4 Cell Purpose Identification as discussed in Chapter 1, General Concepts.

At a minimum, styles should be created and applied to differentiate between:

- Cells containing constant, formula and mixed content; and
- Assumption cells and non-assumption cells.

The following table shows the process of differentiating the most basic style set required to undertake purpose-based formatting using styles:

Basic Style Set Breakout



The minimum format components of these basic styles (assuming the adoption of the recommended modeling colors) are summarized below:

Example Style	Font Color	Fill Color	Locked
Assumption	Constant Blue	White	False
Constant	Constant Blue	N/A	True
Formula	Formula Black	N/A	True
Mixed	Mixed Green	N/A	True

Note from these basic style examples:

- Every style needs to take into account the content of the underlying cell and indicate this through its font color component;
- Non-assumption styles should not include a preset fill color because the fill color of these cells will always be the fill color of the sheet to which they are being applied (i.e. assumptions grey if an assumptions sheet, otherwise white); and
- Assumptions styles are not locked – this will ensure that model users cannot change non-assumptions in the model unless granted this right by the developer (by either not protecting the worksheets or disclosing the worksheet protection passwords).

Hence, it can be seen that the cell *content* (i.e. constant, formula or mixed) determines the *font color* component of the style, while the cell *purpose* (assumption versus non-assumption) determines the *fill color* and *protection* properties of the style.

Extensive Utilization of Styles

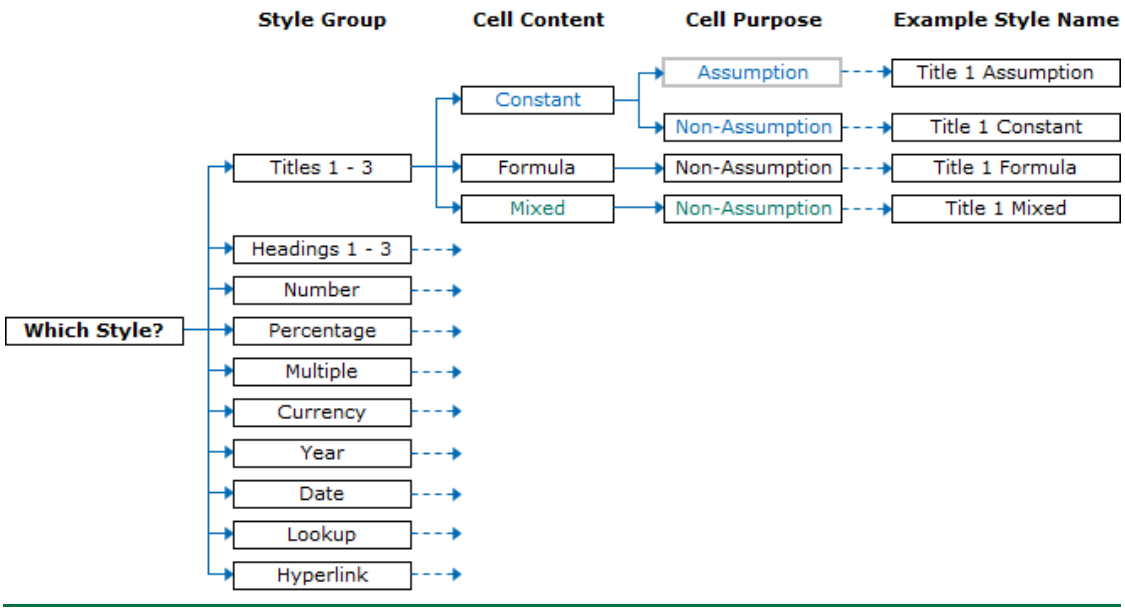
Although only a small number of basic styles are required to ensure that the requirements of purpose-based formatting are met, most model developers will wish to use styles extensively to minimize the amount of time and effort required to ensure workbook consistency and maximize the aesthetic appeal of their spreadsheet models.

The extensive utilization of styles consists of two steps:

1. Determine the exhaustive set of different styles to be used in the spreadsheet model, considering potential:
   a. Titles;
   b. Headings;
   c. Number formats (e.g. text, numbers, percentages, etc);
   d. Lookup table formats;
   e. Hyperlinks; and
2. Determine the format properties of each of these styles.

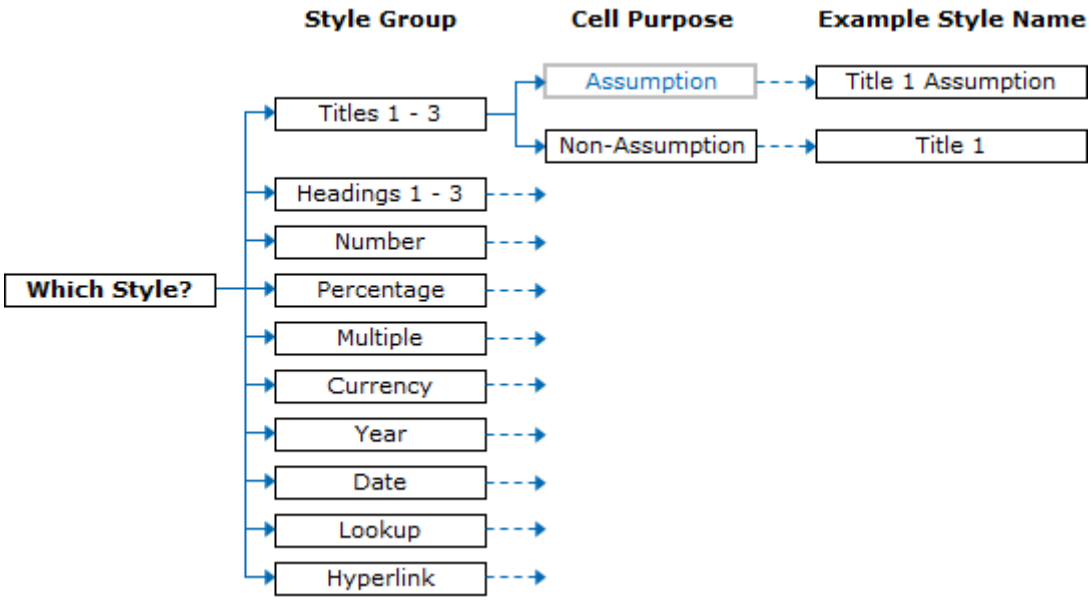
Because there are a finite number of different types of entry into a workbook, there are a limited number of different styles required by a model developer. The following diagram shows an example of the process which can be used to create an extensive and generally applicable set of styles which will serve the dual purposes of ensuring that best practice purpose-based formatting requirements are met while allowing for significant customization of the spreadsheet model worksheets:

Extensive Style Set Breakout



This example assumes that different styles will be used within each style for every different cell content and purpose combination. In reality, it is more efficient to only create an assumption and non-assumption version of each style group (which will ensure that the required fill color and cell protection components are correct) and then if necessary set the font color of the cell to constant blue, formula black or mixed green (formula black usually being the default). If this approach is adopted, font color (i.e. cell content considerations) should *not* be included as a component of the style when it is created and the style creation process is simplified to the following:

Simplified Style Set



If this simplified style structure is adopted, care must be taken to ensure that the font color of cell ranges is formatted correctly after content is entered to identify the underlying cell content – i.e. constant, formula or mixed.

Styles – Additional Comments

Although it is recommended that styles be used extensively by model developers, a detailed discussion of their creation and application is outside the scope of these standards. However, the following points should help model developers create and apply styles safely, efficiently and effectively:

- Avoid the tendency to define the components of a style too precisely. For example, if a heading style is created, this heading style will no doubt be used on both assumptions sheets and outputs sheets. Hence, if the fill color is specified as white, this style will only be appropriate on outputs sheets, and another duplicate style (but for the fill color format property) will be required for assumptions sheets. This concept should also be considered when debating the inclusion of borders and alignment properties. Generally, the model developer must decide whether each format property will always be expected as part of a style, or whether its inclusion will actually limit the applicability of the style or require frequent adjustments to cells post-style application;

- Styles are *workbook-specific*, but almost all spreadsheet applications allow the 'merging' or 'adoption' of styles from another workbook. Hence, the most efficient means of ensuring that a set of styles is used consistently and efficiently is to create a workbook to hold the styles, and adopt them each time the development of a new spreadsheet model commences. Obviously this template should be kept in a safe place and only updated when changes are required to the base style set; and

- Avoid applying styles to cells on a case by case basis. Instead, become familiar with the 'Copy' and 'Paste Special' tools which are available in spreadsheet applications. These tools, among other things, allow only the format of a cell to be copied to other cells (i.e. without values or formulas being transferred). If these tools are used in conjunction with shortcut keys, model developers should only have to apply a style once to each sheet after which these formats can be copied and pasted repeatedly to other ranges within that sheet.

Conversely, the following points should be noted as cautions to model developers using styles extensively for the first time:

- Unlike a workbook's color palette, cells which have already had styles applied to them are not always retrospectively updated when changes are later made to the components of these styles in all spreadsheet applications. For example, if a style is applied to a large number of cells and then the font name of the style is changed, it is likely that many of the existing cells will retain the original *font name* property. The model developer will then be required to re-apply the style on a case-by-case basis to each of these cells to ensure consistency. Although this problem is being addressed with the advancement of modern spreadsheet applications, it remains common and difficult to circumvent, and it is therefore recommended that model developers be certain about the majority of their style settings before commencing large spreadsheet modeling projects; and

- Avoid adding an excessive number of styles to a workbook. Although it may be satisfying to have a large number of different heading levels, etc, large numbers of styles require more application decisions and often result in inconsistencies between different cells in different sheets. The general principle is one of underlying simplicity which tends more towards practicality than aesthetics.

4.3 Data Alignment

The grid nature of worksheets allows the model developer the opportunity to introduce another dimension to data differentiation and presentation, aside from font and cell properties. That dimension is data alignment.

In presenting data in different columns or rows the model developer should consistently apply this presentation to data of a similar type or purpose. In doing so model users will be able to efficiently interpret and associate the different alignment levels of the data within the worksheet.

BPMS 4-1 Worksheet Data Alignment

All *data* of the same type on a *worksheet* should be consistently aligned down *rows* or across *columns*.

So it is important that model developers position data within a sheet so that it is consistently aligned between columns and/or rows. As such, the model developer should consistently start data of the same type in the same column and/or row of a sheet.

BPMS 4-2 Cell Data Alignment

It is recommended that all *data* within *cells* or *ranges* of *cells* be aligned such that different number *formats*, including any relevant symbols are perfectly aligned to the right of the *cell* or *cell range* (different number *formats* might include positive numbers, negative numbers, currency, percentages and multiples).

The nature of spreadsheets is such that data within cells should align either across columns or down rows when it is viewed or printed. This ensures that model developers and users can efficiently group, associate and interpret data within a sheet. Having data on a worksheet that is out of alignment diminishes the ability of model users to efficiently understand and work with the worksheet.

As such it is best practice to ensure that all data that is contained on a sheet is consistently aligned, even where some data may have specific symbols or formats associated with them. The example shows how various multiples of 10 would appear following the application of different number formats with correct data alignment:

Data Alignment

Number	Percentage	Multiple	Currency
(1,000,000.0)	(1,000,000.0%)	(1,000,000.0x)	($1,000,000.0)
(100,000.0)	(100,000.0%)	(100,000.0x)	($100,000.0)
(10,000.0)	(10,000.0%)	(10,000.0x)	($10,000.0)
(1,000.0)	(1,000.0%)	(1,000.0x)	($1,000.0)
(100.0)	(100.0%)	(100.0x)	($100.0)
(10.0)	(10.0%)	(10.0x)	($10.0)
0.0	0.0%	0.0x	$0.0
10.0	10.0%	10.0x	$10.0
100.0	100.0%	100.0x	$100.0
1,000.0	1,000.0%	1,000.0x	$1,000.0
10,000.0	10,000.0%	10,000.0x	$10,000.0
100,000.0	100,000.0%	100,000.0x	$100,000.0
1,000,000.0	1,000,000.0%	1,000,000.0x	$1,000,000.0

Number formats can become quite complicated. The most efficient way of ensuring that correctly aligned number formats are always applied is to build them into styles and then simply re-apply these styles when required.

4.4 Data Identification

There is a wide variety of data types that can be included in a spreadsheet model. The following are just a few examples of different ways in which the same number, 20.5, could be presented in a spreadsheet model:

$20.50, 2050%, 21kg, 20.5x, 20.5000Pj, 20/01/1900, 20.500m2,

£20.5, 20.5tons, US$20.50, 20.500, €20.50, 21, 20.50MWh.

It is therefore important that model developers clearly identify the denomination of all numbers within a model, whether they have been entered as an assumption or calculated as an output.

BPMS 4-3 Denomination Identification

Every number in a *workbook* should clearly indicate what type of *denomination* it is by either:

a) Stating the *denomination* of a number in an appropriate corresponding *heading*, *title column, row* or *label*; or

b) Formatting the number such that it is displayed as its *denominator* (e.g. $20, 20 tonnes, 20% or 20.0x).

Numbers that are included in a workbook will always be stated in a certain denomination. In this regard it is important that both the type of number and the denomination of numbers be clearly articulated wherever numbers appear in a spreadsheet model.

This can be achieved by:

a. creating appropriate headings, titles or labels for each group of numbers; or

b. formatting numbers so that they clearly state their denomination.

BPMS 4-4 governs the use of single and multiple denominations in a spreadsheet model:

BPMS 4-4 Workbook Denomination

There should be a primary *denomination* that is used consistently throughout the *workbook*.

Where *denominations* differ from the primary *denomination*, they should be clearly *labelled* to inform other *model developers* and *model users*.

Clearly indicating the denomination of numbers in a spreadsheet model is particularly important on assumptions sheets. For example, an assumptions entry interface may allow a model user to enter an assumption on either a 'Total' basis or on a 'Per Unit' basis. Depending on which option the model user selects, the denomination will change (i.e. possibly from 'Dollars' to 'Dollars/Unit'). In such a situation, it is fundamental that the change in denomination is clearly communicated (in this case via a heading or title) to the model user to prevent assumption entry errors.

4.5 Work in Progress Identification

It is important for both model developers and model users to keep track of areas within a spreadsheet model that are 'work in progress'. Work in progress might include:

a. Incomplete calculation formulas;

b. Incomplete links from other worksheets or workbooks;

c. Assumptions that are not finalized;

d. Missing assumptions or outputs; or

e. An area that has been temporarily modified.

It is important that areas within the model that are 'work in progress' are clearly and visually communicated as such to both model users and other model developers.

As such it is recommended that model developers apply a distinctive fill color to cells that are work in progress or subject to change as a clear visual identifier for both themselves and model users. BPMC 4-3 recommends the use of a light yellow fill color to achieve this objective:

BPMC 4-3 Work in Progress Identification

It is recommended that any *cells* in a *workbook* which have not been finalized be colored in light yellow *fill color* to visually identify these cells as being work in progress.

Note that the light yellow fill color recommended in BPMC 4-3 is consistent with the 'Work In Progress Yellow' fill color introduced when discussing cell purpose identification in Chapter 1, General Concepts.

4.6 Hyperlink Formatting

When inserting hyperlinks into a workbook, a model developer is creating workbook navigation tools for the workbook. These navigation tools are important for both the model developer and model user, particularly in large workbooks. As such, any hyperlinks that are included in a workbook need to be readily identifiable as being hyperlink navigation tools. This should be done through the use of a consistent and dedicated format or style for all hyperlinks in a workbook.

BPMS 4-5 Hyperlink Consistency

All *hyperlinks* within a *workbook* should use a consistent, dedicated *style* or *format* so that they are visually identifiable as being *hyperlinks*.

Ensuring hyperlink consistency in this way encourages model users to easily recognize hyperlinks and navigate around a workbook in the most efficient manner.

It is further recommended that model developers adopt hyperlink formats that are clearly differentiated from other formats that are used in a workbook and that the format mirror those that are regularly used by people on the internet. To achieve these objectives it is recommended that the consistently applied hyperlink format be a bold, underlined, plum colored font.

BPMC 4-4 Hyperlink Formats

It is recommended that all *hyperlinks* in a *workbook* be consistently *formatted* as follows:

a) Bold and underlined font; and

b) Plum *font color*.

Note that the plum font color recommended in BPMC 4-4 is consistent with the 'Hyperlink Plum' font color introduced when discussing cell content identification in Chapter 1, General Concepts.

Chapter 5

Assumptions Entry Interfaces

5.1 Overview

In Chapter 1, General Concepts, an *assumption* was defined as:

- Anything within a workbook that the model developer intends to be manipulated by model users to affect the workbook calculations.

Following on from this definition, an *assumptions entry interface* is:

- An area within a workbook in which an assumption is entered or modified.

Assumptions entry interfaces can take many forms including cells, controls and dialog boxes. For a model developer, constructing user friendly assumptions entry interfaces is one of the most important aspects of meeting the needs of model users. More importantly, constructing appropriately controlled assumptions entry interfaces is critical to maintaining the integrity of a spreadsheet model in the hands of model users.

Every assumption in a workbook should be entered via an assumptions entry interface. As discussed in BPMS 1-8 Assumptions Classification, there are two types of assumptions that can exist within a workbook:

a. Base assumptions; and

b. Sensitivity assumptions.

Any reference in these standards to an assumption or an assumptions entry interface is a reference to both base assumptions and sensitivity assumptions. For more information regarding sensitivity assumptions entry interfaces, see Chapter 6, Sensitivity Analysis.

5.2 The Interface Control Concept

The development of best practice assumptions entry interfaces within a workbook is governed by the *interface control concept*. The interface control concept requires that model developers use every possible method of controlling the assumption to be entered or modified by model users – thereby minimizing the risk of an inappropriate entry and flow on errors within a spreadsheet model.

Assumptions can be entered in many forms including numbers, percentages, boolean choices, text, list choices and multiple options to name a few. Most types of assumptions have a finite number of possibilities.

Some examples of finite assumptions include:

a. a boolean decision where the assumption must be either 'TRUE' or 'FALSE';

b. a date assumption where the date that is entered must be after 1 January 2010;

c. a list of depreciation methodology options, where one of four different methods must be chosen;

d. a percentage, where the percentage entered must not exceed 100%;

e. a number, where the number must be a positive number; or

f. a number, where the number must be an integer.

When an assumptions entry interface has a finite number of possibilities, the model developer should ensure that model users are limited to only those finite assumptions when making entries into an assumptions entry interface.

BPMC 5-2 Assumptions Entry Interfaces

It is recommended that every *assumption* in a *workbook* that has a finite number of entry possibilities should use an *assumptions entry interface* that limits the *model user* to only those finite entry possibilities.

If the model developer does not limit the assumptions entry interface where there are a finite number of assumption possibilities, there is a considerable risk that the model user will enter or modify an assumption inappropriately, compromising the integrity of the spreadsheet model outputs.

To provide a simple example, consider an assumptions entry interface that requires that a percentage assumption to be entered must be between 1% and 100%. If the model developer has not limited the assumptions entry interface to this range of possibilities there are any number of invalid assumptions that model users could enter that could compromise the outputs including, 101%, 1.5, dog, 31/12/10 and 500 to name a few.

Because model users generally do not know which assumption entries are acceptable and which are not, it is important that the model developer implement appropriate limits around finite assumptions entry interfaces.

There are a number of techniques than can be used to control assumptions entry interfaces. These techniques can be divided into two types of interface control:

1. *Preventative Interface Control* prevents model users from entering unacceptable or erroneous assumptions; and

2. *Retrospective Interface Control* warns model users after an unacceptable or erroneous assumption has been entered.

Clearly, preventative control is the best method of controlling the assumption entry process. However, as discussed below, this will not always be possible and in such cases retrospective interface control must be used instead.

Preventative Interface Control

Preventative interface control involves the development of assumptions entry interfaces in such a way to effectively disallow the entry of unacceptable or erroneous assumptions. As discussed in this section of these Standards, this is done primarily through the use of controls, data validation and sheet protection.

BPMC 5-1 Preventing Invalid Assumption Entries

It is recommended that *controls*, *data validation* and *sheet protection* be used to limit the scope for *model users* to enter invalid *assumptions* into *assumptions sheets*.

Spreadsheet applications offer many types of controls, some of which can be customized by the model developer to create any number of assumptions entry interfaces that are required during the construction of a best practice spreadsheet model. Where controls are not suitable (i.e. where a very large range of assumptions are acceptable), data validation allows the model developer to define parameters that an entry into a cell or range of cells must meet. Further, data validation can be used to display a screen tip when the mouse pointer is hovered over an assumption cell, providing instructive information to model users.

In addition to the use of controls and data validation to prevent invalid assumption entries, model developers should ensure that all non-assumptions are locked and that all the sheets in the spreadsheet model are protected to prevent the manipulation of non-assumptions. The protection of non-assumptions in this way is recommended by BPMS 14-1 and serves other important functions. For a full discussion of the standards and conventions relating to workbook and sheet protection, see Chapter 14, Security and Protection.

Therefore it is recommended that model developers extensively use controls, data validation and sheet protection as tools to create appropriately controlled assumptions entry interfaces. For more information on controls and data validation, see 5.4 Controls / Forms and 5.5 Data Validation. Both sections include detailed examples and commentary.

Retrospective Interface Control

In situations where preventative interface control is not possible (i.e. controls and data validation do not adequately prevent the entry of unacceptable or erroneous assumptions), retrospective interface control techniques can be used to minimize the likelihood of assumption entry errors.

The primary purpose of tools used to retrospectively control the assumption entry process is to immediately communicate errors to model users and, where possible, provide information relating to the cause of the error. The most common form of retrospective interface control is the use of error checks which may involve the use of conditional formatting to clearly communicate detected errors.

BPMC 5-3 Controlling Assumptions Entry Interfaces

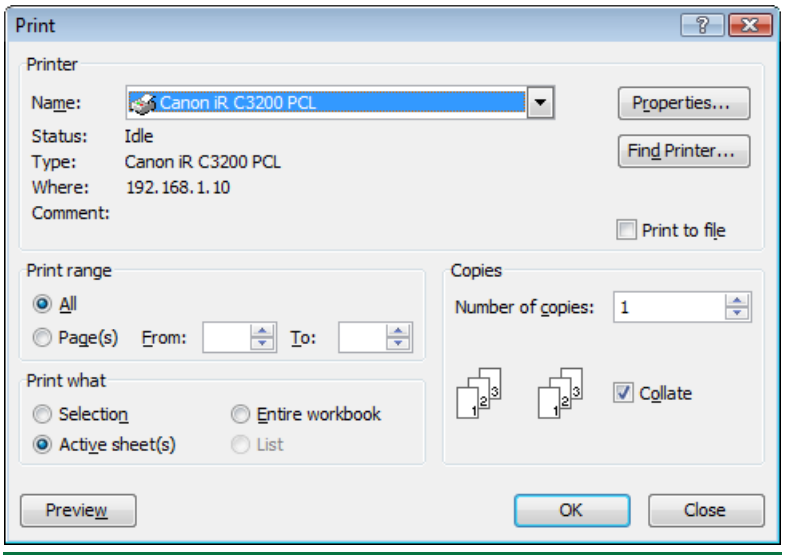
It is recommended that combinations of the following tools be used to limit *assumptions entry interfaces* to finite possibilities:

a) Controls;
b) Data validation;
c) Error checking;
d) Conditional formatting; and
e) Sheet protection.

For a full discussion of the standards and conventions relating to error checking, see 11.2 Error Checks. For information and examples relating to conditional formatting, see 5.6 Conditional Formatting below. For a full discussion of the standards and conventions relating to workbook and sheet protection, see Chapter 14, Security and Protection.

Model developers should aim to create assumptions entry interfaces which mirror the controlled manner in which dialog boxes collect information from application users. For example, the Microsoft Excel® Print Dialog Box is shown below:

Print Dialog Box



Note that this dialog box is actually a set of controls which collect information from users while in each case either limiting the options available (which is done on a worksheet via controls / forms) or warning the user with prompts (which is done on a worksheet via data validation and conditional formatting).

5.3 Assumptions Entry Interface Rules

A number of general rules have been included in these standards to guide the creation of best practice assumptions entry interfaces. These rules have been summarized below.

Assumptions Location

A fundamental requirement when working with a spreadsheet model from a model user's perspective is the ability to quickly differentiate assumptions from non-assumptions. Assumptions are the basis for all spreadsheet models. They form the basis for all of the formulas contained within a spreadsheet model, and are the only entries within a spreadsheet model that model users will seek to manipulate.

Assumptions should always be clearly separated from all of the other components of a workbook. The easiest way to assist model users and provide clarity for other model developers during the development of a workbook is to create dedicated and visually identifiable assumptions sheets within which all the assumptions within a workbook are located.

BPMS 5-1 Assumptions Location

All *assumptions* contained in a *workbook* should be located on dedicated and visually identifiable *assumptions sheets*.

Assumptions should never be *located* on *outputs sheets*.

Hence, all assumptions should be located on dedicated and clearly identifiable assumptions sheets. In this way model users will be able to easily identify and manipulate the assumptions. More importantly, model users will be able to clearly understand and identify the segregation between assumptions and outputs within a workbook.

The practice of entering assumptions within calculations or within outputs sheets of a workbook creates considerable confusion and significant risk not only for model users, but for model developers themselves. As such, an assumption should never be entered into an outputs sheet.

Assumptions Repetition

In creating a best practice spreadsheet model it is important that the model developer ensures that when any single assumption is modified or when a sensitivity assumption is run on any single base assumption, that the change flows through to every area of the spreadsheet model that is impacted by that base assumption or sensitivity assumption. Entering the same assumption twice in a spreadsheet model results in a situation whereby the assumption interface is misleading in that changing one of the repeated assumptions will not reflect the change in all of the outputs.

BPMS 5-2 No Assumption Repetition

Any single *assumption* should never be entered more than once into a *workbook*.

In any case it is far more efficient to link any repeated assumption entries to the first assumption entry and in doing so reduce the number of assumptions in the workbook.

Heading and Label Repetition

Whilst headings and labels are often constants in a spreadsheet model, they are generally not assumptions (in that the model developer does not intend the model user to change headings or labels). Despite this, in the same way as an assumption should never be entered more than once into a workbook, a heading or label should never be entered more than once into a spreadsheet model.

BPMC 5-4 No Heading, Title or Label Repetition

It is recommended that, where feasible, no *heading, title* or *label* that is inserted into a *workbook* be entered more than once. All identical *headings, titles* and *labels* that are contained in a *workbook* should be linked to the base *heading, title* or *label* that was entered.

Hence, every time a model developer requires an identical heading or label in a spreadsheet model, it should be linked by formula to the first entered heading or label. This will ensure that if and when the headings or labels are changed, they can be changed in one location and will flow through to the entire workbook via formulas.

Inactive Assumptions

Assumptions sheets should always be clearly identifiable as such and should be dedicated to the task of collecting assumptions – i.e. primarily contain assumptions. Assumptions sheets should never contain inactive assumptions that appear active, because model users may mistakenly modify such an inactive assumption believing that the workbook outputs will change to reflect the change, which will not be the case.

BPMC 5-12 Visual Identification of Inactive Assumptions

It is recommended that an *assumption cell* that is currently irrelevant for *outputs* as a consequence of a prevailing *assumption* in another *assumptions entry interface* be visually identifiable as being an *inactive assumption cell* using grey *fill color* and white *font color*.

Hence, it is recommended that data should never be entered onto an assumptions sheet as though it was an assumption if it is not used in the workbook calculations. Including non-assumptions and inactive assumptions on assumptions sheets can be very misleading for model users.

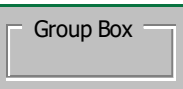
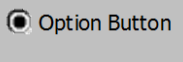
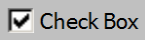
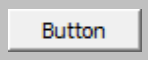
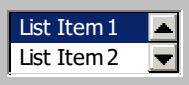
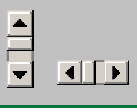
5.4 Controls / Forms

Controls (which are commonly referred to as 'forms' as a result of their programming-based background) should be used extensively throughout assumptions sheets to limit the ability of model users to enter invalid assumptions. In fact, a control should be used wherever possible such that only residual assumptions which cannot be limited via the use of a control remain in the form of assumption cells.

There are a number of clear benefits of using controls instead of assumptions cells to collect assumptions from model users:

- The entry of invalid assumptions is prevented;
- Controls usually provide clear guidance as to what type of assumption should be entered and the limitations on that assumption entry; and
- Controls are aesthetically appealing and non-threatening to model users.

A number of different controls are available to the model developer, each with a different application. The following table lists the commonly available controls which should be used when constructing assumptions entry interfaces:

Control	Appearance	Description
Group Box		'Groups' other controls (usually option buttons)
Option Button		Provides a choice between mutually-exclusive options
Check Box		Provides the user with a dual choice – i.e. yes / no, off / on, etc
Button		Triggers a macro
Drop Down Box		Provides a 'drop down' list of options from which the model user can choose
List Box		Similar to a drop down box, but can display more than one option in view at all times
Spin Button		Spins' through a specified set of numbers – i.e. 1 - 100
Scroll Bar		Similar to a spin button but displays a visual representation of the selected number relative to the specified set of numbers

Each of these controls has characteristics which make them suitable for some purposes and unsuitable for others.

Cell Link Principles

All of the controls listed in the above table other than group boxes and buttons are linked to a worksheet via a *cell link*. Cell links are critical to the operation of the associated controls but they are not required to be modified by the model user and as such are not assumptions. More importantly, the model user should not manually modify a cell link, because this may adversely affect the impacts of the control.

As such, the following principles should be applied when creating a cell link and linking a control to it:

a. The cell link should be named to indicate its linked control type according to the range naming principles explained in these standards (see BPMS 9-3 Range Naming, BPMS 9-4 Standardized Naming Prefixes and BPMC 9-5 Range Naming - Prefixes);

b. The cell link should be positioned directly under the inserted control (if inserted on a worksheet), with the exception of option button cell links, which should be positioned in the top left cell of the surrounding group box control; and

c. The font color of the cell link should be the same as the fill color of its worksheet (i.e. hidden).

The first of these principles is recommended by BPMC 5-5, but not required to implement best practice because the use of range names is not required by the standards:

BPMC 5-5 Control Cell Link Range Names
It is recommended that control *cell link* ranges be named to indicate the type of control to which the cell link relates.

The placement of control cell links based on the second of the above principles is required by BPMS 5-3 below:

BPMS 5-3 Control Cell Link Placement

Every *cell link* that is attached to a *control* in a *workbook* should be located in the top left cell of the range over which its control is placed.

Hiding cell links (the third principle stated above) is not necessary but has been included as visible cell link values not only confuse model users but are also at risk of being deleted by other model developers when not positioned directly under a control.

Note that although cell links are not technically assumption cells (and should never be formatted as such) it is important to ensure that all control cell links are unprotected before protecting their parent worksheets. If the cell protection property of control cell links is not unlocked and their parent worksheet is protected, model users will be prevented from changing the value in the linked control, rendering the control inactive.

For more information on cell protection, see 4.2 Styles.

Control Input Ranges

Some controls (specifically drop down boxes and list boxes), require input data via a linked input range in order to operate correctly. This input data is referred to as *lookup data*. Model developers generally do not want this lookup data to be in prominent view within the workbook or to be modified by model users. Lookup data is therefore not considered to be assumption data. Lookup data is more akin to headings or labels that are utilized within a control.

Further, control lookup data are a specific form of workbook information that should be separated from other components within a workbook. As such, when control lookup data is required in a workbook, the lookup data should be located on a separate Lookups Sheet with other control input ranges.

BPMS 5-4 Control Lookup Data

When using a *control* in a *workbook* that requires an input *range* (*lookup data*), the *lookup data* should always be located on a separate *lookups sheet*.

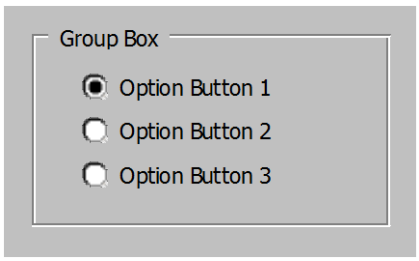
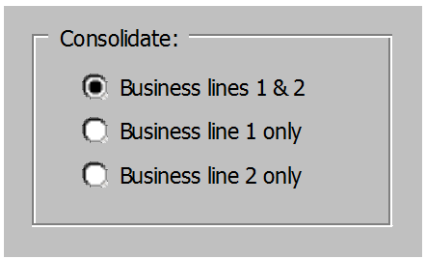
In this way the model developer will have a centralized location in which to access all control lookup data, and model users will be less likely to inadvertently modify the lookup data.

For a more detailed discussion and examples of the creation and presentation of lookups sheets, see 3.7 Sample Sheet Layouts.

Group Boxes and Option Buttons

Group boxes should always be used to isolate sets of option buttons. If this is not done, only one option button in each worksheet can be selected at any time even if it was intended that multiple sets of options be independent of each other. Group boxes can also be used to aesthetically isolate other controls and information, but such uses are not instrumental to the correct operation of a spreadsheet model.

The following examples show the generic use of group boxes and option buttons and a more realistic example of their application in spreadsheet modeling. Note that the assumptions grey background color has been used because controls should almost always be inserted on assumptions sheets:

Generic Application	Sample Application
	

The following rules should be applied when inserting group boxes and option buttons:

- Group boxes and option buttons should not be used for a large number of options. A drop down box or list box will achieve this purpose and use less worksheet area;
- The cell link should be positioned in the cell under the first option button and hidden;
- The cell link should be named with the option button cell link range naming prefix ('OB_') (for more information on the best practice use of range names, see Chapter 9 Naming Principles); and
- The group box must fully enclose the option buttons in order for them to not conflict with other sets of option buttons on the worksheet – 'spacer' rows or columns are recommended to provide a safety buffer.

Check Boxes

Check boxes should be used whenever an assumption requires that a binary or boolean choice be made by the model user. Model users should never be required to enter a 1 or 0, TRUE or FALSE or 'Yes' or 'No' as an assumption because this will often result in errors if these entries are entered incorrectly.

BPMC 5-6 Use of Check Box Controls

It is recommended that a *check box* be used in a *workbook* when the *assumption* entry is *binary* (or *Boolean*).

The following are some examples of assumption entries that should always be made via a check box:

- Yes / No;
- Include / Exclude;
- 1 or 0; or
- TRUE / FALSE.

The following examples show the generic use of a check box and a more realistic example of its application in spreadsheet modeling:

Generic Application	Sample Application
☑ Check box	☑ Check box

The following rules should be applied when inserting check boxes:

a. The cell link should be positioned in the cell under the check box and hidden; and

b. The cell link should be named with the check box cell link range naming prefix ('CB_') (for more information on the best practice use of range names, see Chapter 9 Naming Principles).

Buttons

Buttons are only required in spreadsheet models that contain macros that are required to be called by the model user (as opposed to those which run automatically as a result of certain events such as the spreadsheet application calculating) and do not require a cell link. Buttons should only be inserted where a macro has been created which will always operate safely when called from the location of the inserted button.

BPMC 5-7 Use of Button Controls

It is recommended that a *button* be used in a *workbook* only when a *macro* needs to be assigned to a *control*.

The creation of macros is outside the scope of these standards and conventions. For limited discussion of the application of macros, see 15.2 Recording Macros.

Drop Down Boxes and List Boxes

Drop down boxes and list boxes should be used where there are a limited number of options available for an assumptions entry but there are too many options to justify using option buttons.

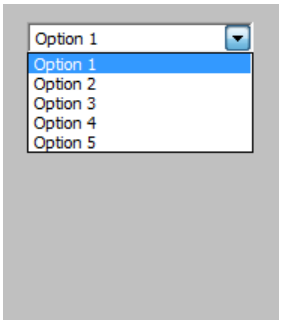
BPMC 5-8 Use of Drop Down Box or List Box Controls

It is recommended that a *drop down box* or *list box* be used in a *workbook* when there are a definite and limited number of possible *assumption* entries.

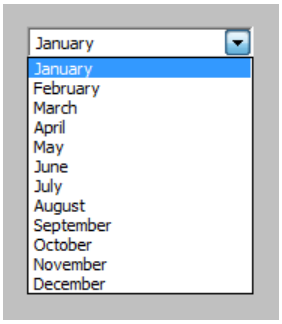
Drop down boxes and list boxes should also be used to limit the size of assumptions entry interfaces without limiting the number of options available to model users. These controls should not be used where the required assumption entry is numerical in which case spin buttons and scroll bars should be used.

The following examples show the generic use of drop down boxes and list boxes and a more realistic example of their application in spreadsheet modeling:

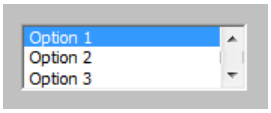
Generic Application – Drop Down Box



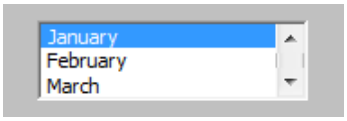
Sample Application – Drop Down Box



Generic Application – List Box



Sample Application – List Box



Note that the same lookup data has been used for the drop down boxes and the list boxes in the above example to highlight the different ways in which these controls collect the same assumptions entries. The primary differences are:

- Drop down boxes take up less space than list boxes on the worksheet when unexpanded, but only display the selected option. When expanded, drop down boxes display all possible options, while list boxes cannot be expanded and must therefore be scrolled; and
- List boxes take up more space on a worksheet but have the benefit of displaying multiple options other than only the selected options at all times. This may be particularly useful where the model developer wants all options to appear when the model is printed.

The following rules should be applied when inserting drop down boxes and list boxes:

- The cell link should be positioned in the cell directly under the top left corner of the drop down box or list box and hidden;
- The cell link should be named with the appropriate cell link range naming prefix ('DD_' for a drop down box and 'LB_' for a list box); and
- The input range should be named with the Lookup range naming prefix ('LU_').

For more information on the best practice use of range names, see Chapter 9 Naming Principles.

Spin Buttons and Scroll Bars

Spin buttons and scroll bars should be used where there are a limited number of numerical options available for an assumptions entry.

BPMC 5-9 Use of Spin Button or Scroll Bar Controls

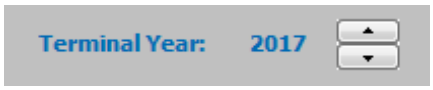
It is recommended that a *spin button* or *scroll bar* be used in a *workbook* when an *assumption* entry is in the form of a numbered sequence that has upper and lower bounds.

Spin buttons and scroll bars should not be used where there are a large number of numerical options available because the model user will be required to spin or scroll through a large number of options when changing assumptions and this may take some time – especially if the model is large and the calculation time is slow.

The following examples show the generic use of spin buttons and scroll bars and a more realistic example of their application in spreadsheet modeling:

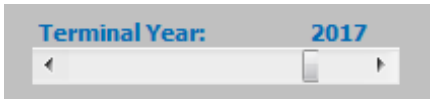
Generic Application – Spin Button

Sample Application – Spin Button



Generic Application – Scroll Bar

Sample Application – Scroll Bar



Note that the same numerical options are provided by the spin buttons and the scroll bars in the above examples, but the interface is very different. The primary differences are:

a. Spin buttons use less worksheet space than scroll bars with the same purpose; and

b. Scroll bars provide model users with a visual indication of the relative position of their selection within the limited range of options, whereas spin button limits are only discovered when they are clicked up or down.

The following rules should be applied when inserting spin buttons and scroll bars:

- The cell link should be positioned in close proximity to the inserted control and displayed in constant font color; and
- The cell link should be named with the appropriate cell link range naming prefix ('S_' for a spin button and 'SB_' for a scroll bar) (for more information on the best practice use of range names, see Chapter 9 Naming Principles);

The use of spin buttons and scroll bars in spreadsheet models should be limited as a result of the inherent problems they create:

- Calculation delays are encountered with each click when a complex spreadsheet model is automatically calculating; and
- Spin button and scroll bar cell links appear to be non-assumption constants, when they are in fact technically assumptions, because the model user is able to change them (via the linked spin button or scroll bar). Hence, there is a risk of confusion resulting from the mis-classification of these cell links.

In general, where a spin button or scroll bar can be used, one of the other types of controls could be used more safely and with less confusion. Hence, the avoidance of extensive spin button and scroll bar utilization is recommended.

5.5 Data Validation

Where it is not appropriate or possible to use controls, model developers should use data validation to prevent invalid assumption entries and meet the requirements of the interface control concept.

Data validation should be used to:

a. Inform model users about the assumption entries required;
b. Control the type of data being entered into an assumption cell; and
c. Set the minimum and maximum bounds of the entered assumption.

Data validation should be applied where the type of assumption entry is known and/or the use of controls is not suitable due to the number of potential entry values or the type of assumption entry required.

BPMC 5-10 Data Validation

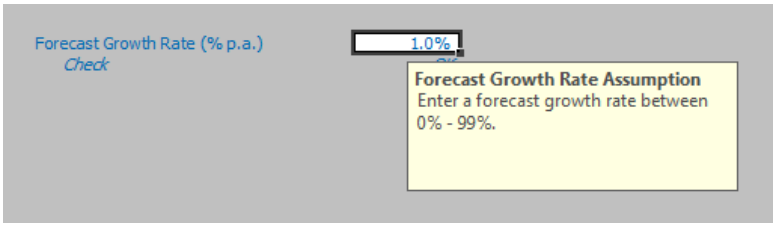
It is recommended that *data validation* be used to:

a) Inform *model users* about the *assumption* entries required;
b) Control the type of *data* being entered into *assumption cells*; and/or
c) Set the minimum and maximum bounds of the *assumptions* that are entered.

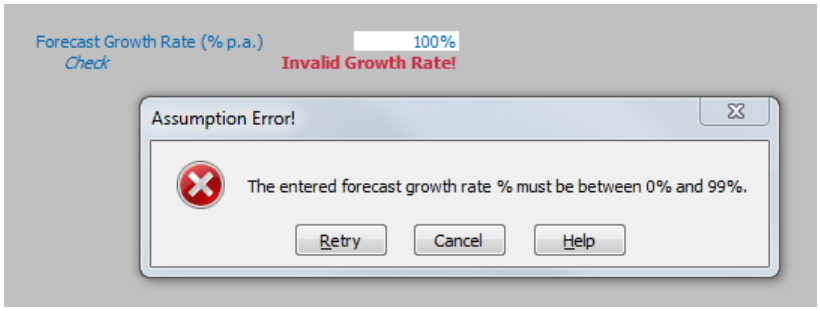
Data validation should be used when the type of *assumption* entry is known, but the use of *controls* is not suitable.

The following example shows the application of data validation to an assumption cell that requires a percentage entry between 0% and 99%. The first part of the example shows how an input message can be used to clearly communicate the assumption entry conditions to model users when they select the assumptions cell. The second part of the example then shows the warning message which appears when the model user enters an assumption that is outside these conditions:

Data Validation – Informing the Model User



Data Validation – Warning the Model User



Data validation has two major advantages over conditional format-based error checking:

- Data validation is preventative in its operation; and
- Data validation corrects the invalid assumption entry after the error is detected whereas conditional formatting only warns that an error has arisen but does not correct the mistake.

The major drawback with data validation when compared with error checks and conditional formatting is that data validation is only effective on assumption cells and therefore cannot be used to warn model users of output errors that might result from assumption entries.

BPMS 5-5 In-Cell Drop Down Lists

A *cell* in which *data validation* is used to create *in cell drop down lists* should always be *formatted* as an *assumption cell*.

An 'In-Cell Drop Down List' is similar to a drop down box control. However an in-cell drop down list returns data from a range, rather than a number in a cell link. Hence, a common problem for model users is that an in-cell drop down list is not visually distinguishable from any other assumption cell. Hence, an in-cell drop down list is a controlled method for entering hard coded data into a cell and should always be formatted as an assumption to inform model users and other model developers that the entry can be manipulated.

5.6 Conditional Formatting

Conditional formatting is used for two purposes when developing assumptions entry interfaces according to the interface control concept:

a. To activate or deactivate assumption cells when they are required or not required to be changed by model users; and

b. To indicate an invalidly entered assumption or that an error has resulted somewhere in the model from an assumption entry.

The first of these purposes is designed to prevent model users confusing relevant or *active* assumptions from irrelevant or *inactive* assumptions, while the second purpose is designed to prompt a user to retrospectively change an assumption after it has been found to be invalid (via a formula-based check) when observing the resulting outputs in the model. The latter purpose is discussed in detail in 11.2 Error Checks.

Activating / Deactivating Assumption Cells

Model developers should aim to make the process of entering assumptions as simple as possible for model users. One of the most effective ways of doing this is to activate and deactivate assumption cells (using conditional formatting) depending on whether or not they are relevant to the model at that particular time.

BPMC 5-11 Conditional Formatting of Assumption Cells

It is recommended that *conditional formatting* be used to indicate to model users which *assumption cells* are inactive at any point in time – i.e. not relevant to output calculations.

For example, the model developer may want to allow model users to enter forecast widget numbers sold based on either:

1. Absolute sales forecasts;
2. A base year sales figure and forecast growth rates; or
3. A combination of absolute sales forecasts and forecast growth rates.

Without conditional formatting, this section of the assumptions sheet might look like the following:

Assumptions Entry Interface – No Conditional Formatting

Year Ending 31 December	2013	2014	2015	2016	2017
Widget Sales Assumptions					
First Growth Rate Year:	2014				
Sales Forecasts (Units)	5.0	6.0	7.0	8.0	9.0
Sales Growth Forecasts (% p.a.)		2.50%	3.00%	2.00%	5.00%

These assumptions are quite misleading because the *Sales Forecasts (Units)* assumptions and *Sales Growth Forecasts (% p.a.)* assumptions both appear active, although they are actually mutually exclusive in the years 2014 – 2017 based on the assumed *First Growth Rate Year* – i.e. based on the assumed *First Growth Rate Year* of 2014 in the above example, the *Sales Forecasts (Units)* assumptions for the years 2014 – 2017 are irrelevant to the model output calculations, yet they are displayed as active assumptions to model users.

To prevent such confusion, conditional formatting should be used to effectively *deactivate* assumption cells from view when they are not relevant to model output calculations and therefore not required to be entered by model users. This is done by applying conditional formatting which will apply *deactivation formatting* to the *inactive* assumption cells, making it clear that they are not relevant at that point in time. If the purpose-based formats and styles which are recommended by the conventions in these standards have been used, this *deactivation formatting* will set the fill color of the cells which are inactive to the same color as the assumptions sheet background (i.e. assumption grey if applying the recommended modeling colors) and the font color of these cells to an *inactive* color (in this example, white). These two conditional formatting adjustments cause the inactive assumption cells to no longer be displayed as normal assumption cells without completely hiding them and thereby creating risks of unintended deletion of over-writing by other model developers.

In this example, both the *Sales Forecast (Units)* row of assumption cells and the *Sales Growth Forecasts (% p.a.)* assumption cells must be conditionally formatted so that only the active assumption cell in each row for each period is displayed as an active assumption at any point in time. To do this, separate conditional formatting is added to both these rows with their format conditions reading off the *First Growth Rate Year* drop down box cell link to determine the active or inactive nature of each assumption cell in each row, applying *deactivation formatting* to any cell which is determined to be inactive. The result, assuming a *First Growth Rate Year* of 2014, is shown below:

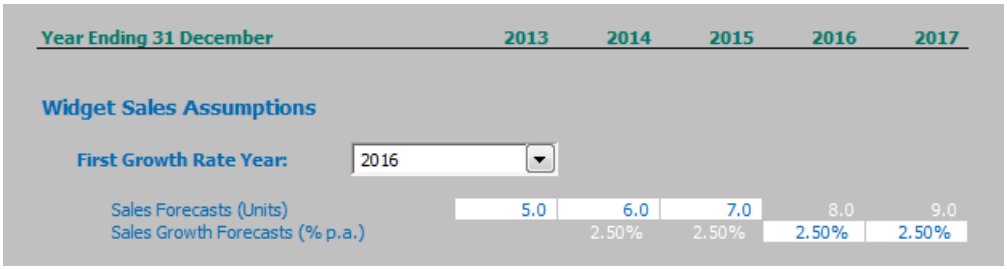
Assumptions Entry Interface – With Conditional Formatting

Year Ending 31 December	2013	2014	2015	2016	2017
Widget Sales Assumptions					
First Growth Rate Year:	2014				
Sales Forecasts (Units)	5.0	6.0	7.0	8.0	9.0
Sales Growth Forecasts (% p.a.)		2.50%	2.50%	2.50%	2.50%

As can be seen in this example, the assumptions entry interface now clearly communicates the *active* and *inactive* assumptions – i.e. the *Sales Forecast (Units)* assumptions from 2014 onwards now appear *inactive* because the conditional formatting which has been added to these cells is adjusting their font and fill color accordingly.

Similarly, if the model user elects to apply growth rates from 2016 instead of 2014, the conditional formatting would deactivate the *Sales Forecasts (Units)* assumption cells in 2014 and 2015 and activate the *Sales Growth Forecasts (% p.a.)* assumption cells in 2014 and 2015. The result of the operation of these two sets of conditional formats is the *Sales Forecasts (Units)* assumption cells being displayed as active for the years 2013 – 2015 and the *Sales Growth Forecasts (% p.a.)* assumption cells being displayed for the years 2016 – 2017, as shown below:

Assumptions Entry Interface
With Conditional Formatting (Changed Assumptions)



Hence, the model user is able to clearly distinguish *active* assumptions and *inactive* assumptions when entering *Sales Forecasts (Units)* assumptions and *Sales Growth Forecasts (% p.a.)* assumptions.

The font and fill colors used in this example are based on the conventions for displaying active and inactive assumption cells specified by BPMC 5-12 below:

BPMC 5-12 Visual Identification of Inactive Assumptions

It is recommended that an *assumption cell* that is currently irrelevant for *outputs* as a consequence of a prevailing *assumption* in another *assumptions entry interface* be visually identifiable as being an *inactive assumption cell* using grey *fill color* and white *font color*.

This approach should be adopted universally for visually distinguishing active and inactive assumption cells. Model users should never need to spend time assessing whether or not an assumption cell needs to have data entered for the model to function properly.

Check Indicating – Check Conditional Formatting

The second application of conditional formatting according to best practice is for error indicating. This section should be read in conjunction with the standards and conventions discussed in Section 11.2 Error Checks.

Conditional formatting should be used throughout a model wherever the results of a check are displayed. In the event that any check returns an error result, conditional formatting should be used to highlight this error by applying bold and check red font color to the check cell. This will immediately alert the model user to the error within the model.

The following example shows the results of the application of check red and bold conditional formatting to error checks which have been included to check that a balance sheet does in fact balance. The conditional formatting has been set to apply when the check flag cells are not equal to zero, indicating an error result. The first image shows the check without an error having been triggered, whilst the second image shows the error checks once an error has been flagged – i.e. when the balance sheet it not balancing:

Balance Sheet Error Check – No Error Flagged

Net Assets		**100.3**	**102.8**
Equity			
Ordinary Equity		75.0	75.0
Other Equity		5.0	5.0
Retained Profits		20.3	22.8
Total Equity		**100.3**	**102.8**
Error Values Check		-	-
Balance Check		-	-
Total Error Check Result	-	-	-
Alert Check (Negative Cash)	-	-	-

Balance Sheet Error Check – Error Flagged

Net Assets		**97.0**	**78.0**
Equity			
Ordinary Equity		75.0	75.0
Other Equity		5.0	5.0
Retained Profits		20.3	22.8
Total Equity		**100.3**	**102.8**
Error Values Check		-	-
Balance Check		1	1
Total Error Check Result	1	1	1
Alert Check (Negative Cash)	-	-	-

This is a simple example of the type of conditional formatting-based error check which should be used to retrospectively indicate the presence of errors within a spreadsheet model. For more information on the extensive use of error checking, see Section 11.2 Error Checks.

5.7 Security and Protection

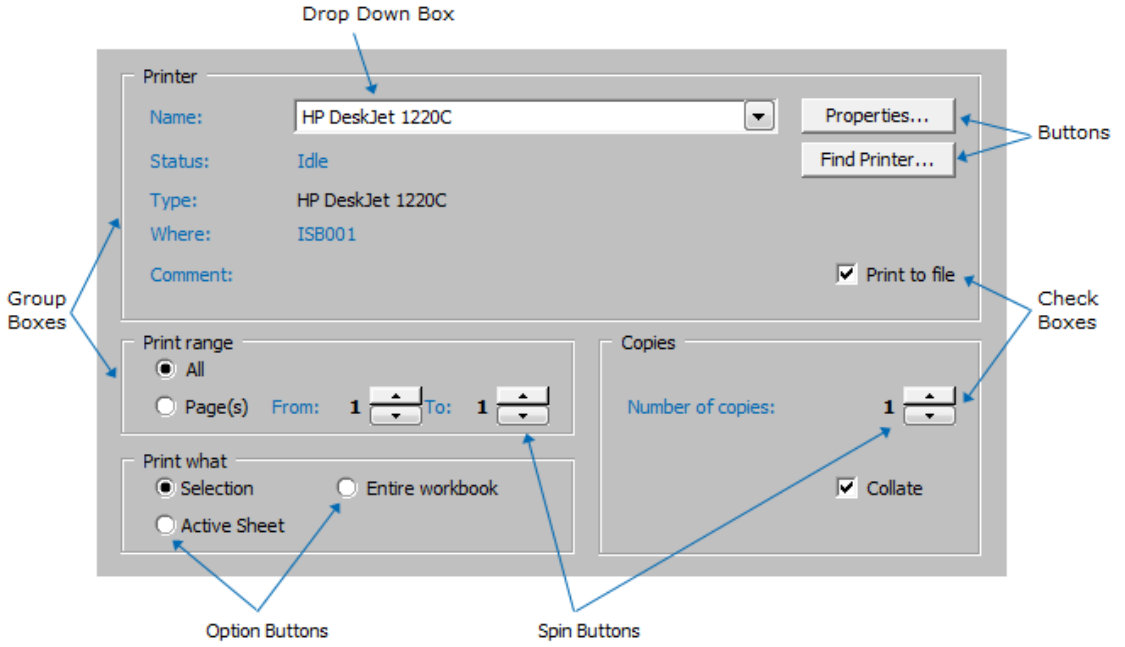
Worksheet protection should always be used on assumption and sensitivity interfaces to prevent model users from changing non-assumptions cells. This is done through the locking of all cells other than assumption cells and then protecting the contents of all of the sheets in the surrounding workbook.

A full discussion of the best practice use of protection and security can be found in Chapter 14, Security & Protection.

5.8 Interface Control Example

The following example demonstrates how controls, conditional formatting and data validation could hypothetically be used in a worksheet to re-create, the Microsoft Excel® Print Dialog Box. This has been done to help model developers conceptualize the interface control concept and the use of these tools to implement it:

Interface Control Example



Note that the construction of this interface uses most of the available types of controls and mirrors almost exactly the layout and feel of the Microsoft Excel® Print Dialog Box. In addition to the visible controls, the entry of assumptions into this worksheet would be controlled by:

- *Conditional Formatting* indicating where an assumption is to be entered and when an invalid assumption is entered; and
- *Data Validation* which would prevent model users from entering invalid types of assumptions (i.e. entering a non-integer *Number of copies*) and prompting them to change the entry.

Hence, through this unusual example it can be seen that assumptions sheets, if developed according to the interface control concept, can largely control the assumptions entry process in most cases. Although some errors may be captured retrospectively (see Section 11.2 Error Checks), most errors encountered during the assumption entry process should immediately be either prevented or highlighted to model users.

Chapter 6

Sensitivity Analysis

6.1 Overview

Sensitivity analysis is an important factor in many spreadsheet models, providing model users with valuable information about the ways in which assumptions are impacting the model outputs. Because the nature of assumptions is such that they are often estimates or forecasts, it is important that model users understand how the outputs might differ if base assumptions turn out to be different in reality. This understanding is commonly obtained through the use of sensitivity analysis.

Sensitivity Analysis can be defined as being:

- The analysis of the sensitivity of the outputs from a spreadsheet model to its base assumptions.

This definition has been simplified to avoid confusion but as a result does not account for output-based sensitivity analysis. Output-based sensitivity analysis is more complex than sensitivity analysis relating purely to base assumptions because the model user is effectively testing the sensitivity of one model output to another model output. A discussion of output-based sensitivities has been provided below in 6.5 Assumption vs. Output-Based Sensitivity Analysis.

To perform a sensitivity analysis on a base assumption, a change needs to be effected in a spreadsheet model to simulate the desired change in the base assumption. The entry that is made into a workbook to affect a sensitivity analysis is referred to as a *sensitivity assumption*.

Sensitivity assumptions should always be entered into a spreadsheet model via *sensitivity assumptions entry interfaces* that are separated from their underlying base assumptions entry interfaces. Furthermore, all sensitivity assumptions entry interfaces included in a spreadsheet model should be located in a separate section in the spreadsheet model from base assumptions entry interfaces. In this way the interface for analyzing the sensitivity of a base assumption or an output will be clearly identifiable for model users. Furthermore, sensitivity assumptions entry interfaces will be clearly distinguishable from base assumptions entry interfaces.

Because a sensitivity assumption is a form of assumption, all of the standards and conventions that apply to assumptions also apply to sensitivity assumptions. For more information on the standards and conventions pertaining to assumptions entry interfaces, see Chapter 5, Assumptions Entry Interfaces.

Important Note

Sensitivity analysis is an extremely broad area of analysis with the spreadsheet modeling process which differs widely based upon the requirements of each spreadsheet model and the preferences of model developers and model users. Because these standards and conventions address *how* to develop spreadsheet models rather than *what* to develop, many of the issues surrounding the development of valuable sensitivity analysis are outside the scope of these standards and conventions. For this reason, there are a small number standards and conventions in this spreadsheet modeling area, and they are designed only to canvas sensitivity analysis considerations relevant to best practice modeling.

6.2 Sensitivity Analysis vs. Scenario Analysis

Before discussing the standards and conventions relevant to sensitivity analysis, it is important to distinguish between *sensitivity analysis* and *scenario analysis*:

- **Sensitivity Analysis:** involves the analysis of the sensitivity of the outputs from a spreadsheet model to its base assumptions; whilst
- **Scenario Analysis:** involves multiple sets of related assumptions which are together used to analyze a particular *scenario*, usually with only one set of assumptions affecting the outputs from a spreadsheet model at any point in time.

This distinction is fundamental to interpreting the standards and conventions relating to sensitivity analysis, because they may not be practically applicable to scenario analysis – e.g. it may be more practical to place assumptions for different scenarios within the same assumptions entry interface in order to improve the user-friendliness of a spreadsheet model.

Whilst the standards and conventions relating to assumptions and assumptions entry interfaces remain applicable to assumptions used within scenario analysis, a detailed discussion and explanation of scenario analysis is outside the scope of these standards and conventions.

6.3 Sensitivity Assumptions Entry Interface Rules

A number of general rules have been included in these standards and conventions to guide the creation of best practice sensitivity assumptions entry interfaces. These rules have been summarized below.

Note that because sensitivity assumptions are a form of assumption, all rules governing the development of assumptions entry interfaces (see 5.3 Assumptions Entry Interface Rules) apply in addition to the rules stated below.

Separate Sensitivity Assumptions Section

A primary risk resulting from the inclusion of sensitivity analysis within a spreadsheet model is that of model users confusing base assumptions with sensitivity assumptions – e.g. entering sensitivity assumptions and wondering why base outputs are not being affected by these assumption entries.

To prevent this confusion, sensitivity assumptions should be located within a separate assumptions section from their underlying base assumptions, as stated in BPMS 6-1:

BPMS 6-1 Separate Sensitivity Assumptions Section

Every *workbook* that contains *sensitivity analysis* functionality should contain a dedicated *sensitivity assumptions section* (which is separate to the *base assumptions section*).

In this way, each sheet that contains sensitivity assumptions can be located within this section of the workbook and clearly labelled as being a sensitivity assumptions sheet.

Sensitivity Assumptions Sheets

As discussed above, sensitivity assumptions are a form of assumption because they are a component of a workbook that the model developer intends the model user to modify. As a result, the assumption nature of sensitivity assumptions needs to be clearly communicated to model users. Furthermore, because they are not the underlying base assumptions of the workbook, they need to be clearly labelled as being sensitivity assumptions to prevent confusing model users.

The best way of communicating the assumptions nature of sensitivity assumptions is to ensure that all the sensitivity assumptions in a workbook are located on assumptions sheets and that all sensitivity assumption cells are formatted accordingly.

BPMS 6-2 Sheet Type for Sensitivity Assumptions Entry Interfaces

All *sensitivity assumptions* in a *workbook* should be *located* on *assumptions sheets*.

If these assumptions sheets are placed within a dedicated sensitivity assumptions section in accordance with BPMS 6-1, model users should always be aware of the sensitivity nature of the assumptions within these sheets.

Separate Sensitivity Assumptions Entry Interfaces

If sensitivity analysis is included within a spreadsheet model, a separate assumptions entry interface should be created to correspond with its underlying base assumptions entry interface. Embedding sensitivity assumptions within a base assumptions entry interface (i.e. within a base assumptions sheet) does not allow the model developer or model users to distinguish readily between the base and sensitivity assumptions within a workbook.

BPMS 6-3 Separate Sensitivity Assumptions Entry Interfaces

Sensitivity assumptions should always be *located* on a dedicated *sensitivity assumptions sheet* which is separate to its corresponding *base assumptions sheet*.

An additional benefit of separate base and sensitivity assumptions entry interfaces is the resulting ability to calculate both base case and *running case* outputs (i.e. outputs where both base and sensitivity assumptions are operative) within a workbook simultaneously. This functionality allows a model developer to construct outputs that analyze the difference between the base case and sensitivity case outputs without continually adjusting base assumptions or storing outputs by copying and pasting values. This approach is discussed in more detail below in 6.4 Common Sensitivity Analysis Methods.

Consistent Sensitivity Assumptions Entry Interfaces

To the extent possible, sensitivity assumptions sheets should mirror their corresponding base assumptions sheets to prevent model users being required to re-familiarize themselves with the assumption entry layout when switching between base and sensitivity assumptions. This consistency of assumptions entry interfaces is recommended by BPMC 6-1:

BPMC 6-1 Sensitivity Assumptions Entry Interface Structure

It is recommended that, to the extent that it is practical, any *sensitivity assumptions entry interface* in a *workbook* be structured consistently with its corresponding *base assumptions entry interface*.

6.4 Common Sensitivity Analysis Methods

There is no single prescribed method for undertaking sensitivity analysis, although the common objective of sensitivity analysis is always to gain an understanding of the sensitivity of the outputs from a spreadsheet model to its base assumptions. However, there are two most commonly used sensitivity analysis methods which are worthwhile mentioning briefly in these standards and conventions:

- **Single Outputs Sensitivity Analysis:** uses only one set of outputs to analyze the sensitivity of these outputs to their base assumptions; and
- **Dual Outputs Sensitivity Analysis:** includes separate outputs used to calculate, display and compare base case and sensitivity case outputs.

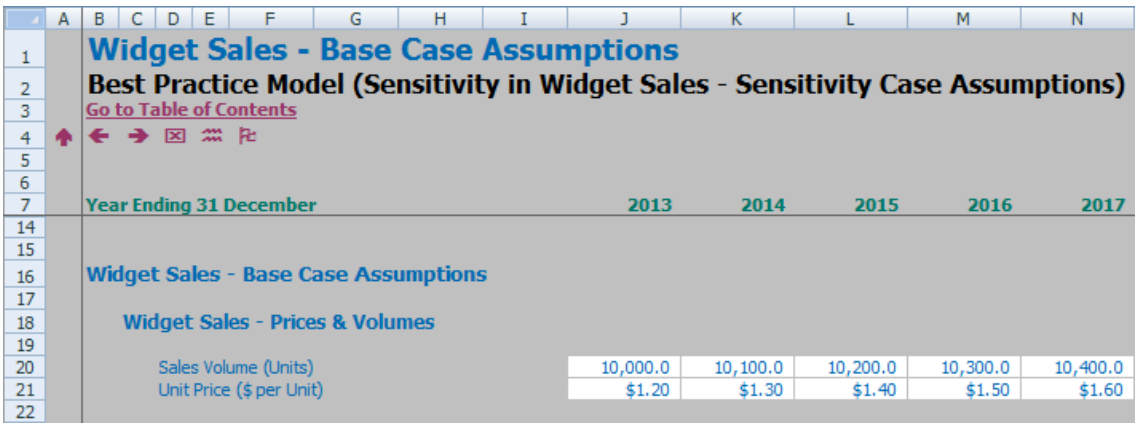
These two common sensitivity analysis methods are discussed below.

Single Outputs Sensitivity Analysis

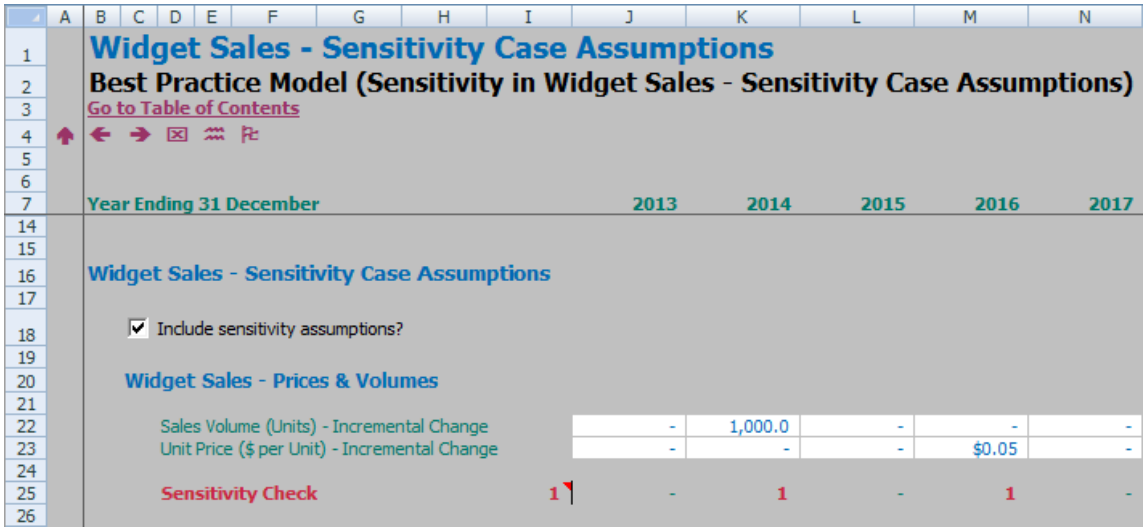
Single outputs sensitivity analysis uses only one set of outputs to analyze the sensitivity of these outputs to their base assumptions. As a result, this set of outputs may or may not contain the impacts of active sensitivity assumptions depending on their inclusion via sensitivity assumptions entry interfaces. This creates a high risk of model users being unaware of active sensitivity assumptions, although this risk can be mitigated by the inclusion of robust and extensive sensitivity checks within a spreadsheet model (see Chapter 11 Checks).

The following basic example demonstrates a simple application of single outputs sensitivity analysis in which base and sensitivity assumptions entry interfaces are used to forecast the sales revenue for widgets over a 5-year period based on *Sales Volume* and *Unit Price* assumptions. A single set of outputs are used to calculate the resulting sales volumes, capturing both base and assumptions entry interfaces, with sensitivity checks being used to clearly indicate the presence of active sensitivity assumptions. The base and sensitivity assumptions entry interfaces are shown below:

Single Outputs Sensitivity Analysis – Base Assumptions Entry Interface



Single Outputs Sensitivity Analysis – Sensitivity Assumptions Entry Interface



1		**Widget Sales - Sensitivity Case Assumptions**												
2		**Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)**												
3		Go to Table of Contents												
4														
5														
6														
7		**Year Ending 31 December**								**2013**	**2014**	**2015**	**2016**	**2017**
14														
15														
16		**Widget Sales - Sensitivity Case Assumptions**												
17														
18		☑ Include sensitivity assumptions?												
19														
20		**Widget Sales - Prices & Volumes**												
21														
22		Sales Volume (Units) - Incremental Change								-	1,000.0	-	-	-
23		Unit Price ($ per Unit) - Incremental Change								-	-	-	$0.05	-
24														
25		**Sensitivity Check**							**1**	-	**1**	-	**1**	-
26														

Note from these assumptions entry interfaces:

- The base and sensitivity assumptions entry interfaces have been placed within separate assumptions entry interfaces and within separate sections of the model in accordance with BPMS 6-1, BPMS 6-2 and BPMS 6-3;
- The sensitivity assumptions entry interface layout has been structured to closely align with the base assumptions entry interface in accordance with BPMC 6-1;
- An *Include sensitivity assumptions* check box has been included in the sensitivity assumptions entry interface (in the range C18:H18) to allow model users to quickly and easily de-activate the sensitivity assumptions;
- The words *Incremental Change* have been included within the sensitivity assumptions entry interface to clearly communicate the incremental nature of the sensitivity assumptions – i.e. in this example sensitivity assumptions are added to base assumptions when calculating model outputs; and
- A sensitivity check has been included within the sensitivity assumptions entry interface to flag the existence of active sensitivity assumptions (as per the checks requirements discussed in detail in Chapter 11 Checks).

When implementing single outputs sensitivity analysis, the model output calculations are made more complicated as a result of the need to capture the impacts of both base assumptions and sensitivity assumptions in a single set of outputs. The outputs corresponding to the above assumptions entry interfaces are shown below:

Single Outputs Sensitivity Analysis – Outputs

Widget Sales - Outputs

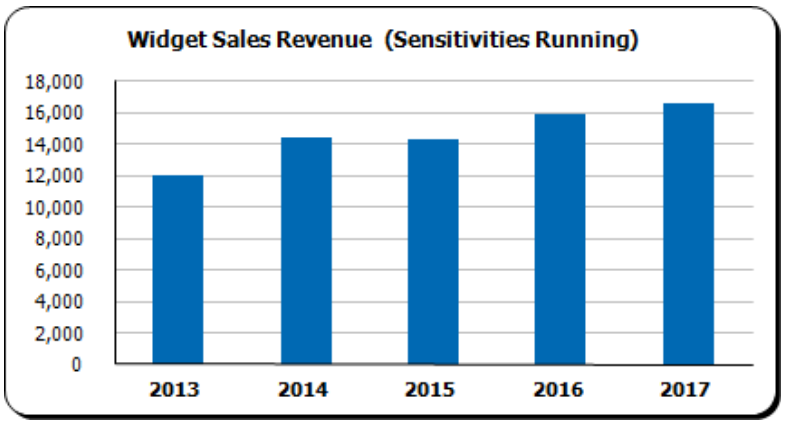
Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)

Go to Table of Contents

Year Ending 31 December	2013	2014	2015	2016	2017
Widget Sales - Outputs					
Sales Volume (Units)	10,000.0	11,100.0	10,200.0	10,300.0	10,400.0
Unit Price ($ per Unit)	$1.20	$1.30	$1.40	$1.55	$1.60
Widget Sales Revenue	**12,000.0**	**14,430.0**	**14,280.0**	**15,965.0**	**16,640.0**

These outputs can be displayed graphically for inclusion within an outputs dashboard presentation (for more information on presentation outputs, see Chapter 7 Outputs & Presentations) as follows:

Single Outputs Sensitivity Analysis – Graphical Output Example



Note from these outputs:

- The outputs have been labelled simply as *Outputs* to reflect the fact that only one set of outputs has been used to calculate the outputs of the base and sensitivity assumptions;
- The presence of active sensitivity assumptions is clearly communicated via the *Model Name* reference cell in B2 containing the text *Sensitivity in Widget Sales – Sensitivity Case Assumptions* in accordance with the best practice checks requirements discussed in Chapter 11 Checks;
- The outputs capture the impacts of both the base and sensitivity case assumptions in a single set of outputs/graphs; and
- The title of the output graph has been made dynamic (i.e. linked by formula to a cell containing a calculation) to reflect *Sensitivities Running* so that there is no risk of model users being unaware of active sensitivity assumptions.

Dual Outputs Sensitivity Analysis

Dual outputs sensitivity analysis uses two separate sets of outputs – the first to calculate outputs based only on base assumptions (i.e. a *base case*) and the second to calculate outputs based on both base and sensitivity assumptions (i.e. a *running case*). As a result, these two sets of outputs may be used as a basis for comparing *base case outputs* with *running case outputs* without needing to copy and paste a single set of outputs or run multiple versions of a model to represent different scenarios.

The following basic example demonstrates a simple application of dual outputs sensitivity analysis in which base and sensitivity assumptions entry interfaces are used to forecast the sales revenue for widgets over a 5-year period based on *Sales Volume* and *Unit Price* assumptions. A single set of outputs are used to calculate the resulting sales volumes, capturing both base and assumptions entry interfaces, with sensitivity checks being used to clearly indicate the presence of active sensitivity assumptions. The base and sensitivity assumptions entry interfaces are shown below:

Dual Outputs Sensitivity Analysis – Base Assumptions Entry Interface

		2013	2014	2015	2016	2017
1	**Widget Sales - Base Case Assumptions**					
2	**Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)**					
3	Go to Table of Contents					
7	Year Ending 31 December					
16	**Widget Sales - Base Case Assumptions**					
18	**Widget Sales - Prices & Volumes**					
20	Sales Volume (Units)	10,000.0	10,100.0	10,200.0	10,300.0	10,400.0
21	Unit Price ($ per Unit)	$1.20	$1.30	$1.40	$1.50	$1.60

Dual Outputs Sensitivity Analysis – Base Assumptions Entry Interface

		2013	2014	2015	2016	2017
1	**Widget Sales - Sensitivity Case Assumptions**					
2	**Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)**					
3	Go to Table of Contents					
7	Year Ending 31 December					
16	**Widget Sales - Sensitivity Case Assumptions**					
18	☑ Include sensitivity assumptions?					
20	**Widget Sales - Prices & Volumes**					
22	Sales Volume (Units) - Incremental Change	-	1,000.0	-	-	-
23	Unit Price ($ per Unit) - Incremental Change	-	-	-	$0.05	-
25	Sensitivity Check	1 -	1	-	1	-

These assumptions entry interfaces are identical to those used to undertake single outputs sensitivity analysis, and therefore the same considerations should be noted:

- The base and sensitivity assumptions entry interfaces have been placed within separate assumptions entry interfaces and within separate sections of the model in accordance with BPMS 6-1, BPMS 6-2 and BPMS 6-3;
- The sensitivity assumptions entry interface layout has been structured to closely align with the base assumptions entry interface in accordance with BPMC 6-1;
- An *Include sensitivity assumptions* check box has been included in the sensitivity assumptions entry interface (in the range C18:H18) to allow model users to quickly and easily de-activate the sensitivity assumptions;
- The words *Incremental Change* have been included within the sensitivity assumptions entry interface to clearly communicate the incremental nature of the sensitivity assumptions – i.e. in this example sensitivity assumptions are added to base assumptions when calculating model outputs; and
- A sensitivity check has been included within the sensitivity assumptions entry interface to flag the existence of active sensitivity assumptions (as per the checks requirements discussed in detail in Chapter 11 Checks).

When implementing dual outputs sensitivity analysis, the model output calculations are simplified as a result of the output calculations being separated into two separate sets of outputs. The base and running case outputs corresponding to the above assumptions entry interfaces are shown below:

Dual Outputs Sensitivity Analysis – Base Case Outputs

Widget Sales - Base Case Outputs

Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)

Go to Table of Contents

Year Ending 31 December	2013	2014	2015	2016	2017
Widget Sales - Base Case Outputs					
Sales Volume (Units)	10,000.0	10,100.0	10,200.0	10,300.0	10,400.0
Unit Price ($ per Unit)	$1.20	$1.30	$1.40	$1.50	$1.60
Widget Sales Revenue	**12,000.0**	**13,130.0**	**14,280.0**	**15,450.0**	**16,640.0**

Dual Outputs Sensitivity Analysis – Sensitivity Case Outputs

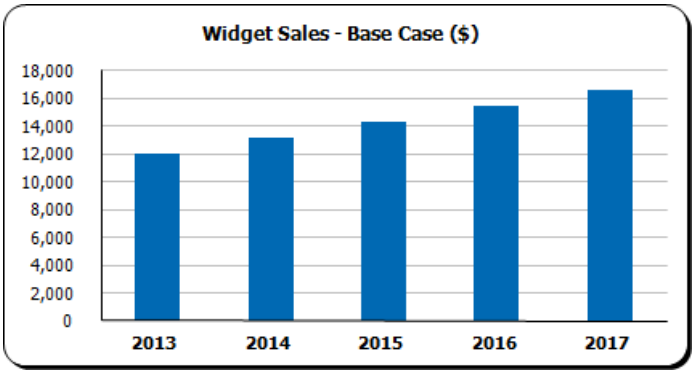
1		**Widget Sales - Running Case Outputs**												
2		**Best Practice Model (Sensitivity in Widget Sales - Sensitivity Case Assumptions)**												
3		Go to Table of Contents												
4														
5														
6														
7		**Year Ending 31 December**								**2013**	**2014**	**2015**	**2016**	**2017**
14														
15														
16		**Widget Sales - Running Case Outputs**												
17														
18		Sales Volume (Units)								10,000.0	11,100.0	10,200.0	10,300.0	10,400.0
19		Unit Price ($ per Unit)								$1.20	$1.30	$1.40	$1.55	$1.60
20		**Widget Sales Revenue**								**12,000.0**	**14,430.0**	**14,280.0**	**15,965.0**	**16,640.0**
21														

Note from these base case and running case outputs:

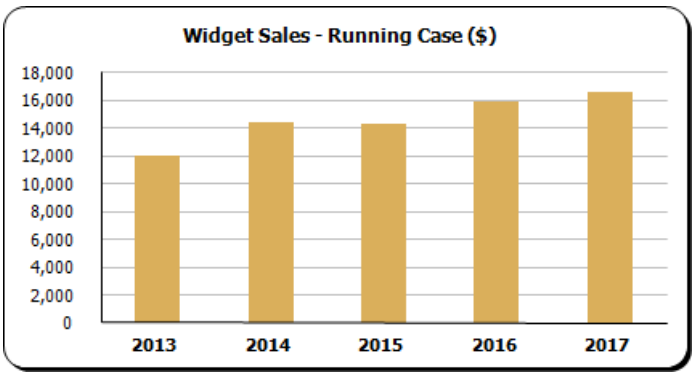
- The base case and running case outputs have been placed within separate outputs sheets and within separate sections of the model in accordance with BPMS 6-1, BPMS 6-2 and BPMS 6-3;
- The running case outputs have been structured to closely align with the base case outputs in a similar way in which base and sensitivity case assumptions entry interfaces are recommended to be consistently structured by BPMC 6-1;
- The base case and running case outputs have been clearly labelled *Base Case Outputs* and *Running Case Outputs* to communicate to model users that the running case outputs may contain the impacts active sensitivity case assumptions; and
- The presence of active sensitivity assumptions is clearly communicated in both sets of outputs via the *Model Name* reference cell in B1 containing the text *Sensitivity in Widget Sales – Sensitivity Case Assumptions* in accordance with the best practice checks requirements discussed in Chapter 11 Checks.

These outputs can be displayed graphically for inclusion within an outputs dashboard presentation (for more information on presentation outputs, see Chapter 7 Outputs & Presentations) as follows:

Dual Outputs Sensitivity Analysis
Base Case Graphical Outputs Example

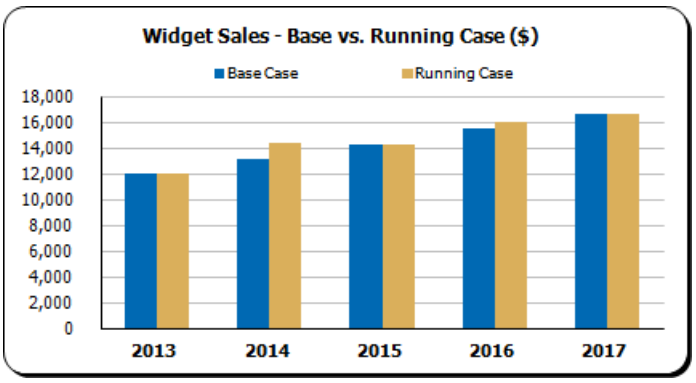


Dual Outputs Sensitivity Analysis
Running Case Graphical Outputs Example



Additionally, dual outputs sensitivity analysis facilitates the presentation of case comparisons as a result of the two sets of outputs – i.e. the ability to compare the base case outputs with a running case which includes the impacts of active sensitivity assumptions. An example of how this type of analysis can then be represented graphically is provided below:

Dual Outputs Sensitivity Analysis
Case Comparison



Single vs. Dual Outputs Sensitivity Analysis

The decision to use single or dual outputs sensitivity analysis must be made based on the requirements of each particular model, and the practical realities governing the meeting of those requirements. Because dual outputs sensitivity analysis effectively involves the creation of two entire sets of assumptions and outputs within a spreadsheet model, it may not be possible or practical to implement this sensitivity analysis method when developing larger and more complex models. A summary of the primary advantages and disadvantages of each approach is provided in the table below:

Consideration	Single Outputs	Dual Outputs
• Model structure	• Simpler	• More complex
• File size	• Smaller	• Larger
• Formula complexity	• Higher	• Lower
• Segregation of outputs	• None	• Complete
• Live case comparisons	• No	• Yes

6.5 Assumption vs. Output-Based Sensitivity Analysis

Although most sensitivity analysis is based upon the sensitivity of base assumptions (referred to as *assumption-based sensitivity analsysis*), sensitivity analysis can also be included in a spreadsheet model to analyze the sensitivity of one model output to another model output (referred to as *output-based sensitivity analysis*). In relation to complex spreadsheet models with a large number of base assumptions, this functionality can make the process of running sensitivities far more efficient and transparent for model users.

The primary differences between assumption and output-based sensitivity analysis are summarized by the following definitions:

- *Assumption-Based Sensitivity Analysis*: analyzes the sensitivity of outputs to base assumptions; whilst
- *Output-Based Sensitivity Analysis*: analyze the sensitivity of one model output (or set of model outputs) to another model output (or set of model outputs).

An example of the application of assumption and output-based sensitivities is provided below:

Assumption-Based Sensitivity Analysis	Output-Based Sensitivity Analysis
• Widgets - Volumes • Widgets - Unit Prices	• Widgets - Revenue

An example of assumption-based sensitivity analysis was provided in 6.4 Common Sensitivity Analysis Methods – i.e. in that example model users were able to enter incremental sensitivity assumptions in relation to widget volumes and prices to understand the impact that these incremental changes in base assumptions have on model outputs.

However, if instead model users wanted to enter sensitivity assumptions which directly increased or decreased widget revenue (instead of entering sensitivity assumptions relating to widget prices and volumes – i.e. revenue drivers) the model outputs would need to be re-created to facilitate this output-based sensitivity analysis. Importantly, the model developer would need to make some implicit assumptions when building this sensitivity analysis in order for the model to still make sense – e.g. if a model user enters a sensitivity assumption that increases revenue by 10% after entering base assumptions relating to prices and volumes, the model developer must decide whether this change in revenue is being driven by a change in volume or a change in prices, or both – in order to maintain the underlying logic – i.e. that revenue is the product of volumes and prices in each period. There is no correct way of doing this, and as a result model users should be consulted when developing output-based sensitivity analysis to ensure that they are comfortable with the assumed ways in which the outputs logic accommodates this analysis without invalidating the model.

Hence, output-based sensitivity analysis should be used carefully to ensure that the underlying relationships represented in a spreadsheet model always remain valid. This is generally done through disallowing model users from running assumption *and* output-based sensitivity analysis at the same time, and communicating the ways in which logic is manipulated to facilitate output-based sensitivity assumptions being incorporated within a model. Other more complex techniques of preventing model errors resulting from conflicting sensitivity assumptions can also be used (such as allowing *some* assumption-based sensitivities to be run with an output-based sensitivity) but these are outside the scope of these standards and conventions.

Chapter 7

Outputs & Presentations

7.1 Overview

Outputs are important components of a workbook. For model users the outputs of a workbook are the primary point of focus and represent the information that will form the basis for any related decision making. As such, model developers should ensure that they devote an appropriate amount of time to constructing model outputs and then creating insightful presentations to provide further clarity and understanding of these outputs. By representing the outputs of a workbook in clear tabular, graphical, diagrammatical and/or pictorial form, model users will be able to understand a workbook's outputs more efficiently. Moreover, with clear and presentable workbook outputs and presentations, model users will be more readily able to apply the workbook to practical presentation and data provision purposes that might be associated with a spreadsheet model.

The outputs in a workbook are the results of calculations based on the assumptions contained within the workbook. The term *outputs* covers a broad range of areas because outputs may take many forms, including:

a. Formulas within cells (that may be formatted in any number of ways);

b. Data tables;

c. Diagrams/schematics;

d. Pictures; and/or

e. Charts/graphs.

In these standards and conventions the term *outputs* generally refers to the raw formulas outputs of a workbook and the content surrounding these formula outputs – i.e. the *engine* of the spreadsheet model. A subset of outputs is *presentations*. A *presentation* is a sheet or group of sheets within a workbook that has manipulated outputs (formula results) to present them in the manner desired by model users. As such, tables, charts or graphs would generally be considered to be *presentation outputs*.

7.2 Outputs Segregation

Outputs are the primary focus of any spreadsheet model. Model users rely on outputs for decision making and analysis. Any presentations that are included in the spreadsheet model will be based on outputs. The primary purpose of any spreadsheet model must be to produce outputs.

Separating outputs from other components of a workbook ensures that both model developers and model users interpret the information in a workbook appropriately. As a minimum standard, the outputs and presentations components of a workbook should be located in a separate, clearly labelled section. For more information relating to the sectionalizing of workbooks, see 2.3 Workbook Sections.

BPMS 7-1 Segregation of Outputs

Outputs sheets and *presentations*, which may take the form of tables, graphs, diagrams or pictures, amongst other forms, should always be located in either:

a) a separate, clearly labelled section of a *workbook*; or

b) a separate dedicated *outputs workbook*.

The separation of the outputs and presentations of a spreadsheet model in this way serves a number of important purposes, including:

- Preventing model users from confusing model outputs with other components of the spreadsheet model;
- Focusing the attention of model users on the most relevant outputs of the spreadsheet model; and
- In some cases, providing security to the model by allowing only limited access to the outputs and presentations components of a spreadsheet model (or dedicated outputs workbook).

As the size and complexity of a spreadsheet model increases, the model developer should consider creating an entirely separate (but linked) dedicated outputs workbook. For more information on developing and working with multiple workbooks, see Chapter 9, Multiple Workbooks.

BPMC 7-1 Separate Outputs Workbooks

It is recommended that separate, dedicated *outputs workbooks* be created for medium to large *workbooks* or where the *model developer* does not want to divulge certain *workbook content* to certain *model users*.

There are many circumstances where locating the outputs in a separate workbook may be advantageous, including:

a. When model users only require or are interested in outputs;

b. When the model developer does not want to divulge the workbook assumptions or formulas;

c. Where different model users are interested in different outputs; or

d. When the outputs need to be provided to several model users in the form of a presentation.

Using separate workbooks for outputs has many advantages including:

a. Clearly separating outputs from assumptions and calculations (which in some circumstances may be of little interest to model users);

b. Allowing model users to analyze outputs without having the (sometimes large) underlying spreadsheet model workbooks open;

c. Allowing the dissemination of the outputs from a spreadsheet model without divulging the calculation logic or associated intellectual property; and

d. Creating a book of pure outputs that can be either viewed on screen or printed in book form.

Whether the model developer chooses to locate the model outputs and presentation materials in a separate section or in a separate outputs workbook, the primary consideration should always be the purpose of the outputs. In relation to model outputs, this purpose will always be governed by the demands of the expected model users.

Each of these methods will appropriately segregate the outputs and presentation sections of the model, but will create different issues for model users. The advantages and disadvantages of the two methods are summarized below:

	Separate Section	Separate Workbook
Advantages	• Model remains compact. • No multiple workbook issues.	• Easy to handle. • Easy distribution to presentation audience. • Multiple presentation outputs tailored to specific audiences.
Disadvantages	• Entire model distributed to presentation audience.	• Multiple workbook issues.

Presentation outputs can take the form of graphical, tabular or diagrammatical outputs, amongst other forms. Presentation outputs provide the model developer with an opportunity to introduce personal preferences and tastes to the model without sacrificing best practice. However, this is conditional upon the presentation outputs sections of the model being clearly segregated from the remaining model sections. Hence, the choice of a separate section versus a separate workbook depends on a number of factors including the size of the model and the number of different audiences that will receive the presentation outputs.

Outputs Section Consistency

Even if the outputs from a spreadsheet model are clearly segregated in accordance with BPMS 7-1, the information presented in this outputs section may remain at risk of confusing and overwhelming model users if not presented and structured in a logical and familiar manner.

Because the model user will in many cases have been involved in the process of entering assumptions into the spreadsheet model, the model developer can usually assume that the model user will be reasonably familiar with the assumptions entry interfaces used to enter these assumptions into the model. On this basis, it is recommended that the best way to prevent model users from encountering difficulties when first viewing the outputs section of the model is to ensure that the layout and structure of the outputs section is consistent with the layout and structure of the assumptions section of the spreadsheet model.

BPMC 7-2 Outputs Section Structure

It is recommended that, where feasible, the *outputs sections* within a *workbook* be structured consistently with their corresponding *assumptions sections*.

Structuring the outputs section of a workbook in accordance with its corresponding assumptions section involves the use of consistency on every level. For example, it is recommended that the following components of the assumptions and outputs sections of a spreadsheet model should be made consistent to ensure that model developers are made aware of the relationships between them:

a. The order and names of the sheets within the sections;

b. The presentation and layout of the components within the sheets in the sections; and

c. The wording of titles and headings within corresponding assumptions and outputs sheets.

A simple example of the consistent structuring of the assumptions and outputs sections of a workbook is provided in the table of contents shown below:

Assumptions and Outputs Section Consistency

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Best Practice Model

Go to Cover Sheet

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a. Keys	8
- Formats & Styles Key	-
- Sheet Naming Key	-
- Range Naming Key	-
2. Assumptions	11
2.1. Time Series Assumptions	12
a. Time Series Assumptions	13
2.2. Forecast Assumptions	14
a. Assumptions	15
- Operational - Assumptions	-
- Working Capital - Assumptions	-
- Assets - Assumptions	-
- Capital - Assumptions	-
- Taxation - Assumptions	-
- Other Balance Sheet Items - Assumptions	-
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a. Outputs	22
- Operational - Outputs	-
- Working Capital - Outputs	-
- Assets - Outputs	-
- Capital - Outputs	-
- Taxation - Output Summary	-
- Other Balance Sheet Items - Outputs	-
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b. Balance Sheet	32
c. Cash Flow Statement	34
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- Capital Providers - Cash Flow Reconciliation	-
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- Error Checks	-
- Sensitivity Checks	-
- Alert Checks	-
4.2. Lookup Tables	44
a. Time Series Lookup Tables	45
b. Capital - Lookup Tables	48
c. Dashboards - Lookup Tables	49
Total Pages:	49

Note in this example workbook structure the consistency between the structure and sheet titles within the related sections – i.e. the *Forecast Assumptions* and *Forecast Outputs* sections and the sheets within each of these sections. Note also the segregation of presentation outputs from the other model outputs via the inclusion of a presentation outputs sub-section entitled *Dashboard Outputs*.

7.3 Outputs Worksheet Layout

Although model developers should always aim to limit the depth of the worksheets within their spreadsheet models according to BPMC 3-8, many outputs worksheets in complex spreadsheet models can easily become large and detailed. While rows and columns can be grouped to filter the information that is visible at any given time (see BPMC 3-10 Grouping Levels), this approach will not always simplify a worksheet enough to prevent it from overwhelming and confusing model users.

As a result, it is recommended that every outputs sheet (with the exception of those with very little depth) should be structured such that a summary of the primary outputs of the worksheet is provided at the top of the worksheet before the commencement of the detailed output calculations.

BPMC 7-3 Outputs Worksheet Summaries

It is recommended that, where feasible, a summary of the primary *outputs* on each *outputs worksheet* be provided at the top of the *outputs worksheet*.

It is recommended that an *outputs worksheet* is structured in the following order, going down or across the worksheet:

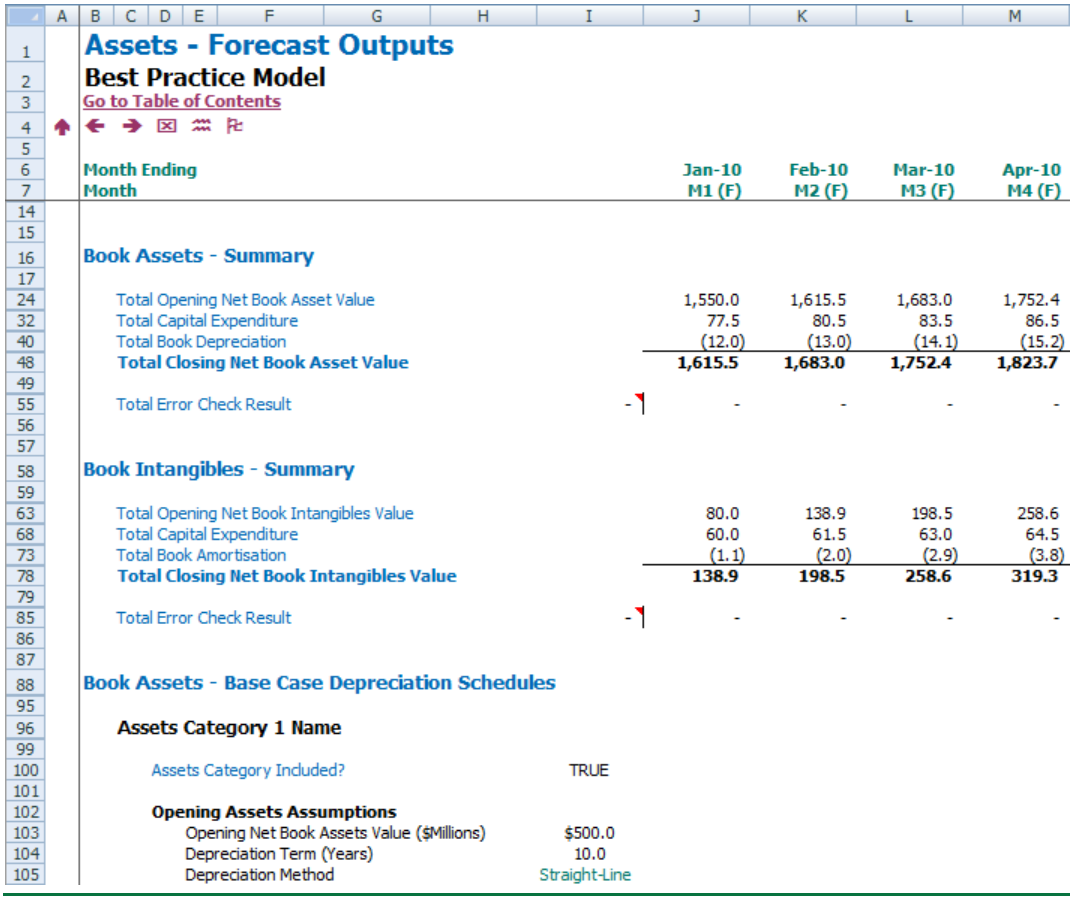
a) *Outputs* summary (primary *outputs* only); then

b) *Output* calculations (including details).

Additionally, if only the summary at the top of each outputs sheet is used as the basis for linking to other worksheets in the spreadsheet model, other model developers will be confident in their ability to change the detailed calculations without invalidating links to other worksheets or workbooks.

Shown below is the screen view of a time series outputs sheet which contains the full book depreciation and amortization schedules for multiple book assets and intangibles categories. In accordance with BPMC 7-3, a summary of the primary outputs of the worksheet (in this case *Book Assets* and *Book Intangibles*) has been included at the top of the worksheet to allow model users to view this information before or without viewing the detailed calculations (i.e. asset schedules) below this section of the worksheet.

Output Worksheet Summaries - Example



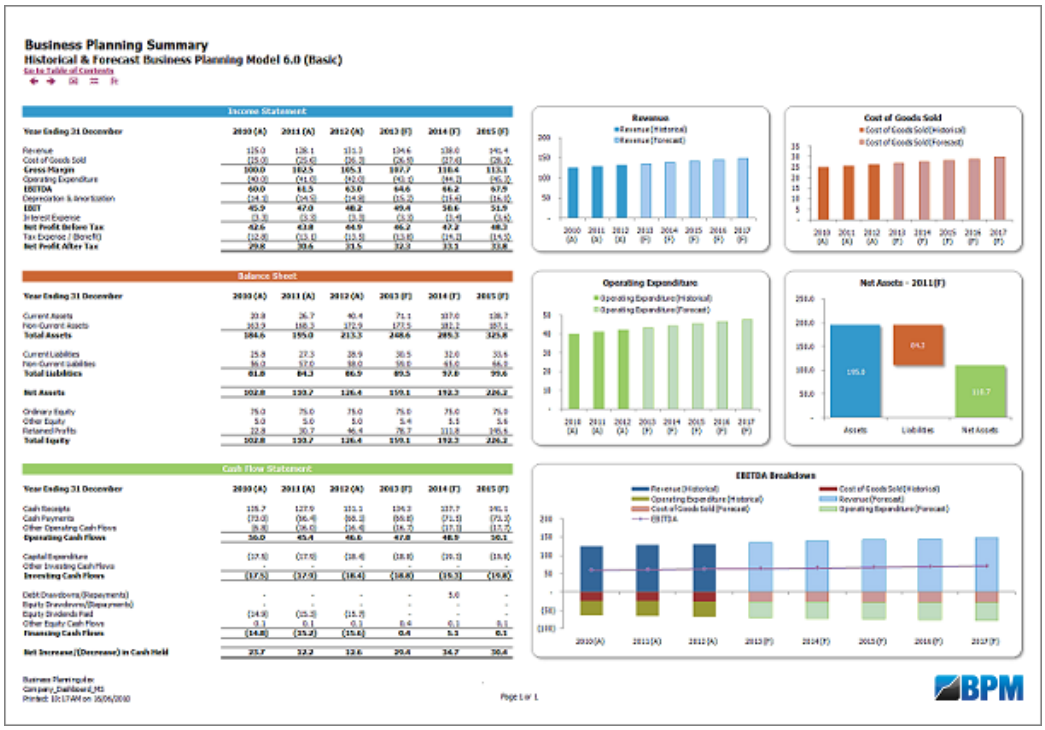
1		**Assets - Forecast Outputs**											
2		**Best Practice Model**											
3		Go to Table of Contents											
4													
5													
6		**Month Ending**								**Jan-10**	**Feb-10**	**Mar-10**	**Apr-10**
7		**Month**								**M1 (F)**	**M2 (F)**	**M3 (F)**	**M4 (F)**
14													
15													
16		**Book Assets - Summary**											
17													
24		Total Opening Net Book Asset Value								1,550.0	1,615.5	1,683.0	1,752.4
32		Total Capital Expenditure								77.5	80.5	83.5	86.5
40		Total Book Depreciation								(12.0)	(13.0)	(14.1)	(15.2)
48		**Total Closing Net Book Asset Value**								**1,615.5**	**1,683.0**	**1,752.4**	**1,823.7**
49													
55		Total Error Check Result							-	-	-	-	-
56													
57													
58		**Book Intangibles - Summary**											
59													
63		Total Opening Net Book Intangibles Value								80.0	138.9	198.5	258.6
68		Total Capital Expenditure								60.0	61.5	63.0	64.5
73		Total Book Amortisation								(1.1)	(2.0)	(2.9)	(3.8)
78		**Total Closing Net Book Intangibles Value**								**138.9**	**198.5**	**258.6**	**319.3**
79													
85		Total Error Check Result							-	-	-	-	-
86													
87													
88		**Book Assets - Base Case Depreciation Schedules**											
95													
96		**Assets Category 1 Name**											
99													
100		Assets Category Included?							TRUE				
101													
102		**Opening Assets Assumptions**											
103		Opening Net Book Assets Value ($Millions)							$500.0				
104		Depreciation Term (Years)							10.0				
105		Depreciation Method							Straight-Line				

In this example, only the summaries at the top of the worksheet would be referenced by formula from other worksheets, thereby preventing other model developers from having to search the detail below for dependent formulas before making structural changes to the worksheet.

7.4 Presentation Sheets

Presentation outputs provide a means by which model outputs may be presented in a manner which is consistent with the aesthetic and personal preferences of model users without contravening the requirements of these standards and conventions. The most common use of presentation outputs is the inclusion of *dashboard-style* presentation outputs in spreadsheet models to provide a tabular and/or graphical summary of the model outputs, often located on schematics sheets (as discussed in Chapter 3 Sheet Structure). These dashboard outputs are often created using formats and styles designed to meet corporate or personal preferences rather than the purpose-based formatting requirements of the standards and conventions, as shown below:

Dashboard Presentation Outputs Example



The primary consideration when developing presentation outputs is to use *presentation sheets* – i.e. sheets which have been designated as being for presentation use only and are therefore exempt from the standards and conventions.

BPMS 7-2 Presentation Sheets

A *workbook* may contain sheets which do not comply with the *standards* and *conventions*, but these sheets must be *presentation sheets*.

A *presentation sheet* is a *sheet* that is included in a *workbook* in order to present *outputs which are necessarily* exempt from the *standards* and *conventions* in order to meet aesthetic or corporate requirements.

As discussed above in 7.2 Outputs Segregation, presentation sheets should always be included with a separate presentation section within a spreadsheet model in order to prevent other model developers from being confused by their non-application of best practice standards and conventions. Additionally, model developers should avoid the temptation to use presentation sheets throughout spreadsheet models for purposes which could be achieved using non-presentation sheets (and therefore adopting best practice).

BPMS 7-3 Presentation Sheet Usage

Presentation sheets should only be included in a *workbook* where it is not possible to use non-presentation sheets to achieve the same objective.

Hence, whilst presentation outputs can be one of the most powerful and important analytical components within a spreadsheet model, they should be used sparingly and not when developing the core *engine* of the model – i.e. the main assumptions entry interfaces and output calculations that perform the primary analysis undertaken by the model.

Chapter 8

Calculation Formulas

8.1 Overview

Formulas are one of the most fundamental analytical tools provided by spreadsheet applications, and can be used to efficiently analyze almost anything. For the purposes of these standards, a formula can exist in the following forms within a workbook:

a. Within a cell or range of cells;

b. As a conditional format condition;

c. Data validation; or

d. Within macros.

A formula in a cell can be used for something as simple as adding the values in two cells to something as complex as looking up data based on multiple embedded logic functions. The construction and use of formulas is beyond the scope of these standards and conventions. Calculation formulas need to be customized and tested for each purpose or requirement and as such there are few universal standards that can be applied to the specific calculation construction process.

Constructing calculation formulas within a workbook is where the true skill in spreadsheet modeling lies, and is the factor that differentiates a good spreadsheet model from a great spreadsheet model. Most of the standards and conventions contained in this spreadsheet modeling area relate to the four most important areas of formulas construction:

a. Consistency;

b. Transparency;

c. Flexibility; and

d. Robustness.

The important fact to remember is that formulas errors account for almost all errors that are found in spreadsheet models. Therefore, model developers should carefully construct and audit the formulas in a workbook before allowing model users to rely upon the outputs of the workbook. For large or complex spreadsheet models that are going to be relied upon for important decision making, it is recommended that an independent model audit or review be undertaken to verify the formula logic and accuracy of the outputs.

8.2 Formula Consistency

Spreadsheets are conducive to formulas that calculate outputs both across columns and down rows – e.g. operating cost projections for a ten year period for five different business units. This allows the model developer to use a minimal number of different formulas in a workbook, because outputs of the same type can be grouped and the same formula can consistently be applied for all of these similar outputs. The model developer should not construct different formulas for outputs of a similar type, as this makes the workbook more difficult to understand. One of the primary causes of complexity and lack of understanding on the part of model users is an overwhelming number of different calculation formulas being used for similar or identical purposes. Therefore, the number of different formulas in a workbook should be minimized.

A good model developer will standardize the formulas that are used in the workbook such that they either use the same formula or are presented consistently where there are similar types of formulas. When the same type of outputs are required across a row or down a column, the formula that is applied should be the same, such that it can be copied across the row or down the column.

BPMS 8-1 Consistent Formulas

When more than one adjacent *cell* contains a similar type of *outputs* the structure and components of the *formulas* within the *cells* should always be consistent, so that the *cell* can be copied across / down the relevant range without needing to make changes.

Any formula that is calculating the same type of outputs should be grouped together and should apply the same formula both across columns and down rows. The only difference in each formula will be the assumptions that are referenced, depending upon the position of the formula in the columns and rows.

8.3 Assumptions Segregation

In accordance with the assumptions entry interface standards and conventions discussed in Chapter 5, all assumptions within a workbook should be located on clearly labelled, dedicated assumptions sheets. Hence, as implied from this principle, assumptions should never be entered within output formulas.

BPMS 8-2 No Assumptions in Mixed Cell Content

Assumptions should not be embedded in cells containing *mixed cell content* – i.e. cells containing content with a combination of *constant* and *formula*.

Placing an assumption within an output formula makes it very difficult for both the model developer and model user to operate and understand a spreadsheet model. Not only will the assumption be out of view on the screen (unless the relevant cell is selected and the formula bar is analyzed) but it also will not print. More importantly it will not be at all clear to model users that the entry is in fact an assumption. Additionally, embedding an assumption within output formulas will make it very difficult for other model developers to understand and manipulate the spreadsheet model.

Note that the inclusion of mixed cell content with spreadsheet models does not indicate that assumptions have been embedded within formulas – i.e. a mixed formula content may have been used to enter or concatenate text or to specify a row or column offset number within a lookup of OFFSET-type function. Many such uses of mixed cell content are completely acceptable and in fact necessary to develop high-quality spreadsheet models.

Possibly the worst way in which assumptions can be embedded in mixed cell content is when the constant that is embedded within the formula is clearly an assumption that directly affects model outputs in a way which is not obvious to model users without examining the detail within the formula. An example of this non-best practice use of mixed cell content might be the use of an IF function to check if a time series period is the seventh time series period, knowing that a particular event takes place in this period within the spreadsheet model. In the unlikely event that this event will always take place in the seventh time series period, and that this fact will be obvious to model users, the embedding of an assumption in this way might be acceptable and therefore not contravene BPMS 8-2. However, in the more likely scenario where the model users will not know why the model logic is specifically addressing the seventh period, the timing of the underlying event should be broken out as an assumption so that model users may select the applicable period, even if the default is always the seventh period.

8.4 Complex Formulas

One of the major problems in the spreadsheet modeling sector is communicating the logic contained within a spreadsheet model, particularly where there are complex formulas. Hence as a general rule it is recommended that, where feasible, model developers avoid the use of complex formulas when developing spreadsheet models.

BPMC 8-1 Avoid Complex Formulas

It is recommended, where feasible, that *complex formulas* not be used within a *workbook*.

However, in reality very few spreadsheet models are developed without the necessary use of some complex formula. To assist with this problem, it is recommended that the model developer create flow diagrams to represent the logic of complex formulas. A diagrammatic representation of complex, often multi-level logic formulas has been proven to be an effective method of conveying an understanding of workbook logic to model users.

BPMC 8-2 Complex Formula schematics

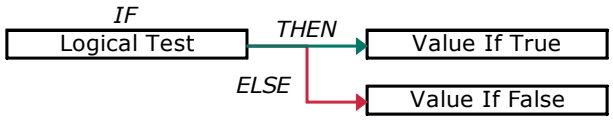
It is recommended, where feasible, that complex *formulas* within a *workbook* be explained through the creation of *Formula schematics* (diagrams representing *formula* logic) that are placed in a separate *schematics section* of the *workbook*.

Formula schematics are a specific type of schematic that are designed to provide a diagrammatical representation of the logic within a particular formula. They can be contrasted with more general schematics that provide general model information such as links that may exist between workbooks, or representations of the logic between related formulas. Formula schematics are usually created to help other model developers understand selected complex formulas within a model.

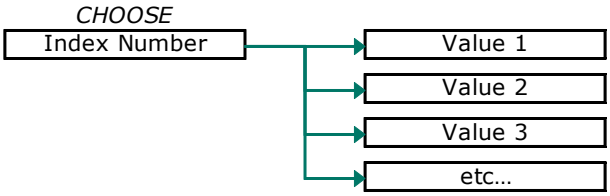
As the name implies, formula schematics should be constructed within schematics sheets. For more information on the schematics sheet type and examples of the creation of schematic diagrams within this sheet type, see 3.7 Sample Sheet Layouts.

The following simple schematic examples show how Excel's IF and CHOOSE functions might be represented within a formula schematic:

IF Function – Sample Formula Schematic



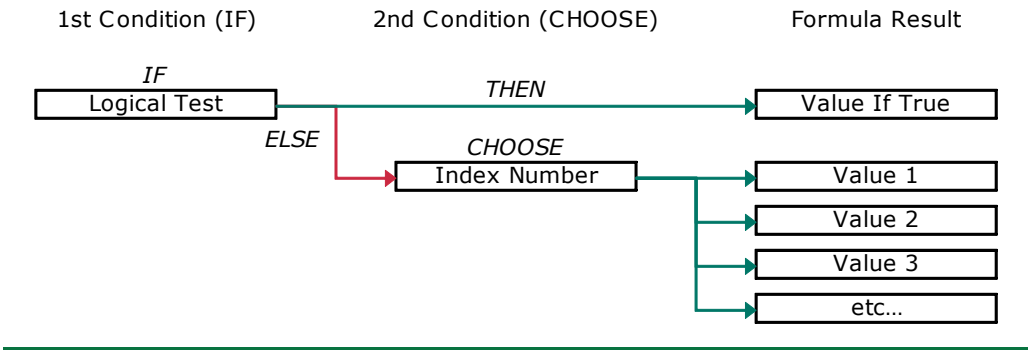
CHOOSE Function – Sample Formula Schematic



Although the formula schematic for each particular function will usually be quite simple, complexity results from the use of numerous functions (often embedded within each other) in a single formula. In such cases, formula schematics can appear quite overwhelming, but the formula logic should be communicated regardless.

The following example shows how a *CHOOSE* function might be represented in a formula schematic when embedded within the FALSE Result of an IF statement:

CHOOSE Function Embedded In IF Function – Sample Formula Schematic



Creating formula schematics has the dual benefits of simplifying the explanation of the logic behind a complex formula and forcing the model developer to undertake a self-review of the logic driving complex formulas. Formula schematics can be particularly useful in resolving calculation logic errors in formulas that are too large to analyze easily within the formula bar.

8.5 Formula Presentation

Individual formulas can contain several functions or components. When a formula within a workbook contains several functions, the formula becomes difficult for both model developers and model users to understand and mentally separate into its component parts. It is therefore recommended that the functions in the formula be separated into several lines to break the formula into logical components, representing the logic. In this way, formulas can be presented in virtual paragraphs, with each paragraph representing a component of the formulas.

BPMC 8-3 Multiple Function Formulas

It is recommended that *formulas* within a *workbook* that contain more than one *function* be separated within the *formula* such that each new *function* is displayed on a separate line of the formula bar.

Creating a new line in a formula can be achieved (in Microsoft Excel®) by holding down 'Alt' and then pressing 'Enter' whilst the cursor is located in the formula bar. The following simple examples show a formula containing an IF function embedded within another IF function both with and without the use of multiple lines in the formula bar:

Embedded IF Functions - Formula Bar *Without* Multiple Lines

```
=IF(logical_test1,[value_if_true1],IF(logical_test2,[value_if_true2],[value_if_false2]))
```

Embedded IF Functions - Formula Bar *With* Multiple Lines

```
=IF(logical_test1,[value_if_true1],
IF(logical_test2,[value_if_true2],
[value_if_false2]))
```

Another situation in which the use of multiple lines within the formula bar can greatly assist model users and other model developers in understanding the logic within a formula is when a *CHOOSE* function is being used to determine the value of a cell. The following example shows how a choose function with four potential outcomes might be represented in the formula bar using multiple lines:

CHOOSE Function - Formula Bar *Without* Multiple Lines

```
=CHOOSE(index_num,value1,value2,value3,value4)
```

CHOOSE Statement - Formula Bar *With* Multiple Lines

```
=CHOOSE(index_num,
value1,
value2,
value3,
value4)
```

It may be difficult from these examples to envisage how the use of multiple lines in the formula bar can significantly aid in the understanding of formula logic. However, if each of the values in the above *CHOOSE* statement example (value1 – value4) was replaced with an embedded *IF* function, the benefits of using multiple lines in the formula bar become more apparent.

The use of multiple lines within the formula bar when writing complex multi-function formulas is recommended by BPMC 8-3 but is not required by any of the standards in these standards and conventions. It has been recommended from the experience of those on the Spreadsheet Standards Review Board but is not required to achieve best practice.

8.6 Calculation Layout & Sequence

Microsoft Excel® provides the user with endless flexibility for the layout and sequencing of calculations. The factors impacting on this include simple user-friendliness, logical presentation, calculation efficiency, ease of navigation and so on. In many cases these factors can even be at odds with one another.

The Standards are intended to provide guidance on ***how*** rather than ***what*** to model and therefore avoid any detailed guidance on the *layout* of specific content. There is commentary on broad content, such as the consistency of time period columns and the segregation of assumptions and outputs, but specific layout of calculations is beyond the scope of the Standards.

The only recommendation possible with respect to the sequencing of calculations relates to model calculation efficiency and not having duplicated calculations.

BPMC 8-4 No Repeated Calculations

It is recommended that, where feasible, a calculation should be performed only once, with dependent calculations referring back to this single instance.

In the case of a sequencing discussion such as 'daisy-chaining' or calculations not flowing up the worksheet, there are arguments for and against these issues and much of this relates to ***what*** rather than ***how***.

8.7 Circular References

Circular references cause a spreadsheet application to iterate or calculate multiple times in order to solve the model formulas outputs. This increases the calculation time of a workbook significantly and can also cause instability within the surrounding spreadsheet application. Further, circular references are generally managed using iterative calculation methods, which introduce the possibility of inaccurate outputs, where amongst other issues:

a. Not enough iterations are performed; or

b. Multiple solutions exist (where boundaries are not managed or set).

Circular references also limit the size at which a workbook will operate effectively, and are a significant cause of spreadsheet application shut down. As a result, a workbook should never contain circular references.

BPMS 8-3 Circular References

A *workbook* or group of *linked workbooks* should never contain a *circular reference*.

The creation of circular references in worksheet formulas is the primary reason for many developers requiring the calculation method of the spreadsheet application to be set to manual (with iterations) instead of automatic. This outcome alone conflicts with BPMS 16-1 which requires that a workbook, where feasible, be set to calculate automatically.

If a relationship that is being modeled is unavoidably circular, this circular should be broken using a combination of constants (instead of formulas) and a code (such as the Visual Basic for Applications code available within Microsoft Excel®) used to perform iterations on command (see 15.2 Recording Macros). However, this is a last resort and all possible steps should be taken to resolve a circular reference mathematically before adopting this approach.

Circular references can be avoided in almost all cases by re-evaluating the mathematical relationships which have caused them. In some cases the model developer may be warranted in making some simplifying assumptions (where possible) to prevent a circular reference without materially affecting the validity of the outputs within the spreadsheet model.

Chapter 9

Naming Principles

9.1 Overview

Names are used on three main levels within most spreadsheet applications:

a. Workbook naming;

b. Sheet naming; and

c. Worksheet range naming.

The use of structured and logical systems promotes clarity for model users and developers.

As a general rule, names (especially sheet names and worksheet range names) should be limited in length to prevent the creation of excessively long inter-workbook and inter-worksheet formulas. Other than this general rule, different considerations apply to the creation of names on each of these three levels. This chapter of these standards and conventions discusses each of these three areas in the following pages.

9.2 Workbook Naming

Naming workbooks (or files) is very important, because the name of the workbook is the only factor that distinguishes it from other files within a directory or folder. The nature of the spreadsheet model development process is such that multiple versions of workbooks are often created over time, resulting in several versions of the same spreadsheet model. Spreadsheet models are also often stored and used at later points in time. When this occurs it can be difficult for model developers or users to find the correct file or version without appropriate workbook names having been applied.

Therefore, the model developer should always ensure that the name of a workbook provides the appropriate information, bearing in mind the need to differentiate the name from other workbook names and the potential need for different versions of the workbook.

BPMS 9-1 Workbook Naming

Each *workbook* should be named such that the name:

a) Allows for different versions of the *workbook*;

b) Remains consistent between versions of the *workbook*; and

c) Differentiates the *workbook* from other *workbooks*.

The creation of meaningful and descriptive workbook names is relevant in two cases:

1. When multiple workbooks are linked in a group and the name of each workbook is used to distinguish it from others in the group; and

2. When a number of versions of the same model (but for amendments and modifications) are distributed during the course of its development.

In the second case, a system of versioning should be used to ensure that model users are always aware of the relative version of the model they are using. The most important considerations when putting in place a system of versioning to derive workbook names are:

- The system must be able to handle a large number of versions without becoming confusing;
- A new version of each model should be created after every distribution to model users; and
- A log should be maintained within the model (i.e. in an Appendix section) explaining the versioning system and the changes made between different versions.

Although it is not possible to put in place a system to strictly govern the creation of workbook names, model developers should consider the workbook naming system used for each model as it is constructed. This will avoid the need to retrospectively change workbook names after finalizing the development process, which can create issues when multiple linked workbooks are involved.

Workbook Name Display

Following the creation of a workbook name which allows for the efficient and effective storage and differentiation of the workbook, it is important to ensure that model users and model developers are always aware of the model they are analyzing. This is particularly relevant where either the model is one of a number of versions or is one of multiple linked workbooks in a group.

In order to achieve this, it is recommended that a model name be entered into a worksheet in each workbook (usually as a non-assumption constant on the workbook cover sheet) and then referenced by formula in the sheet title area of every worksheet in the workbook. The entered model name does not have to be exactly the same as the workbook file name and in fact should be more user-friendly because it will not be governed by file naming rules and restrictions. However, the model name should correspond closely enough to the workbook file name to ensure that model users and developers are able to relate the two names.

BPMC 9-1 Workbook Name Display

It is recommended that every *workbook* have a name and that the name correspond with the file name.

It is recommended that every *worksheet* in the *workbook* displays the *model name* (in addition to the *sheet title*) and that the *model name* is consistently *formatted* and located.

BPMC 9-2 File Name Visibility

It is recommended that the file name for every *workbook* is contained within the header or footer of each *sheet* in the *workbook*.

The table below provides some examples of logical, informative workbook file names (for Microsoft Excel®) and possible associated model names:

Workbook File Name	Possible Model Name
Acme Revenue Model 1.01.xls	Acme Revenue Model – Version 1.01
Acme Opex Model 150606.xls	Acme Operating Expenditure Model (15th June 2006)
Acme WIP Log 2.35.xls	Acme Work In Progress Log – Version 2.35

Workbook naming is unlike sheet and range naming (both discussed below) because there are an unlimited number of types of workbook and purposes for which workbooks might be used. As a result, the model developer will be required to develop a suitable workbook naming system for each spreadsheet modeling project and ensure that this system is consistently followed throughout the project to avoid misleading and confusing model users and other model developers. This will create a level of standardization in the naming approach.

9.3 Sheet Naming

Sheet naming refers to the name entered into the sheet tab of each sheet within a workbook. Sheet naming should not be confused with the entering of sheet titles at the top of each sheet (as per BPMS 3-1 Sheet Titles), which in almost every case will be different to the sheet name because of the requirement to limit sheet name lengths (discussed below).

The primary importance of sheet naming is that the name of a worksheet that is referenced by a formula in a cell in another worksheet will always appear in that formula. Hence, especially in workbooks containing a large number of worksheets, it is important that the name given to each worksheet provides sufficient information to a model developer or model user analyzing a formula in which it is referenced to prevent the need to trace the formula to the source worksheet(s).

As such, the naming of sheets in a workbook should always be done with three considerations in mind:

1. Excessively long sheet names reduce the number of external worksheet precedents that can be included in a formula because the length of a formula string within a cell is limited;

2. Model users (and other model developers) should generally be made aware of the content of the sheet based on its name; and

3. Model users (and other model developers) should be able to determine the sheet type (see BPMS 1-3 Sheet Content and BPMC 1-1 Sheet Types) of each sheet from its name.

The first of these considerations can be dealt with simply by ensuring that sheet name lengths are always minimized. Most applications will already contain a limit on sheet name length, but this limit should not normally be reached.

The second consideration cannot be governed by fixed principles because specific sheet content is unlimited and must therefore be described on a case by case basis. Similarly to workbook naming, the model developer will be required to develop a suitable sheet naming system for each spreadsheet modeling project and ensure that this system is consistently applied throughout the project to avoid misleading and confusing model users and other model developers.

Finally, ensuring that the sheet name given to each sheet in a workbook indicates its sheet type is best achieved through a system of *suffixing.* This technique is discussed in detail below.

Sheet Type Naming – Suffixing

When a spreadsheet model is developed in accordance with the sheet classifications stated and recommended by these standards and conventions (see BPMS 1-3 Sheet Content and BPMC 1-1 Sheet Types), every sheet in the underlying workbook will have been classified as a specific *sheet type*. Although this information should be conveyed through the use of purpose-based formats and styles (see BPMS 1-2 Sheet Classification and BPMC 1-4 Sheet Purpose), it should also be indicated by the name given to each sheet in the workbook.

BPMS 9-2 Sheet Naming

Every *sheet* name in a *workbook* should indicate the *sheet* type.

To meet this requirement, it is recommended that the type of each sheet in a workbook be communicated through its sheet name via the addition of a sheet type specific *suffix* using a technique referred to throughout these standards and conventions and sheet name *suffixing*.

Suffixing refers to the technique of adding a suffix (a short, informative text string) to each sheet name in a workbook with the purpose of clearly indicating the sheet type to other model developers and model users. The exact suffixes used to represent different sheet types will vary depending on whether or not the sheet classifications recommended in these standards and conventions have been adopted. However, the model developer should ensure that model users and other model developers who come into contact with the model are made aware of the suffixing system adopted in each workbook (see BPMC 9-5 Sheet Naming Key below).

BPMC 9-3 contains a list of sheet naming suffixes corresponding to the exhaustive list of sheet types recommended by BPMC 1-1 Sheet Types:

BPMC 9-3 Sheet Type Naming Suffixes

It is recommended that the following *suffixes* be appended to *sheet tab* names to indicate the type of *sheet* that is being named:

Sheet Type	Suffix
a) *Cover sheet*	Cover
b) *Contents sheet*	Contents
c) *Section cover sheet*	SC
d) *Schematics sheet*	MS
e) *Time series sheet*	
i) *Time series assumptions sheet*	TA
ii) *Time series outputs sheet*	TO
f) *Blank sheet*	
i) *Blank assumptions sheet*	BA
ii) *Blank outputs sheet*	BO
g) *Lookups sheet*	LU
h) *Chart sheet*	CHT

These *suffixes* are exhaustive and, other than *secondary sheet naming suffixes*, should be the only *sheet* naming *suffixes* required when naming *sheets*.

Additionally, it is recommended that additional sheet naming suffixes be used to reflect the sub-classification of sheets as *import*, *export* or *presentation*.

BPMC 9-4 Secondary Sheet Naming Suffixes

In addition *sheet type naming suffixes*, it is recommended that the following suffixes be appended to any *sheet tab* names to indicate any of the following sub-classifications of the *sheet*:

Sheet Sub-Classification	Secondary Suffix
a) Import	MI
b) Export	ME
c) Presentation	P

These secondary sheet naming suffixes should be appended prior to appending the applicable *sheet type naming suffix*.

Hence, instead of simply naming a time series sheet which calculates revenue outputs 'Revenue_Outputs', this sheet could be named 'Revenue_TO', which communicates three pieces of information about that sheet:

1. The sheet contains information relating to *Revenue*;
2. The sheet is a time series sheet; and
3. The sheet is an outputs sheet.

Similarly, a revenue time series assumptions sheet which contained the assumptions underlying this revenue time series outputs sheet could be named 'Revenue_TA', highlighting that the only real difference between these two sheets is the assumption versus output nature of their content. Furthermore, if the revenue time series outputs sheet was actually a presentation outputs sheet (see Chapter 7 Outputs & Presentations), it could be named 'Revenue_P_TO' to also convey this property to model users and other model developers.

Because these sheet naming suffixes will mean nothing to model users and other model developers who are not applying these standards and conventions, it is recommended that a key or legend that explains these sheet naming suffixes should be included in any workbook where they have been applied. This will ensure that every person who comes into contact with the spreadsheet model will be able to efficiently understand the sheet naming system that has been adopted.

BPMC 9-5 Sheet Naming Key

Where the *sheet* naming *prefixes* or *suffixes* are used in a *workbook*, it is recommended that a key or legend that explains the *sheet* naming *prefixes* or *suffixes* also be included in the *workbook*.

If the sheet naming suffixes recommended in BPMC 9-3 (discussed above) are applied, the Sheet Naming Key included in the workbook might appear as follows:

Sheet Type	Description / Purpose	Suffix
Cover	Indicates the start of a workbook.	Cover
Contents	Contains the workbook Table of Contents.	Contents
Section Cover	Indicates the start of a workbook section.	SC
Sub-Section Cover	Indicates the start of a workbook sub-section.	SSC
Blank Assumptions	Residual category (contains assumptions).	BA
Time Series Assumptions	Contains time series titles for forecasting assumptions over a set time frame.	TA
Blank Outputs	Residual category (contains outputs).	BO
Time Series Outputs	Contains time series titles for calculating outputs over a set time frame.	TO
Lookups	Contains lookup data for use in forms / controls and in worksheet formulas.	LU
Schematics	Contains model diagrams and flow charts.	MS
Chart	Contains a chart.	CHT
Presentation	Contains presentation outputs.	P
Import	Contains formulas that reference worksheet ranges in another workbook.	MI
Export	Contains worksheet ranges that are referenced by formulas in another workbook.	ME

This example sheet naming key includes references to import and export sheets, which are relevant if the underlying workbook is part of a group of linked workbooks, and presentation sheets, which may be included if presentation outputs are included within the underlying spreadsheet model. For more information on import and export sheets, see Chapter 13 Multiple Workbooks. For more information on presentation sheets, see Chapter 7 Outputs & Presentations.

The inclusion of a sheet naming key becomes more important with the number of expected model users and the level of familiarity that these model users will be expected to have of the spreadsheet model and these standards and conventions. Generally, it is recommended that every workbook contain a sheet naming key to prevent any potential confusion in understanding the sheet naming system used in the workbook.

To further elaborate on the sheet naming suffixes, the following table provides examples of the application of sheet naming suffixes to each sheet type (including sheets that have been sub-classified as presentation, import and export):

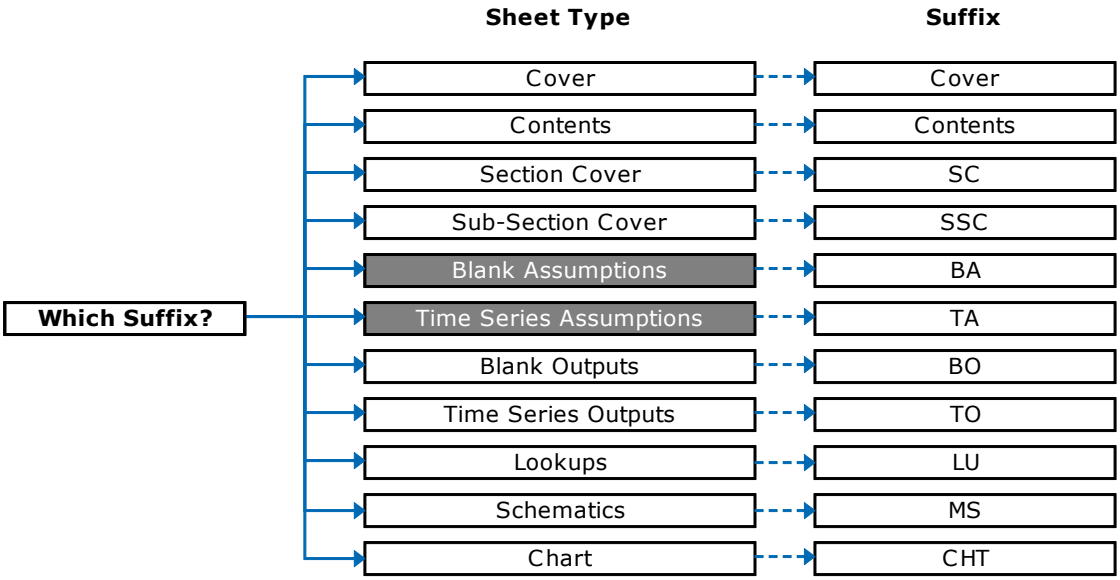
		Example	
Sheet Type	**Suffix(es)**	**Sheet Title**	**Sheet Name**
Cover	Cover	Model Name	Cover
Contents	Contents	Table of Contents	Contents
Section Cover	SC	Assumptions	Ass_SC
Sub-Section Cover	SSC	Tax Assumptions	Tax_Ass_SSC
Blank Assumptions	BA	Timing Assumptions	Timing_BA
Time Series Assumptions	TA	Revenue Assumptions	Rev_TA
Blank Outputs	BO	Revenue Summary	Rev_BO
Time Series Outputs	TO	Revenue Projections	Rev_TO
Lookups	LU	Revenue – Lookup Tables	Rev_LU
Schematics	MS	Model Diagrams	Diagrams_MS
Chart	CHT	Revenue Chart	Rev_CHT
Schematics / Presentation	P MS	Revenue Dashboard Summary	Rev_Dashboard_MS
Time Series Outputs / Import	MI TO	Revenue Projections – Imports	Rev_MI_TO
Time Series Outputs / Export	ME TO	Revenue Projections – Exports	Rev_ME_TO
Blank Outputs / Import	MI BO	Revenue Projections – Imports	Rev_MI_BO
Blank Outputs / Export	ME BO	Revenue Projections – Exports	Rev_ME_BO

Note from this table:

- The workbook cover sheet and contents sheet should be unique in each model and therefore should have the same post fix and sheet name;
- Sheet names have been based on the title of each sheet and shortened wherever possible to minimize the length of formulas in the workbook that contain precedent range references on other sheets; and
- Spaces within sheet names have been replaced with underscores (i.e. 'Ass_SC' instead of 'Ass SC') in order to maximize the readability of formulas in the workbook that contain precedent range references on other sheets.

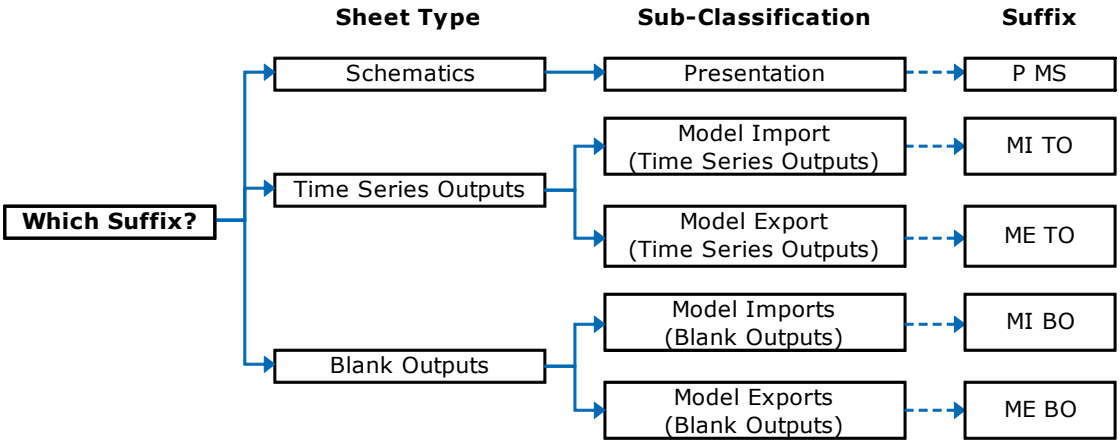
The appropriate sheet naming suffix determination process (excluding presentation, import and export sheets) is summarized in the following diagram:

Sheet Naming Classification- Suffixes



The incorporation of the presentation, import and export sub-classifications (if applicable) is shown below. This summary shows only the use of schematics sheets for presentation outputs and time series outputs and blank outputs sheets for imports and exports:

Sheet Naming Sub-Classification - Suffixes



Note that the presentation, import or export secondary sheet naming suffix is always included immediately before the sheet type sheet naming suffix.

9.4 Range Naming

The naming of worksheet ranges in spreadsheet models allows ranges to be referred to using meaningful phrases as opposed to the range address that is by default given to each range by the spreadsheet application. By naming a cell or range of cells, a model developer can make formulas within a spreadsheet model read more like sentences, and in this way make the logic of formulas in the model more transparent and readable.

The use of range names in spreadsheet models is not *required* in order to implement best practice, and is therefore a choice made by model developers when building each spreadsheet model. However, the conventions within these standards and conventions *recommend* the use of range names because it is the view of the Spreadsheet Standards Review Board that the benefits of the systematic use of range names far outweigh the costs of doing so.

Hence, it is recommended that worksheet range naming be used throughout a spreadsheet model to convey an understanding of the formulas to both other model developers and model users. In particular, assumptions ranges should be named wherever reasonable to prevent the need for the tracing of formula precedents from outputs sheets back to assumptions sheets in order to understand a formula.

The following example shows how the naming of an assumption cell can greatly simplify the interpretation of a formula on an outputs sheet. In this case, cell F21 on the active (outputs) sheet contains a company's taxable income, while cell D20 on the related assumptions sheet (here named 'Tax_BA') contains the tax rate assumption. In the first instance, the tax rate assumption cell is not named (and therefore referred to in the equation as 'Tax_BA!D20'), while in the second instance it has been named 'Tax_Rate':

Formula Without Range Naming	Formula With Range Naming
=MAX(0,F21*Tax_BA!D20)	=MAX(0,F21*Tax_Rate)

Note that without range naming, a model user or developer would not be required to trace the precedent reference 'Tax_BA!D20' back to the tax assumptions sheet in order to learn that this assumption cell is the tax rate assumption. This can be compared with the formula with range naming, in which it is clear that the cell F21 is being multiplied by a tax rate.

The naming of worksheet ranges is very simple but will always be limited by the rules put in place by each particular spreadsheet application. The principles discussed in these standards and conventions can be applied in all spreadsheet applications for any modeling purpose and should be used to ensure that at a minimum other model developers are able to understand at a glance the *type* or *purpose* of the range referred to by each name.

BPMS 9-3 Range Naming

Every *range name* in a *workbook* should describe the content or use of the *range* being named.

In this way, worksheet range names can provide considerable information to model users and developers about the content and purpose of cells within a spreadsheet model. Because there are a limited number of types of worksheet ranges and purposes that a worksheet range can have (see below), every range name in a workbook should indicate either the type or purpose of the range to which the name is referring. This is best achieved through a system of prefixing. This technique is discussed in detail below.

Range Naming – Prefixing

Worksheet range names should be differentiated by the use of *range naming prefixes*. Naming *prefixes* are simply a two to three character prefix attached to the start of a name to indicate the type or purpose of the underlying range to other model developers and users. In this sense, names differ depending on the *type* or *purpose* of the range to which they refer.

BPMS 9-4 Standardized Naming Prefixes

Every *range name* in a *workbook* should have a standardized *prefix* to identify what type of *range* the name refers to or the purpose of that *range*.

BPMC 9-6 contains a list of worksheet range naming prefixes that correspond to the exhaustive list of range types and purposes. This list is provided below:

BPMC 9-6 Range Naming Prefixes

It is recommended that the following *prefixes* be used when naming *ranges* to indicate the type of *range* that is being named or the purpose of that *range*:

Range Type	Prefix	Range Description / Purpose
Row Array	RA_	Single *row*, multiple-*column*, single-area array.
Column Array	CA_	Single-*column*, multiple-*row*, single area array.
Block Array	BA_	Single-area, multiple-*cell*, non-*row*, non-*column* array.
Multiple Area Array	MAA_	Multiple-area (includes areas of any type).
Base Cell	BC_	Single *cell* base *cell* (for OFFSET *function* reference, etc.).
Lookup	LU_	Names a *lookup table range* on a *lookups sheet*.
Hyperlink Cell Reference	HL_	*Hyperlink cell reference*.
Check Box Cell Link	CB_	*Check box cell link*.
Drop Down Box Cell Link	DD_	*Drop down box cell link*.
List Box Cell Link	LB_	*List box cell link*.
Option Button Cell Link	OB_	*Option button cell link*.
Spin Button Cell Link	S_	*Spin button cell link*.
Scroll Bar Cell Link	SB_	*Scroll bar cell link*.
Residual	N/A	Residual category (i.e. single *cell* non-base *cells*, etc.).

This list of *range* naming *prefixes* is exhaustive, and should be the only *range* naming *prefixes* required when naming *cells*, *cell ranges* or *control cell links*.

Because these range naming prefixes will mean nothing to model users and other model developers who are not applying these standards and conventions, it is recommended that a key or legend that explains these range naming prefixes should be included in every workbook where they have been applied. This will ensure that every person who comes into contact with the spreadsheet model will be able to efficiently understand the range naming system that has been applied.

BPMC 9-7 Range Naming Key

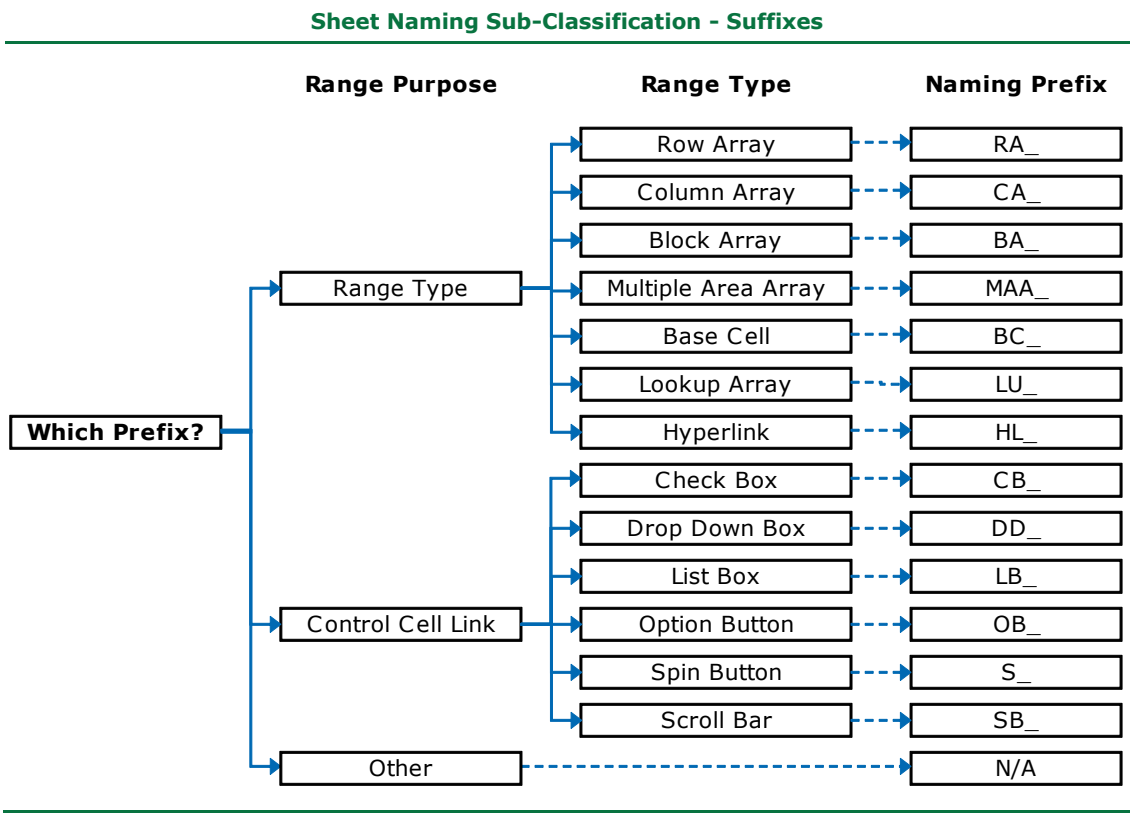
Where *range* naming *prefixes* are used in a *workbook*, it is recommended that a key or legend that explains the *range* naming *prefixes* also be included in the *workbook*.

If the range naming prefixes recommended in BPMC 9-6 (discussed above) are applied, the Range Naming Key included in the workbook might appear as follows:

Range Type / Purpose	Description / Purpose	Prefix
Row Array	Single row, multiple-column, single-area array.	RA_
Column Array	Single column, multiple-row, single-area array.	CA_
Block Array	Single area, multiple-cell, non-row, non-column array.	BA_
Multiple Area Array	Multiple-area (includes areas of any type).	MAA_
Base Cell	Single cell base cell (for OFFSET function reference, etc.).	BC_
Lookup	Names a lookup table range on a lookups sheet.	LU_
Hyperlink Cell Reference	Hyperlink cell reference.	HL_
Check Box Cell Link	Check box cell link.	CB_
Drop Down Box Cell Link	Drop down box cell link.	DD_
List Box Cell Link	List box cell link.	LB_
Option Button Cell Link	Option button cell link.	OB_
Spin Button Cell Link	Spin button cell link.	S_
Scroll Bar Cell Link	Scroll bar cell link.	SB_
Residual	Residual category (e.g. single cell non-base cells, etc.).	N/A

This table would also need to include a footnote explaining the treatment of range naming prefixes (explained below). The inclusion of a range naming key becomes more important with the number of expected model users and the level of familiarity that these model users will be expected to have of the spreadsheet model. Generally, it is recommended that every workbook contain a range naming key to prevent any potential confusion in understanding the range naming system used in the workbook.

The appropriate range naming prefix determination process is summarized in the following diagram:



The effective use of naming prefixes when creating worksheet range names creates many benefits, especially in large spreadsheet models. These benefits include:

a. Immediate communication of name types (or purposes) to model users and other model developers;

b. A reduction in the time required to determine / understand the formula precedents to a cell (i.e. readable formulas);

c. To provide a reliable reference point for code (e.g. Visual Basic for Applications®) which is manipulating worksheet ranges without concerns about adding and removing rows and columns; and

d. The names for each model, when alphabetically listed in a dialog box, are as a result automatically segregated by prefix and therefore grouped by type for easy identification.

One caution when using range names in workbooks is that each range name is by nature an absolute reference to a specific range. This means that formula references to named cells will not automatically offset when the cell containing the formula is copied and pasted or filled down a column or across a row. For this reason, where large arrays of cells are being referenced by formulas, it is generally not appropriate or efficient to name each cell individually and then update each formula reference manually. In such cases, it may be more practical to avoid using names or use base cells and OFFSET or LOOKUP-type functions instead of referencing each cell in the range explicitly.

Range Naming Conflicts

In some cases a range may satisfy the conditions required to justify the inclusion of more than one range naming prefix within one name. The most common example of this is a lookup table range. Every lookup table will contain row arrays (or sometimes column arrays) that are also lookup ranges. In such a case, the model developer should name the range by *purpose* and not by *type*. This general rule is supported by BPMC 9-8:

BPMC 9-8 Range Naming Conflicts

Where a *worksheet range* qualifies for more than one *range* naming *prefix* under BPMC 9-6, the *prefix* derived from the purpose of the *range* should be used when naming the *range*, not the *prefix* derived from its type.

Chapter 10

Time Series Analysis

10.1 Overview

Time series analysis involves the analysis of numbers over designated periods of time and due to its general application is one of the most common uses of spreadsheet modeling. Time series analysis may be undertaken on a historical and/or forecast basis over periods of any duration. Moreover, time series analysis is generally more mathematically complicated than other uses of spreadsheet modeling. For this reason, this chapter introduces a series of standards and conventions which have been specifically designed to govern spreadsheet modeling based time series analysis.

For the purposes of these standards and conventions, a **time series model** can be defined as:

- A workbook or group of linked workbooks that analyzes numbers over more than one period of time – i.e. a time series model includes more than one time series period and as such requires time series assumptions and period labels.

Technically, a time series model only needs to contain more than one time period in order to analyze data over time. As such, the worksheets within each time series model require period labels and it is primarily the inclusion of these period labels that differentiates a time series model from all other types of spreadsheet model.

Time Series Sheets

Consistent with the above definition of a time series model, a **time series sheet** can be defined as:

- A worksheet that analyzes data over more than one period of time – i.e. a time series sheet includes more than one period and as such requires period labels.

Best practice time series analysis should be undertaken through the use of time series sheets - which were introduced in Chapter 1 General Concepts and discussed in detail in Chapter 3 Sheet Structure. The time series sheet type is designed to facilitate any form of time series analysis – i.e. historical and/or forecast over any periodicity.

The following example (drawn from 3.7 Sample Sheet Layouts) shows the print preview of a sample time series outputs sheet:

Time Series Outputs Sheet Example

Company 1 - Revenue Projections

Model Name

Home / Contents

Year Endhg 31 December	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Revenue Summary - A$m														
Revenue Stream 1	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 2	25.0	26.9	27.1	27.8	28.5	29.2	30.0	30.7	31.5	32.3	33.1	33.9	34.7	35.6
Revenue Stream 3	7.5	8.1	8.1	8.3	8.6	8.8	9.0	9.2	9.4	9.7	9.9	10.2	10.4	10.7
Revenue Stream 4	52.5	56.4	57.0	58.4	59.9	61.4	62.9	64.5	66.1	67.8	69.5	71.2	73.0	74.8
Revenue Stream 5	10.0	10.8	10.9	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2	13.6	13.9	14.2
Revenue Stream 6	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Revenue Stream 7	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 8	30.0	32.3	32.6	33.4	34.2	35.1	36.0	36.9	37.8	38.7	39.7	40.7	41.7	42.7
Revenue Stream 9	15.0	16.1	16.3	16.7	17.1	17.5	18.0	18.4	18.9	19.4	19.8	20.3	20.8	21.4
Revenue Stream 10	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Total Revenue	250.0	268.8	271.4	278.2	285.2	292.3	299.6	307.1	314.8	322.7	330.7	339.0	347.5	356.1

Revenue Growth Summary - %p.a.													
Revenue Stream 1	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 2	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 3	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 4	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 5	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 6	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 7	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 8	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 9	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 10	7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%

File Name.xls
Revenue_TO
Printed: 12.00AM on 01/01/2010

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The content of the time series sheet in this example clearly falls within the definition of time series analysis – i.e. it analyzes revenue by category on an annual basis for 5 years commencing in 2013.

In this example, note the time series period labels across the top section of the worksheet clearly communicating to model users and other model developers the annual nature of the worksheet time periods and that each period is a year ending on 31st December.

10.2 Time Series Assumptions

In order to ensure the consistency of all time series period labels within a time series workbook, the time series period labels in every time series sheet within the workbook need to be based on the same time series assumptions. These assumptions will provide all the relevant information required to form the foundation for the time series analysis undertaken by the time series model, including:

a. The start date of the model;

b. The term of the model; and

c. The model periodicity.

Depending on the complexity of the time series model, it may not be necessary to provide a model periodicity assumption, but this information is always of primary importance to model users and other model developers when they first come in contact with a spreadsheet model and should therefore be clearly communicated nonetheless.

In a time series model, these basic assumptions are referred to as *time series assumptions* because they are referenced either directly or indirectly by almost every formula in the spreadsheet model.

BPMS 10-1 Time Series Assumptions

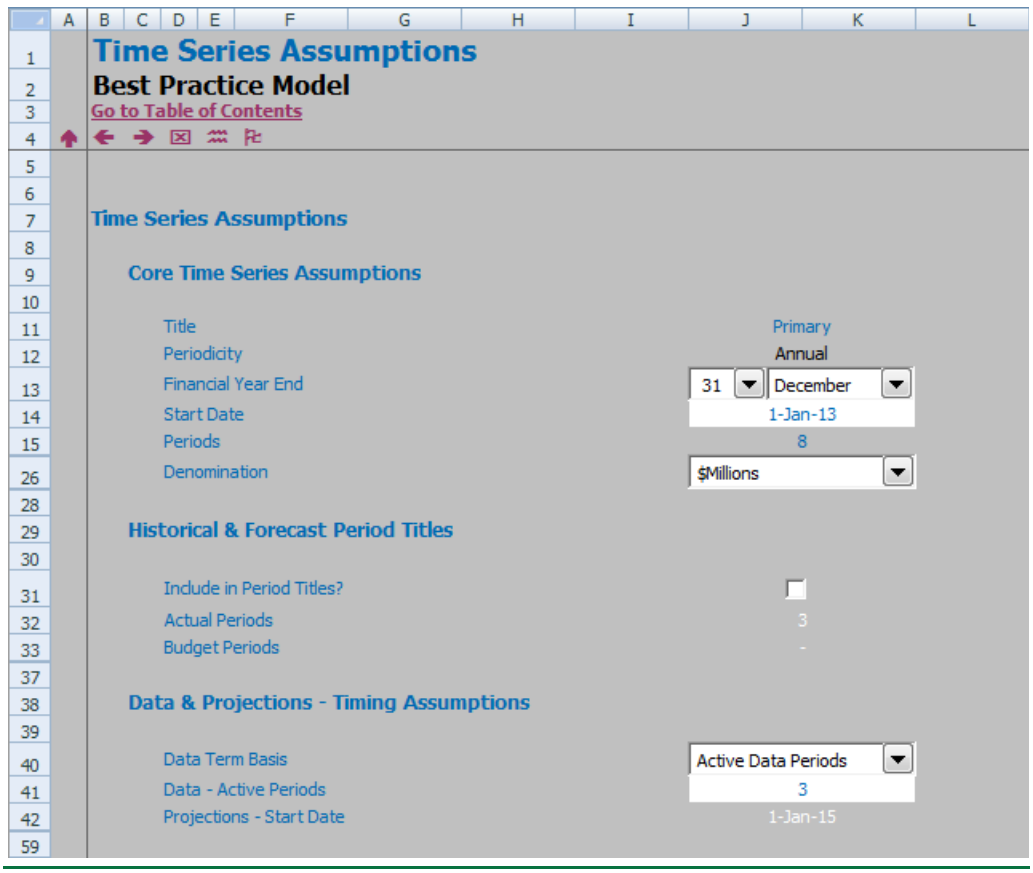
Every *workbook* that undertakes *time series analysis* should clearly state, for each distinct *time series*:

a) the *time series* start date; and

b) the *time series periodicity*.

The following example shows how these time series assumptions could be presented on a blank assumptions sheet. The example also demonstrates how a limited use of output calculations on the assumptions sheet can provide assumption entry guidance to model users and other model developers:

Time Series Outputs Sheet Example



Note the application of best practice assumptions entry interface principles in the construction, presentation and layout of this time series assumptions entry interface in accordance with BPMC 5-3 Controlling Assumptions Entry Interfaces. These principles include:

- The use of drop down boxes to collect all limited scope finite assumptions; and
- The use of data validation within the model start date assumption to prevent invalid entries.

This type of centralized time series assumptions entry interface should be included and labelled as a dedicated set of time series assumptions in every best practice time series model.

Time Series Constants

In every time series model, a large proportion of the formulas in the workbook will need to reference the same general constants relating to time, unit measurements, denominations, etc. Examples of these general constants include the number of minutes in an hour, the number of hours in a day, the names of months in a year, etc. They can also include conversion factors such as powers of ten, etc. All such constants are universal and never change.

As a result of the common need to have these assumptions available in every time series model, it is recommended that as a general rule a summary of these assumptions be included in every time series model.

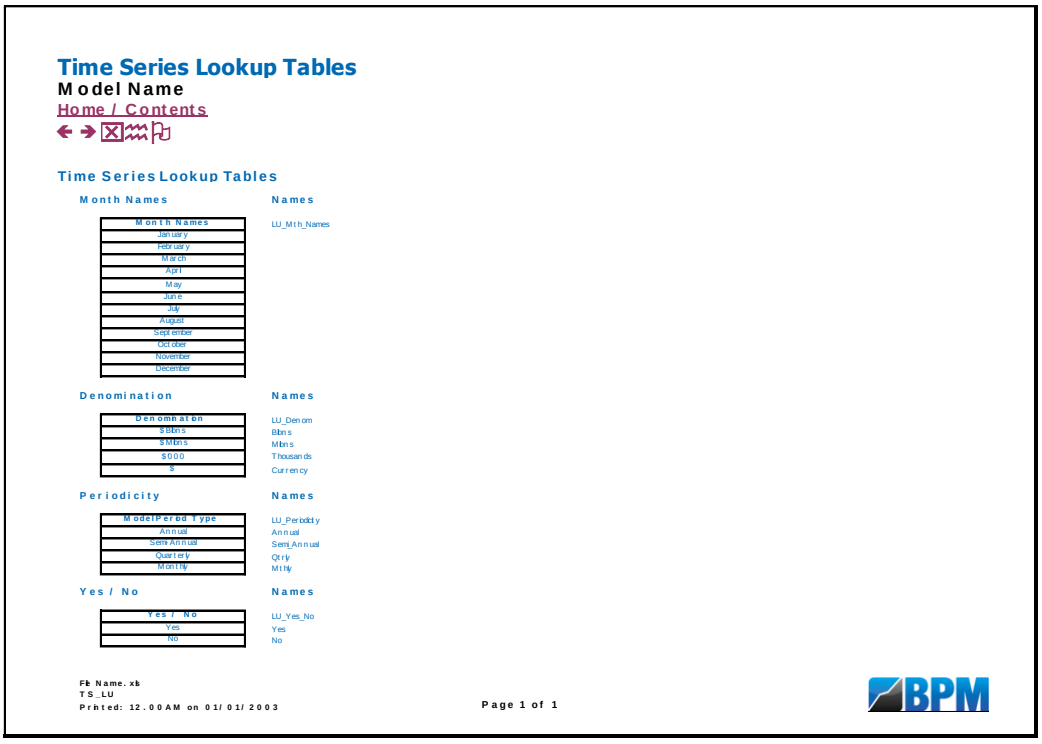
BPMC 10-1 Time Series Constants

It is recommended that every *workbook* that undertakes *time series analysis* contains time constants (e.g. months in year, days in week, weeks in year).

Note that the model developer will never need to decide whether or not to classify these entries as assumptions or non-assumptions – i.e. all of these entries will be known and therefore fixed (i.e. an hour will always have 60 minutes and a day will always have 24 hours). Hence, the model developer might therefore prefer to include these entries as lookup data on a lookups sheet. See 3.7 Sample Sheet Layouts for an example of a lookups sheet.

The following example (drawn from 3.7 Sample Sheet Layouts) shows the print preview of a sample lookups sheet that has been populated with lookup tables containing general time series data for use throughout the underlying model:

Time Series Lookups Sheet Example



Time Series Lookup Tables
Model Name
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Time Series Lookup Tables

Month Names — **Names**

Month Names
January
February
March
April
May
June
July
August
September
October
November
December

LU_Mth_Names

Denomination — **Names**

Denomination
$Bbns
$Mbns
$000
$

LU_Denom
Bbns
Mbns
Thousands
Currency

Periodicity — **Names**

ModelPeriod Type
Annual
Semi-Annual
Quarterly
Monthly

LU_Periodcty
Annual
Semi_Annual
Qtrly
Mthly

Yes / No — **Names**

Yes / No
Yes
No

LU_Yes_No
Yes
No

File Name. xls
TS_LU
Printed: 12.00AM on 01/01/2003

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If a model developer decides to use a lookups sheet in this way, this sheet could be re-used in every time series model that the model developer builds to reduce model development time.

10.3 Periodicity Labels

As mentioned at the start of this chapter, it is the inclusion of periodicity labels in a spreadsheet model that differentiates it as a time series model. The period labels that are included within a time series model should provide the model developer with all the information about each particular time period that might be required by the calculations within the worksheet below. This information might include:

a. The period start date;

b. The period end date;

c. The period number (counter);

d. Days within the period;

e. Days within the related financial year; or

f. Months within the period.

The level of detailed information included within the period labels of a time series model will differ depending on the required complexity of the model calculations. However, as stated in BPMS 10-2 below, at least the first three pieces of information listed above should be included within the period labels on every time series sheet:

BPMS 10-2 Time Series Period Labels

A *time series* should always contain a consistent set of *periodicity* labels and counters that are located in the same *position* on every relevant *worksheet* in the *workbook*.

The *periodicity labels* and counters that should appear in every *time series sheet* are:

a) *Period* start date;

b) *Period* end date; and

c) *Period* number (counter).

The period number is simply a numeric representation of the number that the period represents where the first period in workbook is number '1'. To ensure that the workbook calculations remain consistent with the time series assumptions entered into the spreadsheet model (see 10.2 Time Series Assumptions above), every formula in the workbook involving time-based calculations should reference this information in the period labels. In this way, the periodicity of the model will be dynamic, in that it could be changed by simply changing the time series assumptions referred to in BPMS 10-1 Time Series Assumptions.

Once the model developer has determined what information to include within the period labels in a time series model, those period labels should then appear in a consistent format and location on each and every time series sheet in the spreadsheet model. As such there should rarely be a need for the model developer to create new period counters or references for the purposes of creating calculations that refer to periods.

It is also important that both the model developer and model users are always aware of what each period represents. The best way to achieve this is to ensure that the period end date for each period within the workbook is always in view on every time series sheet.

BPMS 10-3 Time Series Period End Dates

The *period* end date *label* for each *period* in a *time series sheet* should always be in view on the screen.

This is important for both the screen viewing of time series models and the analysis of printed output information from time series models. This is done as follows:

- *Screen viewing* – period titles should be kept in view by freezing window panes below them (see 3.4 Window Panes and Splits); and

- *Printing* – period titles should be kept in view by ensuring that the period titles rows (or in some cases columns) are repeated with each new page within each time series sheet. This functionality is available in the page setup properties of each worksheet and prevents the need to repeatedly enter period titles as the depth of a worksheet results in it printing more than one page.

Although the periodicity of each period within a time series model should be ascertainable by viewing the period label end dates, this is such an important piece of information that it should nonetheless be clearly labelled on each worksheet in the workbook.

BPMS 10-4 Time Series Periodicity Identification

The *periodicity* of each *time series sheet* should be clearly identified and always in view on each *time series sheet*.

In some cases, a model user may know the period end year but may not know the end date of each annual period. For example, a model user working with a time series model with annual periods might know that each period represents one year but still may not know whether each year ends on 30th June or 31st December.

As such, it is important that the periodicity and the period end date are always clearly communicated to model users and other model developers. This will provide clarity to the model user as to the period of time that each period represents, and will ensure that any individual printed sheet in the workbook contains the critical periodicity information.

BPMS 10-5 Time Series Number of Periods

A *workbook* that undertakes time series analysis should always include a *cell* or *cell range* that indicates the number of *periods* in each distinct *time series*.

The number of periods in a time series model is important for many reasons. Aside from dictating when calculations within a workbook will cease, it also drives the timing of the inclusion of many common time series model features, including valuation terminal values, contract start and end periods or changes in structure, to name a few.

The number of periods can also be important for many other formulas that can be included in a time series model. It is therefore important for model users that the number of periods in a workbook be clearly labelled and located within the workbook.

The following examples show two sample time series sheets that are the same in every way except for periodicity. The first example contains annual periods while the second example contains quarterly periods:

Time Series Sheet – Annual Periods

Company 1 - Revenue Forecasts (Annual)

Model Name

Go to Table of Contents

Year Endng December	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Revenue Summary - A$m														
Revenue Stream 1	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 2	25.0	26.9	27.1	27.8	28.5	29.2	30.0	30.7	31.5	32.3	33.1	33.9	34.7	35.6
Revenue Stream 3	7.5	8.1	8.1	8.3	8.6	8.8	9.0	9.2	9.4	9.7	9.9	10.2	10.4	10.7
Revenue Stream 4	52.5	56.4	57.0	58.4	59.9	61.4	62.9	64.5	66.1	67.8	69.5	71.2	73.0	74.8
Revenue Stream 5	10.0	10.8	10.9	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2	13.6	13.9	14.2
Revenue Stream 6	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Revenue Stream 7	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 8	30.0	32.3	32.6	33.4	34.2	35.1	36.0	36.9	37.8	38.7	39.7	40.7	41.7	42.7
Revenue Stream 9	15.0	16.1	16.3	16.7	17.1	17.5	18.0	18.4	18.9	19.4	19.8	20.3	20.8	21.4
Revenue Stream 10	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Total Revenue	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Revenue Growth Summary - %p.a.														
Revenue Stream 1		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 2		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 3		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 4		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 5		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 6		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 7		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 8		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 9		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 10		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%

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Time Series Sheet – Quarterly Periods

Company 1 - Revenue Forecasts (Quarterly)

Model Name

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Quarter Endng Quarter	Mar-13 Q1	June-13 Q2	Sep-13 Q3	Dec-13 Q4	Mar-14 Q1	June-14 Q2	Sep-14 Q3	Dec-14 Q4	Mar-15 Q1	June-15 Q2	Sep-15 Q3	Dec-15 Q4	Mar-16 Q1	June-16 Q2
Revenue Summary - A$m														
Revenue Stream 1	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 2	25.0	26.9	27.1	27.8	28.5	29.2	30.0	30.7	31.5	32.3	33.1	33.9	34.7	35.6
Revenue Stream 3	7.5	8.1	8.1	8.3	8.6	8.8	9.0	9.2	9.4	9.7	9.9	10.2	10.4	10.7
Revenue Stream 4	52.5	56.4	57.0	58.4	59.9	61.4	62.9	64.5	66.1	67.8	69.5	71.2	73.0	74.8
Revenue Stream 5	10.0	10.8	10.9	11.1	11.4	11.7	12.0	12.3	12.6	12.9	13.2	13.6	13.9	14.2
Revenue Stream 6	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Revenue Stream 7	17.5	18.8	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.6	23.2	23.7	24.3	24.9
Revenue Stream 8	30.0	32.3	32.6	33.4	34.2	35.1	36.0	36.9	37.8	38.7	39.7	40.7	41.7	42.7
Revenue Stream 9	15.0	16.1	16.3	16.7	17.1	17.5	18.0	18.4	18.9	19.4	19.8	20.3	20.8	21.4
Revenue Stream 10	37.5	40.3	40.7	41.7	42.8	43.8	44.9	46.1	47.2	48.4	49.6	50.8	52.1	53.4
Total Revenue	####	####	####	####	####	####	####	####	####	####	####	####	####	####
Revenue Growth Summary - %p.a.														
Revenue Stream 1		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 2		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 3		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 4		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 5		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 6		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 7		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 8		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 9		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Revenue Stream 10		7.50%	1.00%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%

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Note that the above examples are exactly the same with the exception of the identification of the workbook periodicity (within the sheet title and left-most header of each set of period labels) and the period end dates (which clearly indicate the difference in periodicity).

10.4 Time Series Sheet Consistency

Implementing formats, styles and worksheet structures consistently within every worksheet is a critical part of creating best practice time series models. Using a consistently structured approach to developing time series models can remove many of the issues that both model developers and model users face in working with spreadsheet models. Moreover, the ongoing application of a consistently structured approach will allow model users to develop a familiarity with the structures utilized in the model developer's time series models and greatly reduce the amount of time required to understand and use time series models.

When model users work with time series models they generally need to view several worksheets that contain different types of information analysed over the modeled time periods. It is important for the model user that the periods that are contained within each worksheet are consistently structured such that the first period is always in the same column on each time series sheet. Conversely, if the period labels go down a column, the first period should always start in the same row.

BPMC 10-4 Time Series Data Direction

It is recommended, where feasible, that *periodicity* labels be *positioned* across *rows*, not down *columns*.

More importantly, each worksheet should contain the same number of periods. By having a consistent number of periods starting in a consistent column (or row) on each time series sheet, it will be significantly easier for model users to develop an understanding of the spreadsheet model.

BPMS 10-6 Time Series Sheet Consistency

Time series sheets for each distinct *time series* within a *workbook* should always:

a) Contain the same number of *periods*; and

b) Have the first *period* starting in the same *column* (or more rarely, *row*).

If different time series sheets contain different numbers of periods, it is often difficult for model users to recognize that this is the case, because the final periods may not be in view on the screen at all times. For more information and examples of the structuring of time series sheets, see Chapter 3, Sheet Structure.

10.5 Multiple Periodicities

A time series model is not restricted to collecting or presenting assumptions, calculations and outputs based on a single periodicity (annual, semi-annual, quarterly, monthly, etc). Rather, in many cases it may incorporate several sets of these components based on a number of periodicities.

While this approach is functional, it requires model users and model developers to manage model components across multiple periodicities, thereby increasing complexity and the potential for confusion.

It is therefore strongly recommended that if a time series model requires assumptions, calculations or outputs for more than one periodicity, the different periodicities be presented on separate, clearly labelled time series sheets. Moreover, these time series sheets should be separated into different sections or sub-sections within the workbook containing time series sheets with the same periodicity. These recommendations are specified below in BPMC 10-2 and BPMC 10-3:

BPMC 10-2 No Mixing of Periodicities

It is recommended that, where feasible, a *time series sheet* never contains *assumptions* or *outputs* for more than one *periodicity*.

BPMC 10-3 Multiple Periodicities in One Workbook

It is recommended that no *section* in a *time series workbook* contains more than one *periodicity*.

Chapter 11

Checks

11.1 Overview

Every spreadsheet model incorporates elements which are critical to the proper operation of the model. The nature of these elements varies between individual models, but will generally take the form of assumptions, outputs and the calculations that relate them. Alerting the model user to the status or state of these elements is fundamental to ensuring that the model accurately and efficiently meets its purpose and objectives. This requirement is best satisfied by use of checks in a workbook.

The primary objective when incorporating model checks is to detect and alert model users to the state of particular outputs or the occurrence of particular events. This function confers an almost limitless scope for their application in spreadsheet models, and as the purposes of models vary greatly the nature of individual checks will also vary greatly between models. The model developer should seek to customize specific checks according to the purpose, content and function of any particular model. It is nonetheless possible to categorize any check used in any workbook according to one of the three following check types:

Check Type	Description
• Error Checks	• Tests included in a spreadsheet model to detect and indicate the existence of errors.
• Sensitivity Checks	• Tests included in a spreadsheet model to detect and indicate the existence of active sensitivity assumptions.
• Alert Checks	• Tests included in a spreadsheet model to detect and indicate the occurrence of designated events, that the model developer intends to notify the model user of, excluding error checks and sensitivity checks.

Accordingly, the standards and conventions require that all checks in a model be classified within one of the three categories outlined above:

BPMS 11-1 Checks Classification

All *checks* in a *workbook* should be classified as being one of the following *check types*:

a) Error check;

b) Sensitivity check; or

c) Alert check.

These check types share common principles and modes of operation. However, each has a distinct and important function within a spreadsheet model. The standards and conventions in this chapter provide guidance as to the proper application of checks to ensure that the effectiveness and user-friendliness of checks are optimized.

11.2 Error Checks

Errors in spreadsheet models, generally represented as incorrect outputs, indicate flaws in the design or function of a model. Typically, model users and developers consider only those errors which occur in the underlying modeling logic or worksheet formulas - the *engine* of a model. However, errors also frequently arise in other less obvious components of a workbook, such as workbook names, conditional formats, controls and external workbook references.

All errors, irrespective of their source, compromise the integrity of a workbook - any single error may have potentially critical implications for the validity of a model's outputs. Therefore, performing a check for errors within a spreadsheet model is fundamental to mitigating risks associated with errors, and maximizing user confidence in a spreadsheet model as a tool for analytical and decision-making processes.

Error checks automate the processes that model developers and users often perform manually to test the integrity of a spreadsheet model. In fact, there are very few manual checks that cannot be automated by incorporating error checks into a model. The benefit of automating the checking process is that it introduces a level of consistency and transparency that may not be achieved when relying upon manual checks. This in turn reduces the risk of errors and the likelihood of confusion on the part of model users.

BPMS 11-2 Error Checks

Every *workbook* should contain appropriate *error checks* to assist in identifying *errors* in the *workbook*.

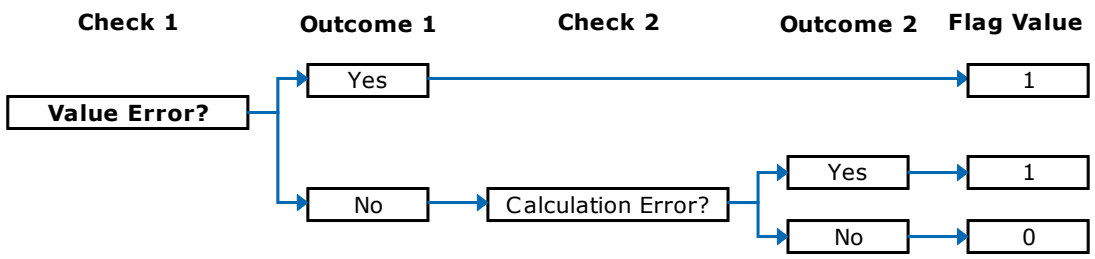
The primary purpose of error checks is to locate errors in modeling logic or worksheet formulas. Worksheet formulas can contain two types of errors:

- **Value errors**: exist when the actual value of a cell is erroneous – e.g. #N/A, #VALUE!, #REF!, #DIV/0!, #NUM!, #NAME?, or #NULL!; and
- **Calculation errors**: result from calculations not correctly representing the relationships that the model developer intended to represent – e.g. the product of total employees and average salary cost does not equate to the calculated total salary expense.

These error types are closely related – ie. value errors are typically generated when formulas and calculations are erroneous or misstated. Problems with value errors are in turn compounded within a workbook when other functions or calculations reference that error, as they will return further value errors as a consequence. Consequently, calculation outputs may not correctly represent mathematical relationships defined by the model developer. These cascades of errors can only be quarantined using the functions of a spreadsheet application which have been designed specifically to capture them (for example, Microsoft Excel© contains the ISERROR function which returns TRUE if a value error is detected).

The most efficient means of checking for errors is to combine the tests for value and calculation errors into a single equation. This can be achieved by creating a formula which includes two nested *IF* functions (*nested* meaning that one IF function is embedded as an argument within the other *IF* function). As the diagram below demonstrates, the first *IF* statement checks for value errors, while the second (*nested*, or *embedded*) *IF* function checks for calculation errors:

Error Checking – Error Check Formula Example



In this example, the tests for each error type have been deliberately ordered so as to prioritize the test for value errors. This allows an error trapping function, such as the *ISERROR* function, to be used to quarantine any value errors and therefore prevent the error check formula itself returning a value error. Hence, a formula that simultaneously tests for value and calculation errors would look something like the following:

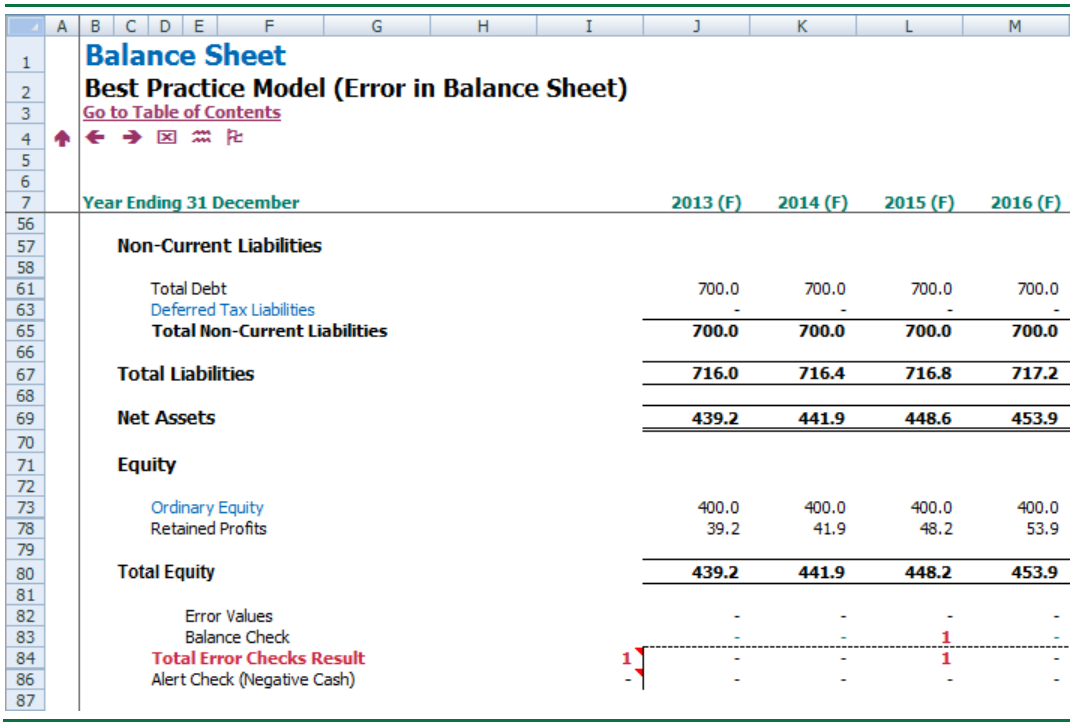
=IF(value_error_check,1,IF(calculation_error_check,1,0))

An example of the practical insertion of an error check is provided below – in this case checking for error values and imbalances within a balance sheet. The error check is shown before and after an error is detected in the balance sheet:

Error Check – No Error

		2013 (F)	2014 (F)	2015 (F)	2016 (F)
1	**Balance Sheet**				
2	**Best Practice Model**				
3	Go to Table of Contents				
7	Year Ending 31 December				
57	**Non-Current Liabilities**				
61	Total Debt	700.0	700.0	700.0	700.0
63	Deferred Tax Liabilities	-	-	-	-
65	**Total Non-Current Liabilities**	**700.0**	**700.0**	**700.0**	**700.0**
67	**Total Liabilities**	**716.0**	**716.4**	**716.8**	**717.2**
69	**Net Assets**	**439.2**	**441.9**	**448.2**	**453.9**
71	**Equity**				
73	Ordinary Equity	400.0	400.0	400.0	400.0
78	Retained Profits	39.2	41.9	48.2	53.9
80	**Total Equity**	**439.2**	**441.9**	**448.2**	**453.9**
82	Error Values	-	-	-	-
83	Balance Check	-	-	-	-
84	Total Error Checks Result	-	-	-	-
86	Alert Check (Negative Cash)	-	-	-	-

Error Check – Error Detected



Balance Sheet

Best Practice Model (Error in Balance Sheet)

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Year Ending 31 December		2013 (F)	2014 (F)	2015 (F)	2016 (F)
Non-Current Liabilities					
Total Debt		700.0	700.0	700.0	700.0
Deferred Tax Liabilities		-	-	-	-
Total Non-Current Liabilities		**700.0**	**700.0**	**700.0**	**700.0**
Total Liabilities		**716.0**	**716.4**	**716.8**	**717.2**
Net Assets		**439.2**	**441.9**	**448.6**	**453.9**
Equity					
Ordinary Equity		400.0	400.0	400.0	400.0
Retained Profits		39.2	41.9	48.2	53.9
Total Equity		**439.2**	**441.9**	**448.2**	**453.9**
Error Values		-	-	-	-
Balance Check		-	-	1	-
Total Error Checks Result	1	-	-	1	-
Alert Check (Negative Cash)	-	-	-	-	-

Note that in this example, error values and the balance sheet check (i.e. the calculation error check) have been split over two separate rows to simplify the calculation logic within these rows and also to make it clear whether the ultimate error being detected is a value error or a calculation error. Note also that although this error check is checking for errors in multiple periods over multiple rows, only one error check cell is recording the outcome of all these checks (the cell I84).

Unfortunately, errors can exist within a workbook such that they are not immediately evident to model users or developers. For example, errors in external workbook links and conditional format conditions are not detectable using worksheet formulas and can only be located by undertaking a thorough manual or programmatic search of a workbook. To detect errors in these components, the model developer should thoroughly audit every cell, name and conditional format formula prior to distributing a model to users or developers.

11.3 Error Check Summaries

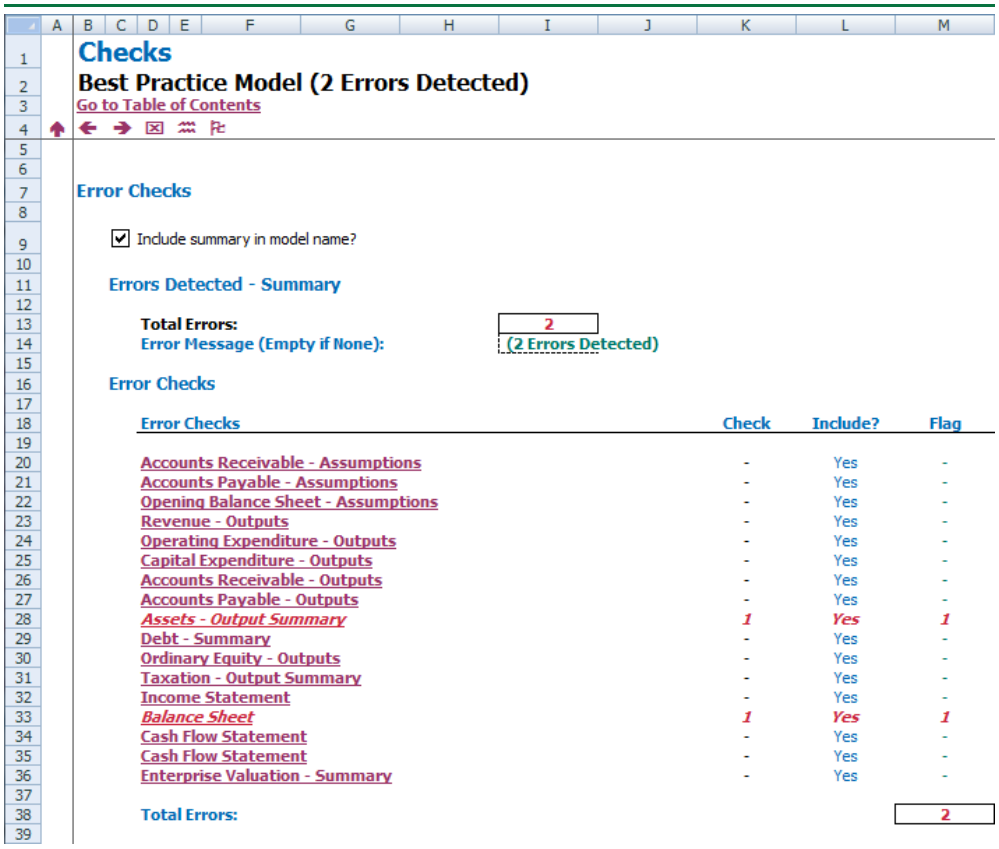
Error checks do not represent part of the primary outputs of a workbook. Rather, they are used to evaluate the correctness of a workbook's logic and/or calculations, and to make users aware of erroneous outputs. The results of all error checks within a model should be presented on a single, dedicated *error checks summary* to provide a centralized summary which is easily referenced by model users.

BPMS 11-5 Error Checks Summary

The outcome of every *error check* in a *workbook* should be displayed in a dedicated and separate *error checks summary*.

Below is an example of an error checks summary with several error check areas, two of which have been triggered (the *Assets – Forecast Outputs* and *Balance Sheet* error checks):

Error Checks Summary - Example



Checks

Best Practice Model (2 Errors Detected)

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Error Checks

☑ Include summary in model name?

Errors Detected - Summary

Total Errors:	2
Error Message (Empty if None):	(2 Errors Detected)

Error Checks

Error Checks	Check	Include?	Flag
Accounts Receivable - Assumptions	-	Yes	-
Accounts Payable - Assumptions	-	Yes	-
Opening Balance Sheet - Assumptions	-	Yes	-
Revenue - Outputs	-	Yes	-
Operating Expenditure - Outputs	-	Yes	-
Capital Expenditure - Outputs	-	Yes	-
Accounts Receivable - Outputs	-	Yes	-
Accounts Payable - Outputs	-	Yes	-
Assets - Output Summary	*1*	*Yes*	*1*
Debt - Summary	-	Yes	-
Ordinary Equity - Outputs	-	Yes	-
Taxation - Output Summary	-	Yes	-
Income Statement	-	Yes	-
Balance Sheet	*1*	*Yes*	*1*
Cash Flow Statement	-	Yes	-
Cash Flow Statement	-	Yes	-
Enterprise Valuation - Summary	-	Yes	-
Total Errors:			2

This example illustrates how an error checks summary can be used to summarize the outcome of every error check in a workbook. This summary incorporates a link to each error check area within the workbook, with the *Total Errors* (representing the number of errors detected in the workbook) being used to create an error message (in cell I14) which has then been referenced by the model name on the workbook cover sheet. Because each sheet references the model name (in this example via the formula in cell B2), every sheet in the workbook will indicate the existence of the two detected errors.

BPMC 11-4 Check Type Summary Cell

It is recommended that the outcome of all *checks* of each *check type* be summarized into a single *check cell* for each *check type* contained within a *workbook*.

Note also the conditional formatting has been used to clearly highlight the detection of errors within check flag cells and their related heading cells by applying check red font color and bold font style.

BPMC 11-2 Check Cell Conditional Formatting

It is recommended that every *check cell* in a *workbook* be consistently *formatted* such that, when triggered, they appear formatted as follows:

a) Bold font; and

b) Red *font color*.

Note from the above example that the use of area-specific error checks greatly assists in the locating of errors within a model in addition to their detection. In this example, the *Balance Sheet* check has been flagged, indicating that the balance sheet in the model may be dis-balanced. However, the error checks summary also indicates that the *Assets – Forecast Outputs* error check has been flagged, which thereby provides evidence of the balance sheet check most probably being flagged as a result of an error within the assets area of the workbook. This level of sophistication in error checks systems is only possible when error checks are added throughout a spreadsheet model during the development process in order to capture lower-level errors such as that in this example.

Hence, error checks should be added to workbooks as each section of the workbook is constructed, not retrospectively or as part of the model finalization process. There are two reasons for this. Firstly, detailed and robust checks should take into account the particular issues and vulnerabilities of each set of formulas, the details of which can often be forgotten by the time development of the model is completed. Secondly, by including error checks within a model as it is constructed, the model developer can ensure that the ongoing development of a workbook does not compromise the integrity of the existing components of the workbook.

It is important that checks of different types are centralized in a workbook.

BPMS 11-10 Dedicated Checks Summaries

A *workbook* should not contain more than one of each of the following types of *check summaries*:

a) *Error checks summary;*

b) *Sensitivity checks summary; and/or*

c) *Alert checks summary*.

11.4 Sensitivity Checks

Sensitivity checks are used in spreadsheet models to detect the presence of operative sensitivity assumptions. Sensitivity assumptions are the basis by which model users can analyze the sensitivity of the outputs of spreadsheet model to changes in its base assumptions. This functionality can be of great value to model users as it allows them to understand the sensitivity of model outputs to changes in base assumptions. For more information on sensitivity analysis, see Chapter 6 Sensitivity Analysis.

Sensitivity checks are employed to minimize these risks, as they enable model users to quickly determine which sensitivity assumptions are active in a model, and identify the drivers of differentials between base and running cases.

BPMS 11-3 Sensitivity Checks

Every *workbook* that contains one or more *sensitivity assumptions* should contain *sensitivity checks* to identify when there is an *operative sensitivity assumption*.

In comparison with error checking (particularly checks for calculation errors), checking for sensitivities is a straight-forward procedure. Put simply, it involves activating a check once a sensitivity assumption is operative within a model.

A simple sensitivity check formula may be something like the following:

```
=IF(active_sensitivity_assumption_value<>0,1,0)
```

Note that this check should also incorporate a function to quarantine error values and prevent the sensitivity check returning an error in the event that an invalid sensitivity assumption is inserted by a model user. Section 11.2 Error Checks contains information about using spreadsheet functions to mitigate problems in spreadsheets caused by error values.

BPMC 11-3 Check Calculation Location

It is recommended that the calculations for *checks* be *located* on the *sheet* to which the *check* is relevant and not on the associated *check sheet*.

A sensitivity check should be applied to every sensitivity assumption in a workbook, and each sensitivity check should be located on the same worksheet as the sensitivity assumption to which it refers. As a workbook may contain a number of sensitivity assumptions entry interfaces located on several sensitivity assumptions sheets, it is important that a model incorporate a centralized summary of all sensitivity checks that it contains. This is discussed further in below in 11.5 Sensitivity Checks .

11.5 Sensitivity Checks Summaries

Sensitivity checks are used to alert model users to the fact that sensitivity assumptions within the model are impacting model outputs. As a workbook may contain a large number of sensitivity assumptions, the best means of communicating the status of all sensitivity checks in a workbook is using a centralized worksheet which summarizes the status of each check.

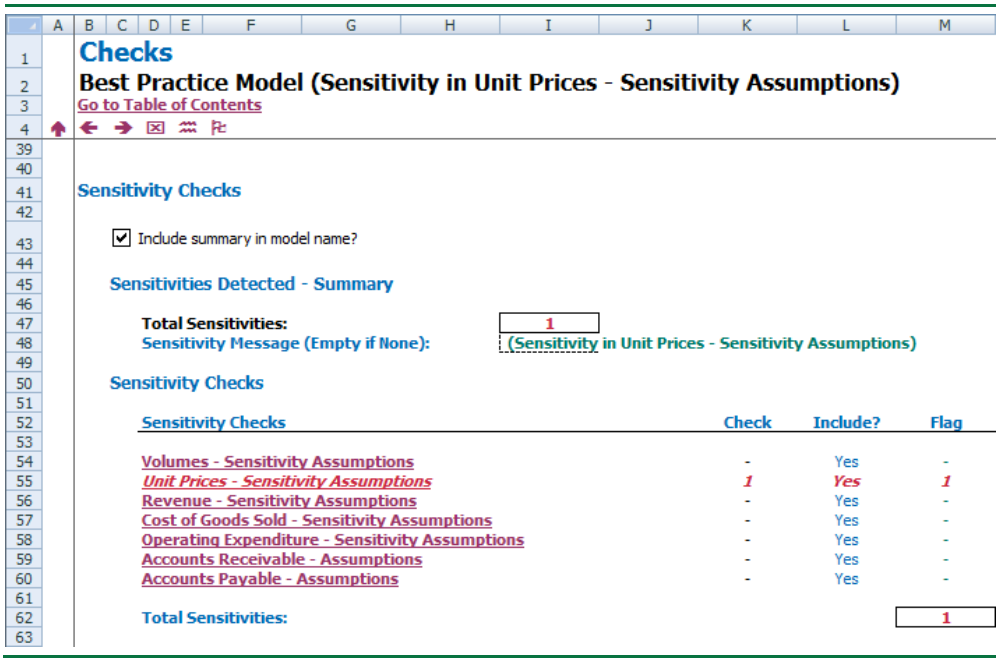
BPMS 11-6 Sensitivity Checks Summary

The outcome of every *sensitivity check* in a *workbook* should be displayed in a dedicated and separate *sensitivity checks summary*.

The construction of sensitivity checks summaries is governed by the same principles as those recommended for the construction of error checks summaries (see 11.3 Error Check Summaries). The sensitivity checks summary should contain simple flags for each sensitivity assumption or group of sensitivity assumptions in a workbook, and provide visual identifiers to model users when a sensitivity assumption is operative.

The following illustration provides an example of a sensitivity checks summary. This worksheet incorporates a link to each sensitivity check area within the workbook, and the *Total Sensitivities* (representing the number of operative sensitivity assumption areas detected in the workbook) being used to create an error message (in cell I48) which has then been referenced by the model name on the workbook cover sheet. Because each sheet references the model name (in this example via the formula in cell B2), every sheet in the workbook will indicate the existence of the detected operative sensitivity assumptions.

Sensitivity Checks Summary - Example



Checks

Best Practice Model (Sensitivity in Unit Prices - Sensitivity Assumptions)

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Sensitivity Checks

☑ Include summary in model name?

Sensitivities Detected - Summary

Total Sensitivities:	1
Sensitivity Message (Empty if None):	(Sensitivity in Unit Prices - Sensitivity Assumptions)

Sensitivity Checks

Sensitivity Checks	Check	Include?	Flag
Volumes - Sensitivity Assumptions	-	Yes	-
Unit Prices - Sensitivity Assumptions	*1*	*Yes*	*1*
Revenue - Sensitivity Assumptions	-	Yes	-
Cost of Goods Sold - Sensitivity Assumptions	-	Yes	-
Operating Expenditure - Sensitivity Assumptions	-	Yes	-
Accounts Receivable - Assumptions	-	Yes	-
Accounts Payable - Assumptions	-	Yes	-
Total Sensitivities:			1

Note that the sensitivity checks summary enables very specific information about sensitivity status to be communicated throughout the model – e.g. it is possible to reference the title of operative sensitivity assumptions and link this information to the model name. In this case, the *Unit Prices – Sensitivity Assumptions* assumptions entry interface is referenced via a hyperlink on the sensitivity checks summary, and this title is also captured by the *Sensitivity Message* which is then fed back into the model name cell on the workbook cover sheet. This approach ensures that model users will always be aware of the detection of operative sensitivity assumptions as well as their location within the surrounding workbook.

11.6 Alert Checks

This chapter has discussed the importance of including error and sensitivity checks in spreadsheet models to alert users to events considered fundamental to the operation of models. It is possible, however, that model users may regard other specific events or modeling outcomes not representing errors or sensitivities as equally critical elements of a model's outputs, would therefore also expect to be alerted to their existence. The role of detecting and alerting users of these residual events should be performed by *alert checks*.

BPMS 11-4 Alert Checks

Every *workbook* that requires *checks* that are not classified as *error checks* or *sensitivity checks* should contain *alert checks* to identify when such a check has been triggered.

Alert checks will generally be customized to match the specific circumstances of individual models on a case-by-case basis. For example, alert checks may be included to check for the following outcomes:

- Outputs falling outside the bounds of designated target ranges (e.g. interest coverage ratios breaching the minimum requirements of debt providers); or
- Negative revenues or positive expenses; or

- Negative balance sheet items (e.g. cash at bank).

In some circumstances it may be difficult for the model developer to determine whether a particular check should be classified as an alert check or an error check. In this situation, the model developer should be guided by the expectations of model users – if the model users were to consider the occurrence of a designated event as an error, then the check should be classified as an error check, otherwise it should by default be classified as an alert check.

11.7 Alert Check Summaries

Consistent with the principles governing the use of error and sensitivity checks, the standards and conventions require that all alert checks in a workbook be presented on a single alert checks summary. This worksheet should visually identify the results of every alert check or group of alert checks in the workbook in order to provide a centralized reference for communicating the total alert check results to model users.

BPMS 11-7 Alert Checks Summary

The outcome of every *alert check* in a *workbook* should be displayed in a dedicated and separate *alert checks summary*.

The structure of the alert checks summary should be standardized with the error and sensitivity checks summaries. As the example below illustrates, the alert check summary should include a flag for each alert (or group of alerts). Additionally, the total alert checks result should be linked to the model name cell on the workbook cover sheet to ensure that the total alert checks result is immediately viewable on every worksheet within the workbook.

Alert Checks Summary - Example

Checks

Best Practice Model (Alert in Ordinary Equity - Assumptions)

Go to Table of Contents

Alert Checks

☑ Include summary in model name?

Alerts Detected - Summary

Total Alerts:	1
Alert Message (Empty if None):	(Alert in Ordinary Equity - Assumptions)

Alert Checks

Alert Checks	Check	Include?	Flag
Revenue - Assumptions	-	Yes	-
Operating Expenditure - Assumptions	-	Yes	-
Capital Expenditure - Assumptions	-	Yes	-
Accounts Receivable - Assumptions	-	Yes	-
Accounts Payable - Assumptions	-	Yes	-
Assets - Depreciation Assumptions	-	Yes	-
Debt - Assumptions	-	Yes	-
Ordinary Equity - Assumptions	*1*	*Yes*	*1*
Taxation - Assumptions	-	Yes	-
Opening Balance Sheet - Assumptions	-	Yes	-
Enterprise Valuation - Assumptions	-	Yes	-
Revenue - Outputs	-	Yes	-
Operating Expenditure - Outputs	-	Yes	-
Capital Expenditure - Outputs	-	Yes	-
Ordinary Equity - Outputs	-	Yes	-
Balance Sheet	-	Yes	-
Total Alerts:			1

11.8 Check Identifiers

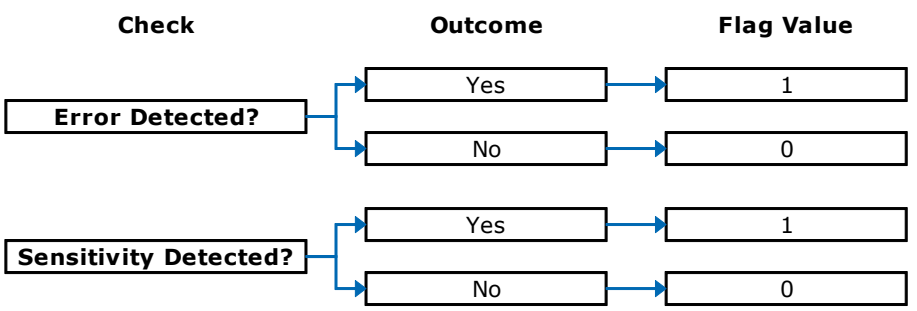
The most simple and effective method of creating checks is to use a checks *flagging* system which identifies checks as they are activated and alerts the user immediately. Although any binary system can be used as flags, using the numbers 1 and 0 to represent *flagged* and *not flagged* respectively means that the check flags can be summed and used to provide more detailed reporting information such as the total number of checks detected.

BPMS 11-8 Check Indicator Flag

A message or indicator that clearly notifies the *model developer* or *user* that a *check* has been triggered in a *workbook* should always be in view on every *worksheet* in a *workbook*.

These check flags should be created through the use of simple IF functions as follows:

Check Indicator Flags – Formula Logic



Further, the outcome of multiple checks can be summarized to a total outcome.

BPMC 11-4 Check Type Summary Cell

It is recommended that the outcome of all *checks* of each *check type* be summarized into a single *check cell* for each *check type* contained within a *workbook*.

The total of the flag values on the relevant checks sheet can then be used as the basis for a check message which should appear on every worksheet in a model (this is discussed below).

11.9 Reporting the Status of Checks

The inclusion of extensive error, sensitivity and alert checking in a spreadsheet model must be coupled with the adoption of effective means for indicating the status of checks. Detecting active checks will serve no purpose if model users are not made aware of the change in status of the checks immediately upon taking the action which gave rise to the detected outcome. This is particularly relevant for error checks, as model users or developers will often experience difficulties retracing their steps to determine the cause of errors when the detection of errors is not immediately communicated to them.

There are two main objectives in delivering immediate awareness for triggered error, sensitivity and alert checks:

a. To ensure that model users are immediately made aware of a triggered error or active sensitivity assumption; and

b. To guide model users to the source of the detected error, sensitivity or alert.

The first of these objectives is easier to achieve as it primarily involves the disciplined and consistent placement of indicators throughout the model. Achieving the second objective involves more initiative on behalf of the model developer and must generally be done on a case by case basis.

Immediate Awareness

To ensure that model users are immediately made aware of detected errors, operative sensitivity assumptions or active alerts, model users should not be able to use a spreadsheet model without a check message in view at all times. The best way to ensure that this is the case is by linking the error, sensitivity and alert checks to a common cell on every worksheet. This cell should be positioned above the window splits that have been used to ensure that the sheet title and table of contents hyperlink are always in view (see 3.4 Window Panes and Splits).

If the sheet layout principles in these standards and conventions are followed (see BPMC 9-1 Workbook Name Display), the model name cell on the workbook cover sheet should be used as the link cell to the error and sensitivity checks.

BPMC 11-1 Linking Checks to Model Name Entry Cell
It is recommended, where relevant, that the outcome of the *check type* summary cell referred to in BPMC 11-4 be linked to the *model name* entry *cell* on the *workbook cover sheet*.

Because every worksheet in the model should contain a link to this cell above its window pane, there should never be an instance when an event that triggers a check is not communicated to the user immediately. To link the model name cell to the error and sensitivity check worksheets, the following mixed cell formula could be inserted in the model name cell on the workbook cover sheet:

```
="[Model Name] "&IF(error_flag_count<>0,"(Errors Detected) ","")
        &IF(sensitivity_flag_count<>0,"(Sensitivities Running)","")&
          IF(alert_flag_count<>0,"(Alerts Detected) ","")
```

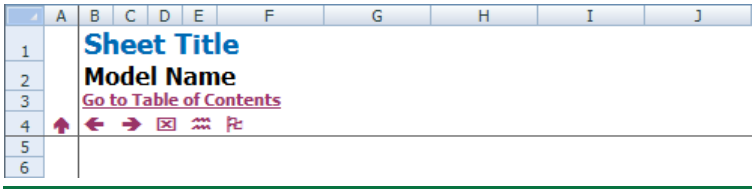
The following table shows the results of this formula in the model name cell when various combinations of errors, sensitivities and alerts detected:

Scenario / Checks Detected:	Model Name Cell Formula Result:
No errors, no sensitivity, no alerts	[Model Name]
Errors, no sensitivities, no alerts	[Model Name] (Errors Detected)
Sensitivities, no errors, no alerts	[Model Name] (Sensitivities Running)
Alerts, no errors, no sensitivities	[Model Name] (Alerts Detected)
Errors, sensitivities, alerts	[Model Name] (Errors Detected) (Sensitivities Running) (Alerts Detected)

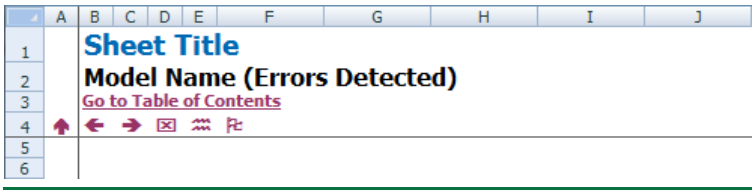
The result of the formula in the model name cell will be displayed by every cell which is linked to the model name cell and positioned at the top of every worksheet in the model. This ensures immediate awareness on the part of model users (and other model developers) regarding the status of all checks in the workbook. See BPMC 9-1 Workbook Name Display, for discussion surrounding the linking of the model name to each worksheet in a workbook.

The following examples show how the model name cell on a blank outputs sheet would reflect some of these scenarios:

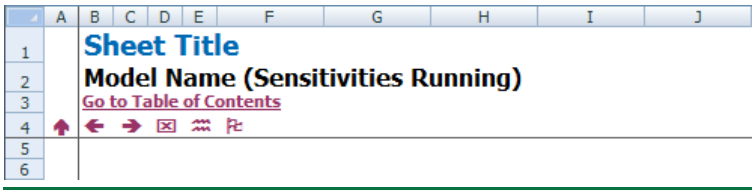
No Checks Detected



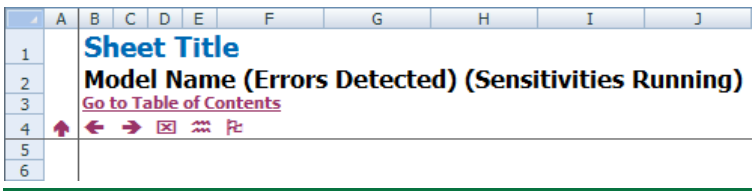
Errors Detected



Sensitivities Detected



Errors and Sensitivities Detected



Note the use of the window pane frozen around the cell B5 (see 3.4 Window Panes and Splits) to ensure that when model users scroll down the worksheet on screen, the model name reference cell (in this case in cell B2) always remains in view. This also ensures that the main sheet hyperlinks (including hyperlinks to each of the check summaries) remain in view at all times on each worksheet.

The model reference cell in this example would not contain the mixed cell formula previously mentioned, but rather a direct link to the model cell on the workbook cover sheet (which would contain the mixed cell formula). This prevents the need to enter the mixed cell formula into every sheet and ensures consistency between all worksheets. It also explains the use of formula (black) font color in the model name reference cell as opposed to the mixed (green) font color applied to the workbook cover sheet model name cell (see 1.7, Cell Identification, for more information on color coding).

Locating the Source of Error, Alert and Sensitivity Checks

The second objective of effectively indicating model checks is ensuring that model users are guided to the source of the flagged checks. This should be done on a case by case basis, but in the case of error checking may be complicated by the *cascading* effect of errors – i.e. the potential for a single error to flow through dependent formulas throughout the surrounding workbook, therefore making it very difficult to isolate the error source error. The best way of minimizing the risk of confusion in such cases is ensuring immediate awareness of the value errors (discussed above).

There are three steps that should be taken to ensure that model users are guided to the source of errors and/or sensitivities detected in a spreadsheet model:

1. Error, sensitivity and alert check summaries should be placed on sheets which are located in a separate section of the workbook. This checks section should be clearly labeled and included in the Table of Contents to ensure easy access by model users;

2. Check conditional formatting (usually bold and red font) should be used on check sheets to highlight non-zero flags (see 5.6 Conditional Formatting); and

3. Hyperlinks should be added to the checks summaries to enable model users to click through to the source of the detected error, sensitivity or alert.

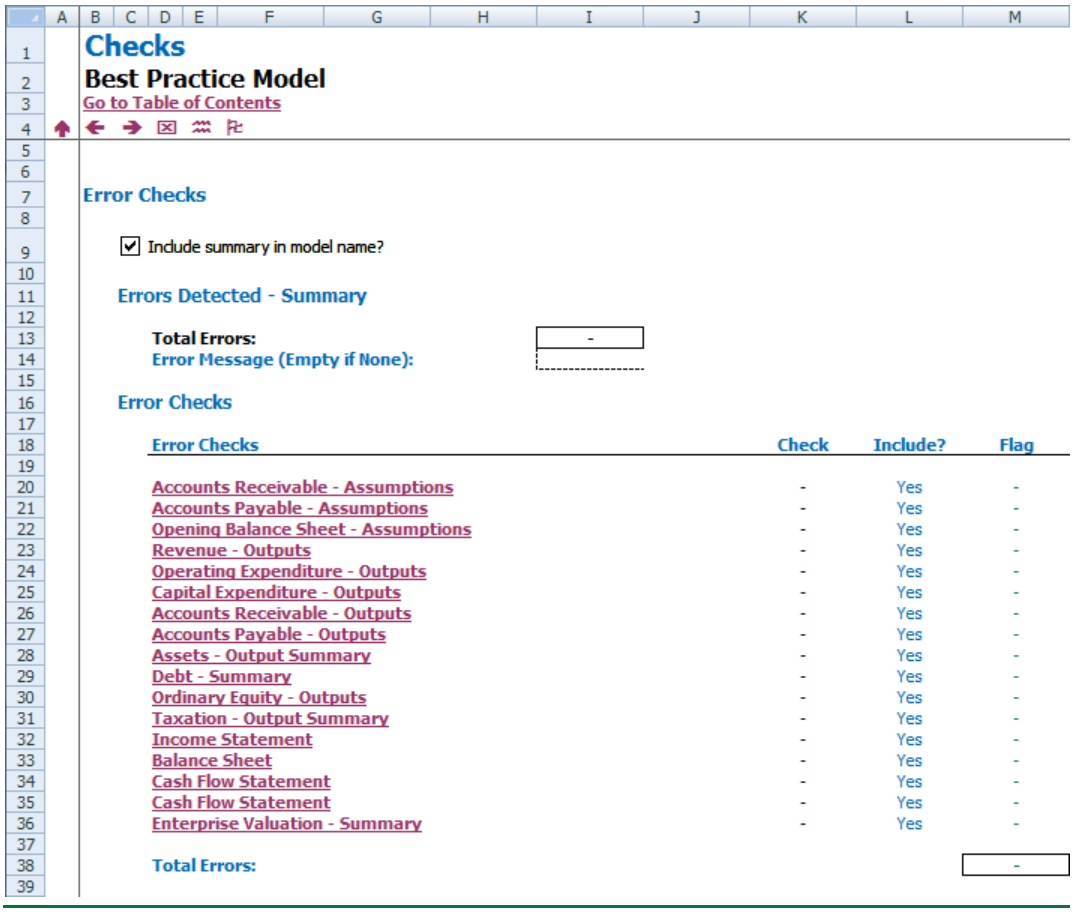
The second of these steps is the subject of BPMS 11-9 below:

BPMS 11-9 Check Cell Formatting

Each *check cell* in a *workbook* should be *formatted* in such a way that it will visually indicate when an *error*, *sensitivity* or *alert check* has been triggered.

The following example shows an error checks summary both with and without errors having been flagged in the underlying workbook:

Error Checks Summary – No Errors Detected



Checks

Best Practice Model

Go to Table of Contents

Error Checks

☑ Include summary in model name?

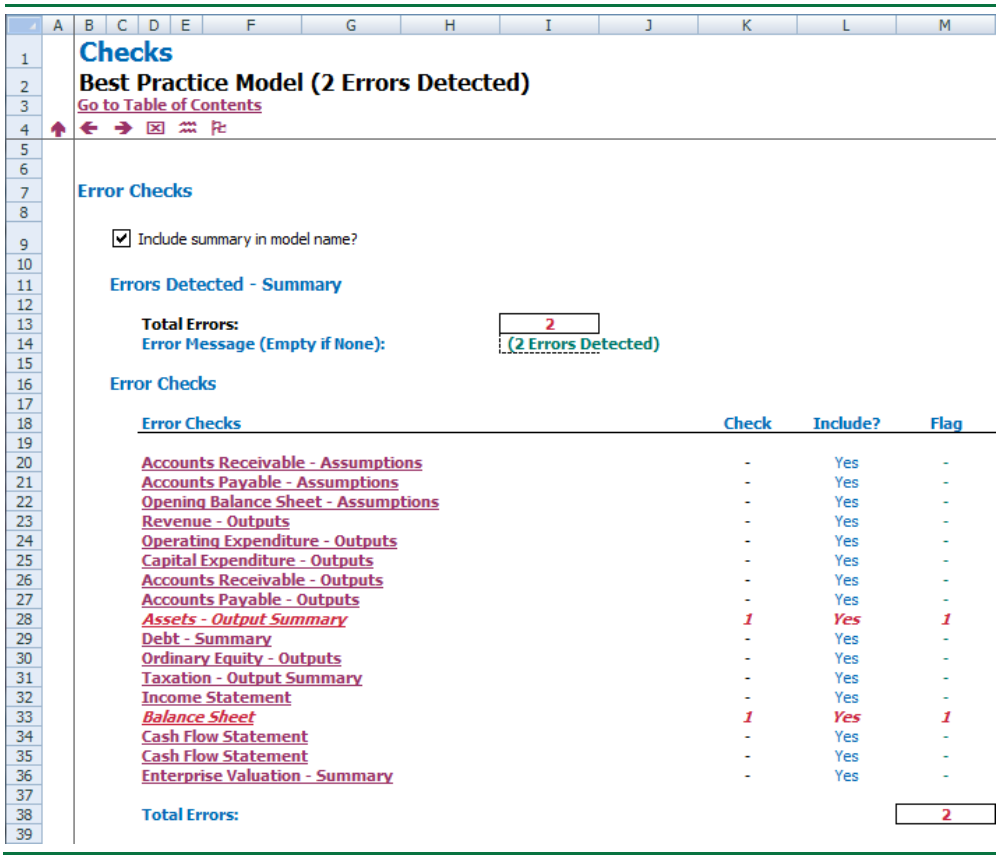
Errors Detected - Summary

Total Errors:	-
Error Message (Empty if None):	

Error Checks

Error Checks	Check	Include?	Flag
Accounts Receivable - Assumptions	-	Yes	-
Accounts Payable - Assumptions	-	Yes	-
Opening Balance Sheet - Assumptions	-	Yes	-
Revenue - Outputs	-	Yes	-
Operating Expenditure - Outputs	-	Yes	-
Capital Expenditure - Outputs	-	Yes	-
Accounts Receivable - Outputs	-	Yes	-
Accounts Payable - Outputs	-	Yes	-
Assets - Output Summary	-	Yes	-
Debt - Summary	-	Yes	-
Ordinary Equity - Outputs	-	Yes	-
Taxation - Output Summary	-	Yes	-
Income Statement	-	Yes	-
Balance Sheet	-	Yes	-
Cash Flow Statement	-	Yes	-
Cash Flow Statement	-	Yes	-
Enterprise Valuation - Summary	-	Yes	-
Total Errors:			-

Error Checks Summary – Errors Detected



Checks

Best Practice Model (2 Errors Detected)

Go to Table of Contents

Error Checks

☑ Include summary in model name?

Errors Detected - Summary

Total Errors:	2
Error Message (Empty if None):	(2 Errors Detected)

Error Checks

Error Checks	Check	Include?	Flag
Accounts Receivable - Assumptions	-	Yes	-
Accounts Payable - Assumptions	-	Yes	-
Opening Balance Sheet - Assumptions	-	Yes	-
Revenue - Outputs	-	Yes	-
Operating Expenditure - Outputs	-	Yes	-
Capital Expenditure - Outputs	-	Yes	-
Accounts Receivable - Outputs	-	Yes	-
Accounts Payable - Outputs	-	Yes	-
Assets - Output Summary	*1*	*Yes*	*1*
Debt - Summary	-	Yes	-
Ordinary Equity - Outputs	-	Yes	-
Taxation - Output Summary	-	Yes	-
Income Statement	-	Yes	-
Balance Sheet	*1*	*Yes*	*1*
Cash Flow Statement	-	Yes	-
Cash Flow Statement	-	Yes	-
Enterprise Valuation - Summary	-	Yes	-
Total Errors:			2

Note from this example:

- The error checks summary is located on a blank outputs sheet designed specifically to hold checks and is clearly separated and labelled accordingly (which would appear as such in the Table of Contents);
- The application of check (bold italic red font) conditional formatting to the rows within the error checks summary ensuring that triggered checks are clearly differentiated from non-triggered checks; and
- The use of hyperlinks within each check row to enable model users to immediately click through to the source of the detected errors – e.g. the *Assets – Output Summary* sheet and the *Balance Sheet*.

Chapter 12

Printing & Viewing

12.1 Overview

In order to make spreadsheet models readily comprehensible, printing and viewing layouts should be considered carefully from an end user perspective. Obviously, a spreadsheet model is pointless if it cannot communicate the information that it contains. More importantly, a spreadsheet model that has been set to print and view appropriately can make the difference between it being user-friendly and difficult for model users (and other model developers) to work with.

Printing and viewing settings within spreadsheet models are often neglected by model developers. This has primarily been due to an inappropriate focus on the part of model developers on the fact that the printing and viewing settings do not affect the functionality or calculations within a spreadsheet model. As a result, the printing and viewing properties of spreadsheet models rarely receive significant attention.

Because the primary purpose of most spreadsheet models is to analyze and then communicate information to model users, a best practice spreadsheet modeler should devote considerable time to model printing and viewing settings to ensure that there is minimal scope for the misunderstanding or miscommunication of spreadsheet model information.

12.2 Page Numbers

As every best practice spreadsheet model with more than one sheet should contain a table of contents that displays the page numbers for each printed page on each sheet in the workbook (see BPMS 2-5 Table of Contents Information), it is important that those page numbers correspond to the printed page numbers.

BPMS 12-1 Table of Contents Page Numbers

Every *workbook* with more than one *sheet* should contain a *table of contents* that displays the corresponding printed page numbers for each *sheet*. As such a *workbook* should always print with a *Table of Contents* that is consistent with any page numbers printed on the individual *sheet* pages.

When printing a workbook, the primary goal should be to ensure that the spreadsheet model prints like a page-numbered book. Because workbooks can include page numbers when printed, a model developer should construct a workbook such that when it prints it includes:

a. A table of contents, summarizing each worksheet in the workbook including page numbers; and

b. Page numbers on every printed page of the workbook that correspond with the table of contents page numbers.

As such, whenever a best practice workbook is printed, it should include page numbers on every printed page that correspond to the page numbers on its centralized table of contents.

BPMS 12-2 Sheet Page Numbers

Every *sheet* within a *workbook* should contain page numbers that correspond with the printed page numbers stated in the *workbook table of contents*, when printing the entire *workbook*.

In this way, a printed copy of a workbook can be navigated via the table of contents and the page numbers in an efficient and user friendly manner.

12.3 Printing Workbooks

The primary consideration of the model developer when printing a workbook should be ensuring that all the sheets within the workbook print consistently. This is done by ensuring that all the relevant printing and viewing properties of each sheet (referred to in some spreadsheet applications as 'page setup properties') are the same, in particular:

a. Printed page margins; and

b. Print scaling settings.

Ensuring that the printing and viewing properties of each sheet in relation to these two areas are kept consistent, the model developer will ensure that a spreadsheet model prints in a logical, consistent and professional way.

Note that most of the standards and conventions in the Printing & Viewing Spreadsheet Modeling Area relate to worksheets and therefore not chart sheets. This is because chart sheets usually print as a single page and therefore are not generally at risk of being printed in a way which will cause significant inconsistencies in the printed workbook layout. In any case, if charts are appropriately embedded within worksheets instead of placed on chart sheets (as per BPMC 3-3 No Chart Sheets), chart sheet print settings need never be considered by the model developer. If chart sheets are used, the standards and conventions discussed in this chapter should still be applied to the extent possible.

Page Margin Consistency

The page margins of a sheet determine the placement of the information within that sheet when it is printed and the size of the margin areas around the edge of each printed page. Because worksheets are based on a grid structure that is used to align data across columns and down rows for easy interpretation, it is important that the alignment within the worksheets of a workbook remain consistent when the workbook is printed. If the page margins for each sheet are different, the appearance of the printed data will not be consistently aligned on each printed page. In the same way as the page margins in a report or document would be consistently set before printing, so too should the model developer set the page margins in a workbook before printing.

BPMS 12-3 Page Margin Consistency

The page margins on every *sheet* in a *workbook* should be consistent.

To assist model users when using printed copies of workbooks it is important to maintain consistency in the page margin properties. In this way, the printed workbook will be more readily useable and will be presented in a more professional and user-friendly manner. Therefore, the model developer should always ensure, where feasible, that the page margins for each sheet in a workbook are consistent.

Print Scaling Consistency

The print scaling of a sheet determines the size of the information within that sheet when it is printed. Hence, if the print scaling settings for sheets within a workbook are different, the information within each sheet will print with different sizes. Not only will the information on different pages be aligned differently, but the information will not be able to be associated with each other based on size or positioning on the page, as may have been intended by the model developer. To prevent these issues from arising, the print scaling settings for each sheet in a workbook should, where feasible, be consistent.

BPMS 12-4 Print View Consistency

The *print scaling* setting and hence the size of the content on each printed page in a *workbook* should, where feasible, be consistent for each *sheet*.

Where it is not practical to ensure print scaling consistency between sheets (i.e. where the model developer wants to fit more information on certain printed pages) the number of different print scaling settings used in the workbook should be limited to the minimum number possible. This is best done through ensuring *sheet type consistency* (see 3.2 Sheet Consistency) – i.e. ensuring that the print scaling settings of all sheets of the same type are made consistent. In this way, all time series sheets will print the same size, as will all section cover sheets, etc.

Additionally, because the print scaling settings of each sheet determine the size of the components within each sheet when printed, the use of small or large print scaling settings may result in confusion on behalf of model users and other model developers who are viewing a printed version of the spreadsheet model. For example, if different heading levels are differentiated on screen by their font size property and different sheets print different sizes, it may be impossible to distinguish heading levels on the different sheets.

To prevent such issues arising from the use of small and large print scaling settings, it is recommended that model developers always set the print scaling settings of every sheet, where possible, to 100%.

BPMC 12-1 Workbook Print Scaling

It is recommended that, where feasible, the *print scaling* for every *sheet* in a *workbook* should be set to 100%, where possible, to ensure clarity and consistency when printing and viewing a printed copy of the *workbook*.

Ensuring that all print scaling settings are set at 100% means that the sheets within a workbook will always print in consistency with how they are viewed on screen (assuming consistent screen zooms are being used for each sheet in the workbook). This is particularly important in the case where model users or other model developers have a soft copy of the spreadsheet model and have familiarized themselves with the layout and appearance of the model on screen.

12.4 Printed Information

It is important for model developers to expect that their spreadsheet models will frequently be printed by model users. Moreover, when a spreadsheet model, or part thereof, is printed, it can potentially be stored indefinitely. The printed outputs from many spreadsheet models are often analyzed by model users some time after the underlying spreadsheet model was constructed. As such, the printed information that appears on each page of a spreadsheet model can be critical to the current and future understanding of model users.

As such, model developers should ensure that potential users of the printed workbook are aware of certain critical information before using the information. It is recommended that this be done including the following critical information in the header or footer of every printed page in a workbook:

a. The name of the workbook; and

b. The date that the page was printed.

The inclusion of this information on every printed page in a workbook ensures that anyone who comes in contact with the printed pages is immediately made aware of the source of the printed pages and the date at which they were printed. It also allows for the separate printing and storage of sheets within a spreadsheet model without compromising these objectives.

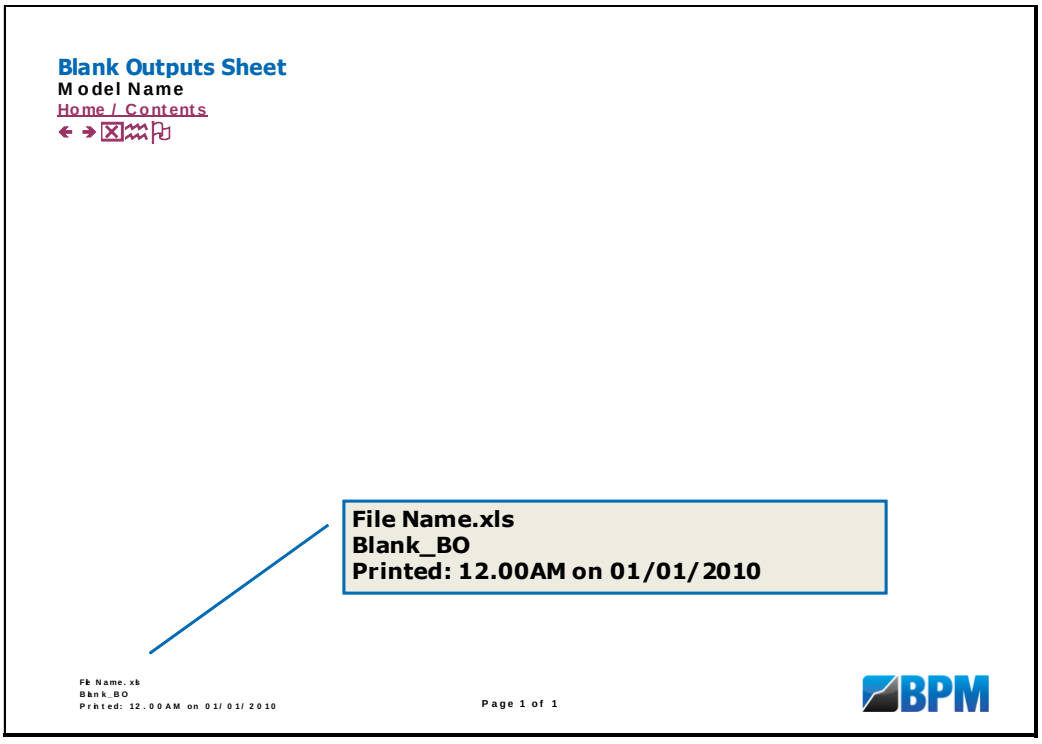
BPMC 12-2 Printed Information

It is recommended that every printed page include the following information:

a) The date and time that the page was printed;
b) The name of the *workbook*;
c) The name of the *sheet;* and
d) The page number.

Below is an example of a printed page with this information in the footer:

Printed Information In Sheet Footers



In this example, the file name and exact date and time of printing have been included in the left footer (with the printed page number being included in the center footer in accordance with BPMS 12-2 Sheet Page Numbers). Additionally, the name of the sheet has been included with this information to ensure that the sheet can be easily located within the model if the model user decides to view the information on screen.

12.5 Viewing Workbooks

Many model users are not accustomed to the different view types that exist within Microsoft Excel®. These can include:

a. Normal view; or

b. Page Break Preview.

Moreover, many model users may not know how to change the page view – especially for a large number of sheets at one time. Therefore, model developers should always ensure that each sheet in a workbook is set the same view type, and further, that this view type is the most appropriate one for model users to be viewing the workbook on screen. In this way each sheet in the workbook will look consistent to the model user.

BPMC 12-5 Page View Consistency

The *print scaling* setting and hence the size of the content on each printed page in a *workbook* should, where feasible, be consistent for each *sheet*.

It is further recommended that the consistent view type that is applied to a workbook before providing it to model users be the Normal view type, because the Page Break Preview view type is primarily intended for setting page breaks and not for normal workbook viewing.

Model users often use workbooks by simply viewing them on their computer. When the cursor on a sheet is positioned down columns or across rows, the view of the sheet will not be at its natural starting point, which is the top left corner. Additionally, the viewing position of each sheet will be saved when the workbook is saved such that the next model user will automatically see the saved view.

As such it is important that when a model developer provides a workbook to a model user that the way that the workbook will appear (or view) to the model user is appropriate and promotes the efficient use of the workbook by the model user. To ensure that this is the case:

a. Always set each sheet to the same view type (as per BPMS 12-5 Page View Consistency);

b. Ensure that the vertical and horizontal scroll of each sheet is set to the top left of the sheet before saving the workbook; and

c. Always position the cursor on each worksheet in the top-left corner of the sheet (i.e. select cell A1).

Ensuring that the cursor on each worksheet is positioned in the top-left corner will ensure that the sheet title, hyperlinks and other important information at the top of each worksheet is always in view when the model user first activates each sheet (See Chapter 3, Sheet Structure).

BPMC 12-6 Worksheet View Consistency

Prior to providing a *workbook* to a *model user*, the view of every *worksheet* in the *workbook* should be set such that the top-left corner of the *worksheet* is in view (i.e. *cell* A1 is selected).

Ensuring consistent view types between the sheets of a workbook, and that the top-left corner of each worksheet is in view before distributing a spreadsheet model to model users will ensure that the screen viewing user-friendliness of the workbook is maximized.

Chapter 13

Multiple Workbooks

13.1 Overview

Spreadsheet applications are different to most other applications in their ability to efficiently link different workbooks and maintain inter-relationships between their calculations. These links are generally contained within formulas cell references, whereby a formula in one workbook refers to a cell or range of cells in another workbook. If used correctly, this functionality has many benefits including:

a. Limiting individual workbook (file) size;

b. Segregation of different workbooks within a group;

c. Segregation of outputs workbooks for ease of use and distribution; and

d. Security control of different workbooks in a group (i.e. different users allowed access to different workbooks within the group of linked workbooks – see Chapter 14 Security & Protection).

The overriding consideration when working with multiple linked workbooks is ensuring that the links between the workbooks remain valid and that model users are made aware of these links. As discussed in this section of the standards, this is done via the use of import sheets and export sheets and the constant consideration of the links between workbooks when working with multiple workbooks.

13.2 Import and Export Sheets

The problem with having formulas throughout workbooks that reference other workbooks is that it is impossible to identify, without viewing the formula bar within individual cells (or merged cell ranges), where the links to external workbooks exist. This problem is exacerbated when the workbook is printed, in which case there is generally no way of identifying which cells are linked to external workbooks.

As such, all links to external workbooks should enter and leave a workbook via dedicated and clearly separated worksheets. In this way all of the links to and from other workbooks can be centralized and model users and other model developers will be readily able to identify where the links occur.

Providing clarity to model developers and users regarding external workbook links can be achieved via the use of *import sheets* and *export sheets*. The purpose of these sheets is summarized below:

- **Import Sheets:** contain formulas that reference worksheet ranges in another workbook (i.e. *imports* information from another workbook); and

- **Export Sheets:** contain worksheet ranges that are referenced by formulas in another workbook (i.e. *exports* information to another workbook).

Hence, import and export sheets effectively become the plug sheets between linked models – i.e. links from other workbooks should always enter a workbook via an import sheet and links to other workbooks should always exit via an export sheet.

BPMC 13-1 External Workbook Imports

All *links* from an external *workbook* into a *workbook* should be made via dedicated and separate *import sheets*.

BPMC 13-2 External Workbook Exports

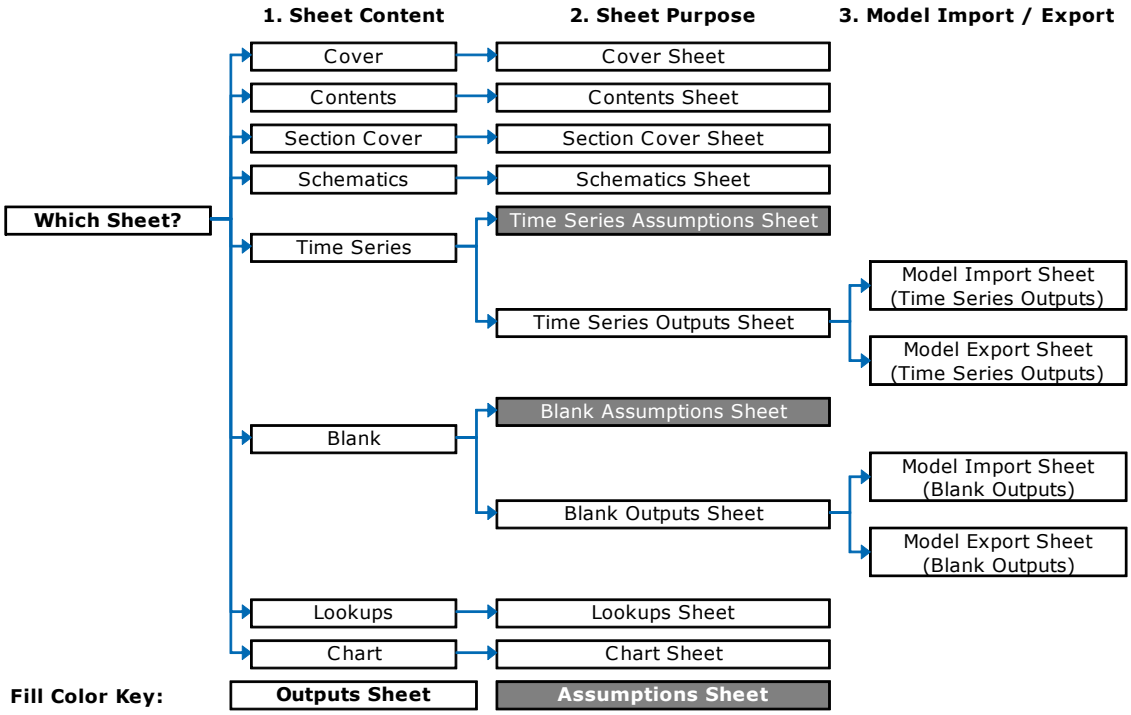
All *links* to an external *workbook* from a *workbook* should be made via dedicated and separate *export sheets*.

Note that import and export sheets are not separate sheet types that need to be added to the sheet types listed in BPMS 1-3 Sheet Content and BPMC 1-1 Sheet Types. The import and export nature of a sheet is a sub-classification decision that the model developer needs to make after making the initial sheet content and purpose decisions required by BPMS 1-2 Sheet Classification (discussed in detail in Chapter 1 General Concepts).

Hence, import and export sheets can technically take the form of any of the sheet types listed in BPMS 1-3 and recommended in BPMC 1-1. However, in most cases it will be unusual for these sheets to be any sheet type other than time series outputs or blank outputs. In any case, import sheets should never be assumptions sheets because they will primarily contain formula referencing the export sheet of a linked external workbook (which should never be assumptions).

The import and export sheet classification process is shown as an extension to the basic sheet classification process (discussed in Chapter 1 General Concepts and Chapter 3 Sheet Structure) in the diagram below:

Import and Export Sheet Classification



Note that this diagram assumes that import and export sheets will usually take the form of time series outputs or blank outputs sheets.

Workbook-Specific Import and Export Sheets

To provide further clarity to model users and other model developers it is recommended that external workbook links be further segregated into separate worksheets, by workbook. This can easily be achieved by creating a separate import and export sheet for each workbook that a workbook imports or exports information from or to.

BPMC 13-1 Workbook-Specific Import and Export Sheets

It is recommended that, where feasible, a separate *import* and *export sheet* be created for each external *workbook* that a *workbook links* from and to.

Hence, if external workbook links are separated on a workbook by workbook basis, a spreadsheet model that imports information from two linked external workbooks will contain two workbook specific import sheets. Conversely, if the same spreadsheet exports information to two linked external workbooks, it will contain two workbook specific export sheets. This concept is clearly demonstrated in the examples provided below in 13.3 Linked Workbooks Diagrams.

The creation of workbook specific import and export sheets will also result in further clarity in the workbook table of contents (see BPMS 2-5 Table of Contents Information). By providing a descriptive title for each worksheet, each of the external workbooks referenced by import and export sheets will be listed in its table of contents.

Consistent Import and Export Sheets

If a model developer has created separate import and export sheets in accordance with BPMC 13-1 above, then it is best to structure each import sheet in consistency with its corresponding export sheet in the linked external workbook.

BPMC 13-2 Import and Export Sheet Consistency

It is recommended that the *import sheet* in one *workbook* be structured in exactly the same way as the corresponding *export sheet* in the relevant linked *workbook*.

By ensuring the structural consistency of import sheets and their corresponding export sheets the group of linked workbooks will be significantly easier to understand and modify. In particular, formula references on import sheets will be very easy to audit as they will generally be referring to the cell in exactly the same location on the source export sheet. However, this user-friendliness is greatly diminished if complex calculations are included on import sheets.

To prevent this loss of transparency, BPMC 13-3 recommends that complex formulas never be used on import sheets (i.e. within formula that contain direct references to external workbooks):

BPMC 13-3 No Complex Formulas on Import Sheets

It is recommended that, where feasible, *functions* not be included within *formulas* that contain *links* to external *workbooks*.

A similar issue is addressed by BPMS 13-3, which aims to prevent data inconsistencies between linked workbooks by requiring that export sheets link directly to workbook output calculations, and furthermore that export sheet data is always moved into linked workbooks via formula links:

BPMS 13-3 Workbook Outputs Links

All *formulas* on an *export worksheet* should always be linked directly to the *workbook* calculations.

Content on an *export worksheet* should never be moved from one *workbook* to another *workbook* in a manner (e.g. copied and pasted as values) which creates static data that will not change when changes are made to the *workbook* from which the *data* originated.

Separate Import and Export Sections

Where a spreadsheet model contains import and export sheets, it is recommended that these sheets be placed in a separate, dedicated section (or sub-section) of the workbook. This section should be clearly labelled as being the import and export section of the workbook.

BPMC 13-4 Import and Export Sections

It is recommended that *import* and *export sheets* be placed in separate, dedicated *sections* of a *workbook*.

Because import and export sheets will not be a primary point of focus to model users, it may often be appropriate to place the section (or sub-section) of the workbook containing these sheets in the appendix of the workbook (if one exists). Otherwise, a separate section could be created near the back of the workbook specifically to house these sheets.

Import and Export Sheets - Summary

The following rules should be applied when using import sheets and export sheets:

- Avoid locating links to or from more than one workbook on any single import or export sheet – e.g. if a workbook imports information from two other workbooks, two different import sheets should be included to collect these links;
- Never change an export sheet without ensuring that the workbook which is drawing information from that sheet is open during this process. This will prevent external workbook links from becoming invalid;
- Clearly list any linked workbooks on the workbook cover sheet. For larger groups of workbooks, it is recommended that a schematic diagram be included on a schematics sheet in each workbook clearly illustrating the inter-linking between the workbooks in the group (see BPMC 13-5 Linked Workbooks Diagrams below);
- Place the import sheets and export sheets in a separate section or sub-section of each workbook (e.g. a sub-section within an appendix section) and clearly indicate on these sheets which workbook the information is coming from or going to;
- Aim to layout and present import sheets and their corresponding export sheets (in the linked workbook) in a virtually identical way. This is often best achieved by copying the first developed import sheet or export sheet into the linked workbook *after* finalizing its layout and design; and
- Avoid the use of complex formulas on import sheets. As a general rule, all formulas on a import sheet should simply contain a direct link to its corresponding cell on its corresponding export sheet. This concept is discussed above in BPMC 13-3 No Complex Formulas on Import Sheets.

These general principles should always be followed when using import and export sheets to create secure, transparent links between multiple workbooks.

13.3 Linked Workbooks Diagrams

When a spreadsheet model consists of a group of linked workbooks, it is necessary to communicate both the links between workbooks and the different content of each workbook to model users. This is best achieved by creating a diagram (referred to as a *linked workbooks diagram)* that represents:

a. Each workbook;

b. The flow of links between each workbook; and

c. Brief summaries of the purpose and content of each workbook.

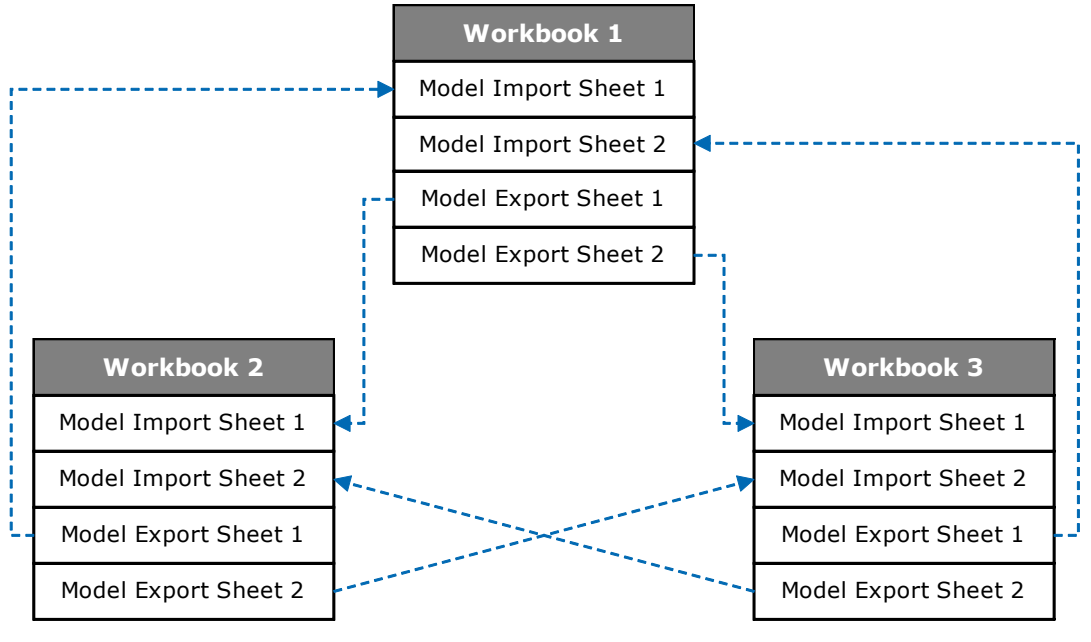
The use of linked workbooks diagrams to convey information about multiple linked workbooks is recommended by BPMC 13-5:

BPMC 13-5 Linked Workbooks Diagrams

It is recommended that whenever there are more than two *workbooks linked* to each other in a *workbook* group, that a diagram be created within each *workbook* showing the *links* between the group of *linked workbooks*.

The following linked workbooks diagram shows technically how the links between three workbooks might operate. This example ignores all other sheets in each workbook other than the import sheets and export sheets:

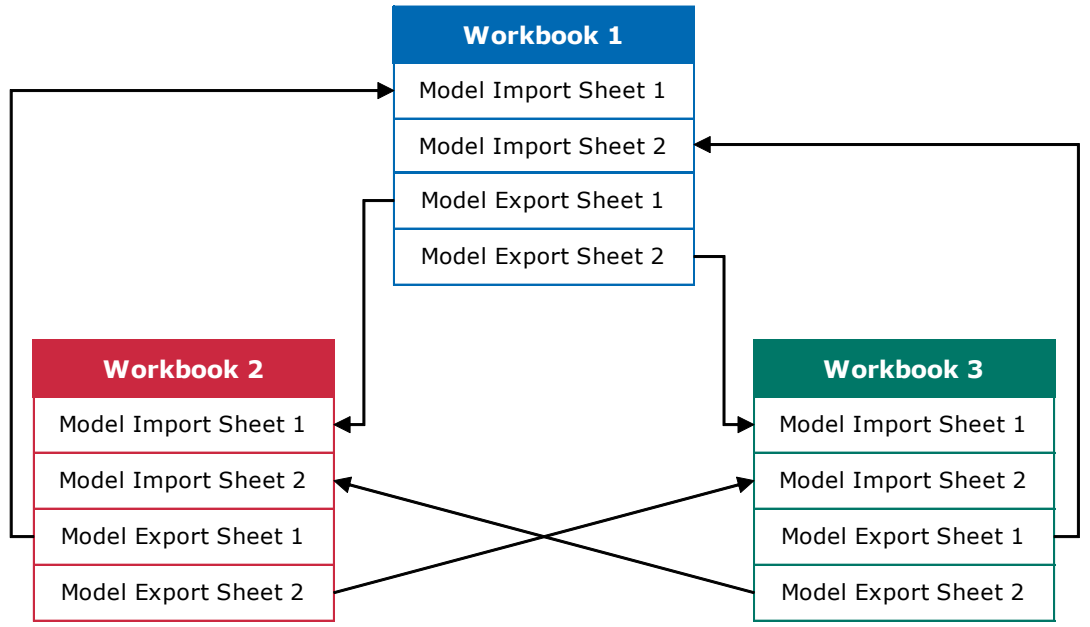
Linked Workbooks Diagram Example 1



Note that no import sheet or export sheets should contain links from or to more than one workbook.

The following linked workbooks diagram provides an example of how the links between multiple models in a group might be communicated to other model developers and model users on a schematics sheet (see BPMS 1-3 Sheet Content and BPMC 1-1 Sheet Types) in a less technical way:

Linked Workbooks Diagram Example 1



This diagram could then be included in each workbook in the linked group to ensure that the model user is always aware of their relative position within the group of linked workbooks. Note that double-ended arrows have been used in this example because all the workbooks contain import sheets and export sheets. In the event that the links between two workbooks only go in one direction, single-ended arrows should be used in these diagrams.

13.4 Multiple Workbook Issues

Although the identification of issues surrounding the use of multiple linked workbooks is not strictly a required part of these standards, they have been included to address the frequent problems encountered by model developers and model users in working with groups of linked workbooks.

These problems usually result from either a failure to communicate clearly the existence of external workbook links to model users and other model developers or the use of common spreadsheet functionalities which are not suitable for multiple workbook links.

In summary, the following considerations should be borne in mind when working with multiple linked workbooks:

- Although multiple linked workbooks can be opened individually, links from closed workbooks will be treated as constants when applied in open workbooks. Hence, if the workbooks rely on calculations from each other these will not function properly if one of the workbooks is closed. Hence, only workbooks with import sheets (and no export sheets) can be safely opened and used with their linked models closed;

- Complex calculations should never contain external workbook references (as recommended by BPMC 13-3 No Complex Formulas on Import Sheets). Import sheets and export sheets should be used to directly import or export information from linked external workbooks before this information is used as the basis for calculations (which should not be undertaken on these sheets);

- Care should be applied when using some functions on an inter-workbook basis – e.g. the OFFSET function may not update in some circumstances when used with external workbook references and therefore will create errors. This problem will always be prevented by completely avoiding the use of functions in import sheet formulas;

- Avoid retaining redundant links in workbooks – i.e. links to external workbooks which unintentionally remain after the model developer intended to remove all links to these workbooks. This can often occur in unpredictable ways (such as inter-workbook worksheet name links) and can often cause serious errors in the model and spreadsheet application generally;

- Care should be applied when re-naming linked workbooks or changing their directories. Preventing the loss of links during these processes is generally achieved by ensuring that all the workbooks in the group are open before re-saving them and checking the validity of the links before and after each workbook is saved; and

- Linked workbooks should always be distributed (i.e. provided to model users or other model developers via disk or email) as a group and not individually as separate distribution will almost certainly break any links between the workbooks.

Chapter 14

Security & Protection

14.1 Overview

The encryption on workbooks, sheets and cells in Microsoft Excel® is not highly secure. Passwords can be cracked in minutes with free software. Microsoft acknowledges that these protection functionalities are *display* features rather than *security* features. Therefore, it should be noted that passwords will only stop the casual user and cannot be relied upon as a security feature in distributed applications.

Nevertheless, security and protection tools within spreadsheet applications can be used to limit and/or prevent accidental access to a workbook or certain designated components of a workbook. Common security and protection tools can be used to control:

a. Access to workbooks;

b. Access to designated sheets;

c. Access to cells; and

d. Access to other objects within sheets.

The use of security and protection tools in spreadsheet models serves two primary purposes:

a. Preventing unauthorized access to a workbook or designated components within a workbook (limited, as described above); and/or

b. Controlling the way in which model users use the workbook – i.e. preventing the manipulation of non-assumptions cells.

These purposes are closely related because controlling the way in which model users use a workbook is done by preventing access to components of the workbook (such as sheets and cells) that should not be capable of manipulation (or in some cases inspection) by model users.

Many model developers only begin to consider using security and protection tools at the end of the model development process when they want to protect their spreadsheet models from unauthorized use. It is recommended that model developers apply the intended locked properties during the construction process, rather than at the end of construction. This is a significantly more efficient and accurate method of implementing security and protection properties. However, in addition to the security features offered by security and protection tools, these tools are an instrumental component of the Interface Control Concept discussed in 5.2 The Interface Control Concept.

14.2 Non-Assumptions Protection

In terms of best practice spreadsheet modeling and the interface control concept, one of the primary purposes of security and protection tools is to prevent model users from changing non-assumptions. As discussed in 1.3 Assumption Classification, every component of a spreadsheet model that is not an assumption is by default a non-assumption (output) and is therefore not intended to be manipulated by model users.

The benefits of using security and protection tools to prevent model users from manipulating non-assumption components of a workbook include:

a. Preventing model users from accidentally or intentionally changing model outputs in a way which invalidates analysis undertaken by the model;

b. Providing further guidance to model developers in relation to distinguishing assumption and non-assumption components of a workbook (i.e. in addition to purpose-based formats and styles); and

c. Ensuring that the model developer is always required to be a party to non-assumptions manipulation.

Hence, security and protection tools should be used to ensure that model users are only able to manipulate the assumptions components of a workbook.

BPMC 14-2 Protection of Non-Assumptions

Security and protection tools should be used to ensure that only the *assumptions* components of a *workbook* are capable of manipulation by *model users*.

It is important to understand that this standard does not require that model users are prevented from viewing and analyzing non-assumptions components of a workbook (such as formula calculations). Rather, it requires that model users are not able to *change* non-assumptions components of a workbook, which will often result in changes to model logic and outputs that are not controlled by the model developer.

In this regard, it is important to bear in mind the distinction between model users and developers (as discussed in the introduction and overview of these standards and conventions). A model user should only ever be looking to manipulate the assumptions of a spreadsheet model with a view to analyzing the resulting outputs. In the event that a model user wishes to manipulate non-assumptions (outputs) components of the spreadsheet model, this will involve stepping into the shoes of the model developer and removing any security and protection measures that have been taken to control model users. Hence, security and protection tools should be used to limit and control the actions of model users, *not* model developers.

The protection of non-assumptions is achieved via a combination of security and protection techniques, including workbook and sheet protection tools. The use of these tools is discussed throughout the remainder of this chapter.

14.3 Workbook Protection

Workbook protection tools can be used to protect both the unauthorized access to a workbook or components within a workbook and the unauthorized manipulation of the structure of a workbook. Prior to the distribution of a complete spreadsheet model, it is important to prevent both of these things from taking place.

More specifically, workbook protection can be applied in two ways, each with a different purpose:

- *Workbook Access Protection*: prevents a workbook from being opened without (password) access being granted; and
- *Workbook Structure Protection*: prevents changes being made to the structure of a workbook (e.g. the removal, addition, hiding and unhiding of sheets) without (password) consent being given.

It is recommended that workbook access protection be used wherever unauthorized parties have access to the spreadsheet model file(s) (e.g. via a network) but should not be allowed to open them. It is noted that password protection for spreadsheet applications is generally not strongly encrypted and can be circumvented.

Additionally, it is recommended that workbook structure protection should be used where model users are granted limited access to the spreadsheet model (e.g. not to hidden sheets) or there is a risk that other developers may attempt to make unauthorized structural changes to the workbook.

BPMC 14-1 Workbook Protection

It is recommended that *workbook protection* be used whenever a *model developer* is required to:

a) Control access to a *workbook*;

b) Control access to designated *sheets* within a *workbook*; and/or

c) Prevent structural changes being made to a *workbook*.

Workbook protection is primarily used to prevent and limit access to spreadsheet models and/or the sheets within a spreadsheet model. Hence, it is not primarily focussed on preventing the manipulation of the non-assumptions components of a workbook (although this could take place via the deletion of sheets which is prevented when the structure of a workbook is protected). Preventing the manipulation of the non-assumptions components of a workbook is primarily achieved through the use of sheet protection, which is discussed below.

14.4 Sheet Protection

Sheet protection plays a fundamental role in both the protection of model infrastructure and the control of model users. Once a model is complete, sheet protection should be used extensively to ensure that model users do not change non-assumption cells and cannot inadvertently change or delete model contents (including headings, controls and calculations) which would cause errors in the model.

If the sheets of a workbook are constructed according to the purpose-based approach underpinning these standards and conventions, only assumption cells on assumptions sheets will be able to be changed by model users when the sheets of the workbook are protected (for more information on purpose-based formats and styles Chapter 1 General Concepts , and Chapter 4 Formats and Styles). This preventative method of limiting the actions of model users is always preferable to retrospective warnings and prompts.

It is recommended that the following rules be applied when using sheet protection:

- All sheets in a workbook should be protected prior to its distribution to model users; and
- Generally, only assumption cells on assumptions sheets should be unlocked when a model is provided to a model user.

These concepts are reiterated by BPMC 14-3:

BPMC 14-3 Sheet and Cell Protection

It is recommended that every *cell* in a *workbook* that is not an *assumption cell* be *protected* (locked) prior to distribution of the *workbook* to *model users*.

For this *cell protection* to operate effectively, every *sheet* in the *workbook* must be *protected*.

It is recommended that sheet protection not be applied before the finalization of a model. A logical system should be used to create and apply sheet protection passwords (if they are being used) and a backup password list should always be maintained at all times.

14.5 Passwords

Inserting passwords when applying workbook or sheet protection can be dangerous and should be done carefully, as it may be difficult (or impossible) to return the workbook to its original state following the loss of a password. As such, it is recommended that passwords never be applied unnecessarily to a workbook.

BPMC 14-4 No Unnecessary Passwords

It is recommended that unless the *model developer* does not want *model users* to access certain areas of a *workbook* when *protecting* a *worksheet* or *workbook*, that no password be applied.

It is often just as effective, when workbook and sheet protection is being used to prevent unintentional modifications by model users, to apply protection without a password. In this way a model user would need to consciously remove protection before making any modifications.

In the event that passwords must be used when applying workbook or sheet protection (e.g. when a spreadsheet model is to be distributed to a large number of users or placed on a network but with controlled access), it is recommended that a list of the inserted passwords be printed and stored in safe location.

BPMC 14-5 Storing Passwords

It is recommended that when applying *workbook* or *worksheet protection* using passwords, that a password list be printed and stored in a safe location for future reference.

Failing to maintain an up to date list of passwords for a spreadsheet model will often result in passwords being lost or confused and is a common cause of a model redundancy.

Chapter 15

Visual Basic Programming

15.1 Overview

The standards currently contain one Visual Basic® programming convention on the basis that Visual Basic programming skills are not currently prevalent in the spreadsheet modeling community. The Spreadsheet Standards Review Board envisages the further development of this spreadsheet modeling area in future versions of the standards.

15.2 Recording Macros

A macro is a series of commands and functions that are stored in a Microsoft Visual Basic® module. As such a macro is made up of lines of computer code that are written in the Microsoft Visual Basic® programming language.

The use of macros can in many cases greatly improve the capabilities, functionalities and user-friendliness of spreadsheet models. However, they should be used with extreme care as they are very unforgiving if not recorded or written correctly and may inadvertently cause irreparable damage to a spreadsheet model. More importantly, macros and the Microsoft Visual Basic® programming language are generally not well understood by model users. As such, macros generally represent a *black box* to model users and create concern as to what impact they are having on a spreadsheet model.

BPMC 15-1 Recording Macros

It is recommended that only extremely simple *macros* be created using the *macro* recorder. *Macros* created using the *macro* recorder should not be relied upon by *model developers* who are not familiar with the resulting source code.

Macros should only be written by experienced VBE programmers.

Although a full discussion of the rules and application of macros is currently outside the scope of these standards and conventions, the following points should be considered whenever using them:

- Macros should never be used instead of calculations. Not only are macros generally slower than worksheet formulas, they are also less widely understood and therefore more likely to confuse other model developers and model users;
- If macros are recorded (as opposed to written), model developers should ensure that no changes are made to any of the objects affected by the macro (e.g. sheet names, range names, charts, etc) that would invalidate the macro; and
- If macros are written, care should be used to ensure that the macro will always operate correctly from wherever it is expected to be called, and also that the code used to write the macro will be valid in older versions of the spreadsheet application used to construct the model.

As a general rule, only extremely simple macros should be recorded and only developers experienced in macro writing should include written macros in spreadsheet models provided to model users.

Chapter 16

Miscellaneous

16.1 Multiple Model Developers

One of the major problems within the spreadsheet modeling sector is the fact that the model developer is often the only person who understands a spreadsheet model well enough to modify it. This situation primarily occurs when a model developer does not apply Best Practice Spreadsheet Modeling Standards, and hence does not communicate the underlying logic of spreadsheet models to model users.

This situation has resulted in unusable spreadsheet models and significant costs on the part of the business community to replace or re-develop existing spreadsheet models. Moreover, the risks that are associated with only one person understanding the logic within a spreadsheet model are significant. When a model user applies the outputs of a spreadsheet model that only one person understands (the model developer), it could be compared to reporting historical accounting results to the Board that one person has prepared and no-one else has verified. Moreover, and to take the analogy further, that person not only prepared the historical accounting results, but they also independently constructed the accounting system, with no-one else checking their work. Obviously, most businesses would not allow this situation to occur.

Spreadsheet modeling should always be undertaken with the expectation that at some stage another model developer might wish to use or change the model in some way. With this expectation in mind, a number of steps can be taken to aid other model developers who come in contact with the spreadsheet model, including:

- Entering the name of the primary or original model developer into the workbook;
- Maintaining a record of the model development process, including construction and amendment dates and allocations of responsibility;
- Maintain a password list where security and protection has been applied with passwords (as per BPMC 14-4 No Unnecessary Passwords); and
- Including a detailed help file/user guide with the model to aid in its use and further development (see 16.4 Help Files and Instructions below).

The first of these steps is the subject of BPMC 16-1:

BPMC 16-1 Model Developer Identification

It is recommended that the name of the *model developer* is entered into the *workbook* (normally on the *cover sheet* if applicable).

When multiple developers are involved in the model development process, the overriding requirement is to ensure that these standards and conventions are universally applied at every stage of the spreadsheet model development process. This will ensure that other model developers who are also applying Best Practice Spreadsheet Modeling Standards will be immediately familiar with the model construction techniques and methodologies used.

16.2 Calculation Methodology

When a workbook is set to calculate manually, several problems are created for a model user. In the first instance, some model users may not know how to execute a manual calculation within the spreadsheet application (i.e. in Microsoft Excel®, this is done by pressing the *F9* key on the keyboard). If this is the case, the model user will not be able to manipulate the outputs of the workbook and as such will not be able to use the workbook for analysis purposes.

Further, the model user may not know how to change the calculation methodology from *manual* to *automatic*. In this case, the model user then needs to remember to execute a manual calculation every time they change an assumption within the workbook.

Therefore, as a general rule, the calculation methodology of a spreadsheet model should always be set to automatic when provided to model users. In some cases, a manual calculation setting may be required to ensure that the model actually calculates (i.e. where the calculations in the model are creating an irresolvable circular reference) but these instances should always be avoided and are considered to be inappropriate spreadsheet modeling practice. See 8.6 Circular References for more details.

BPMS 16-1 Automatic Calculation Setting

A *workbook* should, where feasible, be set to calculate automatically.

16.3 'Calculate' in the Status Bar

Setting a spreadsheet to manual calculation is not the only instance when *Calculate* will show in the status bar. In total, there are four known occasions in Microsoft Excel® in which the status bar will show CALCULATE:

- The application calculation setting has been set to *manual* and the workbook contains uncalculated formulas. Excel sets the calculation mode from the first workbook opened in a session: where two workbooks are opened, one saved in manual mode and one saved in automatic mode, both will have the calculation mode of the first workbook opened;
- The *Iteration* setting is turned on and the workbook contains circular references;
- Excel 2000 is being used without the SR1 update and a user-defined function is being used that attempts to define a name and depends on a volatile function; and
- Excel's limit for tracking formula dependencies has been reached. The number of different areas in a sheet that may have dependencies is limited to 65,536 for Excel 2003 and 16,384 for Excel 2000 and/or the number of cells that may depend on a single area is limited to 8,192. After the workbook has passed these limits, Excel no longer attempts to recalculate only changed cells. Instead, it recalculates all cells at each calculation. At the time of writing, these limits are understood to have been removed entirely from Excel 2007.

16.4 Emphasizing Information

Using visual tools to differentiate data is the commonly accepted method for rapidly delivering information about the purpose, content and importance of data to model users. There are dozens of different types of format properties that can be applied to an individual cell in a workbook to differentiate its appearance.

Entrenching the correct level of visual emphasis for inputs or outputs within a spreadsheet model is a critical aspect to effectively communicating purpose and content to model users.

Applying appropriately different levels of emphasis to data formats applies not only to assumption inputs and calculation outputs, but also to headings, titles and labels contained within a spreadsheet model. Importantly, a model developer should ensure that the formats that are applied to create different levels of emphasis should be applied consistently throughout a spreadsheet model to information requiring similar levels of emphasis.

BPMC 16-2 Emphasizing Information

It is recommended that you create and consistently apply various levels of *headings* in a *workbook* that visually communicate the appropriate level of emphasis or importance that should be attached to each *cell* or *range* of *cells*.

The use of different formats to create different levels of emphasis for information contained within a spreadsheet further enhances the ability of model developers and users to differentiate the importance of different levels of information using visual standards.

For more information and examples of purpose-based formats and styles, see Chapter 1 General Concepts and Chapter 4 Formats and Styles.

16.5 Help Files and Instructions

The concept of help files is associated almost exclusively with computer programs and rarely with specific spreadsheet models. However, for spreadsheet models that will be used by large numbers of users for reporting and/or important decision making, the development and inclusion of a help file to be distributed with the model should be considered.

A help file is a file of information to assist model users and model developers with how to operate a spreadsheet model. A help file might include information such as:

a. How to use the assumptions entry interfaces;

b. What are the primary workbook outputs (non-assumptions);

c. What are the primary workbook inputs (assumptions);

d. How to use the workbook or group of workbooks (workbook schematics);

e. Formula schematics or diagrams;

f. Schematics conveying the logic of a model or part of a model; and

g. Any other relevant notes or commentary.

These points are reiterated by BPMC 16-3:

BPMC 16-3 Help Files and Instructions

It is recommended that every *workbook* be accompanied by instructions that explain the following for both *model users* and future *model developers*:

a) What the primary *outputs* are;

b) What the primary *assumptions* are;

c) How to use the *workbook* or group of *workbooks*; and

d) Any other relevant *notes* or commentary.

A help file does not necessarily have to be in the spreadsheet model and might even be more suited to a word processing application and instruction manual layout. However, it should always be distributed with the model and referenced throughout to ensure that users are always made aware of its existence.

16.6 Other Commentary

This additional commentary has been included in these standards to address selected issues which are commonly encountered during the spreadsheet model development process. The areas discussed in this section are not exhaustive.

Schematics

Schematic diagrams should be used extensively throughout a spreadsheet model to communicate information about its structure, functions and limitations to other model developers and model users. There is no limitation on the use of diagrams and they will almost always be received favourably by model users when compared with purely numerical outputs.

Examples of information that is often better conveyed via diagrams than via purely numerical outputs include:

- The relative position of a workbook within a group of linked workbooks (see Section 13.3, Linked Workbooks Diagrams);
- An overview of the structure of a model – i.e. broken down by sections and sub-sections; or
- Logic diagrams showing the relationships between the different components of the model – i.e. the flow of base assumptions and sensitivity assumptions to the output calculations and presentation outputs.

Schematic diagrams should always be constructed on schematics sheets (see Chapter 3 Sheet Structure).

Compatibility Issues

Compatibility issues may emerge whenever a model is expected to be used in a different version of the spreadsheet application than that used to create it. This is particularly relevant for model developers who build models for a large number of users or for distribution to users within a different organization.

It is often very difficult to obtain a list of areas within a spreadsheet application that will create compatibility issues. The most commonly encountered problem is the use of a capability in a model developed in a newer application which was not available in an earlier version of the same application. Generally, this can only be prevented by testing (or developing) the model on the earliest version of the spreadsheet application that the model will be used on, and making any required adjustments to prevent problems. In some cases, such as the upgrade of Microsoft Excel® from version 2003 to version 2007, this approach is not completely reliable, and in such cases the best approach is always to ensure that all model developers and model users are using the same version of Microsoft Excel and are aware of the potential issues associated with moving between versions.

In the event that a new functionality is required in a model, it should be made clear to model users in advance whether or not the model will operate correctly on their version of the spreadsheet application.

Specialized Spreadsheet Modeling Software

Using specialized spreadsheet modeling software in conjunction with your spreadsheet application (i.e. Microsoft Excel®) can greatly improve your spreadsheet modeling, and make the implementation of these Best Practice Spreadsheet Modeling Standards and Conventions significantly easier.

Specialized spreadsheet modeling software is available to assist a model developer with many areas of spreadsheet modeling, including:

a. Developing a spreadsheet model;

b. Auditing a spreadsheet model; and

c. Presenting a spreadsheet model.

To rapidly implement these standards and conventions, the Spreadsheet Standards Review Board recommends Modano® - an add-in to Microsoft Excel® designed specifically to facilitate the ultra-efficient implementation of these standards and conventions.

For more information about specialised spreadsheet modeling software, please go to www.ssrb.org or www.modano.com.

Appendix 1

Defined Terms

Term or Word	Definition
#REF!	An error value which denotes that the value resulting from the formula in a cell is invalid.
Active Cell	A cell on a worksheet which is outlined by the active cell indicator and which is ready for formatting, entering data, formulas, or any other action which can be performed in a cell.
Alert Check(s)	Tests included in a spreadsheet model to detect and indicate the occurrence of designated events that the model developer intends to notify the model user of, excluding error checks and sensitivity checks.
Alert Checks Summary	An area within a workbook dedicated specifically to centralize and contain flags for all of the alert checks in a workbook.
Alignment	The position of data within a cell or object. The data can be positioned horizontally to the left, centre, or right of the cell / object, as well as positioned vertically to the top, middle, or bottom of the cell / object.
Alt (Button)	A key on the keyboard (located on either side of the space bar), which when used in combination with shortcut keys will create keyboard shortcuts.
Anchored	Locking a column and/or row cell reference to a fixed position using the '$' sign with the cell reference.
Appendices	A section of a workbook that contains checks, lookups sheets, import sheets, export sheets and other secondary sheets.
Assumption	Anything within a workbook that the model developer intends to be manipulated by model users to affect the workbook calculations.
Assumption Cell	A cell in a worksheet containing an assumption.
Assumption Repetition	Erroneously collecting the same assumption twice resulting in one of the entered assumptions being inoperative.
Assumptions Entry Interface	An area within a workbook in which an assumption is entered or modified.
Assumptions Grey	Fill color recommended to be used to distinguish Assumptions Sheets.
Assumptions Sheet	A sheet of any type that contains one or more assumptions.
Base Assumption	A base entry into a workbook that drives base outputs (outputs that do not include the impacts of sensitivity assumptions).
Base Assumptions Sheet	An assumptions sheet used to collect base assumptions.
Base Case	The outputs case from a model when no sensitivity assumptions are operative – i.e. when only the base assumptions are operative.
Base Cell	A cell that is used as a reference cell in formulas which use OFFSET and/or INDEX functions.
Best Practice Model	A spreadsheet model built according to these Best Practice spreadsheet modeling standards.
Best Practice Spreadsheet Modeling Standards	A set of Standards (and Conventions) which involve a methodology or approach required (or recommended) to implement Best Practice spreadsheet modeling.
Binary	A choice between two exhaustive options (eg 1 or 0, TRUE or FALSE, YES or NO, Include or Exclude).

Term or Word	Definition
Blank Assumptions Sheet	A blank sheet that contains one or more assumptions.
Blank Outputs Sheet	A blank sheet that does not contain assumptions.
Blank Sheet	A worksheet that does not fall within any of the other sheet types listed in BPMS 1-7. Sub-classified as either a Blank Assumptions Sheet or a Blank Outputs Sheet depending on whether or not the worksheet contains assumptions.
Block Array	Single area, multiple cell, non-row, non-column array.
Boolean	A TRUE or FALSE result.
Button	A control that triggers a macro.
Calculation Errors	Errors resulting from calculations not correctly representing the relationships that the model developer intended to represent.
Calculation Methodology	Refers to whether the spreadsheet application is calculating manually or automatically.
Cell (Range)	One (or more) of the entry boxes that make up worksheets within a workbook.
Cell Content	Information or data that is contained within a cell. Cell content must be either constant, formula or mixed.
Cell Data	Any data located within a cell or cell range.
Cell Link	The cell which is linked to a control and returns a value representative of the option chosen within the control.
Cell Protection	The property of a cell that determines whether or not the cell can be modified when its worksheet is protected.
Cell Purpose	Whether or not the model developer intends model users to modify the cell. Cells must have either an assumption or non-assumption purpose.
Cell Range	More than one cell.
Chart Sheet	A sheet containing a chart as a standalone object.
Check(s)	Tests included in a spreadsheet model to detect and indicate the existence of errors, operative sensitivity assumptions and/or alerts. See also Error Check, Sensitivity Check and Alert Check.
Check Box	A control which provides the model user with dual choice – i.e. yes / no, off / on, etc.
Check Cell(s)	A cell containing a formula to affect an error check, sensitivity check or alert check. See also Error Check, Sensitivity Check and Alert Check.
Check Red	Font color recommended to be used to indicate that a check has been triggered. Check Red is used primarily as a conditional format.
Check Sheet	A worksheet that contains flags to indicate whether a type of check, being an error, sensitivity or alert check, has been triggered. There are three types of check sheet, being error check sheets, sensitivity check sheets and alert check sheets.
Check Type	A category of check, being either error check, sensitivity check or alert check. See also Error Check, Sensitivity Check and Alert Check.
Circular Reference	A formula that refers back to its own cell, either directly or indirectly.
Click /(ing)	The action of pressing the left or right mouse button.
Column	A single vertical group of cells which is 1 cell in width, and is the height of an entire worksheet.
Compatibility	The ability of a spreadsheet model developed in one version of a spreadsheet application to operate in earlier or later versions of the same spreadsheet application.
Complex Formulas	A formula in a cell that cannot be easily and efficiently understood by the

Term or Word	Definition
	model user. Depending on the model user, a complex formula may include one or more of the following attributes: - too many different functions; - too many different operators; and/or - too many different references.
Conditional Formatting	Cell formatting that is only applied when a specified condition has been met.
Constant(s)	A numerical value, text, macro generated value, control generated value (cell link) or any other entry contained within a cell that is not a formula and does not contain a formula. Also referred to as a hard-code.
Constant Blue	Font color recommended to be used to indicate constant cell content.
Constant Cell	A cell in a worksheet that contains a constant.
Contents Sheet	A worksheet containing a workbook Table of Contents.
Control	'Choosing' tools, which via an interface allow the selection of one option from a defined number of options.
Convention	A methodology or approach that is recommended to implement best practice spreadsheet modeling. This methodology or approach is universally applicable and is recommended by the Spreadsheet Standards Review Board.
Cover Sheet	A worksheet used to indicate the start of a workbook or a Section or Sub-Section within a workbook.
Cover Sheet Notes	Informative notes included on the workbook cover sheet to provide guidance to model users and other model developers. Also called Cover Notes.
Data	Numerical values, text, or formulas.
Data Validation	A method of controlling the type and/or boundaries of the data entered into a cell.
Denomination	A class of one kind of unit in a system of quantities.
Denominator	A single denomination assumption.
Drag	To move anything on the screen from its original position to a new one. This can include moving toolbars, cell ranges, objects, or charts.
Drop Down Box	A control that provides a 'drop down' list of options from which the model user can choose.
Entry Interface	A cell, range of cells or control for entering base or sensitivity assumptions.
Error	A deviation from accuracy or correctness within a spreadsheet model. An error may include a value error, formula error, assumption error or output error.
Error Check(s)	Tests included in a spreadsheet model to detect and indicate the existence of errors.
Error Checks Summary	An area within a workbook dedicated specifically to centralize and contain flags for all error checks in a workbook.
Esc (button)	The key on a keyboard which allows you to exit from any command or procedure taking place.
Excel	Short reference to the Microsoft Excel® spreadsheet application.
Expanded View	The recommended worksheet view in which all the information in the worksheet is displayed (i.e. all Group Levels).
Export	Information referenced by an external linked workbook.
Export Sheet	A worksheet of any type that contains worksheet ranges that are referenced by formula in another workbook (i.e. exports information to

Term or Word	Definition
	another workbook).
Fill Color	The background color of a cell or range of cells. Used to indicate cell purpose.
Financial model	A spreadsheet model that contains financial information.
Financial Modeling	The process of developing or using a financial model.
Flag	A formula returning a 1 (positive result) or 0 (negative result) depending on whether or not an error, sensitivity or alert has been detected in the underlying workbook.
Font Color	The color of any character within a cell or range of cells. Used to indicate cell content.
Forecast	A time series which projects from a start date into the future.
Form	See Control.
Format or Formatted	A single property of a cell or other object that affects its outward appearance.
Formula	An equation that performs calculations, including a function or mathematical operator that does not include a constant.
Formula Black	Font color recommended to be used to visually identify a cell as having formula content.
Formula Reference	A cell or range referenced within a formula.
Frozen panes	When a worksheet has panes (sections) which do not move regardless of the active selection on the worksheet.
Function	Predefined formulas contained within Excel that perform calculations by using specific values/arguments in a specific order.
General Sheet	A sheet type that can only be included once in each spreadsheet model. General Sheets include the Workbook Cover Sheet and Contents Sheet.
Group Box	A control that can be used to 'group' other controls (usually option buttons).
Group Level	A level of grouping that has been applied to a row or column of a worksheet.
Hard-Code(d)	A numerical value, text, macro generated value, control generated value (cell link) or any other entry contained within a cell that is not a formula and does not contain a formula. Also referred to as a Constant.
Heading	A subject caption for a workbook, sheet, range, cell or object in a spreadsheet model. Also referred to as Title or Label.
Help File	A file of information to assist model users and model developers with how to understand and operate a spreadsheet model.
Hyperlink(s) or Hyperlinked	A link located within a workbook which, when activated, moves the active cell to another worksheet in the same workbook, a different workbook, or another area on the same worksheet.
Hyperlink Cell Reference	The cell or range of cells referenced by a hyperlink.
Hyperlink Plum	Font color recommended to be used to indicate a hyperlink within a cell.
Import	Information sourced from an external linked workbook.
Import Sheet	A worksheet of any type that contains formula that references worksheet ranges in another workbook (i.e. imports information from another workbook).
In Cell Drop Down List	A form of drop down box control that is inserted via data validation and contained within a cell.
Inactive Assumption Cell	An assumption cell that is currently irrelevant for outputs as a consequence of a prevailing assumption in another assumptions entry

Term or Word	Definition
	interface.
Indicating	A technique involving the use of formats, styles and conditional formatting used to ensure that cell purpose, content and errors are always communicated to model users and other model developers.
Input Range	A worksheet range that provides lookup data for drop down boxes or list boxes.
Integer	A non-decimal number, e.g. 10.
Interface Control Concept	Requires that model developers use every possible method of controlling the assumption to be entered or modified by model users.
Keyboard	The implement with which you type on your computer.
Keyboard Shortcut	A combination of keyboard keys which call a menu command.
Label(s)	A subject caption for a workbook, sheet, range, cell or object in a spreadsheet model. Also referred to as Heading or Label.
Link(s) or Linked	A reference within a formula that refers to a cell or range of cells that is located on another worksheet or in another workbook.
List Box	A control that is similar to a drop down box, but can display more than one option in view at all times.
Location	A cell reference or named position within a worksheet. Also referred to as Position.
Locked	Allows or prevents a cell (or other object) from being changed when its sheet is protected.
Lookup Data	Data for use in controls / forms and in worksheet formulas.
Lookup Range	A lookup table range on a lookups sheet.
Lookup Table	A table in the form of a worksheet range (usually a Column Array) containing data for use in controls / forms and in worksheet formulas.
Lookups Sheet	A worksheet containing Lookup Tables.
Macro	A macro is a series of commands and functions that are stored in a Microsoft Visual Basic® component and can be called on command from within a workbook.
Mixed Cell	A cell that contains a combination of constant and formula cell content.
Mixed Cell Green	Font color recommended to be used to indicate mixed cell content.
Model/(ling)	The process of developing or using spreadsheet models.
Model Developer	A person involved in the construction of a spreadsheet model and the derivation of the underlying calculations.
Model Export	Information referenced by an external linked workbook.
Model Export Sheet	A worksheet of any type that contains worksheet ranges that are referenced by formula in another workbook (i.e. exports information to another workbook).
Model Import	Information sourced from an external linked workbook.
Model Import Sheet	A worksheet of any type that contains formula that references worksheet ranges in another workbook (i.e. imports information from another workbook).
Model Name	The name of a workbook. Entered on the General Cover Sheet and referenced by formula on every other worksheet.
Model Output(s)	Any component of a worksheet that is not an assumption. Also referred to as Output(s).
Model User	A person who relies upon outputs from a spreadsheet model for various purposes, often to analyze or gain an understanding of the area being modeled or to provide them with assistance in decision-making.

Term or Word	Definition
Modeler	See Model Developer.
Multiple Area Array	Multiple area worksheet range.
Navigate	To move around a spreadsheet model or between multiple spreadsheet models.
Non-Assumption	Any component of a worksheet that is not an assumption. Also referred to as Output.
Note(s)	Descriptive information and commentary contained within a spreadsheet model to inform model users and other model developers.
Operative Sensitivity Assumption(s)	Sensitivity assumptions that are causing differences between base case outputs and sensitivity case outputs.
Option Button	A control that provides a choice between mutually exclusive options.
Orientation	The way in which a worksheet will print. This can be either 'landscape' or 'portrait'.
Output(s)	Any component within a workbook that is not an assumption.
Output Cell	A cell in a worksheet that does not contain an assumption.
Outputs Sheet	A sheet of any type that does not contain assumptions.
Output-Based Sensitivity	Sensitivity assumptions that do not correspond to specific base assumptions and therefore analyze the sensitivity of one model output (or set of model outputs) to another model output (or set of model outputs).
Period	Any stated division or length of time.
Period Titles	Labels which display the date or period for each point in time that is being analysed in a Time Series Model.
Periodicity	The frequency of the periods analysed in a Time Series Model - i.e. usually annual, semi-annual, monthly or quarterly.
Position	A cell reference or named position within a worksheet. Also referred to as Location.
Prefix (Range Naming)	A short, informative text string added to the start of a range name to indicate the type or purpose of the range.
Presentation Output(s)	The content of a Presentation Sheet.
Presentation Sheet	A sheet that is included in a workbook in order to present outputs which are necessarily exempt from the standards and conventions in order to meet aesthetic or corporate requirements.
Print Scaling	The property of a sheet that determines the size of its contents when printed.
Print View	The recommended worksheet view in which a worksheet should be printed (displaying Group Levels 1 and 2). Generally only displays information that is intended to be printed.
Protection or Protected	Tools used to protect the workbook and/or its sheets to limit and/or control the actions of model users.
Purpose-Based Formatting	The consistent use of distinct formats to clearly and logically distinguish the different components of a workbook and its worksheet ranges by purpose (and often also by content).
Range	See cell range.
Range Name	A text string assigned to a worksheet range that can be used as a formula reference in place of the address of the range.
Range Naming Key	A key or legend that explains the range naming (prefixing) system used throughout a workbook.
Read-Only	When a worksheet or workbook cannot be modified, only viewed.

Term or Word	Definition
Row	A single horizontal group of cells which is a worksheet width wide and 1 cell long.
Schematic	A diagrammatic representation of a spreadsheet model's logic, structure, or concepts.
Schematic(s)	A tree diagram representation contained within a spreadsheet model. See also Schematic and Workbook Schematic.
Schematics Sheet	A worksheet containing Schematics.
Scroll	The action of moving the slide bar in a scroll bar up / down or left / right.
Scroll Bar	A control that is similar to a spin button but displays a visual representation of the selected number relative to the specified set of numbers.
Secondary Sheet Naming Suffix	A suffix appended to a sheet tab (in addition to a sheet type naming suffix) to indicate any sub-classification of a sheet.
Section	Sheets within a workbook that have been grouped (located) together.
Section Cover Sheet	A Cover Sheet used to indicate the start of a section within a workbook.
Section Cover Sheet Notes	Informative notes included on the section cover sheets to provide guidance to model users and other model developers.
Section Title	The sheet title of a Section Cover Sheet.
Sensitivity Analysis	The analysis of the sensitivity of the outputs from a spreadsheet model to changes in its base assumptions (using sensitivity assumptions).
Sensitivity Assumption	An entry into a workbook that drives running case outputs (outputs that includes the impacts of both base assumptions and sensitivity assumptions).
Sensitivity Assumptions Sheet	An Assumptions Sheet used to collect sensitivity assumptions.
Sensitivity Check(s)	Tests included in a spreadsheet model to detect and indicate the existence of operative sensitivity assumptions.
Sensitivity Checks Summary	An area within a workbook dedicated specifically to centralize and contain flags for all sensitivity checks in a workbook.
Sheet	A worksheet or chart sheet in a workbook.
Sheet Content	Relates to the type of information that is contained within a sheet. Sheet content determines sheet type.
Sheet Left Hyperlink	A hyperlink that moves the active cell to the left of the active sheet.
Sheet Name	The descriptive text inserted on a sheet tab indicating what the sheet contains.
Sheet Naming Key	A key or legend that explains the sheet naming (suffixing) system used throughout a workbook.
Sheet Protection	Prevents the modification of any locked components within a worksheet without (password) consent being granted.
Sheet Purpose	Whether or not assumptions will be entered into the sheet. Sheets must have either an assumptions or non-assumptions (Outputs) purpose.
Sheet Right Hyperlink	A hyperlink that activates the worksheet to the right of the active sheet.
Sheet Tab	The tab positioned at the bottom of the workbook which can be used to navigate between the sheets in a workbook.
Sheet Title	The text displayed in the top / left corner of a worksheet that describes the information within that sheet.
Sheet Top Hyperlink	A hyperlink that moves the active cell to the top left of the active worksheet.
Sheet Type	One of the eight sheet types as stated in BPMS 1-3 Sheet Content.

Term or Word	Definition
Shortcut Key	The underlined letter in a menu / submenu / sub submenu / option's name which indicates its keyboard shortcut when combined with the Alt key.
Slide Bar	The block which moves from left to right, or from up to down in a scroll bar.
Sourcing	The process of leading model users or developers to the source of detected errors and/or sensitivities.
Spin Button	A control used to 'spin' through a specified set of numbers – i.e. 1 – 100.
Spreadsheet	A program for organizing numerical data in tabular formats allowing rapid calculations with changing variables.
Spreadsheet Model	A theoretical construct in a spreadsheet that represents numerical processes by a set of variables and a set of logical and quantitative relationships between them. A spreadsheet model may be a workbook or group of linked workbooks.
Spreadsheet Modeler	See Model Developer.
Standard	A methodology or approach that is required to implement Best Practice spreadsheet modeling. This methodology or approach is universally applicable and is the best way to develop Best Practice spreadsheet models.
Style	A collection of pre-determined formats consistently applied to cells or other objects.
Sub-Section	Sheets within a section that have been grouped (located) together.
Sub-Section Cover Sheet	A Cover Sheet used to indicate the start of a sub-section within a workbook.
Sub-Section Title	The sheet title of a Sub-Section Cover Sheet.
Suffix (Sheet Naming)	A short, informative text string added to the end of a sheet name to indicate the type of the sheet.
Table of Contents (Sheet)	A summary of the section, sub-section and sheet titles contained within a workbook.
Time Series Analysis	Analysis undertaken over more than one sequential period of time.
Time Series Assumptions Sheet	A time series sheet that contains one or more assumptions.
Time Series	Analysis of values across multiple time periods where the time periods can be historical or forecast.
Time Series Assumptions	Assumptions used as the basis for calculating the time series period labels used when undertaking time series analysis, including the model start date assumption.
Time Series Common Assumptions	Conversion factors and time constants utilized in most Time Series Models.
Time Series Model	A workbook or group of linked workbooks that analyzes numbers over more than one sequential period of time. A Time Series Model includes more than one period and as such requires date and time assumptions and period labels.
Time Series Outputs Sheet	A time series sheet that does not contain assumptions.
Time Series Sheet	A worksheet that analyzes data over more than one period of time – i.e. a time series sheet includes more than one period and as such requires period labels. Sub-classified as either a time series assumptions sheet or a time series outputs sheet depending on whether or not the sheet contains assumptions.

Term or Word	Definition
Title	A subject caption for a workbook, sheet, range, cell or object in a spreadsheet model. Also referred to as Heading or Label.
Uncheck	The action of de-selecting a check box and therefore making the cell link return a FALSE value.
Value Error	An error that is displayed as the result of a formula in a cell. Includes #N/A, #VALUE!, #REF!, #DIV/0!, #NUM!, #NAME?, and #NULL!.
View Type	The manner in which sheets are viewed in a workbook – e.g. normal view, page break preview, etc.
WIP Yellow	The fill color recommended to be use to indicate work in progress ranges.
Workbook	A file that contains one or more sheets.
Workbook Cover Sheet	A Cover Sheet used to indicate the start of a workbook.
Workbook Protection	Prevents a workbook and/or sheets from being opened and/or modified without (password) access being granted.
Workbook Schematic	A Schematic used to convey information about multiple linked workbooks.
Workbook Structure Protection	Prevents changes being made to the structure of a workbook (i.e. the removal, addition, hiding or unhiding of sheets) without (password) consent being given.
Work In Progress	Content within a workbook which remains subject to final review by the model developer.
Worksheet	A sheet which consists of rows and columns, and therefore contains cells.

Appendix 2

Standards Listing

SMA 1. General Concepts

SMA 2. Workbook Structure

SMA 3. Sheet Structure

SMA 4. Formats & Styles

SMA 5. Assumptions Entry Interfaces

SMA 6. Sensitivity Analysis

SMA 7. Outputs & Presentations

SMA 8. Calculation Formulas

SMA 9. Naming Principles

SMA 10. Time Series Analysis

SMA 11. Checks

SMA 12. Printing & Viewing

SMA 13. Multiple Workbooks

SMA 14. Security and Protection

No standards in Spreadsheet Modeling Area.

SMA 15. Visual Basic Programming

No standards in Spreadsheet Modeling Area.

SMA 16. Miscellaneous

Appendix 3

Conventions Listing

SMA 1. General Concepts

SMA 2. Workbook Structure

SMA 3. Sheet Structure

SMA 4. Formats and Styles

SMA 5. Assumptions Entry Interfaces

SMA 6. Sensitivity Analysis

SMA 7. Outputs & Presentations

SMA 8. Calculation Formulas

SMA 9. Naming Principles

SMA 10. Time Series Analysis

SMA 11. Checks

SMA 12. Printing & Viewing

SMA 13. Multiple Workbooks

SMA 14. Security and Protection

SMA 15. Visual Basic Programming

SMA 16. Miscellaneous

Appendix 4

Open Licence Agreement

Background

a. SSRB is the Intellectual Property Rights holder of various items of Foundation Material.

b. SSRB acts as the Custodian of the Foundation Material and is responsible for granting licences to You to enable You to use and adapt the Foundation Material.

c. You are permitted to use and adapt that Foundation Material on the terms of this Agreement.

d. Any licence that You may grant to any person to adapt or modify Your adaptation of the Foundation Material will be on the terms of this Agreement.

e. BY ACCESSING THE FOUNDATION MATERIAL YOU AGREE THAT YOUR USE OF THAT FOUNDATION MATERIAL IS GOVERNED BY THE TERMS AND CONDITIONS OF THIS AGREEMENT.

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1. Definitions

In this Agreement:

Acts means the (Australian) Trade Practices Act 1974 (Cth) and other consumer protection legislation in force from time to time;

Agreement means this agreement including (if any) the recitals, schedules and annexures;

Claim means any demand, claim, suit, action, liability or any other remedy actual, contingent or otherwise;

Contributor means each entity that creates or contributes to the creation of a Contributor Adaptation, but does not include any Owner or the Custodian;

Contributor Adaptation means any adaptation (including any translation, derivative, or amendment, or any incorporation into or combination with other material) of the structure or substance of either the Foundation Material or any previous Contributor Adaptation, in any form and in any media and includes any part thereof. For the Avoidance of doubt this includes any Modification;

Custodian means SSRB or such other party as may replace SSRB from time to time;

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Foundational Form means:

a. in relation to the Schema, Microsoft Word Format (.doc);

b. in relation to the Guides the form in which the Guides are made available by the Custodian from time to time; and

c. any other permitted form, including online digital forms, as advised by the Custodian on the website located at www.ssrb.org from time to time;

Foundation Material means the Schema and Guides or any part of any of them. A reference to the Foundation Material of an Owner means those items of the Foundation Material that pertain to that Owner unless otherwise expressly stated;

Guide means the document entitled Best Practice Spreadsheet Modeling Standards, explaining the operation of the Schema, available at www.ssrb.org and any Modifications that may be made to them from time to time and which are incorporated into them by the Custodian;

Intellectual Property Rights means:

a. all rights under patent law, copyright law, trademark law, design patent or industrial design law, semi-conductor chip or mask work law, trade secret law, or any other statutory provision or common law principle applicable to any of the subject matter of this Agreement which may provide a right in either (i) ideas, formulas, algorithms, concepts, inventions, technologies, software, data compilations, drawings, specifications, confidential business information, procedures or know-how generally, including trade secrets or (ii) the expression or use of such ideas, formulas, algorithms, concepts, inventions technologies, software, data compilations, drawings, specifications, confidential business information, procedures or know-how; and

b. all applications, registrations, licences, sub-licences, franchises, agreements or any other evidence of a right in any of the foregoing;

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a. SSRB; and

b. any other person notified by SSRB to You from time to time;

and a reference to **Owners** in the plural is a reference to each of them severally;

Schema means the document entitled Best Practice Spreadsheet Modeling Standards available at www.ssrb.org;

SSRB means Best Practice Modeling (BPM Analytical Empowerment Pty Ltd and its associated entities) and its respective successors and permitted assigns;

You (or Your) means a natural person or any other entity exercising rights under this Agreement.

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2.1 Licence *by Custodian*

a. Subject to the terms of this Agreement, the Custodian grants You a non-exclusive right to use, reproduce, edit, adapt, display and communicate its Foundation Material for the purpose of making Contributor Adaptations.

b. You may sell, license and otherwise deal with such Contributor Adaptations subject to the terms of this Agreement.

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Notwithstanding the scope of the licence grant in clause 2.1(b), you must not, without the written consent of the Custodian, create, sell, licence or otherwise deal with a software package based upon the Foundation Material otherwise than for internal use within your business.

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b. A Contributor may impose other terms on You in relation to the licence of its Contributor Adaptation, but those rights must not in any way limit, modify, preclude or conflict with the terms of, or compliance with, this Agreement.

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a. If You create or contribute to a Modification (whether or not as part of a larger Contributor Adaptation), then You must promptly deliver the Modification to the Custodian by sending it via email to proposals@ssrb.org.

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   ii) promptly deliver the Modification to the Custodian in accordance with clause 3.1(a).

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4.1 Application of this Agreement

a. You may only Distribute Foundation Material under the terms of this Agreement.

b. The Contributor Adaptations which You create or to which You contribute are governed by the terms of this Agreement. You may impose other terms in relation to the licence of those Contributor Adaptations, but those rights must not in any way limit, modify, preclude or conflict with the terms of, or compliance with, this Agreement.

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Every copy of the Foundation Material and every copy of each Contributor Adaptation that You Distribute must be accompanied by a copy of this Agreement in an identical form as this Agreement and must contain a notice stating that this Agreement applies to the Distributed copy.

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You must not make any representation, whether written or oral, that You have received accreditation from SSRB or that You are endorsed, recommended or sponsored by SSRB unless specifically authorized by SSRB.

4.4 Copyright and Authorization Notices

Without limiting clause 4.2:

a. You must display the following notice in a prominent location on any Foundation Material that You publish or communicate to the public, 'This document is a copy of the authorized version of the Best Practice Spreadsheet Modeling Standards as at 20th August 2016. Please check www.ssrb.org for any updates to this document. This document is subject to an Open Licence available at www.ssrb.org and all copyright in this document and any derivation of this document is owned by the Spreadsheet Standards Review Board'.

b. You must display the following notice in a prominent location on any Modification of the Foundation Material that you publish or communicate for your internal business purposes or to the public, 'This document is based upon the Best Practice Spreadsheet Modeling Standards as at 20th August 2016, and contains modifications NOT AUTHORIZED BY the Spreadsheet Standards Review Board. This document is subject to an Open Licence available at www.ssrb.org and all copyright in this document and any derivation of this document is owned by the Spreadsheet Standards Review Board'.

5. Warranties and Liability

5.1 Warranty

Each Contributor warrants and represents that:

a. the Contributor Adaptations that it creates or to which it contributes are its own original creations and do not and will not infringe the Intellectual Property Rights of any person; and

b. Contributor has sufficient capacity, rights and authority to grant the rights conveyed under this Agreement.

5.2 Indemnity

a. Contributor will fully indemnify each of the Owners and the Custodian in respect of all Loss arising out of any Claim by any person alleging that a Contributor Adaptation created or contributed to by that Contributor infringes any Intellectual Property Rights.

b. Contributor will not be required to indemnify an Owner under clause 5.2(a) to the extent that the alleged infringement arises out of the Owner's use of any part of that Owner's Foundation Material other than a Modification created or contributed to by that Contributor.

5.3 Acknowledgment and Exclusion of Warranties

a. The Foundation Material is provided to You as a 'work in progress' and as such You acknowledge that it may contain deficiencies. Due to the developing and experimental nature of the Foundation Material, You are required to make Your own investigations regarding the condition, accuracy, suitability, quality or fitness for any purpose of the Foundation Material. Neither the Owners nor the Custodian gives any express warranties in this regard, and to the fullest extent permitted by law each of them negates and excludes all such conditions, warranties and representations that may be implied.

b. You acknowledge that You have not relied on any representation of any of the Owners or the Custodian regarding the condition and suitability of the Foundation Material for Your purposes, but have satisfied Yourself in this regard.

5.4 Liability

The Owners' or the Custodian's liability to You for any proven Loss or Claim arising directly or indirectly out of this Agreement, whether under statute, common law (including negligence) or otherwise will be limited to the following extent:

a. Notwithstanding any other provision of this Agreement, neither the Owners nor the Custodian will be liable for any direct or indirect lost profit or revenue, exemplary damages, deletion or corruption of electronically or digitally stored information, or without limiting the foregoing, any indirect or consequential loss or damage howsoever described or claimed.

b. The total liability of all Owners and the Custodian will be limited to $20 for an aggregate of all Losses and Claims.

5.5 Breach of Implied Warranty

Nothing in this Agreement excludes, restricts or modifies any condition, warranty, right or remedy which is conferred on You by the Acts. If an Owner or the Custodian breaches a condition or warranty which has been implied by the Acts in relation to the supply of goods or services not of a kind ordinarily acquired for personal, domestic or household use or consumption, its liability for breach will be limited to (where permissible by the Acts):

a. In the case of the supply of goods: the replacement of the goods or the supply of equivalent goods, or the repair of the goods, or the payment of the cost of replacing the goods or of acquiring equivalent goods, or the payment of the cost of having the goods repaired; and

b. in the case of the provision of services: the supplying of the services again, or the payment of the cost of having the services supplied again,

whichever the Owner or the Custodian sees fit to provide.

5.6 Intellectual Property Claims

In the event that any Claim is brought or threatened against You alleging that Your use of any Foundation Material (including as part of a Contributor Adaptation) infringes the Intellectual Property Rights of any person, or if you suspect that such a Claim is possible, then the following provisions apply:

a. As soon as is practicable You must notify the Custodian of that Foundation Material in writing of the Claim.

b. You must permit the Custodian to modify, alter or substitute the infringing part of the Foundation Material at its own expense in order to avoid continuing infringement, or authorize the Custodian to procure for You the authority to continue the use and possession of the infringing Foundation Material.

5.7 Contribution

A party's liability under this Agreement will be reduced in proportion to the extent that the events giving rise to that liability are attributable to any act or omission of the other party, and the other party will assume liability in that proportion.

6. Termination

6.1 Termination for Breach

a. This Agreement and all rights granted to you under it will terminate automatically if You fail to comply with any of the terms and conditions contained herein, and fail to cure the breach within 14 days of becoming aware of it. Any licence of Contributor Adaptations that You have properly granted in accordance with this Agreement will survive termination of this Agreement.

b. Upon termination of this Agreement You must immediately forward all Modifications to the Custodian in accordance with clause 3.1.

6.2 Obligations Survive Termination

Clauses 3, 5 and 7 survive termination of this Agreement.

7. General

7.1 Interpretation

In this Agreement, unless the context requires otherwise:

a. the singular includes the plural and vice versa;

b. a gender includes the other genders;

c. the headings are used for convenience only and do not affect the interpretation of this Agreement;

d. a reference to a document includes the document as modified from time to time and any document replacing it;

e. the word 'person' includes a natural person and any body or entity whether incorporated or not;

f. the word 'month' means calendar month and the word 'year' means 12 months;

g. the words 'in writing' include any communication sent by letter, facsimile transmission or email;

h. a reference to any statute, proclamation, rule, regulation or ordinance includes any amendment, consolidation, modification, re-enactment or reprint of it or any statute, proclamation, rule, regulation or ordinance replacing it. A reference to a specified section, clause, paragraph, schedule or item of any statute, proclamation, rule, regulation or ordinance means a reference to the equivalent section of the statute, proclamation, rule, regulation or ordinance which is for the time being in force;

i. wherever 'include' or any form of that word is used it must be construed as if it were followed by '(without being limited to)';

j. money amounts are stated in Australian currency unless otherwise specified; and

k. a reference to any agency or body, if that agency or body ceases to exist or is reconstituted renamed or replaced or has its powers or functions removed ('defunct body'), means the agency or body which performs most closely the functions of the defunct body.

7.2 Nature of Obligations

a. Any provision in this Agreement which binds more than one person binds all of those persons jointly and each of them individually.

b. Each obligation imposed on a party by this Agreement in favour of another is a separate obligation.

7.3 Entire Understanding

a. This Agreement contains the entire understanding between the parties concerning the subject matter of the Agreement and supersedes all prior communications between the parties.

b. Each party acknowledges that, except as expressly stated in this Agreement, that party has not relied on any representation, warranty or undertaking of any kind made by or on behalf of the other party in relation to the subject matter of this Agreement.

7.4 No Waiver

A failure, delay, relaxation or indulgence by a party in exercising any power or right conferred on the party by this Agreement does not operate as a waiver of the power or right. A single or partial exercise of the power or right does not preclude a further exercise of it or the exercise of any other power or right under this Agreement. A waiver of a breach does not operate as a waiver of any other breach.

7.5 Severability

If any provision of this Agreement offends any law applicable to it and is as a consequence illegal, invalid or unenforceable then:

a. where the offending provision can be read down so as to give it a valid and enforceable operation of a partial nature it must be read down to the extent necessary to achieve that result; and

b. in any other case the offending provision must be severed from this Agreement in which event the remaining provisions of the Agreement operate as if the severed provision had not been included.

7.6 Successors and Assigns

This Agreement binds and benefits the parties and their respective successors and permitted assigns.

7.7 No Variation

This Agreement cannot be amended or varied except in writing signed by the parties.

7.8 Costs

Each party must pay its own legal costs of and incidental to the preparation and completion of this Agreement.

7.9 Counterparts

If this Agreement consists of a number of counterparts, each is an original and all of the counterparts together constitute the same document.

7.10 Conflicting Provisions

If there is any conflict between the main body of this Agreement and any schedules or annexures comprising it, then the provisions of the main body of this Agreement prevail.

7.11 Notices

Any notice or other communication to or by a party to this Agreement:

a. may be given by personal service, post or facsimile;

b. must be in writing, legible and in English;

c. that is from You to SSRB must be addressed as follows:

Address: Level 5, South Tower, 459 Collins Street, Melbourne, Victoria, Australia 3000

Attention: Chairman

or to any other address notified by the SSRB;

d. in the case of a corporation, must be signed by an officer or under the common seal of the sender;

e. is deemed to be given by the sender and received by the addressee:

i) if delivered in person, when delivered to the addressee;

ii) if posted, 2 business days (or 6, if addressed outside Australia) after the date of posting to the addressee whether delivered or not; or

iii) if sent by facsimile transmission, on the date shown on the transmission report by the machine from which the facsimile was sent which indicates that the facsimile was sent in its entirety and in legible form to the facsimile number of the addressee notified for the purposes of this clause,

but if the delivery or receipt is on a day which is not a business day or is after 4.00 pm (addressee's time) it is deemed to have been received at 9.00 am on the next business day.

7.12 Non Merger

A term or condition of, or act done in connection with, this Agreement does not operate as a merger of any of the rights or remedies of the parties under this Agreement and those rights and remedies continue unchanged. Each term of this Agreement that has not been carried into effect at the termination of this Agreement survives the termination.

7.13 No Adverse Construction

This Agreement is not to be construed to the disadvantage of a party because that party was responsible for its preparation.

7.14 Further Assurances

A party, at its own expense and within a reasonable time of being requested by another party to do so, must do all things and execute all documents which are reasonably necessary to give full effect to this Agreement including, in Your case, the execution of any assignment of copyright.

7.15 Consents and Approvals

Where anything depends on the consent or approval of a party, then, unless this Agreement provides otherwise, that consent or approval may be given conditionally or unconditionally or withheld, in the absolute discretion of that party.

7.16 Governing Law and Jurisdiction

This Agreement is governed by and must be construed in accordance with the laws of the State of Victoria. The parties submit to the exclusive jurisdiction of the courts of that State and the Commonwealth of Australia in respect of all matters or things arising out of this Agreement.

7.17 No Partnership, etc.

Nothing in this Agreement may be construed as creating a relationship of partnership, of principal and agent or of trustee and beneficiary.

Spreadsheet Standards Review Board
Email: info@ssrb.org
Website: www.ssrb.org