AUSTRALASIAN BIM ADVISORY BOARD

Asset Information Requirements Guide:

Information required for the operation and maintenance of an asset

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Australasian BIM Advisory Board (ABAB)

In May 2017, the Australasian BIM Advisory Board (ABAB) was established by the Australasian Procurement and Construction Council (APCC) and the Australian Construction Industry Forum (ACIF), together with NATSPEC, buildingSMART Australasia and Standards Australia. This partnership of national policy and key standard-setting bodies represents a common-sense approach that captures the synergies existing in, and between, each organisation's areas of responsibility in the built environment. It also supports a more consistent approach to the adoption of Building Information Modelling (BIM) across jurisdictional boundaries.

The establishment of the ABAB is a first for the Australasian building sector with government, industry and academia partnering to provide leadership to improve productivity and project outcomes through BIM adoption.

The ABAB is committed to optimal delivery of outcomes that eliminate waste, maximise end-user benefits and increase the productivity of the Australasian economies. The ABAB has evolved from a previous APCC–ACIF collaboration established in 2015 at a BIM Summit. This summit produced resource documentation to support BIM adoption (refer to www.apcc.gov.au for copies).

Members of the ABAB have identified that, without central principal coordination, the fragmented development of protocols, guidelines and approaches form a significant risk that may lead to wasted effort and inefficiencies, including unnecessary costs and reduced competitiveness, across the built environment industry.

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What is Building Information Modelling (BIM)?

For the context of the *Asset Information Requirements Guide*, the European Union (EU) BIM Task Group's description has been adopted:

> BIM is a digital form of construction and asset operations. It brings together technology, process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision-making for both buildings and public infrastructure assets across the whole life cycle. It applies to new build projects; and crucially, supports the renovation, refurbishment and maintenance of the built environment – the largest share of the sector.
>
> European Union (EU) BIM Task Group, *Handbook for the Introduction of Building Information Modelling by the European Public Sector*, European Union (EU) Building Information Modelling (BIM) Task Group, 2017.

Asset Information Requirements Guide

Information required for the operation and maintenance of an asset

This Guide was developed by a small, dedicated Technical Working Group whose visions for Building Information Modelling (BIM) span beyond their usual domains. The Australasian BIM Advisory Board (ABAB) acknowledges the immense contribution given by the following individuals.

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EXECUTIVE SUMMARY

An asset's operational costs account for a very large proportion of costs over its entire life cycle, so the potential savings from effectively managing its operation and maintenance (O&M) are substantial. These benefits extend beyond financial savings. A well-managed asset fulfils its functional and business purposes more effectively and reliably, resulting in greater satisfaction and productivity for the asset's users or occupants.

Maximising benefits
To realise these benefits, a strategic approach to asset management must be adopted from the very beginning: the long-term nature of asset management/facilities management (AM/FM) makes this essential. For effective AM/FM, quality asset information is fundamental for forward planning and day-to-day decision-making. The key to having the right information delivered is defining the asset information requirements (AIR) before commencing the design and construction of an asset.

Crucial role of top management
Leadership, commitment and support from top management are crucial to achieving a good outcome. For more effective asset management, it is essential that top management drives change, especially if constraints apply in the existing system and resources. An organisation's commitment of the necessary personnel and resources from the start is essential for the success of the AIR definition process. To foster a common approach, top management needs to align open and transparent decision-making on asset management priorities with organisational goals.

Digital deliverables for asset management/facilities management (AM/FM)
This Guide identifies the asset information components that are expected to be delivered in response to asset information requirements (AIR), namely, models, documents and data. It explains the basic concepts of digital information management (e.g. structured data) for those new to the subject, and seeks to dispel common misconceptions about the roles played in AM/FM by tools such as Building Information Modelling (BIM).

Asset information requirements (AIR) definition process
Defining information requirements can be a daunting prospect for many undertaking this task. The Guide, by outlining a clear AIR definition process, is designed to help those with this responsibility to overcome the challenge. The many decisions that must be made during the AIR definition process are part of the challenge. The Guide assists by outlining the options available, along with supporting information and guidance to assist with decision-making and priority setting.

Key points of the Guide

- With good planning and management, digital technologies, such as BIM and digital engineering (DE), offer a more efficient means than was previously possible of capturing AM/FM information during the delivery phase of an asset.
- Asset information requirements (AIR) should be derived from the information that an organisation needs for business and strategic decision-making about an asset during its operational life.
- It is important to have realistic, targeted information requirements and avoid asking for everything 'just in case'. The Guide emphasises a lean approach to asset information.
- The Guide illustrates the need to focus on defining the deliverables required, before defining the method of their delivery, to avoid becoming bogged down in excessive details early in the process.
- It is necessary to coordinate the information included in models, documents and databases (e.g. the asset register) to avoid discrepancies and to make it easier to undertake the ongoing management of this information.
- Following on from the point above, the Guide emphasises the need to consider models, documents and data collectively to achieve the most effective overall solution.
- In the absence of existing client standards, the Guide recommends the adoption of open data standards to ensure the ready exchange of information between systems and asset operators.

1 INTRODUCTION

1.1 Background

One of the most commonly cited benefits of Building Information Modelling (BIM) is its capacity to deliver the information, captured during the design and construction processes, about a built asset to those responsible for its ongoing operation and maintenance (O&M).

However, several problems stand in the way of realising this benefit, including:

- a lack of clear understanding by design consultants and construction/project managers of the information needs of asset managers and facility managers
- an inability of clients to articulate their information requirements early enough in the project for these requirements to be well-defined contractually, or to allow for effective planning of their delivery
- misconceptions about BIM and, in particular, how it should be used to deliver asset information
- the huge volume of information generated during the design and construction phases, much of which is not relevant to the operation phase.

1.2 Purpose

The purpose of this Guide is to assist clients and their consultants to define their information requirements to take advantage of BIM's capacity to capture and deliver asset data.

The Guide is no substitute for the early involvement of those ultimately responsible for managing the built asset, or for the engagement of experienced specialist operations consultants, but it can assist the asset information requirements (AIR) definition process. This is achieved through provoking discussion of the key considerations between clients, their agents, lead consultants and stakeholders, and by providing a common framework for these discussions.

Therefore, the aim is to sufficiently cover the factors that need to be considered when formulating information requirements to assist users of the Guide to make more informed decisions.

1.3 Audience

The primary audience of this Guide comprises:

- clients, their agents and lead consultants who have relatively limited experience in using BIM to deliver information for operational purposes
- clients who do not have well-developed statements of organisational information requirements (OIR), asset management strategies, AIR, existing data standards, etc.

1.4 Focus and scope

- **Decision support:** This Guide focuses more on decision-making about the information required, rather than on providing detailed coverage about the information itself.
- **Handover deliverables:** This Guide focuses on defining the information deliverables required at the handover between the construction and operational phases of an asset, rather than on the requirements at each stage of a project. The intention, first and foremost, is to focus the attention of the Guide's primary audience on the outcomes of the AIR definition process without becoming distracted by the multiple considerations associated with information delivery. Once this is accomplished, the work breakdown structure necessary for its delivery can be developed.

In many ways, this Guide is more about information management in general than about Building Information Modelling (BIM). Many of the principles outlined can be applied to standard asset management systems, even when BIM is absent. The Guide introduces concepts found in asset management, facilities management and BIM standards, and in technically detailed documents on these subjects. It does not intend to provide an in-depth exploration of their subject matter, but to act as a companion document and reference for those setting out to formulate their organisation's asset information requirements (AIR).

1.5 Terminology

Asset

Depending on the context, the term 'asset' can be interpreted as an element of infrastructure, a facility, a building, a space, a system, a piece of equipment or a product.

Asset management/building management/facilities management

The Asset Management Council (AMC) defines asset management as "the life cycle management of physical assets to achieve the stated outputs of the enterprise".

Asset, Building and Facility (or Facilities) Managers can have different roles and/or encompass a different spectrum of activities. As this Guide addresses principles relevant to all three, it adopts the term 'asset and facilities management' as the broader term. The abbreviation for asset management/facilities management (AM/FM) is used throughout the Guide.

Data and information

- Data are facts such as individual properties or attributes of things (e.g. measurements).
- Information is data that has been aggregated, structured and placed in context to give it meaning and purpose (e.g. measurements plotted on a graph included in a report).

Operations/operational phase

Operations/operational phase generally refers to the 'in-use' phase of an asset.

See **Section 9.1: Glossary** for definitions of terms used in the Guide.

1.6 Value of asset management/facilities management (AM/FM)

The operation and maintenance (O&M) stages account for the largest proportion of whole-life costs of assets. The O&M costs represent 50–70% of the total annual operating costs, and 85% of the entire life cycle costs.[1] Most built assets have intended service lives spanning decades. Effective management of an asset's operational costs and performance over its service life can thus provide significant financial benefits.

Strategic approach to AM/FM

As AM/FM is long term in nature, its benefits are realised through a strategic approach. Effective decision-making over time relies heavily on reliable and accessible information, including historical data about the performance and condition of assets. This allows projections to be made about maintenance, replacement, operating costs, etc. with these forming the basis for forward planning.

Strategic planning for AM/FM should start at the very beginning of a project, if not before. Members of the project team need to know what data and information they are expected to provide, and for which they will be held contractually accountable; thus, the client's asset information requirements (AIR) must be defined. As clients' requirements vary so much, no single set of predefined requirements are available; they must be defined for each project. The scale of the task will be significantly reduced if clients with existing assets have already formulated generic requirements that can be adapted.

This Guide outlines a definition process and highlights some essential considerations, as well as decisions that need to be made throughout the process.

Value of digital asset data

As previously noted, effective AM/FM relies on reliable information. General expectations about information deliverables for AM/FM purposes are well established and documented. The NATSPEC *0171 General requirements* worksection, for example, specifies general requirements, such as quantities, formats and contents for as-built drawings, product information, O&M manuals, warranties, etc. that the contractor must submit. Other worksections specify requirements for their subject system under the SUBMISSIONS clause.

These expectations still stand, but simply delivering these items in digital form, for example, with computer-aided design (CAD) or PDF files instead of printed drawings, does not capitalise on the potential value offered by digital technologies such as BIM or digital engineering (DE). The biggest difference between traditional deliverables and BIM deliverables is structured data. This is explained in more detail in the following sections.

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[1] J. K. W. Wong, J. Ge, and S. X. He, "Digitisation in facilities management: A literature review and future research directions," *Automation in Construction*., Vol. 92, pp. 312-326, Aug. 2018.

Quality information supports good decision making –
Good information management maintains quality.

Useful references

Further information that will assist in the implementation of effective AM/FM practices can be found in the following documents:

- *ISO 55000:2014 Asset Management – Overview, principles and terminology*
- *ISO 55001:2014 Asset Management – Management systems – Requirements*
- *ISO 55002:2014 Asset Management – Management systems – Guidelines for the application of ISO 55001*
- *ASTM Standards for asset management:* Standards on a wide range of AM topics – American Society for Testing and Materials (ASTM)
- *AMBoK Publication 000: Framework for Asset Management* – Asset Management Council (AMC) 2014
- *AMBoK Publication 001: Companion Guide to ISO 55001* – Asset Management Council (AMC) 2014
- *AGAM01-18: Guide to Asset Management* – Austroads 2018
- *International Infrastructure Management Manual (IIMM)* – Institute of Public Works Engineering Australasia (IPWEA) 2015
- *The Asset Management Landscape* – Global Forum on Maintenance and Asset Management
- *Asset Management Maturity Scale and Guidance Version 1.1* – Institute of Asset Management
- *Asset Management Accountability Framework* – State of Victoria, Department of Treasury and Finance

2 DELIVERING ASSET INFORMATION

Digital technology processes, including BIM and digital engineering (DE), offer many opportunities not only for streamlining asset-information collection throughout a project, but also for delivering it for handover between the construction and operational phases.

If the process is well planned and data are consistently structured from the outset, considerable savings in time and effort can be made compared to traditional methods which involve reconfiguring or re-entering information each time it passes from one project participant to another.

For these benefits to be realised, a planned, coordinated and disciplined approach is required from project inception. Without it, much effort can be wasted, creating volumes of irrelevant, disorganised and unreliable data that are unfit for AM/FM purposes.

> It is estimated that in 2002, American companies spent US$4.8 billion to verify the reliability of such data, with an extra US$613 million for transferring the information into required formats.[2]

Consequently, the first step in planning for the delivery of useful AM/FM data is defining the asset information requirements (AIR).

2.1 Asset information requirements (AIR)

The asset information requirements (AIR) are a subset of the overall project brief. Just as the functional design brief describes the client's requirements for the finished built asset, the AIR describe the client's requirements for asset data. The processes of delivering the assets and the associated data and information are parallel and connected.

[2] M. R. Hosseini, R. Roelvink, E. Papadonikolaki, D. J. Edwards & E. Pärn, "Integrating BIM into facility management: Typology matrix of information handover requirements," *International Journal of Building Pathology and Adaptation*, Vol. 36, No. 1, pp. 2-14, Feb. 2018.

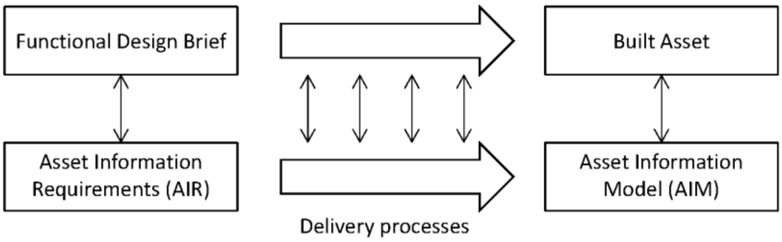


Figure 2.1: Parallel delivery of built asset and asset data

The provision of asset data in response to the specified requirements should form part of design and construction obligations within the associated contracts. To make this enforceable and fair, the data required have to be clearly defined, objectively measurable and testable against defined standards.

2.1.1 Benefits of early definition of AIR

Defining AIR prior to the commencement of design has significant benefits at different stages of a project:

- **During project planning and design:** Going through the process of defining AIR makes clients and their advisers think carefully about what information is important and helps them balance aspirations against resources.
- **At team engagement and tender stage:** A clear formal statement of information requirements helps the many project stakeholders deliver information in a consistent and coordinated way. It creates certainty for everyone and reduces the risk of time and effort being wasted on collecting unnecessary information. As consultants and contractors can then plan and provide information deliverables with greater certainty and confidence, they do not have to load their fee proposals and bids with as many contingency allowances.
- **During project delivery and handover:** Clients can more readily verify that the information they receive matches their stated requirements. They also have more contractual power to enforce this outcome.

2.1.2 Other information requirements

The focus of this Guide is on AIR for the following reasons:

- high-value asset information is essential for effectively managing the asset after handover
- a relative lack of maturity is found in defining AIR within the industry.

However, AIR cannot be viewed in isolation: these requirements are part of a broader set of client information requirements associated with a project. Clients need information for decision-making purposes, such as monitoring progress and assessing the impact of project events on their business activities. Information is also generally not created for asset management purposes alone; it is usually derived from information generated during the design and construction phases of a project. To place AIR and asset information deliverables in context, **Figure 2.2** provides an overview of information requirements and deliverables. The concepts and terminology used are from ISO 19650-1 (see **Section 10: Bibliography**).

Note: The information requirements and deliverables covered in this overview are those related specifically to the client's needs. While most are based on the complete set of information required to deliver a project, they represent a distinct subset tailored to the client's specific needs.

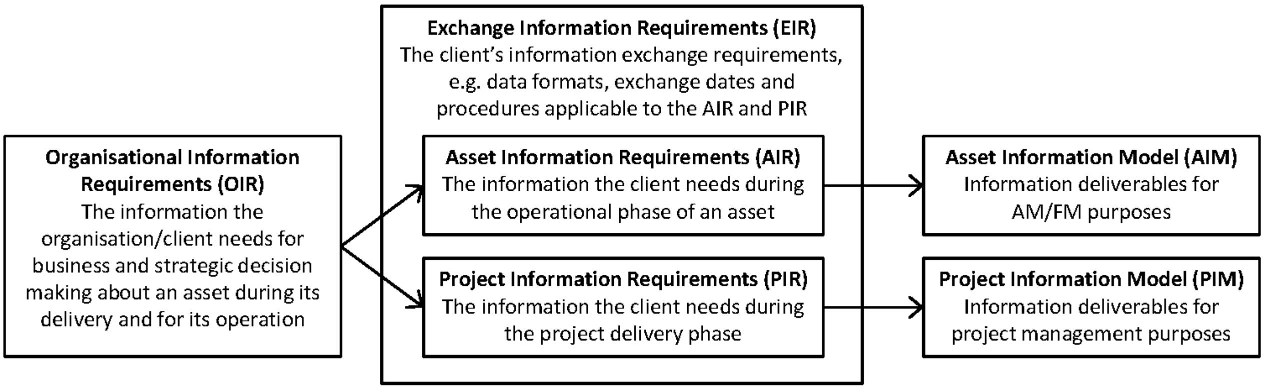


Figure 2.2: Relationship of AIR to other information requirements

Organisational information requirements (OIR)

The organisational information requirements (OIR) are established in a statement about the information needed by an organisation to inform decision-making about high-level strategic objectives. The OIR inform the AIR and the project information requirements (PIR) but, unlike the AIR and PIR, the OIR are generally not issued as part of tender documentation.

Asset information requirements (AIR)

Asset information requirements (AIR) primarily set out the technical aspects of the required asset information, that is, the information needed to support operational activities. This Guide provides little coverage of the information standards, production methods and procedures to be implemented by the delivery team. Most of these details are expected to be contained in the exchange information requirements (EIR).

Project information requirements (PIR)

Project information requirements (PIR) set out the information required by the client for decision-making about the project throughout its duration. These requirements can include excerpts of construction and project management documents and/or purpose-written reports including cost and progress reports. Organisational policies, such as financial reporting procedures and formats, also influence project information requirements (PIR). Experienced clients usually have generic PIR that they adopt or customise for each of their projects.

Exchange information requirements (EIR)

Note: The term ‘exchange information requirements’ from ISO 19650-1 has the same meaning as the term ‘employer’s information requirements’ from PAS 1192-2.

While the AIR and PIR primarily describe ***what*** information is required, the EIR are primarily concerned with the ***who***, ***how*** and ***when*** of their delivery. The EIR represent the overall information requirements incorporating managerial, commercial and technical aspects with both AIR and PIR encompassed. These requirements include details of the roles and responsibilities of project team members, information production processes and procedures, data standards, file formats and timetables for information exchanges. The EIR inform the later development of the BIM Management Plan (BMP)/BIM Execution Plan (BEP).

Asset information model (AIM)

The asset information model (AIM) is the deliverable provided by the delivery team in response to the client’s AIR. It supports the client’s strategic and day-to-day AM/FM processes. It can also provide information at the start of a refurbishment or extension of an existing asset. The AIM should not be mistaken for a virtual 3D model. It comprises documents, models and structured data, as explained in more detail in **Section 3**.

Project information model (PIM)

The project information model (PIM) supports the delivery of the project and contributes to the asset information model (AIM). As not everything added to the PIM during the project is relevant to the AIM, part of the project planning process should include how the AIM will be derived from the PIM, and which parties will be responsible. A PIM should be stored for auditing purposes and to provide a long-term archive of the project. Again, it should not to be mistaken for a virtual 3D model, as the PIM contains information such as methods of construction, scheduling and costing, and details of systems, components and equipment installed during project construction.

2.1.3 Thinking about requirements and deliverables

Requirements and deliverables have a complementary relationship: requirements represent a request, or a call, for something, while deliverables are the response.

In the process of defining AIR, it can be helpful to regularly switch thinking between requirements and deliverables. Requirements can prompt thinking about needs in general terms without preconceived solutions: thinking about deliverables can help define requirements in more concrete, specific forms.

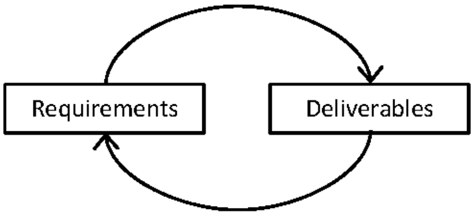


Figure 2.3: Requirements and deliverables

Section 3 outlines the nature of the deliverables sought by the client from the project team before the decision-making process for defining AIR is described in Section 4.

Useful references

Briefing process for asset management/facilities management (AM/FM)

The following documents provide more detailed coverage of the AM/FM briefing process. They include checklists of items for consideration that can be used to prompt discussions to help define the client's requirements:

- *BS 8536-1:2015 Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure)*
- *BS 8536-2:2016 Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure)*
- *ISO 41001:2018 Facility management – Management systems – Requirements with guidance for use.*

ISO 19650 – Information management using BIM

Many concepts described in this Guide are covered in more detail in *ISO 19650 Organization of information about construction works — Information management using building information modelling — Part 1: Concepts and principles* and *Part 2: Delivery phase of the assets.*

Based on the British publicly available specification (PAS) 1192-2, ISO 19650-1 & .2 provide a comprehensive framework, when using BIM, for managing the delivery of asset and other information.

Important points to note

- While the client does not need detailed knowledge of ISO 19650, they need to understand its purpose and what its application entails for them.
- For a consistent approach to be fostered from project to project across the industry, ISO 19650 is designed to provide a general framework for projects. It emphasises the need to define specific requirements for individual projects.
- A cornerstone of ISO 19650 is that the appointing party, or client, is responsible for defining their information requirements at the beginning of the project. These requirements form the basis of the project team's response throughout the project.

3 DIGITAL DELIVERABLES FOR ASSET MANAGEMENT

3.1 Models, documents and data

Having BIM in place alone will not create value for an asset owner: the benefits only arise from its effective use with this intention in mind.[3] Misconceptions about what BIM is expected to deliver for operational purposes first need to be addressed. Common misconceptions include:

- All the information about an asset or facility can be stored in BIM.
- BIM replaces drawings and documents as a means of communication about an asset.
- BIM replaces computer-aided facility management (CAFM) systems.
- All data in BIM are readily useable by operations and other systems.
- BIM provides a data repository platform for operational AM/FM data.

BIM authoring applications and the virtual models they produce are very useful during the design and construction phases of an asset. They can be used to generate and help manage asset information during these phases but, as they are not designed for day-to-day AM/FM tasks, they are generally not well suited to this purpose. Furthermore, specialist training is required to operate BIM applications, and few operational managers are expected to have these skills.

The three digital deliverables for AM/FM are virtual 3D models, documents including drawings, and tabulated data. Collectively, these deliverables are referred to as the asset information model (AIM) [ISO 19650-1].

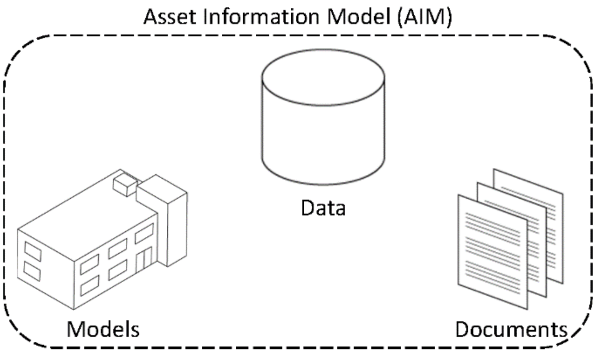


Figure 3.1: Digital AM/FM deliverables

Models, drawings, text-based documents and non-graphical data – usually stored in spreadsheets or databases – each have their strengths and weaknesses as information sources, depending on the circumstances in which they are used. Instead of relying on only one as a primary source, it is more sensible to explore how to obtain the best result by using them collectively.

3.2 Structured data and information

To obtain the most value from asset data and information, they need to be well structured. The features of structured data are that they:

- use a “single source of truth”
- are linked in a useful way
- are object-based
- are based on a schema
- leverage metadata.

Use of data determines how data are structured.

[3] E. D. Love, J. Matthews, I. Simpson, A. Hill, and O. A. Olatunji, “A benefits realization management building information modelling framework for asset owners,” *Automation in Construction*, Vol. 37, pp. 1-10, Jan. 2014.

Many topics related to the structuring of data can seem highly conceptual, particularly when discussed in general terms. However, when deciding how best to structure data for specific applications, the primary determinant of structure will be its use cases, that is, how it will be used for practical purposes. Concepts associated with organising asset data in a structured way are introduced in the next subsection.

3.2.1 Elements of structured data

Single source of truth

One of the key principles of digital information management is to maintain a single location for data, thus avoiding the duplication that results from storing the same data in different locations. Apart from the extra work needed to update data in multiple locations, duplication increases the risk that data will be amended in one location but not in others, increasing the risk of incorrect or out-of-date information being used.

A digital system allows multiple locations to link to a single source of data. Advantage should be taken of this capability to maintain the integrity of data and minimise data maintenance overheads.

Strategic decisions about where particular types of data are to be located and how they are to be linked need to be made in the process of defining information requirements.

Linked data

As noted above, one great advantage of digital data is the ability to link the data in useful ways (e.g. links between database tables, hyperlinks, etc.)[4]. Data do not need to be accessed in the predefined, linear manner found in traditional documents. Linking data has a multiplier effect on the value of data. It allows more sophisticated queries to be addressed to a body of information. For example, on one hand, information about an asset can be linked to information about the room or space where it is located while, on the other hand, information about the space can include all assets found in that space. The asset record can be linked to O&M manuals, models and drawings showing its location in a system or assembly, as well as being linked to product data, manufacturer data, contact data for service and maintenance contractors, service records, performance logs, etc.

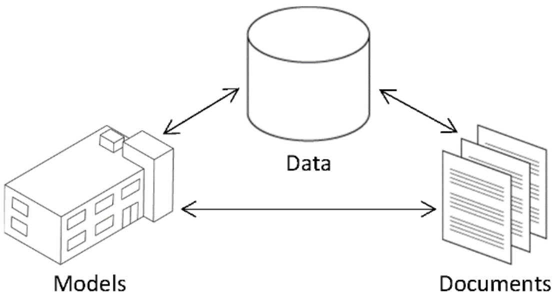


Figure 3.2: Linked data

As with much in the digital domain, greater functionality has implications. Links do not just happen: they must be manually created and maintained. The cost must be factored in when considering what type and scope of linking might be the most useful.

The competencies of the system's intended operators and managers are another factor to consider: the creation of a sophisticated system is not of value if they are not readily able to maintain and update it.

Object-based organisation

An object-based approach to organising information is one in which objects – representations of real-world objects – act as a unifying point of reference. This differs from a file-based approach in which information about the same item might be found in several different locations (e.g. folders).

[4] E. Curry, J. O'Donnell, E. Corry, S. Hasan, M. Keane & S. O'Riain, "Linking building data in the cloud: Integrating cross-domain building data using linked data," *Advanced Engineering Informatics*, Vol. 27, No. 2, pp. 206-219, Apr. 2013.

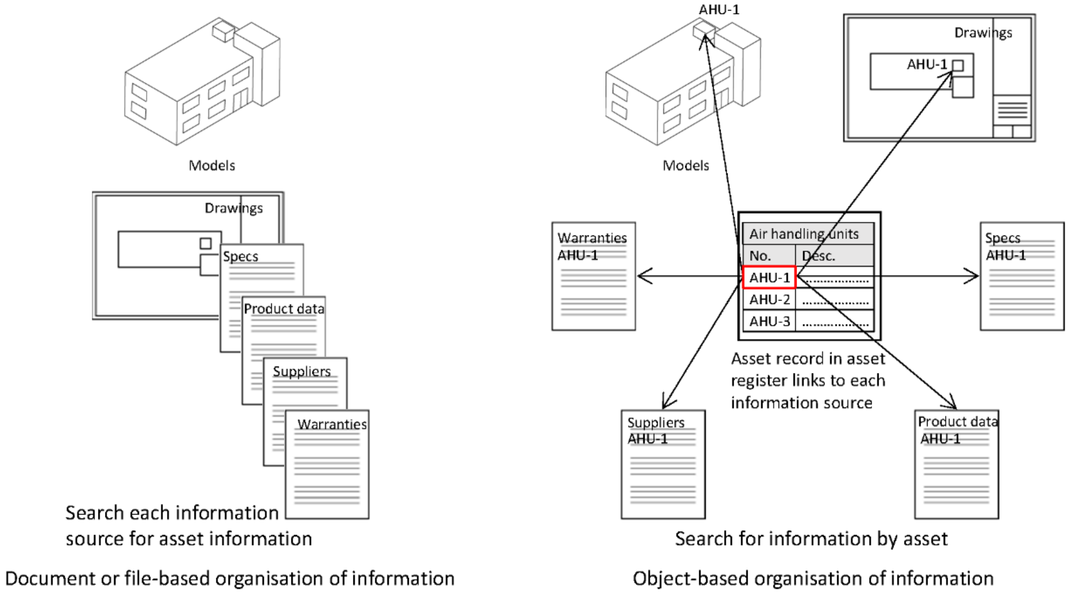


Figure 3.3: Object-based versus file-based organisation of information

An object-based approach is well suited to the organisation of asset registers as it reflects the way we tend to think about assets and associated tasks; for example, who supplied that pump? when was it last serviced? where can I find it?

An object-based asset register is also well suited to exchanging information with BIM because BIM software is based on an analogous concept: object-oriented programming; that is, data are associated with individual objects, for example, windows, walls and spaces in the model. Each object encapsulates the code, data and attributes which define the object and its behaviour, including parametric behaviour.

Data schema

A schema is an overall plan of the relationships between different concepts associated with a specific field of knowledge or practice. Communication and understanding are assisted by having an explicit conceptual framework that includes clearly defined terms for concepts regularly discussed within a community of practice.

For similar reasons, digital applications need a schema for their exchange of data. Applications do not have the capacity to interpret information by relying heavily on prior knowledge or its context as humans do. Therefore, data must be made machine-readable, that is, consistently formatted and based on a highly structured data schema.

Schemas for architecture, engineering and construction (AEC) and AM/FM data can range from those that are very broad and comprehensive, such as Industry Foundation Classes (IFCs), to those that are small scale and single purpose, such as categories of assets used by a computer-aided facility management (CAFM) system. For example, while the organisation of the asset register may be object-based, the next layer of organisation could be a classification system with all objects/assets arranged by type to assist in finding assets of interest. Naming conventions for database tables, objects, properties and designations can form the sub elements of a schema.

Metadata

Metadata in this context are data about an asset record, rather than about the asset itself. This is the information typically found under 'Properties' of a PDF or other type of electronic file, including the file creation date, last modified date, author and file size. This type of data is generally used for administrative purposes, such as auditing and quality control.

3.2.2 Location referencing methods (LRMs)

From an asset management perspective, space has two roles:

1. As an organiser of asset information: a method of accurately describing the location of assets is fundamental to asset management because it allows assets to be quickly located for inspection, servicing, repair, replacement, etc.
2. As an asset that accommodates functions and business processes: information about space provides the basis for planning and managing an organisation's business processes and activities, and maintaining the desired conditions for their users. This second role is not the subject of this section. See **Appendix G** for a brief coverage of the common attributes or properties assigned to space for space management purposes.

The three main types of location referencing methods (LRMs) used for asset management[5] are listed below.

- Geometric LRMs which are based on coordinate geometry within local model coordinates typically applied in 2D (CAD) or 3D digital models (BIM).
- Topological LRMs which describe locations relative to the distance from a connection point (node) along a connecting line segment (link).
- Geographic LRMs which describe locations on the Earth's surface by reference to real-world coordinates (e.g. latitude and longitude).

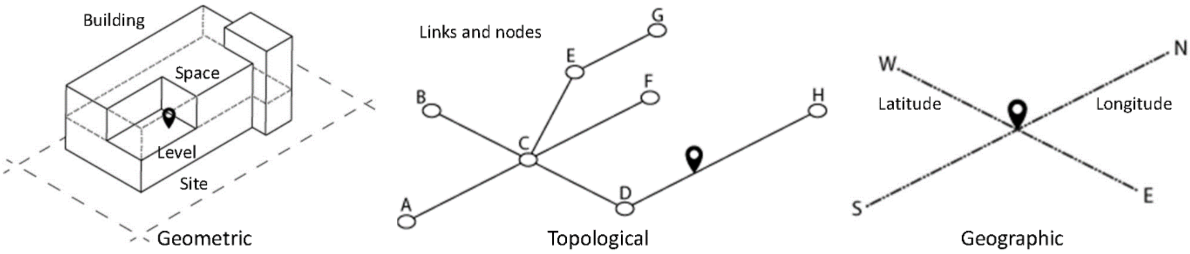


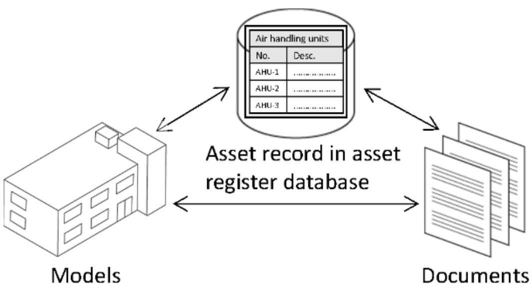
Figure 3.4: Location referencing methods

The most appropriate LRM for assets depends on the type of asset. Generally, a geometric LRM is used for buildings; a topological LRM for linear or network infrastructure such as road, rail and reticulated utilities; and a geographic LRM for distributed networks such as transport and telecommunication systems. For some types of assets, combined methods may be more effective (e.g. nodes of a topological system cross-referenced to geographical coordinates).

After deciding on the most appropriate LRM for a given application, a location reference system (LRS) must be chosen. This system is used to implement the LRM, including the information and communications technology (ICT) infrastructure, hardware, software and standards. See **Appendix G** for elements of standards to be considered when selecting the LRS for a space management system.

3.3 Asset register organisation

An asset register – whether in the form of spreadsheets, a database or part of a computer-aided facility management (CAFM) system – is the platform used to host asset data. It plays a central role in the asset information model (AIM). Apart from being a repository of asset data, an asset register can act as a 'switchboard' that links each asset to relevant information sources.



[5] R. Kenley and T. Harfield, *Scoping Study for a Location Referencing Model to Support the BIM Environment*, Austroads, Research AP-R568-18, 2018.

Figure 3.5: Asset register as a means of linking information

Designations for coordinating information

While databases use numerical identifiers (keys) or global unique identifiers (GUIDs) to link data in their constituent tables, human-readable designations are still necessary to make it easier for people coordinating or using the information.

Designation codes, or ‘tags’, are used to coordinate and cross-reference information about items in construction documents familiar to many in the industry.

> “If we forget about BIM for a moment and focus on what one would assume to be a best practice regardless of the technology used, it would be reasonable to expect even in a hand-drawn set of documents from the1980s that:
>
> 1. rooms are uniquely named and numbered
> 2. schedules of doors and equipment are uniquely numbered and associated with rooms
> 3. attributes about rooms and equipment can be found and associated with the room and equipment.
>
> This allows us to answer the following sorts of questions: What is the floor finish of Room 101? Where is AHU-2 and what are its characteristics?”[6]

The same principles can be applied to referencing information about items inside and outside the database. Figure 3.6 shows how the same item can be found in several locations using its designation code.

The same designation, for example, for a door, should appear in the asset register, schedules, specifications, models and drawings, and should correspond to the signage on the actual door in the completed building.

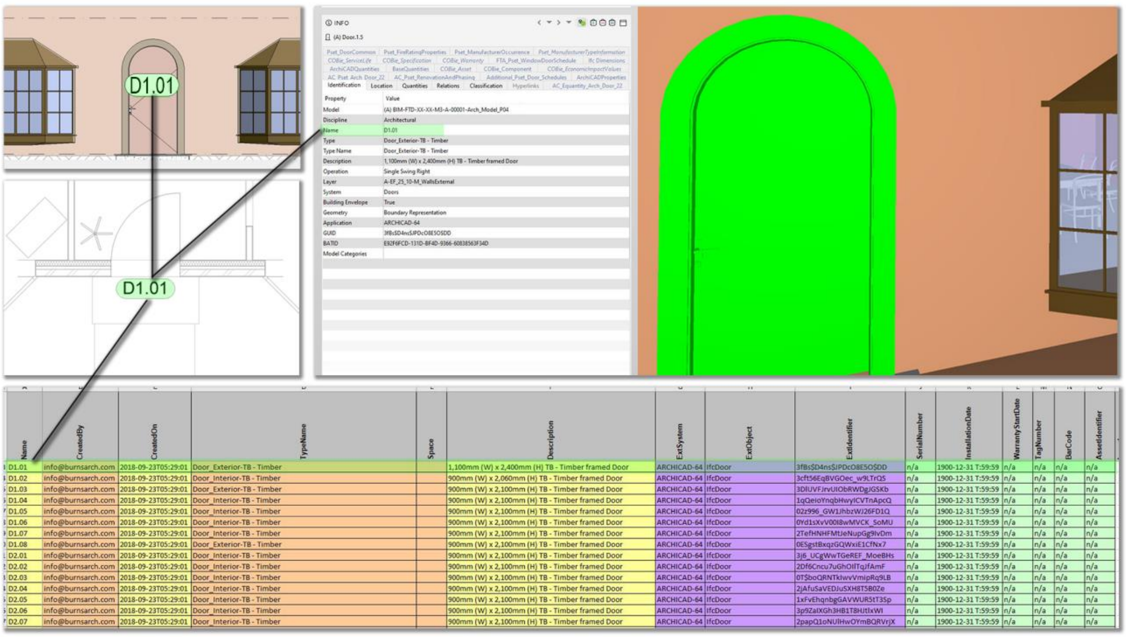


Figure 3.6: Designation codes for coordinating information

Section 5 covers the decision-making process for determining what data to include directly in the asset register versus what to reference, as well as the method used for linking the data.

[6] J. Grady, “Paraphrased from a comment by Kimon on a post COBie is dead!!!,” Epic BIM, 06 Feb 2013.

4 PROCESS OF DEFINING ASSET INFORMATION REQUIREMENTS (AIR)

This section provides an overview of the process for defining asset information requirements (AIR) before examining the steps involved in the process in more detail in **Section 5**.

4.1 Process overview

In this section, the process of defining AIR focuses on defining the content of the asset register, the repository of generally non-graphical asset data. It is the core element of any asset management system as it is best suited to:

- searching, filtering and sorting information about assets
- handling the ever-changing data associated with asset management
- aggregating data to provide insights into patterns and trends useful for strategic decision-making
- linking to the other elements of the AIM: documents, virtual 3D models and 'in-use' data.

4.2 Process outcome

The objective of the AIR definition process is to provide a clear statement of the requirements that will enable the project team to deliver an asset information model (AIM) comprising:

- a well-structured asset register, including asset data appropriate to the organisation's needs
- a well-organised repository of drawings, documents and files, including a building manual
- an accurate as-built model/s (with minimum non-graphic data)
- all above components coordinated and consistently cross-referenced, with minimal duplication of data, and all presented in a format appropriate to the organisation's systems and management capabilities.

The purpose of the asset information model (AIM) is to provide the information that forms a sound foundation for the client's asset management system, and not to provide the management system itself. Well-structured, reliable and accessible information is more important than the volume of data. Quality data based on established standards can be readily repurposed and extended as required, whereas a mass of inconsistent, poorly structured data cannot.

4.3 Process participants

Early involvement of the asset operator is key to the success of the AIR definition process. The following parties should be involved in defining AIR.

- Information Manager: This role can be separate or an additional role undertaken by the BIM Manager, Lead Consultant, Project Manager or other suitably qualified person. It is preferable for one person to undertake the role during the delivery and early operation stages of the asset to facilitate a smooth handover to occupants and those responsible for the ongoing management of the asset. It is particularly important that sufficient time is allowed for the transfer of information and knowledge from the design and construction team to the operational team to ensure they have a thorough understanding of the asset's systems.
- Client AM/FM Manager: Representative/s of those responsible for operating and maintaining the asset after handover. In their absence, the following people must participate:
    - Client representative: Representative/s of the client who are most responsible for, or familiar with, the organisation's operational management policies and systems. In the scenario where a trained AM/FM Manager is not available, it is important to develop a reverse brief for approval by the client. Even if a client AM/FM Manager is available, it is still desirable for a client representative to be actively involved.

The contractor generally does not play a part in defining technical information requirements, but when considerations shift to its delivery, it is best to involve the contractor as soon as possible.

For the definition process to be completed in a timely and effective manner, it is essential for all participants to commit the necessary time, including attending meetings and responding to proposals and requests for information from the other parties.

4.3.1 Information management perspectives

Although the process participants identified above automatically bring different perspectives to the AIR definition process, the conscious application of the perspectives shown in Table 4.1 throughout the process is useful for prompting comprehensive consideration of the information requirements, and as a tool for assessing proposals.

Table 4.1: Information management perspectives

Perspective	Information management purpose
Asset owner	To establish and maintain the purpose of the asset or project, and to inform strategic business decisions.
Asset users	To identify the actual requirements of users or occupiers and to ensure the asset solution has the right qualities and capacities.
Project delivery and AM/FM teams	To plan and organise the work, mobilise the right resources, and coordinate and control development of the asset or project.
Society	To ensure that the community's interests are taken care of during the asset life cycle (planning, delivery and operation).

[Source: ISO 19650-1]

4.3.2 Projects involving alteration, upgrade or extension of an existing asset

The types of projects involving alteration, upgrade or extension of an existing asset entail tasks and responsibilities additional to those undertaken in new-build projects. For example, decisions need to be made about who will be responsible for tasks such as:

- extracting historical data on retained assets from existing systems
- updating and linking new and old data sources to new and old assets
- ensuring that data and information formats are compatible with existing information management systems used by the client.

5 DEFINITION OF ASSET INFORMATION REQUIREMENTS (AIR)

The AIR definition process described in this section is concerned with decision-making about the asset register's content and structure, and how it links to the other elements of the AIM: virtual 3D models and documents.

The challenge this involves is choosing between a seemingly unlimited number of options and making decisions that have long-term consequences on what, in the beginning, can seem like very sketchy information. This section seeks to make the process easier and less daunting.

The steps in the process are summarised in Figure 5.1 and are explored in more detail below.

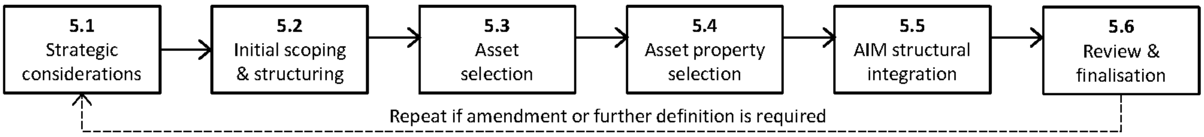


Figure 5.1: Decision-making about asset registers

Note: Figure 5.1 simplifies the process to assist with its explanation and is not intended to imply a linear process. Taking an overly procedural approach can lead to investing disproportionate amounts of time defining details early in the process that are later superseded. Each step informs the other steps. It is therefore better to conduct quick iterations of the process so requirements are defined progressively and in a cohesive form.

5.1 Strategic considerations

When defining the AIR, the overall organisational information requirements (OIR) need to be taken into consideration to provide a broader context for decision-making about the asset information requirements (AIR). OIR help to identify and prioritise AM/FM information based on their level of importance to the organisation. These requirements can arise for reasons including the following:

- strategic business operation
- strategic asset management
- portfolio planning
- legislative and regulatory obligation
- policy making.

In this part of the process, organisational objectives, policies, systems, resources and constraints regarding asset management should be analysed. The purpose of this analysis is to provide a consistent framework for setting priorities and assessing the relative merits of options. This is much easier if these items have already been formalised in a Strategic Asset Management Plan (SAMP).

If your organisation does not have a Strategic Asset Management Plan (SAMP), develop one.

Documents such as the ISO 5500 series, ISO 41012 and the *International Infrastructure Management Manual (IIMM)* provide sound frameworks for developing a SAMP. They outline many points that need to be considered during this process.

5.2 Initial scope and structure

Roughly sketching the overall scope and structure of the AIM at the outset reduces the risk of becoming buried in the detail and losing perspective of what is important in the next parts of the process.

Factors influencing the overall scope of the AIM that need to be considered include:

- **Project scope:** The nature of the project affects the type of asset data required and the method of data collection. If the works are solely for new assets, this information is derived only from design and construction processes. If the works are for the alteration, upgrade or extension of an existing asset or facility, information may need to be gathered about existing assets. The quality and reliability of existing asset information will determine how much work is involved, so the scope of this task needs to be well defined.
- **Organisational priorities:** The Facility Management Association of Australia (FMA Australia)'s *FM data and information management interest matrix* (https://www.fma.com.au/resources/fm-data-and-information-management-interest-matrix) provides a framework to help stakeholders identify their level of interest, and hence the priority given, in applying operational, tactical and strategic data and information to achieve efficient and effective AM/FM operations over the life of an asset. A property developer's priorities regarding the collection of asset information, for example, could be very different to those of the operator of a public transport system.
- **Organisational resources and constraints**: Various factors, such as the availability of personnel with the requisite expertise, influence the appropriate volume of data to collect as well as the data's structural sophistication, that is, the way that the data in the asset register are linked to documents and models. These factors also determine the most appropriate platform for hosting data, for example, a computer-aided facility management (CAFM) system or spreadsheet. If organisational resources are limited, a simple system will probably be a safer option than a sophisticated one for which maintenance cannot be assured.

As all aspects of the AIM – the volume of data, the data structure, the platform used for data hosting and the standards adopted – influence each other, it is best to view the AIM holistically and, when defining it, to take an iterative approach. Before selecting the assets and their properties, an initial review of aspects covered in more detail under **Section 5.5: Asset information model (AIM) structural integration** should be undertaken.

When defining information requirements, it is best to avoid asking for everything – 'just in case it is needed'. This approach is simply an excuse for avoiding crucial decision-making. It is costly and leads to large volumes of often irrelevant data in which truly useful data are buried. Techniques such as MoSCoW ('Must have, Should have, Could have, Won't have') can be used to prioritise requirements.[7]

5.3 Asset selection

The selection of the assets to be included in an asset register is one of the most fundamental decisions that needs to be made. This section outlines factors that need to be considered. The two broad groups of assets considered in this Guide are: (a) spaces and (b) systems and products.

The focus of this section is on the selection of system and product assets – it is assumed that spaces are selected as part of the response to the functional design brief. See **Appendix G** for a brief coverage of some common attributes or properties assigned to spaces for space management purposes. Also see **Section 3.2.2: Location Referencing Methods (LRMs)** for information about space's role as an organiser of asset information.

This Guide does not cover other assets such as human resources and intellectual property.

[7] Z. Racheva, M. Daneva, A. Herrmann, and R. J. Wieringa, "A conceptual model and process for client-driven agile requirements prioritization," in *Fourth International Conference on Research Challenges in Information Science (RCIS),* 2010, pp. 287-298.

5.3.1 Information purposes

Thinking about the main purposes for asset information in relation to OIR can help to clarify requirements at a broad level. Another approach that can help in defining requirements is to think about the main questions that the client needs answered for each purpose. The following categories of information purposes provide different perspectives or 'lenses' for viewing requirements. Purposes include:

- **Regulatory compliance:** Information to support reporting for certification purposes and to meet statutory requirements, for example, annual reporting on essential (fire) services. This includes information which an organisation is contractually obliged to collect and on which it needs to report as part of its ministerial charter or licensing requirements.
- **Business cases:** Information critical to the delivery of core business services including providing a pleasant and productive working environment for occupants. This can include information for financial reporting purposes.
- **Capacity and utilisation:** Information to identify the capacity and utilisation of spaces and building services for operational and strategic planning purposes.
- **Risk management:** Information required (or required to be suppressed) to support risk management, especially for identifying and reviewing risks to which an asset could be exposed, for example, natural hazards, extreme weather events or fire. This can include financial information such as replacement value for insurance purposes.
- **Security and surveillance:** Information necessary to operate and maintain assets affecting security and surveillance.
- **Disaster management:** Information needed to respond effectively to disasters and emergencies.
- **Impacts:** Information for monitoring impacts such as sustainability, energy efficiency, water usage and waste generation.
- **Operations:** Information needed to operate systems, equipment and products.
- **Maintenance and repair:** Information needed to maintain and repair systems, products and finishes.
- **Replacement/upgrade:** Information needed to replace or upgrade key systems and products.
- **Repurposing/alteration:** Information needed to repurpose or alter key systems and products.
- **Decommissioning and disposal:** Information needed to decommission and dispose of key systems and products.

Purpose categories are arranged roughly in descending order from overarching considerations through to operational considerations in life cycle order (see ISO 19650-1 clause 5.1 for more details). This list of purposes is not exhaustive. Other categories, more meaningful to an organisation's specific needs, could be added.

Appendix A includes a list of Plain Language Questions (PLQ) that can be posed when considering which assets and properties are to be included in the asset register. The questions are designed to prompt thinking about the information required and its relative importance, as well as prompting other questions to add to the list.

Useful reference

The Facility Management Association of Australia (FMA Australia) *Facilities Information Good Practice Guide* (2015) provides an overview of facilities information from a facilities management perspective. It outlines the different types of information that can be useful for strategic, tactical and operational purposes. An appendix lists the types of data used to create facilities information. It includes standard units of measurement to assist in the consistent application and comparison of information.

5.3.2 Asset priorities

The assets in an asset register are best included in an order which approximates the order in which the data purpose categories are listed in **5.3.1 Information purposes**. Typical asset groups, in order of priority, include the following.

Essential services

Description: Asset elements and services directly affecting personal safety or loss of property, required by law to be maintained and routinely certified as operational.

Includes: Signage, fire doors, fire hose reels, fire extinguishers, fire sprinklers, fire dampers, smoke detection systems, smoke exhaust systems, fire stair pressurisation systems, emergency lighting systems and emergency warning and intercommunication systems (EWIS), and signalling for road and rail networks.

Mission-critical systems

Description: Elements or systems which, if they fail or inadequately perform, severely disrupt or compromise the core business functions of an asset.

Examples: Electrical, communication, security and mechanical services, and back-up systems in transport networks and in buildings such as hospitals and airports.

Major plant and equipment

Description: Costly plant and equipment that need to be regularly monitored and maintained to ensure they operate efficiently and contribute the maximum value over their life cycle. This group can include items that are similar to 'mission-critical systems', even though the consequences of failure are not as great.

Includes: Individual chillers, pumps and fans.

Critical building envelope elements

Description: Elements protecting against external environmental conditions, for example, water ingress that degrades the fabric of the building or interferes with its function.

Includes: Roofing, gutters, downpipes, external walls, windows, doors, waterproofing and tanking.

Fittings and fixtures – internal and external

Description: Assets that require routine cleaning, servicing or replacement due to the nature of their operation or use.

Includes: Doors, windows and their hardware, plumbing fixtures, taps, bathroom fittings (soap dispensers, paper towel dispensers, hand dryers), kitchen/food preparation equipment, drains and grates, filters, pressure relief valves, fuses and light fittings.

Finishes – internal and external

Description: Finishes that require routine cleaning or renewal due to their use or exposure to the environment.

Includes: Floor finishes, paving, paint finishes, applied finishes, tiled finishes and ceiling finishes.

Soft landscaping

Description: Plants that require regular/routine cultivation, care and maintenance.

Includes: Trees, shrubs, ground covers and turf.

Loose items

Description: Furniture and equipment installed as part of the project that need to be tracked, managed or routinely cleaned, serviced, repaired or replaced.

Includes: Tables, chairs, shelving, filing cabinets, workstations and screens.

5.3.3 Criteria for assessing asset priorities

It is important to identify critical assets as well as critical failure modes. It is then possible to target and refine maintenance plans, capital expenditure plans and investigative activities in these critical areas. Critical assets are defined as those which have a high consequence of failure (not necessarily a high probability of failure) (e.g. fire-fighting equipment, security systems). The overall risk depends on both the probability and consequences of the event. To estimate the level of risk, organisations should determine:

- the consequences of the failure caused by the event
- the probability of the failure of the asset
- the probability of the event occurring.

Several criteria and metrics have been developed for evaluating the criticality of assets. These metrics, including systems for rating, ranking and weighting, provide a consistent framework for discussing and evaluating options. Establishing the criteria and metrics at the beginning of the selection process and applying them throughout the process result in more consistent and accountable decision-making.

Several methodologies – based on these metrics and other criteria – have been developed for setting priorities and making decisions about asset data. Documents describing these methodologies include:

- *AP-R577-18: Minimum Levels of Componentisation for Road Infrastructure Assets –* Austroads 2018
- *IPWEA PN3 Building and Performance Assessment Guidelines*
- *Optimum Decision Making in Asset Management.*[8]

Appendix B includes an example of how assets could be prioritised, based on a rating system.

10 building services assets to track (example)

This example is one asset manager's priority list for building assets that need to be tracked.

1. Heating, ventilation and air conditioning (HVAC) systems and auxiliary equipment
2. Active and passive fire protection systems
3. Emergency lighting
4. Electrical distribution switchboards and HVAC switchboards
5. Building management systems and HVAC controls
6. Lighting control systems
7. High-energy-consuming plant and equipment
8. Obsolescent/end-of-life plant and equipment
9. Assets that represent exposure to safety and critical breakdown risks
10. Replacement and maintenance items

[Source: www.forteassetservices.com.au/building-services-audits/asset-register/]

5.4 Asset property selection

After deciding which assets are to be included in an asset register, the data to include for each asset need to be decided. The amount of data associated with assets can be vast and overwhelming. The following examination of data associated with assets is designed to assist in decision-making about what is appropriate for a project or an organisation.

Each asset in a register has several properties for which data can be provided, for example, manufacturer, model number, etc. For data to be meaningful, some properties must be included before others: basic identification and location properties must be included before more detailed information is added.

Note: Generic/plain language descriptions for properties are used in the Guide. On your project, the naming conventions for the schema adopted for AM/FM data, for example, Industry Foundation Class (IFC), Construction Operations Building information exchange (COBie) should be substituted (refer to **Appendices E and F).**

[8] M. C. Carnero and V. González-Prida, *Optimum Decision Making in Asset Management*, IGI Global, 2001.

Useful tool

The NATSPEC *BIM Object Properties Generator* is a free online tool that helps to standardise BIM object properties across the project team: https://www.propgen.bim.natspec.com.au/

5.4.1 Asset property types

As noted in **Section 5.3.1 Information purposes**, thinking about the purposes of asset information assists decision-making and priority setting about asset information requirements (AIR).

Understanding the types of properties associated with assets provides an insight into their significance and helps in identifying those that are most useful for a project or an organisation. The types of properties can be arranged roughly in order of precedence and specialisation. **Figure 5.2** illustrates one way of arranging them[9]:

- Precedence in this context means that some properties must first be in place for others to make sense.
- Specialisation in this context means that some properties support basic operational activities while others are required for activities associated with a more tactical and strategic approach to asset management. Generally, for tactical and strategic purposes, more data are needed and more types of data need to be combined in different ways.

The establishment of this ordering also reflects data management and maintenance costs. Items at the top of the pyramid are generally less subject to change, while those toward the bottom are more dynamic and more specialised, requiring more organisational resources to manage.

It is worth keeping in mind that as the number of properties per asset increases, the total number of properties needing to be managed increases exponentially.

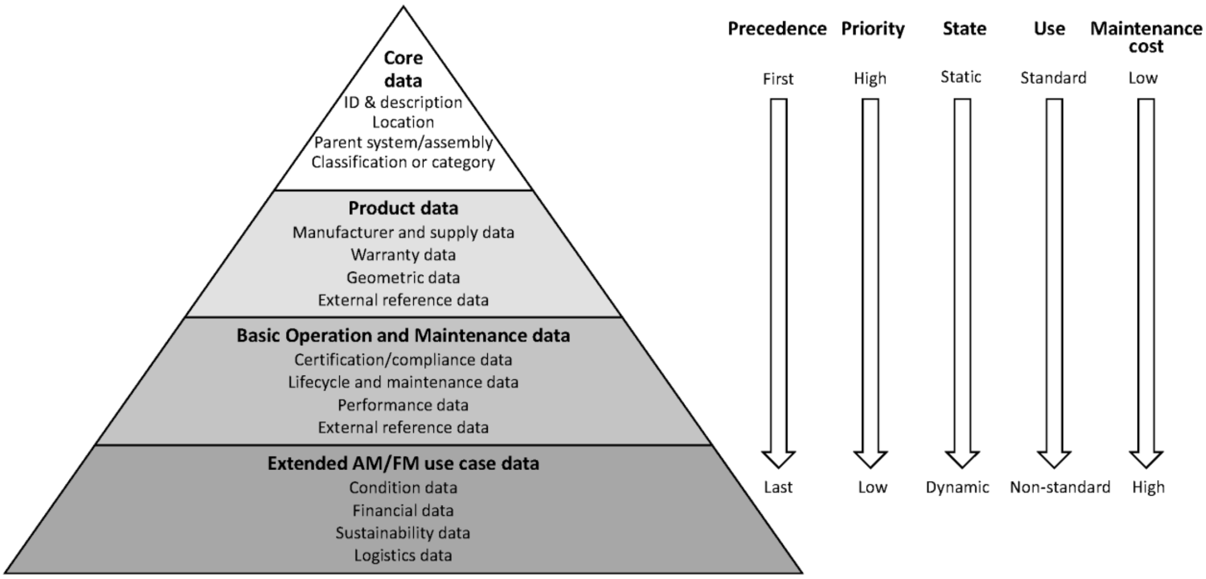


Figure 5.2: Asset property types

[9] B. Becerik-Gerber, F. Jazizadeh, N. Li, and G. Calis, "Application areas and data requirements for BIM-enabled facilities management," *Journal of Construction Engineering and Management*, Vol. 138, No. 3, pp. 431-442, 2011.

5.4.2 Core data

Core data properties provide an essential foundation or framework for all other data. More detailed information about an asset cannot realistically be added until these data are in place. Core data can generally be entered early in the project, for example, in the design development stage. They are the properties/parameters typically included in COBie data drop 1 for spaces and data drop 2 for equipment (see **Section 9.1: Glossary** for definitions of COBie and data drop). Core data include the following information.

- **General identification and description data:** such as asset ID and asset name.
- **Location data:** such as floor ID (i.e. floor level), space ID or space name. The location data in the models and documents need to be updated to reflect the names and numbers shown on signage on site.
- **Parent system or assembly data:** describes 'part-of' relationships between assets (e.g. a pump that is part of a chiller).
- **Classification or category data:** describes 'type-of' relationships (e.g. a fan is a type of mechanical services product).

5.4.3 Product data

Product data properties provide basic product information about the asset. They are typically entered during the project's contract documentation and construction phases when the asset is specified and installed. These properties generally constitute record data that does not require frequent amendment or updating but which forms the foundation for more dynamic data needed for AM/FM activities after handover. Product data includes the following information.

- **Manufacturer and supply data:** such as manufacturer name, product reference number or supplier name.
- **Warranty data:** such as warranty end date, warranty duration (parts) or warranty duration (labour).
- **Geometric data:** such as area (for spaces/rooms), height, length, width or thickness (for products).
- **Composition data:** such as material, colour or finish.
- **External reference data:** such as references to product data sheets or warranties included in a digital repository.

5.4.4 Basic operation and maintenance (O&M) data

These properties support basic operation and maintenance (O&M) activities. They generally represent the initial data sets for systems and products entered after they have been installed and commissioned. They provide benchmarks or baselines for dynamic data that is routinely monitored and updated during an asset's operational phase. Basic O&M data includes the following information.

- **Certification/compliance data**: such as next certification inspection date or certificate identifier.
- **Life cycle and maintenance data:** such as maintenance frequency, Expected Life or spares identification.
- **Performance data:** performance properties such as energy consumption, primary outputs, for example, litres/second flow or baseline commissioning properties.
- **External reference data:** such as references to O&M manuals, etc. included in a digital repository.

5.4.5 Extended AM/FM use case data

These properties support extended AM/FM use cases, that is, uses that require more extensive organisational resources and specialist expertise than are needed for basic O&M activities. They therefore need more careful evaluation. (Refer to **Appendix C** for a list of properties in each category.) Extended AM/FM use case data include the following information.

- **Condition data:** such as condition assessment date, condition grade or defects.
- **Financial data:** such as replacement cost (actual cost may be different to insured value), asset accounting category or asset tax type. The date that cost values are assigned to assets should also be included.
- **Sustainability data:** such as embodied carbon or post-consumer recycled content.
- **Logistics data:** such as gross weight or shipping weight.

While financial data are an important part of asset management, the volume of the data can become extensive. Careful attention is needed in deciding the scope of the data, which data should be managed in the asset management system versus in the financial management system, and how information is to be exchanged between these two systems. Cost data entered into the asset management system in a piecemeal, unmanaged way are worthless for decision-making purposes.

If a long-term commitment cannot be made to install the necessary management systems and have the appropriate personnel in place to support the maintenance of these groups of data, it is pointless requesting them. Decisions about the inclusion of the use cases, in particular, should be guided by the organisation's Strategic Asset Management Plan (SAMP).

Tips when making decisions about asset information requirements (AIR)

- Start with the end in mind.
- If those currently managing the facility or who will do so in future are available, the simplest way to decide what information is required is to ask them. What do they need? What is most important to them?
- Give preference to quality over quantity. It is better to have a well-structured data set that has been verified and validated, and is reliable, than a large volume of poorly organised, unreliable data.
- A good reference point when deciding what to include is to start with whatever data are usually scheduled in drawings or specifications. These data reflect industry expectations about the content of traditional documentation provided at handover from the project's construction phase to the operation phase.
- Adopt a 'fit and lean' approach to asset data. Identify the tightest set of data that will satisfy 80–90% of your foreseeable AM/FM needs rather than simply adding more data, even if readily available.
- Be realistic. Be clear about the difference between your real, foreseeable needs, and the 'nice to haves'.
- Do not ask for data beyond what are needed. All data come with 'overhead' – the more you have, the more resources need to be devoted to managing and maintaining the data. The more superfluous data you have, the more effort is involved in filtering it out when searching for the data you really need.
- Understand the implications of requesting certain sets of data. Data do not exist in isolation, but are part of a larger system. Asset condition monitoring, for example, entails an inspection regime, people to carry out inspections and assessments, and resources to manage the whole process.
- Recognise that requiring more properties for each asset has a significant multiplier effect.
- Consider the granularity of information needed. Does every instance of an asset type and its location need to be recorded for management purposes, or will a summary suffice? For example, Building X has 30 desks of Type A.

Useful references

The following documents provide guidance on facilities management and frameworks for strategic planning.

- *BS 8210:2012 Guide to facilities maintenance management*
- *BS 8544:2013 Guide for life cycle costing of maintenance during the in-use phases of buildings*
- *ISO 15686 series Buildings and constructed assets – Service life planning*
- *ISO 41001:2018 Facility management – Management systems – Requirements with guidance for use.*
- *ISO 41011:2017 – Facility management – Vocabulary*
- *ISO 41012:2017 – Facility management – Guidance on strategic sourcing and the development of agreements*

5.5 Asset information model (AIM) structural integration

After selection of the assets and properties for inclusion in the asset register, the structure of the AIM must be finalised. Decisions about the location, linking, formatting and hosting of asset data must be made. All of these must be considered together to optimise the system as a whole.

If data are considered important enough to include in the AIM but not specifically in the asset register, the data need an appropriate location, with that location referenced from the asset register.

5.5.1 Data locations

- As noted previously, 3D models on their own are not well suited to managing AM/FM information. In most cases, it is best to use these models to show spatial relationships and generate drawings, while using the asset register for all other information. Facilities management (FM) software designed to link to models has its own specific requirements.
- Duplication of data in the model and the asset register needs to be minimised. This reduces the risk of inconsistent or contradictory information arising due to changes being made in one but not in the other. Generally, the asset register is preferred for non-graphical data.

The key decisions that need to be made are:

- What should be included directly versus what should be referenced?
- What method of referencing should be used?

Considering the different types of data used in the day-to-day management of assets assists in deciding the most appropriate location for each type. It also helps when deciding on the most appropriate method of linking these locations.

Data can be categorised based on how frequently they are likely to be used, and what sort of operations need to be undertaken on these data:

- Record/static data: Data that do not change, or very rarely need to be amended (e.g. only when significant alterations or additions are made to an asset).
- Working data: Dynamic or transactional data that need to be:
    - referenced or monitored frequently
    - updated regularly
    - regularly aggregated, analysed, compared or reported on for strategic asset management purposes such as forecasting conditions, performance and costs
    - located very quickly in emergency situations (e.g. contacts, procedures, isolation device locations, etc.).

Criteria for assessing the appropriate location for data include the following:

- the frequency the data will be accessed for reference and reporting purposes
- the frequency the data will be updated
- the speed at which the data will need to be accessed, particularly in emergency situations
- the data's criticality with reference to the main purposes identified for the data.

5.5.2 Linking data

After deciding to reference an item of information, various implementation options are available, depending on the platform and data format selected.

- Live links: When a user clicks on the link in the asset register, the relevant document or model view opens directly.
- Addresses: The file path to the file that includes the required information is displayed in the asset register. The user must navigate to the location and open the file themselves.
- No link/implicit link only: No link is displayed in the asset register; however, sufficient documentation (e.g. a user guide or an index) is provided elsewhere in the asset management system so the user can find the information when required. This option is only appropriate for very simple sets of asset information, or where it is expected that the user/s will quickly become sufficiently familiar with the locations of information to retrieve it readily when needed.

The following terms in this Guide are defined as stated below.

- **Reference:** A description, designation or code that informs a reader of the location of a specific document or file. The reader then uses the reference to navigate to that location and open the document or file.
- **Link:** An on-screen hyperlink displayed as a designation, code, icon or something similar that, when clicked on, takes the reader directly to a file's location or opens it.

Options for data standards and formats need to be considered. If an organisation already uses, or proposes to use, a CAFM system, this will determine the data format to be provided. If this is not the case, it is better to make use of existing open standards than to try to develop standards from scratch. Even if every aspect of a standard is not implemented, it is still better to use relevant parts of the standard than to disregard it altogether.

5.5.3 Data schema selection

The schema selected for organising the asset data collected throughout the project will depend on how end-users intend to use the data for everyday work tasks, and what platforms they will use to host the data (e.g. CAFM system, spreadsheet). A data schema includes data standards, file formats, file types, naming conventions and units of measure.

The options, in order of preference, are listed below.

- To suit the CAFM system to be used: this reduces the need to translate data from other schemas.
- Conforming to an open standard, such as IFC or COBie: this is preferred if a CAFM system has not been selected or if the client plans to outsource asset management to several service providers who may, or may not, have different systems. This option also makes sense if service providers are required to return updated data at a future date. Open standards have the advantage of being the product of expert collaboration over a period of time. They are usually well documented, readily available, supported by a community of users, and embodied in some applications, including those for automatically checking and validating data submissions.

If a client does not have their own data standards, such as metadata, naming conventions, etc., they should ask their consultants to propose ones for their approval. These standards should be based on international standards and open file formats. If none exist for a specific subject, national and industry standards are the next preference. Standards developed by individual organisations should only be proposed when all other options have been exhausted.

5.5.4 Hosting platform

Some options to consider for a platform to host asset data include:

- the project's common data environment (CDE) maintained by the client after the completion of construction
- an existing computer-aided facility management (CAFM) system
- a CAFM system established for the project
- a database of a type used by the client
- spreadsheets of varying degrees of sophistication.

All of the above options may be used by different members of the project team at different stages of the project. Provided the format of the data and the ultimate destination are decided at the outset, it is relatively straightforward to transfer the data between platforms.

For details of the functional requirements of a United Kingdom (UK) Level 2 AIM common data environment (CDE), see Centre for Digital Built Britain (2018) *Asset Information Management – Common Data Environment*.

5.5.5 AIM accessibility

Equally important as optimising the integration of the AIM is to make it readily accessible to its intended users. Again, factors such as the organisational systems and resources available and the experience and expertise of AM/FM personnel will determine the AIM's sophistication and the systems used to access it.

5.5.6 Integration of the AIM with enterprise systems

Some types of information included within the AIM can be found in other enterprise systems (information management systems used by organisations). These include:

- financial management systems
- supplier or customer relationship management (SRM or CRM) systems/contact databases
- file or document management systems
- enterprise resource planning (ERP) systems.

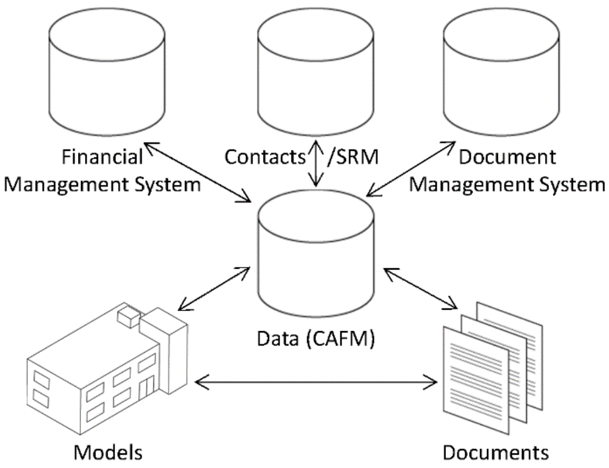


Figure 5.3: Integration of AIM with enterprise systems

Asset management, because it touches so many parts of the organisation, is a natural candidate for an integrated systems approach (ISO 55000).

Excluded from this list are CAFM systems, as consideration of their content is fundamental to determining the AIM's whole structure.

In the process of deciding the scope and location of information within the AIM, decisions must be made about what information is best managed within the AIM, what is best managed in other external systems, and how to make sure that all are aligned. Policies and procedures need to be put in place to ensure that this alignment is maintained.

5.6 Review and finalisation

After completion of the initial round of the asset information requirements (AIR) definition process, all decisions should be reviewed together and any necessary adjustments made. If necessary, the process should be repeated to produce a clear statement of requirements.

The review is a good time to formulate auditing and verification processes for asset data collected prior to handover to ensure that the information delivered meets the stated requirements.

6 AS-BUILT MODELS

Just as the physical asset is verified against the contract documentation, the AIM should also accurately mirror the physical asset delivered. Although it is important that as-built models are accurate geometric representations of their real-world counterparts, they do not need to include most of the data that accumulate during the design and construction phases of the project. Much of these data will be irrelevant for AM/FM purposes and will simply make it harder to find data that are relevant. The as-built models generally need to be edited, or even to be purpose-made from other models.

6.1 Creating as-built models

Various options are available for documenting a project in its final built form, each with different levels of accuracy, resourcing requirements and costs. It is also worth keeping in mind that a single approach does not need to be applied to the whole project: depending on the criticality of accuracy, the approach can be varied for different aspects.

Three aspects of the documentation process need to be considered.

1. Recording methods
2. Processes for updating models
3. Verification methods

6.1.1 Recording as-built conditions

The options for including as-built conditions include the following methods.

- Visual confirmation only: Photographs taken of building elements on site are visually compared to the construction BIM. This is used only when the exact position of the as-built elements is not critical or the return on investment (ROI) does not warrant anything additional.
- Manual measurements are used to mark up the installation drawings which provide a reference for a CAD operator to manually update a construction model. See **Figure 6.1.**
- Progressive photographs of the construction site taken with a 360° digital camera are used as a reference to update a construction model. See **Figure 6.2**.
- Progressive capture of 3D data (point clouds) of the construction site generated by a laser scanner is loaded into BIM authoring tools and is used to update a construction model. See **Figures 6.3** and **6.4**. Laser scanners can range from inexpensive hand-held devices through to expensive tripod-mounted professional surveying equipment. The accuracy of scanners generally increases with cost.

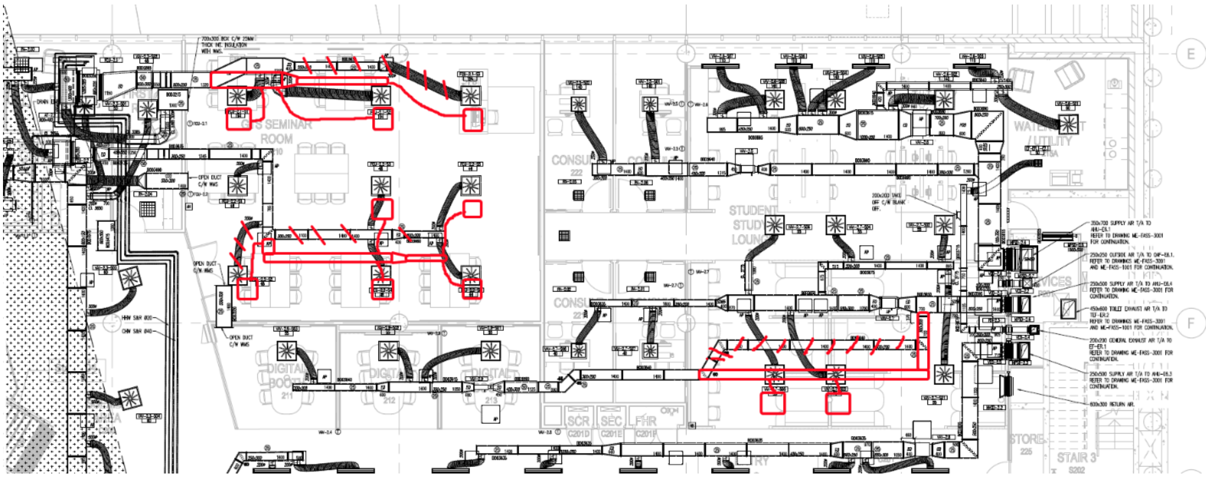


Figure 6.1: Mark-up of installation drawing

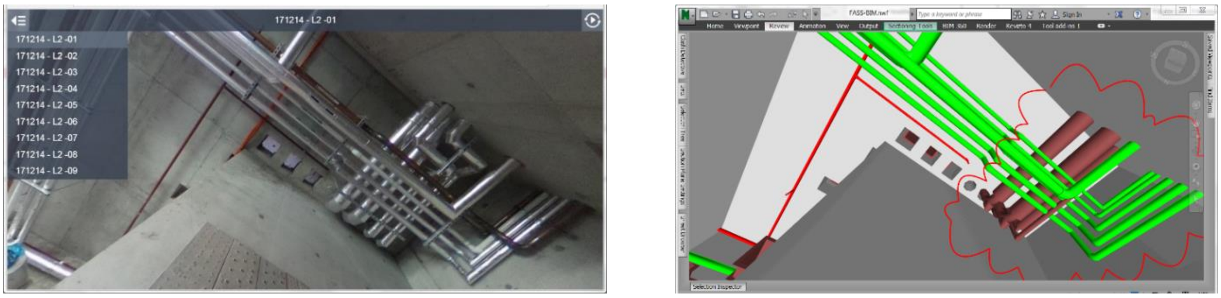


Figure 6.2: On-site photograph (on left) used to update construction model (on right)

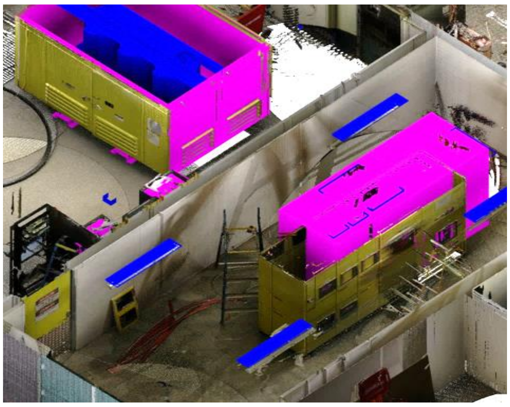


Figure 6.3: Colourised point cloud compared to model (magenta and blue elements)

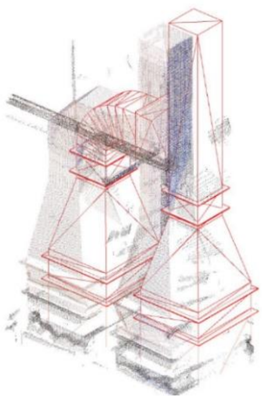


Figure 6.4: Point cloud compared with red wireframe of construction model

6.1.2 Updating as-built models

Regardless of the method used to capture as-built conditions, the process of using the information to update a model is usually a manual one. Even high-accuracy point clouds generated by laser scanners require a BIM modeller to model forms to match them. Some applications automate this process for some forms, such as uniform pipework runs, but, in most instances, the process is largely manual.

Owing to the effort involved, a clear business case for an as-built model needs to be established at the outset, and decisions need to be made about how closely this model must reflect the recorded information.

6.2 Verifying as-built models

To be certain that a virtual model truly reflects the real-world reality after it has been updated with the information recorded, the two need to be compared. This process can range from a simple visual check by the person who has updated the model through to a formal reporting and review process by independent parties. Depending on the rigour with which verification is carried out and to what extent, this process can consume significant resources. For example, a rigorous verification process might include taking laser scans, creating a report on the findings, reviewing what changes should be made in the model, making the changes, and then repeating the process as often as needed to achieve the desired level of fidelity.

The verification process must be described in detail in the exchange information requirements (EIR) or in the pre-contract BIM Management Plan (BMP) to avoid any post-tendering ambiguity. The approach to existing services also needs to be considered. For example, if the BMP states that in-ground services must be updated and verified to create an as-built model, what happens with the existing in-ground services (known and unknown) on the site? Do they also need to be located, verified and modelled? How will the contractors undertake this work? Will ground-penetrating radar verification be expected? It is important that all grey areas in these matters are clarified and resolved.

6.2.1 Identifying construction changes

If the verification process highlights errors or deviations from the specified construction tolerances, their rectification should be handled in accordance with the contract. Good documentation and good coordination during construction will minimise the effort required to verify the model and rectify construction errors.

Additionally, geometric variations during construction can be reduced by setting out construction works from the design BIM (if this is an approved use of the model noted in the BMP) through the use of laser total station devices and/or reusing BIM data and design model elements to inform the fabrication process.

6.3 Deciding on as-built modelling requirements

A calibrated approach to modelling as-built conditions is required, not only as project requirements vary, but because millimetre accuracy is not required for every aspect of most projects. Manual measurement may be adequate for some items, such as confirming the mounting location of an item relative to floor levels and adjacent walls, but not for inaccessible items or more difficult-to-measure items, such as complex intersections of services.

The criticality and accessibility of individual elements will suggest how much effort should be invested in measurement, modelling and verification. For many asset management purposes, simply being able to find any given item in the room, ceiling space, service cupboard, etc. that is indicated in the model or on the drawings is all that is necessary: whether it is within 10–100 mm of the model location may be of no consequence.

The following categories, arranged roughly in order of priority, may assist decision-making about where efforts are best directed.

- **In-ground items:** includes in-ground cables, conduits, ducts and pipework. Four quality levels are defined in *AS 5488-2013 Classification of Subsurface Utility Information (SUI)* for location and attributes information about subsurface utilities that can be used to specify the quality of modelling requirements.
- **Embedded items:** includes items embedded in concrete such as cables, conduits, ducts and pipework, for example, for hydronic heating, and pre- or post-tensioning tendons.
- **Built-in items:** includes services in riser ducts and walls or behind bulkheads and fixed ceilings.
- **Items in difficult-to-access areas:** includes service runs, valves and equipment in tight spaces, areas only accessible with specialist equipment, or items in high traffic areas where access will cause significant disruption. This is even more important for items that are expensive to maintain or retrofit.
- **Complex intersections of elements:** includes locations in which many service runs intersect, such as exits from service risers, or where they pass through penetrations in structural elements.

- **Emergency or service-critical items:** for example, isolation or shutdown valves or switches, or smoke detectors in data centres.
- **Business-crucial items:** for example, accurate floor areas are crucial for rental tenancies but may be less so for other building spaces.

6.3.1 Verification options

After taking project requirements into consideration, the overall approach to accuracy and verification can be decided. The following options represent a range of possible approaches.

- **Minimum:** Photographs taken of building elements on site are visually compared to the construction model or changes noted during construction are marked up on drawings and the model is updated to reflect them. Generally, the minimum approach is only used when limited funds are available or the client is certain that nothing additional is required.
- **Moderate:** 360° photographs are progressively taken in key locations which match model views. The model is updated and visually compared to the photographs.
- **High:** A laser scan is used to create a review report that identifies the items to be changed in the model. These items are changed, with the verification process repeated until the specified level of accuracy is reached.

6.4 Arrangements for delivering as-built information

Arrangements for delivering as-built information must be agreed before construction work starts. This is particularly important for in-ground services, with this information relatively easy to capture during construction, but difficult and expensive to gather afterwards. Lack of accurate information can cause costly delays on future projects. Roles, responsibilities and procedures should be agreed and adequately resourced.

Other decisions include:

- whether surveys will be done by on-site staff or professional surveyors
- whether surveys need to occur outside normal site operation hours to minimise visual noise on the scans (people getting in the way of the scanner).

Formal variation or change requests usually flag that the model needs to be updated and this must be included as part of the process. Other minor amendments agreed on site are often not contractually formalised. They can range from sketches or mark-ups through to drawings or verbal instructions. Those issuing these requests need to be made aware of the procedures for notifying the appropriate person/s of the changes.

6.5 Maintaining as-built information

To ensure long-term access to as-built information, models should be saved as IFC files. Accurate as-built information has little ongoing value if it is not updated as changes are inevitably made to an asset, so resources and systems need to be put in place for its management and maintenance. Likewise, it has little value if it is not supported by enforced protocols for anyone making changes to the asset, for example, contractors checking with the facility manager about the location of post-stressing tendons and services before core holing concrete slabs.

Key things to keep in mind with as-built information

- Tailor the approach taken to capture and verify as-built information to the criticality of different categories of items.
- Make the management of as-built information part of standard construction management and contract administration processes such as variation requests and rectification orders.

6.6 Models for asset management/facilities management (AM/FM)

Models created during the design and construction phases of a project contain much information that is not particularly relevant to an asset or facility manager, but which presents an obstacle to finding required information. A purpose-made AM/FM model is derived primarily from the as-built model. The following modifications are made to a copy of the as-built model.

- The model is 'purged', with extraneous information removed including construction details and working drawing sheets. None of this information needs to be lost as design records and construction models should be archived so they can be retrieved as required.
- Where separate or federated models have been used to represent the building core, building shell and tenancy fit-outs, these are merged into a single model.
- If practicable, separate models representing architectural, mechanical, electrical, fire protection and specialised equipment are merged. For large projects, this may not be practicable with the current technology, so multiple models that are linked may need to be maintained.
- Unique asset IDs are used to number building equipment items.
- Occupancy room numbers are checked and matched with building signage, or with the as-built model where signage is not installed.
- Office spaces, workstations and offices are defined separately from rooms and are numbered with an occupancy numbering system. This is essential for matching office occupants to desks, cubicles and offices and also for the management of work orders. Responsibility for tasks such as this should be agreed upon at the beginning of the project to avoid disputes between the project team and facility manager.[10]

7 ASSET INFORMATION MODEL (AIM) DOCUMENTS

This section is not an in-depth exploration of project documentation or document management for which principles and practices are well established and described in detail in many existing documents.
The section provides a broad outline of requirements for project documents and examines some options for linking them to the other elements of the asset information model (AIM): asset data and virtual 3D models.

The fundamental principle is that the asset owner or operators are provided with all the information relevant to the operation and management of the asset. Just as importantly, it is essential that the information is organised to allow ready retrieval of relevant information as required.

7.1 Existing handover documentation expectations

Several established documentation deliverables relevant to asset management should be part of any construction contract. Most NATSPEC worksections specify documents that must be submitted as part of the work that they cover. For example, *NATSPEC 0171 General requirements* specifies the requirements for the documents to be submitted including their content, organisation and format. The types of documents covered include:

- record drawings
- operation and maintenance (O&M) manuals
- emergency information manuals.

While the focus of this Guide is on digital records, it is still advisable to retain an indexed archive of hard copies in a secure off-site location as a back-up. Hard copies of documents, such as drawings or wet signed-on film, may still be a requirement in some contracts.

[10] Haines, B. "The Evolution of Revit Models for each phase of a building's life," *FM Systems*, 11 May 2017. [Online]. Available: https://fmsystems.com/blog/the-evolution-of-revit-models-for-each-phase-of-a-buildings-life/ [Accessed: 06 Sep 2018].

7.2 Additional handover documentation for asset management/facilities management (AM/FM)

The *NATSPEC National BIM Guide*, *Section 10.10 Final BIM Deliverables* outlines requirements for models and files, as well as for documents. It includes requirements for files in several formats and printed copies of documents. To be effective for AM/FM purposes, the following additional requirements should be considered.

Authority approvals

Certificates and licences issued by authorities are critical documents for demonstrating legitimate occupation and operation of an asset for a specific purpose. Maintaining their currency is a key function of asset management: it is essential that current copies and supporting documentation can be retrieved quickly when required. Conditions of approval are crucial for the asset operator's understanding of the parameters within which they operate. These conditions are particularly important when it comes to altering or extending an existing asset.

Basis for design information

The basis for design information for structural, mechanical, electrical, hydraulic and fire control systems is important for those responsible for operating or altering an asset, particularly if it is a complex system or if it has been approved as a performance solution under the provisions of the National Construction Code (NCC). The absence of this information or a lack of awareness by the operators of how a system should be operated and maintained can lead to significant safety issues in emergencies, for example, failure of control measures in a fire.

Users' guide

Assets incorporate increasingly sophisticated systems for monitoring and control, for example, energy management. Designers can invest significant effort in their design, but the potential benefits they offer can be easily subverted if asset/facility users do not understand how to get the best from them. Incorrect operation may result in poor performance and dissatisfied occupants, for example, due to uncomfortable thermal conditions.

The aim of users' or occupants' guides is to help asset or building users to use the asset/building effectively and to ensure its safe and healthy operation. These provide a simple, quick and easy guide for the everyday use of the asset/building. The guide can be complemented with single sheet instructions or guidance notes mounted adjacent switches, controls, etc.

Technical guide

For similar reasons to those cited for a users' or occupants' guide, that is, the increasing complexity of systems, it can be very helpful for asset owners or operators to be provided with a high-level manual and guide to all of the asset's sub-systems, including how they are meant to operate together and the performance that is to be expected. A technical guide is particularly useful during the transition of responsibility from the project team to the asset management team. This guide should act as a central reference to other more detailed technical documents, such as O&M manuals, and should complement an index to all documents.

7.3 Delivery format

All documents outlined must be delivered in an organised, integrated form. To this end, they should be incorporated in a digital information container, such as a cloud-based or compressed file folder, that includes logically arranged subfolders, an index and an introductory guide to its contents.

7.3.1 Information container structure

A typical information container structure comprises the following components:

- guide to container contents including an index and explanation of any classification systems or file-naming and document-naming conventions used
- users' guide
- technical guide
- hierarchically arranged folders holding documents, drawings and models.

More complex projects can benefit from more sophisticated container structures that employ XML and RDF/OWL technologies to link their content. Their linked structure allows information on an item located in several different file formats (e.g. files for 3D models, drawings, spreadsheets, documents) to be readily located.

7.3.2 Conventions for file and document naming

To assist with document retrieval, a naming standard for files and documents should be specified at the beginning of the project for adoption by all members of the project team. If the client does not specify a standard, it is advisable to select an international or national standard, for example, *BS 1192:2007+ A2:2016 Collaborative production of architectural, engineering and construction information – Code of practice.*

7.4 Linking to other elements of the asset information model (AIM)

As noted in **Section 3.2: Structured data and information**, linking data can significantly increase their value. However, linking also requires a more considered approach to assembling the data and more sophisticated management afterwards.

Decisions need to be made about what data should be linked and the nature of the links. Refer to **Section 5.5: AIM structural integration** for more on this topic.

7.4.1 Integration with enterprise systems

The format of the information delivered is determined by the requirements of the client's or operator's enterprise systems, such as CAFM systems, document management systems and intranets. Procedures, roles and responsibilities for the handover of information and its integration with these systems should be agreed at the start of the project.

Useful references

The Soft Landings Framework Australia and New Zealand CIBSE ANZ 2014: The framework outlines a process for ensuring a smooth handover of a building from the design and construction team to its owners, operators and users. The framework includes guidance on technical guides and users' guides.

Building Manuals and Building User Guides – Guidance and worked examples (BG 26/2011) BSRIA 2011: This includes a template for building user guides and worked examples.

8 NEXT STEPS

When the AIR have been defined, decisions need to be made about the requirements for their delivery, which lie beyond the scope of this Guide.

In defining these requirements, the following questions need to be answered.

- What information needs to be provided at different times prior to handover for project management and client decision-making purposes?
- Who will be responsible for providing the information?
- Who will be responsible for checking the information?
- What verification and rectification procedures will be used to ensure data integrity at handover?
- Who will be responsible for managing these processes and workflows?

Many of these requirements may have been described in the PIR or EIR, but they will need to be extended to capture the information required during the operational phase of the asset. Several templates for EIR documentation are available.

9 RESOURCES

9.1 Glossary

Actor	A person, organisation or organisational unit (such as a department, team, etc.) involved in a construction process [Source: AS ISO 29481-1:2016, 3.1]
AEC	Architecture, engineering and construction
Aggregated data	Data combined from several sources or measurements to provide higher level summaries useful for identifying relationships, patterns and trends
Agile development	A development approach based on iterative development, frequent inspection and adaptation, and incremental deliveries, in which requirements and solutions evolve through collaboration in cross-functional teams and through continuous stakeholder feedback [Source: ISO/IEC/IEEE 26515:2011]
AHU	Air handling unit: a group of components designed to move, filter and/or mix, heat and/or cool the air [Source: ISO 19659-1:2017]
AIM	Asset information model: information model relating to the operational phase
AIR	Asset information requirements: specification for data and information by the asset owner/operator in relation to the asset(s) for which they are responsible [Source: ISO 19650-1:2018]
AM	Asset management: coordinated activity of an organisation to realise value from assets [Source: ISO 55000:2014]
AM/FM	Asset management/facilities management
AMBoK	Asset management body of knowledge: a technical product of the Asset Management Council (AMC) comprising a collection of models, definitions and content that describes the profession and practices of asset management
AMC	Asset Management Council
AMCA	Air Conditioning and Mechanical Contractors' Association of Australia
AMP	Asset Management Plan: documented information that specifies the activities, resources and timescales required for an individual asset, or a grouping of assets, to achieve the organisation's asset management objectives [Source: ISO 55000:2014]
As-built	Description of a model or document that records the details of a construction work following its completion
As-constructed	Use *as-built*
Asset	Item, thing or entity that has potential, or actual, value to an organisation [Source: ISO 55000:2014, 3.2.1]
Asset information management	Life cycle management of physical assets to achieve the stated outputs of the enterprise [Source: Asset Management Council (AMC)]
Asset register	List of assets with associated information kept by an organisation for asset management purposes, generally stored in a digital system
ASTM	American Society for Testing and Materials
ATO	Australian Taxation Office
Attribute	Inherent characteristic [Source: ISO 9241-302:2008]
BEP	BIM Execution Plan: see *BMP*
BIM	Building information model: an object-based digital representation of the physical and functional characteristics of an asset or facility
BIM	Building Information Modelling: use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions [Source: AS ISO 29481-1:2016, 3.2 – modified]
BIM Manager	A person who coordinates BIM use on a project, determines the schedule of use, sharing activities, quality control, modelling responsibilities and documentation specified in the BIM Management Plan

BIM Viewer	See *Model Viewer*
BMP	BIM Management Plan: a formal document that defines how the project will be executed, monitored and controlled within BIM [Source: NATSPEC *National BIM Guide*]
CAD	Computer-aided design: a geometric/symbol-based computer drawing system that replicates hand drawing techniques
CAFM	Computer-aided facility management: the use of software applications to support facilities management
CDBB	Centre for Digital Built Britain
CDE	Common data environment: a single source of information for any given project, used to collect, manage and disseminate all relevant approved project documents for multi-disciplinary teams in a managed process [Source: PAS 1192-2:2013]
Classification	A systematic arrangement of headings and sub-headings for aspects of construction work including the nature of assets, construction elements, systems and products [Source: PAS 1192-2:2013]
Client	An individual or organisation commissioning a built asset [Source: PAS 1192-2:2013]
COBie	Construction Operations Building information exchange: an information exchange specification for life cycle capture and asset information needed by facility managers. It identifies the content of the information that must be captured and exchanged at each phase of a project
CRM	Customer relationship management (system)
Data	Facts, such as individual properties or attributes of things, for example, measurements
Data drop	Predefined sets of information delivered at agreed milestones in a project program. Data drops are produced at set stages of a project, through the design, construction and operation phases. A data drop provides the capability to analyse and check the proposed design at set stages [Source: *UK Government BIM Maturity*]
Data Manager	Use *Information Manager*
Data schema	Representation of the relationships between data elements in a system, usually a database. It defines how the data are organised and how the relationships among them are associated
Database	Collection of data stored in a software application, organised so it can be easily accessed, managed and updated
DE	Digital engineering
Deliverable	Product of engineering and design efforts to be delivered to the client as digital files and/or printed documents
Delivery phase	Part of the life cycle during which an asset is designed, constructed and commissioned [Source: ISO 19650-1]
Designation	Description, name or title given to someone or something. In this Guide, it generally applies to a short alpha, numeric or alphanumeric code applied to individual items in models, databases or documents for identification, cross referencing and coordination purposes
DIS	Draft international standard: this identifies the stage of development that a draft ISO standard has reached
Effective Life	Length of time during which an asset can be used to produce income: a measure used to calculate an asset's depreciation for which an income tax deduction can be claimed. The Australian Taxation Office (ATO) publishes its determinations of Effective Life in taxation rulings
EIR	Exchange information requirements: specification for data and information by the appointing party that the appointed party is expected to meet during the appointment [Source: ISO 19650-1:2018]. This term has the same meaning as Employer's Information Requirements from PAS 1192-2
ERP	Enterprise resource planning (system)

EWIS	Emergency warning and intercommunication system
Facility Manager	A person responsible for the facility management of buildings, properties or infrastructure
FM	Facilities management: the process of managing and maintaining the efficient operation of facilities including buildings, properties and infrastructure. The term is also applied to the discipline concerned with this process
FMA Australia	Facility Management Association of Australia
GIS	Geographic information system: a system that integrates hardware, software and data for capturing, managing, analysing and displaying all forms of geographically referenced information
Graphical data	Data conveyed using shape and arrangement in space [Source: PAS 1192-2]
GreenStar	A national, voluntary rating system, managed by the Green Building Council of Australia, for assessing the sustainable design, construction and operation of buildings, fit-outs and communities' buildings and communities. See https://new.gbca.org.au/green-star/
GTIN	Global Trade Item Number: an identifier used to identify trade items, products or services, developed by GS1
GUID	Global unique identifier: an identifier given to a product that guarantees its uniqueness throughout its entire life [Source: ISO 15686-4:2014]
Handover	Process for completing the design and construction of an asset, including asset information, and transferring responsibility or ownership for it to another party. Key handover events are usually contractually defined
HVAC	Heating, ventilation and air conditioning (systems and auxiliary equipment)
Hyperlink	Link that represents a digital connection between two digital objects [Source: ISO 5127:2017]
IAM	Institute of Asset Management
ICT	Information and communications technology
ID	Identifier
IFC	Industry Foundation Class: a data model standard for defining and representing standard architectural and construction-related graphic and non-graphic data as 3D virtual objects to allow data exchange between BIM tools, cost estimation systems and other construction-related applications in a way that preserves the ability to perform analysis on these objects as they move from one BIM system to another
IIMM	*International Infrastructure Management Manual*: a key document published by the Institute of Public Works Engineering Australasia (IPWEA)
Information	Reinterpretable representation of data in a formalised manner, suitable for communication, interpretation or processing [Source: adapted from IEC 82045.1:2001, 3.1.4 "data"]
Information Manager	A person responsible for setting up and managing the common data environment (CDE). This role differs from that of the BIM Manager in that their primary role is to manage data and information in general, rather than modelling processes, procedures and standards
IPWEA	Institute of Public Works Engineering Australasia
ISO	International Organization for Standardization
Link	On-screen hyperlink displayed as a designation, code, icon or similar that, when clicked on, takes the reader directly to a file's location, or opens it
LRM	Location referencing method: A model-specific methodology for assigning unique references to a location [Source: Austroads AP-R568-18]

LRS	Location referencing system: Integrated systems by which location references are coded and decoded according to individual location referencing methods, and the rules for converting and exchanging location references between LRMs, as well as associated standards, definitions, UML models, databases and software [Source: Austroads AP-R568-18]
MEP	Mechanical, electrical and plumbing: referring to these building services or the engineering disciplines
Metadata	Data describing the content (including indexing terms for retrieval), context and structure of electronic document-based information and its management over time [Source: ISO/TR 18492:2005]
Model Viewer	Software application allowing users to inspect and navigate Modelling Project Information according to ad-hoc or standard Model View Definitions. As opposed to Model Servers, models accessed by a Model Viewer (MV) are read-only and cannot be modified. Autodesk Navisworks and Solibri Model Checker are examples of Model Viewers (MVRs) [Source: bimdictionary.com/en]
MoSCow	"Must have, Should have, Could have, Won't have": a prioritisation technique used in management, business analysis, project management and software development to reach a common understanding with stakeholders on the importance they place on the delivery of each requirement. It is also known as MoSCoW prioritisation or MoSCoW analysis
MVD	Model View Definition: an IFC View Definition, or Model View Definition, defines a subset of the IFC schema that is needed to satisfy one or many exchange requirements of the AEC industry. An MVD defines a subset of the IFC Schema providing implementation guidance for all IFC concepts (classes, attributes, relationships, property sets, quantity definitions, etc.) used within this subset. It thereby represents the software requirement specification for the implementation of an IFC interface to satisfy the exchange requirements
NABERS	National Australian Built Environment Rating System
NAMS	National Asset Management Strategy: an IPWEA program for developing and delivering infrastructure asset management knowledge and resources for those with responsibility for managing public infrastructure assets
NATSPEC	Australian National Building Specification system: used in this Guide to describe the master specification system, or the organisation that produces it
NCC	National Construction Code
O&M	Operation and maintenance
Object	Any item that can be individually selected and manipulated. This can include shapes and pictures that appear on a display screen as well as less tangible software entities. [Source: www.webopedia.com]
Object-based	A schema or system of organisation based on objects
OIR	Organisational information requirements: specification of information requirements in relation to organisational objectives
OOP	Object-oriented programming: a type of computer programming (software design) in which programmers define not only the data type of a data structure, but also the types of operations (functions) that can be applied to the data structure. In this way, the data structure becomes an object that includes both data and functions. In addition, programmers can create relationships between one object and another. For example, objects can inherit characteristics from other objects. [Source: www.webopedia.com] BIM software is based on object-oriented programming (OOP)
Operational phase	Part of the life cycle, during which the asset is used, operated and maintained
OWL	Ontology Web Language: a web-based language designed for use in applications that need to process the content of information. [Source: ISO 14199:2015]

Parameter	In software applications: an input variable that is assigned an actual value. For most practical purposes, the terms ‘parameter’ and ‘property’ can be used interchangeably in this Guide
PAS	Publicly available specification: a document that standardises elements of a product, service or process. Publicly available specifications (PASs) are usually commissioned by industry leaders – be they individual companies, small and medium-sized enterprises (SMEs), trade associations or government departments (British Standards Institution). They are usually available for free download
PDF	Portable document format: a file format developed by Adobe Systems
PIM	Project information model: an information model relating to the delivery phase
PIR	Project information requirements: specification of information requirements in relation to the delivery of an asset
PLQ	Plain Language Question: A request for information that is expressed in simple, easy-to-understand terms [Source: BS 8536-1]. Posing a series of PLQs about the decisions they need to make at key stages of a project can help clients define their information requirements
Property	An attribute or abstract quality associated with an individual, object or concept. See also *Parameter*
RDF	Resource Description Framework: an XML syntax for describing metadata [Source: ISO 16684-1:2012]
Record drawing	Has the same meaning as as-installed drawings, as-built drawings and work-as-executed drawings. Record drawing is the preferred term for post-construction drawings as they are usually based on information supplied by the contractor and others on completion of the work rather than the designer's observation and documentation of the actual construction. As the designer usually has a limited construction role, certification of Record drawings, if required, should be by the contractor.
Reference	Description, designation or code that informs a reader of the location of a specific document or file
ROI	Return on investment
SAMP	Strategic Asset Management Plan: documented information that specifies how organisational objectives are to be converted into asset management objectives, the approach for developing asset management plans, and the role of the asset management system in supporting achievement of the asset management objectives [Source: ISO 55000:2014]
SME	Small and medium-sized enterprise
SRM	Supplier relationship management (system): a software application used to manage interactions with third-party organisations that supply goods and/or services to an organisation to maximise the value of those interactions
Strategic asset management (of assets or facilities)	Asset management activities directed at realising long-term organisational goals and objectives
Structured information	Information assembled from predefined concepts (vocabulary or code set) using an organisational scheme (information model) [Source: ISO/TS 17251:2016]
Tactical asset management (of assets or facilities)	Proactive approach to asset management informed by strategic asset management activities and based on measurable and achievable deliverables, for example, performance and condition data
XML	Extensible Markup Language [Source: W3C https://www.w3.org/TR/xml/]

9.2 Further reading

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9.3 Online resources

Asset management/facilities management

- Asset Management Council (AMC) http://www.amcouncil.com.au/
- Asset Management Standards https://www.assetmanagementstandards.com/
- Facility Management Association of Australia (FMA Australia) https://www.fma.com.au/
- Institute of Asset Management (IAM) https://theiam.org/
- Institute of Public Works Engineering Australasia (IPWEA) National Asset Management Strategy (NAMS) https://www.ipwea.org/communities/assetmanagement
- New Zealand Asset Management Support (NAMS) http://www.nams.org.nz/

Building Information Modelling (BIM)

- BIM in NZ https://www.biminnz.co.nz/
- Centre for Digital Built Britain (CDBB) https://www.cdbb.cam.ac.uk/
- Designing Buildings Wiki https://www.designingbuildings.co.uk/wiki/Home
- NATSPEC BIM Portal http://bim.natspec.org/
- NATSPEC BIM Properties Generator https://www.propgen.bim.natspec.com.au/
- Scottish Futures Trust BIM Portal https://bimportal.scottishfuturestrust.org.uk/
- UK BIM Level 2 Website http://bim-level2.org/en/
- Whole Building Design Guide COBie page http://www.wbdg.org/resources/construction-operations-building-information-exchange-cobie

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Racheva, Z., Daneva, M., Herrmann, A., and Wieringa, R. J. (2010), "A conceptual model and process for client-driven agile requirements prioritization," in *Fourth International Conference on Research Challenges in Information Science (RCIS)*, 2010, pp. 287-298.

Schley, M. (2018). *Best Practices for Space Management,* FM Systems. [Online].

Wong, J. K. W., Ge, J., and He, S. X. (2018), "Digitisation in facilities management: A literature review and future research directions," *Automation in Construction*, Vol. 92, pp. 312-326.

International standards

ISO 4157:1998 Construction drawings — Designation systems:

— Part 1: Buildings and parts of buildings

— Part 2: Room names and numbers

— Part 3: Room identifiers

ISO 5127:2017 Information and documentation – Foundation and vocabulary

ISO 9241-302:2008 Ergonomics of human-system interaction – Part 302: Terminology for electronic visual displays

ISO 15686 series Buildings and constructed assets – Service life planning

ISO 15686-4:2014 Building Construction – Service Life Planning – Part 4: Service Life Planning using Building Information Modelling

ISO/TS 17251:2016 Health informatics – Business requirements for a syntax to exchange structured dose information for medicinal products

ISO/TR 18492:2005 Long-term preservation of electronic document-based information

ISO 19650: Organization of information about construction works — Information management using building information modelling:

— Part 1: Concepts and Principles

— Part 2: Delivery phase of the assets.

ISO 19659-1:2017 Railway applications – Heating, ventilation and air conditioning systems for rolling stock – Part 1: Terms and definitions

ISO/IEC/IEEE 26515:2011 Systems and software engineering – Developing user documentation in an agile environment

ISO 41001:2018 Facility management – Management systems – Requirements with guidance for use.

ISO 41011:2017 – Facility management – Vocabulary

ISO 41012:2017 – Facility management – Guidance on strategic sourcing and the development of agreements

ISO 55000:2014 Asset management – Overview, principles and terminology

ISO 55001:2014 Asset management – Management systems – Requirements

ISO 55002:2014 Asset management – Management systems – Guidelines for the application of ISO 55001

IEC 82045-1:2001 Document management – Part 1: Principles and methods

Australian, British and US standards

Note: References with links are generally available free of charge.

AS ISO 29481-1:2016 Building information models – Information delivery manual–- Part 1: Methodology and format

AS 5488:2013 Classification of Subsurface Utility Information (SUI)

ASTM Standards for asset management: Standards on a wide range of AM topics – American Society for Testing and Materials (ASTM)

BS 1192:2007+A2:2016 Collaborative production of architectural, engineering and construction information – Code of practice. Available from http://bim-level2.org/en/standards/

BS 1192-4:2014 Collaborative production of information Part 4: Fulfilling employer's information exchange requirements using COBie – Code of practice. Available from http://bim-level2.org/en/standards/

BS 8210:2012 Guide to facilities maintenance management

BS 8536-1:2015 Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure). Available from http://bim-level2.org/en/standards/

BS 8536-2:2016 Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure). Available from http://bim-level2.org/en/standards/

BS 8544:2013 Guide for life cycle costing of maintenance during the in-use phases of buildings

PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling. Available from http://bim-level2.org/en/standards/

PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling. Available from http://bim-level2.org/en/standards/

PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smart asset management. Available from http://bim-level2.org/en/standards/

Government and industry organisation standards and guides

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AMBoK Publication 001: Companion Guide to ISO 55001 – Asset Management Council (AMC) 2014

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Centre for Digital Built Britain (CDBB): *Asset Information Management - Common Data Environment* 2018. Available from https://www.cdbb.cam.ac.uk/Resources/Publications

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Government of Western Australia, Department of Local Government and Communities: *Integrated Planning and Report – Asset Management Guidelines* 2016. Available from https://www.dlgsc.wa.gov.au/

Institute of Asset Management (IAM): *Asset Management Maturity Scale and Guidance Version 1.1*

Institute of Public Works Engineering Australasia (IPWEA): *International Infrastructure Management Manual* (IIMM) 2015

Institute of Public Works Engineering Australasia (IPWEA): *PN3 Building and Performance Assessment Guidelines*

NATSPEC 0171 General requirements worksection

NATSPEC (2011 & 2016). *NATSPEC National BIM Guide.* Available from http://bim.natspec.org/

New Zealand Asset Management Support (NAMS): *Optimised Decision Making Guidelines (for infrastructure assets)*

New Zealand Asset Management Support (NAMS): *Property Manual*

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APPENDICES

APPENDIX A: PURPOSES OF DATA AND PLAIN LANGUAGE QUESTIONS (PLQS)

Section 3.2: Structured data and information outlines how thinking about the purposes for which data are needed can assist in defining asset information requirements (AIR).

The following Plain Language Questions (PLQ) are examples of questions that can be asked by those defining AIR to prompt them to think not only about the information they require, but also to assess its relative importance. The PLQs are categorised by data purpose as a means of grouping together related questions.

Designations in square brackets, e.g. [5.3.3] are clause references from BS 1192-4:2014.

Purpose of data	Plain Language Questions
Regulatory compliance [5.2.4]	Which assets have to be reported on to meet statutory requirements (e.g. essential fire services) or to meet the organisation's charter (e.g. a government department's reporting obligations to a Minister)? What financial information is required for regulatory compliance and taxation purposes?
Business cases [5.2.3]	The failure of which assets could result in the loss of licence or contract, or imposition of penalties? Which assets are critical to the delivery of core business services? Which assets, beyond statutory requirements, need to be managed to ensure the health and safety of the asset/facility's users? Which assets are crucial to providing a productive and pleasant environment for workers, clients/customers, users or visitors? Which assets are crucial to satisfying the expectations of external stakeholders (e.g. local councils, adjoining residents)?
Capacity and utilisation of spaces [5.3.2]	Are data about spaces required beyond that needed solely for locating assets (e.g. for purposes such as monitoring utilisation)? How do the actual capacity and utilisation of spaces within a facility compare to the brief? How well utilised are the spaces within a facility? Which ones are under/over-utilised? What data are most useful for space planning purposes?
Capacity/performance/ utilisation of systems and products [5.3.2]	How do the actual capacity/performance/utilisation of systems and products compare to the brief? Which criteria are most useful for monitoring and predicting performance of systems (e.g. power usage versus output)? What data will provide a benchmark for the performance of systems and products?
Security and surveillance [5.3.3]	Which assets are critical to maintaining the security of the asset/facility?
Disaster management [5.3.3]	Which assets are critical to effectively responding to disasters or emergencies? What systems need to be started or closed down in a range of disaster or emergency scenarios? What data need to be readily accessible in a range of disaster or emergency scenarios? Who will need access to these data in each scenario?

Purpose of data	**Plain Language Questions**
Impacts [5.4.2]	Which impacts (e.g. water or energy usage, waste generation) need to be monitored, evaluated or reported on to satisfy the organisation's policies or to meet the requirements of schemes to which it subscribes (e.g. NABERS, GreenStar)?
Operations [5.4.3]	What data are required to operate key systems and products? What data are needed to estimate operational costs and formulate annual budgets?
Maintenance and repairs [5.4.4]	What data are needed to maintain and repair key systems, products and finishes? What data are needed to close down and restart key systems for maintenance and repair? Which dampers, valves or switches need to be operated to isolate each system for maintenance and repair? What is the maintenance regime for assets? How often do assets need to be maintained? How often are assets likely to need repair? What is the Expected Life and/or Effective Life (ATO definition) of assets? What consumables and spare parts are required for the maintenance and repair of assets? What are the costs of maintaining and repairing assets (historical and projected)? What warranties apply to assets? What are the conditions of the warranties? When do warranties expire? Who manufactured the asset? Who supplied the asset? Who services the asset? How do I contact them? What data are needed to assess alternative strategic approaches to preventative versus corrective maintenance? What data are needed to monitor the condition of an asset? What data are needed to estimate maintenance costs and formulate annual budgets?
Replacement/upgrade [5.4.5]	What data are needed to replace/upgrade key products or systems? What data are needed to decommission key equipment or systems? Which dampers, valves or switches need to be operated to isolate equipment for replacement or upgrade? How often do assets need to be replaced/ upgraded? What is the Expected Life and/or Effective Life (ATO definition) of assets? What are the costs of replacing/upgrading assets (historical and projected)? Who manufactured the asset? Who supplied the asset? Who serviced the asset? How do I contact them? What data are needed to assess alternative strategic approaches to replacing and/or upgrading assets? What data are needed to monitor the condition of an asset? What data are needed to estimate life expectancy and replacement costs for amortisation and formulating annual budgets?
Repurposing/alteration	Similar questions to those for *Replacement/upgrade*
Decommissioning and disposal [5.4.6]	Similar questions to those for *Replacement/upgrade*

APPENDIX B: ASSET PRIORITY TABLE (EXAMPLE)

This table is provided as an example of how assets could be prioritised, based on a rating system. In this instance, priorities have been based on aggregated safety and failure criticality ratings assigned to a selection of items from *IPWEA PN3 Building and Performance Assessment Guidelines.* The basis of each priority group is provided below the table.

Priority 1 items	Priority 2 items	Priority 3 items	Priority 4 items	Priority 5 items	Priority 6 items
Fire extinguishers	Fire hydrant system	Sprinkler heads	EWIS system	Chillers	Chilled water valves & pipework
Fire hose reels	Fire collars	Fire indicator panels	Sprinkler valves & pipework	Chilled water pumps	Condenser water pumps, tanks, valves & pipework
Smoke & heat detectors	Fire & smoke dampers	Smoke ventilation systems	Cooling towers	Air handling units	Heated water pumps & valves
Magnetic door holders	Illuminated exit signs	Fire stair pressurisation systems	Condensing units	Duct heaters & ducting	Toilet exhaust systems
Emergency lighting system	Distribution boards	Boilers & burners	HVAC control system	Building management systems (BMS)	Bathroom grab rails & mirrors
Standby power systems	Emergency power systems	Fan coil units	Car park ventilation systems	Hot water cylinders & pressure relief valves	Interior doors
Security alarm systems	Security lighting	Variable air volume units	Building ventilation fans	Thermostatic mixing valves	Downpipes
Closed-circuit television (CCTV) monitoring systems	Incandescent lamps	Variable speed drives	Heated water pumps	Back flow valves	Non-painted external walls
Fire & smoke doors	Hot water circulation pumps	Light switches & power outlets	Fluorescent lamps	Kitchen appliances	External soffits
Fire shutters	Lift controllers & door sets	Sanitary fixtures	Tapware	Hand dryers	Channels & grates
Glazed partitions & doors	Emergency exit doors	Statutory signage	Boiling water units	Bathroom soap dispensers, etc.	Fences
Stair nosings	Automatic opening doors	Floor finishes	Lift car interior & buttons	Window coverings	
Roof access systems	Security fences	Tiled wall finishes	Lift motors, gears, etc.	Roller shutters & garage doors	
		Door hardware	Painted wall finishes	Segmental paving	
		Concrete paths, steps & ramps	Ceiling finishes	Decking	
		Retaining walls	Roofing, guttering & skylights		
			Windows & doors		
			Painted external surfaces		
			Rubbish bins & fixtures		
			Car park & road line marking		

Safety Criticality Grade	Consequence of failure
1: Low	Low risk of personal injury
2: Low/Medium	Personal injury possible
3: Medium	Personal injury likely
4: Medium/High	Limited group injury likely
5: High	Widespread injury or death likely

Failure Criticality Grade	Consequence of failure
1: Low	Low risk of property damage
2: Low/Medium	Property damage possible
3: Medium	Property damage likely
4: Medium/High	Localised property damage likely
5: High	Extensive damage or destruction likely

Priority groups are based on combined safety and failure criticality ratings as follows:

Priority 1 items: 5+5 Priority 2 items: 5+<5 Priority 3 items: 4+4

Priority 4 items: 4+<4 Priority 5 items: 3+3 Priority 6 items: ≤3+<3

APPENDIX C: PROPERTY CATEGORIES WITH DESCRIPTIONS

The table below lists some properties typically associated with AM/FM applications. Most projects will only require a small proportion of these properties. Property names used in this table are generic. Refer to **Appendices E and F** for the names used by IFC and COBie.

Property category	Generic property descriptions	Comments
General identification and description	Asset ID Asset name Designation (for document references) Product type	For unambiguously identifying each asset. A product-type property can be used to identify an asset before a specific product is specified or supplied.
Location	Campus or facility name Building ID Building name Floor ID Space ID Space name Location or GIS reference	For unambiguously identifying a space for space management purposes, or the location of assets for their operation and maintenance (O&M). Linear infrastructure systems use other properties, such as node and link designations or GIS references, for similar purposes.
Parent system or assembly	System type/discipline System ID System name Assembly type Assembly ID Assembly name Asset is a system-isolating device (True/False)	Systems for describing relationships are organised hierarchically to make clear the relationship between an asset and the system or assembly as a whole. For O&M purposes, systems include system/assembly ID (a short alphanumeric code) and system/assembly name (a short description) for unambiguously identifying the system to which an asset belongs.
Classification or category	Asset category code Classification code Classification system name Classification system version Barcode	Classification systems are organised hierarchically to assist navigation when browsing or searching for an item. Asset category or asset classification codes, based on a classification system, aid searches for assets of a similar type and help in filtering and sorting results for reporting and analysis. The process of categorising and classifying assets is a useful organisational tool when managing large numbers of assets.
Manufacture and supply	Make or manufacturer Product reference number Product name Supplier name Serial number Date of manufacture Order number Purchase date Manufacturer URL Country of origin or manufacture Installation date Global Trade Item Number (GTIN)	Information useful for maintenance, repair and replacement purposes. When the asset has been supplied, data such as the serial number and GTIN can be added.
Warranties	Warranty start date Warranty end date Warranty duration – parts Warranty duration – labour Warranty identifier Extended warranty (Yes/No)	For tracking the status of warranties and whether work required on the asset is covered by the warranty.
Certification/ compliance	Next certification inspection date Certificate identifier Certification or compliance properties to suit system or product	For managing compliance and certification requirements.

Life cycle and maintenance	Maintenance frequency Expected life Replacement cycle Consumables identification Consumables location Spares identification Spares location Source of consumables and spare parts Permit-to-work requirement Potential hazard or risk	For maintenance activity support, maintenance planning and strategic asset management.
Performance	Performance properties to suit system or product Baseline commissioning properties to suit system or product Performance level	For performance monitoring that informs O&M optimisation. The properties needed vary significantly from system to system or product to product, so they need to be specified to suit.
Condition	Condition assessment date Condition grade Defects	For condition monitoring that informs strategic asset management. Not applicable to new-build projects. Only required when existing systems are being extended and the collection of data on existing assets has been specified.
Geometry	Area (for spaces) Height Length Width Thickness	Generally included in the object properties of an asset modelled in a BIM application.
Composition	Material Colour Finish Finish: Floor Finish: Walls Finish: Ceiling Finish: Doors	Information useful for maintenance, repair and replacement purposes.
Specification	Specification worksection code Specification worksection title Specification system name	Information useful for maintenance, repair and replacement purposes.
External references	3D model reference Resource reference	A reference code, directory path description or live link to the target document or file. Resource reference includes a reference to drawings, documents, images, audio-visual recordings, data log records, physical storage locations for samples, etc.
Financial	Shipping cost Assembly cost Installed cost Effective life (ATO definition) Replacement cost Total cost of ownership Asset accounting category Asset tax type Asset insurance type	For cost-planning purposes whether operational or business. Decisions need to be made about which cost data will be maintained in the organisation's AM/FM system, or in its financial control system, and how these data will be exchanged between these systems.
Sustainability	Carbon footprint Item is new (True/False) Item is partially recycled (T/F) Item is recycled (T/F) Post-consumer recycled content Post-industrial recycled content Pre-consumer recycled content	For monitoring performance in relation to the requirements of schemes (e.g. NABERS, GreenStar) or policies to which an organisation subscribes.
Logistics	Gross weight Shipping weight	When combined with location and geometric data, this is useful for assets that are regularly moved or relocated

APPENDIX D: PROPERTY PRIORITY TABLE (EXAMPLE)

This table is an example of how properties could be prioritised for inclusion in each asset record. It is indicative only and could represent decisions at one stage in the prioritisation process, for example, the first iteration. Priorities and final inclusion of each property must be determined in response to the project's specific requirements.

Property names used in this table are generic. Refer to **Appendices E and F** for the names used by IFC and COBie.

Priority 1 (Minimum)	Priority 2 (Basic)	Priority 3 (Intermediate)	Priority 4 (Advanced)	Priority 5 (Extended uses)
Asset ID	Asset category code	Asset is a system-isolating device (True/False)	Classification system name	Bar code
Asset name	Designation (for document references)	Classification code	Classification system version	Global Trade Item Number (GTIN)
Product type	System type/ discipline	Manufacturer URL	Warranty duration – parts	Expected Life
Campus or facility name	System ID	Country of origin or manufacture	Warranty duration – labour	Condition assessment date
Building ID	System name	Purchase date	Consumables location	Condition grade
Building name	Assembly type	Installation date	Spares location	Defects
Floor ID	Assembly ID	Warranty start date	Performance level	Shipping cost
Space ID	Assembly name	Extended warranty (Yes/No)	Finish: Floor	Assembly cost
Space name	Serial number	Certification or compliance properties to suit system or product	Finish: Walls	Installation cost
Location or GIS reference	Date of manufacture	Maintenance frequency	Finish: Ceiling	Installed cost
Make or manufacturer	Order number	Consumables identification	Finish: Doors	Maintenance cost
Product reference number	Warranty end date	Spares identification	Specification worksection code	Replacement cost
Product name	Warranty identifier	Performance properties to suit system or product	Specification worksection title	Total cost of ownership
Supplier name	Area (for spaces)	Baseline commissioning properties to suit system or product	Specification system name	Asset accounting category
	Source of consumables and spare parts	Height x length x width	Replacement cycle	Effective Life (ATO definition)
	Next certification inspection date	Thickness	Permit-to-work requirement	Accumulated depreciation
	Certificate identifier	Material	Potential hazard or risk	Written-down value
		Colour		Asset tax type
		Finish		Asset insurance type
		3D model reference		Carbon footprint
		Resource reference		Item is new (True/False)
				Item is partially recycled (True/False)
				Item is recycled (True/False)
				Post-consumer recycled content
				Post-industrial recycled content
				Pre-consumer recycled content
				Gross weight
				Shipping weight

APPENDIX E: GENERIC PROPERTIES MAPPED TO IFC4 ADD2

This table presents a few of the many IFC properties equivalent to the generic properties used in the rest of this Guide. Where there is a difference between IFC4 Addendum 2 (Add2) and IFC2x3, items from the latter are shown in square brackets, e.g. [IFC2x3 item]. This table and the following table in **Appendix F** show that IFC and COBie apply different terminology to some properties. Whichever schema is selected, it is important to apply its terminology consistently to avoid potential ambiguities. It should be noted that IFC incorporates information about the file's author and creation date in its metadata, whereas COBie incorporates it in the record itself on the Contact sheet under CreatedBy, CreatedOn, etc.

Property category	Generic property name	Description & comments	Example	IFC4 property name	IFC4 property set or entity/attribute
General ID & description	Asset ID	Asset designation code from a nominated system	MEC-AHU05	N/A	IfcExternalReference /IfcClassificationReference
	Asset name	Description of the asset	Horizontal Fan-Coil Unit	N/A	Appropriate IfcElementType, etc
	Designation (for document references)	A designation code or tag applied to items in project documentation for the purposes of coordination and cross referencing. Referred to as 'Mark' in US	AHU-0105	Reference	PSet_(relevant IFC entity name) Common
Location	Space ID	Unique room number / designation	101	N/A	IfcSpace.Name
	Space name	Room name / description	Office	N/A	IfcSpace/Long Name
Parent system or assembly	System ID	Designation code or short name from a nominated system	MSA-01	IfcIdentifier	Pset_Distribution SystemCommon
	System name	Description of the system	Mechanical supply air system serving first floor	IfcLabel	Appropriate IfcDistributionSystem , etc
Classification or category	Asset classification or category	Classification or category code from nominated system	Pr_70_65_03_29	N/A	IfcExternalReference /IfcClassificationReference
	Asset type: Fixed or moveable	Complete value with: 'Fixed' or 'Movable'	Fixed	N/A	IfcExternalReference /IfcClassificationReference
Manufacture & supply	Make / Manufacturer	Name of the manufacturer (or assembler). COBie uses their email address	sales@coolaircon.com	Manufacturer	Pset_Manufacturer TypeInformation
	Product / Model number	Model number or designator (or product line) as assigned by the manufacturer	CA-680	ModelLabel	Pset_Manufacturer TypeInformation
	Product / Model name	Model name (or product line) as assigned by the manufacturer	Cool Air Slimline	ModelReference	Pset_Manufacturer TypeInformation
	Serial number	Serial number assigned to the occurrence of the product	3005 2337 1800 2554	SerialNumber	Pset_Manufacturer Occurrence
	Acquisition date	Date the item was purchased (YYYY-MM-DD)	2017-11-16	AcquisitionDate	Pset_Manufacturer Occurrence
	Barcode	Bar code given to occurrence of the product (Number below the barcode graphic)	6157 2289 3005 2337 1800 2554	BarCode	Pset_Manufacturer Occurrence
Warranties	Warranty start date	Format: YYYY-MM-DD	2023-03-19	WarrantyStart Date	Pset_Warranty
	Warranty end date	Format: YYYY-MM-DD	2023-03-22	WarrantyEnd Date	Pset_Warranty
	Warranty identifier	Identifier assigned to warranty	MECH-FCU-CA-AHU-0105	WarrantyIdentifier	Pset_Warranty

Property category	Generic property name	Description & comments	Example	IFC4 property name	IFC4 property set or entity/attribute
Life cycle & maintenance	Expected Life	Expected serviceable life of object	25 years	N/A	IfcDuration [IfcTimeMeasure]
	Maintenance frequency	Scheduled time interval for maintenance tasks	6 months	N/A	IfcTaskTime/IfcTaskTimeRecurring [Not in Ifc2x3]
Performance	Output & Input measurements at commissioning	Measurements of the outputs & inputs to building services equipment, e.g. power output & full-load current rating of a motor	11 kW & 41 Amps	Appropriate property for the item, e.g. IfcPowerMeasure & IfcElectricCurrentMeasure	Appropriate Pset for the item, e.g. Pset_ElectricMotorTypeCommon [Not in Ifc2x3]
	Efficiency measurement at commissioning	Key efficiency measurement for building services equipment, typically the ratio of output capacity to input/intake capacity.	90%	Appropriate property for the item, e.g. IfcPositiveRatioMeasure	Appropriate Pset for the item, e.g. Pset_ElectricMotorTypeCommon [Not in Ifc2x3]
Condition	Condition rating	Overall condition rating based on assessment. Rating scale to be nominated, e.g. *IPWEA PN3* scale 1 – 5	2	AssessmentCondition	Pset_Condition
	Condition assessment date	Date of overall condition assessment (Format: YYYY-MM-DD).	2018-06-22	AssessmentDate	Pset_Condition
Financial	Asset tax type	Taxation group to which the item belongs	Capitalised	AssetTaxType	Pset_Asset
	Asset insurance type	Insurance rating for the item	Real	AssetInsuranceType	Pset_Asset

APPENDIX F: GENERIC PROPERTIES MAPPED TO COBIE

This table shows a few of the many COBie parameters equivalent to the generic properties used in the rest of this Guide. COBie is a Model View Definition (MVD) or subset of the IFC schema. Also note that COBie uses different terms to IFC for some properties; for example, for product or model number, COBie uses ModelNumber whereas IFC uses ModelLabel. Whichever schema is selected, it is important to apply its terminology consistently to avoid potential ambiguities.

COBie colour coding	Required	Reference sheet or pick list	Required if specified

Property category	Generic property name	Description & comments	Example	COBie sheet	COBie parameter
Record data	Record author	The name of the person or organisation that created the record. COBie uses their email address	name@smithsupplies.com	Contact	CreatedBy
	Record creation date	Date and time the record was created	2017-06-25 T15:20:18	Contact	CreatedOn
General ID & description	Asset ID	Asset designation code from a nominated system	MEC-AHU05	Component	AssetIdentifier
	Asset name	Description of the asset	Horizontal Fan-Coil Unit	Type	Description
	Designation (for document references)	A designation code or tag applied to items in project documentation for the purposes of coordination and cross referencing. Referred to as 'Mark' in US	AHU-0105	Component	Name
Location	Floor ID	Unique floor number	Level 1	Floor	Name
	Space ID	Unique room number/designation	101	Space	Name
	Space name	Room name / description	Office	Space	Description
Parent system or assembly	System ID	Designation code or short name from a nominated system	MSA-01	System	Name
	System name	Description of the system	Mechanical supply air system serving first floor	System	Description
Classification or category	Asset classification or category	Classification or category code from nominated system	Pr_70_65_03_29	Type	Category
	Asset type: Fixed or moveable	Complete value with: 'Fixed' or 'Movable'	Fixed	Type	AssetType
Manufacture & supply	Make / Manufacturer	Name of the manufacturer (or assembler). COBie uses their email address	sales@coolaircon.com	Type	Manufacturer
	Product / Model number	Model number or designator (or product line) as assigned by the manufacturer	CA-680	Type	ModelNumber
	Product / Model name	Model name (or product line) as assigned by the manufacturer	Cool Air Slimline	Type	ModelReference
	Serial number	Serial number assigned to the occurrence of the product	3005 2337 1800 2554	Component	SerialNumber
	Installation date	Format: YYYY-MM-DD	2018-03-22	Component	InstallationDate
	Barcode	Bar code given to occurrence of the product. (Number below the barcode graphic)	6157 2289 3005 2337 1800 2554	Component	BarCode
	Tag number	Tag number for product or equipment at installation	180322-MECH-0187	Component	TagNumber

Property category	Generic property name	Description & comments	Example	COBie sheet	COBie parameter
Warranties	Warranty duration – Parts	Warranty period for parts (the units of measurement are defined by another parameter: WarrantyDurationUnit)	3 (years)	Type	WarrantyDuration Parts
	Warranty duration – Labour	Warranty period for labour (the units of measurement are defined by another parameter: WarrantyDurationUnit)	3 (years)	Type	WarrantyDuration Labor
Life cycle & maintenance	Expected Life	Expected serviceable life of object	25 years	Type	ExpectedLife
	Maintenance frequency	Scheduled time interval for maintenance tasks	6 months	Job	Frequency
Financial	Replacement cost	Cost to replace product	$3,500.00	Type	ReplacementCost

APPENDIX G: SPACE

As noted in **Section 3.2.2: Location referencing methods (LRMs)**, space has two roles from an asset management perspective:

1. as an organiser of asset information
2. as an asset that accommodates functions and business processes.

Standards for location reference systems (LRSs)

After deciding on the most appropriate LRM for a given application, a location reference system (LRS) must be chosen. The LRS is used to implement the LRM, including the ICT infrastructure, hardware, software and standards.

As an example, some elements of the standards to be considered when selecting an LRS for a facility's space management system are examined below. If the client does not specify a standard, select an international or national standard. Standards for the following should be agreed by all project team members before design development starts.

- **Building names and numbers:** Each building within a complex or campus should be given a unique ID, generally a number and a name.
- **Floor levels:** Each floor and roof level should be uniquely numbered.
- **Room names and numbers:** Each room should be uniquely numbered. Room-naming conventions should be agreed with the person assigned the responsibility of coordinating the assignment of names.
- **Space identifiers:** If the client is planning to implement an occupancy management system, each space accommodating multiple uses or occupied by a number of people (e.g. open plan offices) should be given a unique identifier.

Consistent location identification

All identification names and numbers used for buildings, floors, levels, rooms and spaces should be consistent across all final models and documents (e.g. schedules for room finishes) and correspond to signage installed in the finished building. In cases where a different numbering system is planned for the construction and occupation phases of a project, workflows for the transition between the systems should be agreed well before construction commences.

Space as an asset

Some common attributes or properties assigned to spaces for space management purposes are listed below. Many more properties than those shown below can be assigned to spaces.

As with products and systems included in the asset register, decisions should be made (before design development starts) about the data that are appropriate for inclusion in the space management system, and what data can be stored externally. For example, should fixtures and finishes be associated with each space or is it sufficient to include this information in a room finishes schedule stored outside the system? Likewise, what asset data, if any, need to be directly linked to a space, and what can be stored in a separate system? Influences on these decisions include the scale and complexity of the project, how intensively it needs to be managed, and the resources available for ongoing management.

- **Area:** The purpose/s for which floor area will be measured should be determined so the appropriate method/s of measurement can be selected. Areas of buildings are generally measured for three purposes:
  - planning and building application assessment
  - tenancy and leasing definition
  - analysis and comparison of buildings (e.g. for cost or occupancy rates).
- **Capacity:** The method of measuring the occupant capacity for each space needs to be carefully designed to provide reliable data for management purposes (e.g. meeting room capacities tracked separately to those for workspaces).

- **Classification:** Space can be classified by several criteria including function, use, department/business unit, etc. The management and reporting purposes and requirements should be defined and the appropriate classification systems selected. Sectors such as education and health usually have established classification standards.
- **Space standards:** Categorising spaces into broad groups based on size and quality (e.g. small private office, medium private office, large private office) can be useful for quickly comparing spaces and determining their suitability for assignment to individuals based on their job positions.

Useful references

ISO 4157:1998 Construction drawings — Designation systems:

— Part 1: Buildings and parts of buildings

— Part 2: Room names and numbers

— Part 3: Room identifiers

NATSPEC National BIM Guide 2011. Refer to *10.5 Requirements for modelling space*

Book of Areas – Australian Institute of Quantity Surveyors (AIQS)

Method of Measurement: Commercial – Property Council of Australia 2008

Method of Measurement: Domestic – Property Council of Australia 2008

Kenley, R. and Harfield, T. (2018), *Scoping Study for a Location Referencing Model to Support the BIM Environment, Austroads, Research AP-R568-18*

Schley, Michael (2018). *Best Practices for Space Management*. FM Systems

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Asset Information Requirements Guide:
Information required for the operation and maintenance of an asset

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