

BIM Theory and Practice: Digital Information Management

Master of Science in BIM and Digital Built Environment

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December 2024, Manchester

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# **Strategic Advisory on Standardized Digital Information Management**

**Healthcare Facility in Sale, Manchester**



BIM Theory and Practice: Digital Information Management  
Assignment 2 (3300 words used)

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What to Expect

1.	Executive Summary .....	8
2.	Introduction .....	8
3.	Key Frame works & Standards.....	8
3.1.	ISO Standards.....	8
3.2.	The Construction Playbook .....	8
3.3.	The Building Safety Act 2022 .....	10
3.4.	The RIBA Plan of Work 2020.....	10
3.5.	NHS and Industry-Specific Documents .....	10
3.6.	Interoperability Standards.....	11
4.	Information Management Activities.....	11
4.1.	Assessment and Need .....	11
4.2.	Invitation to Tender.....	16
4.3.	Tender Response.....	17
4.4.	Appointment.....	18
4.5.	Mobilization.....	18
4.6.	Collaborative production of information .....	19
4.7.	Information model delivery .....	19
4.8.	Project close-out.....	24
5.	Challenges and Mitigations.....	24
6.	Recommendation .....	25
7.	Conclusions.....	25
8.	Appendices.....	26
8.1.	Glossary of Key Terms .....	28
8.2.	Assignment Matrix .....	30
8.3.	OIR list for NHS Client .....	32
8.4.	EIR list for NHS Client.....	34
8.5.	Responsibilities Matrix.....	35
8.6.	Information Protocol .....	36
8.7.	BIM Protocol.....	37
8.8.	Pre contract BEP .....	38
8.9.	Cpix Post-BEP .....	39
8.10.	Health & Saftey Information Requirments.....	40
8.11.	Bibliography .....	42

List of Figures and Tables

List of Figures

**Figure 1:** he list of activities by the Appointing party, Lead Appointed party, and Appointed party to manage the information in the project lifecycle. pp.12-13

**Figure 2:** Project information delivery milestone aligned with RIBA Plan of work 2020. p.15

**Figure 3:** Process Map. pp.20-21

**Figure 4:** Process Map. pp.21-22

**Figure 5:** Information Protocol guide to support asset delivery phase. p.36

**Figure 6:** BIM Protocol document showing the security requirments p.37

**Figure 7:** Pre Contract BIM Execution Plan (BEP). p.38

**Figure 8:** Post Contract BIM Execution Plan (BEP). p.39

List of Tables

**Table 1:** Abbreviations and acronyms. p.7

**Table 2:** The list of relevant ISO standards that will be used through out the projcet lifcycle. p.9

**Table 3:** Stages of the project lifecycle based on RIBA Plan of work that also alignes with ISO 19650 Series. p.10

**Table 4:** Organizational Information Requirments with Asset Information Requirments and Project Information Requirments for the Health-care facility in Sale. p.14

**Table 5:** Exchange Information Requirments with Project Information Requirments and purposes for the Healthcare facility in Sale. p.16

**Table 6:** A summary of Challenges and Mitigations for the Healthcare Project. p.24

**Table 7:** Glossary of key terms used in the document. pp.28-29

**Table 8:** Information Management Assignment Matrix. pp.30-31

**Table 9:** Organizational Information Requirment (OIR) list for assent management activities. pp.32-33

**Table 10:** Exchange Information Requirment (EIR). p.34

**Table 11:** An improved approach to the design Responsibility Matrix. p.35

**Table 12:** The Client’s Health and Saftey Information requirments Maturity Matrix. p.40

Abbreviations and Acronyms

Abbreviation or acronym	Term
AIR	Asset information requirements
BEP	BIM execution plan
BIM	Building information modelling
CDE	Common data environment
CIC	Construction Industry Council
COBie	Construction Operations Building Information Exchange
EIR	Exchange Information Requirements
GDPR	General Data Protection Regulation
GSL	Government Soft Landings
HBN	Health Building Note
IFC	Industry Foundation Classes
IPD	Integrated Project Delivery
ISO	International Organization for Standardization
LOIN	Level of Information Need
MIDP	Master Information Delivery Plan
NHS	National Health Service
OIR	Organizational Information Requirements
PAS	Publicly Available Specification
PIM	Project Information Model
PIR	Project Information Requirements
RIBA	Royal Institute of British Architects
TIDP	Task Information Delivery Plan

Table 1. Abbreviations and acronyms

# 1. Executive Summary

This strategic document outlines a tailored approach to delivering a state-of-the-art healthcare facility in Sale, Manchester. As a consultant advising the client, the focus is on aligning the project with internationally recognized standards, including ISO 19650, the Building Safety Act 2022, and NHS-specific guidelines, to ensure regulatory compliance, operational efficiency, and long-term asset value. The intent of this project is to use BIM to enable better stakeholder collaboration, enhance digital workflows, and achieve sustainability goals like the NHS and government’s net zero carbon targets. The solution is addressed by a staged digital strategy for the resolution of some of the key challenges in this regard: the alignment of stakeholder priorities, data interoperability, and regulatory complexity. Underpinning this is a robust governance framework focused on communication and accountability. Its successful delivery will be serving the needs of regional healthcare and will act as a replicable model for sustainable public infrastructure.

# 2. Introduction

The Healthcare facility project meets regional needs with a sustainable, effective asset. It is hereby recommended that the consultant integrates BIM on better information management, collaboration, and lifecycle-led asset management. It meets global benchmarks set for the industry in line with ISO 19650, the Building Safety Act 2022, and the guidelines provided by the NHS for operation and regulatory requirements on safety, efficiency, and sustainability. It meets the safety, efficiency, and sustainability objectives through methodologies taken from leading frameworks that guide throughout the project: the Construction Playbook and the RIBA Plan of Work 2020. This cannot be easy to attain, considering that key challenges include reaching consensus among stakeholders, ensuring data compatibility across platforms, and integrating safety

processes without slowing up the project. Interoperability will depend on standards such as COBie and IFC, which have to be implemented with much care in order not to compromise data integrity. The project will design a governance framework to help address and mitigate these issues, implement a high-performance healthcare facility, and set the standard in the context of sustainable infrastructure.

# 3. Key Frame works & Standards

The healthcare facility project in Sale, Manchester, is underpinned by a strong suite of frameworks and standards to ensure effectiveness, compliance with regulations, and long-term operational success. The frameworks put safety, sustainability, and interoperability at the forefront in recognition of all stages of the project life cycle, including design, construction, operation, and maintenance.

## 3.1. ISO Standards

The ISO 19650 series and other standards (Table 2.2) offers a framework for managing project information across design, construction, and operations (BSI, 2018). Following these standards promotes consistency in information exchange and aligns with NHS goals.

## 3.2. The Construction Playbook

The Construction Playbook stresses value-based procurement, collaboration, and sustainability in public projects, like healthcare (UK Government, 2020). BIM workflows must align with these principles, especially Early Contractor Involvement (ECI) and integrated project delivery.

Standard/Part	Relevance to the Project	Specific Application
ISO 19650-1: Concepts and Principles	Establishes high-level principles for information management, defining roles, workflows, and key deliverables like OIR and AIR.	Helps define Organizational Information Requirements (OIR), such as NHS Net Zero Carbon goals, and Asset Information Requirements (AIR) for operational needs.
ISO 19650-2: Delivery Phase	Focuses on the design and construction phases, outlining the creation, exchange, and validation of project information.	Guides BIM implementation during design and construction, ensuring compliance with NHS-specific standards and seamless integration into the CDE.
ISO 19650-3: Operational Phase	Guides the use of the AIM during the operational phase, supporting maintenance, operational efficiency, and eventual decommissioning.	Ensures that the Asset Information Model (AIM) supports effective maintenance and operational management of the healthcare facility.
ISO 19650-4: Information Exchange	Defines protocols for consistent and high-quality data exchange, ensuring interoperability between stakeholders and systems.	Supports efficient and error-free data sharing between contractors, designers, and facility managers using open standards like IFC and COBie.
ISO 19650-5: Security	Addresses information security risks, emphasizing secure data exchange and compliance with GDPR and NHS Digital standards.	Protects sensitive patient and operational data by enforcing robust security protocols within the CDE.
PAS 1192-6: Health and Safety	Focuses on managing health and safety information within BIM workflows.	Ensures compliance with Planning Gateway One and fire safety standards, particularly during pre-construction stages.
ISO 14001: Environmental Management	Provides a framework for integrating environmental sustainability into project workflows, addressing lifecycle carbon assessment and energy management.	Supports NHS Net Zero Carbon targets by embedding energy modeling, lifecycle assessments, and environmental design strategies into BIM workflows.
ISO 55001: Asset Management	Guides the management of assets throughout their lifecycle to ensure optimal operational efficiency, reliability, and sustainability.	Ensures the facility’s assets (e.g., HVAC systems, medical equipment) are managed efficiently throughout their lifecycle to reduce downtime and maintenance costs.
ISO 21500: Project Management	Offers guidelines for project management, focusing on aligning project objectives with stakeholder expectations and regulatory requirements.	Aligns project milestones and deliverables with stakeholder requirements, such as NHS performance metrics and regulatory compliance.
ISO 50001: Energy Management Systems	Establishes a framework for improving energy efficiency during the design, construction, and operational phases of assets.	Optimizes energy usage through BIM-enabled energy modeling, ensuring compliance with NHS sustainability targets and reduced operational costs.

**Table 2.** The list of relevant ISO standards that will be used through out the project lifecycle.

3.3. The Building Safety Act 2022

The Building Safety Act 2022 tightened safety rules for higher-risk buildings, including health facilities.

**Golden Thread of Information:** Ensures that the correct and accessible safety-critical information is maintained throughout the asset’s lifecycle.

**Gateway Process:** Establishes three approval steps as follows:

**Planning Gateway One:** Ensures fire safety at the planning stage.

**Gateway Two:** Ensures safety compliance before construction commences.

**Gateway Three:** Confirms compliance before occupation.

**Accountability and Transparency:** Roles and responsibilities of safety-critical decisions are clearly defined.

3.4. The RIBA Plan of Work 2020

The project follows the RIBA Plan of Work, an eight-stage framework (Table 3) that ensures

consistency and clarity across the project lifecycle.

3.5. NHS and Industry-Specific Documents

The project integrates health-specific guidance, to meet the operational and regulatory standards of the NHS:

**HBN 00-01:** This guide provides principles for the design of healthcare environments, focusing on patient flow, infection control, and access (NHS Estates, 2013). Models in BIM should reflect ward layouts, ventilation, and access based on HBN 00-01.

**HBN 04-01:** This guidance emphasizes inpatient facility design for better patient care and efficiency (NHS Estates, 2013). BIM models should simulate patient flow and include critical safety elements like emergency evacuation plans.

**NHS Digital Standards for Information Governance:** NHS Digital Standards ensure the secure management of sensitive healthcare data, such as patient safety information (NHS Digital, 2021). BIM systems must use encryption and access controls in the CDE to meet GDPR and NHS Digital guidelines.

**The NHS Estates Technical Guidance** outlines requirements for healthcare infrastructure, focusing on sustainability and efficiency (NHS Estates, 2021). BIM workflows must include lifecycle analysis tools for energy performance, costs, and maintenance.

**ProCure22 BIM Client Guide:** NHS-focused guidance on how the use of BIM can achieve better project efficiency and cost control. Department of Health and Social Care 2016 It highlights, among others, a Common Data Environment for managing NHS data, including fire safety and COBie-compliant operational data.

**CIC BIM Protocol:** outlines contractual obligations for BIM use, aligning with ISO 19650 (Construction Industry Council, 2018). Contractors must include NHS-specific deliverables like infection control plans and energy performance models.

3.6. Interoperability Standards

The project will emphasize interoperability of data, so the interaction between stakeholders and different software packages is flawless.

**Industry Foundation Classes (IFC):** Provides interoperability between BIM platforms such as Revit, ArchiCAD, and Navisworks, thereby providing consistency of data.

**COBie:** (Construction Operations Building Information Exchange) facilitates the transition of non-geometric data, such as equipment schedules, into operational use for asset management (Eastman et al., 2018). For NHS projects, COBie ensures the integration of maintenance data into the Asset Information Model (AIM).

The structured approach used in this healthcare project was RIBA Plan of Work 2020, ISO 19650, Building Safety Act 2022 and NHS protocols. Key information management stages include requirements preparation by the Appointing party, coordination by the Lead appointed party, and data production by Appointed parties (see Figure 1 pp.12-13). Data governance, stakeholder collaboration, and regulatory compliance all contribute to project success. The main information management stages of ISO 19650-2 are:

4.1. Assessment and Need

- **Clause 5.1.1: Appointing Individuals for the Information Management Function**

The NHS and ISO 19650-2 underpin competent appointees managing information operations in healthcare projects, enabling them to control the CDE and deliver the data accurately according to the Information Management Assignment Matrix (see Appendix B). The information management role needs to be independent of client-facing roles in order to avoid any potential conflict of interest.

- **Clause 5.1.2: Establishing the Project’s Information Requirements**

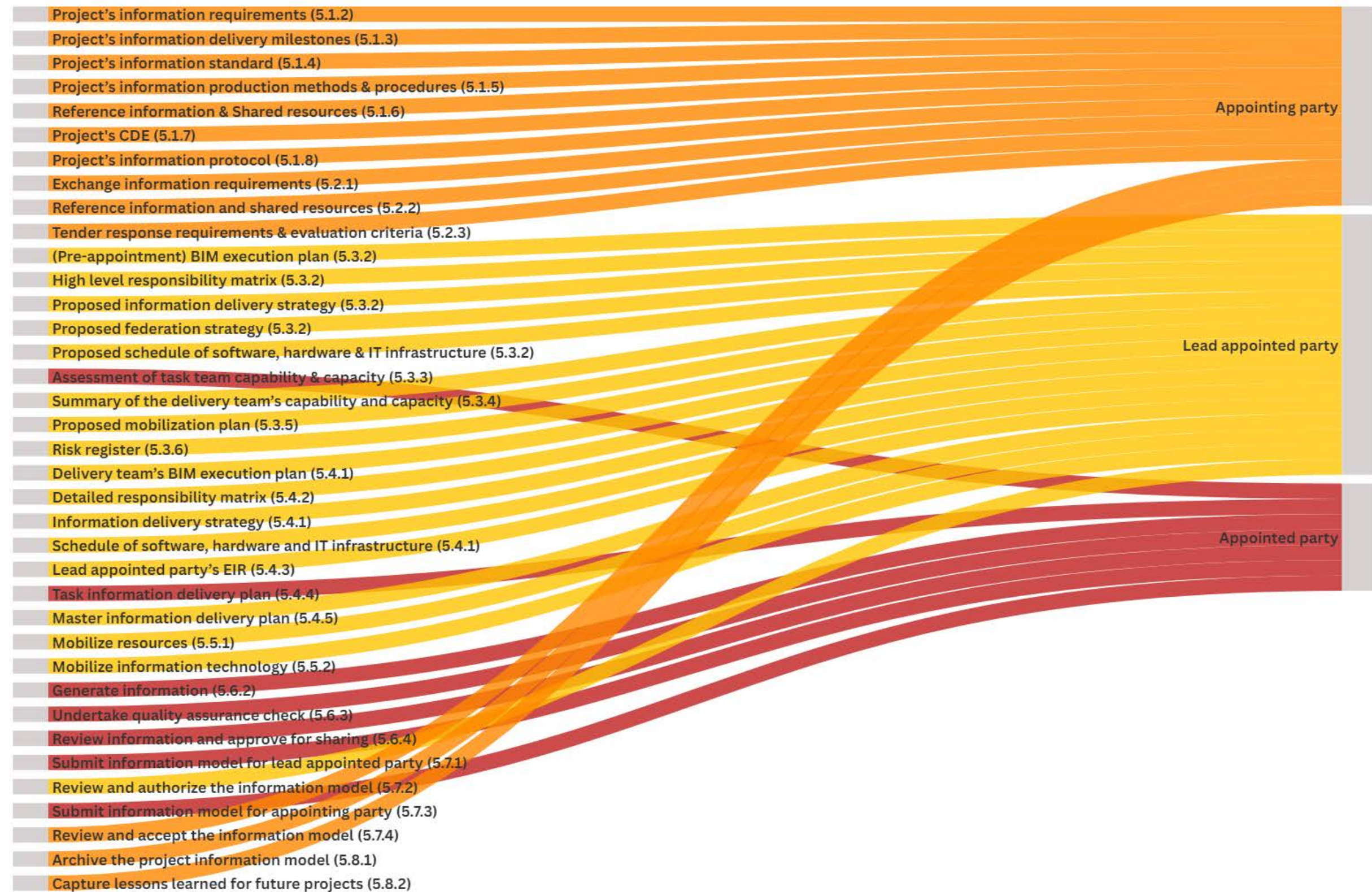
Specify the Project Information Requirements for milestone decisions. PIR gives an indication of decision points on safety, design validation, sustainability, NHS HBN 00-01, and ISO 19650. Well-defined OIR, Appendix C, and PIR as in the ProCure22 BIM Client Guide enable good EIR, Appendix D, for accurate and timely information. Objectives, indicators, and results of the project are given in Table 4.

4. Information Management Activities

Table 3. Stages of the project lifecycle based on RIBA Plan of work that also alignes with ISO 19650 Series.

Stage	Description	Reference
Strategic Definition	Define high-level objectives and information requirements.	RIBA,2020
Preparation and Brief	Develop the project brief, aligning it with information and regulatory requirements.	
Concept and Developed Design	Refine designs, incorporating stakeholder input and ensuring regulatory compliance.	
Technical Design	Prepare detailed, construction-ready designs.	
Construction	Oversee construction and ensure compliance with approved designs.	
Handover	Deliver the final information model and train operational teams for effective use.	
In Use	Monitor and optimize the asset’s operational performance to ensure long-term efficiency and usability.	





**Figure 1.** The list of activities by the Ap-pointing party, Lead Appointed party, and Appointed party to manage the information in the project life-cycle.



**Table 4.** Organizational Information Requirements with Asset Information Requirements and Project Information Requirements for the Healthcare facility in Sale.

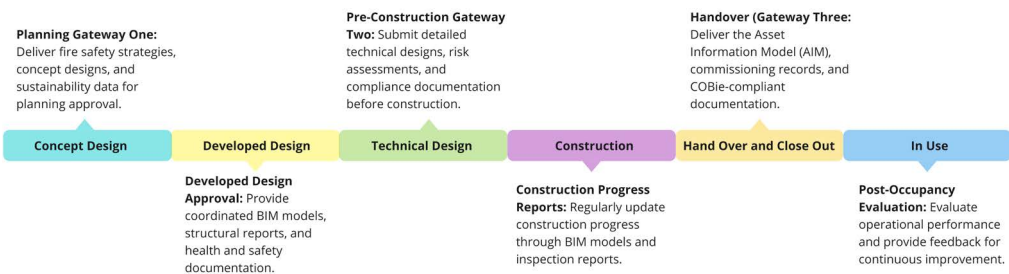
OIR	AIR	PIR	Information Purpose	Standards Use	to
Information required to ensure compliance with health and safety regulations (Appendix J).	Provide risk assessments, emergency escape plans, and fire safety reports for every hospital location.	To verify health and safety regulations, provide design models, specifications, and compliance reports.	Health and safety compliance and audits.	ISO 19650-1 & Pro-Cure22 for defining OIR, PAS 1192-6 for health and safety compliance, Building Safety Act 2022.	
Information needed to track and achieve NHS Net Zero Carbon targets.	Provide records of the sustainable materials used in construction, emissions statistics, and energy consumption measurements	For the design and construction phases, submit sustainability reports that include energy models and emissions statistics	Monitoring and reporting on sustainability progress.	NHS Net Zero Carbon Guidance, ISO 19650-3 for operational lifecycle data, ISO 14001 (Environmental Management), ISO 50001 (Environmental Management)	
Information necessary for routine maintenance and repair planning.	Provide schedules and logs for preventive maintenance, repair histories, and asset life-cycle predictions.	Provide construction schedules with maintenance integration and repair protocols.	Efficient maintenance planning and operational cost reduction.	ISO 19650-3 for maintenance data management, NHS Estates Technical Guidance for asset lifecycle.	
Data required to support daily hospital operations and asset performance	Provide operational information on the functioning of the IT infrastructure, HVAC systems, and medical equipment use.	Send in information about operational readiness, such as commissioning logs and crucial system performance test results.	Optimized daily operations and patient care delivery.	ISO 19650-2 for operational data exchange, COBie for asset performance, and NHS standards for healthcare operations.	

• **Clause 5.1.3: Establish the project’s information delivery milestones**

Key milestones for information delivery on the Sale health facility project would be the NHS Net Zero Carbon target and the requirements of Planning Gateway One. These will feature importantly in the RIBA Plan of Work that maps out the project between enabling works and contractors. Without clear milestones, there are bound to be delays and non-compliance with ISO 19650-2 and the Building Safety Act 2022. An effective milestone system guarantees project progress, accountability, and timely information exchange (Figure 2).

• **Clause 5.1.4: Establish the project’s information standard**

The information standard for the Project initiative should be developed for ease of operation. Proper naming and coding by industry and to the set standards by NHS ensure minimal waste. A good standard will enhance asset performance, compliance, and help in improving collaboration and effectiveness. The key focus areas are: **Information sharing:** good naming and metadata based on NHS and Planning Gateway One standards. **Information Structure:** Work breakdown structure for the needs of the hospital.



**Figure 2.** Project information delivery milestone aligned with RIBA Plan of work 2020.

LOD and LOI must therefore be clearly pre-defined to keep pace with the demands of compliance and operational needs. **Operational Phase:** Harmonize lifecycle information to enhance asset management and achieve the NHS aim of Net Zero Carbon.

• **Clause 5.1.5: Establish the project’s information production methods and procedures**

Establishment of information protocols (see Appendix F & G) is paramount in ensuring that the project, will effectively, safely, and consistently come into being. These are the main areas of focus: **Current Asset Information:** The CDE containers shall be consistently used to capture the site information, utilities, and existing hospital facilities. **New Data Creation, Review, and Approval:** Utilize BIM tools in the creation of new data that aligns with established workflows and standards set out by NHS and ISO 19650-2. **Distribution and Security:** It will ensure the security through the security clearance process, metadata evaluation, and strong access to CDE. **Information Flow:** Transition processes may be developed based on the readiness levels that come up from within the forms.

• **Clause 5.1.6: Establishing the Project’s Reference Information and Shared Resources**

The appointing party shall provide the referenced data for the site plans, utility schematics, existing asset data, templates, 3D libraries, and project line styles. Such delivery reduces the risks involved while it allows clarity right from the tender stage, hence reducing waste and delay. This includes CDE resources aligned to the ISO 19650 standards for assuring compliance with NHS-HBN 00-01/04-01 on the delivery of quality (see the Process Map pp.20-23).

• **Clause 5.1.7: Establish the project’s common data environment**

The appointing party will have an CDE fully deployed before receiving proposal for the project. A properly designed, running CDE enhances the effectiveness of communication, reduces risks, and offers full compliance with both the regulatory requirements and the NHS directives. The use of CDE ensures information is exchanged in a secure and auditable way by: **Unique identifications:** Information containers are supplied with harmonized identifiers using the ISO 19650-2 rules. **Metadata and Attributes:** This provides clarity and usability through the labeling of containers of status, revision, and classification. **Work Tracking:** Keeps an audit trail to log the changes made, approvals, and transitions. Access to information containers, controlled in terms of role and responsibility, is called controlled access.



• **Clause 5.1.8: Establish the project’s information protocol**

Compliance with ISO 19650 will develop for the project an information process that ensures appropriate information management by all parties concerned. In being compliant an organisation has to adopt existing regimes such as CIC BIM Protocol 2nd Edition (Appendix G). Protocols must be according to BS EN ISO 19650 Part 1 Annex C in order to be legal, clear, and well understood by the stakeholders.

**4.2. Invitation to Tender**

• **5.2.1. Establish the Appointing Party’s Exchange Information Requirements (EIR)**

- The appointments should be made regarding

the EIR (see Appendix D) in order to make the lead appointed parties know the requirements about data and objectives of information delivery during the entire lifecycle.

- The EIR for this project is regarding the following; the deliverables must include timescales, safety-critical data, and BIM models according to the NHS standards which is HBN 00-01.
- Specify what the required format, timelines, and workflow are. This will ensure accountability and consistency of tender submissions. Based on this, Table 5 shows the EIR for the project.

• **5.2.2 Assemble Reference Information and Shared Resources**

Compile critical resources, such as site data (geospatial maps, utility layouts) and templates (naming conventions, Uniclass 2015 classifications), to guide tender responses, minimizing risks and reducing costs.

• **5.2.3 Establish Tender Response Requirements and Evaluation Criteria**

Indicate that a statement will be needed regarding compliance with the NHS, EIR, and specific project skills and experience. The technical experience is listed first, followed by compliance to the Building Safety Act 2022, and then sustainability considerations-for example, the NHS Net Zero Carbon commitment.

• **5.2.4 Compile Invitation to Tender Information**

Make that the invitation to tender package is in line with NHS principles such as operational efficiency, safety, and sustainability by including EIR documentation, reference data, and assessment criteria.

• **5.2.5 Progress Information Model for Subsequent Delivery Teams**

The revision and transition at each stage, for example from design to technical design, shall be performed by persons with well-defined responsibilities to make sure the CDE workflow with respect to Data Integrity and collaboration is followed.

**4.3. Tender Response**

• **5.3.1 Nominate Individuals for Information Management**

Assign competent personnel to oversee project data, guaranteeing adherence to NHS guidelines, ISO 19650-2, and the seamless operation of the Common Data Environment (CDE).

• **5.3.2 Establish the Delivery Team’s Pre-Appointment BIM Execution Plan (BEP)**

Produce a pre-appointment BEP ((see Appendix H) with a focus on NHS priorities such as patient safety, Net Zero Carbon targets, and the Building Safety Act 2022. It should detail procedures, resources, and compliance tactics to be adopted in discharging EIRs.

• **5.3.3 Assess Task Team Capability and Capacity**

Assess task teams’ knowledge of NHS projects, their familiarity with HBN standards, and their capacity to provide designs that are both safety-critical and sustainable (see Appendix H).

• **5.3.4 Establish the Delivery Team’s Capability and Capacity**

Make that the whole delivery team has the technical know-how and resources necessary to complete the project from design to handover.

• **5.3.5 Establish the Delivery Team’s Mobilization Plan**

Provide a mobilisation strategy that takes into account collaborative readiness, integration into project workflows, and alignment with CDE procedures and NHS operational demands.

• **5.3.6 Establish the Delivery Team’s Risk Register**

Such risks should be tracked and mitigated via a risk register, including: non-compliance with Planning Gateway One; deferral of key deliverables impacts on the sustainability; data security or management issues.

• **5.3.7 Compile the Delivery Team’s Tender Response**

Create a bid response that outlines strategies for creating BIM models that are compliant, free of conflicts, in line with NHS standards, and have strong information management systems.

**Table 5.** Exchange Information Requirements with Project Information Requirements and purposes for the Healthcare facility in Sale.

PIR	EIR	Purpose	Standard to use
To verify health and safety regulations, provide design models, specifications, and compliance reports.	Provide specific contractor deliverables, such as model formats and validation schedules, for fire safety design compliance.	Health and safety compliance and audits.	ISO 19650-1 for defining OIR, PAS 1192-6 for health and safety compliance, Building Safety Act 2022.
For the design and construction phases, submit sustainability reports that include energy models and emissions statistics.	During design and construction, specify the contractor’s responsibility for energy efficiency reports and lifecycle cost studies.	Monitoring and reporting on sustainability progress.	NHS Net Zero Carbon Guidance, ISO 19650-3 for operational lifecycle data, and relevant sustainability reporting standards.
Provide construction timelines that incorporate repair and maintenance procedures.	Specify the data exchange needs for maintenance integration, such as repair histories and asset identification.	Efficient maintenance planning and operational cost reduction.	ISO 19650-3 for maintenance data management, NHS Estates Technical Guidance for asset lifecycle.
Submit operational readiness data, including commissioning records and performance test results for critical systems.	Outline operational data delivery requirements for commissioning, training, and system performance validation.	Optimized daily operations and patient care delivery.	ISO 19650-2 for operational data exchange, COBie for asset performance, and NHS standards for healthcare operations.

4.4. Appointment

5.4.1 Confirm the Delivery Team’s BIM Execution Plan (BEP)

Approve the BEP (see Appendix I) to ensure that the document is aligned with the EIR and the project’s sustainability and safety standards set out in the brief in line with NHS requirements.

5.4.2 Establish the Delivery Team’s Detailed Responsibility Matrix

A Responsibility Matrix (see Appendix E) needs to be developed that will address accountability, compliance with NHS standards, and delivery against fire safety and operational preparedness in an articulate manner.

5.4.3 Establish the Lead Appointed Party’s Exchange Information Requirements

Produce an EIR to the lead appointed party to ensure that data is appropriately shared, according to ISO 19650-2, on time, and with accurate information.

5.4.4 Establish the Task Information Delivery Plan (TIDP)

Develop TIDPs that detail how the activities will capture and deliver the required information, including key milestones for the delivery of safety-critical data, BIM models, and sustainability reports, in line with NHS guidelines.

5.4.5 Establish the Master Information Delivery Plan (MIDP)

Integrate the TIDPs in the MIDP to provide a project-wide information production and delivery plan aligned with RIBA phases and key milestones, such as operational readiness and

design validation.

5.4.6 Complete the Lead Appointed Party’s Appointment Documents

Complete documentation with the lead party with clear definitions of roles and responsibilities and agreed-upon deliverables. This must be done in concurrence with specific protocols laid down by the NHS regarding information management.

5.4.7 Complete the Appointed Party’s Appointment Documents

Customise the appointment documentation for each appointed party to specify their scope, such as the NHS-compliant designs for designers and the fire safety and sustainability criteria for contractors.

4.5. Mobilization

5.5.1 Mobilize Resources

Provide the right resources to fulfil the project’s needs, such as skilled workers who are conversant with NHS standards (HBN 00-01) and the required equipment, like platforms with CDE integration and BIM authoring software.

5.5.2 Mobilize Information Technology

Design an information technology infrastructure that will support secure and efficient information workflows, assure compliance with GDPR, NHS information governance standards, ISO 19650-2, allowing interoperability between different software and data formats.

5.5.3 Test the Project’s Information Production Methods and Procedures

To validate EIR compliance, ensure conflict-free BIM models, and identify standards or procedural problems in advance of the start of official production, test information production methods and workflows.

4.6. Collaborative production of information

5.6.1 Check Availability of Reference Information and Shared Resources

Ensure the CDE is updated with the most current and accessible reference data and shared resources, including site data, utility layouts, and NHS-compliant templates.

5.6.2 Generate Information

Produce project-specific deliverables, including but not limited to, BIM models and schedules, through ensuring compliance with the EIR while placing foremost emphasis on design data that is both safe and conflict-free (see the Process Map pp.20-23).

5.6.3 Complete Quality Assurance Check

Provide assessment against the NHS design standards, project specification, and sustainability objective includes the Net Zero Carbon targets through quality assurance testing.

5.6.4 Review Information and Approve for Sharing

Information sharing within the CDE is reviewed and signed off by parties that it has complied with ISO 19650-2 and has been suitably adequate for the purpose it had been created.

5.6.5 Information Model Review

Integrate operational data on maintenance and energy performance evaluation. Revisit the information model constantly to solve design conflicts, inconsistencies, and lack of data.

4.7. Information model delivery

5.7.1 Submit Information Model for Lead Appointed Party Authorization

The delivery team shall ensure from safety and sustainability data that NHS requirements and the EIR are met in presenting the information model to the lead party.

5.7.2 Review and Authorize the Information Model

Before the model is accepted for submission to the appointing party by the lead appointed party, the latter checks for accuracy, completeness, and compliance with NHS aims on fire safety and Net Zero Carbon targets, together with ISO 19650-2 procedures.

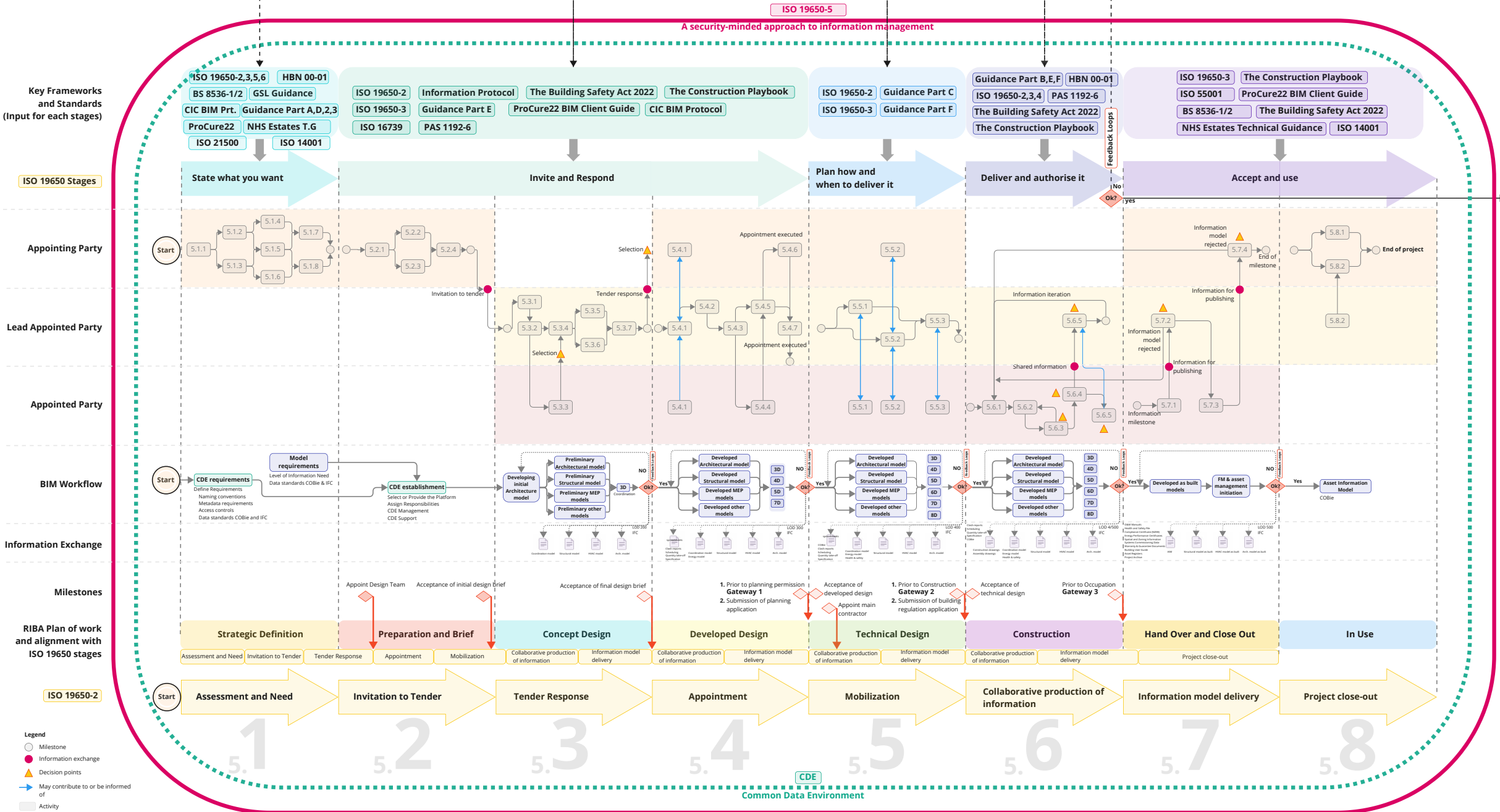
5.7.3 Submit Information Model for Appointing Party Acceptance

The model is aligned with the project milestones-identified handover and compliance with the Building Safety Act 2022-and integrates both operational and regulatory data; it is sent to the appointing party once permission is granted.

5.7.4 Review and Accept the Information Model

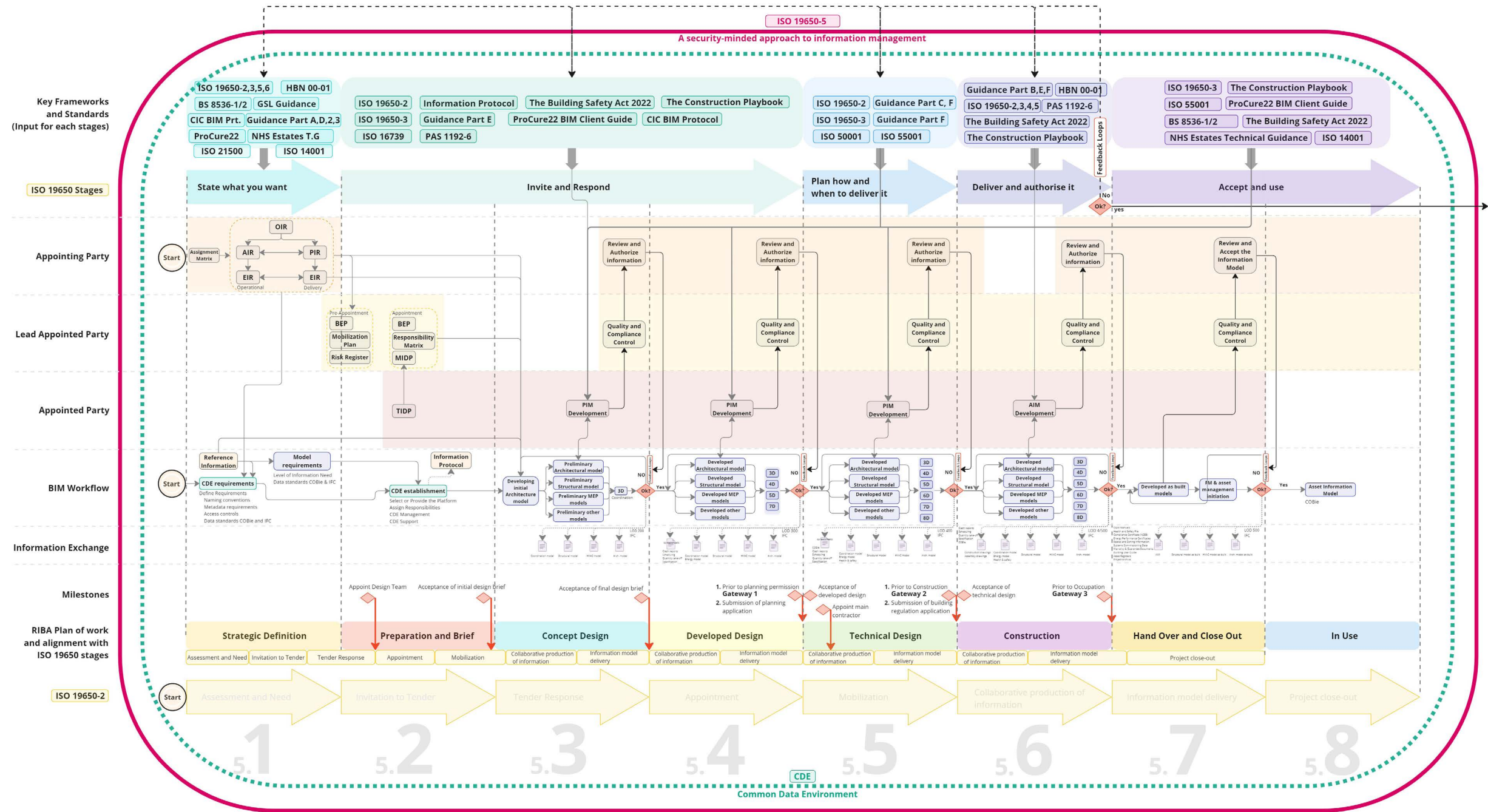
This activity will be completed when the appointing organization checks the model for compli-

**Figure 3.** The Process Map summarizes the project's delivery activities and it consists of different layers (horizontal). The top layer has key frameworks and standards which are the main input during information management process, the second layer is about the ISO 19650-2 information management activities which is informed by the first layer. The 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> layers show the Appointing, Lead Appointed, and Appointed party activities during the whole life cycle of the project which is based on the Eight major ISO 19650-2 steps (vertical). The 6<sup>th</sup> layer is the BIM workflow that has input from the top layers and aligned with ISO 19650-2 and RIBA Plan of Work, and the information exchange files that will be produced from this layer are shown in layer 8. The 9<sup>th</sup> layer shows important milestones during the life cycle of the project and it is informed by ISO standards, RIBA stages, and the Building Safety Act 2022. The 10<sup>th</sup> layer shows the RIBA Plan of Work and ISO 19650 stages aligned. And the last layer shows all ISO 19650 stages in a sequentiality order.





**Figure 4.** This Process Map is similar with the above one, except the 3rd, 4th, and 5th layers. The 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> layers show the Appointing, Lead Appointed, and Appointed party activities respectively. It shows the major activities and required documents by the stallholders.





ance with set standards, including COBie data to be used operationally, and it is ready for embedding into the Asset Information Model

4.8. Project close-out

5.8.1 Archive the Project Information Model

All information within the PIM should be safely preserved at project close-out, from BIM models through to compliance paperwork. The archive shall support long-term asset management and operational readiness to meet the requirements of both the NHS and ISO 19650-2.

5.8.2 Compile Lessons Learned

The PIM should be safely preserved at project close-out but in such a way that retains all the in-

formation, including BIM models and compliance paperwork, within it. The archive will support long-term asset management and operational readiness to meet the requirements of both the NHS and ISO 19650-2.

5. Challenges and Mitigations

A number of challenges can be foreseen by developing the healthcare project. Meeting such challenges in a predictive manner is going to be crucial to meet the NHS standard, staying within project schedule, and meeting criteria of being an efficient yet environmentally friendly building. Below is the summary of challenges with mitigations for the healthcare project (Table 6).

Challenge	Mitigation
Planning and Regulatory Compliance	Trafford Council has a target to determine 85% of household applications within 8 weeks, although the larger ones will obviously take longer. It is very important that all documents are submitted in time to avoid delay, especially for major projects such as the hospital. CDE workflows help to meet planning requirements and improve communication with the council.
Interoperability Issues	Mandate the use of open standards like Uniclass 2015 and IFC. Establish the CDE to ensure seamless integration and standardization of data from one platform to another.
Data Security Risks	Embed encryption, role-based access controls, and regular audits to secure sensitive operation and healthcare data in CDE. Confirm conformity with information governance guidelines laid down by the NHS and GDPR.
Stakeholder Collaboration	Use the responsibility matrix to define the role and responsibilities. Common understanding for all stakeholders through regular BIM coordination meetings and workshops.
Quality Assurance of Information Models	Agree to strict quality control processes of deliverables of information and BIM models. Regularly review as necessary to ensure completeness, accuracy, and consistency of data to project goals and EIR.
Handover and Operational Readiness	Ensure there is a clearly defined requirement within the EIR, which states that a COBie-compliant, operationally ready Asset Information Model must be delivered at handover. Train NHS staff.
Managing Sustainability Goals	Workflows should include sustainability metrics; lifecycle assessment at both design and construction stages in relation to achieving NHS Net Zero Carbon targets.

Table 6. A summary of Challenges and Mitigations for the Healthcare Project.

6. Recommendations

Early planning supported by robust information management, Lean principles, and stakeholder integration through Integrated Project Delivery (IPD) is crucial to the success of the project. Setting these in context, wider NHS goals such as Net Zero Carbon and patient safety will bring clarity and eliminate waste processes. ISO-compliant CDE ensures interoperability and data integrity, responsibility matrices ensure clear lines of accountability, and coordination workflows enable collaboration. Embed sustainability and lifecycle principles, efficiency driven by Lean, and robust quality assurance to ensure compliance with NHS standards and the Building Safety Act 2022. Handover and readiness requirements against the operational Asset Information Model allow the capture of lessons learned and enable improvement on future projects. Failure to adopt these approaches will result in risk of inefficiency and delay, which is contrary to project success.

7. Conclusions

The Sale health facility in Manchester represents a new benchmark in safety, efficiency, and sustainability of healthcare. Success is ensured through collaboration, detailed planning, and strict information management. ISO standards, together with compliance with the NHS standards such as HBN 00-01/04-01, and the Building Safety Act 2022, and the principles of General Data Protection Regulation (GDPR), ensures data security. Interoperability solutions, such as COBie and IFC, will continue to drive better collaboration, while sustainability frameworks include ISO 14001 and ISO 50001, informing the NHS Net Zero Carbon goals. Well-managed Common Data Environment and clear Exchange Information Requirements enable fully integrated lifecycle processes for operational excellence, providing a model for healthcare improvements that will help improve patient outcomes and system resilience in the UK.

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## **8. Appendices**

8.1. Glossary of Key Terms

Term	Definition
Asset Information Model (AIM)	It is a digital model with all data needed for the operation, maintenance, and lifecycle management of a built asset, per ISO 19650-3.
Building Information Modelling (BIM)	It is basically the management of digital information about a built asset from design to decommissioning.
BIM Execution Plan (BEP)	A document detailing the implementation of the BIM process, ensuring stakeholder coordination in information production, sharing, and management, aligned with the project's Exchange Information Requirements (EIR).
CIC BIM Protocol	A contract to ensure appropriate management of BIM requirements between all parties to a project.
Common Data Environment (CDE)	A virtual platform to maintain and share project data, maintaining consistency, version control, and stakeholder collaboration.
COBie (Construction Operations Building Information Exchange)	It is a nongeometric data format in asset management, including lists of equipment with maintenance schedules. Such formats are being utilized in BIM workflows for efficient facilities management.
Exchange Information Requirements (EIR)	According to ISO 19650-2, EIR defines what information should be produced at which stage in the project.
GDPR (General Data Protection Regulation)	The GDPR controls personal data processing and storage, therefore, for privacy and security issues, especially sensitive NHS healthcare data.
HBN (Health Building Note)	is a set of NHS design guidelines for healthcare buildings, including HBN 00-01 (general design) and HBN 04-01 (inpatient facilities), emphasizing safety, efficiency, and patient care.
IFC (Industry Foundation Classes)	A standard data format that allows interoperability between BIM software, ensuring consistent information exchange among stakeholders.
Information Protocol	A document in appointment contracts that outlines the responsibilities, standards, and procedures in managing project information in compliance with the ISO 19650.
Integrated Project Delivery (IPD)	A collaborative approach which integrates people, systems, and practices to improve project outcomes and encourages early involvement of stakeholders with appropriate alignment of risk and reward for clear communication to achieve enhanced efficiency throughout the project life cycle for better value (AIA, 2007).
Lean Principles	Lean Manufacturing practices will be applied to project delivery to find more value and reduce waste. Core principles of Lean in construction emphasize continuous improvement, collaboration, and efficiency in the workflows for cost-effective high-quality results with fewer delays and redundancies (Liker, 2004).
ISO 14001	It is a global standard for environmental management, aimed at reducing impact and enhancing sustainability in projects.
ISO 19650 Series	The standards for the management of information throughout the life cycle of a built asset include concepts, delivery, operation, exchange, and security.

Table 7. Glossary of key terms used in the document.

Term	Definition
ISO 55001	It is an international standard for asset management that helps organizations optimize asset performance and lifecycle.
ISO 50001	It is the new international standard for energy management that promotes efficiency and reduces operating costs.
Level of Information Need (LOIN)	It defines the required detail and information needed by project stages to ensure consistency with stakeholder expectation.
Master Information Delivery Plan (MIDP)	A plan produced by the lead appointed party that describes the overall timeline, milestones, and responsibility for delivering project information at each stage of the project with regard to the EIR.
Net Zero Carbon	A sustainability goal focused on cutting carbon emissions in a project's lifecycle, especially for NHS healthcare infrastructure.
Organizational Information Requirements (OIR)	They are strategic information needs aligned with an organization's goals, and form the basis for project-specific requirements.
PAS 1192-6	It defines how to manage health and safety information within BIM workflows. It includes advice on incorporating safety-critical data into designs and construction.
ProCure22 BIM Client Guide	NHS guidance for implementing BIM in healthcare to improve efficiency, collaboration, and lifecycle management.
Responsibility Matrix	A tool to define and assign roles for project tasks, ensuring clarity and accountability.
RIBA Plan of Work	An eight-stage framework for construction projects, from strategic definition to operation, ensuring consistency across all phases.
Risk Register	A document used to identify, assess, and manage risks throughout a project lifecycle. It lists potential risks, their impact, likelihood, mitigation strategies, and responsible parties.
Sustainability	It involves designing and operating facilities to minimize environmental impact, emphasizing energy efficiency, waste reduction, and lifecycle carbon assessment.
Task Information Delivery Plan (TIDP)	A plan that outlines the tasks, deliverables, and timeframe within which parties shall act in producing information to feed into the MIDP.
Uniclass 2015	It is a BIM classification and naming convention that organizes information about built assets to be delivered into consistent project management.

8.2. Assignment Matrix

Information management assignment matrix

Table A.1 — Information management responsibility matrix template

ID	Key	Appointing party	Third party	Lead appointed party	Appointed party
	R Responsible for undertaking activity				
	A Accountable for activity completion				
	C Consulted during activity				
	I Informed following activity completion				
	Task				
5.1.1	Appoint individuals to undertake the information management function				
5.1.2	Establish the project's information requirements				
5.1.3	Establish the project's information delivery milestones				
5.1.4	Establish the project's information standard				
5.1.5	Establish the project's information production methods and procedures				
5.1.6	Establish the project's reference information and shared resources				
5.1.7	Establish the project's common data environment				
5.1.8	Establish the project's information protocol				
5.2.1	Establish the appointing party's exchange information requirements				
5.2.2	Assemble reference information and shared resources				
5.2.3	Establish tender response requirements and evaluation criteria				
5.2.4	Compile invitation to tender information				
5.3.1	Nominate individuals to undertake the information management function				
5.3.2	Establish the delivery team's (pre-appointment) BIM execution plan				
5.3.3	Assess each task team capability and capacity				
5.3.4	Establish the delivery team's capability and capacity				
5.3.5	Establish the delivery team's mobilization plan				
5.3.6	Establish the delivery team's risk register				
5.3.7	Compile the delivery team's tender response				
5.4.1	Confirm the delivery team's BIM execution plan				
5.4.2	Establish the delivery team's detailed responsibility matrix				

Table 8. Information management Assignment Matrix according to ISO 19650 Part-2.

Table A.1 (continued)

ID	Key	Appointing party	Third party	Lead appointed party	Appointed party
	R Responsible for undertaking activity				
	A Accountable for activity completion				
	C Consulted during activity				
	I Informed following activity completion				
	Task				
5.4.3	Establish the lead appointed party's exchange information requirements				
5.4.4	Establish the task information delivery plan(s)				
5.4.5	Establish the master information delivery plan				
5.4.6	Complete lead appointed party's appointment documents				
5.4.7	Complete appointed party's appointment documents				
5.5.1	Mobilize resources				
5.5.2	Mobilize information technology				
5.5.3	Test the project's information production methods and procedures				
5.6.1	Check availability of reference information and shared resources				
5.6.2	Generate information				
5.6.3	Undertake quality assurance check				
5.6.4	Review information and approve for sharing				
5.6.5	Information model review				
5.7.1	Submit information model for lead appointed party authorization				
5.7.2	Review and authorize the information model				
5.7.3	Submit information model for appointing party acceptance				
5.7.4	Review and accept the information model				
5.8.1	Archive the project information model				
5.8.2	Capture lessons learned for future projects				



8.3. OIR list for NHS Client

Project Name		Ref. P22-01	
Organisational Information Requirements			
Table 1: Specific asset management activities	Client/Authority	Service Provider	Construction Contractor
Asset accounting, activity costing, forecasting			
Planning and budgeting			
Demand management and customer expectation policy			
Capital investment and life cycle costing			
Innovation and change management			
Interfacing with regulatory bodies;			
Asset operation or utilization;			
Asset modifications, refurbishment, replacement, reuse/redeployment, disposal, recycling;			
Spares, materials and purchasing;			
Data, information and knowledge management;			
Contractor and supplier management;			
Human resources, skills development and competencies;			
Maintenance, inspection, condition and performance monitoring;			
Contingency planning and emergencies;			
Energy efficiency and environmental aspects, e.g. Renewable resources, recycling, waste management, air purity, hygiene;			
Risk assessment and management;			
Safety, health and environmental management.			
Optimizing the asset management strategy and optimizing/prioritizing its asset management plan(s);			
Assessing the financial benefits of planned improvement activities;			
Modelling the asset to support operational decision making;			
Determining the operational and financial impact of asset unavailability or failure;			
Making life cycle cost comparisons of alternative capital investments; identifying expiry of warranty periods;			
Determining the end of an asset's economic life, e.g. When the asset related expenditure exceeds the associated income;			
Determining the cost of specific activities (activity based costing), e.g. The total cost of maintaining a specific asset(s)/asset system;			
Obtaining/calculating asset replacement values;			

**Table 9.** Organization- al Information Requirement (OIR) list for assent manage- ment activities according to ProCure 22 Client Guide 2016.

Project Name		Ref. P22-01	
Organisational Information Requirements			
Table 1(Cont.): Specific asset management activities	Client/Authority	Service Provider	Construction Contractor
Undertaking financial analysis of planned income and expenditure;			
Obtaining/calculating the financial and resource			
Impact of deviating from plans that might result in a change in asset availability or performance (e.g. What is the financial impact of deferring the maintenance of a specific generator by six months?);			
Assessing its overall financial performance;			
Undertaking the on-going identification, assessment and control of asset related risks.			
Optimizing the asset management strategy and optimizing/prioritizing its asset management plan(s);			
Assessing the financial benefits of planned improvement activities;			
Modelling the asset to support operational decision making;			
Determining the operational and financial impact of asset unavailability or failure;			
Making life cycle cost comparisons of alternative capital investments;			
Identifying expiry of warranty periods			
Determining the end of an asset's economic life, e.g. When the asset related expenditure exceeds the associated income;			
Determining the cost of specific activities (activity based costing), e.g. The total cost of maintaining a specific asset(s)/asset system;			
Obtaining/calculating asset replacement values;			
Undertaking financial analysis of planned income and expenditure;			
Obtaining/calculating the financial and resource			
Impact of deviating from plans that might result in a change in asset availability or performance (e.g. What is the financial impact of deferring the maintenance of a specific generator by six months?);			
Assessing its overall financial performance;			
Undertaking the on-going identification, assessment and control of asset related risks.			

8.4. EIR list for NHS Client

Project Name			350-03	
Employers Information Requirements (EIR)				
Information Type	Tab	Field	Responsibility	Workstage Deliverable
Spatial		SiteName	Lead Consultant	6
		ProjectName	Lead Consultant	6
		Name	Lead Consultant	6
		SiteDescription	Lead Consultant	6
		Name	Lead Consultant	6
		Description	Lead Consultant	6
	Space	Name	Lead Consultant	6
		Name	Task Team - Design	6
Asset				
		Description	Task Team - Design	6
		Manufacturer	Task Team - Design	6
		ModelNumber	Task Team – Supply Chain	6
		WarrantyGuarantorParts	Task Team – Supply Chain	6
		WarrantyDurationUnit	Task Team – Supply Chain	6
		ModelReference	Task Team – Supply Chain	6
		SerialNumber	Task Team – Supply Chain	6
		InstallationDate	Task Team – Supply Chain	6
		WarrantyStartDate	Task Team – Supply Chain	6
		Name	Task Team - Design	6
		Description	Task Team - Design	6
	O&M Information	Name	Task Team - Design	6
		Description	Task Team - Design	6
		Duration	Task Team – Supply Chain	6
		Frequency	Task Team – Supply Chain	6

Table 10. Exchange In-formation Requirment (EIR) according to ProCure 22 Client Guide 2016.

8.5. Responsibilities Matrix

Task/Deliverable	Author Task Team					Stage for exchange with Lead Appointed Party for Review					
	1	2	3	4		1	2	3	4	5	6
	AAA	BBB	CCC	GGG	Other input						
DOORS (IFCDDoor)											
1. Internal Door Geometry Information (IFCDoor_DOOR)	R	#			38		1	1	1	38	38
1.1 Required Door Attributes via COBie SpeadsheetML	R	#			40		1	1	1	40	40
1.1.1 All standard properties of MVD 2.4	1	#			40		1	1	1	40	40
1.1.2 <Minus> "SerialNumber"											
1.1.2 <Plus> "FireRating"	R	#			40		1	1	1	1	1
1.1.3 <Plus> "AcousticRating"	R	#			40		1	1	1	1	1
1.1.4 <Plus> "FireExit"	R	#			40		1	1	1	1	1
1.2 Required Door Properties via IFC Step	R	#			40		1	1	1	1	1
1.2.1 All standard properties of MVD RV 1.2	R	#			40		1	1	1	1	1
2. Access Hatch Geometrical Information (IFCDoor_TRAPDOOR)	R				40		1	1	1	1	1
2.1 Required Door Attributes via COBie SpeadsheetML	R	#			40		1	1	1	40	40
2.1.1 All standard properties of MVD 2.4	1	#			40		1	1	1	40	40
2.1.2 <Minus> "SerialNumber"											
Metal Doors (IFCDDoor)											

Table 11. An improved approach to the design Responsibility Matrix (BS EN ISO 19650, Guidance Part F, 2020).

8.6. Information Protocol



Figure 5. Information Protocol guide to support asset delivery phase (UK BIM Framework, 2023).

8.7. BIM Protocol

### BIM Protocol

CIC/BIM Pro  
Second Edition 2018

*This is a framework of a generic Security Requirements. Parties may choose to include further detail if they require.*

#### Appendix 3 – Security Requirements

[State “Not Used” or do not include the Security Requirements in the Protocol if the Security Minded Provisions are not to apply]

[If the matters referred to below are included in the Employer’s Information Requirements refer to the relevant parts of that document]

##### 1. Sensitive Information

1.1 The following information is Sensitive Information:

---

1.2 The Employer’s requirements in respect of the Sensitive Information are as follows:

---

##### 2. Project Specific Security Requirements

2.1 The Built Asset Security Information Requirements applicable to the Project Team Member are as follows:

---

[Refer to the Built Asset Security Information Requirements included in the EIRs. See paragraph 10 PAS 1192.5]

2.2 The Employer’s Baseline Security Requirements are:

---

[See PAS 1192–5 (5.6). The contractual obligations under the Agreement in relation to security should be considered carefully (see paragraph 11.4 of PAS 1192:5) and referred to here if necessary]

##### 3. Employer’s Policies and Procedures

3.1 Employer’s Standards

- PAS1192–5

[any other Employer specific security standards (see PAS 1192–5, 11.4.4)]

3.2 Built Asset Security Manager

The Built Asset Security Manager shall be the following person:

Figure 6. BIM Protocol document showing the security requirements, for example, patient safety information for this project (CIC, 2018).

8.8. Pre contract BEP

Project Name	350-03
Pre Contract BIM Execution Plan (BEP)	

5 COMPETENCE ASSESSMENT

5.1 Project Implementation Plan (PIP)

Supply Chain Capability Summary
Insert Supply Chain Capability Summary (PAS 6.3.2)

Supplier Building Information Management Assessment Forms
Insert Supplier Building Information Management Assessment Forms (PAS1192-2 6.3.2a)

Supplier Information Technology Assessment Forms
Insert Supplier Information Technology Assessment Forms (PAS1192-2 6.3.2b)

Supplier Resource Assessment Forms
Insert Supplier Resource Assessment Forms (PAS1192-2 6.3.2c)

5.2 Capability Assessments

The Supplier should confirm that the project team have been assessed in line with the following:

- PAS1192-2:2013
- CPix BIM Capability Assessment
- CPix IT Questionnaire

Insert supplier confirmation and evidence as applicable.
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Figure 7. Pre Contract BIM Execution Plan (BEP) in this case showing the competence assessment of the suppliers (ProCure client Guide, 2016).

8.9. Cpix Post-BEP

3 Management

This section of the BEP covers the requirements of PAS1192-2 Clause 7.2.1 a).

3.1 Roles, responsibilities and authorities

At the start of a project it is important to identify the roles and responsibilities of the design teams. Table 2 is used to record the names and contact details of the individuals fulfilling the necessary project roles

Table 2 – Roles and responsibilities

Role Company	Name	Email and Telephone number
Lead Designer Company.....		
Project Delivery Manager Company .....		
Construction Manager Company.....		
Project Information Manager Company..... Company.....		
Task Team Manager * Company..... Company.....		
Task Team Information Manager * Company..... Company.....		
Task Team Interface Manager * Company..... Company.....		
Task Team BIM Authors * Company..... Company..... Company.....		

\* Note – specify these roles for each task team involved in the project

The standard authorities of the different roles related to production and management of information are given in Table 3.

Table 3 – Role authorities

Role	Authority
Project Information Manager	Enforce the Project BIM Standard and ensure delivery of the Information requirement in the EIR.
Lead Designer	Enforce spatial coordination
Task Team Manager	Enforce documentation standards
Interface Manager	Negotiate space allocation
Task Team Information Manager	Reject non compliant models, drawings & documents
CAD Coordinator	Enforce CAD related Project BIM Standards

Figure 8. Post Contract BIM Execution Plan (BEP) in this case showing Roles, responsibilities and authorities (CPix, 2013).



8.10. Health & Saftey Information Requirnments

THE CLIENT’S HEALTH AND SAFETY INFORMATION REQUIREMENTS MATURITY MATRIX

Question	PIR's To Consider	First steps	Keeping up with the pack	Taking the lead
<div>1. What information does the Client already have or need to obtain at the initiation of a project?</div> <div>(Note: suggested focus is on, early project decisions that will have health and safety implications for the operation and end use of the asset, Pre-Construction Information that has been assembled and used to guide the procurement strategy and key areas of risk identified for further study.)</div> <div>Key clause(s): PAS1192:6 Section 6.1 &amp; 6.2</div>	1,2,3,5,6,7	<div>1) Client carries out an initial Preliminary Hazard Analysis &amp; Safety Review (PHASR) to identify hazards and risks, including for operational use.</div> <div>2) Information on key early decisions is recorded for others to use.</div> <div>3) Client identifies where support is needed (high uncertainty, significant hazards identified).</div>	<div>1) PHASR results recorded on CDE.</div> <div>2) PHASR outputs embedded into contract documents and informs focus areas for tender returns.</div> <div>3) Output of PHASR feeds into project life cycle design risk management requirements (HAZOP / HAZCON, site layout study etc.)</div>	<div>1) Comprehensive PHASR with independent chair carried out early with multi-discipline designer/contractor involvement.</div> <div>2) Time bound actions monitored to check outcomes in ongoing design reviews, recorded on CDE, with audit trail.</div> <div>3) Formal early risk study for operations and maintenance carried out alongside PHASR.</div>
<div>2. What systems does the Client have in place to monitor Information requirements and how will this information be managed effectively to deliver the required outcome safely? (For example: A CDM Compliance strategy.)</div> <div>Key clause(s): PAS1192:6 Section 5</div>	1,2,3,4,5,6, 12,13,14	<div>1) Client identifies knowledge he/she has to share, sets up meeting with design team to identify gaps and puts a plan in place to mitigate the gaps.</div> <div>2) Client sets up checks to ensure that that information is understood, valid and reliable.</div> <div>3) Client sets design risk objectives and a method of monitoring to ensure that they are met.</div>	<div>1) Client identifies age and confidence in data as part of knowledge share, highlighting potential surveys required.</div> <div>2) CDM Principal Designer and design team involved in validating and seeking gaps in PCI.</div> <div>3) Client monitors progress in fulfilment of the Project Information Requirements.</div>	<div>1) Client captures feedback on gap analysis and progressively closes gap to improve asset and H&amp;S data.</div> <div>2) Client monitors risk studies, design risk objectives and progress with Design Plan.</div> <div>3) Client regularly checks the supply chain has received, understood and acted on H&amp;S information provided by designers.</div>
<div>3. What information has the Client specified and what is required for the Common Data Environment (CDE) for this project?</div> <div>(Note: Focus needs to be on - how will this contribute and improve communication of Health &amp; Safety information including elevated risks.)</div> <div>Key clause(s): PAS1192:6 Section 6.2.1-6.2.8</div>	1,6,8	<div>1) Client specifies use of appropriate and accessible IT tools to share information.</div> <div>2) Client specifies who will have access to information using a Responsibility matrix.</div> <div>3) Client specifies format and structure of H&amp;S File – specifies as built models as required.</div>	<div>1) A project information manager is appointed to manage the CDE.</div> <div>2) Periodic reviews of H&amp;S File quality, accessibility and content undertaken.</div> <div>3) Progressively developing and sharing H&amp;S information within the CDE, with a dual focus on 1) what is required to handover on practical completion, 2) what is required to manage construction work safely?</div>	<div>1) A CDE is established early, and controlled access is granted to all project participants.</div> <div>2) Seamless integration of risk information from inception (PCI) to construction phase to handover (H&amp;S File); and operational use within the CDE.</div> <div>3) Tools are specified to enable H&amp;S federation and sharing of models</div>
<div>4. What risk studies and reviews have been specified at key stages to solve H&amp;S issues, enable collaborative working and provide information to ensure that risks are where possible, eliminated, or otherwise reduced and treated?</div> <div>Key clause(s): PAS1192:6 Section 6.3</div>	6,8,9,11,12 , 13,14	<div>1) Client specifies reviews at key stages- Minimum terms of reference developed for reviews.</div> <div>2) Reviews include key participants (including early contractor involvement and experts where required).</div> <div>3) Reviews are led/managed by Principal Designer / Principal Contractor.</div>	<div>1) Design review actions generated and assigned owner and time bound actions to resolve. Risk treatments are recorded.</div> <div>2) Residual actions from each project stage are formally passed forward to next stage.</div> <div>3) Design review and risk study requirements are revalidated and reset at each project stage.</div>	<div>1) Design reviews are regular, comprehensive and include model federation and clash detection / avoidance.</div> <div>2) A constructability review/ construction phase rehearsal informs Temporary Works register &amp; Design risk log/register/tracker/schedule.</div> <div>3) Design decisions and assumptions recorded on CDE and linked to formal risk management systems.</div>
<div>5. What are the design risk objectives to eliminate and reduce risks in the project? These objectives need to be set t by the Client to guide the design team.</div> <div>Key clause(s): PAS1192:6 Section 6.2.11</div>	6,11,12,	<div>1) Client states those hazards or risks they want eliminated by design, including occupational health risks.</div> <div>2) Client sets out what H&amp;S risks he/she wants information on, and where risk studies will be needed.</div> <div>3) Designers explain how information management methods will be used to aid H&amp;S in design through their tender responses.</div>	<div>1) Client/design team agree which risks will be eliminated, reduced or controlled by the design - early design options are scoped out/modelled.</div> <div>2) Objective set on how to use models, symbols, animations, simulations, to share risk information via the project team, including in construction.</div> <div>3) Active monitoring by Client and Principal Designer of design risk objectives.</div>	<div>1) Client design risk objectives and outcomes are cascaded through the project and supply chain.</div> <div>2) Client requires best mix of geometrical model and simulation/sequencing in models for project, operations and stakeholder engagement.</div> <div>3) Client specifies H&amp;S health reporting / dashboard reporting from Principal Designer and Principal Contractor via CDE, to reflect stress in workforce caused by programming of work.</div>
<div>6. Has a design plan been requested, from the Principal Designer, which maximises the opportunities for collaboration in design risk management?</div> <div>(Note: This needs to consider how design risk objectives will be met and how the different design disciplines will work together including how design risk data will be shared).</div> <div>Key clause(s): PAS1192:6 Section 6.3.4</div>	3,6,9,	<div>1) Client specifies strategy for collaboration in the design in order to improve design risk management. Where appointed, Principal Designer to lead on creating and managing the plan.</div> <div>2) All design participants identified and co-ordinated in the design plan.</div> <div>3) Design plan includes design risk objectives and track elevated risks.</div>	<div>1) Pre-contract design plan forms part of the tender return.</div> <div>2) Design plan includes design assurance activities, which monitor risk treatment through design.</div> <div>3) Design plan incorporates constructability and temporary works requirements.</div>	<div>1) Design plan is comprehensive and shows in detail how objectives will be met and how elevated risks will be closed out.</div> <div>2) Plan shows how design of temporary works will be enabled by design team.</div> <div>3) Plan shows how risk burden will be measured and minimised throughout design, construction and in use.</div>
<div>7. Are models produced by different design disciplines capable of effective federation and has Health &amp; Safety Information been integrated and conserved for re-use?</div> <div>Key clause(s): PAS1192:6 Section 7</div>	6,7,9,10,1	<div>1) The tender responses include a Federation strategy to identify how models shall be federated and combined to support H&amp;S and integrate risk information.</div> <div>2) Principal Designer and design team decide how risk information is to be shared and recorded through the CDE.</div> <div>3) H&amp;S information is made available through CDE for re-use.</div>	<div>1) Temporary works information is included in the CDE and shared within the design team.</div> <div>2) Soft clash (temporary works) detection / avoidance includes consideration to workers, the public and end users.</div> <div>3) Reviews regularly see opportunities for improving risk management as clashes are identified and shared.</div>	<div>1) Soft and hard clash detection / avoidance is continuous and includes consideration of worker activities</div> <div>2) A range of information is combined with models and used in reviews and designers are informed of pending changes and revisions.</div> <div>3) Models enable automated rule checking to reduce risk, ensure efficient co-ordination of effort during the design stage, and ensure feed forward to the construction teams.</div>
<div>8. What are the arrangements that will be put in place at the outset to ensure testing and commissioning is carried out effectively?</div> <div>(Note: These arrangements will include the need to assure the client that what was specified has actually been built, and how to feed forward vital operational health and safety information.)</div> <div>Key clause(s): PAS1192:6 Section 6.5</div>	9,10,11,12, 13,14	<div>1) Client specifies who will be responsible for commissioning.</div> <div>2) Client identifies early what commissioning tasks are needed and how these will be recorded.</div> <div>3) Commissioning, test and validation results integrated with H&amp;S File and available in the CDE.</div>	<div>1) Commissioning reviews (including temporary works) completed through visualisation.</div> <div>2) Model and visualisation used in commissioning to be supplied to the end user for continual / reuse.</div> <div>3) As built models and information that has been verified is identified in the CDE.</div>	<div>1) Incorporate the commissioning plan into soft landing scope.</div> <div>2) Model information is used to populate asset management system.</div> <div>3) An index to all H&amp;S information required for asset operation, maintenance and end use is recorded in the CDE.</div>
<div>9. What are the arrangements that will be put in place at the outset to ensure that information in a Health &amp; Safety File is valid, verified and made available to the end user?</div> <div>Key clause(s): PAS1192:6 Section 6.5</div>	1,2,9,14.	<div>1) Client sets out an Information Requirement to ensure that the H&amp;S File is delivered contractually</div> <div>2) Client specifies H&amp;S File content as a level of need for delivery through Exchange information Requirements.</div> <div>3) H&amp;S File is pre-structured in the CDE, for access by all participants</div>	<div>1) Client provides the PCI to reflect H&amp;S File handover.</div> <div>2) End user reviews are carried out progressively through the project life cycle on H&amp;S File content and structure for usability.</div> <div>3) All handover info on CDE tested and exchanged with the end user.</div>	<div>1) All H&amp;S File info is indexed on CDE and incorporated into soft landing strategy.</div> <div>2) H&amp;S File is in a format to enable ready access to end users and next project manager.</div> <div>3) As-built(s) validated through laser scanning / point clouds for construction tolerances.</div>
<div>10. How will you be able to ensure that lessons are learned from this project experience, in relation to health and safety?</div> <div>(Note: PAS 1192-6:2018 requires lessons learned in relation to innovation, good practice and sharing of knowledge to be generalised and shared for re-use by the industry.)</div> <div>Key clause(s): PAS1192:6 Section 5.5</div>	2,4	<div>1) At inception, Client requests from all Duty Holders to provide appropriate best practices and lessons learned from previous projects.</div> <div>2) Action plan and process in place to capture new lessons learnt from appointed all Duty Holders.</div> <div>3) Client considers Key Performance Indicators from the lessons learnt from appointed all Duty Holders.</div>	<div>1) Best practices and lessons learnt reviewed by Client and all appointed Duty Holders and where appropriate, issued in timely fashion within industry</div> <div>2) KPI utilised for measuring the quantity and type of H&amp;S lessons learnt, forms part of project reporting to Client.</div> <div>3) Identification of new lessons learnt in relation to BIM / PAS1192:6.</div>	<div>1) Client reviews action plan and recognises positive outcomes at regular intervals.</div> <div>2) Lessons learned and best practices fed back by all Duty Holders to all relevant design disciplines and supply chain in project.</div> <div>3) Client shares generalisation of learning and best practices across industries for open learning.</div>

Table 12. The Client’s Health and Saftey Informa- tion requirments Maturity Matrix (PAS 1192-6, 2018).

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19. ISO 21500: Project Management. Provides guidance on project management principles and practices, ensuring alignment with project goals.

20. ISO 50001: Energy Management Systems. Outlines energy efficiency measures to support sustainability and reduce operational costs.

