

EXPLO National Manual of Assets and Facilities Management Volume 16, Chapter 1

Operations and Maintenance - Projects Interface

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1.0 PURPOSE

This document defines the actions required by the Facilities Management (FM) team during initial planning, concept design, detailed design, construction tendering, construction, commissioning and handover in order to ensure the best outcomes for operability and maintenance over the asset lifecycle for a new construction or refurbishment project.

Construction of an asset consumes only 20-30% of its total life cycle cost, assuming it is capable of being operated efficiently. The remaining cost is expended during operation. Any annual inefficiency in how the asset is operated is multiplied by the number of years of its life. It is in the Entity's best interest to minimize the costs during operation. By proper integration of Operations and Maintenance (O&M) into the asset's project phases such as initial planning, design, construction, commissioning and handover, it is possible to eliminate issues which cause unnecessary ongoing expenditure for the Entity.

2.0 SCOPE

Design of an asset with the end user (Entity) in mind is key to its success and should be the starting point for any construction project, whether it is a new building or a major renovation. The FM team should represent the interests of the Entity continuously from the pre-planning stage through the project phases into handover and operation.

There are two parts to the FM role during the life of the project. The first is to ensure that the Entity's strategic long term interests are being served throughout. The second part is to prepare for the operation of the new asset so that the handover from the project team to the FM team is seamless.

Operations and Maintenance - Projects Interface activities are carried out during the planning, design, construction, Stage Gate sign-offs, commissioning and handover phases of the project process. For these reasons the Operations and Maintenance - Projects Interface related responsibilities are defined and explained in the relevant sections of the Expro Projects White Book (White Book). The White Book leads this activity and is the premier source of truth. The National Manual for Assets and Facilities Management (NMA&FM) reflects what is written in the White Book and will be adjusted accordingly as changes are made to White Book procedures.

3.0 DEFINITIONS

Term	Definition
Attic Stock	Parts, spares, consumables, building elements provided as part of a construction contract at the time of handover.
Defect Liability Period	This is a contract specific period of time expressed from the time of handover of the asset during which the contractor is obliged to correct specific types of fault in the fabric or systems of the asset other than wear and tear.
Hard Services	Operation, maintenance, repair and refurbishment of the asset.
Operability	The extent to which an asset can successfully be operated by an Entity in relation to its intended function.
Soft Services	Cleaning, catering, pest control, concierge, helpdesk, landscape maintenance, post and others as determined by the Entity.
White Book	Expro Projects White Book
Acronyms	
AMS	Asset Management Software
APD	Asset Property Director (Entity Director)
BIM	Building Information Modeling
BMS	Building Management System
BIFM	British Institute of Facilities Management (Now known as IWFM)
BSRIA	Building Services Research and Information Association
CAPEX	Capital Expenditures
CIBSE	Chartered Institution of Building Services Engineers



Term	Definition
DLP	Defect Liability Period
FAT	Factory Acceptance Test
FM	Facilities Management OR Facilities Manager
IWFM	Institute of Workplace and Facilities Management
NMA&FM	National Manual for Assets and Facilities Management
O&M	Operations and Maintenance
PM	Planned Maintenance (see Volume 6 Ch.3)
OPEX	Operational Expenditures
RFID	Radio Frequency Identification
RICS	Royal Institution of Chartered Surveyors
SOC	Strategic Outline Case
TCO	Total Cost of Ownership

Table 1: Definitions and Acronyms

4.0 REFERENCES

- BSRIA BG 9/2011 – Rules of Thumb
- BSRIA BG4/2009 – Soft Landings Framework
- CIBSE GMV/14 – Guide 'M'
- ISO55000 (and family) – Asset Management
- IWFM – Operational Readiness Guide
- Expro 5-Year Projects Portfolio Planning Handbook
- Expro Projects White Book Volume 3, Project Initial Planning
- Expro Projects White Book Volume 4, Contracts and Tendering
- Expro Projects White Book Volume 5, Procurement
- Expro Projects White Book Volume 6, Maintenance Management
- Expro Projects White Book Volume 9, Construction Management
- Expro Projects White Book Volume 10, Testing and Commissioning
- Expro Projects White Book Volume 15, Sustainability
- Expro Projects White Book Volume 16, Handover and Closeout
- National Manual of Assets and Facilities Management, Volume 2, Asset Management
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning
- National Manual of Assets and Facilities Management, Volume 5, Operations Management
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management
- National Manual of Assets and Facilities Management, Volume 8, Supply Chain Management
- National Manual of Assets and Facilities Management, Volume 9, Contracts Management
- National Manual of Assets and Facilities Management, Volume 10, Safety, Health, Environment Management
- National Manual of Assets and Facilities Management, Volume 12, Risk Management
- National Manual of Assets and Facilities Management, Volume 13, Document Management
- National Manual of Assets and Facilities Management, Volume 14, Emergency Management
- National Manual of Assets and Facilities Management, Volume 17, Energy Management and Sustainability
- RICS –Property Asset Management



5.0 RESPONSIBILITIES

5.1 Asset Manager

- Develop the Entity business case.
- Develop the Entity strategic brief.
- Appoint the FM as the representative of the Entity in the project team. (If there are no suitably experienced FM personnel available in the Entity FM team, the Asset Property Director (APD) will appoint a suitably qualified and experienced consultant in time to carry out the responsibilities of the Facilities Manager as defined below.)
- Delegate authority for decision making up to a specified level in relation to operability of the asset(s) being developed.
- The development, implementation and monitoring of Entity Asset Management Policy
- Strategy and Lifecycle planning for all stages of asset life from planning through acquisition, construction, operation and disposal.
- The responsibility extends to linear and non-linear assets as well as owned and leased assets.
- Ensure alignment of all new budget items (OPEX & CAPEX) with required activities, resources and timescales required for new Capital Assets and provide required assessment of integration between CAPEX & OPEX and other information requirements.

5.2 Facilities Manager

- Act as the Entity representative from concept to operation.
- Support the APD in the development of the Entity's strategic brief.
- Delegate specific project related responsibilities to members of the FM team depending on specialism.
- Ensure that the Entity strategic brief and business case are fully considered throughout.
- Ensure that proposed design or construction changes are evaluated for potential impact on OPEX, operability and maintainability.
- Stipulate the requirements for information deliverables including format and timeframe.
- Stipulate the requirements for physical deliverables including location and timeframe.

5.3 Project Manager

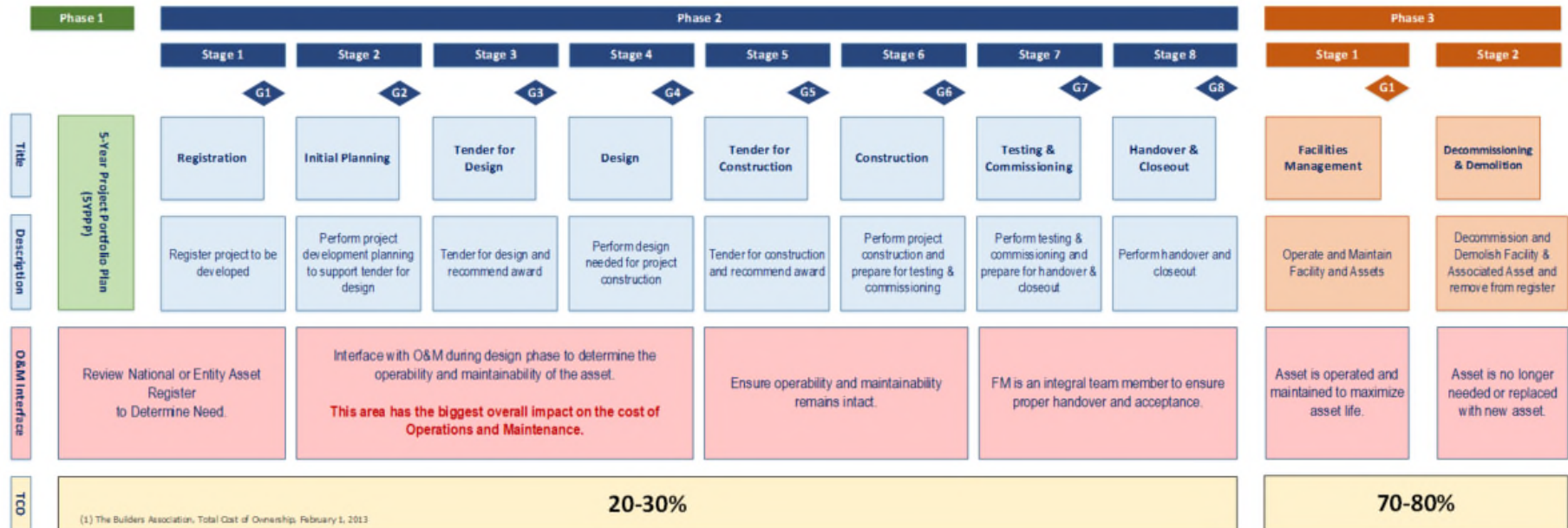
- Manage the project from inception to handover.
- Incorporate the FM into the project team.
- Ensure FM sign-off of decisions affecting operability of the project at all stage-gate levels.
- Ensure the FM is included in all feasibility studies.
- Ensure that changes to design or construction are not approved without consideration of consequences to OPEX, operability and maintainability, including allowing sufficient time for the review of the proposed changes.
- Ensure that all operability requirements identified in design and/or construction by the FM are incorporated in the project.
- Ensure that the FM is invited to all Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT).
- Ensure safe access for the FM to the project throughout the construction process.
- Ensure that the FM has free and unrestricted access to the BIM with the support of a BIM technician if necessary.
- Ensure Asset Tagging is carried out according to the specification.
- Ensure that the FM is invited to all Commissioning activities.
- Ensure that the FM is invited to snag list / punch list walkthrough.
- Ensure the provision of all project and construction information deliverables to the FM – in the format and timescale required by the FM including:
 - o As-Built drawings
 - o Testing and inspection reports
 - o O&M Manuals
 - o Material Data Sheets
 - o Spare parts list and supplier information
 - o Certificates required by Authority or Regulator
 - o Asset Register



- Ensure the provision of all physical deliverables to the FM – in the timescale and at the location stipulated by the FM.
- Ensure the provision of training for the FM team in relation to the operation and maintenance of the assets.
- Ensure the provision of Defect Liability Period (DLP) information in the format and timeframe required by the FM.
- Ensure the provision of Warranty information for each asset in the format and timeframe required by the FM.
- Ensure that the design team creates safe and workable methodologies for the maintenance and cleaning of every element of the asset. This task includes specifying specialist equipment necessary for accessing the entire internal and external building envelope as well as for incorporating straightforward access and unobtrusive storage for that equipment.



6.0 PROCESS





6.1 Introduction

6.1.1 Cost Effective and Efficiently Operated

The goal of an Entity with respect to newly constructed assets, is for it to be capable of efficiently and cost effectively meeting the needs of the Entity from the moment of handover and for the foreseeable future.

With good operability the people who work for the Entity can deliver the service needed in comfort, and with the right amount and configuration of space to meet the needs of efficiency as well as safe and easy operation. The asset should be straightforward to maintain and keep clean. The asset should be cost effective to run and should be capable of continuing like that for decades into the future.

The only way to achieve good operability is for the FM to be responsible for representing the Entity's interests throughout the project. This will need various people from different FM disciplines to be involved at one or more stages of the project. However, the FM presence will be continuous from concept to handover.

6.2 5-Year Project Portfolio Plan (5YPPP)

6.2.1 Entity Strategic Outline Case

Prior to entering the Project Stage Gate process, an Entity Strategic Outline Case (SOC) shall be developed to determine the viability and need of the asset along with determining preliminary Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) over the asset's life cycle as per the Financial Planning requirements. The FM needs to be fully involved during this process to ensure OPEX issues and concerns are properly addressed.

In addition, a review of the Entity Asset Register shall be conducted to further determine the viability and need of the proposed new asset and to determine if other assets already exist that can meet the operational requirements needed by the Entity.

Refer to:

- Expro 5-Year Projects Portfolio Planning Handbook
- National Manual of Assets and Facilities Management, Volume 2, Asset Management

6.3 Initial Planning

6.3.1 Entity Budget Constraints

The FM shall interpret Entity budget constraints in terms of both CAPEX and OPEX and shall share these with the project team in accordance to the Budget Principles requirements. The CAPEX numbers will drive the construction costs of the project. The OPEX number shall be shared with the project team for information only as confidentiality permits.

Refer to:

- National Manual of Assets and Facilities Management, Volume 4, Financial Planning



6.3.2 OPEX Estimation:

Operation Expenditure (OPEX) estimation is a key and critical deliverable during the initial planning and execution of a new Capital Expenditure (CAPEX). It plays a major role in determining the feasibility of investment by ensuring the Return of Investment (ROI) is assessed properly and the Total Cost of Ownership (TCO) is injected into the Business Plan of the Entity. The benefits that flow from efficient trade-off between CAPEX and OPEX include optimum budget planning, resources allocation, minimizing current and future costs, compliance with regulations, new assets with increased performance and sustainability with lower maintenance costs. The OPEX estimation of the new CAPEX is developed and forecasted through different approach that depend of the availability of historical data, nature of the CAPEX and design requirements of the CAPEX. The OPEX estimate is forecast through a variety of methods including, Base-Step-Trend, benchmarking, market testing and bottom up forecasts where appropriate. The OPEX estimation shall be submitted during the CAPEX progress in accordance to the following table:

Project Stage	Delivery Name (As agreed)	Cost Estimate Class	Level of Project Definition	Expected OPEX Uncertainty (Accuracy) Range
Initial Planning	Initial OPEX Cost Estimate.	Class 5	0% to 2%	L: -20% to -30% H: +30% to +50%
Testing & Commissioning	Final OPEX Cost Estimate	Class 3	10% to 40%	L: -5 to -15% H: +10 to +20%
Handover & Closeout	Actual OPEX Cost.	Class 1	65% to 100%	L: -3 to -5% H: +3 to +10%

6.3.3 Operational Service Quality

The FM shall define the service quality for the completed asset in line with Entity expectations and operating budget. This includes all elements of the operation of the asset. The needs of the Entity and expectations of the Entity's customers will be the key drivers in the thinking around this topic.

This topic may involve the creation of a unique solution for every Entity and even for every asset owned or operated by an Entity. It is not possible to define every solution but there are common elements. Starting with the job the Entity has to perform the FM shall define the services needed to enable the asset to deliver those services to the standard expected by the customers of the Entity.

The FM creates the environment for services to be delivered and the consistent quality of the physical experience around the core service delivery by the Entity.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning, Chapter 11, Operations & Maintenance.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.

6.3.4 Sustainability

The FM shall define sustainability expectations for the completed asset. This shall include considering:

- Lifecycle of the proposed development
- Orientation of the building (to manage solar gain)
- Position, scale and shading of windows (to manage solar gain)
- Energy usage and metering
- Water consumption control
- Occupant sensors for lighting and HVAC control
- Out of hours HVAC temperature settings
- Solar panels for water heating and/or electricity generation
- District cooling (if available)



- Use of water efficient plants in landscaping
- Waste management
- Recycling
- Pest control

It is not possible to list every possibility to consider when looking at sustainability. However, it is important to list those that are most important to the operability and maintainability of the asset. The bullet statements below provide examples for consideration for the electrical supply to the asset:

- Does the purpose of the building require two sources of high voltage supply from different points on the grid?
- If not, does it require a permanently installed standby generator (or generators)?
- If that isn't necessary, does the building need one or more points in the system where a temporary generator can be connected to support all or part of the load of the building?
- Alternatively, would it be sufficient to have a UPS system installed to support key functions for a fixed period of time?

The decisions should be based on need and risk. Where a service must not be interrupted the FM and the project should act accordingly. Where there is limited risk to the building occupants or to the service provided if the supply fails then an appropriate option should be chosen.

Refer to:

- Expro Projects White Book, Volume 15, Sustainability
- National Manual of Assets and Facilities Management, Volume 17, Energy Management and Sustainability,
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning

6.3.5 Development of the Project Brief

The FM shall support the Project Manager in the development of the project brief. The support will take the form of ensuring the inclusion of requirements affecting the operability of the asset. Physical and financial implications shall be incorporated in the brief.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning, Chapter 11, Operations and Maintenance.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management

6.3.6 Feasibility Studies

The FM shall review the purpose of every feasibility study and provide input into those studies which affect the future operability of the asset, which may mean that all the studies require FM input.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning, Chapter 11, Operations and Maintenance.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management

6.3.7 Construction Project Plans

The FM shall assist with the development of construction project plans. The extent of this activity will vary with the scope and scale of the project and for the most part will consist of reviewing the plans as part of the project team to ensure that FM related inspections and FM sign off activities associated with stage gates are included.



Where the project is on an existing site the FM will review potential shut down activities for integration into existing services. The FM will review the impact on operating the facilities during project construction

The operational component to this activity is that the FM can plan for planning, specifying, tendering and letting Hard and Soft Services contracts to allow for the asset to be operated on the day of handover.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning, Chapter 11, Operations and Maintenance.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management

6.3.8 Operating Requirements

The FM shall define the operating requirements for the asset and shall brief the Project Team on the ultimate objectives of the project. This shall relate to the requirements of the Entity in relation to meeting the expectations of its customers.

These factors should be considered at this stage of the project:

- The core services which the Entity is obliged to provide
- Staff opening hours
- Public opening hours
- Space considerations for staff
- Space considerations for customers
- Comfort
- Lifecycle
- Obsolescence
- Energy consumption
- Ease of maintenance
- Ease of cleaning

Taking the last point as an example, the FM shall consider all of the surfaces which need to be cleaned. Materials should be chosen with a view to the cost effective operability of the asset over its appearance.

An example would be the use of black marble flooring in the entrance foyer. In a dusty environment the Entity will need to provide continuous cleaning of the floor during opening hours to provide a positive first impression to visitors. Choosing non-reflective, light colored, non-absorbent stone or tile for the foyer over black marble will provide benefits in terms of reduced OPEX every day of the asset's life.

Another example is access for maintenance or cleaning of elements of the asset. Every element of the asset must be capable of being maintained. There must be a methodology created by the project team and signed off by the FM for safe and efficient access to the entire external and internal envelope of the asset.

There is a need to consider operating hours to address asset lifecycle. Buildings which operate 24/7 work their HVAC and electrical systems harder and consequently often have higher maintenance and utility costs. This needs to be factored into OPEX planning.

Refer to:

- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.4 Concept Design



6.4.1 Entity Operational and Occupational Requirements

The FM shall ensure that the Entity operational and occupational requirements have been considered by the project team and incorporated into the design concept and construction contract(s). These requirements include:

- Location, size and topography of the site.
- Sufficient space to carry out the function provided by the Entity.
- Sufficient space for the recipients of the service.
- Potential future expansion, bearing in mind the anticipated life of the asset.
- Anticipated working hours for the asset.
- Availability of utilities at the proposed location.
- Corporate (Entity) identity or style.
- Sufficient space allowance for utilities, services, plant-rooms, storerooms and workshops. Information on good practice with respect to allowances for these elements can be found in BSRIA Rules of Thumb.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.4.2 Concept Design Drawings Review

The FM shall review design drawings on an ongoing basis. Not all of the drawings, whether paper drawings or drawings held electronically, will be available at once. The FM should be involved throughout as additional drawings may change the perspective on one or more elements impacting operability.

The main focus of the FM at this stage shall be on evaluating the access arrangements to plant, equipment, systems and components for maintenance purposes as well as on safe access for cleaning and maintaining the building envelope.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.

6.4.3 Concept Design Specification Review

The FM shall review design specifications on an ongoing basis with particular emphasis on evaluating the intended finishes to be adopted for the building envelope and internally.

Refer to:

- Expro Projects White Book, Volume 3, Project Initial Planning.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.

6.5 Detailed Design

6.5.1 Detailed Design Drawings Review

The FM shall review detailed design drawings on an ongoing basis. This activity continues from the concept stage. This stage includes development of the design of services, the FM role is to review and comment on the suitability of access to utilities and services and to determine whether there is safe and sufficient access for maintenance and replacement of plant and equipment in plant-rooms. The team will look to minimize the extent and duration of any shutdown required during construction.

At this stage there will have been consideration made for the internal transport and concealed storage of access equipment for use in maintenance and for cleaning the internal envelope of the asset. The FM shall review the proposed internal transport and storage arrangements and comment as necessary.



Refer to:

- Expro Projects White Book, Volume 6, Engineering.
- National Manual of Assets and Facilities Management Volume 5, Operations Management.

6.5.2 Detailed Design Specifications Review

The FM shall review detailed design specifications when they are issued and revised. At this stage the focus of the FM shall be on the philosophy of design in relation to all aspects of the asset. The FM is looking for quality systems and materials which are easy maintain and clean and which have a long potential life. The FM shall specifically look for materials which are optimized for the intended purpose.

The team shall check for the implications of obsolescence at this stage and consider how long parts and materials should be supported by the manufacturers.

Refer to:

- Expro Projects White Book, Volume 6, Engineering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.5.3 Constructability Review

The FM shall be part of the constructability review procedure to ensure that all constructability suggestion consider the followings:

- Make sure that any Constructability suggestion targeting to reduce project cost does not have an impact of the asset OPEX.
- Ensure that the design is aligned with the operation requirements.
- Full consideration shall be given to life cycle costs during the constructability review.
- Full consideration shall be given to the suitability of access to utilities and services and to determine whether there is safe and sufficient access for maintenance and replacement of plant and equipment in plant-rooms.

Refer to:

- Expro Projects White Book, Volume 6, Engineering.
- Expro Projects White Book, Volume 9, Chapter 2, Project Construction Constructability Procedure
- National Manual of Assets and Facilities Management Volume 5, Operations Management.

6.5.4 Asset Information

The FM shall define the requirements for developing the critical data for the operation and maintenance, this will include the development of the Asset Coding, Classification methodology, Tagging and Building Information Modelling (BIM) (if applicable). These data will be the basis for developing the information by the execution team and should be part of the projects documentation during the closeout & handover.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.

6.5.5 Value Engineering

The FM shall review value engineering proposals as these are often targeted at saving CAPEX cost with minimal consideration of consequences to OPEX. Full consideration shall be given to lifecycle costs before significant changes to design or specification are approved.



Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.

6.6 Tender for Construction

6.6.1 Construction Proposals

The FM shall review construction proposals to ensure compliance with Entity goals. If the construction proposals comply with the design and specification requirements, then this is likely to be straightforward.

This is the stage where warranty and defect liability periods shall be defined. The FM shall request that both of these periods commence at the time of final completion rather than commissioning.

The duration of time to deal with any snagging and punch lists shall be addressed at this stage. It shall be made clear in the construction contract that it is not permitted to use attic stock for the completion of snagging.

The FM shall prepare an estimate of the number and spread of maintenance personnel necessary to deliver the maintenance of the asset.

Refer to:

- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.6.2 Alternative Construction Proposals

The FM shall review alternative proposals for compatibility with Entity goals. Depending on how extensive the proposed changes are this may require the involvement of additional FM team members to complete a timely review. The FM shall comment on the suitability of proposals and those comments shall be factored into the decision around acceptance or otherwise.

Refer to:

- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 4, Financial Planning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.7 Construction

6.7.1 Construction Drawings and Building Information Modeling

The FM shall review Building Information Modeling (BIM) images or physical drawings, depending on which is specified in the contract, on an ongoing basis looking for compromises to operability and maintainability. This review shall happen as early as possible in the process. BIM has advantages in that, if used correctly, it will prevent services clashing with the structure and each other.

It is necessary to build in minimum access requirements to all maintainable items so that physical maintenance can be performed. This is achieved by having a virtual bubble around components and the extent of the bubble determines how close serviceable items may be to each other. This information comes from manufacturers and is built in to the design files of components, plant and equipment.

All equipment and components must be considered from this aspect. Poor access for maintenance is often a factor that negatively affects assets constructed without the benefit of BIM. Practical guidance for access is that the technician should be able to safely and comfortably rest his or her forehead on the maintainable component to allow for safe and ergonomically comfortable maintenance.

Refer to:



- Expro Projects White Book, Volume 4, Contracts and Tendering.
- Expro Projects White Book, Volume 5, Procurement.
- Expro Projects White Book, Volume 6, Engineering.
- Expro Projects White Book, Volume 9, Construction Management.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.

6.7.2 Site Walks

The FM shall physically inspect the site regularly and methodically throughout the construction process with a view to identifying compromises to operability as early as possible in the process. Although FM personnel are well versed in reading physical and electronic drawings, it is vital for the FM to inspect the site regularly as the physical world can highlight challenges which are less tangible on a screen or printed drawing. This activity is in addition to any formal inspection process instigated by the project manager.

Refer to:

- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.

6.7.3 Factory Acceptance and Site Acceptance Tests

The FM shall evaluate the need and attend Factory Acceptance Tests (FAT) and Site Acceptance Tests of equipment as deemed necessary.

Refer to:

- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.

6.7.4 Design Change Proposals

The FM shall review proposed design changes as this aspect can be challenging in terms of degrading operability. Where issues arise from these reviews the FM shall carry out an analysis of the implications to operability, maintainability and the OPEX budget.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- Expro Projects White Book, Volume 6, Engineering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 8, Inventory Management.
- National Manual of Assets and Facilities Management, Volume 9, Contracts Management.

6.7.5 Material Submissions

The FM shall review material submissions with a view to determining if they are consistent with expectations from the design and specification. The FM will be looking for hard wearing and easy to clean materials for the building fabric aspect and high quality easy to maintain components from a maintenance point of view. If the design and specification are rigorously developed material submissions should simply be there for reassurance of the FM and wider project team. By this stage the FM should be looking at surface finishes and visual appearance only.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.



6.7.6 Material Change Proposals

The FM shall review material change proposals with a view to determining whether the proposed materials affect maintainability, operability, asset life and future OPEX. If a material change proposal is likely to have a significant cost impact, then the FM shall evaluate that and present the conclusion to the Entity.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.

6.7.7 Physical Accessibility for Maintenance

The FM shall review physical accessibility for maintenance of assets, as issues are not always visible on a screen or on physical drawings. The FM shall be looking for maintenance space and safe access for maintenance.

Example: Drainage can be a significant challenge in this regard. Drainage is often the first of the services to be installed and is usually closest to the soffit on multi floor buildings. There can be issues with other services crowding the space around drainage lines and in particular around rodding points.

Drains in hospitals, for example, contain not only the normal unpleasant materials but also dangerous chemicals as well as poisonous residues from the treatment of patients. For this reason, it is imperative for the safety of maintenance staff that drainage systems are readily and safely accessible.

Refer to:

- Expro Projects White Book, Volume 6, Engineering.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.

6.7.8 A&FM / O&M Service Contracting Strategy & Plan

The FM will have been planning and establishing their strategy for maintenance and cleaning contracts since the Construction stage of the project. Many of the contracts will require a period of months to go through the procurement process so the planning around that should begin at the Construction stage. All contracts should be ready to commence at final contract handover, or earlier if phased handover of the facility is required.

The FM shall consult the Entity procurement function for guidance in relation to the timeframes for letting contracts so that the maintenance contractor has sufficient personnel on site to participate in both Operation and maintenance training.

The FM shall compile the information necessary to recruit the necessary staff or to hire a contract for maintenance.

For more details about A&FM / O&M Service Contracting Strategy & Plan, the user may refer to the NMA&FM Volume 9: Contract Management, Chapter 2 A&FM Contracting Strategies Procedure.

The Entity shall have Contracting Strategy document template.

Refer to:

- Contracting Strategy Tracking Sheet Template: EOM-KD0-TP-000009
- National Manual of Assets and Facilities Management, Volume 9, Contracts Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management

6.8 **Testing & Commissioning**

6.8.1 Commissioning Program



The FM shall review and comment on the commissioning program. The FM needs to understand the timing of planned activities in order to be able to arrange for people of the correct experience and discipline from the maintenance team to be present at the right time.

Refer to:

- Expro Projects White Book, Volume 10, Testing and Commissioning.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 10, Health, Safety and Environment.
- National Manual of Assets and Facilities Management, Volume 12, Risk Management.

6.8.2 Maintenance Staff Involvement

The FM shall invite maintenance staff to commissioning activities within their discipline so that they become aware of the location, nature and extent of the equipment as well as its performance. By participating in the commissioning process they will become familiar with the operation of the equipment and the transition from construction to operation will be smooth.

Refer to:

- Expro Projects White Book, Volume 10, Testing and Commissioning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 10, Health, Safety and Environment.
- National Manual of Assets and Facilities Management, Volume 12, Risk Management.

6.8.3 Critical Systems

The FM shall attend commissioning of critical systems. The extent of this activity depends on the complexity of the asset. The FM shall seek to understand how all the key systems operate. Electrical distribution and HVAC systems shall be a key focus but fire detection, fire alarms, security and access systems will also need the attention of the FM. The BMS will require a great deal of focus as the FM shall ensure that all connected systems are both monitored and controllable via the BMS.

Refer to:

- Expro Projects White Book, Volume 10, Testing and Commissioning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 10, Health, Safety and Environment.
- National Manual of Assets and Facilities Management, Volume 12, Risk Management.
- National Manual of Assets and Facilities Management, Volume 14, Emergency Management.

6.8.4 Commissioning Reports

The FM shall analyze commissioning reports in order to confirm performance criteria are met as well as confirming the interoperability of linked systems. This understanding will come from comparing physically measured data with information from the BMS. Discrepancies shall be addressed by the contractor to the satisfaction of the FM before sign off on commissioning.

Refer to:

- Expro Projects White Book, Volume 10, Testing and Commissioning.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.



- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9 Handover & Closeout

6.9.1 Final Design Documentation

The FM shall request and receive final design documentation and as-built drawings in the desired format and in accordance with the planned delivery time and as per Asset Management Software (AMS) data entry requirements. In the case of larger projects, the information may will come via the BIM system and in hard copy.

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 13, Document Management

6.9.2 Asset Register

The FM shall receive and review the information to be populate in the Asset Register prior to upload to a LIVE AMS. The information shall be provided in a format compatible with the AR (Asset Register) and Asset Management standard and Software (AMS).

Refer to:

- Asset Data Capture Template: NPM-ZA0-TP-000011
- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management

6.9.3 Operational Manuals

The FM shall request and receive operational manuals in the desired format and in accordance with the planned delivery time. This shall include operational information for every installed system in the asset. The information shall be provided electronically and if required by the contract in hard copy as well.

The information must also be provided for the safe and efficient operation of each engineering system, under normal and emergency conditions. These will be in addition to manufacturers' literature for plant items, and should include:

- A recommended strategy for operation and control
- An outline of the general operating mode
- Control data (location, effect, object, sequence, limits of capability, modes, set-points)
- Standard operating and emergency operating procedures, and sequences for start-up, running and shut-down, under normal and emergency conditions. These should be accompanied where possible with photographs or video recordings of the standard operating and emergency operating procedures
- Interlocks between plant items
- Operating procedures for stand-by plant
- Precautions necessary to overcome known hazards
- How any potentially hazardous plant can be made safe
- Target figures for both energy consumption and energy costs
- BMS supporting systems



- Any supporting forms for recording plant running hours, energy consumption and energy costs

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 13, Document Management

6.9.4 Maintenance Information

The FM shall request and receive maintenance manuals in the desired format and in accordance with the planned delivery time. The maintenance information for each and every installed system and piece of equipment shall be provided in a format compatible with the Entity's Asset Management System and Software (AMS).

Details of the manufacturer's recommended planned maintenance shall also be provided in soft copy and in a compatible format so that the maintenance team can combine those with the asset register in order to devise an evenly distributed Planned Maintenance (PM) regime.

The manufacturer's recommendations and instructions for maintenance are to be detailed for each item of plant and equipment installed. Clear distinction should be made between planned tasks (preventative maintenance) and work done on a corrective basis. Instructions should be given on each of the following:

- The isolation and return to service of plant and equipment
- Adjustments, calibration and testing
- Dismantling and re-assembly
- The exchange of components and assemblies
- Dealing with hazards that may arise during maintenance
- The nature of deterioration and checks for defects
- Special tools, test equipment and ancillary services

A comprehensive list of the spare parts required for maintenance together with the relevant suppliers shall be provided. This should comprise a parts identification list detailing and identifying replaceable assemblies, sub-assemblies and components. It should include suppliers' recommendations for both spares and running spares (parts required for replacement due to wear or deterioration).

Items normally held in stock by a supplier, or for which a refurbishment service is available, should be identified separately.

A spares policy with supporting spares list will need to be defined for the project which is designed to offer a guide to the setting up of a spares facility including recommended stock levels. It should be prepared as part of the consultation with the handover documentation this covering the consequences of failure, risk to core business, and the period of acceptable downtime. This should also consider and detail the suppliers' recommendations as given above. Again, those items are normally held in stock by a supplier (or for which a refurbishment service is available) should be clearly identified.

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 7, Work Control.
- National Manual of Assets and Facilities Management, Volume 13, Document Management

6.9.5 Attic Stock



The FM shall request and take delivery of attic stock at the specified locations in accordance with the planned delivery times. The FM shall check the supplied items for completeness and damage.

Attic Stock may include capital spares as an element of the construction contract. These spares should be segregated and stored according to their physical needs, so that they are available and fit for use when required.

The list of consumables is intended to be available in full from the time of handover. It is important to check that AC filters, as an example, in the attic stock have been replenished after commissioning.

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.6 Special Tools

The Project contractor shall identify and inform the Entity / Contractor of any specialist tools required to carry out maintenance activities. The FM shall take delivery of any special tools provided with the installed or provided equipment. It is important to check at this stage that the actual number of tools provided is in line with the contract. As an example, in many instances, chillers should each come with a set of special tools. Any required specialist training should be provided the project team to entity or contractor.

On provision or partial provision of special tools can lead to the inability to maintain plant or equipment which has implications for sustainable operation as well as for reduced life of the affected plant or equipment. The procurement of specialist tools should be covered in the contracts, either in projects or maintenance contracts.

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.7 Security Devices

The FM shall request and take delivery of physical and electronic security devices including keys and passes. This will be in conjunction with the Security department who will receive specific items which are outside of the responsibility of the FM department.

The FM shall ensure that all items are handed over in the numbers expected.

The FM shall take possession of master keys and sub-master keys and shall ensure that those are stored safely and securely. Losing a master key can involve great expense in changing locks.

The FM shall take possession of any access card programming equipment and ensure that it is stored safely.

Refer to:

- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.8 Maintenance Training



Maintenance training shall form part of the construction contract as a deliverable. The main construction contractor shall propose the training program prior to the commencement of the commissioning phase. The delivery of training shall be completed prior to the final handover (before the final acceptance of the project deliverables). The FM/O&M will confirm a list of trainees that represents the range of maintenance tasks applicable to the engineered systems. The FM/O&M and contractor will agree the program of classroom and site activities, including but not limited to practical demonstrations of early indications, fault finding, resetting, start up, shutdowns, isolation, access, removal, mitigation, temporary services, disposal, site delivery/collection, reinstatement and Post Maintenance Testing of assets/components subject to minor and major planned maintenance tasks and agreed limited unplanned maintenance scenarios. Witnessing/shadowing during commissioning and Defect Liability Period phases will also be promoted.

The FM/O&M team are required to nominate a training coordinator (technical competent staff will be in place when the project completed by 70% - 80%) to agree and record all trainings and to familiarize the teams initially. This role will include joining any gaps and ensure effective communications. Following the handover this role will be the most important role, as this coordinator should be familiar with all systems, warranties and contractual terms and conditions. Key experienced systems FM/O&M managers should be in place or clearly identified to take the handover of each of the critical systems, in conjunction with the training coordinator.

Cleaning of high level areas and confined spaces (such as water tanks and drainage systems) should be included in maintenance training.

All passwords, 'admin' access permissions, system self-diagnosis/reporting fault codes explanations will be provided, including training on the 'Internet of Things' (IoT) and remote access/diagnosis/repair.

Refer to:

- Expro Projects White Book, Volume 10, Testing and Commissioning.
- Expro Projects White Book, Volume 16, Handover and Closeout.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 6, Maintenance Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.9 Electronic Systems (with the exception of IT)

The FM shall review and accept all of the electronic systems. All of them shall be shown to be fully operational with all of the intended functionality demonstrated. All of the systems are important in their own way.

The most critical from an operability perspective is the AMS system, if specified on a project. The BMS must be integrated to every element specified and must be demonstrably capable of reading and controlling every element specified. If that is achieved then energy consumption of the asset will be minimized for the entire life cycle, thus controlling OPEX.

The proposed AMS Software shall be scalable and highly available to accommodate AMS future expansion of O&M contracts or facilities to scale the data with hierarchal structure followed by the entity. This will include the ability to make relevant changes to the AMS to support future business processes and workflow and any integration requirements for PDA/Hand held devices and potentially a unified contact center environment.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- Expro Projects White Book, Volume 6, Engineering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.10 Warranty Information



The FM shall review and receive warranty information in a format compatible with the AMS. This is often a complex task as each piece of equipment has its own warranty conditions as well as a duration stipulated by the contract or defined by the manufacturer or supplier.

Warranties often commence when the individual piece of equipment is commissioned so there could be hundreds of warranty end dates which need to be managed in terms of the level of maintenance required.

The Entity and project manager should insist that warranty commences at final project handover in order to maximize the duration of cover.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.11 Defect Liability Period

The construction contract will define the DLP. During that time, which normally begins at the time of final handover from the contractor to the Entity, the contractor is obliged to correct any defects arising with the exception of wear and tear.

Construction contracts incorporate a retention of funds which is only released to the contractor at the end of the DLP. In the event that the contractor does not carry out repairs then the cost of completing these can be withheld from the retention payment.

The FM shall review and understand DLP documentation for all items which comprise the asset in a format compatible with the AMS.

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.

6.9.12 Maintenance Contracts

The FM shall review and receive maintenance contracts for specialist equipment in a format compatible with the AMS.

There is no fixed list of maintenance contracts, however the following equipment/systems often come with a maintenance contract:

- Elevators
- Escalators
- Fire detection
- Fire fighting
- BMS
- HVAC Chillers
- Access control
- CCTV

Refer to:

- Expro Projects White Book, Volume 4, Contracts and Tendering.
- National Manual of Assets and Facilities Management, Volume 2, Asset Management.
- National Manual of Assets and Facilities Management, Volume 5, Operations Management.
- National Manual of Assets and Facilities Management, Volume 9, Contracts Management.
- National Manual of Assets and Facilities Management, Volume 13, Document Management.