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Phone: +1.304.2968444
E-mail: info@aacei.org
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Basic Technical Paper Template
(Rev. 2010-04-05)

Richard P Helper; PSP and William J Mihelich
31805 and 04492

A Template for EPC Project Management and Execution

January 26, 2016

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Abstract

Cost, Scheduling, Earned Value, WBS, Risk Management, Change Management, KPIs, AACE Recommended Practices - there is an overwhelming amount of published information readily available to today's project management professionals. Trying to implement all the available tools, techniques and practices without a system to organize, choreograph and integrate project execution and management processes will not produce consistent results. Many organizations face this problem. This paper will present a case study in how a major EPC contractor created an EPC project template featuring graphical process maps and gated milestones. The processes incorporate AACE Recommended Practices as well other industry and company practices. This paper will also show how supporting documentation such as handbooks, manuals, milestone review checklists and training programs are integrated, creating a complete operations system. The EPC Template is the glue that holds all the elements of project execution and management together in an organized, life cycle phased, collaborative environment developed using Microsoft Office and Adobe Acrobat files all residing on a Share Point site.

Introduction

Project management professionals have been continuously looking for ways to improve the project execution and management delivery process since the days of the Egyptians and Romans. The development of the Critical Path Method in the late 1950s heralded in an era of exponential knowledge growth and collaboration based around mathematical models for time management. Time management evolved into resource and cost management. Subsequently, the knowledge base broadened to include non-mathematical solutions. Over the past several decades, several organizations have formed which have made significant contributions in knowledge of techniques, tricks, traps and lessons learned to elevate the competence of project management.

AACE International (AACE) was established in 1956. The Project Management Institute (PMI) was established in 1969. The Construction Industry Institute (CII) was established 1983. These are three leading organizations that provide standardization in terminology and methodologies for managing projects. Additionally, AACE and PMI offer credentialing and certification.

For several decades, AACE have published the monthly "Cost Engineer" magazine, which featured several technical papers. Each year, they compile the technical papers of presentations of the Annual Meeting into the "Transactions". Thousands of Technical Papers have been published. In addition, they maintain a library of Recommended Practices.

CII has published almost seven hundred products consisting of Research Summaries, Research Reports, Implementation Resources, technical specifications and training courses. Research Reports are typically in excess of two hundred pages.

In more recent years, social media has provided a forum in which an overwhelming amount of individual publications and commentaries are uploaded on a daily basis. On any given day, a significant number of discussions can be found on LinkedIn addressing topics such as Project Management, Cost Control, Scheduling and Risk Management.

This paper focuses on how a large, publicly traded Engineer, Procure, Construct (EPC) company documented and organized their project execution and project management processes. After mapping existing processes, they aligned AACE and CII publications to them. This allowed for documenting integration of AACE Recommended Practices and CII Best Practices. Upon completion, the company had a complete set of project execution and management processes based on industry recommended and best practices. A system for assigning responsibility and verifying compliance supports the implementation of the processes. All the documentation is uploaded to a share point site available to project team members wherever they have an internet connection.

The Problem: How to organize information for use within the company.

As previously stated, there are libraries of published books, journals, technical papers, research papers in addition to spreadsheet tools, recommended practices, best practices which all contain useful information and guidance. AACE and CII each have a system of organization of their knowledge base.

AACE have developed the TCM Framework as shown in Figure 1 below. "*The TCM Framework is a structured, annotated process map that for the first time explains each practice area of the cost engineering field in the context of its relationship to other practice areas including allied professions*". [1]

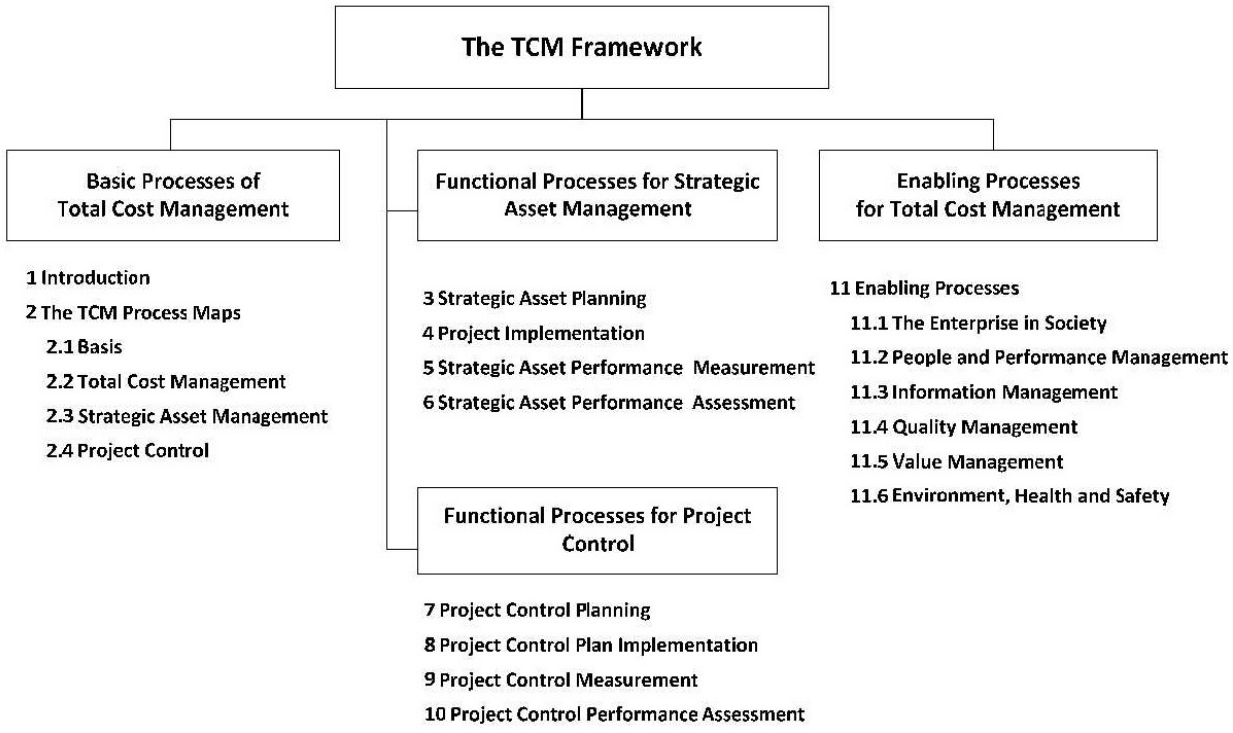


Figure 1 - The TCM Framework [2]

CII have organized their body of knowledge into a topological form called Knowledge Areas. The current list of Knowledge Areas is:

00 – General CII Information

01 – Project Planning

02 – Design Optimization

03 – Procurement and Materials Management

04 - Construction

05 – Facility Startup and Operations

06 – Human Resources Management

07 – Project Organization and Management

08 – Business and Project Processes

09 – Project Controls

10 – Risk Management

11 – Safety, Health and Environment

12 – Information Management and Technology Systems

13 – Globalization Issues

14 - Security

Knowledge Areas are further broken down into practice areas. Current practices are designated as Best Practices; the remaining are designated as Other Practices.

In both cases, the knowledge repository consists primarily of publications. AACE publications are typically knowledge sharing or case studies and focused on project controls. A knowledge sharing publication may address how to perform a technical task, such as calculating Earned Value or calculating acceleration. Case studies are similar to this paper: success stories resulting from the application of knowledge sharing.

CII publications focus more widely on industry problems such as change management, craft productivity improvement. Their scope expands beyond project controls into project execution areas such as procurement, constructability and even guidelines for technical specifications. Generally, they provide a technique for producing an intended result.

Both organizations represent a wide range of constituents from industrial, infrastructure, and building contractors, owners and government organizations. As a result, they have to provide somewhat generic solutions. Furthermore; they don't address all the knowledge areas that encapsulates an EPC contractor's required expertise.

Some of the additional information needed to configure generic solutions to a specific company include:

1. Who in the organization is responsible for implementing the actions included in the solution?
2. How the solution integrates with company specific solutions?
3. When in the life cycle of the project is the solution implemented?

Knowledge areas not addressed include:

1. Process engineering
2. Detailed Design
3. Quality Control

The rest of this paper will address how one EPC company has solved the problem of organizing knowledge areas and incorporating industry recommended practices in an integrated and collaborative environment.

The case study company was incorporated in 1984. Initially, they provided maintenance and repairs to oil tanks in Tulsa, Oklahoma. As their tank business grew, they added capabilities to construct new tanks. This lead to acquiring an engineering group that could design tanks. Other acquisitions lead to maintenance work in refineries. Yet other acquisitions lead to maintenance and small cap capabilities in other industries. As the new organizations came onboard, they kept their old ways of doing projects. The company has self-perform competence in civil, concrete, equipment installation, tank construction, process piping and high voltage substations. Industries served include Electrical Infrastructure, Oil Gas and Chemical Facilities, Liquid and Gas Storage facilities, mining and industrial facilities.

The company leadership has made a business decision to homogenize the various organizational groups into an integrated company that can seamlessly work together to provide large cap EPC services in addition to maintain their existing stand-alone capabilities.

Initially, each operating unit had some degree of procedural documentation. However, the size and complexity of projects contemplated required a significantly different approach to proposing and executing projects. It was decided to start from a "clean sheet of paper". Rather than write handbooks or text, it was decided to build a corporate knowledge base in a graphical environment. As the case study company is a member of CII and several managers are members of AACE; it was decided to take advantage of the opportunity to integrate Recommended Practices and Best Practices into the company specific processes.

The next step is to create the structure of the graphical environment and the process for integrating AACE Recommended Practices and CII Best Practices.

Step 1: Define and Organize "What You Do"

The first step to take toward integrating Recommended Practices is to understand the current practices. If the philosophy that an EPC contractor adds value to the project is accepted, an analogy can be made to the typical EPC project; a process facility. A process facility takes feedstock as inputs; the facility adds value and produces products and byproducts as outputs. In the same way, an EPC contractor takes an owner's business case; adds value through the application of engineering, procurement and construction services, culminating with the turnover of a working process facility to the owner.

In reality, the EPC process is a compilation of hundreds of discipline processes choreographed throughout the project life cycle. Each of these discipline processes also have inputs; add value and produce outputs. Hundreds of processes require an organized structure.

Using the case study company; at the highest level, processes are grouped into two functional areas: Project Execution and Project Management. Project Execution processes represent those processes which are required to produce the client's scope of work. Project Management processes are those processes which are needed to ensure the scope of work is produced safely, cost effectively, timely; meets client contract requirements and meets the company's requirements.

As an EPC contractor; it was logical that the project execution processes be grouped by engineering, procurement, construction. Beyond each end of the EPC project life cycle, the company provides additional services. Ahead of engineering, front end planning services can be provided which may be stand alone or in conjunction with an EPC project. Commissioning and Start up services can be provided at the tail end of the project followed by continuing maintenance of the facility. Each of these groupings (engineering, procurement, etc.) are called Key Activities. CII refers to them as Knowledge Areas.

The Key Activities identified in Figure 2 provide the vertical structure of the EPC Project Template.

PROJECT MANAGEMENT KEY ACTIVITIES	PROJECT EXECUTION KEY ACTIVITIES
PM01 FRONT END PLANNING MANAGEMENT	PE01 FRONT END PLANNING EXECUTION
PM02 PROJECT EXECUTION MANAGEMENT	PE02 HSE IN DESIGN
PM03 CONTRACT MANAGEMENT	PE03 SYSTEM ENGINEERING
PM04 RISK MANAGEMENT	PE04 LAYOUT, 3D MODELING AND DISCIPLINE DESIGN
PM05 QUANTITY MANAGEMENT	PE05 PROCUREMENT
PM06 ESTIMATING AND COST CONTROL	PE06 SUBCONTRACTING
PM07 PLANNING AND SCHEDULING	PE07 FABRICATION AND CONSTRUCTION
PM08 CHANGE MANAGEMENT	PE08 COMMISSIONING
PM09 HSE MANAGEMENT	
PM10 QUALITY MANAGEMENT	
PM11 INFORMATION MANAGEMENT	

Figure 2 - Key Activity Structure

The naming structure is as follows: “PM” for Project Management; “PE” for Project Execution. This prefix will follow through the naming of all documents of the EPC Template.

The EPC project life cycle provides the horizontal structure of the EPC Project Template. Figure 3 depicts the entire project life cycle beginning with Front End Planning (FEP) and continuing through the EPC phases.

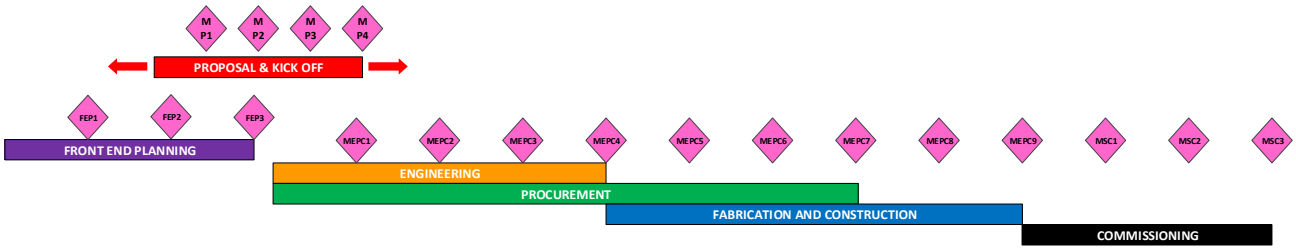


Figure 3 - EPC Project Life Cycle

The names of the phases are the same as those commonly used throughout the industry. As a result of phase overlap during most of the project life cycle, the EPC project cannot be discreetly defined as being in any single phase. However, each specific gate has interlocking relationships between activities in each of the active phases at that point in time.

The red Proposal & Kickoff phase is depicted as movable. Because the case study company provides Front End Planning (FEP), EPC and Construction (C) services, this phase “slides” to represent the different points along the project life cycle a specific contract begins.

The magenta diamonds shown above the phases represent milestones or gates. The time increment between milestones or gates is called a sub phase. Each sub phase has a unique Alpha-numeric number as well as a name to characterize the work performed during that time period. Figure 4 depicts the first four sub phases after EPC contract award. These sub phase names reflect engineering activities, but also include references to procurement and construction. While the EPC Project Template shows the milestones in equidistant spacing; this does not represent time intervals. As an example, it may only take eight weeks from project award to complete all the work to achieve Milestone EPC 1 (MEPC1); whereas it will take several months to complete all the work required to achieve Milestone EPC4 (MEPC4).

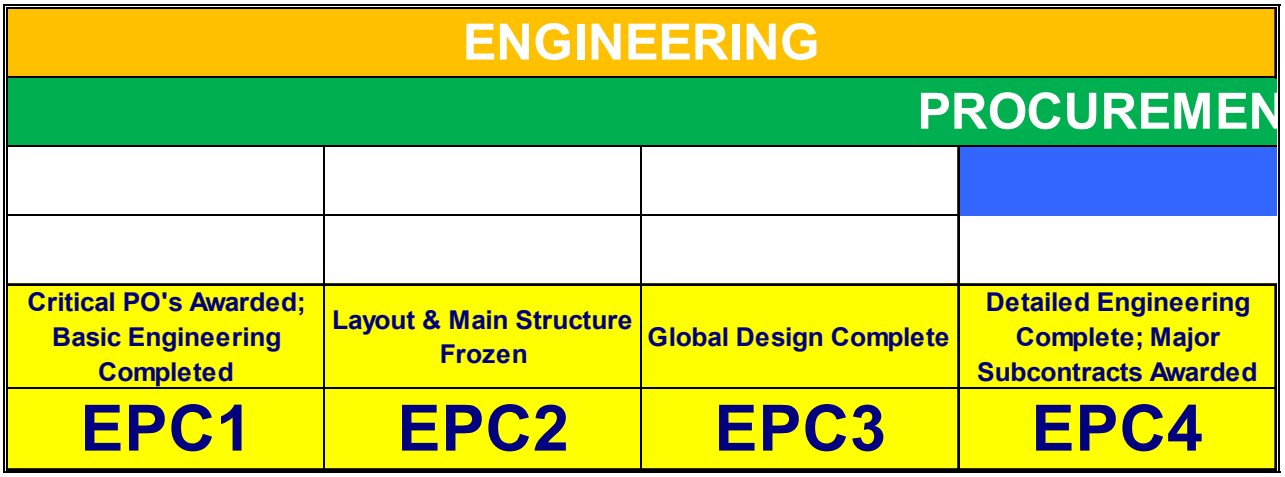


Figure 4 - Engineering Sub phases

The EPC Template is structured in two hierarchical levels of detail; Control Level and Execution Level.

The Control Level is an executive and managerial level that reflects experience and knowledge. The names of each sub phase try to capture the essence of activity in that sub phase. Significant activities for each sub phase are “Milestone Objectives”. The completion of these objectives by their required milestone date provides an executive or management level confidence the project is on track.

The milestone objectives for the first four EPC sub phases are itemized in Figure 5.

Critical PO's Awarded; Basic Engineering Completed	Layout & Main Structure Frozen	Global Design Complete	Detailed Engineering Complete; Major Subcontracts Awarded
EPC1	**EPC2**	**EPC3**	**EPC4**
Piping & Instrument Diagram -Material Selection reflected - Pipe spec & spec breaks -Valves shown -Lines shown with estimated sizes -Design Basis issued -'First Supplier Information' included for 1st Priority equipment Master Equipment List - Draft equipment list completed (Initial Info) - 'First Supplier Information' included for 1st Priority Equipment	Piping & Instrument Diagram -Critical lines sized - HAZOP performed -PCV/PSV and inline instruments sized -'First Supplier Information' included for 1st Priority equipment Master Equipment List -All Tagged items listed -'First Supplier Information' included for 2nd Priority Equipment	Piping & Instrument Diagram -All lines sized -HAZOP comments incorporated -Vents & drains identified -P&ID/3-D model comparison done -'Frozen Supplier Interface Information' included for 1st, 2nd & 3rd Priority equipment Master Equipment List -Equipment list ready to be used as basis of design -All tagged items contain process data, load data -'Frozen Supplier Interface Information' included for 1st, 2nd & 3rd Priority Equipment	Piping & Instrument Diagram -All instrument logic reflected - Control and alarm settings included -Certified/final approved vendor info implemented Master Equipment List -Equipment list ready to be issued as a construction/field support document -Information updated based on 'Final Approved Supplier Information' for all Equipment

Figure 5 - Milestone Objectives

At the Control Level, all projects are aligned to meet the same milestone requirements. This allows for standardization of key performance indices across the enterprise.

The lower level is the “Execution Level”. The Execution Level is comprised of processes, performance requirements, handbooks, manuals, forms or reports and milestone checklists. The Execution Level is where standard processes are configured for the specifics of an EPC project. It is also the level at which the project team performs their work.

A process is the fundamental building block of both the project and the organization. It is where the company catalogs what they do. As stated earlier, a process adds value to inputs to create outputs. In the engineering phase of an EPC project, the inputs and outputs are information. Information can come from publications, such as AACE RPs; it can be a report, a calculation, a building code or a client decision as examples. In the same way, outputs can be forms or reports, calculations, drawings, specifications, data or other products.

Figure 6 is the map of Project Execution processes performed to complete the Front End Planning deliverables for a process facility. Engineering is comprised of several iterative processes. The process map is not a critical path schedule and therefore does not show all the logic relationship lines.

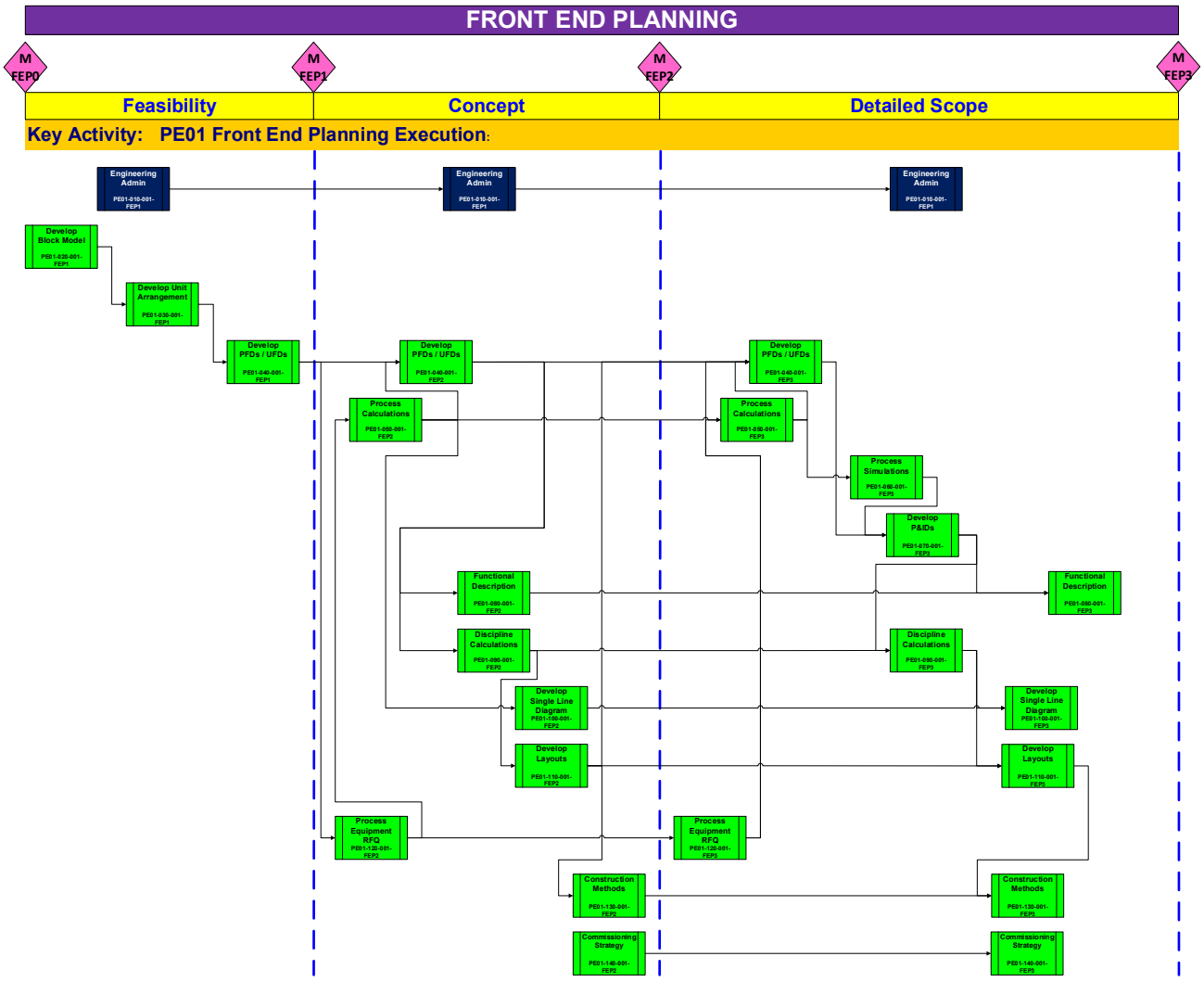


Figure 6 - Front End Planning Execution Process Map

Complementing the Project Execution processes, the Figure 7 shows the map of Project Management processes to manage the development of Front End Planning deliverables of a process facility.

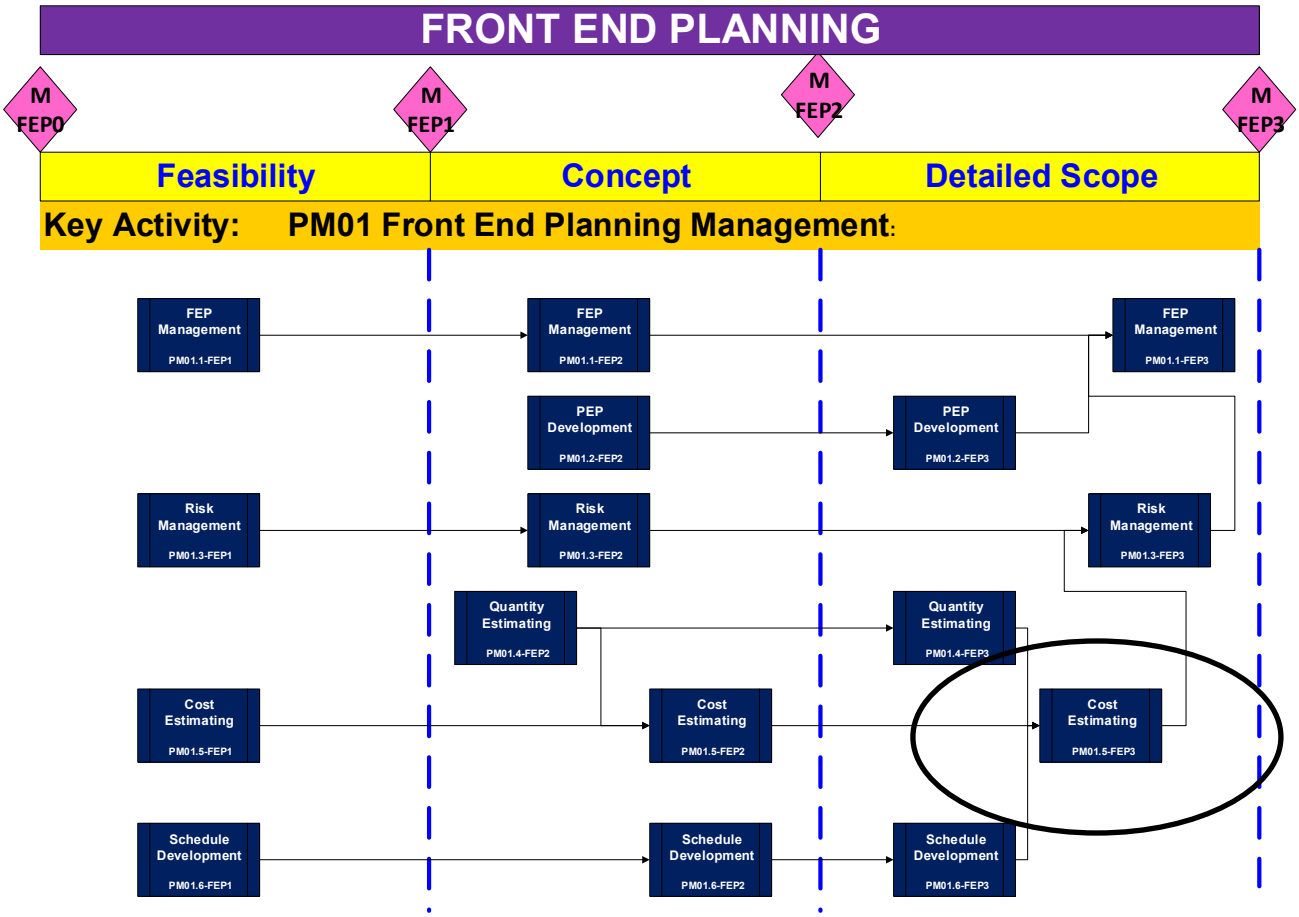


Figure 7 - Front End Planning Management Map

The previous two figures depict the processes defined for Project Execution and Project Management that represent the work necessary to complete the Front End Planning deliverables for a client. The processes are placed on the map in their respective sub phases to support the Milestone Objectives. Some key driving logic is shown, however this is a process map and is intended as a general flowchart and is not intended to be a substitute for Critical Path Method logic.

Each of the processes shown on the process maps is supported by an exploded view called an Activity Flow Diagram (AFD). The AFD shows all the internal and external inputs; relationships to other processes and outputs resulting from the process. The AFD also includes references to its position in the project life cycle through the goal post Milestones.

Figure 8 is the AFD for Cost Estimating during the Detailed Scope sub phase:

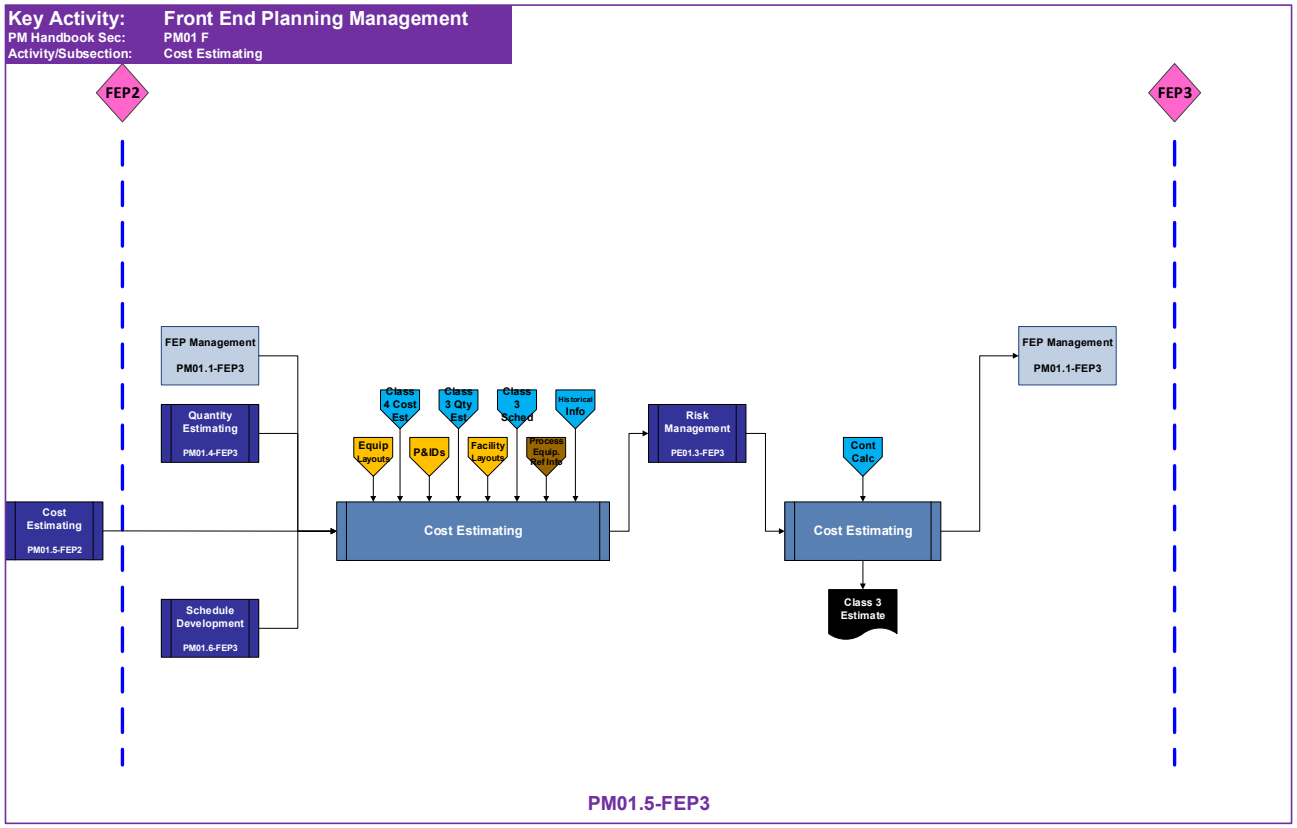


Figure 8 - Activity Flow Diagram

The inputs are the "home plate" shapes on top with pointing into a green rectangle shape which represents discreet activities of the process which are further defined in a Handbook. The inputs are color coded: gold represents information provided by the engineering group, blue represents inputs provided by the construction group and brown represents client and supplier inputs. Note the terminology used to describe several of the inputs; the Class 4 estimate from the previous sub phase, the Class 3 quantity estimate and Class 3 Schedule both from the current sub phase. This terminology comes from several AACE Recommended Practices.

The black output shape represents the deliverables. The deliverables can be information needed for a downstream step or process, reports or updates to reports. In this case, the deliverable is the Class 3 Estimate. The process is goal posted at each end by Milestones. This process starts after Milestone FEP2 (MFEP2) and must be completed by Milestone FEP3 (MFEP3).

Step 2: Integrate Recommended Practices

With the company's current processes documented in the EPC Project Template, the next step is to align with the industry practices considered for integration.

AACE provide a hyperlink on their website to download an Excel version of their Recommended Practices list. The list includes the publication number, name, revision date and description. Once downloaded, additional columns were added to the right of the description which are used to provide implementation comments and to cross reference to the applicable EPC Project Template processes and Handbook Sections.

CII publications are listed on the CII website, however, no list is available in a downloadable format. It took many hours to consolidate a comprehensive list of publication numbers, descriptions, publication date and description information in an Excel list from all the pages on their website. As with the AACE list, the CII list was also used to cross reference to the EPC Project Template processes and Handbook Sections.

Many of the Recommended Practices result in principles that can be applied, however many of them result in discreet inputs and outputs of processes as well as specific terminology or definitions that can be used.

An example of how the case study company aligned an AACE RP to the EPC Template is shown in Figure 9. The background layer shows the data downloaded from AACE's website and the additional columns added for the case study company. The middle layer is a magnified portion of the AACE Recommended Practice Description. The top layer is a magnified section that shows high level comments regarding the extraction of relevant information from the AACE Recommended Practice. Where applicable, specific EPC Template processes, Handbook Sections and Forms/Report Numbers are included.

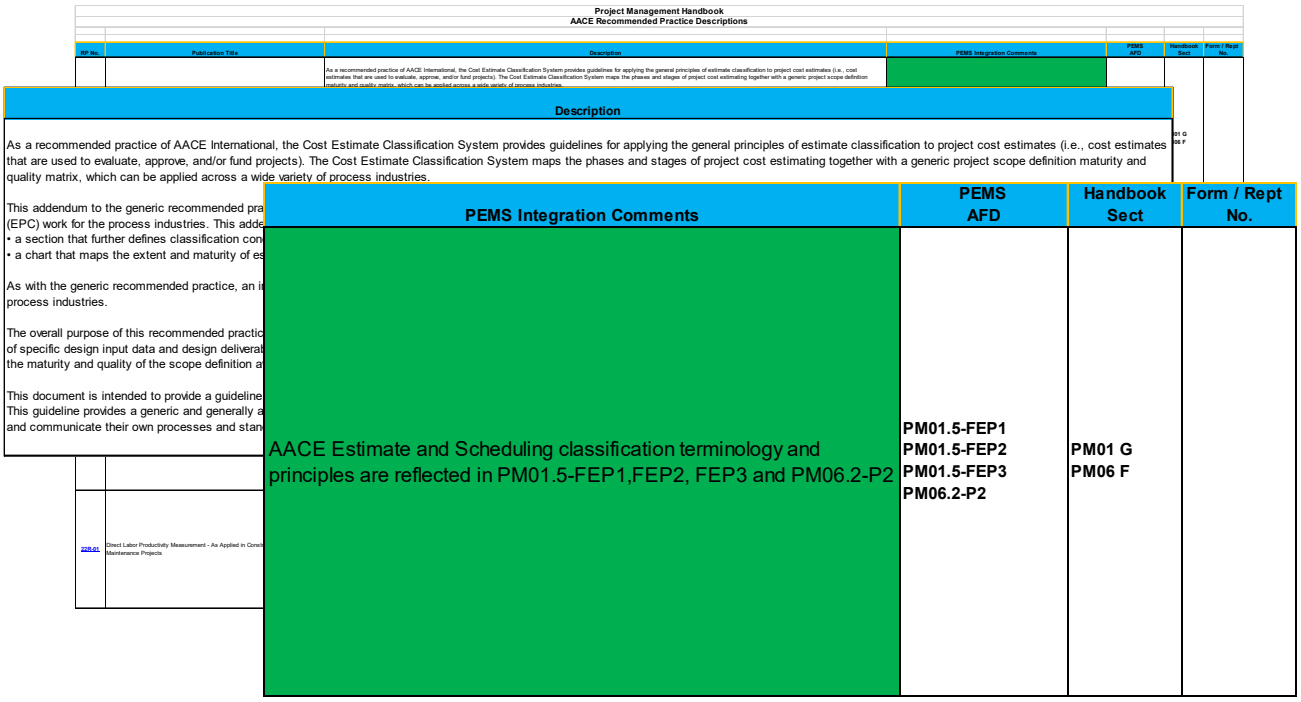


Figure 9 - AACE RP to EPC Template Alignment

Having completed this for all the AACE Recommended Practices, alignment is complete. The next step is to integrate the applicable information into company specific processes and handbook text.

The terminology in Figure 10 was carried over for use in the case study company's processes. [3]

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Figure 10 - Estimate Classification System Matrix and Guideline

AACE RP 27R-03, Schedule Classification System uses the same class and maturity level information – and in fact refers back to AACE RP 18R-97. [5]

Comparing usage purposes for each of the estimate classes; note the alignment with sub phases in the company EPC Template:

AACE End Usage	EPC Template Sub Phase
Concept Screening	FEP1
Study or Feasibility	FEP2
Budget Authorization…	FEP3
Control…	P2 (EPC Proposal)
…Bid/Tender	P2 (Plans & Specs Bid)

Additionally, the Estimate Input Checklist and Maturity Matrix in AACE RP18R-97 shown in Figure 11, was used as the starting point for aligning company specific inputs. [4]

	ESTIMATE CLASSIFICATION				
General Project Data:	**CLASS 5**	**CLASS 4**	**CLASS 3**	**CLASS 2**	**CLASS 1**
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:					
Block Flow Diagrams	S/P	P/C	C	C	C
Plot Plans		S	P/C	C	C
Process Flow Diagrams (PFDs)		S/P	P/C	C	C
Utility Flow Diagrams (UFDs)		S/P	P/C	C	C
Piping & Instrument Diagrams (P&IDs)		S	P/C	C	C
Heat & Material Balances		S	P/C	C	C
Process Equipment List		S/P	P/C	C	C
Utility Equipment List		S/P	P/C	C	C
Electrical One-Line Drawings		S/P	P/C	C	C
Specifications & Datasheets		S	P/C	C	C
General Equipment Arrangement Drawings		S	P/C	C	C
Spare Parts Listings			S/P	P	C
Mechanical Discipline Drawings			S	P	P/C
Electrical Discipline Drawings			S	P	P/C
Instrumentation/Control System Discipline Drawings			S	P	P/C
Civil/Structural/Site Discipline Drawings			S	P	P/C

Figure 11 - Estimate Input Checklist and Maturity Matrix

Figure 12 shows the AACE Input Checklist and Maturity Index aligned to the EPC Project Template structure. This figure is included in several Handbook locations; PM06 Estimating and Cost Control and PM07 Planning and Scheduling. Each of the AACE estimate and schedule classifications correlate to sub phases in the Front End Planning or Proposal phase. Vertically, deliverables are organized by Key Activities. Additional deliverables were added that our case study company has determined are necessary for a complete Front End Planning and/or proposal submission. They also provided a more detailed description of the quality of information used to describe the deliverables across the sub phases. The deliverables are further defined in the Estimating Handbook as well as in client agreements and supplier agreements in order to communicate expectations and ensure consistency for management review and risk analysis.

ESTIMATE & SCHEDULE CLASSIFICATION					
AACE Estimate and Schedule Class	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
EPC Template Subphase	**FEP1**	**FEP2**	**FEP3**	**P2 (EPC Proposal)**	**EPC4/P2 (Plans&Specs)**
Client Supplied Information / Decisions					
Site Location	Locations Identified	Locations Identified	Location Selected	Location Selected	Location Selected
Soils and Hydrology	Assumed Soils Conditions	Prelim Soils Rept	Final Soils Rept	Final Soils Rept	Final Soils Rept
Plant Production / Facility Capacity	Requirements provided	R equirements reflect Feasibility Study	Requirements Frozen based on selected technology	Requirements Frozen	Requirements Frozen
Project Management Deliverables					
Project Scope Description	Feasibility	Concept	Defined	As Sold	Detailed
Project Execution Plan		Draft	Defined	EPC	Detailed
Contracting Strategy		Draft	Defined	EPC	Detailed
Risk Register (CII 280-3)		Identification	Deterministic	Probablistic	Probablistic
Escalation Strategy			Defined	Detailed	Detailed
WBS	Level 1	Level 2	Level 3	Level 4/3	Level 5/4
Code of Accounts				Stem	Detail
Project Execution Deliverables					
PE01 FEP Execution					
Block Flow Diagrams	Complete				
Unit Arrangement	Complete				
PE03 System Engineering					
Process Flow Diagrams (PFDs)		Based on Process Equip Reference information; Major Lines Sized	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Utility Flow Diagrams (UFDs)		Based on Process Equip Reference information; Major Lines Sized	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Heat & Material Balances		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Functional Description		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated	Issued for Design
Site Pl					ction
Facility		Estimated BOP Equip	Estimated BOP Equip Info	Information	ction
Equipment Plan		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Construction
Piping and Instrument Diagrams (P&IDs)		Based on Process Equip Reference information; Major Lines Sized	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Process Equipment List		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Utility Equipment List		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
Electrical One Line Diagrams		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info; BOP Equip Reference/Estimated Information	Issued for Design
PE04 Layout, 3D Model, Discipline Design					
BOP Equipment Specifications and Datasheets		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info / Esimated BOP Info	Issued for Design/Purchase
General Equipment Arrangement Drawings		Based on Process Equip Reference information; Estimated BOP Equip	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info	Based on Process Equip Proposal Info / Esimated BOP Info	Issued for Construction
Materials Specifications			Reference	Reference	Issued for Construction
Mechanical Discipline Drawings					Issued for Construction
Electrical Discipline Drawings					Issued for Construction
Instr/Control System Discipline Drawings					Issued for Construction
CSA Discipline Drawings					Issued for Construction
PE05 Procurement					
Spare Parts Lists			Based on Selected Process Equip/Estimated BOP Equip	Based on Process Equip Proposal Info / Esimated BOP Info	Based on BOP Frozen Info
Process Equipment Information	Estimated	Reference	Proposal (to Owner)	Proposal (to EPC)	Issued for Construction
BOP Equipment Information	Estimated	Estimated	Estimated	Estimated / Proposal	Issued for Const/Proposal
PE06 Subcontracting					
Major Subcontract Information	Estimated	Estimated	Estimated	Proposal	Proposal
Other Subcontract Information	Estimated	Estimated	Estimated	Estimated	Proposal / Estimated

EPC Template Subphase	FEP1	FEP2	FEP3
Piping and Instrument Diagrams (P&IDs)		Based on Process Equip Reference information; Major Lines Sized	Based on Updated Process Equip Reference Info; Estimated BOP Equip Info

Figure 12 - Company Specific Estimate Input and Maturity Matrix

Some of the terminology is different and there are more deliverables, but the essence of AACE Figure 4 has been included in the company specific chart. At this point, we have integrated AACE RP18R-97 and AACE RP27R-03 into company specific processes as shown in the Activity Flow Diagram and Handbook text.

Step 3: Assign Responsibilities

The next component of the EPC Project Template we will look at is called Performance Requirements. This component shows the assignment for providing information, performing tasks, producing reports, etc. to named roles of the project team and home office functions. On larger projects, the Project Execution Plan assigns individual names to the roles. A named individual may be assigned to a single role on very large projects, or to multiple roles for smaller construct only projects. This helps to make the EPC Template scalable for the multitude of large and small projects that a company may perform.

There is a Performance Requirements register for each Project Execution and Project Management Key Activity. Performance Requirements are itemized tasks and deliverables that need to be performed. Each performance requirement is also referenced to sub phases and handbook sections where the requirement is narratively described.

Below, Figure 13 shows an example of Performance Requirements. This example is for Cost Estimating for sub phase FEP3.

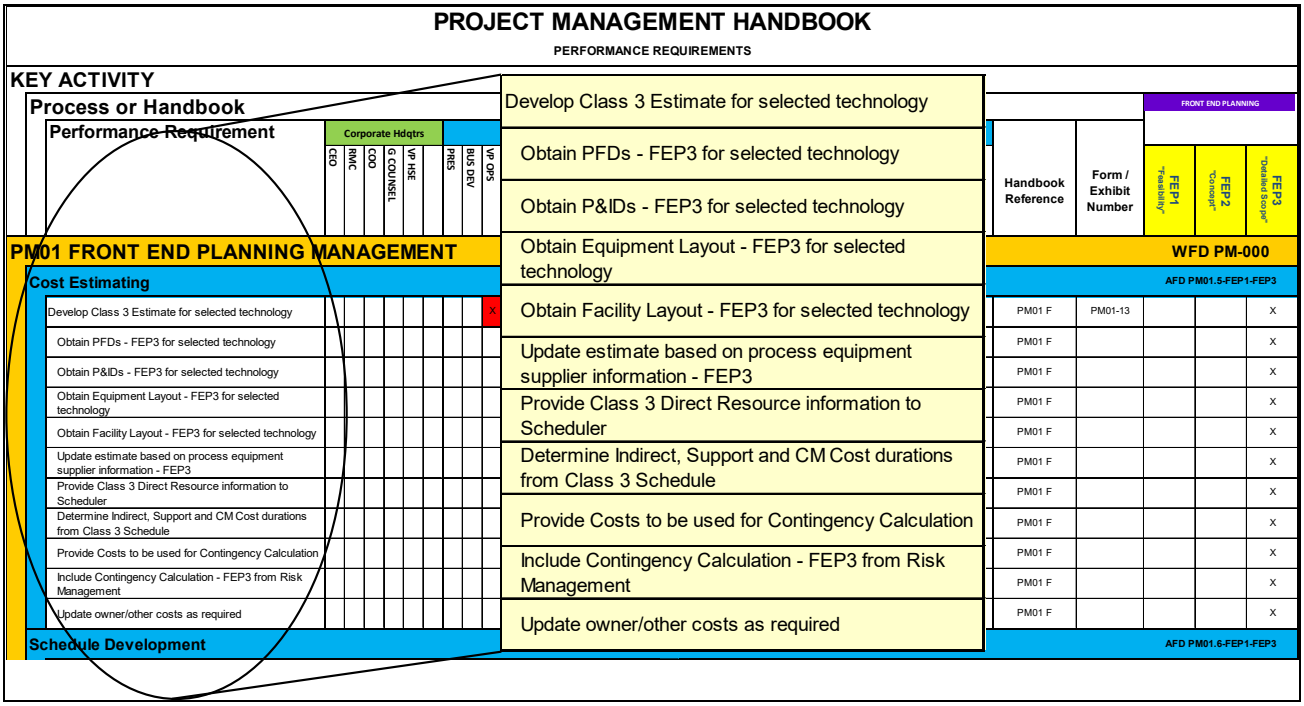


Figure 13 - Performance Requirements

Each Performance Requirement is assigned to roles for a specific responsibility. In the case of the Class 3 estimate; an FEP3 deliverable; the primary responsibility is assigned to the Director of Estimating. The Vice President, Operations is responsible to approve it. The Project Manager is responsible to be knowledgeable of the estimate development.

Figure 14 shows the assignment of responsibilities to roles for development of the Cost 3 estimate; due at Milestone FEP3

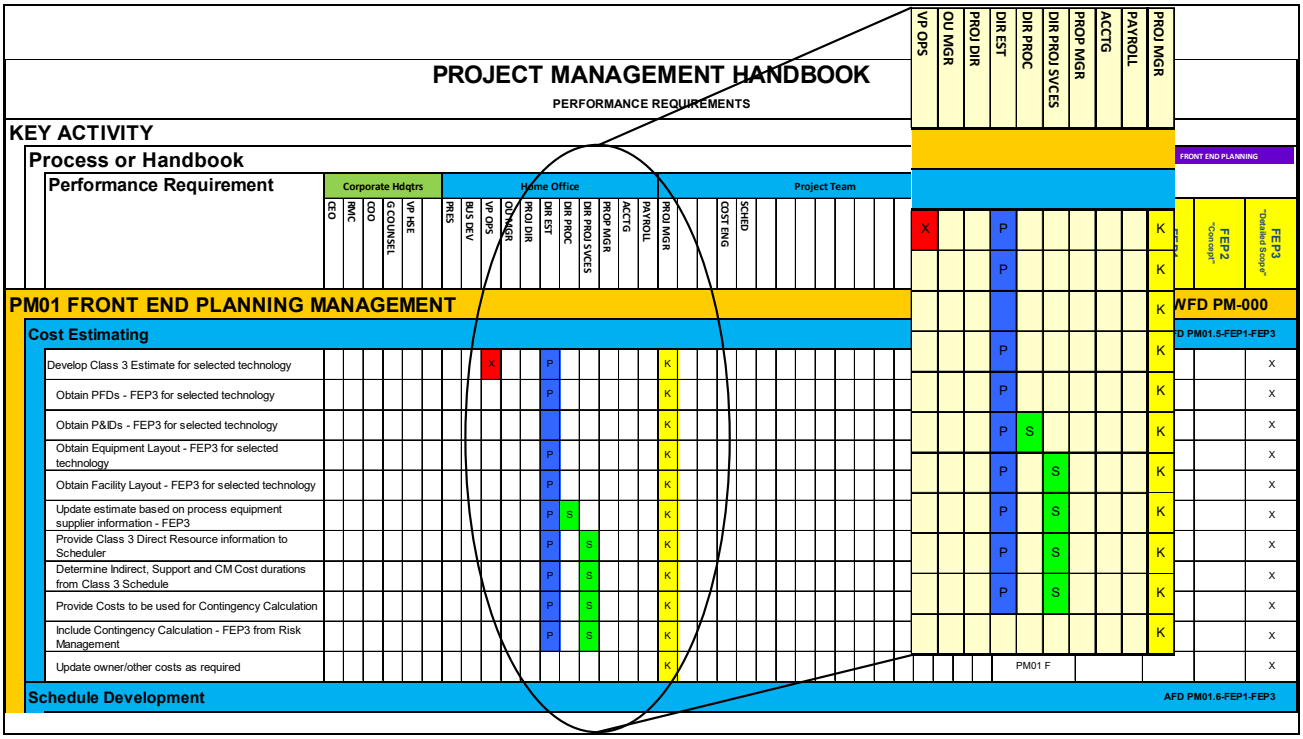
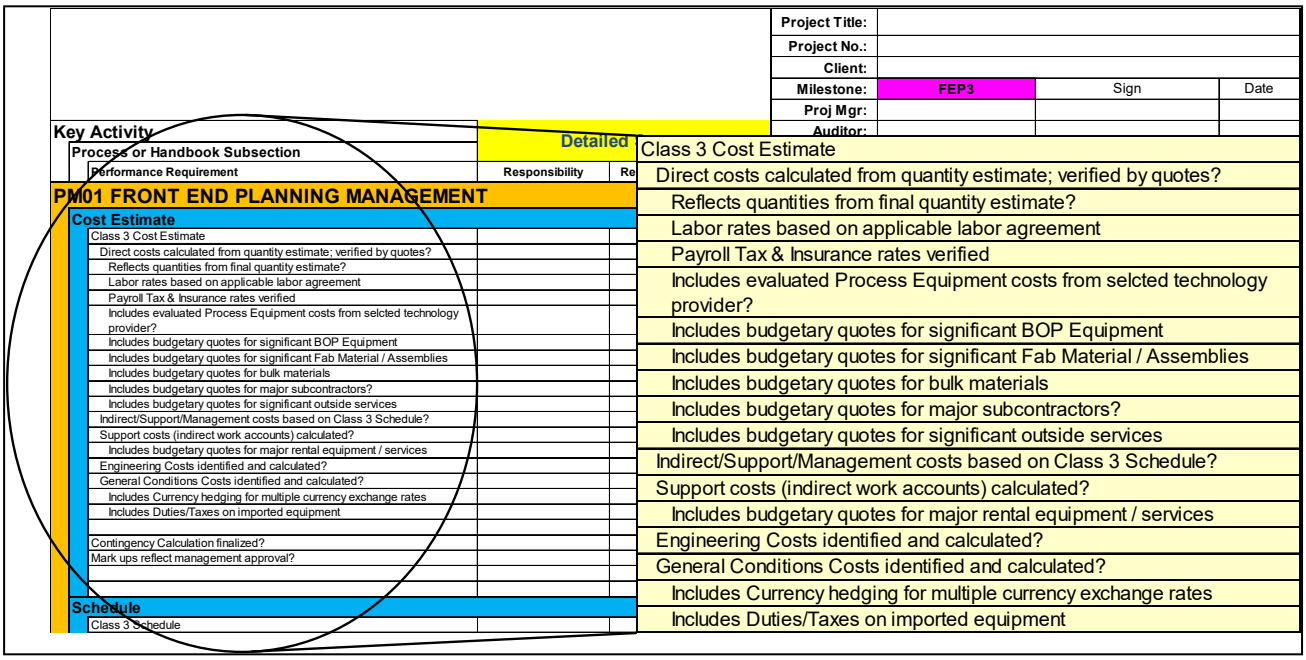


Figure 14 – Roles and Responsibilities

Step 4: Verify Compliance

In order to ensure compliance with processes, Milestone Reviews are held upon reaching the milestone date. To support a Milestone Review, Milestone Checklists are used to document completion of the Performance Requirements.

A Milestone Checklist for Cost Estimating at FEP3 is shown in Figure 15. There are specific checklists for each Key Activity at each milestone.



Project Title:			
Project No.:			
Client:			
Milestone:	FEP3	Sign	Date
Proj Mgr:			
Auditor:			

Key Activity	Detailed
Process or Handbook Subsection	
Performance Requirement	Responsibility
PM01 FRONT END PLANNING MANAGEMENT	
Cost Estimate	
Class 3 Cost Estimate	
Direct costs calculated from quantity estimate; verified by quotes?	
Reflects quantities from final quantity estimate?	
Labor rates based on applicable labor agreement	
Payroll Tax & Insurance rates verified	
Includes evaluated Process Equipment costs from selcted technology provider?	
Includes budgetary quotes for significant BOP Equipment	
Includes budgetary quotes for significant Fab Material / Assemblies	
Includes budgetary quotes for bulk materials	
Includes budgetary quotes for major subcontractors?	
Includes budgetary quotes for significant outside services	
Indirect/Support/Management costs based on Class 3 Schedule?	
Support costs (indirect work accounts) calculated?	
Includes budgetary quotes for major rental equipment / services	
Engineering Costs identified and calculated?	
General Conditions Costs identified and calculated?	
Includes Currency hedging for multiple currency exchange rates	
Includes Duties/Taxes on imported equipment	
Contingency Calculation finalized?	
Mark ups reflect management approval?	
Schedule	
Class 3 Schedule	

Class 3 Cost Estimate
Direct costs calculated from quantity estimate; verified by quotes?
Reflects quantities from final quantity estimate?
Labor rates based on applicable labor agreement
Payroll Tax & Insurance rates verified
Includes evaluated Process Equipment costs from selcted technology provider?
Includes budgetary quotes for significant BOP Equipment
Includes budgetary quotes for significant Fab Material / Assemblies
Includes budgetary quotes for bulk materials
Includes budgetary quotes for major subcontractors?
Includes budgetary quotes for significant outside services
Indirect/Support/Management costs based on Class 3 Schedule?
Support costs (indirect work accounts) calculated?
Includes budgetary quotes for major rental equipment / services
Engineering Costs identified and calculated?
General Conditions Costs identified and calculated?
Includes Currency hedging for multiple currency exchange rates
Includes Duties/Taxes on imported equipment

Figure 15 - Milestone Checklist

In most cases, the checklist items validate that the Performance Requirements have been completed.

As the milestone date nears, the project or proposal manager reviews checklist status with his direct reports. Upon reaching the milestone date, the completed checklists are reviewed and assessed. Because this example is part of Front End Planning, the small team is located in an office as opposed to on a jobsite.

The Project Execution Plan for an EPC project will identify for each milestone whether the review will be a major review or minor review. The risk profile of the project is used to help make that determination. A minor review is performed by the project team. They review their checklists and identify corrective actions and/or punch list items. The results of this minor review should be shared with the upper management or executive level of the company. A major review is audited

on site by upper management and possibly peers from outside the project team. The auditing team and project team will collectively identify corrective actions and/or punch list items. The results of a major review are always shared with executive management and/or the risk management committee.

Upon review of the checklists, meetings and interviews, the Milestone Review is subjectively graded using heat map designations:

Green – the Milestone Gate is passed with no corrective actions required and some minor punch list items.

Yellow – the Milestone Gate is passed with no or some corrective actions required and punch list items.

Red – the Milestone Gate is failed. The project has serious deficiencies requiring immediate corrective action or the project will be at risk for failing to meet its objectives for the client and/or the company.

A "Red" grade requires a written action plan to be followed up upon by the audit team. Yellow and Green grades require written action plans which are followed up upon by the project team with update reports issued to executive management. Any outstanding corrective actions from a previous Milestone Review will result in an immediate "Red" grade for any downstream Milestone Review.

Figure 16 is the Milestone Review Report. For each Key Activity, indicators for both Control Level and Execution Level show whether or not deficiencies have been found requiring attention.

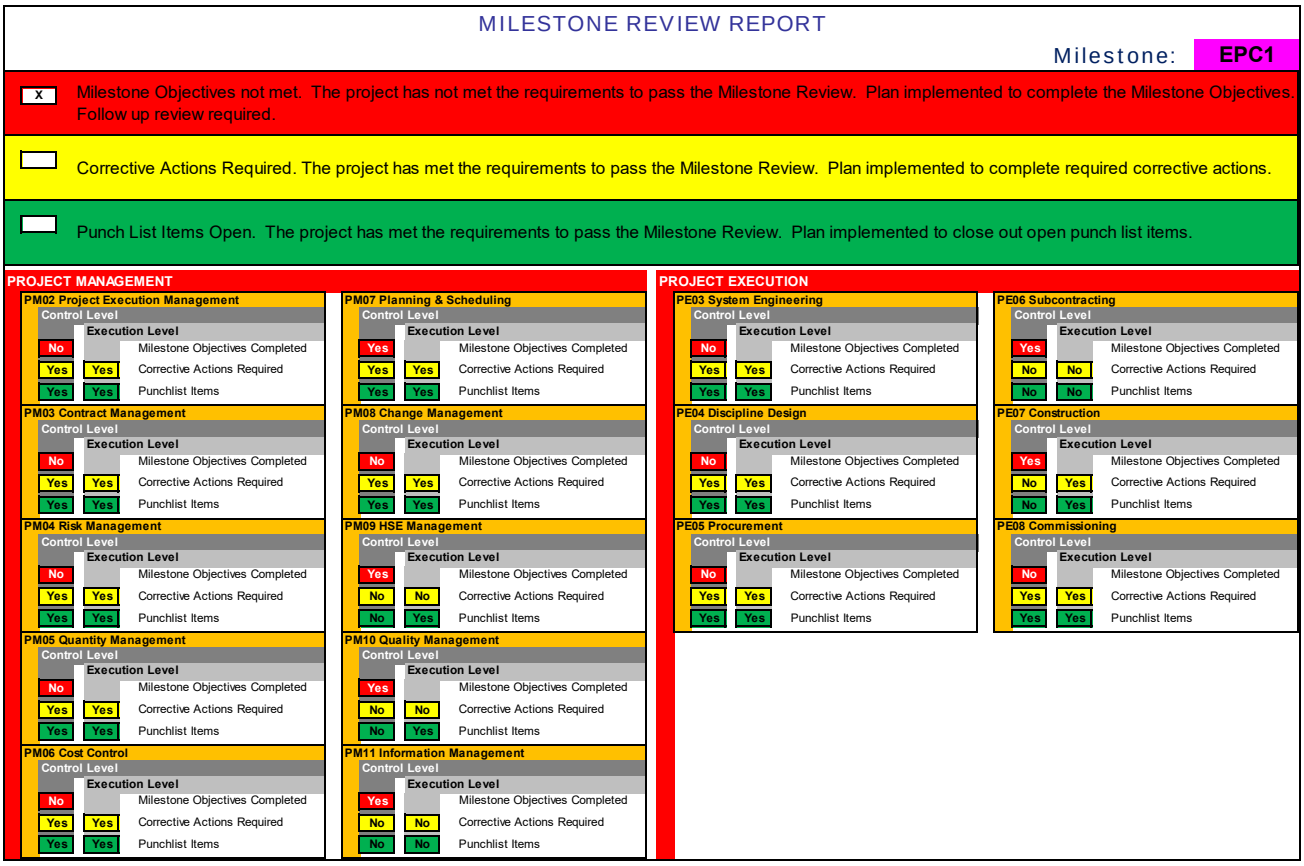


Figure 16 - Milestone Review Report

Collaboration across the enterprise

All the EPC Project Template documentation shown has been produced using standard office programs. The process maps and Activity Flow Diagrams are Microsoft® Visio® drawings. The Handbooks and Manuals are Microsoft® Word® documents. The Performance Requirements, Milestone Checklists and Control Level Objectives are Microsoft® Excel® spreadsheets. Forms and reports are an assortment of these same files. Training modules are Microsoft® Powerpoint® presentations.[1]

[1] Microsoft®, Visio®, Word®, Excel®, Powerpoint®, SharePoint® are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

The EPC Project Template holds the knowledge base for the company; processes that are expected to be followed to produce positive results. It needs to be available to project team members wherever they are working. Large companies work on multiple projects simultaneously at multiple locations. Consequently, project team members are geographically scattered to the various jobsites.

In our case study company, the EPC Project Template is "owned" by operations. It is updated from time to time to reflect changes in processes resulting from lessons learned and new Recommended Practices. It's a "living" system. Keeping the content in commonly used file formats allows operations to make any necessary changes easily. As a result, an IT solution is relatively simple.

A Microsoft® SharePoint® site is used to make all the documents available throughout the enterprise. The process maps open as web parts. Each process on the process map has hyperlinks which allow the user to open the Activity Flow Diagram. From the Activity Flow Diagram, users can hyperlink to related processes, other Activity Flow Diagrams, Handbooks, Performance Requirements, Forms and Milestone Checklists. Also included are registers that hyperlink to CII publications. We have included a register for AACE Recommended Practices, however we do not hyperlink to them as AACE updates them from time to time.

Conclusion

Having graphically documented processes in an integrated structure provides a tangible medium for incorporating AACE Recommended Practices and CII Best Practices.

Recommended Practices and Best Practices and other knowledge bases can be aligned once a process structure is in place. After alignment, the content is reviewed for applicability. Process maps and Activity Flow Diagrams are modified to reflect changes. Handbooks and Manuals are also edited to provide the narrative support. Through Performance Requirements, responsibilities are clearly communicated. Compliance is verified through the use of Milestone Checklists and

Milestone Reviews. With SharePoint, the entire knowledge base is always available throughout the company.

While this paper focused on only a couple processes during the Front End Planning phase of a project, this same methodology is used for all Proposal and EPC processes. Additionally, the company can expand this to include other Operations areas such as Human Resources, HSE, Quality, Labor Relations, Legal and Accounting. Several AACE Recommended Practices focus on skills for cost engineers and schedulers; those subjects are typically outside the scope of projects, but very necessary considerations for operations.

What has been presented in this paper is not proprietary knowledge. It does not require an expensive software application or computer programming capability. Using the MS Office suite operations and project management professionals can create a proactive, integrated system that incorporates industry knowledge and increases chances of project success.

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No.	Description
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5	AACE Recommended Practice 27R-03, Table 1 – Generic Schedule Classification Matrix, page 3 of 9 (November, 2010).