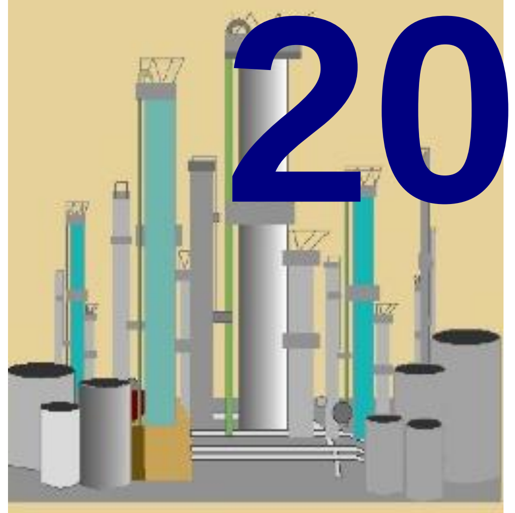
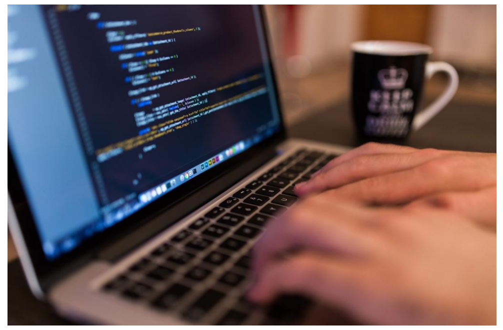
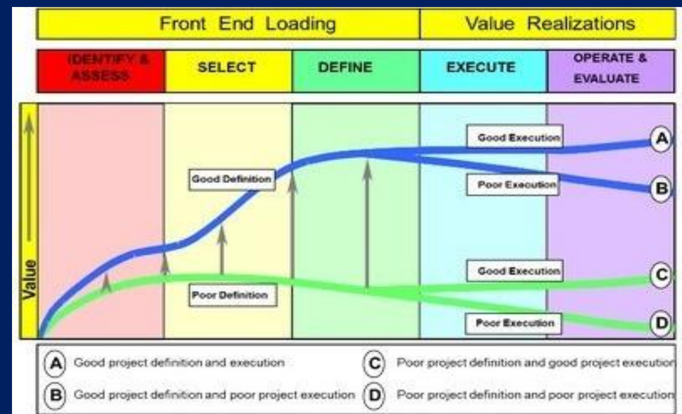
WHITE DOLPHIN REFINERY-FRONT END ENGINEERING





FEED ENGINEERING

Basic Design	FEED	Detailed Design
● Process Design ● Basic Data for Equipment and Instrument	● Equipment Design ● Instrument Design ● Purchase of Critical Equipment ● Building Structure Concept Design ● Feed Back to Process Design	Incorporation of Purchased Item Construction Drawing ● Piping Drawing ● Instrument ● Drawing ● Civil Drawing ● Electrical Drawing
	Purchase of Equipment	Purchase of Material



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KURMANEVSKY REFINERY
ORENBURG

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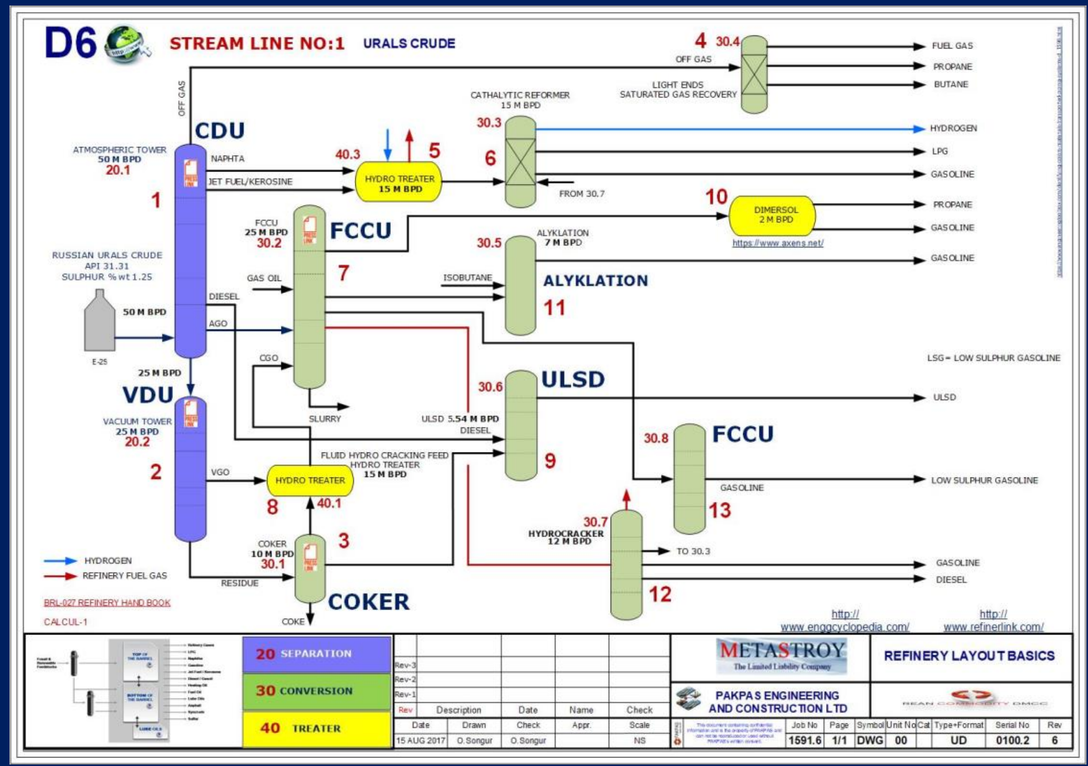
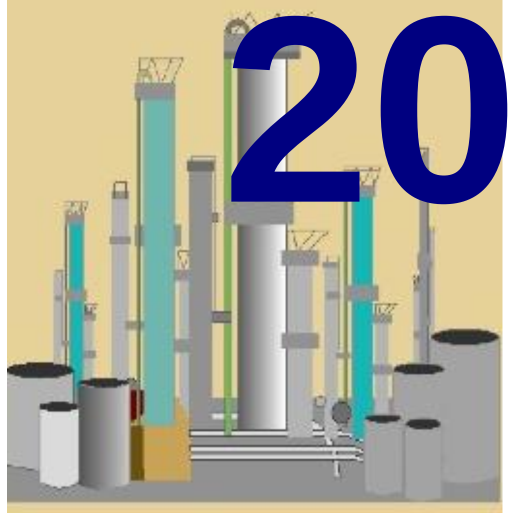
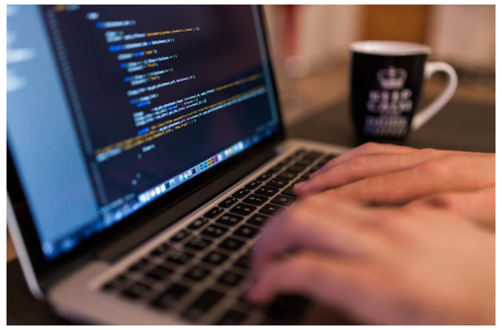
FRONT END ENGINEERING







FEED ENGINEERING

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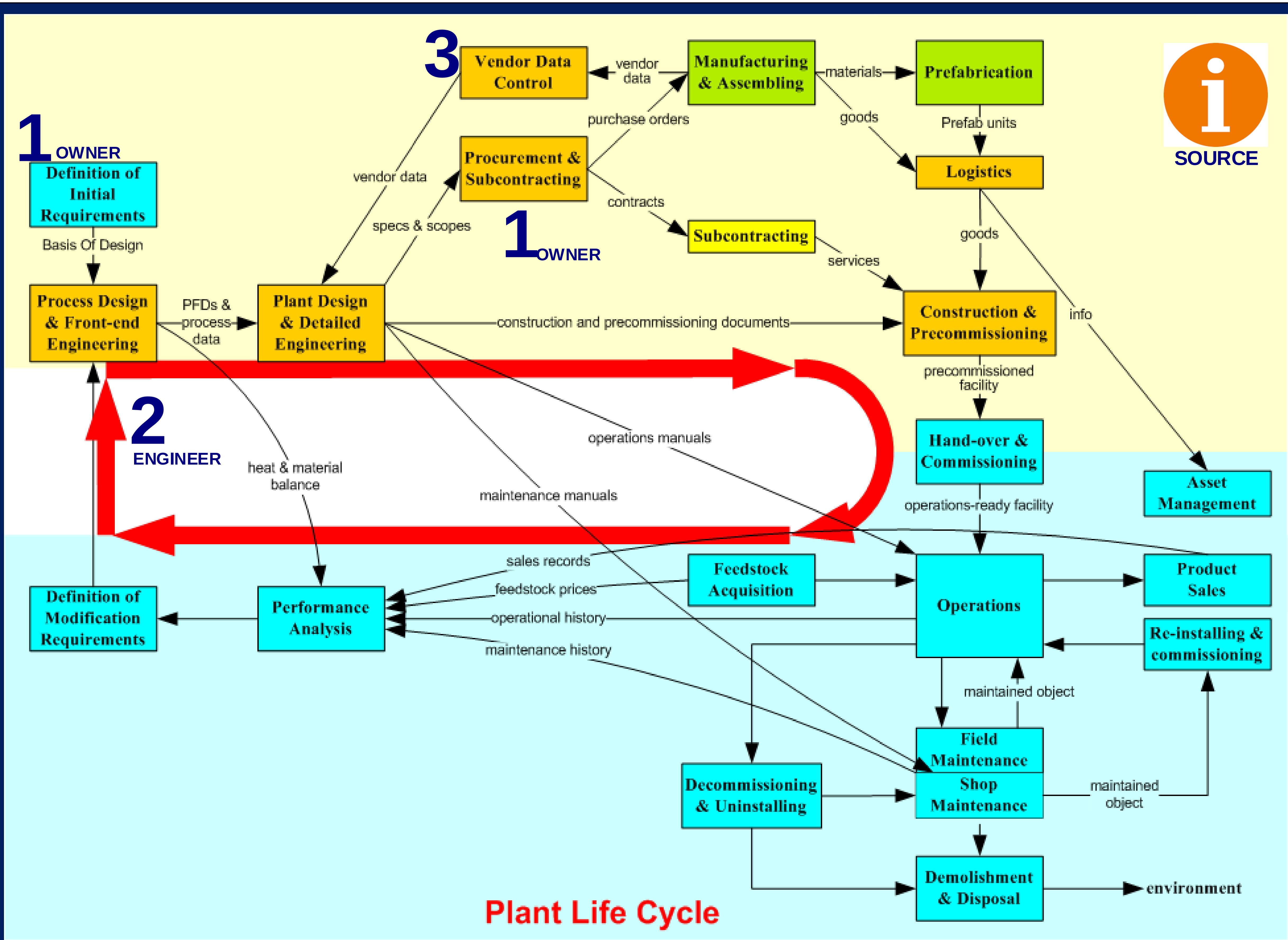

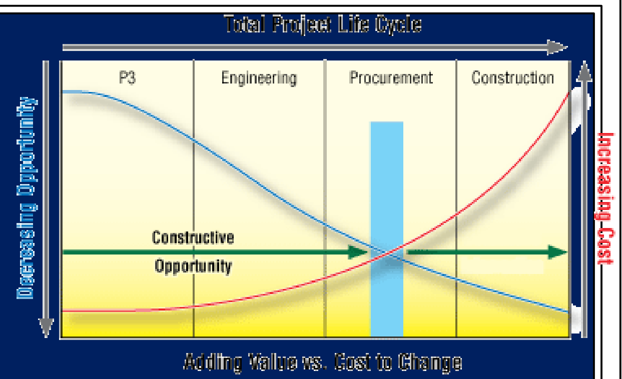

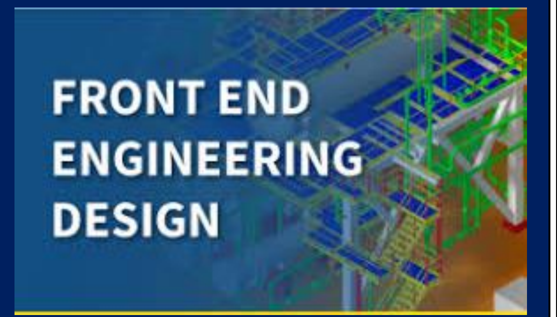

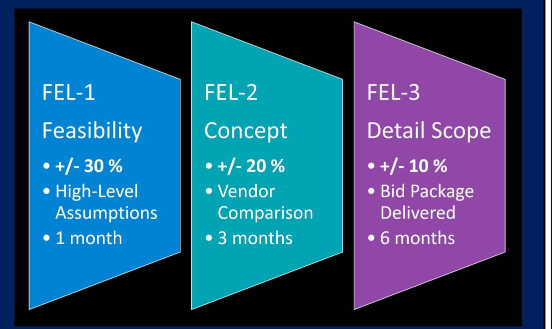

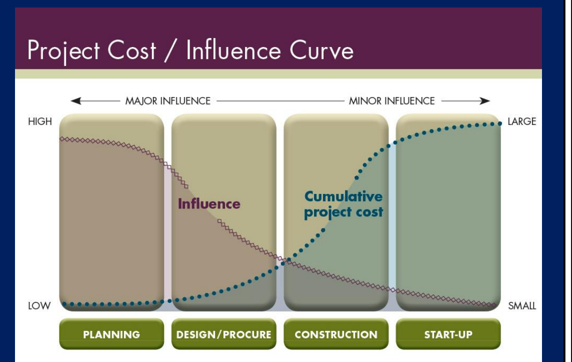

PAKPAŞ
"Quality comes first"

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FRONT END ENGINEERING

Front-End Engineering (FEE), or Front-End Engineering Design (FEED), is an engineering design approach used to control project expenses and thoroughly plan a project before a fix bid quote is submitted It may also be referred to as Pre-project planning (PPP), front-end loading (FEL), feasibility analysis, or early project planning.

The FEE is basic engineering which comes after the Conceptual design or Feasibility study. The FEE design focuses the technical requirements as well as rough investment cost for the project. The FEE can be divided into separate packages covering different portions of the project. The FEE package is used as the basis for bidding the Execution Phase Contracts (EPC, EPCI, etc) and is used as the design basis.

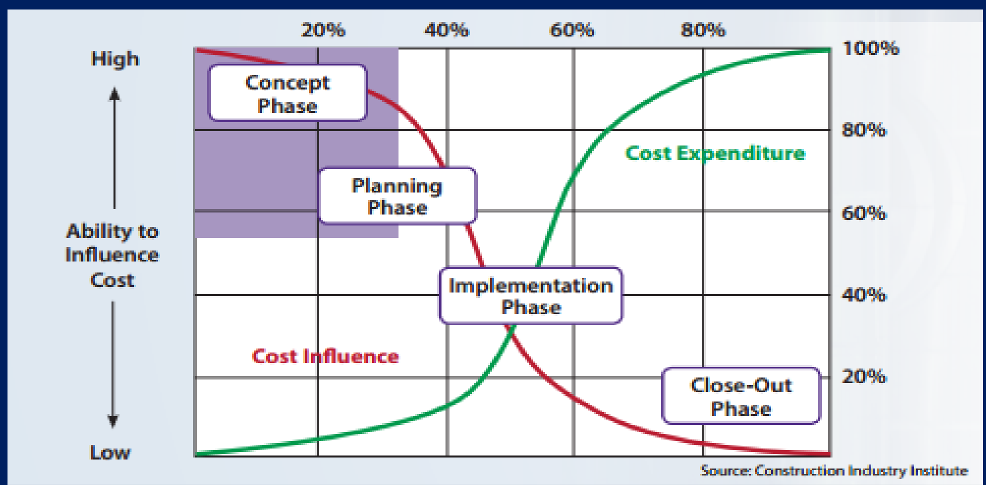
A good FEE will reflect all of the client's project-specific requirements and avoid significant changes during the execution phase. FEE contracts usually take around 1 year to complete for larger-sized projects. During the FEE phase there is close communication between Project Owners and Operators and the Engineering Contractor to work up the project-specific requirements.

Front-End Engineering focuses on technical requirements and identifying main costs for a proposed project.[2] It is used to establish a price for the execution phase of the project and evaluate potential risks. It is typically followed by Detailed Design (or Detailed Engineering). The amount of time invested in Front-End Engineering is higher than a traditional quote, because project specifications are thoroughly extracted and the following typically developed in detail:

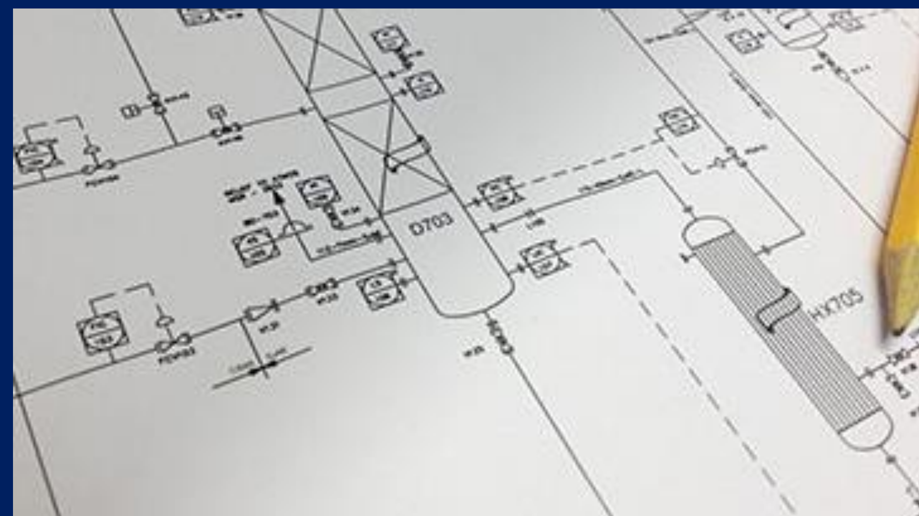
- ☐ *Project Organization Chart*
- ☐ *Project Scope*
  - ☐ *Defined civil, mechanical and chemical engineering*
  - ☐ *HAZOP, safety and ergonomic studies*
  - ☐ *2D & 3D preliminary models*
  - ☐ *Equipment layout and installation plan*
  - ☐ *Engineering design package development*
  - ☐ *Major equipment list*
  - ☐ *Automation strategy*
  - ☐ *Process Flow Diagrams*
  - ☐ *Project timeline*
  - ☐ *Fixed-bid quote*

Traditionally, all of these documents would be developed in detail during a design review after a quote has been agreed to. A company using FEE will develop these materials before submitting a quote. Front-end engineering is typically used by design/build engineering firms. These firms may operate in various industries including:

Too often, FEED is conducted for one purpose: a cost estimate. However, a FEED analysis is about much more than that. Specifically, it provides the groundwork and technical detail from which a project is built. The basic engineering decisions made during the FEED have a significant impact on every project phase that follows.



- ☐ *Automation*
- ☐ *Chemical processing*
- ☐ *Construction*
- ☐ *EPC*
- ☐ *Equipment design*
- ☐ *Manufacturing*
- ☐ *Petrochemicals*
- ☐ *Process system design*
- ☐ *Production line design*
- ☐ *Refining*
- ☐ *Machine Vision*



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FEED ENGINEERING

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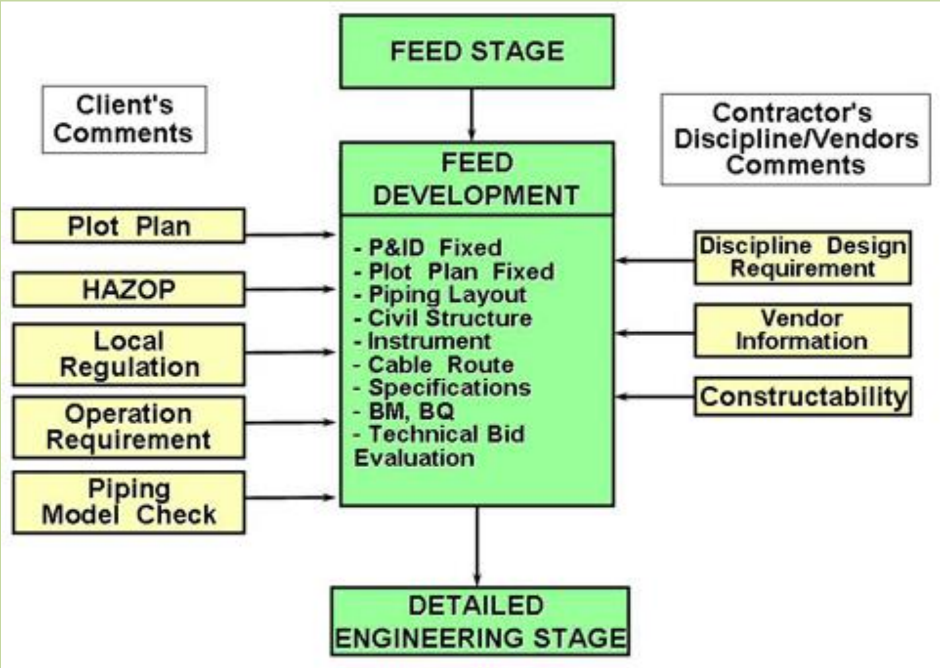
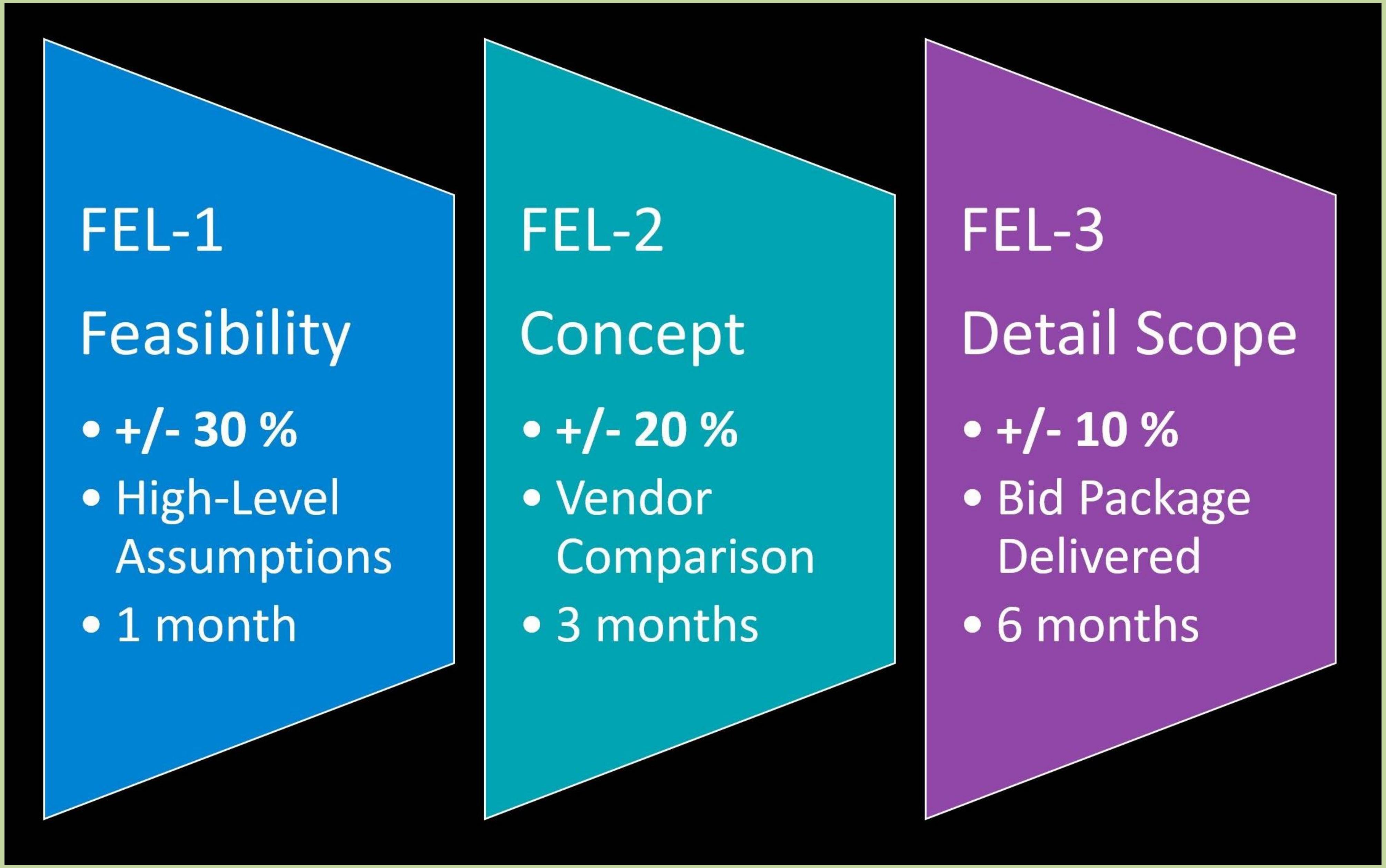
FRONT END ENGINEERING

https://p3planningengineer.com/oil_N_gas/EPC%20practice.htm



The FEED study is a critical phase in the development of large projects – particularly those that are unique in terms of scale, technology, or configuration, where reference plant cost and performance information is unavailable. As described before, the main objective of the FEED study phase is to establish and define the technical scope of work and project execution in sufficient detail to determine the project cost and commercial terms that form the basis of a firm EPC price and proposal for the Project. Doing so requires completion of approximately 15 – 20 percent of the total CC Plant engineering and planning effort, which reduces the Project risk before moving into detailed engineering and construction.



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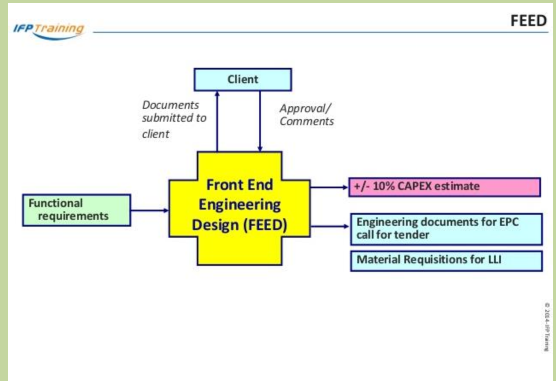

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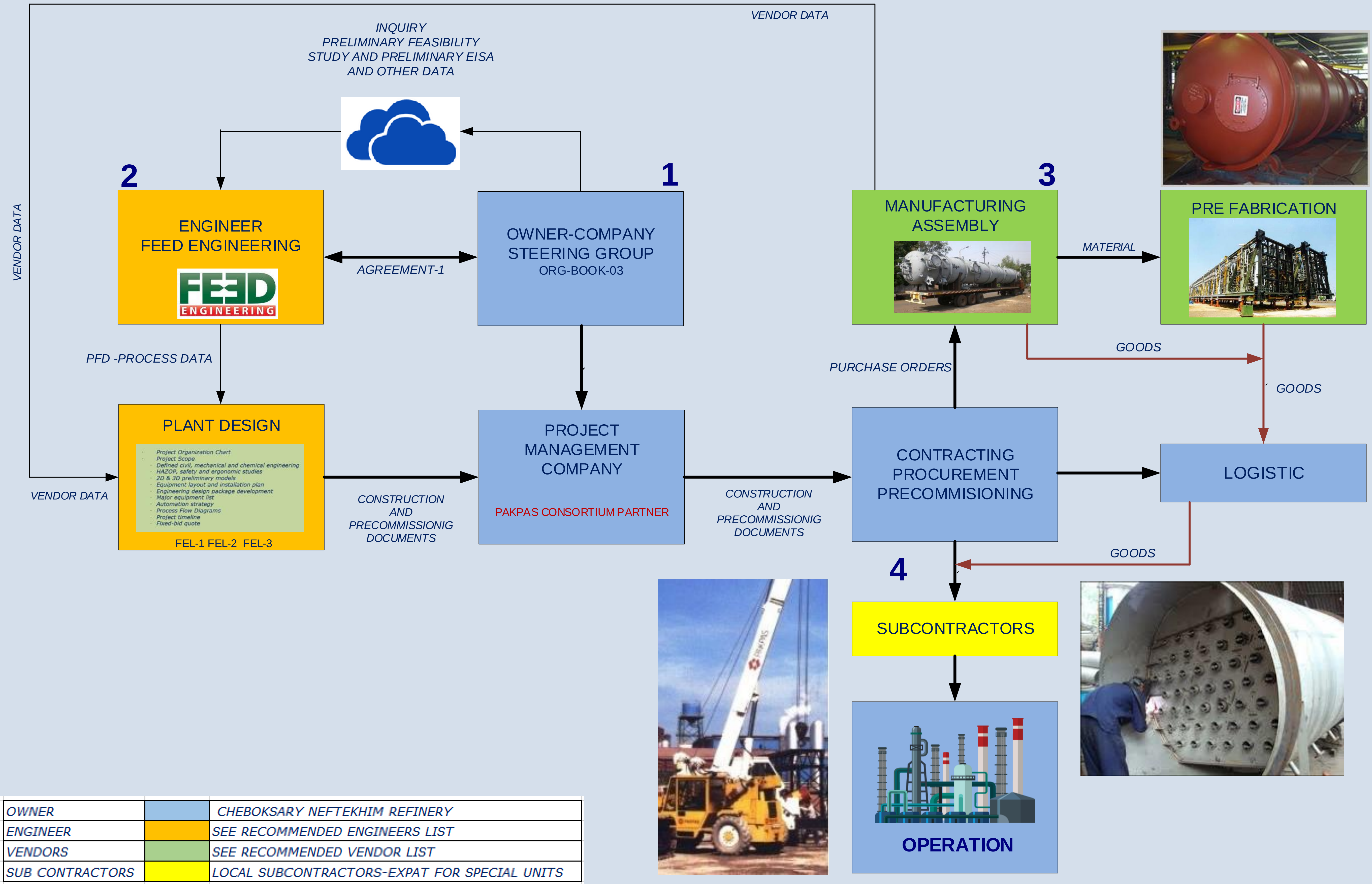

OWNER		CHEBOKSARY NEFTEKHIM REFINERY
ENGINEER		SEE RECOMMENDED ENGINEERS LIST
VENDORS		SEE RECOMMENDED VENDOR LIST
SUB CONTRACTORS		LOCAL SUBCONTRACTORS-EXPAT FOR SPECIAL UNITS

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FRONT END LOADING			PROJECT PLANNING	FEL-4 PROJECT IMPLEMENTATION
FEL-1	FEL-2	FEL-3		
CONCEPTUAL STUDY-DESIGN PROJECT OPTIONS	CONCEPTUAL STUDY-DESIGN PROJECT OPTIONS	FEASIBILITY STUDY DEVELOP PROJECT DEFINITIONS		

- ☐ *Project Organization Chart*
- ☐ *Project Scope*
  - ☐ *Defined civil, mechanical and chemical engineering*
  - ☐ *HAZOP, safety and ergonomic studies*
  - ☐ *2D & 3D preliminary models*
  - ☐ *Equipment layout and installation plan*
  - ☐ *Engineering design package development*
  - ☐ *Major equipment list*
  - ☐ *Automation strategy*
  - ☐ *Process Flow Diagrams*
  - ☐ *Project timeline*
  - ☐ *Fixed-bid quote*

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FRONT END ENGINEERING COST ESTIMATE CLASSIFICATION

COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

	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 [a]
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%

Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

FEL-1

Feasibility

- **+/- 30 %**
- High-Level Assumptions
- 1 month

FEL-2

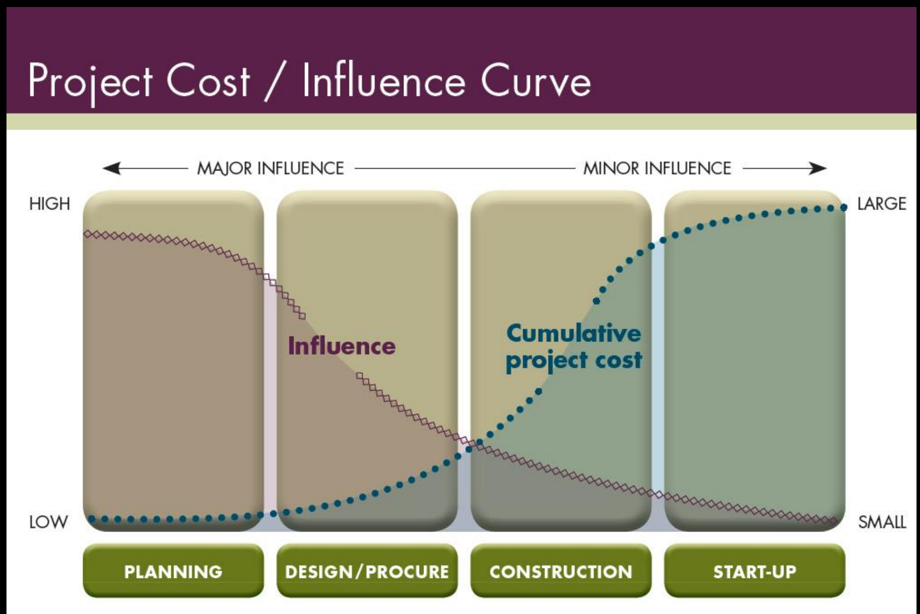
Concept

- **+/- 20 %**
- Vendor Comparison
- 3 months

FEL-3

Detail Scope

- **+/- 10 %**
- Bid Package Delivered
- 6 months



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https://www.manufacturing.net/article/2013/12/right-tools-job-front-end-loading

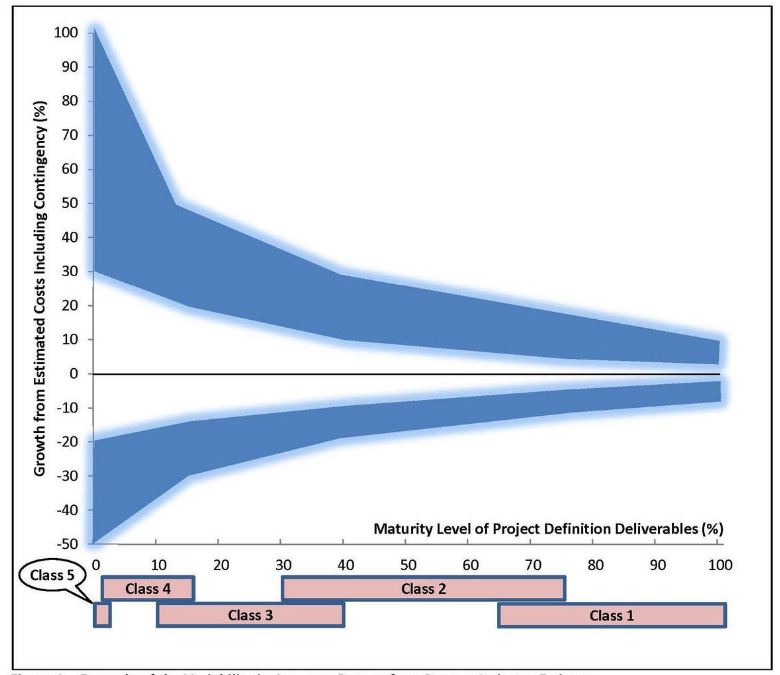

Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate

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by Jens M. Ebert, PE, PMP; SSOE Group

Project success is not limited to an effective end product; it also requires that the project not exceed specified cost and stay on schedule throughout. Good planning is instrumental to achieving a successful project.

The term Front-End-Loading (FEL) refers to a project management process that involves developing sufficient project definition so that owners can make investment decisions, minimize risk and maximize the potential for success. Depending on the industry, FEL is also known as Pre-Project Planning (PPP) and Front End Engineering Design (FEED).

The foundation of all best practices associated with Front End Loading is the Influence Curve. The basic premise is that the majority of planning and design should be completed early in a project when the ability to accommodate design changes is relatively high while the cost of making those changes is still relatively low.

The FEL Process intentionally adds some cost and time to the early part of the project, but this is minor compared to the potential cost and effort required to make changes later in the project.

By extension, the more completely a project is defined, the less likely it is to experience cost performance issues due to the greater accuracy of the supporting cost estimate. AACE International (the Association for the Advancement of Cost Engineering) published a widely referenced Recommended Practice for a cost estimate classification system which assigns an expected accuracy range for each of the five different estimate classes based on the quality of the underlying project definition and the associated level of effort.

Contingency funds are intended to cover the cost of unforeseen variations in design parameters, quantities, pricing, or execution plans. It is generally accepted that the level of contingency included in a cost estimate is a function of the degree of project definition vs. uncertainty.

In more detailed cost estimates the recommended contingency will typically vary by scope area to reflect the relative uncertainty. The composite value across the entire estimate should correlate with the expected accuracy ranges shown above. As a result, as project definition increases, the need for contingency is expected to decrease, which reduces the amount of capital set aside for risk management. This additional capital is now available for other investments, as opposed to being sidelined throughout the entire project.

An FEL program typically utilizes a stage gate process in which a project must pass through formal steps or "gates" at well-defined milestones before funding is released to proceed to the next phase. Each gate will typically include a thorough stakeholder review to ensure that the project team is in agreement before requesting additional funding from senior management.

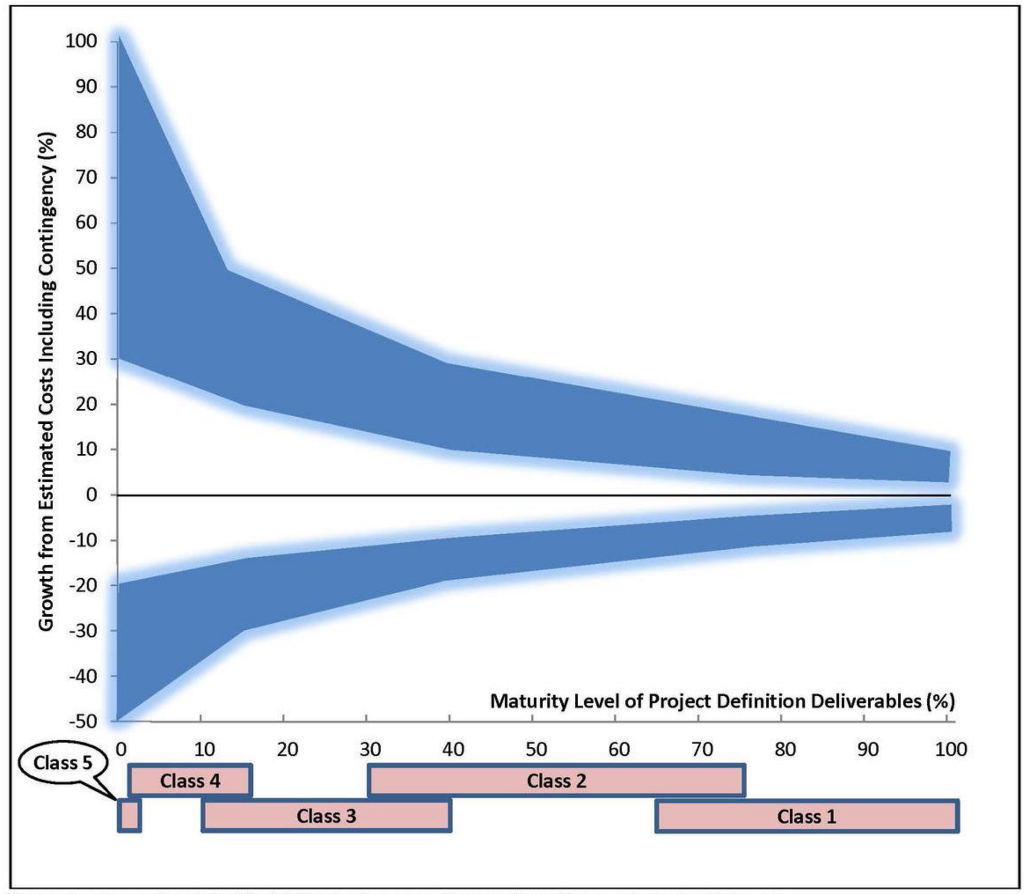

Figure 1 – Example of the Variability in Accuracy Ranges for a Process Industry Estimate

COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

	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 [a]
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Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

FOR CONTINUATION SEE NEXT PAGE

The Risks of Moving Forward Without an FEL, FEED or a Similar Gated Management Process

In the food industry, risks connected to any project include the typical cost and schedule dimensions, but more importantly, they also include the risks associated with producing a poor quality or unsafe product. This possibility demands the appropriate level of due diligence in project execution.

At the same time, the project life cycles in our industry usually reflect the constant pressure associated with meeting promises to stockholders for quarterly earnings results. Under these circumstances the temptation to push ahead can be irresistible. However, the companies that most consistently deliver successful projects have mastered the ability to slow down at the beginning and to plan appropriately before proceeding with execution.

Gateway to Success

The FEL process typically contains three "gateways" before proceeding with project execution and start-up. Passing through each gateway requires the completion, presentation and approval of specific activities.

FEL I: Conceptual Engineering / Financial Feasibility

The purpose of the first project phase, often called FEL I, is to present a concept review for making an informed decision about the project's viability and whether or not to pursue it. Depending upon the size and complexity of the project, this stage can typically take approximately three to four weeks. Emphasis is placed upon establishing the business case, defining criteria for success, and developing the scope of work required to achieve those goals. The criteria for success must establish how the project will change the business for the better. The business case, of course, documents the project's financial benefit. The scope of work enables a preliminary cost estimate, which will typically have limited accuracy due to the need for numerous assumptions at this stage.
While an FEL I is based upon very preliminary information, getting it right lays the foundation for subsequent successful FEL phases. For example, the original concept for a project to upgrade a sauce processing line had included a separate flammable ingredient storage room. However, during the FEL I phase of the project, the engineering team quickly determined through review of the materials in question that the separate storage area could be eliminated.

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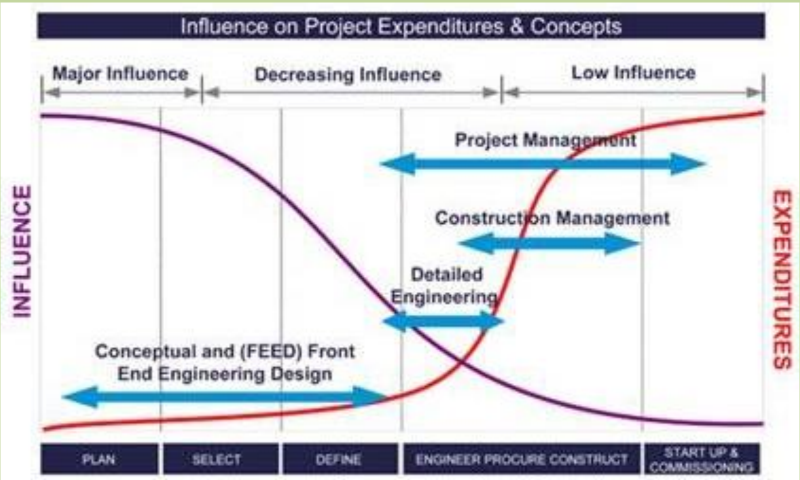
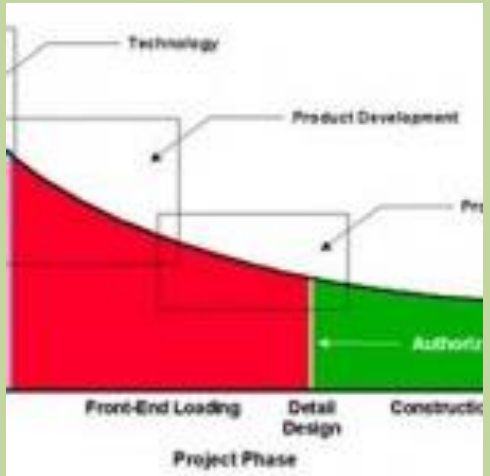
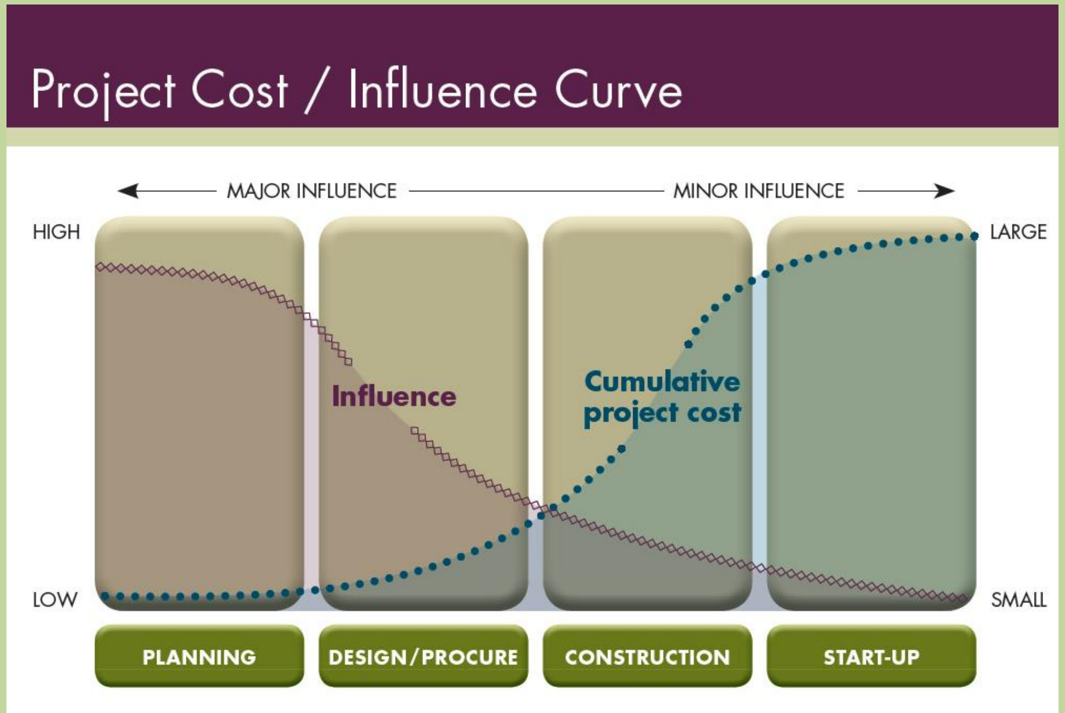
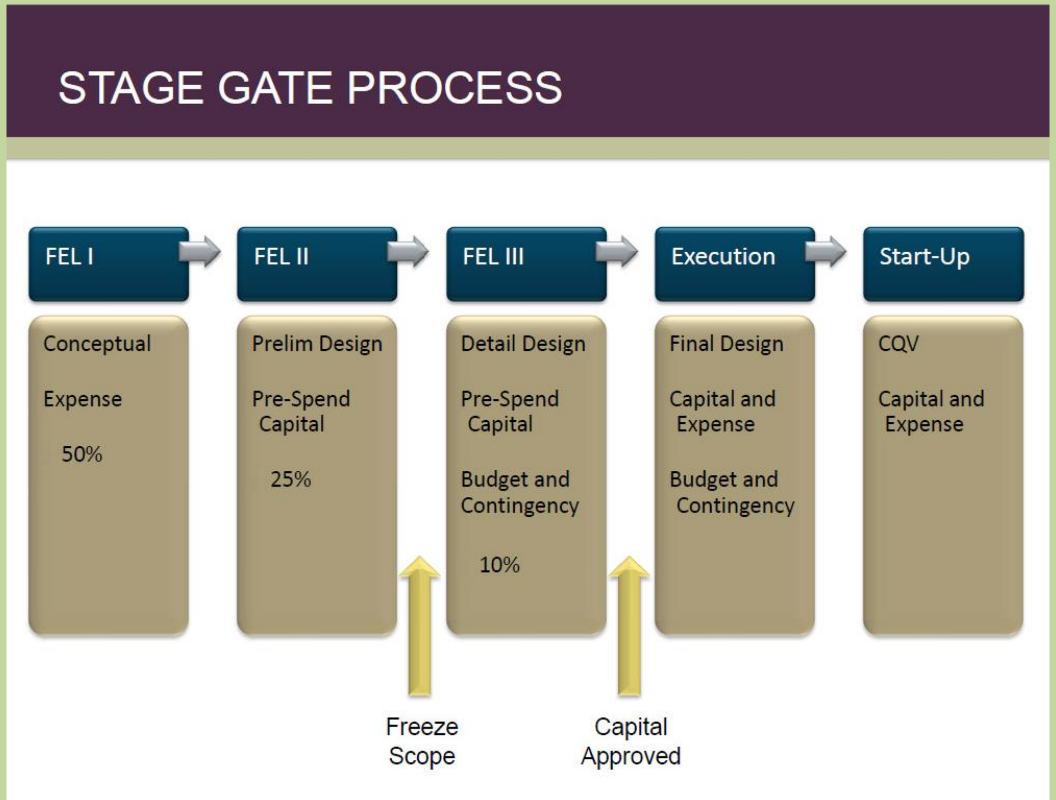


Description	BASE CASE	ALTERNATIVE CASE
HSSE / RISK	LOW	FAIR
Shutdown	Partial S/D Required*	Partial S/D Required*
Constructability	FAIR	FAIR
Materials Lead Time	LONG	FAIR
Operability	GOOD	GOOD
Maintenance	LOW	FAIR
CAPEX	HIGH	FAIR
OPEX	LOW	FAIR







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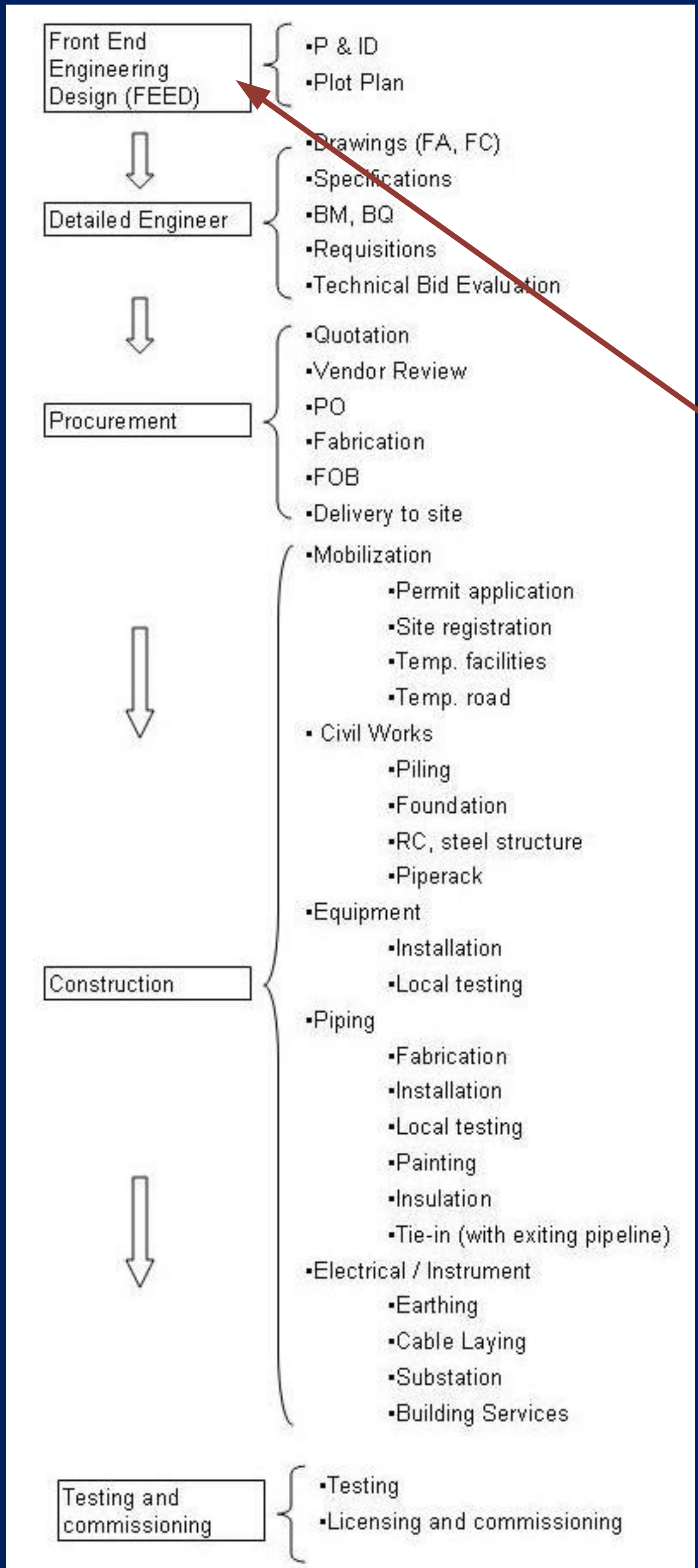
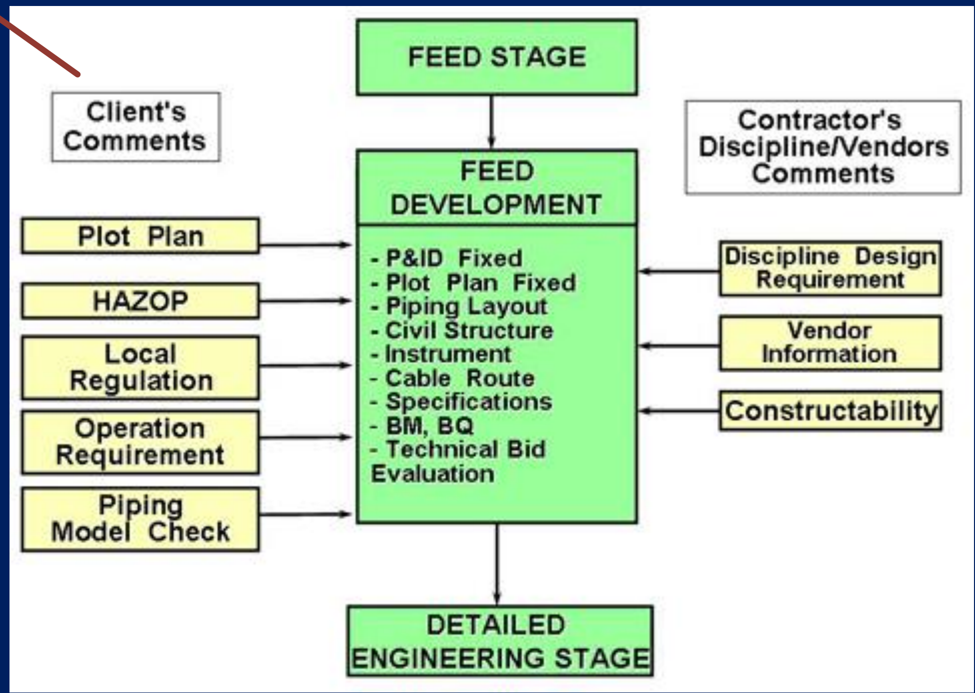
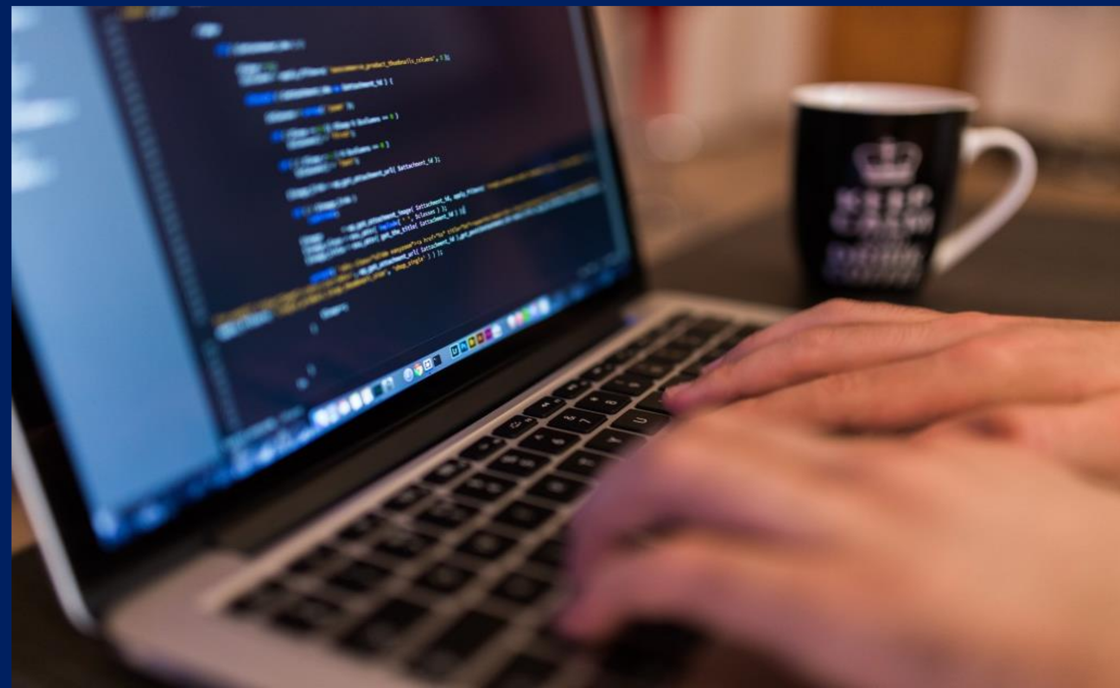


The EPC contractor is made up of Engineering (design) consisting of various disciplines, Procurement and Construction. That's the name EPC stands for. Process discipline, the background of which is chemical, is usually the leader of other disciplines. Piping and equipment disciplines are mechanical based. Instrument and electrical are from electronics and electrical. Civil is supporting role to piping and equipment.

Among them, the process outlines a plant and input data to other disciplines (piping, equipment, instrument and electrical), such as design basis, process flow diagram (PFD), process datasheet, equipment list, piping and instrumentation diagram (P&ID), and utility flow diagram (UFD). Piping, which designs pressurized pipes carrying steam or other media and is usually space dominant with kinds of equipment, will coordinate all the requirements and put them into the 3D programme called PDS (Plant Development System). The 3D piping isometric drawing modeling gives pipe routes and indicates the possible routing space for instrument and electrical. It's usually a heavy work load discipline. The plot plan is the master plan produced by piping.





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COMPANY-WISED PROJECT MANAGEMENT

An ISO certified operation manual and company wised WBS have been established. The WBS is functional based and comprehensive. It covers project management, basic engineering, detailed engineering, commissioning and operation. The three layered WBS gives details of procurement and all disciplines' professional services. The standard has laid a good foundation for other aspects of work, such as drawing numbering, man-hour recording and programmed breakdown items.

*Since EPC operation is inter-disciplines, **Primavera Project Management Enterprise version (P3e)** seems more suitable to the company wised project management (P3 instead, is project based, reflects the building and civil contracting work operation). In reality, application of P3e or P6 is far from satisfactory. In most cases, it is contract-driven and requirements of the client. To implement company wised project management, some refinement of work flow and information re-organization and integration will be involved. This is not just using the software and only a few people or just the planner can deal with.*