Typical Front-End Loaded (FEL) Steps

Complete Front-End Loaded (FEL-1) **FEL-1 Raw Material/Feedstock Supply Characterization**	8-10 weeks

FEL-1:

Typical FEL-1 activities are as follows:

- **Set up schedule to review and update** current business model, preliminary project proforma, and investment discussions and commitments on quarterly basis throughout FEL process, procurement and construction.
- **Conduct initial feasibility study** re: the proposed site with an initial assessment of its potential for requiring environmental mitigation and cleanup; anticipated site preparation and permitting requirements; and utility and transportation connections; as well as the economics, market, potential market penetration, risks, and strengths, weaknesses, opportunities, and threats (SWOT) of the proposed project.
- **Design, plan, and conduct an extended, fully integrated trial** of the project's intended raw material/feedstock supply, encompassing each of the steps required to prepare, ferment, convert, process, extrude, and finish (etc.) the raw material/feedstock to produce the project's end product or products and byproducts.
- **The other FEL-1 activities are as follows:**
  - ✓ Establish a multifunctional project team
  - ✓ Develop a Business Objectives Statement and Charter to guide project team activities.
  - ✓ Review and expand on current business model and plan
  - ✓ Obtain raw material/feedstock analysis from samples provided by feedstock suppliers.
  - ✓ Prepare representative characterization and quantities needed for PDU testing during FEL-2.
  - ✓ Perform laboratory trials on feedstock samples. This testing will generate data required for the environmental analysis and enable an FEL-1 engineering package to be completed in support of permitting.
  - ✓ Develop an Execution Plan, and Level-1 Schedule for FEL-2 activities.
  - ✓ Evaluate and update project proforma and economic life

Complete Front-End Loaded (FEL-2) **FEL-2 Feedstock / Raw Material Supply Testing & Design Basis Preparation**	8-10 weeks

FEL-2:

Typical FEL-2 activities are as follows:

- **Conduct and incorporate results from Phase 1 Environmental Study**, soil survey and hydrology report into site and project planning
- **Proceed with environmental modeling and data gathering**
- **Perform process demonstration trials on raw material/feedstock samples.** This testing will generate data required for the environmental analysis and enable an FEL-2 engineering package to be completed in support of permitting.
- **The environmental data to be collected and evaluated during the process demonstration testing includes:**
  - ✓ Characterize the composition, size distribution, toxicities (if applicable), and other relevant characteristics of the raw material/feedstock supply.
  - ✓ Determine the speciation of toxics and chemicals that have the potential to pose environmental impacts during each of the process/production steps through emissions, liquids, waste streams, and disposed solids.
  - ✓ Determine the presence of contaminants (e.g., tars, particulates, HCl, H_2S, NH_3, COS, HCN, metals) that will need to be managed.
  - ✓ Determine the effluent generation rate and its characteristics.
  - ✓ Determine total service and process water consumption rates.
  - ✓ Determine the wastewater generation rate and its characteristics.
  - ✓ Determine the generation rates of disposed solids and their characteristics.
  - ✓ Determine the removal rates for contaminants (e.g., tars, particulate, HCl, H_2S, NH_3, COS, HCN, metals) and their post-process/production levels.
  - ✓ Demonstrate that all components of the processing/production train can be operated reliably, safely and in a steady manner without contaminant breakthrough.
- **Document technology and performance** following the process/production demonstration
- **Compare with previous trials** on raw materials/feedstocks
- **Establish plant capacity recommendation**
- **Evaluate and update project proforma and economic life**
- **Prepare process and plant summary**
  - ✓ Process principles and theories
  - ✓ Process principles for major systems
  - ✓ Theories used for system designs

- **Document basic process design conditions**

  Raw material/feedstock/product properties
  - ✓ Local design conditions and codes
  - ✓ Utility requirements.
  - ✓ Effluents
  - ✓ Process interfaces
- **Prepare technical report** (Schedule A: Design Basis Document)
  - ✓ Site specific information and design conditions
  - ✓ Raw material/feedstock supply conditions
  - ✓ Overall process/system description
  - ✓ Design conditions for each system component
  - ✓ Design capacities for the overall plant and each system
  - ✓ Raw material/feed and product specifications
  - ✓ Major equipment sizing criteria
- **Engineering tasks**
  - ✓ Prepare project scope
  - ✓ Prepare complete PFDs
  - ✓ Prepare major equipment and preliminary load list
  - ✓ Investigate utility, infrastructure, and off-site requirements
  - ✓ Prepare Factored Cost Estimate
- **Prepare a Level-1, Major Milestone, Integrated, CPM Schedule** to include:
  - ✓ FEL-3 Execution
  - ✓ Permitting
  - ✓ Engineering
  - ✓ Major long lead equipment procurement
  - ✓ Construction
  - ✓ Commissioning and startup activities

Complete Front-End Loaded (FEL-3) **FEL-3 Basic Engineering Package**	20 – 30 weeks

FEL-3

Develop a final commercial execution level project definition, schedule with work breakdown structures, and a definitive estimate, incorporating the relevant information from the previous FEL-1 and FEL-2 activities. At the conclusion of FEL-3, project will be ready for final review and approval to seek financial close and move to start of procurement and construction.

Typical FEL-3 activities are as follows:

- **Continue to update and incorporate environmental permitting requirements**
- **Update technical report** (Final Schedule A: Design Basis Document)
  - ✓ Site specific information and design conditions
  - ✓ Overall process description
  - ✓ Design conditions for each system
  - ✓ Design capacities for the overall plant and each system
  - ✓ Raw material/feed and product specifications
  - ✓ Equipment and line sizing criteria
- **Prepare equipment and load list**
  - ✓ Prices for all major equipment
    - Firm prices are obtained for major equipment and systems that significantly influence the project pricing and or schedule.
    - Budgetary prices are used if firm prices cannot be obtained
    - Indicate status of the included price
  - ✓ Motor and equipment load data from vendor or estimated if not available
- **Prepare and finalize process flow diagrams ("PFDs")**
  - ✓ Overall plant block flow
  - ✓ Flow diagrams that detail major processes and utilities
  - ✓ Issued for design
- **Prepare and finalize heat and material balances** - issued for design
- **Prepare and finalize piping and instrumentation diagrams ("P&IDs")**
  - ✓ Issued for Design
  - ✓ Packages shown on the P&IDs based on vendor data where available
- **Prepare and finalize utility flow diagrams** - issued for design
- **Prepare and finalize piping index and specifications** - issued for design
- **Prepare and finalize instrument list** - issued for design
- **Prepare and finalize major equipment duty and mechanical specifications**
  - ✓ Mechanical specs complete for all systems
- **Prepare and finalize area classification drawings**
  - ✓ Plans based upon best available vendor data
- **Compile environmental information**
  - ✓ Emissions
    - Point source quantities and compositions – where known or estimated
    - Point sources – located on the plot plan
    - Fugitive emissions table
  - ✓ Effluents
    - Quantities – where known or estimated

- **Delineate emergency shutdown and loss prevention requirements**
  - ✓ Relief points identified from preliminary process hazards assessment
  - ✓ Contingencies implemented on P&IDs
  - ✓ Emergency shutdown procedures
- **Update plant layout** with process areas identified including recommended piping, electrical and instrument wiring corridors.
- **Lay out major equipment arrangements**
  - ✓ Names and provide ID#s
  - ✓ Area identification – located on the plot plan
- **Conduct major equipment elevation and location study**
- **Conduct major piping and duct study**
- **Finalize insulation specifications** - issued for design
- **Finalize electrical requirements**
  - ✓ Single line diagrams – based upon best available vendor data – issued for design
- **Finalize major electrical equipment specifications** and preliminary quotes
- **Finalize functional specification and control philosophy** for primary or critical control systems
  - ✓ Control philosophy for entire facility
  - ✓ Functional specification for major process systems.
  - ✓ Process control system architecture plan
  - ✓ DCS specification and proposal
- **Finalize civil, structural, and architectural specifications**
  - ✓ Quote and Evaluate preliminary grading and underground requirements
  - ✓ Quote and Evaluate preliminary roads and fences.
  - ✓ Quote and Evaluate preliminary piling requirements
  - ✓ Quote and Evaluate preliminary foundation requirements
  - ✓ Quote and Evaluate preliminary structures
  - ✓ Quote and Evaluate preliminary buildings
- **Prepare preliminary process hazards assessment**
- **Confirm applicable engineering codes standards required**
- *Prepare labor survey*
- **Develop execution strategies for:**
  - ✓ Design
  - ✓ Procurement
  - ✓ Construction
  - ✓ Turnover sequences
  - ✓ Contracting

- **Develop plans for:**
  - ✓ Contracting
  - ✓ Long-lead procurement
  - ✓ Resource requirements
  - ✓ Local content providers
- **Prepare a Level-2, WBS Activity Based, CPM Schedule to include:**
  - ✓ Permitting
  - ✓ Engineering
  - ✓ Procurement
  - ✓ Construction
  - ✓ Commissioning and startup activities
- **Prepare a Division of Responsibility between owner and EPC contractor for:**
  - ✓ Permitting
  - ✓ Construction
  - ✓ Plant Operation
- **Proceed to financial close and on to start of construction**