COAA & CII Benchmarking & Metrics
Glossary of Terms

Revised Nov14th, 2007

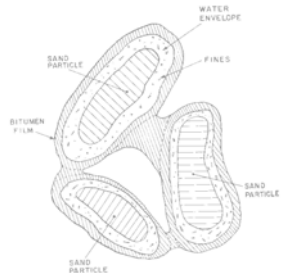
COAA

Table of Content

Note: This Glossary is available online at Project Central. The online Glossary also includes Scoring of Best Practices and other, current information.

Project Type Definition

Oil Sands – is Sand containing bitumen often referred to as "tar sand," because the bitumen (or oil) resembles black, sticky tar. Oil sands are "hydrophilic" or "water wet." Each grain of sand is covered by a film of water, which is then surrounded by a slick of heavy oil (bitumen). The sands are bonded firmly together by grain-to-grain contact. It is considered economically feasible to mine, although it may be mined with a blended stock of higher grade oil sand. On average, it takes 2 tonnes of mined oil sand to produce one barrel of synthetic crude oil (159 litres). *(http://www.oilsandsdiscovery.com/oil_sands_story/upgrade.html)*



Oil Sands Extraction- The process of extracting the oil form resources and separating the bitumen from the oil sands. Oil Sands extraction can be performed by several process depend on condition, efficiency and production cost such as oil sands mining, and In situ which can be Steam assisted gravity drainage (SAGD), Cyclic Steam Stimulation (CSS), Vapor Extraction Process (VAPEX) and Toe to Heel Air Injection (THAI)

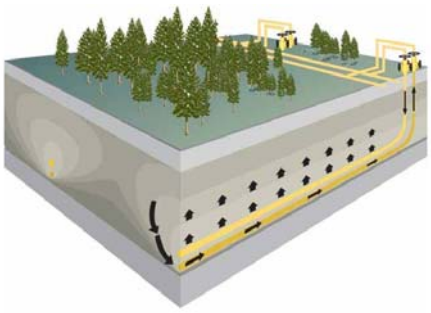
Oil Sands Mining- is one of the oil sands extraction which are from surface mining. In these oil sands there are large deposits of bitumen with little overburden, making mining the most efficient method of extracting it. The overburden consists of water-laden muskeg (peat bog) over top of clay and barren sand. The oil sands themselves are typically 40 to 60 metres deep, sitting on top of flat limestone rock. Originally, the sands were mined with draglines and bucket-wheel excavators and moved to the processing plants by conveyor belts.
(http://en.wikipedia.org/wiki/Tar_sands#Extraction_process)

Oil Sands Mining Extraction Plant- is the process to separate bitumen from sand and clay, then transport by pipeline for upgrading into synthetic crude oil. Recent enhancements to this method include **Tailings Oil Recovery (TOR) units** which recover oil from the tailings, **Diluent Recovery Units** to recover Naptha from the froth, **Inclined Plate Settlers (IPS)** and disc centrifuges. These allow the extraction plants to recover over 90% of the bitumen in the sand.

Oil Sands In situ- In its original place; in position; in situ recovery refers to various methods used to recover deeply buried bitumen deposits, including steam injection, solvent injection and firefloods. No single method of in situ recovery can be applied to all oil sand deposits, since the bitumen varies considerably from deposit to deposit as well as within each deposit. One of the most promising in situ methods is referred to as SAG-D (Steam Assisted Gravity Drainage). There are, however, a number of other techniques that are being used including THAI and VAPEX.

Project Type Definition (Con't)

Steam assisted gravity drainage (SAGD) – is a recovery technique for extraction of heavy oil or bitumen that involves drilling a pair of horizontal wells one above the other; one well is used for steam injection and the other for production. It is an enhanced oil recovery technology for heavy crude oil and bitumen.Two parallel horizontal oil wells are drilled in the formation. The upper well injects steam and the lower one collects the water that results from the condensation of the injected steam and the crude oil or bitumen. The injected steam heats the crude oil or bitumen and lowers its viscosity which allows it to flow down into the lower well bore where it is collected and piped to upgrading facilities. (http://en.wikipedia.org)



Courtesy by OptiCanada

Toe to Heal Air Injection (THAI)- is a proposed revolutionary technology for the in-situ recovery of bitumen and heavy oil that combines a vertical air injection well with a horizontal production well.

Vapor Extraction Process (VAPEX)- is technically similar to SAGD but instead of steam, solvent is being injected into the oil sands resulting in significant viscosity reduction.

Oil Sands Upgrading or Refining- is the process of converting heavy oil or bitumen into synthetic crude oil. Upgrading means the process of removing some carbon while adding additional hydrogen to make more valuable hydrocarbon products. This is done using four main processes: **coking** removes carbon and breaks large bitumen molecules into smaller parts, **distillation** sorts mixtures of hydrocarbon molecules into their components, **catalytic conversions** help transform hydrocarbons into more valuable forms and **hydrotreating** is used to help remove sulphur and nitrogen and add hydrogen to molecules. The end product is synthetic crude oil, which is shipped by underground pipelines to refineries across North America to be refined further into jet fuels, gasoline and other petroleum products

Cost Definition

Baseline Budget- Budget includes contingency and corresponds to funding approved at time of Project Sanction. This is the original baseline budget, and should not be updated to include any changes since change data are collected in a later section.

Bulk Materials - Bulk materials are generally defined as the balance of construction components outside the major equipment classification. Bulks are commonly referred to as commodity materials. In general bulks do not include tagged/numbered equipment or devices (See "**Bulk Reference** Table")

Construction Costs – include the costs of construction activities from commencement of foundation or driving piles to mechanical completion. The costs include construction project management, construction labour, and also equipment& supplies costs that are used to support construction operations and removed after commissioning. See "**Instruction for Construction Direct and Indirect Costs**" for detail of typical cost element.

Contingency - Contingency is defined as an estimated amount included in the project budget that may be required to cover costs that result from project uncertainties. These uncertainties may result from incomplete design, unforeseen and unpredictable conditions, escalation, or lack of project scope definition. The amount of contingency usually depends on the status of design, procurement and construction, and the complexity and uncertainties of the component parts of the project.

Cost of Land - The cost of land includes the purchase price of the land obtained for project use. It does not include the cost of preparing the land for use, such as soil remediation, demolition of existing structures, site preparation, etc.

Cost of Quality Management - The sum of those costs associated with quality deviation prevention and appraisal activities. Examples include:

- Quality System/Program Development
- Personnel Qualification Testing
- Formal Design Check/Review
- On/Off-Site Inspection

Direct Costs – Direct costs are those which are readily or directly attributable to, or become an identifiable part of, the final project (e.g., piping labor and material) [AACE].

Indirect Costs – Indirect costs are all costs that cannot be attributed readily to a part of the final product (e.g., cost of managing the project) [AACE].

Major Equipment – The term Major Equipment is commonly used interchangeably with Engineered Equipment. It is generally defined as tagged/numbered process or mechanical equipment including drivers. See "Major Material Reference Table" for details of cost elements.

Cost Definition (Cont')

Budget at Project Sanction – is defined as the budget approved or authorized to execute the project.

Procurement Phase Costs – is the costs of **Engineered Equipment** (or Major Equipment) including process, mechanical, and construction equipment installed and/ or used after commissioning include management fees and transportation costs. See "**Project Phase Definition Table**" for details of typical cost elements.

Total Cost of Major Equipment – is the costs of the major equipment include mechanical and process equipment which are installed and/ or used after commissioning as listed in **"Equipment Reference Table".** Include costs of the total purchase cost of major equipment. Exclude costs for field services, bulk construction equipment (such as valves, bus duct etc.), off-the-shelf equipment. Project team costs and transportation costs are also excluded.

Total Cost of Mechanical and process Equipment – is the costs of the mechanical and process equipment which are installed and/ or used after commissioning as listed in "**Equipment Reference Table"**. Include the total purchase cost of major equipment and exclude costs for field services, bulk construction equipment (such as valves, bus duct etc.), off-the-shelf equipment. Project team costs and transportation costs are also excluded.

Schedule Definition

Baseline Schedule – is the original planned schedule approved at time of **Project Sanction for owners** and **contract award for contractors**. It should be updated to include any changes since change data are collected in a later section. For benchmarking purposes the Baseline Schedule does not change during project execution.

Project Sanction – is defined as the milestone event at which the project scope, budget, and schedule are authorized. Project Sanction is the start of the execution phase of the project.

Change **-** A change is any event that results in a modification of the project work, schedule or cost. Owners and designers frequently initiate changes during design development to reflect changes in project scope or preferences for equipment and materials other than those originally specified. Contractors often initiate changes when interferences are encountered, when designs are found to be not constructable, or other design errors are found.

Change Order **-** A contractual modification executed to document the agreement and approval of a change (See definition of Change above).

Commissioning and Startup – The transitional phase between construction and commercial operations; major steps include turnover, checkout, commissioning, and initial operations. Commissioning is the integrated testing of equipment and facilities that are grouped together in systems prior to the introduction of feedstocks.

Detail Engineering – Detail engineering is the project phase initiated with a contract to the firm providing detail engineering for the project. The typical activities included in this phase are: preparation of drawings, specifications, bill of materials, development of a definitive cost estimate, technical reviews, and engineering procurement functions. The detail engineering phase terminates with release of all approved drawings and specifications for construction.

Mechanical Completion - The point in time when a plant is capable of being operated although some trim, insulation, and painting may still be needed. This occurs after completion of pre commissioning.

Changes Definition

Change - A change is any event that results in a modification of the project work, schedule or cost. Owners and designers frequently initiate changes during design development to reflect changes in project scope or preferences for equipment and materials other than those originally specified. Contractors often initiate changes when interferences are encountered, when designs are found to be not constructable, or other design errors are found.

Project Development Changes – Project Development Changes include those changes required to execute the original scope of work or obtain original process basis. Examples include:

1) Unforeseen site conditions that require a change in design / construction methods
2) Changes required due to errors and omissions
3) Acceleration
4) Change in owner preferences
5) Additional equipment or processes required to obtain original planned throughput
6) Operability or maintainability changes. (See Change above)

Scope Changes – Scope Changes include changes in the base scope of work or process basis. Examples include:

1) Feedstock change
2) Changed site location
3) Changed throughput
4) Addition of unrelated scope

Safety Definition

Recordable Case - A work event or exposure that is the discernable cause of an injury or illness or of a significant aggravation to a pre-existing condition. A recordable case requires medical aid, restricted work in relation to either medical aid or lost time, or fatality.

Restricted Work Case (RW) - Includes restricted work lost time cases, restricted work medical aid cases and restricted work first aid cases.

Lost Time Case (LT) - Lost Time cases are the result of an occupational injury or illness including any disabling injury which prevents a worker from reporting to work on his/her next regularly scheduled.

Medical Aid Case (MA) - Any occupational injury or illness requiring medical treatment administered by a physician, not including first aid treatment

First Aid Case (FA) - Any one time treatment which does not require medical care or further medical aid e.g. minor scratches, cuts, burns, splinters.

Lost Time Days (LTD) - Equals the number of scheduled work days away from work as a result of an occupational injury or illness, disabling injury or illness which prevents a worker from reporting to work on next regularly scheduled.

Restricted Work Lost Time (RWLT) - As a result of a Lost Time Classification, if restricted work is applied after the worker returns from work due to a work related absence as recommended by a physician or other licensed health care professional, the classification is upgraded to a Restricted Work Lost Time case.

Restricted Work Days (RWD) - Equals the number of scheduled work days that the worker was unable to work their regular duties as a result of an injury or illness as defined in restricted work.

Total Recordable Injury Frequency (TRIF) - This calculation measures the number of all of the recordable cases in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of lost time (LT) cases, medical aid (MA) cases plus the number of lost time (RWLT) & medical aid (RWMA) restricted work cases, by 200,000 and dividing by the exposure hours worked in the period.

$$\text{TRIF} = \frac{\text{Total Number of LT + MA + RWLT + RWMA x 200,000}}{\text{Total Site Work-Hours}}$$

Safety Definition (Cont')

Total Severity Rate (TSR) -This calculation measures the seriousness of recordable lost time cases and all restricted work cases within the exposure period. It is calculated by multiplying the number of lost workdays plus the number of restricted work days for all lost time, medical aid and first aids by 200,000 and dividing by the exposure hours worked in the period.

$$TSR = \frac{\text{Total Number of lost work days + restricted work for LT, MA and FA x 200,000}}{\text{Total Site Work-Hours}}$$

Total Injury Frequency (TIF) -This calculation, measures the number of all cases (recordable and non-recordable) in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of lost time (LT) cases, medical aid (MA) cases, first aid (FA) cases and the number of restricted work cases for lost time (RWLT), medical aid (RWMA) and first aid (RWFA) by 200,000 and dividing by the exposure hours worked in the period.

$$TIF = \frac{\text{Total Number of LT + MA + FA + RWLT + RWMA + RWFA x 200,000}}{\text{Total Site Work-Hours}}$$

Lost Time Severity Rate (LTSR) - This calculation measures the seriousness of recordable lost time injuries within the exposure period. It is calculated by multiplying the number of lost workdays by 200,000 and dividing by the exposure hours worked in the period.

$$LTSR = \frac{\text{Total Number of lost work days x 200,000}}{\text{Total Site Work-Hours}}$$

Lost Time Frequency (LTF) - This calculation measures the total number of lost time incidents (which includes fatalities) in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of lost time (LT) cases by 200,000 and dividing by the exposure hours worked in the period.

$$LTF = \frac{\text{Total Number of LT x 200,000}}{\text{Total Site Work-Hours}}$$

Medical Aid Frequency (MAF) - This calculation measures the total number of medical aid cases in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of medical aid (MA) cases by 200,000 and dividing by the exposure hours worked in the period.

$$MAF = \frac{\text{Total Number of MA x 200,000}}{\text{Total Site Work-Hours}}$$

Safety Definition (Cont')

First Aid Frequency (FAF) - This calculation measures the total number of first aid cases in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of first aid (MA) cases by 200,000 and dividing by the exposure hours worked in the period.

$$FAF = \frac{\text{Total Number of FA} \times 200{,}000}{\text{Total Site Work-Hours}}$$

Restricted Work Frequency (RWF) - This calculation measures the total number of restricted work cases in the exposure period as a frequency of the workforce. It is calculated by multiplying the number of restricted work lost time cases, restricted work medical aid cases and restricted work first aid cases by 200,000 and dividing by the exposure hours worked in the period.

$$RWF = \frac{\text{Total Number of RWLT + RWMA + RWFA} \times 200{,}000}{\text{Total Site Work-Hours}}$$

Restricted Work Lost Time Severity Rate (RWLTSR) - This calculation measures the seriousness of restricted work cases within the exposure period. It is calculated by multiplying the number of restricted work lost time workdays by 200,000 and dividing by the exposure hours worked in the period.

$$RWLTSR = \frac{\text{Total Number of restricted work lost time work days} \times 200{,}000}{\text{Total Site Work-Hours}}$$

Practice Definition

Front End Planning- is the essential process of developing sufficient strategic information with which owners can address risk and make decisions to commit resources in order to maximize the potential for a successful project. Front End Planning is also known as pre-project planning, front end loading, feasibility analysis, conceptual planning/ schematic design, and early project planning.

Project Risk Assessment - Project risk assessment is the process to identify, assess and manage risk. The project team evaluates risk exposure for potential project impact to provide focus for mitigation strategies.

TeamBuilding- is a project- focused process that builds and develops shared goals, interdependence, trust and commitment, and accountability among team members and that seeks to improve team members' problem- solving skills.

Alignment during Front End Planning- is the condition where appropriate project participants are working with acceptable tolerances to develop and meet a uniform defined and understood set of project objectives.

Constructability- is the effective and timely integration of construction knowledge into the conceptual planning, design, construction, and filed operations of a project to achieve the overall project objectives in the best possible time and accuracy at the most cost- effective levels.

Design for Maintainability- Design for maintainability is the optimum use of facility maintenance knowledge and experience in the design/engineering of a facility to pertain the ease, accuracy, safety and economy in the performance of maintenance action; a design parameter related to the ability to maintain.

Material Management - the planning, controlling, and integrating of the materials takeoff, purchasing, economic, expediting, transportation, warehousing, and issue functions in order to achieve a smooth, timely, efficient flow of materials to the project in the required quantity, the required time, and at an acceptable price and quality, and the planning and controlling of these functions (CII Publication SP-4)

Project Change Management- is the process of incorporating a balanced change culture of recognition, planning, and evaluation of project changes in an organization to effectively manage project changes. Practices related to the management and control of both scope changes and project changes.

Zero Accident Techniques- include the site- specific safety programs and implementation, auditing, and incentive efforts to create a project environment and a level of that embraces the mind set that all accidents are preventable and that zero accidents is an obtainable goal.

Practice Definition (cont'd)

Quality Management- Quality management incorporates all activities conducted to improve the efficiency, contract compliance and cost effectiveness of design, engineering, procurement, QA/QC, construction and startup elements of construction projects.

Automation/Integration (AI) Technology. The Automation and Integration Technology practice addresses the degree of automation/level of use and integration of automated systems for predefined tasks/work functions common to most projects.

Planning for startup- is the effectiveness of planning on startup activities that facilitate the implementation of the transitional phase between plant construction completion and commercial operations, including all of the activities bridging these two phases. Critical steps within the startup phase include systems turnover, checkout of systems, commissioning of systems, introduction of feed stocks, and performance testing.

Prefabrication/ Preassembly/ Modularization- Prefabrication/Preassembly/Modularization (PPMOF) is defined as several manufacturing and installation techniques, which move many fabrication and installation activities from the plant site into a safer and more efficient environment. For each technique, more specific definitions are provided below.

- ***Prefabrication***: a manufacturing process, generally taking place at a specialized facility, in which various materials are joined to form a component part of a final installation. Prefabricated components often involve the work of a single craft.

- ***Preassembly***: a process by which various materials, prefabricated components, and/or equipment are joined together at a remote location for subsequent installation as a sub-unit: generally focused on a system.

- ***Module***: a major section of a plant resulting from a series of remote assembly operations and may include portions of many systems: usually the largest transportable unit or component of a facility.

- ***Offsite Fabrication***: the practice of preassembly or fabrication of components both off the site and onsite at a location other than at the final installation location.

This practice consists of two part, constructability at AFE phase and constructability at mechanical completion. Please fill out one part of this practice according to your current project phase.

.

General Terms

3D CAD modeling - Computer aided drafting system that provides three-dimensional views for checking physical interferences in addition to providing two and three dimensional drafting capabilities.

Acceptance Testing - Facility capacity testing at the time a project is expected to reach design capacity. The timing in which this takes place varies by type of facility. Acceptance testing may occur shortly after start-up of a process unit, 6 to 12 months on building or mechanical trains, or 2 to 3 years for a paper mill.

Addition (Add-on) - A new addition that ties in to an existing facility, often intended to expand capacity.

AFE – Authorization for Expenditure - Authorization for Expenditure (AFE) is defined as the milestone event in which company management approves the project scope, budget, and schedule. AFE signals the start of the execution phase of the project.

AFE Budget – The AFE Budget is the amount authorized to execute the project and should be a part of the AFE documentation.

Alliance Partner. A participant in a long-term association with a non-affiliated organization, used to further the common interests of the members. The continued association is based upon mutual trust and the satisfactory performance of each participant, and the alliance as a whole, rather than a pure contractual obligation.

Bar Coding - The use of automatic identification technology by labeling, identifying, and controlling items, materials, and equipment through the use of bar codes. A bar code can be defined as a self contained message with information encoded in the widths of bars and spaces in a printed pattern.

Capacity – The design maximum production rate expressed in units appropriate for the subject process. Nameplate capacity should be used for benchmarking data submission.

Direct Cost of Field Rework. The sum of those costs associated with actual performance of tasks involved in rework. Examples include:

- Labor
- Materials
- Equipment
- Supervisory personnel
- Associated overhead cost

Electronic Data Interchange (EDI). EDI is a technology that permits the direct computer-to-computer exchange of data in a standard format. Data is transmitted in a standard industry format, checked for error, and imported directly into the receiving computer system without re-keying.

General Terms (Cont')

Escalation - Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, etc., due to continuing price changes over time.

Field Rework. Field rework is the activities that have to be done more than once in the field or activities which remove work previously installed as part of the projects.

Grass Roots, Green Field - A new facility from the foundations and up. A project requiring demolition of an existing facility before new construction begins is also classified as grass roots.

Integrated Database. An integrated database is a concept of organizing, storing, and managing all electronic data relating to a project in such a fashion that data is entered and stored once and then accessed and utilized by multiple users and applications. The users may include those involved with facility planning, design, procurement, construction, plant operations, and suppliers.

Mechanical Completion. The point in time when a plant is capable of being operated although some trim, insulation, and painting may still be needed. This occurs after completion of precommissioning. In some industries, mechanical completion may have the same general meaning as beneficial occupancy.

Modularization. Modularization refers to the use of offsite construction. For the purposes of the benchmarking data, modularization includes all work that represents substantial offsite construction and assembly of components and areas of the finished project. Examples that would fall within this categorization include:

- Skid assemblies of equipment and instrumentation that naturally ship to the site in one piece, and require minimal on-site reassembly.
- Super-skids of assemblies of components that typically represent substantial portions of the plant, intended to be installed in a building.
- Prefabricated modules comprising both industrial plant components and architecturally finished enclosures.

Modularization does not include offsite fabrication of components. Examples of work that would be excluded from the definition of modularization include:

- Fabrication of the component pieces of a structural framework
- Fabrication of piping spool-pieces

Modernization, Renovation, Upgrade - A facility for which a substantial amount of the equipment, structure, or other components is replaced or modified, and which may expand capacity and/or improve the process or facility.

Project Budget at Authorization to Proceed - This is the estimated cost for your company's portion of the project at authorization to proceed. If your contract had cost changes before authorization to proceed, then these changes should be included in the project budget. Do not include estimated costs for change orders received during project execution.

General Terms (Cont')

P&IDs (Piping and Instrumentation Diagrams) - Schematic diagrams which show the layout and relationship of piping and instrumentation.

Rework - is defined as activities in the field that have to be done more than once in the field or activities which remove work previously installed as part of project.

Scope Changes - Changes in the base scope of work or process basis. Examples include:

- Feedstock change
- Changed site location
- Changed throughput
- Addition of unrelated scope

Total Construction Hours - The summation of all direct and indirect hours associated with the construction phase.

Turnaround/Shutdown/Outage - The period during which a boiler, generating unit, transmission line, or other facility is shutdown and unable to perform its normal operations. The shutdown of a facility including for maintenance, inspection, testing, regulatory changes, or, in some cases, for refuelling is known as a planned shutdown. Turnaround is interchangeable with shutdown or outage depending on industry groups.

Union Workforce -

- **Building Trades Unions** are organizations of workers formed for the purpose of advancing their members' interests in respect to wages, benefits and working conditions. Building trades unions typically represent single trades.
  Example: IBEW - International Brotherhood of Electrical Workers

- **Alternate Unions** are multicraft unions or wall-to-wall unions similar in purpose to building trades unions but are inclusive of mulitiple trades and industries.
  Example: CLAC - Christian Labour Association of Canada

Project Phase Definition Table

Project Phase	Start/Stop	Typical Activities & Products	Typical Cost Elements
Front End Planning Typical Participants: • Owner Personnel • Planning Consultants • Constructability Consultant • Alliance / Partner	**Start: Single project adopted and Formal project team established** **Stop: Project Sanction**	• Options Analysis • Life-cycle Cost Analysis • Project Execution Plan • Appropriation Submittal Pkg • P&IDs and Site Layout • Project Scoping • Procurement Plan • Arch. Rendering	• Owner Planning Team Personnel Expenses • Consultant Fees & Expenses • Environmental Permitting Costs • Project Manager / Construction Manager Fees • Licensor Costs
Detail Engineering Typical Participants: • Owner Personnel • Design Contractor • Constructability Expert • Alliance / Partner	**Start: Design Basis** **Stop: Release of all approved drawings and specs for Construction (or last package for fast-track)**	• Drawing & spec preparation • Bill of material preparation • Procurement Status • Sequence of operations • Technical Review • Definitive Cost Estimate	• Owner Project Management Personnel • Designer Fees • Project Manager / Construction Manager Fees
Procurement Typical Participants: • Owner personnel • Design Contractor • Alliance / Partner	**Start: Procurement Plan for Engineered Equipment** **Stop: All engineered equipment has been delivered to site**	• Vendor Qualification • Vendor Inquiries • Bid Analysis • Purchasing • Expediting • Engineered Equipment • Transportation • Vendor QA/QC	• Owner project management personnel • Project Manager / Construction Manager fees • Procurement & Expediting personnel • Engineered Equipment • Transportation • Shop QA / QC

Note: The demolition / abatement phase should be reported when the demolition / abatement work is a separate schedule activity (potentially paralleling the design and procurement phases) in preparation for new construction. Do not report the demolition / abatement phase if the work is integral with modernization or addition activities.

Project Phase Table (Cont.)

Project Phase	**Start/Stop**	Typical Activities & Products	Typical Cost Elements
Construction Typical Participants: • Owner personnel • Design Contractor (Inspection) • Construction Contractor and its subcontractors	**Start: Commencement of Foundations or driving Piles** **Stop: *Mechanical Completion***	• Set up trailers • Procurement of bulks • Issue Subcontracts • Construction plan for Methods/Sequencing • Build Facility & Install Engineered Equipment • Complete Punchlist • Demobilize construction equipment • Warehousing	• Owner project management personnel • Project Manager / Construction Manager fees • Building permits • Inspection QA/QC • Construction labor, equipment & supplies • Bulk materials (including freight) • Construction equipment (including freight) • Contractor management personnel • Warranties
Start-up / Commissioning Note: Does not usually apply to infrastructure or building type projects Typical Participants: • Owner personnel • Design Contractor • Construction Contractor • Training Consultant • Equipment Vendors	**Start: *Mechanical Completion*** **Stop: Custody transfer to user/operator (steady state operation)**	• Testing Systems • Training Operators • Documenting Results • Introduce Feedstocks and obtain first Product • Hand-off to user/operator • Operating System • Functional Facility • Warranty Work	• Owner project management personnel • Project Manager / Construction Manager fees • Consultant fees & expenses • Operator training expenses • Wasted feedstocks • Vendor fees

Engineering and Construction Productivity

1. Engineering Productivity:

Engineering Direct work-hours **-** should include all detailed design hours used to produce deliverables including site investigations, meetings, planning, constructability, RFIs, etc., and rework. Specifically exclude work-hours for operating manuals and demolition drawings.

- Engineering work-hours reported should only be for the categories requested and may not equal the total engineering work-hours for the project. (See "**Instructions for Computation of Work-Hours and Rework-Hours"** reference table)
- Exclude the following categories: architectural design, plumbing, process design, civil/site prep, HVAC, insulation and paint, sprinkler/deluge systems, etc. Within a category, direct work-hours that cannot be specifically assigned into the provided classifications, and have not been excluded, should be prorated based on known work-hours or quantities as appropriate.

IFC Drawing: Issued for Construction drawings.

I/O (count): The I/O that comes over digital communication interfaces from outside of the control system. For such interfaces, count the addressable points. For Fieldbus interfaces, count only the devices.

2. Construction Productivity:

Actual Quantities and Work-hours - are all quantities and work-hours of actual installation and include rework-hours for these quantities and work-hours.

Estimated Productivity – are the estimated productivity of direct labor work-hours required for installation according to the estimated quantity.

For owners: Estimated Quantity, Work-hours and Total Installed Unit Cost **at the time of Project Sanction** (or as soon as available following sanction)

For contractors: Estimated Quantity, Work-hours and Total Installed Unit Cost used **as the basis of Contract Award**.

Estimated Quantities and Work-hours - are the estimated quantity to be installed, the estimated work-hours required for the installation and include all change orders.

Estimated Total Installed Unit Cost - including labour and material cost at the time of project sanction (or as soon as available following sanction).

Shop Fabrication — the assembling of components in a supplier shop. (CII publication SP-4)

Engineering and Construction Productivity

2. Construction Productivity (cont'):

ISBL – Inside Battery Limits (ISBL) is defined as all equipment and associated components (piping, etc.) that act upon the primary feed stream of a process. ISBL is functional-based and refers to equipment and other components that are solely dedicated to a single process whether or not the equipment is physically located within the geographical boundaries of the unit. See example illustration.

OSBL – Outside Battery Limits (OSBL) is defined as utilities, common facilities, and other equipment and components not included in the ISBL definition. OSBL refers to systems (equipment pieces and associated components) that support several units. Typical OSBL equipment includes cooling towers, water treatment facilities, feed tanks, etc. See example illustration.

Process Unit – A process unit is comprised of equipment, piping, process control devices, support structures, and associated materials. There may be several systems or a single system in a process unit that make a functional whole. A process unit typically changes the physical properties of whatever enters it, or it can be a utility process that enhances or improves the efficiency of the processing function.

Estimated Total Installed Unit Costs (TIUC) – is the burdened direct cost of labour, material and equipment by pro rata share which are directly attribute to, or become a part of the final product including overhead and profit at the time of project sanction (or as soon as available following sanction).

Actual Total Installed Unit Costs (TIUC) is the burdened direct cost of labour, material and equipment by pro rata share which are directly attribute to, or become a part of the final product including overhead and profit from both direct hire and subcontract.

- The direct labour costs are considered as the costs of the labours listed as Direct in the *"Instructions for Computation of Actual Work-Hours, Rework-Hours, and Installed Costs"* table in Construction Productivity Section.
- **For total of each discipline** - is the weighted average TIUC by quantities of each sub categories in that discipline and any other types of related which are not indicated in each section. For example,

  - ***TIUC for Total Concrete*** is the weighted average of slabs, foundations, concrete structures and any other concrete components not included in construction productivity concrete table.

  - ***TIUC for Total Structural Steel*** is the weighted average of the structural steels, pipe rack& utility bridges, miscellaneous steel and any other structural steel not included in construction productivity structural steel table.

  - ***TIUC for Total Electrical Equipment*** is the weighted average of the panels& small devices, electrical equipment 1kV& below, electrical equipment over 1kV and any other electrical equipment and devices not included in construction productivity electrical equipment table.

Engineering and Construction Productivity (cont'd)

2.1 Construction Productivity Concrete Section:

Installed Neat Quantity of concrete: concrete that is required for the specified slab, foundation, or structure provided in the project's plans and specifications and does not include any quantity of concrete that is used due to rework.

Concrete Structures: This includes concrete structures, columns, beams, cooling tower basins, trenches, formed elevated slabs/structures, and retaining walls.

2.2 Construction Productivity Electrical Section:

UPS: Uninterrupted Power Supply System

MCC: Motor-Control Centers

DCS: Distributed Control System

PLC: Programmable Logic Control

2.3 Construction Productivity Piping Section:

NDE: Non-destructive evaluation

***Hot piping*:** piping which has a design temperature greater than 120 degrees Celsius.

Cold piping: piping which has a design temperature less than minus 20 degrees Celsius.

2.5 Construction Productivity Module Installation Section:

Module: A major section of a plant resulting from a series of remote assembly operations and may include portions of many systems; usually the largest transportable unit or component of a facility e.g. gas compression/ purification module (CII publication, IR171-2).

Pipe rack module: A preassembled structure in a off-site location. Pipe rack module structure may include several components such as structural steel for framework, walkway, platform to support the piping, piping c/w (cooling water) valving. It also may include electrical tray, heat tracing and insulation. However, piping modules (remote fabrication piping) are excluded from piping module.

Preassembly: A process by which various material, prefabricated components, and/ or equipment are jointed together at a remote location for subsequent installation as a sub-unit; generally focused on a system e.g. preassembled equipment skid (CII publication, IR171-2).

Prefabrication: A manufacturing process, generally taking place at a specialized facility, in which various materials are joined to form a component part of a final installation. Prefabricated components often involve the work of a single craft e.g. prefabricated pipe spools (CII publication, IR171-2).

PDRI (Project Definition Rating Index) Buildings

SECTION I: BASIS OF PROJECT DECISION

A. BUSINESS STRATEGY

A1. Building Use

Identify and list building uses or functions. These may include uses such as:

- Retail
- Institutional
- Instructional
- Medical
- Storage
- Food service
- Recreational
- Research
- Multimedia
- Office
- Light manufacturing

A description of other options which could also meet the facility need should be defined. (As an example, was renovating existing space rather than building new space considered?) A listing of current facilities that will be vacated due to the new project should be produced.

A2. Business Justification

Identify driving forces for the project and specify what is most important from the viewpoint of the owner including both needs and expectations. Address items such as:

- Need date
- Target consumers
- Building utilization justification
- Possible competitors
- Level of amenities
- Location
- Sales or rental levels
- Market capacity
- Use flexibility
- Number of lessons/occupant types
- Support new business initiatives
- Facility replacement/consolidation

A3. Business Plan

A project strategy should be developed that supports the business justification in relation to the following items:

- Funding availability
- Cost and financing
- Schedule milestones (including known deadlines)
- Types and sources of project funds
- Related/resulting projects

A4. Economic Analysis

An economic model should be developed to determine the viability of the venture. The model should acknowledge uncertainty and outline the boundaries of the analysis. It should acknowledge items such as:

- Design life
- Building ownership
- Tax implications of investment including length of ownership
- Long-term operating and maintenance costs
- Resale/lease potential or in the case of institutional buildings, long-term use plans
- Analysis of capital and operating cost versus sales or occupancy and profitability

A5. Facility Requirements

Facility size requirements are many times determined by applicable code and are often driven by occupancy. Note that this analysis is at the macro level. Some considerations are listed below:

- Number of occupants
- Volume
- Net and gross square footage by area uses
- Support infrastructure
- Classroom size
- Linear feet of display space
- Number of laboratory stations
- Occupant accommodation requirements (i.e., number of hospital beds, number of desks, number of workstations, on-site child care, on-site medical care, cot space, etc.)

A6. Future Expansion/Alteration Considerations

The possibility of expansion and/or alteration of the site and building should be considered for facility design. These considerations consist of a list of items that will facilitate the expansion or evolution of building use including adaptability/flexibility.

Evaluation criteria may include:

- Provisions for site space in case of possible future expansion up or out
- Technologically advanced facility requirements
- Are departments or functional areas intended to “grow in place” during the future phase?

- If there will not be a future expansion of the building, how will departments or areas expand?
- Are any functional areas more likely than others to move out of the building in the future to allow others to expand or move in?
- Who will occupy the building in five, 10, 15, 20 years?
- Flexibility or adaptability for future uses.
- Future phasing plan

A7. Site Selection Considerations

Evaluation of sites should address issues relative to different locations (i.e., global, country, or local). This evaluation may take into consideration existing buildings or properties, as well as new locations. The selection criteria include items such as:

- General geographic location
  - Access to the targeted market area
  - Local availability and cost of skilled labor (e.g., construction, operation)
  - Available utilities
  - Existing facilities
  - Economic incentive zones
  - Tax
- Land availability and developed costs
- Legal constraints
- Unusual financing requirements in region/locality
- Domestic culture vs. international culture
- Community relations
- Labor relations
- Government relations
- Political issues/constraints
- Education/training
- Safety and health considerations
- Environmental issues
- Symbolic and aesthetic
- Historic preservation
- Weather/climate
- Permitting Schedule

A8. Project Objectives Statement

This statement defines the project objectives and priorities for meeting the business strategy. It should be clear, concise, measurable, and specific to the project. It is desirable to obtain total agreement from the entire project team regarding these objectives and priorities to ensure alignment. Specifically, the priorities among cost, schedule, and value-added quality features should be clear. The objectives also should comply with any master plans if applicable.

B. OWNER PHILOSOPHIES

B1. Reliability Philosophy

A brief description of the project intent in terms of reliability should be defined. A list of the general design principles to be considered to achieve optimum/ideal operating performance from the facility/building should be addressed. Considerations may include:

- Critical systems redundancy
- Architectural/structural/civil durability
- Mechanical/electrical/plumbing reliability

B2. Maintenance Philosophy

A list of the general design principles to be considered to meet building maintenance requirements should be identified. This evaluation should include life cycle cost analysis of major facilities. Considerations may include:

- Daily occupancy loads
- Maximum building occupancy requirements
- Equipment monitoring requirements
- Energy conservation programs
- Selection of materials and finishes
- Requirements for building finishes

B3. Operating Philosophy

A list of the general design issues that need to be considered to support routine operations should be developed. Issues may include:

- Operating schedule/hours
- Provisions for building rental or occupancy assignments (i.e., by room, floor, suite) including flexibility of partitioning
- Future renovation schedule
- User finish out philosophy
- Flexibility to change layout

B4. Design Philosophy

A listing of design philosophy issues should be developed. These issues should be directed at concerns such as the following:

- Design life
- Aesthetic requirements
- Compatibility with master plan
- Theme
- Image
- Environmentally sustainable design (internal/external)
- Quality of life

C. PROJECT REQUIREMENTS

C1. Value-Analysis Process

A structured value analysis approach should be in place to consider design and material alternatives in terms of their cost effectiveness. Items that impact the economic viability of the project should be considered. Items to evaluate include issues such as:

- Discretionary scope issues
- Expensive materials of construction
- Life-cycle analysis of construction methods and structure

C2. Project Design Criteria

Project design criteria are the requirements and guidelines which govern the design of the project. Any design review board or design review process should be clearly articulated. Evaluation criteria may include:

- Level of design detail required
- Climatic data
- Codes and standards
  - National
  - Local
  - Owner specific
  - International
- Utilization of design standards
  - Owner's
  - Contractor's
  - Designer's
  - Mixed
- Level of design detail required
- Donor or benefactor requirements
- Sole source requirements for equipment or systems
- Insurance underwriter requirements
- Cultural preferences

C3. Evaluation of Existing Facilities

If existing facilities are available, then a condition assessment must be performed to determine if they will meet facility requirements. Evaluation criteria may include:

- Capacity
- Power
- Utilities (i.e., potable water, gas, oil)
- Fire water
- Waste treatment/disposal
- Sanitary sewer
- Telecommunications
- Security
- Storm water containment system/filtration
- Access

- Rail
- ADA or local standards
- Roads

- Parking areas
- Type and size of buildings/structures
- Amenities
  - Food service
  - Ambulatory access
  - Medical facilities
  - Recreation facilities including public outdoor spaces
  - Change rooms
- Condition assessment of existing facilities and infrastructure
- Other

C4. Scope of Work Overview

This work statement overview is a complete narrative description of the project that is discipline-oriented and supports development of the project schedule and project cost estimate. It sets the limits of work by each involved party and generally articulates their financial, task, and contractual responsibilities. It clearly states both assumptions and exclusions used to define the scope of work.

C5. Project Schedule

Ideally, the project schedule should be developed by the project team (owner, A/E, and construction contractor). It should include milestones, unusual schedule considerations and appropriate master schedule contingency time (float), procurement of long-lead or critical pacing equipment, and required submissions and approvals.

C6. Project Cost Estimate

The project cost estimate should address all costs necessary for completion of the project. This cost estimate may include the following:

- Construction contract estimate
- Professional fees
- Land cost
- Furnishings
- Administrative costs
- Contingencies
- Cost escalation for elements outside the project cost estimate
- Startup costs including installation
- Miscellaneous expenses including but not limited to:
  - Specialty consultants
  - Inspection and testing services
  - Bidding costs
  - Site clearance
  - Bringing utilities to the site
  - Environmental impact mitigation measures

- Local authority permit fees
- Occupant moving and staging costs
- Utility costs during construction (if paid by owner)
- Interest on borrowed funds (cost of money)
- Site surveys, soils tests
- Availability of construction laydown and storage at site or in remote or rented facilities

SECTION II: BASIS OF DESIGN

D. SITE INFORMATION

D1. Site Layout

The facility should be sited on the selected property. Layout criteria may include items such as:

- Access (e.g., road, rail, marine, air)
- Construction access
- Historical/cultural
- Trees and vegetation
- Site massing and context constraints or guidelines (i.e., how a building will look in three dimensions at the site)
- Access transportation parking, delivery/service, and pedestrian circulation considerations
- Open space, street amenities, “urban context concerns”
- Climate, wind, and sun orientation for natural lighting views, heat loss/gain, energy conservation, and aesthetic concerns

D2. Site Surveys

The site should be surveyed for the exact property boundaries, including limits of construction. A topography map with the overall plot and site plan is also needed. Evaluation criteria may include:

- Legal property descriptions with property lines
- Easements
- Rights-of-way
- Drainage patterns
- Deeds
- Definition of final site elevation
- Benchmark control systems
- Setbacks
- Access and curb cuts
- Proximity to drainage ways and flood plains
- Known below grade structures and utilities (both active and inactive)
- Trees and vegetation
- Existing facility locations and conditions
- Solar/shadows

D3. Civil/Geotechnical Information

The civil/geotechnical site evaluation provides a basis for foundation, structural, and hydrological design. Evaluations of the proposed site should include items such as:

- Depth to bedrock
- General site description (e.g., terrain, soils type, existing structures, spoil removal, areas of hazardous waste, etc.)
- Expansive or collapse potential of soils
- Fault line locations
- Spoil area for excess soil (i.e., location of on-site area or off-site instructions)
- Seismic requirements
- Water table elevation
- Flood plain analysis
- Soil percolation rate and conductivity
- Ground water flow rates and directions
- Need for soil treatment or replacement
- Description of foundation design options
- Allowable bearing capacities
- Pier/pile capacities
- Paving design options
- Overall site analysis

D4. Governing Regulatory Requirements

The local, state, and federal government permits necessary to construct and operate the facility should be identified. A work plan should be in place to prepare, submit, and track permit, regulatory, re-zoning, and code compliance for the project. It should include items such as:

- Construction
- Unique requirements
- Environmental
- Structural calculations
- Building height limits
- Setback requirements
- Fire
- Building
- Occupancy
- Special
- Signage
- Historical issues
- Accessibility
- Demolition
- Solar
- Platting
- Air/water
- Transportation

The codes that will have a significant impact on the scope of the project should also be investigated and explained in detail. Particular attention should be paid to local requirements. Regulatory and code requirements may affect the defined physical characteristics and project cost estimate. The project schedule may be affected by regulatory approval processes. For some technically complex buildings, regulations may change frequently.

D5. Environmental Assessment

An environmental assessment should be performed for the site to evaluate issues that can impact the cost estimate or delay the project. These issues may include:

- Archeological
- Location in an EPA air quality non-compliance zone
- Location in a wet lands area
- Environmental permits now in force
- Existing contamination
- Location of nearest residential area
- Ground water monitoring in place
- Downstream uses of ground water
- Existing environmental problems with the site
- Past/present use of site
- Noise/vibration requirements
- Air/water discharge requirements and options evaluated
- Discharge limits of sanitary and storm sewers identified
- Detention requirements
- Endangered species
- Erosion/sediment control

D6. Utility Sources with Supply Conditions

The availability/non-availability of site utilities needed to operate the facility with supply conditions of quantity, temperature, pressure, and quality should be evaluated. This may include items such as:

- Potable water
- Drinking water
- Cooling water
- Fire water
- Sewers
- Instrument air
- Facility air
- Heating water
- Gases
- Steam
- Electricity (voltage levels)
- Communications (e.g., data, cable television, telephones)
- Special requirement (e.g., deionized water or oxygen)

D7. Site Life Safety Considerations

Fire and life safety related items should be taken into account for the selected site. These items should include fire protection practices at the site, available firewater supply (amounts and conditions), and special safety requirements unique to the site. Evaluation criteria may include:

- Wind direction indicator devices (e.g., wind socks)
- Fire monitors and hydrants
- Flow testing
- Access and evacuation plan
- Available emergency medical facilities
- Security considerations (site illumination, access control)

D8. Special Water and Waste Treatment Requirements

On-site or pretreatment of water and waste should be evaluated. Items for consideration may include:

- Wastewater treatment
- Process waste
- Sanitary waste
- Waste disposal
- Storm water containment and treatment

E. BUILDING PROGRAMMING

E1. Program Statement

The program statement identifies the levels of performance for the facility in terms of space planning and functional relationships. It should address the human, physical, and external aspects to be considered in the design. Each performance criteria should include these issues:

- A performance statement outlining what goals are to be attained (e.g., providing sufficient lighting levels to accomplish the specified task safely and efficiently)
- A measure that must be achieved (e.g., 200 foot-candles at surface of surgical table)
- A test which is an accepted approach to establish that the criterion has been met (e.g., using a standard light meter to do the job)

E2. Building Summary Space List

The summary space list includes all space requirements for the entire project. This list should address specific types and areas. Possible space listings include:

- Building population
- Administrative offices
- Lounges
- Food Service Cafeteria
- Conference rooms
- Vending alcoves
- Janitorial closets

- Elevators
- Stairs
- Loading docks
- Dwelling units
- Special technology considerations
- Classrooms
- Laboratories
- Corridors
- Storage facilities
- Mechanical rooms
- Electrical rooms
- Parking space
- Entry lobby
- Restrooms
- Data/computer areas

A room data sheet should correspond to each entry on the summary space list. Room data sheets are discussed in element E11. The room data sheet contains information that is necessary for the summary space list. This list is used to determine assignable (usable) and non-assignable (gross) areas.

E3. Overall Adjacency Diagrams

The overall adjacency diagrams depict the layout of each department or division of the entire building. They show the relationship of specific rooms, offices, and sections. The adjacency diagrams must adequately convey the overall relationships between functional areas within the facility. Note that these diagrams are sometimes known as “bubble diagrams” or “balloon diagrams.” They are also commonly expressed in an adjacency matrix.

E4. Stacking Diagrams

A stacking diagram portrays each department or functional unit vertically in a multi-story building. Stacking diagrams are drawn to scale, and they can help establish key design elements for the building. These diagrams are easily created with space lists and adjacency (or bubble) diagrams. Critical vertical relationships may relate to circulatory (stairs, elevators), structural elements, and mechanical or utility shafts. Stacking diagrams can establish building elements such as floor size. This type of diagram often combines functional adjacencies and space requirements and also shows how the project is sited.

E5. Growth and Phased Development

Provisions for future phases or anticipated use change must be considered during project programming. A successful initial phase necessitates a plan for the long term phases. The following phasing issues may be addressed.

- Guidelines to allow for additions (i.e., over-design of structural systems, joist layout, column spacing)
- Technology needs as facility grows and expands or changes (e.g., mechanical systems, water demands)

- Compare the additional costs involved with making the building “expandable” versus the probability of the future expansion occurring as envisioned.
- Provisions for infrastructure that allow for future expansion

E6. Circulation and Open Space Requirements

An important component of space programming is common-area open spaces, both interior and exterior. These areas include the items listed and considerations such as:

- Exterior
  - Service dock areas and access
  - Circulation to parking areas
  - Passenger drop-off areas
  - Pedestrian walkways
  - Courtyards, plazas, or parks
  - Landscape buffer areas
  - Unbuildable areas (e.g., wetlands or slopes)
  - Sidewalks or other pedestrian routes
  - Bicycle facilities
  - Lobbies and entries
  - Security considerations (e.g., card access or transmitters)
  - Snow removal plan
  - Postal and newspaper delivery
  - Waste removal
  - Fire and life-safety circulation considerations
- Interior
  - Interior aisle ways and corridors
  - Vertical circulation (i.e., personnel and material transport including elevators and escalators)
  - Directional and location signage

E7. Functional Relationship Diagrams/Room by Room

Room by room functional relationship diagrams show the structure of adjacencies of a group of rooms. With these adjacency diagrams (also known as bubble diagrams), the architect can convert them into a floor plan with all the relationships. Each space detail sheet should have a minimum of one functional relationship diagram. Rooms are often represented by circles, bubbles, squares, or rectangles. Larger rooms are represented with bigger symbols. They are also commonly expressed in an adjacency matrix.

E8. Loading/Unloading/Storage Facilities Requirements

list of requirements identifying materials to be unloaded and stored and products to be loaded along with their specifications. This list should include items such as:

- Storage facilities to be provided and/or utilized
- Refrigeration requirements and capabilities

- Mail/small package delivery
- Recycling requirements

E9. Transportation Requirements

Specifications for implementation of facility transportation (e.g., roadways, conveyers, elevators) as well as methods for receiving and shipping of materials (e.g., air, rail, truck, marine) should be identified. Provisions should be included for items such as:

- Facility access requirements based on transportation
- Drive-in doors
- Extended ramps for low clearance trailers
- Rail car access doors
- Service elevators
- Loading docks
- Temporary parking

E10. Building Finishes

Levels of interior and exterior finishes should be defined for the project. For example, the finishes may include categories such as:

Interior Schedule:
- Type A
  - Floor: vinyl composition tile
  - Walls: painted
- Type B
  - Floor: direct glue carpet
  - Walls: vinyl wall covering
- Type C
  - Floor: carpet over pad
  - Walls: wood paneling

Exterior Schedule:
- Type 1
  - Walls: brick
  - Trim: brick
- Type 2
  - Walls: overlapping masonry
  - Trim: cedar

Finishes and local design standards are further defined in category F.

E11. Room Data Sheets

Room data sheets contain the specific requirements for each room considering its functional needs. A room data sheet should correspond to each room on the building summary space list. The format of the room data sheet should be consistent. Possible issues to include on room data sheets are:

- Critical dimensions

- Technical requirements (e.g., fireproof, explosion resistance, X-ray)
- Furnishing requirements
- Equipment requirements
- Audio/visual (A/V) data and communication provisions
- Lighting requirements
- Utility requirements
- Security needs including access/hours of operation
- Finish type
- Environmental issues
- Acoustics/vibration requirements
- Life-safety

E12. Furnishings, Equipment, and Built-Ins

All moveable furnishings, equipment, and built-ins should be listed on the room data sheets. Moveable and fixed in place equipment should be distinguished. Building modifications, such as wide access doors or high ceilings, necessary for any equipment also need to be listed. Long delivery time items should be identified and ordered early. It is critical to identify the utility impact of equipment (e.g., electrical, cooling, special water or drains, venting, radio frequency shielding). Examples may include:

- Furniture
- Kitchen equipment
- Medical equipment
- Material handling
- Partitions

New items and relocated existing items must be distinguished in the program. The items can be classified in the following categories.

New Items:

- Contractor furnished and contractor installed
- Owner furnished and contractor installed
- Owner furnished and owner installed

Existing Items:

- Relocated as is and contractor installed
- Refurbished and installed by contractor
- Relocated as is and owner installed
- Refurbished and installed by owner

E13. Window Treatment

Any special fenestration window treatments for energy and/or light control should be noted in order to have proper use of natural light. Some examples include:

- Blocking of natural light
- Glare reducing windows
- Exterior louvers

- Interior blinds

F. BUILDING/PROJECT DESIGN PARAMETERS

F1. Civil/Site Design

Civil/site design issues should be addressed to provide a basis for facility design. Issues to address may include:

- Service and storage requirements
- Elevation and profile views
- High point elevations for grade, paving, and foundations
- Location of equipment
- Minimum overhead clearances
- Storm drainage system
- Location and route of underground utilities
- Site utilities
- Earth work
- Subsurface work
- Paving/curbs
- Landscape/xeriscape
- Fencing/site security

F2. Architectural Design

Architectural design issue should be addressed to provide a basis for facility design. These issues may include the following:

- Determination of metric (hard/soft) versus Imperial (English) units (Note: The term "hard" metric means that materials and equipment are identified on the drawings and have to be delivered in metric-sized unit dimensions such as 200mm by 400mm. "Soft" metric means that materials and equipment can be delivered using sizes that approximate the metric dimensions given on the drawings, such as three-inch length instead of eight cm. It is important to set these dimensions and not "mix and match.")
- Requirements for building location/orientation horizontal and vertical
- Access requirements
- Nature/character of building design (e.g., aesthetics)
- Construction materials
- Acoustical considerations
- American with Disabilities Act requirements or other local access requirements
- Architectural Review Boards
- Planning and zoning review boards
- Circulation considerations
- Seismic design considerations
- Color/material standards
- Hardware standards
- Furniture, furnishings, and accessories criteria
- Design grid

- Floor to floor height

F3. Structural Design

Structural design considerations should be addressed to provide a basis for the facility design. These considerations may include the following:

- Structural system (e.g., construction materials, constraints)
- Seismic requirements
- Foundation system
- Corrosion control requirements/required protective coatings
- Client specifications (e.g., basis for design loads, vibration, deflection)
- Future expansion/flexibility considerations
- Design loading parameter (e.g., live/dead loads, design loads, collateral load capacity, equipment/material loads, wind/snow loads, uplift)
- Functional spatial constraints

F4. Mechanical Design

Mechanical design parameters should be developed to provide a basis for facility design. Items to consider include:

- Special ventilation or exhaust requirements
- Equipment/space special requirements with respect to environmental conditions (e.g., air quality, special temperatures)
- Energy conservation and life cycle costs
- Acoustical requirements
- Zoning and controls
- Air circulation requirements
- Outdoor design conditions (e.g., minimum and maximum yearly temperatures)
- Indoor design conditions (e.g., temperature, humidity, pressure, air quality)
- Building emissions control
- Utility support requirements
- System redundancy requirements
- Plumbing requirements
- Special piping requirements
- Seismic requirements

F5. Electrical Design

Electrical design parameters provide the basis for facility design. Consider items such as:

- Power sources with available voltage and amperage
- Special lighting considerations (e.g., lighting levels, color rendition)
- Voice, data, and video communications requirements
- Uninterruptable power source (UPS) and/or emergency power requirements
- Energy consumption/conservation and life cycle cost
- Ability to use daylight in lighting
- Seismic requirements

- Lightning/grounding requirements

F6. Building Life Safety Requirements

Building life safety requirements are a necessity for building operations. They should be identified at this stage of the project. Possible safety requirements are listed below:

- Fire resistant requirements
- Explosion resistant requirements
- Area of refuge requirements in case of catastrophe
- Safety and alarm requirements
- Fire detection and/or suppression requirements
- Eye wash stations
- Safety showers
- Deluge requirements and foam
- Fume hoods
- Handling of hazardous materials
- Isolation facilities
- Sterile environments
- Emergency equipment access
- Personnel shelters
- Egress
- Public address requirements
- Data or communications protection in case of disaster or emergency
- Fall hazard protection
- Gas hazard detection

F7. Constructability Analysis

CII defines constructability as, “the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Maximum benefits occur when people with construction knowledge and experience become involved at the very beginning of a project.” Is there a structured approach for constructability analysis in place? Have provisions been made to provide this on an ongoing basis? This would include examining design options and details of construction that minimize construction costs while maintaining standards of safety, quality, and schedule. Elements of constructability during pre-project planning include:

- Constructability program in existence
- Construction knowledge/experience used in project planning
- Early construction involvement in contracting strategy development
- Developing a construction-sensitive project schedule
- Considering major construction methods in basic design approaches
- Developing site layouts for efficient construction
- Early identification of project team participants for constructability analysis
- Usage of advanced information technologies

F8. Technological Sophistication

The requirements for intelligent or special building systems should be evaluated. Examples of these systems may include:

- Video conferencing
- Internet connections
- Advanced audio/visual (A/V) connections
- Personnel sensing
- Computer docking stations
- "Smart" heating or air-conditioning
- Intercommunication systems
- Security systems
- Communication systems
- Conveyance systems

G. EQUIPMENT

G1. Equipment List

Project-specific equipment should be defined and listed. (Note: Building systems equipment is addressed in element F4 – Mechanical Design and F5 – Electrical Design). In situations where owners are furnishing equipment, the equipment should be properly defined and purchased. The list should define items such as:

- Process
- Medical
- Food service/vending
- Trash disposal
- Distributed control systems
- Material handling
- Existing sources and characteristics of equipment
  - Relative sizes
  - Weights
  - Location
  - Capacities
  - Materials of construction
  - Insulation and painting requirements
  - Equipment related access
  - Vendor, model, and serial number once identified
  - Equipment delivery time, if known

G2. Equipment Location Drawings

Equipment location/arrangement drawings identify the specific location of each item of equipment in a project. These drawings should identify items such as:

- Plan and elevation views of equipment and platforms
- Location of equipment rooms
- Physical support requirement (e.g., installation bolt patterns)

- Coordinates or location of all major equipment

G3. Equipment Utility Requirements

This evaluation should consist of a tabulated list of utility requirements for all major equipment items such as:

- Power and/or all utility requirements
- Flow diagrams
- Design temperature and pressure
- Diversity of use
- Gas
- Water

SECTION III: EXECUTION APPROACH

H. PROCUREMENT STRATEGY

H1. Identify Long-lead/Critical Equipment and Materials

Identify engineered equipment and material items with lead times that will impact the design for receipt of supplier information or impact the construction schedule with long delivery times.

H2. Procurement Procedures and Plans

Procurement procedures and plans include specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project. Evaluation criteria may include:

- Who will perform procurement?
- Listing of approved vendors, if applicable
- Client or contractor purchase orders
- Reimbursement terms and conditions
- Guidelines for supplier alliances, single source, or competitive bids
- Guidelines for engineering/construction contracts
- Who assumes responsibility for owner-purchased items?
  - Financial
  - Shop inspection
  - Expediting
- Tax strategy
  - Depreciation capture
  - Local sales and use tax treatment
  - Investment tax credits
- Definition of source inspection requirements and responsibilities
- Definition of traffic/insurance responsibilities
- Definition of procurement status reporting requirements
- Additional/special owner accounting requirements
- Definition of spare parts requirements
- Local regulations (e.g., tax restrictions, tax advantages)
- Incentive/penalty strategy for contracts

- Storage

J. DELIVERABLES

J1. CADD/Model Requirements

Computer Aided Drafting and Design (CADD) requirements should be defined. Evaluation criteria may include:

- Software system required by client (e.g., AutoCAD, Intergraph)
- Will the project be required to be designed using 2D or 3D CADD? Will rendering be required?
- If 3D CADD is to be used, will a walk-through simulation be required?
- Owner/contractor standard symbols and details
- How will data be received and returned to/from the owner?
  - Disk
  - Electronic transfer
  - Tape
  - Reproducibles
  - Full-size mock-ups

Physical model requirements depend upon the type needed for analysis, such as study models or design checks.

J2. Documentation/Deliverables

Documentation and deliverables required during project execution should be identified. If electronic media are to be used, format and application packages should be outlined. The following items may be included in a list of deliverables:

- Drawings and specifications
- Project correspondence
- Permits
- Maintenance and operating information/startup procedures
- Facility keys, keying schedules, and access codes
- Project data books (quantity, format, contents, and completion date)
- Equipment folders (quantity, format, contents, and completion date)
- Design calculations (quantity, format, contents, and completion date)
- Spare parts and maintenance stock (special forms)
- Procuring documents/contract documents
- Record (as-built) documents
- Quality assurance documents
- Project signage
- Guarantees/warranties
- Inspection documents
- Certificates of inspection
- Shop drawings and samples
- Bonds
- Distribution matrix

K. PROJECT CONTROL

K1. Project Quality Assurance and Control

Quality assurance and quality control procedures need to be established. Responsibility for approvals needs to be developed. Electronic media requirements should be outlined. These issues may include:

- Responsibility during design and construction
- Testing of materials and workmanship
- ISO 9000 requirements
- Submittals and shop drawing approach
- Inspection reporting requirements
- Progress photos
- Reviewing changes and modifications
- Communication documents (e.g., RFIs, RFQs)
- Commissioning tests
- Lessons-learned feedback

K2. Project Cost Control

Procedures for controlling project cost need to be outlined and responsibility assigned. Electronic media requirements should be identified. These may include cost control requirements such as:

- Financial (client/regulatory)
- Phasing or area sub-accounting
- Capital vs. non-capital expenditures
- Report requirements
- Payment schedules and procedures
- Cash flow projections/draw down analysis
- Cost code scheme/strategy
- Costs for each project phase
- Periodic control check estimates
- Change order management procedure, including scope control

K3. Project Schedule Control

The project schedule is created to show progress and ensure that the project is completed on time. The schedule is necessary for design and construction of the building. A schedule format should be decided on at the beginning of the project. Typical items included in a project schedule are listed below.

- Milestones
- Unusual schedule considerations
- Required submissions and/or approvals
- Required documentation and responsible party
- Baseline vs. progress to date

- Long-lead or critical pacing equipment delivery
- Critical path activities
- Contingency or “float time”
- Permitting or regulatory approvals
- Activation and commissioning
- Liquidated damages/incentives

The owner must also identify how special project issues will be scheduled. These items may include:

- Selection, procurement, and installation of equipment
- Design of interior spaces (including furniture and accessory selection)
- Stages of the project that must be handled differently than the rest of the project
- Tie-ins, service interruptions, and road closures

K4. Risk Management

Major project risks need to be identified, quantified, and management actions taken to mitigate problems developed. Pertinent elements may include:

- Design risks
  - Expertise
  - Experience
  - Work load
  - Teamwork orientation
  - Communication
  - Integration and coordination
- Construction risks
  - Availability of craft labor and construction materials
  - Weather
  - Differing/unforeseen/difficult site conditions
  - Long-lead item delays
  - Strikes
  - Inflation
  - Scope growth
- Management risks
  - Availability of designers
  - Critical quality issues
  - Bidders
  - Human error
  - Cost and schedule estimates
  - Timely decisions
  - Team chemistry
- Insurance considerations

K5. Safety Procedures

Safety procedures and responsibilities must be identified for design consideration and construction. Safety issues to be addressed may include:

- Hazardous material handling
- Interaction with the public
- Working at elevations/fall hazards
- Evacuation plans and procedures
- Drug testing
- First aid stations
- Accident reporting and investigation
- Pre-task planning
- Safety orientation and planning
- Safety incentives
- Other special or unusual safety issues

L. PROJECT EXECUTION PLAN

L1. Project Organization

The project team should be identified including roles, responsibilities, and authority. Items to consider include:

- Core team members
- Project manager assigned
- Project sponsor assigned
- Working relationships between participants
- Communication channels
- Organizational chart
- Approval responsibilities/responsibility matrix

L2. Owner Approval Requirements

All documents that require owner approval should be clearly defined. These may include:

- Milestones for drawing approval by phase
  - Comment
  - Approval
  - Bid issues (public or private)
  - Construction
- Durations of approval cycle compatible with schedule
- Individual(s) responsible for reconciling comments before return
- Types of drawings/specifications
- Purchase documents/general conditions and contract documents
  - Data sheets
  - Inquiries
  - Bid tabulations

- Purchase orders
- Supplier information

L3. Project Delivery Method

The methods of project design and construction delivery, including fee structure should be identified. Issues to consider include:

- Owner self-performed
- Designer and constructor qualification selection process
- Selected methods (e.g., design/build, CM at risk, competitive sealed proposal, bridging, design-bid-build)
- Contracting strategies (e.g., lump sum, cost-plus)
- Design/build scope package considerations

L4. Design/Construction Plan and Approach

This is a documented plan identifying the specific approach to be used in designing and constructing the project. It should include items such as:

- Responsibility matrix
- Subcontracting strategy
- Work week plan/schedule
- Organizational structure
- Work Breakdown Structure (WBS)
- Construction sequencing of events
- Site logistics plan
- Safety requirements/program
- Identification of critical activities that have potential impact on facilities (i.e., existing facilities, crane usage, utility shut downs and tie-ins, testing)
- Quality assurance/quality control (QA/QC) plan
- Design and approvals sequencing of events
- Equipment procurement and staging
- Contractor meeting/reporting schedule
- Partnering or strategic alliances
- Alternative dispute resolution
- Furnishings, equipment, and built-ins responsibility

L5. Substantial Completion Requirements

Substantial Completion (SC) is defined as the point in time when the building is ready to be occupied. The following may need to be addressed:

- Have specific requirements for SC responsibilities been developed?
- Have warranty, permitting, insurance, and tax implications been considered?
- Commissioning
  - Equipment/systems startup and testing
  - Occupancy phasing

- Final code inspection
- Calibration
- Verification
- Documentation
- Training
- Acceptance

- Landscape requirements
- Punchlist completion plan and schedule
- Substantial completion certificate

PDRI (Project Definition Rating Index) Industrial

SECTION I - BASIS OF PROJECT DECISION

A. MANUFACTURING OBJECTIVES CRITERIA

A1. Reliability Philosophy

A list of the general design principles to be considered to achieve dependable operating performance from the unit. Evaluation criteria should include:

- Justification of spare equipment
- Control, alarm, and safety systems redundancy
- Extent of providing surge and intermediate storage capacity to permit independent shutdown of portions of the plant
- Mechanical / structural integrity of components (metallurgy, seals, types of couplings, bearing selection, etc.)

A2. Maintenance Philosophy

A list of the general design principles to be considered to meet unit up-time requirements. Evaluation criteria should include:

- Scheduled unit / equipment shutdown frequencies and durations
- Equipment access / monorails / cranes
- Maximum weight or size requirements for available repair equipment
- Equipment monitoring requirements (vibrations monitoring, etc.)

A3. Operating Philosophy

A list of the general design principles that need to be considered to support the routine scheduled production from the unit in order to achieve the projected overall on-stream time or service factor.

Evaluation criteria should include:

- Level of operator coverage and automatic control to be provided
- Operating time sequence (ranging from continuous operation to five day, day shift only)
- Necessary level of segregation and clean out between batches or runs
- Desired unit turndown capability
- Design requirements for routine startup and shutdown

B. BUSINESS OBJECTIVES

B1. Products

A list of product(s) to be manufactured and their specifications. It should address items such as:

- Chemical composition
- Allowable impurities
- Physical form

- By-products
- Raw materials
- Wastes

B2. Market Strategy

Has a market strategy been developed and clearly communicated? It must identify the driving forces (other than safety) for the project and specify what is most important from the viewpoint of the business group. It should address items such as:

- Cost
- Schedule
- Quality

B3. Project Strategy

Has a project strategy been defined that supports the market strategy in relation to the following items:

- Cost
- Schedule
- Quality

B4. Affordability / Feasibility

Have items that may improve the affordability of the project been considered? These should include incremental cost criteria such as:

- Consideration of feedstock availability and transport to the job site
- Performing an analysis of capital and operating cost versus sales and profitability

Results of these studies should be communicated to the project team.

B5. Capacities

The design output of a given specification product from the unit. Capacities are usually defined as:

- On-stream factors
- Yield
- Design rate

B6. Future Expansion Considerations

A list of items to be considered in the unit design that will facilitate future expansion. Evaluation criteria should include:

- Providing space for a possible new reactor train
- Providing tie-ins to permit a duplicate or mirror image unit that can be added without necessitating a shutdown
- Guidelines for over design of structural systems to allow for additions

B7. Expected Project Life Cycle

This is the time period that the unit is expected to be able to satisfy the products and capacities required. Have requirements for ultimate disposal and dismantling been considered? These requirements should include:

- Cost of ultimate dismantling and disposal
- Dismantling equipment requirements
- Presence of contaminants
- Disposal of hazardous materials
- Possible future uses

B8. Social Issues

Evaluation of various social issues such as:

- Domestic culture vs. international culture
- Community relations
- Labor relations
- Government relations
- Education / training
- Safety and health considerations

C. BASIC DATA RESEARCH & DEVELOPMENT

C1. Technology

The chemistry used to convert the raw materials supplied to the unit into the finished product. Proven technology involves least risk, while experimental technology has a potential for change. Technology can be evaluated as:

- Existing / proven
- Duplicate
- New
- Experimental

C2. Processes

A particular, specific sequence of steps to change the raw materials into the finished product. Proven processes involve the least risk, while experimental processes have a potential for change. Processes can be evaluated as:

- Existing / proven
- Duplicate
- New
- Experimental

D. PROJECT SCOPE

D1. Project Objectives Statement (Y/N)

This is a mission statement that defines the project objectives and priorities for meeting the business objectives. It is important to obtain total agreement from the entire project team regarding these objectives and priorities to ensure alignment.

D2. Project Design Criteria

The requirements and guidelines which govern the design of the project. Evaluation criteria should include:

- Level of design detail required
- Climatic data
- Codes & standards
- National
- Local
- Utilization of engineering standards
- Owner's
- Contractor's
- Mixed

D3. Site Characteristics Available vs. Required (Y/N)

An assessment of the available vs. the required site characteristics. Evaluation criteria should include:

- Capacity
- Utilities
- Power
- Fire water
- Pipe racks
- Flare systems
- Waste treatment / disposal
- Cooling water
- Storm water containment system
- Type of buildings / structures
- Amenities
- Food service
- Recreation facilities
- Change rooms
- Ambulatory access
- Medical facilities
- Product shipping facilities
- Material receiving facilities
- Material storage facilities
- Product storage facilities
- Security

D4. Dismantling and Demolition Requirements

Has a scope of work been defined for the dismantling of existing equipment and/or piping which may be necessary for completing new construction? Evaluation criteria should include:

- Timing
- Permits
- Approval
- Safety requirements
- Hazardous operations
- Plant / operations requirements
- Narrative (scope of work) for each system
- Are the systems that will be dismantled...
- Named & marked on process flow diagrams
- Named & marked on P&ID's
- Denoted on line lists and equipment lists
- Denoted on piping plans or photo-drawings

D5. Lead / Discipline Scope of Work

This is a complete narrative description of the project, generally discipline oriented. This should be developed through the use of the Work Breakdown Structure (WBS) (Halpin et al. 1987).

D6. Project Schedule (Y/N)

Has the project milestone schedule been developed, analyzed, and agreed upon by the major project participants? This should involve obtaining early constructability input from:

- Operations
- Engineering
- Construction

E. VALUE ENGINEERING

E1. Process Simplification (Y/N)

Identify activities (through studies, reviews, etc.) for reducing the number of steps or the amount of equipment needed in the process in order to optimize performance.

E2. Design & Material Alternatives Considered / Rejected (Y/N)

Is there a structured approach in place to consider design and material alternatives? Has it been implemented?

E3. Design For Constructability Analysis

Is there a structured approach for constructability analysis in place? Have provisions been made to provide this on an ongoing basis? This would include examining design options that minimize construction costs while maintaining standards of safety, quality, and schedule. CII defines constructability as, "the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives. Maximum benefits occur when people with construction knowledge and experience become involved at the very beginning of a project" (CII 1986).

SECTION II - FRONT END DEFINITION

F. SITE INFORMATION

F1. Site Location (Y/N)

Has the geographical location of the proposed project been defined? This involves an assessment of the relative strengths and weaknesses of alternate site locations. A site that meets owner requirements and maximizes benefits for the owner company should be selected. Evaluation of sites may address issues relative to different types of sites (i.e. global country, local, "inside the fence," or "inside the building"). This decision should consider the long-term needs of the owner company (CII 1995). The selection criteria should include items such as:

- General geographic location
  - Access to the targeted market area
  - Near sources of raw materials
  - Local availability and cost of skilled labor (e.g. construction, operation, etc.)
  - Available utilities
  - Existing facilities
- Land availability and costs
- Access (e.g. road, rail, marine, air, etc.)
- Construction access and feasibility
- Political constraints
- Legal constraints
- Regulatory constraints
- Financing requirements
- Social issues
- Weather
- Climate

F2. Surveys & Soil Tests

Survey and soil test evaluations of the proposed site should include items such as:

- Topography map
- Overall plant plot plan
- General site description (e.g. terrain, existing structures, spoil removal, areas of hazardous waste, etc.)
- Definition of final site elevation
- Benchmark control system
- Spoil area (i.e. location of on-site area or off-site instructions)
- Seismic requirements
- Water table
- Soil percolation rate & conductivity
- Existing contamination
- Ground water flow rates and directions

- Downstream uses of ground water
- Need for soil treatment or replacement
- Description of foundation types
- Allowable bearing capacities
- Pier / pile capacities

F3. Environmental Assessment

Evaluation of the site by characteristics such as:

- Location in an EPA air quality non-compliance zone
- Location in a wet lands area
- Environmental permits now in force
- Location of nearest residential area
- Ground water monitoring in place
- Containment requirements
- Existing environmental problems with the site
- Past / present use of site

F4. Permit Requirements

Is there a permitting plan in place? The local, state, and federal government permits necessary to construct and operate the unit should be identified. These should include items such as:

- Construction
- Fire
- Local
- Building
- Environmental
- Occupancy
- Transportation
- Special

F5. Utility Sources With Supply Conditions

Has a list been made identifying availability / nonavailability of site utilities needed to operate the unit with supply conditions of temperature, pressure, and quality? This should include items such as:

- Potable water
- Instrument air
- Drinking water
- Plant air
- Cooling water
- Gases
- Fire water
- Steam
- Sewers

- Condensate
- Electricity (voltage levels)

F6. Fire Protection & Safety Considerations

A list of fire and safety related items to be taken into account in the design of the facility. These items should include fire protection practices at the site, available firewater supply (amounts and conditions), special safety requirements unique to the site, etc. Evaluation criteria should include:

- Eye wash stations
- Deluge requirements
- Safety showers
- Wind direction indicator
- Fire monitors & hydrants devices (i.e. wind socks)
- Foam
- Alarm systems
- Evacuation plan
- Medical facilities
- Security fencing

G. PROCESS / MECHANICAL

G1. Process Flow Sheets

Drawings that provide the process description of the unit. Evaluation criteria should include:

- Major equipment items
- Flow of materials to and from the major equipment items
- Primary control loops for the major equipment items
- Sufficient information to allow sizing of all process lines

G2. Heat & Material Balances

Heat balances are tables of heat input and output for major equipment items (including all heat exchangers) within the unit. Material balances are tables of material input and output for all equipment items within the unit. The documentation of these balances should include:

- Special heat balance tables for reaction systems
- Information on the conditions (e.g. temperature and pressure)
- Volumetric amount (GPM, ACFM, etc.)

G3. Piping and Instrumentation Diagrams (P&ID's)

These are often referred to by different companies as:

EFD's - Engineering Flow Diagrams
MFD's - Mechanical Flow Diagrams
PMCD's - Process & Mechanical Control Diagrams

In general, P&ID's are considered to be a critical element within the scope definition package of an industrial project. Since incomplete information on P&ID's is frequently identified as a source of project escalation, it is important to understand their level of completeness. It often requires several iterations, or passes, to obtain all of the necessary information from each discipline specialist. During each iteration, additional information is added to the P&ID's. Thus, it is unlikely for P&ID's to be completely defined in a project's scope definition package.

VALVES
- Process needed valves
- Valves needed for maintenance
- Bypasses, blocks, and bleeds
- Drains, vents, freeze protection, etc.
- Type of valve designated
- Non-line sized valves indicated
- Control valves sized
- Miscellaneous designated valves added
- Valve tags added (not always done)
- Valve design details added (as necessary)

PIPING SPECIALTY ITEMS
- Identification of items
- Numbering of items (usually by piping)
- Specialty item design details (as necessary)

UTILITIES
- Main connections and continuations
- Remaining connections and continuations
- Overall distribution and control
- Utilities design details

INSTRUMENTATION
- Elements, loops, and functions
- Primary elements
- Local panel or control house location
- Control panel or CRT location
- Computer inputs and outputs
- Process steam traps (may be specialty items)
- Hard wired interlocks
- Motor controls (need schematics)
- Type of primary elements
- Instrument numbers
- Uniform logic control details
- Indicator lights
- Instrumentation design details (as necessary)

SAFETY SYSTEMS
- Process Safety Management Hazard Analysis review
- Key process relief valves
- Remaining relief valves
- Failure mode of control valves
- Car sealed valves (as necessary)
- Relief valve sizes (instrumentation / process check)
- Relief system line sizes
- System design details (as necessary)

SPECIAL NOTATIONS
- Identification of sloped lines
- Barometric legs (seals)
- Critical elevations and dimensions
- Vendor or designer supplied notes
- Critical locations (valves, etc.)
- Notes on venting or draining
- Vessel trim notes
- Startup and shutdown notes
- Design detail notes (as necessary)

G4. Process Safety Management (PSM)

This refers to OSHA Regulation 1910.119 compliance requirements. Has the owner clearly communicated the requirements, methodology, and responsibility for the various activities?

G5. Utility Flow Diagrams

Utility flow diagrams are similar to P&ID's in that they show all utility lines from generation or supply (i.e. pipeline). They are generally laid out in a manner to represent the geographical layout of the plant. Utility flow diagrams are evaluated using the same criteria as P&ID's.

G6. Specifications

General specifications for the design, performance, manufacturing, material, and code requirements should include items such as:

- Classes of equipment (e.g. pumps, exchangers, vessels, etc.)
- Process pipe heating
- Process
- Freeze
- Jacketed
- Process pipe cooling
- Jacketed

- Traced
- Piping
- Protective coating
- Insulation
- Valves
- Bolts / gaskets

G7. Piping System Requirements

Pipe stress criteria should be provided to establish guidelines for analysis of piping systems and equipment such as:

- Allowable forces and moments on equipment
- Graphical representation of piping line sizes that require analysis based on:
- Temperature
- Pressure
- Cyclic conditions
- Flex
- Stress
- Pulsation
- Seismic

G8. Plot Plan

The plot plan will show the location of new work in relation to adjoining units. It should include items such as:

- Plant grid system with coordinates
- Unit limits
- Gates & fences
- Off-site facilities
- Tank farms
- Roads & access ways
- Roads
- Rail facilities
- Green space
- Buildings
- Major pipe racks
- Laydown areas
- Construction / fabrication areas

G9. Mechanical Equipment List

The mechanical equipment list should identify all mechanical equipment by tag number, in summary format, to support the project. The list should define items such as:

- Existing sources
- Modified
- Dismantled
- Relocated
- Rerated
- New sources
- Purchased new
- Purchased used
- Relative sizes
- Weights
- Location
- Capacities
- Materials
- Power requirements
- Flow diagrams
- Design temperature and pressure
- Insulation & painting requirements
- Equipment related ladders and platforms

G10.Line List

The line list designates all pipe lines in the project (including utilities). It should include items such as:

- Unique number for each line
- Size
- Termination
- Origin
- Reference drawing
- Normal and upset operating
- Temperature
- Pressure
- Design temperature & pressure
- Test requirements
- Pipe specifications
- Insulation requirements
- Paint requirements

G11.Tie-in List

A list of all piping tie-ins to existing lines. It should include items such as:

- Location
- Insulation removal requirements
- Decontamination requirements
- Reference drawings
- Pipe specifications
- Timing / schedule
- Type of tie-in / size
- Hot tap
- Cold cut
- Flange
- Screwed
- Weld
- Cut & weld

G12.Piping Specialty Items List

This list is used to specify in-line piping items not covered by piping material specifications. It should identify all special items by tag number, in summary format. It should include items such as:

- Tag numbers
- Full purchase description
- Quantities
- Materials of construction
- Piping plans referenced
- P&ID's referenced
- Piping details
- Line / equipment numbers

G13.Instrument Index

This is a complete listing of all instruments by tag number. Evaluation criteria should include:

- Tag number
- Instrument type
- Service
- P&ID number
- Manufacturer
- Model number
- Line number
- Relieving devices (e.g. relief valves, rupture disks, etc.)

H. EQUIPMENT SCOPE

H1. Equipment Status

Has the equipment been defined, inquired, bid tabbed, or purchased? This includes all engineered equipment such as:

- Process
- Electrical
- Mechanical
- HVAC
- Instruments
- Specialty items
- Distributed control systems

Evaluation criteria should include:

- Equipment data sheets - how complete?
- Number of items inquired
- Number of items with approved bid tabs
- Number of items purchased

H2. Equipment Location Drawings

Equipment location / arrangement drawings identify the specific location of each item of equipment in a project. These drawings should identify items such as:

- Elevation views of equipment and platforms
- Top of steel for platforms and pipe racks
- Paving and foundation elevations
- Coordinates of all equipment

H3. Equipment Utility Requirements

This should consist of a tabulated list of utility requirements for all equipment items.

I. CIVIL, STRUCTURAL, & ARCHITECTURAL

I1. Civil / Structural Requirements

Civil / structural requirements should include the following:

- Structural drawings
- Pipe racks / supports
- Elevation views
- Top of steel for platforms
- High point elevations for grade, paving, and foundations
- Location of equipment and offices
- Construction materials (e.g. concrete, steel, client standards, etc.)

- Physical requirements
- Seismic requirements
- Minimum clearances
- Fireproofing requirements
- Corrosion control requirements / required protective coatings
- Enclosure requirements (e.g. open, closed, covered, etc.)
- Secondary containment
- Dikes
- Storm sewers
- Client specifications (e.g. basis for design loads, etc.)
- Future expansion considerations

I2. Architectural Requirements

The following checklist should be used in defining building requirements.

- Building use (e.g. activities, functions, etc.)
- Space use program indicating space types, areas required, and the functional relationships between spaces and number of occupants
- Service, storage, and parking requirements
- Special equipment requirements
- Requirements for building location / orientation
- Nature / character of building design (e.g. aesthetics, etc.)
- Construction materials
- Interior finishes
- Fire resistant requirements
- Explosion resistant requirements
- "Safe haven" requirements
- Acoustical considerations
- Safety, security, and maintenance requirements
- Fire detection and / or suppression requirements
- Utility requirements (i.e. sources and tie-in locations)
- HVAC requirements
- Electrical requirements
  - Power sources with available voltage & amperage
  - Special lighting considerations
  - Voice and data communications requirements
  - UPS and / or emergency power requirements
- Outdoor design conditions (e.g. minimum and maximum yearly temperatures)
- Indoor design conditions (e.g. temperature, humidity, pressure, air quality, etc.)
- Special outdoor conditions
- Special ventilation or exhaust requirements
- Equipment / space special requirements with respect to environmental conditions (e.g. air quality, special temperatures, etc.)
- Americans With Disabilities Act requirements

J. INFRASTRUCTURE

J1. Water Treatment Requirements

Items for consideration should include:

- Wastewater treatment
- Process waste
- Sanitary waste
- Waste disposal
- Storm water containment & treatment

J2. Loading / Unloading / Storage Facilities Requirements

A list of requirements identifying raw materials to be unloaded and stored, products to be loaded along with their specifications, and Material Safety Data Sheets. This list should include items such as:

- Instantaneous and overall loading / unloading rates
- Details on supply and / or receipt of containers and vessels
- Storage facilities to be provided and / or utilized
- Specification of any required special isolation provisions
- Double wall diking and drainage
- Emergency detection (e.g. hydrocarbon detectors/alarms)
- Leak detection devices or alarms

J3. Transportation Requirements (Y/N)

Specifications identifying implementation of "in-plant" transportation (e.g. roadways, concrete, asphalt, rock, etc.) as well as methods for receiving / shipping of materials (e.g. rail, truck, marine, etc.).

K. INSTRUMENT & ELECTRICAL

K1. Control Philosophy

The control philosophy describes the general nature of the process and identifies overall control systems hardware, software, simulation, and testing requirements. It should outline items such as:

- Continuous
- Batch
- Redundancy requirements
- Classification of interlocks (e.g. process, safety, etc.)
- Software functional descriptions
- Manual or automatic controls
- Alarm conditions
- On / off controls
- Block diagrams
- Emergency shut down
- Controls startup

K2. Logic Diagrams (Y/N)

The logic diagrams provide a method of depicting interlock and sequencing systems for the startup, operation, alarm, and shutdown of equipment and processes.

K3. Electrical Area Classifications

The electrical area classification plot plan is provided to show the environment in which electrical and instrument equipment is to be installed. This area classification will follow the guidelines as set forth in the latest edition of the National Electric Code. Installation locations should include the following:

- General purpose
- Hazardous
- Class I: Gasses and vapors
- Class II: Combustible dusts
- Class III: Easily ignitable fibers
- Corrosive locations

K4. Substation Requirements / Power Sources Identified

Substation requirements should include the following:

- Number of substations required
- Electrical equipment rating required for each substation
- Specifications for all major electrical substation equipment
- Infrastructure required for each substation considering building type and environment, fencing, access, and substation yard materials

Clearly define power sources for the project in relation to:

- Location, voltage level, available power
- Electrical equipment available
- Electrical ratings and routes of power feeds from their sources to the project substations
- Specifications for special power sources should be described and provided (e.g. emergency generators or in-plant generation)
- Temporary construction power sources

K5. Electric Single Line Diagrams

A single line diagram indicates the components, devices, or parts of an electrical power distribution system. Single line diagrams are intended to portray the major system layout from the public utility's incoming transmission line to the motor starter bus. Depending on the size of the electrical system, the single line diagrams should include several levels of distribution such as:

- Incoming utility with owner substation / distribution to high and medium voltage motors and substations
- Unit substations and 480V distribution
- Motor control centers with distribution to motors, lighting panels, etc.

K6. Instrument & Electrical Specifications

These specifications should include items such as:

- Distributed Control System (DCS)
- Instrument data sheets
- Motor control and transformers
- Power and control components
- Power and control wiring (splicing requirements)
- Cathodic protection
- Lightning protection
- Grounding
- Electrical trace
- Installation standards
- Lighting standards
- Civil requirements for electrical installation
- Protection / warning for underground cabling
- Special slabs or foundations for electrical equipment
- Concrete-embedded conduit

SECTION III - EXECUTION APPROACH

L. PROCUREMENT STRATEGY

L1. Identify Long Lead / Critical Equipment and Materials

Identify engineered equipment and material items with lead times that will impact the detailed engineering for receipt of vendor information or impact the construction schedule with long delivery times.

L2. Procurement Procedures and Plans

Specific guidelines, special requirements, or methodologies for accomplishing the purchasing, expediting, and delivery of equipment and materials required for the project. Evaluation criteria should include:

- Listing of approved vendors
- Client or contractor paper?
- Reimbursement terms and conditions
- Guidelines for supplier alliances, single source, or competitive bids
- Guidelines for engineered / field contracts
- Who assumes responsibility for owner-purchased items?
- Financial

- Shop inspection
- Expediting
- Tax strategy
- Engineered
- Field materials
- Labor
- Definition of source inspection requirements and responsibilities
- Definition of traffic / insurance responsibilities
- Definition of procurement status reporting requirements
- Additional / special owner accounting requirements
- Definition of spare parts requirements
- Local regulations (e.g. tax restrictions, tax advantages, etc.)

L3. Procurement Responsibility Matrix (Y/N)

Has a procurement responsibility matrix been developed?

M. DELIVERABLES

M1. CADD / Model Requirements

Computer Aided Drafting and Design (CADD) requirements should be defined. Evaluation criteria should include:

- Software system required by client (e.g. Autocad, Intergraph, etc.)
- Will the project be required to be designed using 2D or 3D CADD?
- If 3D CADD is to be used, will a walk through simulation be required?
- Application software (e.g. ADEV Pro-series, Cadpipe, PDS, etc.)
- Owner / contractor standard symbols and details
- How will data be received and returned to / from the owner?
- Disk
- Electronic transfer
- Tape
- Reproducibles

Physical model requirements depend upon the type required, such as:

- Study model
- Design check
- Block model
- Operator training

M2. Deliverables Defined

The following items should be included in a list of deliverables:

- Drawings
- Project correspondence
- Project Process Safety Management (PSM) documents
- Permits

- Project data books (quantity, format, contents, and completion date)
- Equipment folders (quantity, format, contents, and completion date)
- Design calculations (quantity, format, contents, and completion date)
- Spare parts special forms
- Loop folder (quantity, format, contents, and completion date)
- Procuring documents
- ISO's / field erection details
- As-built documents
- Quality assurance documents

M3. Distribution Matrix (Y/N)

A distribution matrix identifies most correspondence and all deliverables. It denotes who is required to receive copies of all documents at the various stages of the project.

N. PROJECT CONTROL

N1. Project Control Requirements

Has a method for measuring and reporting progress been established? Evaluation criteria should include:

- Change management procedures
- Cost control procedures
- Schedule / percent complete control procedures
- Cash flow projections
- Report requirements

N2. Project Accounting Requirements

Have all project specific accounting requirements been identified such as:

- Financial (client / regulatory)
- Phasing or area sub-accounting
- Capital vs. non-capital
- Report requirements
- Payment schedules

N3. Risk Analysis (Y/N)

Has a risk analysis for cost and schedule been performed?

P. PROJECT EXECUTION PLAN

P1. Owner Approval Requirements

Has owner clearly defined all documents that require owner approval such as:

- Milestones for drawing approval
- Comment
- Approval
- Bid issues
- Construction
- Durations of approval cycle compatible with schedule
- Individual(s) responsible for reconciling comments before return
- Types of drawings
- Purchase documents
- Data sheets
- Inquiries
- Bid tabs
- PO's
- Vendor information

P2. Engineering / Construction Plan & Approach

This is a documented plan identifying the methodology to be used in engineering and constructing the project. It should include items such as:

- Responsibility matrix
- Contracting strategies (e.g. lump sum, cost-plus, etc.)
- Subcontracting strategy
- Work week plan / schedule
- Organizational structure
- Work Breakdown Structure (WBS)
- Construction sequencing of events
- Safety requirements / program
- Identification of critical lifts and their potential impact on operating units
- QA / QC plan

P3. Shut Down / Turn-Around Requirements (Y/N)

Have any required shut downs or turn-arounds been identified, including definitions of the scope of work to be accomplished during such down times, scheduled instructions for the down time, and timing of outages?

P4. Pre-Commissioning Turnover Sequence Requirements

This defines the owner's required sequence for turnover of the project for pre-commissioning and startup activation. It should include items such as:

- Sequence of turnover
- Contractor's required level of involvement in pre-commissioning
- Contractor's required level of involvement in training
- Contractor's required level of involvement in testing
- Clear definition of mechanical / electrical acceptance Requirements

P5. Startup Requirements

Have the startup requirements been defined and responsibility established?

P6. Training Requirements

Have the training requirements been defined and responsibility established?