



NAC Executive Insights

Construction Execution

Key Points

- An overview of construction execution is provided, highlighting activities at different project phases.
- An eight-phase model is outlined.
- Construction execution planning begins at the proposal/bid phase.
- Various elements of construction execution are identified, many of which would be subject to more detailed development and are substantive activities in their own right.
- Construction execution does not conclude with completion of final physical construction, but includes turnover, project closeout, and collecting lessons learned.

Introduction

The planning and management of construction execution is a key driver of project success. It begins with project initiation and arguably earlier at the proposal stage. The emphasis of construction execution activities changes as the project progresses through the various phases shown in Table 1. **Also identified in that table are engineering activities occurring during these construction phases as might be encountered in a design/build, EPCM (engineering, procurement, and construction management), or EPC (engineering, procurement, and construction) project delivery model.**

In addition to the direct planning and execution of construction, several other activities must occur in parallel and include:

- Constructability (early construction input to design)
- Labor surveys and market analysis and selection of the appropriate labor posture (open shop, union shop) and ongoing industrial relations
- Company, project, and contractor licensing
- Construction systems, including their integration with engineering (Building Information Modeling or BIM) and project management systems
- Project controls
- Procurement and contracting
- Materials management
- Site environmental, health, safety and security (EHSS)
- Site quality management, including materials testing and non-destructive examination (NDE)
- Human resource management
- Accounting, timekeeping, and payroll
- Construction equipment and tools management and maintenance
- Construction turnover

- Other activities dependent on project type and scope, such as modular execution and transport; welding execution; boiler and pressure vessel assembly, erection and compliance; rigging; and commissioning.

Table 1	
Phases of a Construction Project	
Phase 0	Proposal/bid stage
Phase 1	Project initiation
Phase 2	Concept stage (scope definition; conceptual engineering)
Phase 3	Construction planning (preliminary engineering)
Phase 4	Site initiation (detailed design)
Phase 5	Construction (final design; engineering support during construction)
Phase 6	Construction turnover (system checkout; startup support)
Phase 7	Project and contract closeout

Construction Execution Activities by Phase

The balance of this Executive Insight focuses at a high level on the core construction execution activities that must occur as the project progresses through each of the phases identified in Table 1.

Phase 0 – Proposal/Bid Stage

Construction execution planning and initial development of a project execution plan (PEP) begin at the proposal stage with the development of a construction philosophy and strategy. Depending on the nature of the bid, some activities identified in subsequent phases may be pulled forward, in whole or in part, to this phase.

In this stage, input to an expanded basis of design should be provided with additions and refinements happening at later phases as required.

Licenses that may be required to bid are obtained and long-lead licenses required for execution may be initiated at this stage.

Scope development is tested for completeness by construction, ensuring that all facilities and ancillary systems, structures, and components have been reflected in the scope and estimate. Similarly, the scope of services is confirmed for completeness, ensuring that any special or temporary activities have been accounted for.

Phase 1 – Project Initiation

Project initiation begins at execution of a contract and appropriate authorization or notice to proceed (NTP), which may often be a limited notice to proceed. Any work undertaken prior to receipt of a NTP may be unbillable or unrecoverable costs.

Activities include input into and review of the proposed project baseline documents, including risk assessment; the executed version of the prime contract; and any commercial conditions embodied in

the contract, its terms and conditions, or assumed in development of the commercial offering that underpins the contract.

During the project initiation phase, the construction philosophy and strategy promulgated during Phase 0, proposal/bid stage, is memorialized for communication to engineering and the other construction related activities that will now get underway. The construction execution strategy is integrated into the various sections of the project execution plan to create a seamless overall execution plan for the project. Projects undertaken utilizing a design-bid-build execution approach still will require construction execution input to be provided to the engineer.

The overall construction execution strategy will include integrated implementation of strategies for constructability, contracting, and procurement, and other of the related activities detailed in the Introduction to this Executive Insight. Conformance with all corporate requirements also occurs at this phase.

At this stage a work packaging philosophy is developed and memorialized and a preliminary construction sequence highlighting priority design and procurement needs are developed as input to engineering.

Efforts required to obtain any required licenses that are not already in place are initiated. Also, labor market analysis and surveys that may have been undertaken during Phase 0 are refreshed and a labor posture established.

Construction provides initial inputs into the overall contracting and procurement strategies during this phase.

A final activity during this phase is the best practice of developing a business continuity plan.

Phase 2 – Concept Stage

During Phase 2, construction execution continues the development and refinement of the construction strategy, including early constructability reviews that should confirm the expanded basis of design related to construction requirements. Construction planning becomes more detailed. The plan for site-based human resources (HR) also is developed and plans for administration of site construction staff put in place. Construction execution provides input to HR related to cost, staffing, and any special requirements or conditions.

Site based organization and their needs are confirmed with the construction execution function in areas related to EHSS and quality.

Construction work packages are defined. These provide a basis for self-perform versus subcontract decisions. Pre-award contract support is provided related to both subcontracting packages as well as with respect to select elements of other materials or equipment procurements, especially those with particular material property or quality requirements of special handling or erection needs.

Based on the construction work packages defined, modular studies are undertaken to evaluate the feasibility and benefits of utilizing off-site module fabrication or even more limited preassembly.

Project execution plans are updated to reflect any changes as a result of refinements at this stage.

Phase 3 – Construction Planning

Construction planning coincides with the preliminary engineering phase. During this phase, construction basis of design requirements should be incorporated into the project's design. Construction execution confirms their initial consideration in the preliminary designs and begins a process of understanding the approach to address fully in the developing design.

Temporary facilities are identified at this stage as well as required construction equipment and tools. A more definitive estimate of indirect construction costs can now be prepared and then compared against assumptions in the baseline estimate.

Also in this stage, other specialized construction activities begin their detailed planning. Examples of such specialized construction activities include:

- Welding planning, identifying scope of such activities; any site-specific requirements; welding quality required and any standards to be met; welder qualifications, number of staff, time periods, and durations.
- Rigging and hauling studies to determine transport preferences and weight and size limits. In addition, onsite logistics related to movement and placement of large equipment to final position are studied together with requirements in terms of numbers and types of cranes, their placement, and travel envelopes. Any specialized equipment is identified for early procurement or, if required, fabrication. Examples might include self-propelled modular transporters (SPMTs) or heavy lift marine cranes.
- Nondestructive examination.
- Materials management.

Finally, plans for site preparation; mobilization, describing the sequence of activities and actions; and HR mobilization to the site are completed during this phase.

Construction turnover planning begins in earnest with detailed scheduling; cost estimates; system definition and battery limits; risk assessments; contingency planning; and input to engineering with respect to system numbering.

Project execution plans are further updated to reflect any changes as a result of refinements at this stage.

Phase 4 – Site Initiation

In Phase 4, site initiation activities begin as engineering transitions into detailed design.

During this phase, constructability reviews continue and construction execution plans and work packages are refined. Welding and rigging plans are finalized and requirements reviewed with any subcontractors. Any project or location-specific welding procedures are put in place and reviewed and approved.

Lifting lugs are designed at this stage and incorporated into project designs. The same occurs for any special requirements associated with rigging (crane rails, reinforcement for temporary or transitional loads, and special access provisions such as hatches or design keyholes).

Temporary facility design is largely completed at this stage. Included are any ancillary buildings, utilities, warehouse, parking and guard facilities, break and washroom facilities, fencing, and any required environmental protection measures (construction water runoff; solid and recycled materials and waste; noise barriers during construction).

Mobilization begins and, with it, industrial relations. Safety, materials management, and quality organizations implement their plans in support of efficient project execution.

Site focus will be heavily oriented now towards early and enabling activities, although depending on the schedule driven nature of the project, activities more typical of Phase 5 may be accelerated into this phase.

Turnover planning is now detailed and essentially complete. Detailed system level plans have been developed and subcontractor and other support personnel needs communicated. Involvement of equipment suppliers in system turnover has been finalized and spare parts identified for procurement.

Project execution plans are further updated to reflect any changes as a result of refinements at this stage. An emphasis is put on ensuring a smooth transition into construction and subsequent construction turnover.

Phase 5 – Construction

Phase 5 builds upon a site that now has been largely prepared for construction. The site team has mobilized and is in the process of steadily staffing up per defined requirements. Temporary facilities, at least those required in the initial phases of construction, have been put in place and all is ready to support efficient construction.

Construction execution is being led now by the site construction manager, who is responsible for implementation of the construction strategy and overall construction performance. Construction activities are being prioritized as well as final workface planning activities occurring on a daily or weekly basis as appropriate. Special attention is being paid to out-of-sequence construction and project rework levels.

Planning and project control activities include:

- Management of baselines
 - Scope – recognize and respect the primacy of the scope baseline; implement a proactive change management process.
 - Cost – update budgets for direct and indirect costs; track progress and project cost against the baselines; implement an earned value management system (EVMS); measure and monitor productivity.
 - Schedule – develop detailed construction schedules, include daily and weekly schedules from workface planning efforts; track progress against the baseline project schedule utilizing the concept of earned schedule.

- Risk – identify realized risks and risk reserves no longer required; identify emergent risks¹; track assumptions that are core to risk assessment in order to identify any migration of assumptions.
- Dynamic planning, reflecting the current state of the project – daily workforce plans; weekly work plans; and medium-term look-aheads.
- Frequent reporting (weekly; monthly), supported by trend analysis and forecasts and subject to effective project review meetings.

Site alignment meetings begun during site initiation are regularly scheduled as site staffing builds up, new suppliers and subcontractors engage with the site, and site-based activities progress in accordance with the plan.

Site safety, quality, and materials management activities are fully deployed in support of construction, but are not covered in more detail in this Executive Insight.

Interfaces with engineering are focused on engineering support of construction and response to requests for information (RFIs).

Construction execution rests on effective and continuous communications, including:

- Communication of the project’s strategic business objectives.
- Communication and timely issue notification and resolution with the client.
- Continuous reinforcement of safety expectations, risks, and performance to all site-based staff.
- Communication of progress and upcoming activities to all project stakeholders.
- Positive engagement with regulatory authorities and staff, including any assigned Inspectors General.
- Effective listening.

During the construction phase effective utilization of existing relevant knowledge and the capture of new knowledge and lessons learned² is especially important. Most important is broadly sharing that knowledge.

It also is important that all aspects of the construction execution plan be fully implemented and conformance with requirements be reviewed and audited as appropriate. These elements of the overall construction execution effort include:

- Environmental, health, safety, and security (EHSS)
- Materials management and testing
- Quality control
- Human resources and industrial relations
- Prime contract management
- Procurement and contract management or support
- Subcontractor management and administration
- Constructability
- Modularization
- Construction equipment and tools
- Rigging and transport

- Logistics
- Welding
- Nondestructive examination
- Site administration and document management
- Turnover management

Project execution plans are updated to reflect any changes especially as they may impact subsequent construction turnover.

Phase 6 – Construction Turnover

In Phase 6, the facility is nearing the point of turnover to the care and custody of the project owner. Some projects may utilize a beneficial occupancy approach, where portions of the developed facility are made available to the owner even while construction activities are wrapping up.

Construction execution at this stage is focused on completing all elements of construction and implementing the turnover plan that has been under development since project inception. System by system checkouts are undertaken to assure the constructed system is functionally complete in accordance with specifications and is fit for purpose.

Document management systems deliver completed system turnover packages with final material certifications, safety inspections and assessments, and quality documentation.

Spare parts are confirmed as being provided and in good condition and startup and operating documentation is complete and provided. Much of the required documentation will likely be incorporated with the BIM, which increasingly will serve as a basis for a facility asset model during operations. In some instances, a final laser scan of the as-built facility will be used to update the BIM model and any significant differences highlighted and documented.

Phase 7 – Project and Contract Closeout

Phase 7 of any project is closeout of the project and the associated contracts and claims. This section only describes those activities related to construction execution and not other activities related to an overall project, especially the engineering or procurement aspects of a broader project. A pure construction-only contract would need to consider these other elements of project closeout, but they are not described here.

Closeout of construction execution includes:

- **Client related**
 - Transfer all client property to client (surplus owner-furnished materials and equipment; final construction works; spare parts per contract).
 - Transmit all required quality documents (material, weld, NDEs, inspection and acceptance reports) to client.
 - Transmit as-built documents/BIM to client
 - Transmit all field-generated project data (project supplier data, drawings, project manuals, spare parts lists, and operations and maintenance manuals) to client.

- **Employee related**
 - Release employees to HR for reassignment, furlough, or termination.
 - Submit documentation as required by the Warren Act (if required).
 - Close out and worker compensation claims.
- **Physical closeout**
 - Dispose of temporary construction facilities (structures, signs, fences, trailers, scaffolding).
 - Inventory and dispose of computers (donate to education where appropriate) and office equipment.
 - Terminate services contracts (janitorial, food & beverage, medical, security (at appropriate point in time), waste disposal).
 - Disconnect utilities.
 - Identify surplus materials for disposal.
 - Identify, inventory, and dispose of consumables supplies.
 - Prepare equipment/tools for removal or return to third-party suppliers.
 - Execute final job cleanup and obtain acceptance.
- **Project management related**
 - Finalize and transfer field records for retention to the designated document retention center.
 - Finalize construction section of the project completion report.
 - Collect lessons learned.
- **Contractual and financial related**
 - Finalize field procurement and contracts.
 - Collect final receivables including retainage.
 - Close out bank accounts.

Summary

This Executive Insight looks at construction execution as it evolves across project phases. These phases begin at the proposal stage and conclude with project and contract closeout. While this Executive Insight is written from the perspective of a design/build, EPCM, or EPC delivery model, it is readily adaptable for a design-bid-build form of project execution.

For Additional Reading

Executive Insight, Constructability Review before Design Commences

Executive Insight, Procurement Management in Large Complex Programs

Executive Insight, Construction Turnover

Executive Insight, Modularization

Executive Insight, Startup Driven Design

Executive Insight, Project Kickoff for Large Complex Projects

Executive Insight, Management of Engineering in Design/Build

Executive Insight, Business Basis of Design

Executive Insight, Know What You Are Trying to Accomplish: The Primacy of the Scope Baseline

Executive Insight, Systemic Risks in Large Complex Programs

Executive Insight, Prime Contract Management
Executive Insight, Module Design
Executive Insight, Indirect Field Costs (IFC)
Executive Insight, Out of Sequence Construction
Executive Insight, Rework in Engineering and Construction Projects
Executive Insight, Barriers to Productivity
Executive Insight, Earned Schedule
Executive Insight, Event Contingency
Executive Insight, Addressing Emergent Risks
Executive Insight, Effective Project Review Meetings
Executive Insight, Redefining Quality
Executive Insight, Foundations for Success
Executive Insight, Knowledge Management
Executive Insight, Lessons Observed
Executive Insight, Logistics
Executive Insight, Project Administration

About the Author

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