

The True Impact of Late Deliverables: Case Study Summaries



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*Research Team 300, The True Impact of Late Deliverables
at the Construction Site*

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Case Study 1

Late External Permits

Case Study 1: Late External Permits

On this case study project, a late environmental permit interrupted the construction of a mining conveyor system that crossed state lines. Table 1 highlights the applicable late deliverables and project impacts.

Table 1. Case Study 1 Late Deliverables and Impacts

Late Deliverable Categories	Project Impact Categories	
Engineering Documents, Approvals, and Responses	Scope Changes	Management/Supervisor Work
Engineered Equipment	Productivity	Personnel Turnover
Fabricated Materials	Engineering/Design Work	Procurement, Logistics, and Expediting
External Permits	Work Re-sequencing	Onsite Team Dynamics
Prefabricated Assemblies	Overtime and Shift Work	Work Relocation
Project Execution Planning	Critical Path Management	Onsite Material Handling
Human Resources	Commissioning and Start-up	Alternative or Additional Suppliers and Vendors
Utilities and Infrastructure	Rework	Liquidated Damages, Claims, and Bonuses
Bulk Materials	Craft Levels/Density	Alternative or Additional Tools and Equipment
Construction Equipment	Downtime	Offsite/Company Dynamics
	Project Risk Profile Changes	Damage, Degradation, and Loss
	Indirect/Overhead Costs	Training Resources

Company Profile

The general contractor in this study provides construction, manufacturing, and engineering/design services throughout the U.S. and in several foreign markets. The company—the employees of which were interviewed for the study—is a large, employee-owned corporation with projects in the mining, oil and gas, heavy civil, industrial, and manufacturing sectors.

Project Description

Case Study 1 provides an account of a 4.3-mile coal conveyor belt construction project. The project spanned two states, and moved coal from a mine across the state line to a coal power plant. The linear, greenfield worksite traversed very steep, hilly land, crossing several roadways and one large stream, and the general contractor was awarded a lump sum EPCI contract for the job. The project was schedule-driven because the conveyor system was integral to the set opening of the power plant. Tables 2 and 3 below provide general cost and schedule information about the entire project.

Table 2. Project Overview

Sector	Mining
Project Type	Material Handling
Construction Location	Southeast United States
Contract Type	EPCI/Lump Sum
Baseline Project Cost (TIC)	\$41 million
Actual Project Cost (TIC)	\$47 million
Baseline Contract Cost	N/A
Actual Contract Cost	N/A

Table 3. Project Schedule Overview

Task	Baseline Duration	Actual Duration	Difference
Total Project	30 months	40 months	10 months
Engineering	16 months	19 months	3 months
Procurement	12 months	19 months	7 months
Construction	15 months	21 months	7 months
Start-up/Commissioning	3 months	7 months	4 months

Late Deliverables and Impact Description

The late deliverables examined in this case study were environmental permits from one of the two state governments with jurisdiction over the project. The beginning of the construction phase was contingent upon the arrival of the permits for both states, while engineering and procurement began according to the baseline schedule. The construction was scheduled to begin at the mine and proceed towards the power plant. All design, fabrication, and procurement were planned and completed in this

order. However, procurement was completed before the permits were obtained from the state in which the construction was supposed to begin. (The permits had not been considered during front end planning.) Therefore, construction proceeded in the opposite direction.

Due to the delayed commencement of construction, much of the planned work for the summer was pushed into the winter months, which were abnormally severe. The harsher weather lowered project productivity, lengthened activity durations, and necessitated extra safety precautions such as shoe spikes, space heaters, and harnesses to prevent slipping. The movement of materials to the worksite was difficult and hazardous during inclement weather, and many parts of the site were inaccessible when icy. These impediments, along with the arrival of materials before construction could begin, forced the project team to implement remote laydown areas where all materials had to be retagged for the new construction phasing. Additional cranes, trucks, and forklifts were needed for these laydown yards, and transportation to the site took extra time and money. Materials were damaged due to extra handling, galvanized steel components that had developed white rust from exposure had to be replaced, and rubber conveyor belts had to be stored in warehouses to prevent damage. The project team attempted some preassembly in the laydown area, but the nature of the work and the inability to transport large pieces curtailed this effort. Beyond dealing with these worksite problems, the project owner had to fund a bond to repair the roads to and from the laydown yards that had been damaged by heavy equipment and trucks.

When the delayed permits were finally released to the general contractor, work in the first state had been completed, and the site was nearly demobilized. When the permits were finally released, they were released for small segments rather than for the entire project site. As new areas became available, crews were constantly relocated and split along the jobsite. The start of the project was delayed by five months, with the construction duration increased by almost 50 percent. Thus, the total project duration increased by almost one year. Spending this additional time on this project prevented the management team from moving on to other projects and increased turnover among the crews. The increased turnover meant scheduling additional training for new workers on site. The low productivity, the frustrating inability to plan work ahead of time and see progress, and the poor winter weather lowered crew morale and increased turnover further. Weekend work became the norm, since additional shifts were needed to make up for the slow progress.

Not all impacts to the project were negative. The owner and general contractor had improved relations after liquidated damages were rescinded and the change order process was streamlined. These developments allowed the owner and general contractor to improve communication and work together to complete the project. From an engineering perspective, the delays in permitting provided the time needed to complete the original design and make any changes required by the owner or regulatory agencies. Moreover, the eventual release of the permits reduced pressure and frustration among the engineering team members.

Lessons Learned

a. Visibility is necessary for owner-acquired environmental permits during the (RFP) and contract negotiation phases.

The owner had the responsibility of supplying the environmental permits before construction work could begin on site. Had the contract included a phase-gate process for project authorization, it would have enabled the owner and contractor to do a better job of linking resource commitment to the status of owner-acquired environmental permits.

b. Project material storage and laydown areas should be permitted in advance and/or designed to be separate from the capital project areas.

With the project material storage and laydown areas integral to the project site, the owner could not prepare the areas for the receipt of materials by the contractor until the receipt of permits. Once the permits were delayed, the receiving and storage of project materials became an important logistical challenge because of this design. By the time the project team recognized the implications of this design, the project had progressed too far for any significant design changes.

c. Interpersonal skills and the right contracting method can have a constructive influence on the project team's management of late deliverable impacts.

Good soft skills are desirable in any leadership team; however, they are often not as useful without a fair contractual arrangement between parties. On this project, the soft skills of the owner's project manager, along with a cost-reimbursable change order for the initial material double-handling impacts, increased the trust and teamwork between the project teams. Once both parties knew the full impacts of the late deliverables, they negotiated lump sum change orders; but the foundation of these discussions was the relationships built during the initial cost reimbursable change order.

Case Study 2

Late Engineering Documents, Approvals, and Responses

Case Study 2 investigates how late engineering documents on a construction project for a fuel farm system affected construction. The late deliverable as well as its impacts to the project are highlighted below in Table 4.

Table 4. Case Study 2 Late Deliverables and Impacts

Late Deliverable Categories	Project Impact Categories	
Engineering Documents, Approvals, and Responses	Scope Changes	Management/Supervisor Work
Engineered Equipment	Productivity	Personnel Turnover
Fabricated Materials	Engineering/Design Work	Procurement, Logistics, and Expediting
External Permits	Work Re-sequencing	Onsite Team Dynamics
Prefabricated Assemblies	Overtime and Shift Work	Work Relocation
Project Execution Planning	Critical Path Management	Onsite Material Handling
Human Resources	Commissioning and Start-up	Alternative or Additional Suppliers and Vendors
Utilities and Infrastructure	Rework	Liquidated Damages, Claims, and Bonuses
Bulk Materials	Craft Levels/Density	Alternative or Additional Tools and Equipment
Construction Equipment	Downtime	Offsite/Company Dynamics
	Project Risk Profile Changes	Damage, Degradation, and Loss
	Indirect/Overhead Costs	Training Resources

Company Profile

The contractor for this project is a regional mechanical contractor with experience in the civil, oil and gas, piping, and mechanical sectors, and is able to self-perform much of the work. For this project, the contractor was a subcontractor to a joint venture (JV) between two large, international engineering and construction firms, and was also responsible to the owner's third-party representative.

Project Overview

Case Study 2 looks into a fuel farm system that was constructed as a part of a larger airport development in the southeastern United States. The project examined was on a brownfield site and involved the expansion of the existing fuel farm at the airport. It was a small part of the overall project for which the JV was responsible. The contractor was responsible for procurement and construction of the fuel farm, using the design and specifications provided by the JV from a separate design firm. Tables 5 and 6 provide overviews of the project and the schedule.

Table 5. Project Overview

Sector	Oil & Gas
Project Type	Transportation & Storage
Construction Location	Southeastern United States
Contract Type	Lump Sum Subcontract
Baseline Project Cost (TIC)	\$10.0 million
Actual Project Cost (TIC)	\$14.5 million
Baseline Contract Cost	\$6.1 million
Actual Contract Cost	\$9.5 million

Table 6. Project Schedule Overview

Task	Baseline Duration	Actual Duration	Difference
Total Project	61 weeks	77 weeks	16 weeks
Engineering	14 weeks	16 weeks	2 weeks
Procurement	N/A	N/A	N/A
Construction	31 weeks	47 weeks	16 weeks
Start-up/Commissioning	8 weeks	8 weeks	0 weeks

Late Deliverable and Impact Description

The late deliverable investigated in this case study was the correct specification release to the construction teams. The designer inadvertently released incorrect specifications to the JV, and they had been included in the Issue for Construction (IFC) documents. When the IFC was released to the contractor, the designer notified the JV of the mistake. However, the JV did not provide the correct specifications to

the contractor for another 32 days. The updated specifications contained extensive additions and modifications to material and equipment that had already been purchased by the contractor under the outdated specifications. The project became schedule-driven, since the fuel farm system had to be complete by a certain date in order not to delay the overall project. The late specification release, combined with a prior 73-day delay for value engineering, pushed the finish date back approximately six months. The late deliverable itself directly increased the project cost by about nine percent.

When alerted to the mistake, the contractor worked to cancel and update previously placed orders for equipment and piping, and many of the items that had already arrived on site had to be stored in a warehouse. With the updated specifications, the contractor reordered the correct materials such as instruments and valves, returned items for credits lower than the original cost, and expedited new materials at additional cost. The reordering and handling process led to some damage to items, as well as to quality and sizing issues with materials such as underground piping.

The contractor's management team had to revamp the entire project execution plan upon receiving the specification changes; and, in order to meet the "drop-dead" completion date, the team accelerated the schedule, and compressed many activities at additional costs for labor and resources. The project manager even attributed one safety incident to this acceleration. In addition, weekend work was implemented for critical path items, and worker productivity decreased after the delayed specification release made planning ahead more difficult. New workers were also added, and they were unfamiliar with both the safety and work practices on the site. The inability to plan ahead and the accelerated schedule both also led to a drastic growth in punch list items.

One major safety and quality concern that arose from the late deliverable occurred during site preparation. The weather contingency was planned with a winter completion date for site preparation, but this activity was pushed into the spring months. The ditches for underground piping and foundation excavations were vulnerable to collapse during heavy rainfall, and crews had to muck out the excavations several times and then refill and re-compact the foundations. In addition, after having poured heavy foundations to stabilize the ditch sides, the workers had to use shoring to prevent collapse during rainfall. This not only increased the safety risk profile on the project, but also accelerated the depletion of the time and budget contingencies.

As the mandatory completion date came closer, the JV/owner representative began to allocate more resources to the fuel farm project. New safety personnel were continuously assigned to the project, which led to crews receiving mixed signals on procedures. Conversely, the addition of quality personnel and a third party assigned to test the facility improved the project quality; indeed, their clear and open communication on quality was cited as a reason for project success. Three different project managers from the JV were assigned throughout the project, and all three gave the JV and owner varying accounts of project progress and history. This caused several disagreements between the contractor and JV, as well as between crews and management, and blame was passed all around. To remedy this situation and get back on track for the mandatory completion date, the team set up weekly meetings for the final months of the project, to clean up communication and resolve disagreements.

Lessons Learned

- a. Take time to formally review the potential impacts of a late deliverable, then create a recovery plan that mitigates the impacts as much as possible.**

Late deliverables are most often inconvenient and, many times, they occur when the project is so busy that no one has time to properly consider their impacts. At these times, it is easy for the project team to enter a reactive mode and begin “fighting fires” as the impacts arise. However, to have maximized the chance of the project recovering from late deliverables on this project, the team would have benefited from taking a step back from the project, investing time in assessing future impacts, and re-planning the work.

- b. Open up the lines of communication between project stakeholders, and provide means for document control and release, early in a project.**

On this project, several small oversights in engineering and management created much larger issues in the field. Creating open lines of communication and implementing rigorous standards for document release are especially important for projects with more complicated management structures, such as the multiple layers of management teams and organizations that worked on this project.

Case Study 3

Late Fabricated Materials

Case Study 3 examines a project for which a shipment of structural steel and piping was hijacked en route to the construction location. Table 7 highlights the late deliverables category related to this case, as well as its impact categories.

Table 7. Case Study 3 Late Deliverables and Impacts

Late Deliverable Categories	Project Impact Categories	
Engineering Documents, Approvals, and Responses	Scope Changes	Management/Supervisor Work
Engineered Equipment	Productivity	Personnel Turnover
Fabricated Materials	Engineering/Design Work	Procurement, Logistics, and Expediting
External Permits	Work Re-sequencing	Onsite Team Dynamics
Prefabricated Assemblies	Overtime and Shift Work	Work Relocation
Project Execution Planning	Critical Path Management	Onsite Material Handling
Human Resources	Commissioning and Start-up	Alternative or Additional Suppliers and Vendors
Utilities and Infrastructure	Rework	Liquidated Damages, Claims, and Bonuses
Bulk Materials	Craft Levels/Density	Alternative or Additional Tools and Equipment
Construction Equipment	Downtime	Offsite/Company Dynamics
	Project Risk Profile Changes	Damage, Degradation, and Loss
	Indirect/Overhead Costs	Training Resources

Company Profile

The owner of the project examined in this case study is a large multinational energy corporation, with operations in oil and gas exploration, production, refining, and transport. The contractor hired for the project was an international corporation, with experience in offshore engineering, procurement, construction, and installation (EPCI) in the oil and gas industry. The owner assigned project management staff to the project, while also relying on the management teams of contracted companies.

Project Overview

The study focused on the construction and installation of a large oil platform in Southeast Asia. The owner awarded an EPCI contract that combined reimbursable work, unit rate work, and lump sum items. The arrangement with the EPCI contractor spread the risk across multiple project aspects. The project was an expansion of an existing complex that involved renovating existing facilities and linking them to the platform. Therefore, the construction site included both greenfield and brownfield segments. Tables 8 and 9 provide additional project context.

Table 8. Project Overview

Sector	Oil & Gas
Project Type	Offshore Platform
Construction Location	Southeast Asia
Contract Type	EPCI/Lump Sum
Baseline Project Cost (TIC)	\$1.46 billion
Actual Project Cost (TIC)	\$1.56 billion
Baseline Contract Cost	\$1.22 billion
Actual Contract Cost	\$1.32 billion

Table 9. Project Schedule Overview

Task	Baseline Duration	Actual Duration	Difference
Total Project	33 months	43 months	10 months
Engineering	22 months	25 months	3 months
Procurement	23 months	31 months	8 months
Construction	25 months	35 months	11 months
Start-up/Commissioning	3 months	8 months	5 months

Late Deliverable and Impact Description

The late deliverable examined for this case study was the structural steel for the platform and the steel materials for the export pipeline, both of which were on a ship that was hijacked while en route to Asia. Upon news of the hijacking, the project team submitted a second order for the steel to replace the first order, at a cost of about \$15 million. The original order was then actually recovered and arrived to the fabrication yard prior to the second order. When this happened, the owner could only sell the excess steel as surplus at about half the original price—in part due to the softening of the steel market during the window of the delay.

This project was supposed to be the first project in and the first out of the contractor's fabrication yard. However, after the delayed steel delivery, the project was the last one in the yard and no longer a priority. Because the workers understood that, upon completion, they would be out of work, they purposely slowed their pace in order to extend the work; this resulted in poor productivity and even some cases of sabotage in the yard. To solve this problem, management added more crews to the project and scheduled overlapping activities. Against expectations, this worsened productivity, and the overlap of blasting and piping crews on site caused serious quality issues and rework. The grit from the sandblasters got into the pipes and valves, and the pipes had to be removed and flushed. Many of the valves were damaged in the fabrication yard, and most of the damage went unnoticed until the platform had been shipped to the project site offshore. Crews attempted to repair these valves in the field but did not have the appropriate personnel. So, the materials were shipped back to land, refurbished or replaced, and reinstalled upon arrival back at the site, all at an estimated cost of over \$10 million.

Due to the delays, much of the scheduled work was completed out of sequence, leading to more delays in material delivery. No one updated the material management plan to account for the out-of-sequence and accelerated work, and over 200 spools and valves were lost on the site. The project team reordered these materials, but the initial lack of materials slowed production. Decks that required a new crane be used in the yard were lifted before completion; and, since this meant more crews had to work at elevation than planned, this increased the project's safety risk. Since much of the work was unplanned, many pieces of equipment were often unavailable when needed in one part of the yard because they were in use in another. In addition, quality assurance became a bottleneck to the extent that waiting for approvals interfered with crews' progress.