WHITE PAPER / **TANK DESIGNS FOR TERMINALS AND PIPELINES**

ENGINEERING CONSIDERATIONS FOR HYDROCARBON STORAGE TANKS

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Hydrocarbon storage tanks design benefits from a holistic approach that considers more than the fabrication of the tank itself. Understanding the engineering questions to ask and pitfalls to avoid when developing project scopes of work and requests for proposals can help minimize risks and stave off cost and schedule overruns.

The large, above-ground carbon steel tanks used to store crude oil, gasoline, chemicals and produced water are central to oil and gas company operations. Found in gathering, midstream and hydrocarbon production facilities, these long-lead storage tanks are a critical path item on many petroleum industry projects.

To meet aggressive in-service deadlines, owners tend to push for early completion of tank data sheets, arrangement drawings and scopes of work. The potential scheduling benefits of this approach, however, are sometimes offset by errors, gaps in scope and other omissions that can result when project information is limited.

These issues can be compounded when petroleum storage tank suppliers contract to deliver not only the tank itself, but also the ancillary engineering services associated with its installation on an owner's site.

There are risks associated with the design approach driven by the tank supplier, given that the supplier may be inclined to follow API 620 or API 650 guidelines — the standards governing the design and construction of many of these storage tanks — without also considering an owner's unique operating circumstances and site details. Tank engineering decisions also run the risk of being driven by tank supplier preferences, rather than the value they add to the completed project.

From foundations and site grading, to cathodic protection, coatings and tank connections, a variety of factors can impact the engineering decisions on a tank project. All should be included in the request for proposal (RFP) package to produce an accurate scope of supply.

To prevent project delays and cost overruns, projects benefit from early coordination among the owner, tank supplier and experienced engineers to identify and fill gaps in project scope and address other issues that might otherwise impede successful project completion. Factors that warrant special consideration include:

Foundation design. For tank suppliers focused on tank design and construction, the site conditions and soil composition where the tank will be installed are sometimes poorly understood or treated as secondary concerns. That can result in foundation and grading designs that do not meet the facility's geotechnical load parameters.

A pressurized tank, for example, must be anchored to a concrete foundation that is heavy enough to withstand tank uplift pressure. Likewise, if a tank settles because the foundation is underdesigned, piping and liquid level are at risk. These are reasons why tank projects should be designed from the ground up. To minimize cost and schedule overruns, civil engineering and foundation design work should be performed before assembling the tank package.

Air permits. Owners are required to procure air permits from federal and state agencies that specify the emission thresholds allowed for new tanks — a process that can take a year or more. To achieve timely permit approval, owners often submit applications before tank design is complete. Changes to the permit application can mean restarting the process, which encourages project teams to often resign to living with less-than-ideal permitting results and the tank designs they dictate, rather than pursue other options.

Engineers can play an important role in helping owners identify appropriate emission thresholds early in the process and recommending tank designs that comply with them. For example, the standard, lower-cost hatches tank suppliers often propose to seal tank interiors may be inadequate for preferred emissions thresholds. Engineers may be able to recommend alternatives that improve tank performance and comply with air permit requirements.

Material selection. An experienced engineer can review the table of allowable tank materials, identify the options for a given application and prescribe them in a project RFP. Without these specifications, tank suppliers may suggest a tank material in its inventory that meets applicable API 620 or 650 standards — without considering if it meets the owner's need. Potential exists for a shell material to be specified that is convenient for a tank designer but that does not maximize the working characteristics of the tank. An experienced engineering review can help mitigate shortsighted decisions in the material specification and selection process. Final design decisions should reflect the owner's interests and be based on a cost-benefit analysis that considers everything from tank product pressure to air permit requirements.

Interface points. Tank design should consider the equipment and systems that connect to it. One of a designer's early challenges is to define all tank interface points, including piping interfaces, instrumentation and electrical scopes, pumps and foundations. Equipment piping and instrumentation diagrams (P&IDs) — process drawings that identify all piping, instruments and connections — should be as complete as possible. In some cases, owners have later added unbudgeted platforms to access piping valves and instruments not identified in original purchase orders.

It is also helpful to have an interface table where roles and responsibilities of process designers, fabricators and subcontractors are clearly defined. Tank suppliers have been known to omit flush cleanout and other simple connections needed for tank inspections and operations. Similarly, fabricators sometimes have limited experience in running conduits or connecting instruments, resulting in simple but important errors and omissions. Mechanical and electrical subcontractors can provide important insights on these and other interface points and, with preplanning, can be mobilized on-site to complete these connections.

Vapor control systems. Designers must also consider the vapor pressure of the product housed in the tank. In some situations, it is necessary to dilute and blend the tank contents with other potential higher vapor pressure products not identified in the original scope. In those cases, mixers may need to be added to the side of a tank to blend products together. Mixing appurtenances not identified in the P&ID are an additional unidentified cost. Early process design can be invaluable in identifying these needs and supporting decision-making.

Environmental challenges. Hydrotesting water used to test tanks for strength and leaks should not be discharged into waterways. Spent blasting material used in coatings also has the potential to contaminate the owner's site. Engineers aware of these issues can develop and implement protocols to prevent environmental damage.

Tank painting and coating. Both tank painting and coating play critical roles in protecting the interior and exterior of a tank. Typically performed by specialty contractors, coating and painting are some of the final tasks performed before a tank is entered into service. The time needed for special surface preparation is often omitted from project schedules. Planners should factor in weather-related delays, as rushing these tasks could lead to the detriment of the tank's long-term performance.

Tank nozzle evaluation. For tanks that must comply with API 650, stress analysis of tank nozzles and the piping they interconnect with are critical. Pipe stress analysis involves evaluating the expected forces and loads on tank shell nozzles to verify that they will not fail during operating and design conditions. Piping and tank designers must coordinate their work so piping loads imposed on the shell opening are within safe limits. In particular, the piping designer must consider tank shell stiffness and the rotation or deflection at the tank shell opening as a result of the product head, internal pressure and temperature differentials amongst the tank shell, tank bottom and external piping. An experienced engineering team can help secure, calculate or specify critical design data early in the design cycle so that piping and shell nozzle load limitations can be minimized as the tank is brought into service.

Contracting method. Some contracting approaches are more appropriate for hydrocarbon storage tank projects than others. Owners preferring holistic design often choose an engineer-procure-construct (EPC) method. An EPC approach typically places an engineer accustomed to defining project scopes and managing subcontractors in the lead position, providing the owner with a single interface, while helping to reduce the risks associated with contracting.

CONCLUSION

The opportunity costs lost while awaiting a tank project's completion is typically among an owner's greatest concerns. Early engineer involvement through an EPC contract defines project scopes of supply accurately and gets critical path items under contract quickly. An EPC approach also offers insights that help streamline scheduling, while minimizing owner risk.

BIOGRAPHY

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