



Westney
Consulting Group

Confidential Project Piping Schedule Analysis

Discussion document

Context: The most prevalent challenge on recent cracker and derivatives projects is field-erected piping

Schedule-related findings from recent cracker projects

- Actual cracker project durations were ~6-8 months longer than expected, primarily due to piping installation
- Several piping installations challenges were observed, including:
 - Schedule assumptions not matching reality for engineering, fabrication, and site installation
 - Actual production rates not meeting planned rates and sustained performance well below 90s crackers
 - Hydrotest and reinstatement taking ~6-8 weeks longer than anticipated

Given findings, the primary focus area for Westney's Confidential Project's schedule analysis was field-erected piping

Basis of analysis: Key Westney tools and data were utilized

General tool use

Tool #1: ProjectPlanner™

- ProjectPlanner™ generates a set of EPC production profiles based on historical sequence and progress achieved

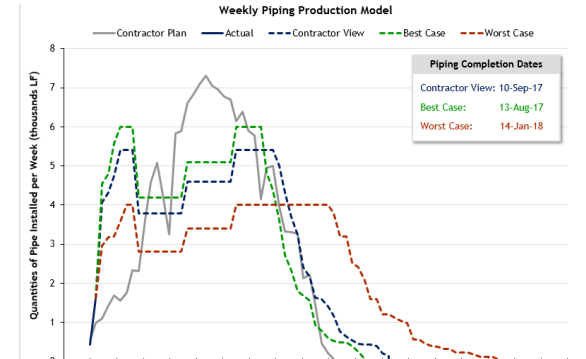
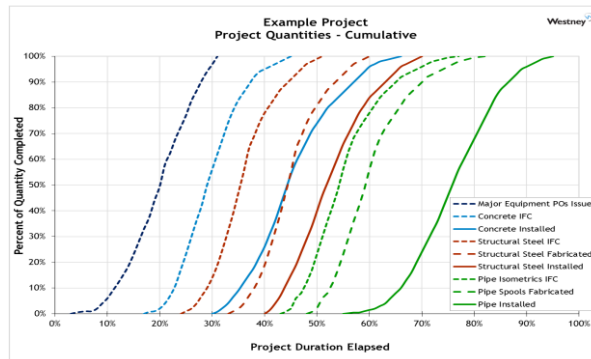
Application for Confidential Project

- Confidential Project's piping installation profiles for each pillar were compared to Westney's profiles
- Comparison reveals whether the shape of Confidential Project's profiles are realistic

Tool #2: PipingPlanner™

- Piping Planner™ generates piping installation curves based on a range of expected performance
- Confidential Project's overall piping installation curve was compared against 3 scenarios (high, low, and required)
- Scenarios provide varying piping completion dates that can be compared to Confidential Project's expected completion date

Example output



Summary of findings and recommendations (1/2)

Analysis	Findings	Slides
<p>1 Piping installation profiles by pillar and overall summation</p>	<ul style="list-style-type: none"> ▪ Holding to the current Confidential Project piping completion dates by pillar: <ul style="list-style-type: none"> – ECU, PE 3, and Cogen profiles are similar to Westney’s historical curves – PE 1&2 and OSBL profiles are more aggressive and likely haven’t been leveled since pipe quantities increased ▪ The peak production of both Confidential Project’s (~18k lf/week) and Westney’s (~15k lf/week) summation profiles are not likely to be achieved 	5 - 10
<p>2 Overall piping installation profile across Confidential Project</p>	<ul style="list-style-type: none"> ▪ PipePlanner™ indicates that if the quantities (pillars) could be leveled, the current schedule could be maintained with peak sustained production of ~12k lf/week and improved ~2 months if ~13k lf/week is achieved (which is reasonable production based on recent cracker and derivatives projects) 	11
<p>3 Potential impact of piping fabrication on installation</p>	<ul style="list-style-type: none"> ▪ Westney’s best practice indicates sustained piping production should not begin until ~60% of piping spools are at the site ▪ Following the 60% of spools onsite rule: <ul style="list-style-type: none"> – Only PE3 and OSBL curves would shift – The impact to the overall profile across Confidential Project is minor ▪ Confidential Project spool deliveries are compressed into a tighter time frame than Westney’s historical curves 	12 - 14
<p>4 Productivity and diameter-inches (DI) of weld</p>	<ul style="list-style-type: none"> ▪ Overall productivity is expected to be ~6 workhours/lf based on recent USGC cracker and derivatives projects <ul style="list-style-type: none"> – Cracker and OSBL is expected to be ~7 workhours/lf – PE 1&2, PE 3, and Cogen is expected to be ~5 workhours/lf ▪ Overall DI of weld is expected to be ~6 DI/day <ul style="list-style-type: none"> – Cracker and OSBL is expected to be ~3-4 DI/day – PE 1&2, PE 3, and Cogen is expected to be ~8-10 DI/day 	15

Summary of findings and recommendations (2/2)

Analysis	Findings	Slides
5 Piping FTEs required	<ul style="list-style-type: none">▪ Utilizing Westney's summation of piping profiles by pillar (analysis #1), a peak piping workforce of ~2,000 FTEs, including ~230 code welders, would be required▪ If the pipe installation can be leveled, the number of required FTEs will fall proportionately▪ The number of welders required reduces sharply with improved DI production	16
6 Thoughts on use of night-shift	<ul style="list-style-type: none">▪ Recent projects that tried to use true second-shifts failed to produce economic results and had minimal schedule improvement▪ Selective use of night shift for material distribution, welding, radiography, and the installation of supports, hangers and anchors has been effective	
7 Thoughts on craft density	<ul style="list-style-type: none">▪ Craft density has not been an issue on recent projects▪ Several projects had as many crafts at peak on their crackers alone, as proposed across all pillars in the current Confidential Project staffing plan▪ Westney experience shows that the limiting factors to piping production are those sequential activities upstream of installing pipe (fabrication, materials management, equipment use), as well as the availability of crafts/trades and frontline leaders, not craft density	

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ECU pipe curve shape is similar to historical progress

