Shell Subsea Experience
Factors to consider in cost estimating
GOM Perspective

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High level Considerations for Abandonment Cost Estimating

**Work Unit**
- MODU
- CAT A
- CAT B
- MSV
- Combination of two

**Intervention Well Access System**
- SSBOP
- Intervention Riser System
- Subsea Intervention Lubricator System
- Light Duty Intervention System
- Subsea Test Tree

**Well Condition**
- Sand Control Failure
- Scale
- Asphaltenes
- Integrity Issues
- Subsea XT Type & condition

**Abandonment Technique**
- Perf & Squeeze
- Circulation Squeeze
- Thru tubing cementing
- Cut & Pull
- Section Mill
- Bullhead cement

**Well Construction**
- Water Depth
- Unsealed annuli
- Tieback or long string
- Liner tops
- Number casing strings
- Wellhead removal
- TOC confidence
- Barite Settlement
- Hydrocarbon Risk
Biggest Levers to Reduce Cost

- Work Unit
- Learning curve
- Wet Verification of WAS
- Campaigning Abandonments
- Abandonment Technique
Recent Shell Upper Abandonment Performance

- **SSBOP Issues**
- **Standalone PA’s**
- **Multiple Field PA’s – Same Work Unit**
- **Abandonment Learning Curve**
- **Stack Hopping**

34% Reduction
Forecasting Deep Water Well Plug & Abandonment Cost

Abandonment Method matched to Well Characteristics, influenced by Historical Costs
Accounting for **Variability** in P&A Outcomes

**Assessing Sources of Variability**
- **Known Knowns** >> Well as constructed, documented, plus known Condition changes
- **Known Unknowns** >> Extent of Condition changes while Operating, ie scale, asphaltenes, sand control failure, pressure or fluid data indicating integrity issues, tree condition/access, top of “good” cement that will pass abandonment pressure test
- **Unknown Unknowns** >> Condition changes that do not indicate their presence via operational data or prior interventions, example lack of concentricity that inhibits cutting control lines or achieving quality cement perf & squeeze

**Contingency >> Dependent on Type of Estimate + Operator Assessment**
- **Deterministic** = Allowed for in NPT and/or Risk Assessed %
- **Probabilistic** = Low to High Range of Key Components (both Duration & Unit Rate)
- % or Range >> Judgment considering in house Actuals and/or industry Benchmarks
Operator Considerations in Estimating P&A Cost

**Scope + Tools:**
- Well Construction
- Well Condition
- Abandonment Technique
- Well Intervention Method
- Well Access System
- Work Unit

**Time:**
- Activity sequence
- Time Estimate by Activity
- Base Duration
- Duration “Adders”
- Non-Productive Time
- Any Well Specific Conditions

**Price:**
- Variable Cost
- Duration: Base + Adders
- Work Unit Spread Rate
- Other Costs
- Mob/Demob
- Non-Time Dependent
- Planning/Oversight

**Cost:**
- P&A Well Cost
- P&A Well Cost
- P&A Well Cost
- P&A Campaign Cost
- Contingency (if not accounted for in NPT)
- Learning Curve
Balance Sheet Liability Provision vs. AFE Funding

Selecting Type of Estimate by Phase & Methods to Account for Uncertainty

• Basis of Estimate >> Document techniques & methods available, and relevant data

• Company Policy >> for Asset/Well Life Cycle
  – Liability Provision vs. Planning for Cease of Production vs. P&A Execution

• Availability of analogue estimated or actual P&A durations
  – Internal
  – Partners
  – Industry Benchmarking
  – Suppliers/Consultants

Deterministic NPT/Contingency >> Typical for Asset Liability Provision
  – Account for Campaign Learning Curve and Outliers in establishing Average Well Cost
  – Future Costs Discounted to Balance Sheet date

Probabilistic Range Analysis >> Calculate Mean Duration by Well and Campaign Cost
  – Typical for requesting funding to execute near term P&A
Industry Sharing and Learning

Well Benchmarking

• Duration, Key Well Attributes (Well Type & P&A Complexity), Work Unit Used
• Total Cost, with inclusions and exclusions specified by Benchmarker
• Individual Fields, Wells and Operators blinded
• Members cautioned to use to sanity check internal estimates, ie not replace them
• Key Objective is to improve Outcomes, by identifying drivers and share learnings
• Actuals by definition include consumed contingency and NPT
• Factored estimates depend on actuals to interpolate/extrapolate to similar scopes
• If actual scopes and future scopes are appropriately “Attributed”, actual durations and work units/tools used can be factored to predict future well outcomes
• Note: Cost breakdowns beyond total requires extensive effort to “qualify” to put to use
Top Down vs. Bottom Up Estimates: Future P&A

Accounting vs. “Bottom Up” Estimating

• Invoiced costs alone not sufficient for Engineers/Estimators to extrapolate directly to future cost estimates

• Invoice level data can calibrate unit rates/durations used to calculate custom “Bottom Up” estimates

• Custom Bottom Up estimates labor intensive, to seek funding to execute near term, specific scopes of work

Benchmarking vs. “Top Down” Estimating

• Actual cost data points are normalized and/or plotted vs. key attributes to identify cost trends and drivers

• Benchmarking plots/trends are used to “sanity check” custom Bottom Up estimates, i.e. not replace them

• However, benchmarking technically viable and less effort to forecast credible future campaign costs

• Factored estimates do depend on actuals to interpolate/extrapolate i.e “Top Down” to similar future scopes

• If actual scopes and future scopes are appropriately “Attributed”, actual durations and work units/tools used can be factored to predict future well outcomes, adjusted for differences in “Attributes”
“A” way to Forecast Future P&A from Actuals?

Actual P&A’d Well Construction → Current Well Construction Factor(s) → Actual P&A’d Well Condition → Current Well Condition Factor(s) → Actual P&A Duration → Factored Average P&A Duration → Factored Average Future Cost → Total Actual Cost Submitted → P&A Cost by Lease → Adjustments for Future (Offset each other?)

Upward Cost Uncertainties
- Unit Rates
- Outliers

Downward Cost Uncertainties
- Learning curve
- Campaigns
- Technology
P&A Cost Estimating Takeaways

- **P&A duration** = Well as constructed + current condition

- Cost estimates for Future Liability Provisions typically “Top Down”:
  - Avg. P&A duration x spread rate (Work Unit matched to P&A technique)
  - Non Productive Time = Deterministic, derived from historical actuals

- In spite of outliers, Learning curve reduces avg. P&A durations over time

- Cost estimates for Execution Funding (AFE) typically “Bottom Up”:
  - P&A duration estimate specific to well
  - May include Probabilistic Ranging