An Onshore Solution for Elimination of Routine Flaring in Angola

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Agenda

- Background Information
- Associated Gas Management
- Onshore Option Development
- Cabinda Gas Plant Overview
- Vapor Recovery System
- Cabinda Gas Plant Challenges
- Project Impacts
- Acknowledgements
Chevron in Angola

- 50+ years in Angola
- Chevron operates in Angola as Cabinda Gulf Oil Company (CABGOC)
- CABGOC operates the Block 0 and Block 14 offshore concessions on behalf of:

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<th>Block 0:</th>
<th>Block 14:</th>
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<td>Sonangol E.P.</td>
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- Operated production of approximately 550,000 bbls/day
- Workforce of approximately 3,000
- Full spectrum of operations:
  - Operated and non-operated interests
  - Offshore and onshore operations
  - Shallow and deepwater exploration, development and production
  - Angola LNG
  - Oil, gas, condensate and LPGs
Associated Gas Management

Routine Flare Elimination
Gas to Angola LNG
Create Value

CABGOC Operated Blocks Associated Gas Infrastructure
Gas Management Project

- Flare and Relief Modifications (FARM) Project
  - Upgrades and modifies the flare gas and relief systems on 14 offshore facilities

- Gas Processing Platform (GPP)
  - Provides additional compression, sweetening, and dehydration. Captures Natural Gas Liquids (NGL’s, C5+).

- Cabinda Gas Plant (CGP)
  - Processes Offshore NGL’s and Terminal gas, produces LPG for export through LPG FPSO
2003: Value Engineering identified opportunity for a single onshore Gas Plant instead of:

- Large Gas Plant on offshore platform
- Small Gas Plant onshore, no export

Alternatives reviewed:

- Dedicated NGL pipeline to onshore
- Keep propane offshore, maximize butane in crude
- Offshore (Inject NGL in Field A)
- Offshore (Inject NGL in Field B)
- Onshore Gas Processing
## Summary of Main Alternatives

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<th>Offshore</th>
<th>Onshore</th>
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<td>Lower Capital Expense</td>
<td>Higher Capital Expense</td>
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<td>Disposal of Natural Gas Liquids</td>
<td>Sale of Natural Gas Liquids</td>
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<td>Fixed Local product volumes (extra volume flared)</td>
<td>Adjustable Local product volumes (extra volume exported)</td>
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<td>No flexibility for future developments</td>
<td>Utilize infrastructure for future developments</td>
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Scope:
- Inlet Separators for recovery of NGL’s from Offshore Crude Pipeline
- Vapor recovery from Terminal tanks and equipment
- LPG Recovery Plant designed for inlet gas flow rate of 25 MMSCFD (708,000 m3/day)
- LPG export to LPG FPSO via 6” pipeline
- 13.2 MW Power Generation Plant
- Flare modifications to existing process facilities

Design Cases:
- Normal & Design Rates
- Low RVP
- No Offshore NGL

CGP will eliminate routine onshore flaring, process NGLs collected offshore, and export LPG
One of the more challenging aspects of this project was designing for the capture and first stage compression of gas streams:

- From multiple sources and varying quality
- That are NGLs rich; and
- Very low pressure

Vapor Recovery Technologies Considered

- Dry Screw Compressors
- Turbo Compressors (Ejectors)
- Wet Screw Compressors
The selected Vapor Recovery System has several unique design elements:

- Rotary screw compressors – best solution for wet gas and the required 3 to 115 psig (0.21 to 7.93 barg) pressure differential.
- Systems for handling condensate dropout and potential slugs of liquids from the field
- Six compressor trains provide flexibility for a wide volume range, and redundancy to minimize downtime
- System designed to operate as one integrated unit, which responds automatically to changes in volume
Vapor Recovery System
One of 3 Vapor Recovery Units that will capture 25 MMscfd of associated gas for the Cabinda Gas Plant project.
Cabinda Gas Plant Location
Vapor Recovery System Installation
Project Challenges

- Change of existing operation and integration of facilities
- Brownfield Construction in operating plant
- New Flare system required
- Alternative Paths for Gas
  - Produce Products
  - Store Feedstocks
  - Flare (last resort)
- Challenging contractor environment
- Infrastructure improvement
- Project Environmental Impact - removal of 25 MMSCFD (708,000 m3/day) has the same greenhouse gas effect as:
  - Removing 812,000 cars from the road
  - Planting 1.1 million acres (4,450 square kilometers) of trees – an area larger than the state of Rhode Island or the country of Switzerland

- Angolan Content:
  - Welding school created in Cabinda
  - Over 400 Angolan workers from Cabinda employed by EPC contractor and subcontractors
Acknowledgements

- **Block 0 Associates:**
  - Sonangol E&P
  - CABGOC (Operator)
  - Total
  - ENI

- **Bob King and CABGOC Gas Management program**

- **Larry Wesselink and Cabinda Gas Plant Project team**

- **Larry Richards and Hybon Engineering Company**
Thank you