Big Bend, Dantzler and Gunflint - Program Approach to Long Deepwater Tiebacks
James Wiseman
Deepwater Project Manager
Noble Energy
James.Wiseman@nobleenergy.com
281-874-6017
Contents

• Noble Tie-Back Program Description
• Engineering, Procurement, Fabrication, Installation Pros and Cons
• Gunflint and Big Bend Lessons Learned
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Noble Energy’s Offshore Track Record

**MARI-B – Israel**
Sanction to First Gas: 3 Years  
Production Rate: 600 MMcf/d  
Water Depth: 230m  
Facility Weight: 18,000 mT

**ASENG – West Africa**
Sanction to First Oil: 2.3 Years  
Safety: 0.21 TRIR  
Production Rate: 80 Kboe/d  
Water Depth: 1000 m

**TAMAR – Israel**
Sanction to First Gas: 2.5 Years  
Total Man-hours: 9.4MM Hours  
Safety: 0.30 TRIR  
Production Rate: 1.1 Bcf/d  
Water Depth: 240m & 1,700m

**ALEN – West Africa**
Sanction to First Gas: 2.6 Years  
Total Man-hours: 11.2MM Hours  
Safety: 0.20 TRIR  
Production Rate: 440 MMcf/d & 40 Kbc/d  
Water Depth: 70m and 400m

**BIG BEND & DANTZLER – GoM**
Sanction to First Oil: 2 Years  
Total Man-hours: 1.4 MM Hours  
Safety: 0.0 TRIR  
Production Rate: 45+ Kboe/d  
Water Depth: 2,200m

**GUNFLINT – GoM**
Sanction to First Oil: 2.6 Years  
Total Man-hours: 1.5MM Hours  
Safety: 0.8 TRIR  
Production Rate: 25+ Kboe/d  
Water Depth: 2,000m
Independent Project Analysis (IPA) Benchmarking

Targets and Competitive Facilities Costs

Facilities Cost Targets (Mean) vs. Facilities Cost Index (Mean)

Source: Independent Project Analysis (IPA)
2016 Upstream Industry Benchmarking Consortium (UIBC)
IPA Benchmarking

Targets and Competitive Facilities Schedule

Execution Schedule Targets (Completed Projects)

Execution Schedule Index (Completed Projects)

Source: Independent Project Analysis (IPA)
2016 Upstream Industry Benchmarking Consortium (UIBC)

Confidential
Project Overview: Big Bend & Dantzler

Subsea Developments

DANTZLER #1 AND #2

Infield Flowline & Umbilical 0.5 Miles Long
Water Depth 6,580 ft

Dantzler Umbilical 8 Miles Long

South Flowline 7.5 Mile Offset

Steel Catenary Risers 2.6 Miles to Inline Seds

Gas Lift Umbilical 4.5 Miles Long

North Flowline 18 Mile Offset

Pigging Loop 12 Miles Long

WATER INJECTION SYSTEM

(Future)

BIG BEND #1 AND #2

(#2 Future)

Flowlines 8” x 12” Pipe-in-Pipe
Risers 8” Wet-insulated

Water Depth 7,250 ft
Big Bend & Dantzler Spec.

- API 10K w/ 7200psi MAOP
- 3 Well Development expandable to 4 wells
- Two field tie-back to Thunderhawk
- 7100’ water depth
- 22 mile PIP flowlines + 5 Layer PP risers
- Separate Umbilicals for each field
- Cameron XT, Aker Controls, Clamp Connectors
Gunflint Project Overview

• Project Objectives
  • Discovered 2008 (MC 948 #2)
    • Appraisal Wells 2012 & 2013
  • Target flowrate of 25MSTB/d
• Partners
  • Ecopetrol
  • Samson
  • Marathon
Project Overview: Gunflint

Gunflint Subsea Field Development
What Was the Program?

• One FEED contractor, all specifications developed jointly for both projects
• Both projects Sanctioned together using shared data from Noble’s risk management process for cost and schedule
• All equipment and services tendered concurrently
• Installation performed back-to-back
Topsides Upgrade of Gulfstar1 for Gunflint
Gunflint Spec.

- API 15K with 12,600psi MAOP
- 2 well development expandable to 3 + 1(WI)
- 6100’ water depth
- 23mile PIP flowlines + 5 Layer PP risers
- FMC trees, Proserv controls, clamp connection system
Shared Owners Team

Pros:
- Consistency
- Sharing P/T Resources
- GOM Specs and guidelines

Cons:
Most resources drawn towards first project

Diagram:
- Project Director
  - Asset / Land / Regulatory
    - BB/D PM
    - Project Services
      - Supply Chain
      - EHS
    - Gunflint PM
Commercial: Equipment

Pros

• Same vendors for umbilical, connection system, valves, distribution equipment, cost savings

Cons

• Separate vendors for project specific equipment: stock 10K trees, host specific controls, subsea multiphase metering
Commercial: Services and Installation

• Pros: Cost
• Cons: Schedule
Subsea Installation: Lessons Learned

Current Readings - LCN, GS1 @ 508' & 561'

Date/Time:
- 8/24/15 12:00
- 8/29/15 12:00
- 9/3/15 12:00
- 9/8/15 12:00
- 9/13/15 12:00
- 9/18/15 12:00

Current Speed (kts):
- LCN DP
- LCN ADCP
- GS1 ADCP @508' [155m]
- GS1 ADCP @561' [171m]
- 2 KNOTS
- LCO ADCP
Pros:
- Tremendous power and ability to work in strong LOOP current
- Proficient ROV crews and adequate power
- Efficient SIMOPS with the Drillship

Cons:
- Multiple vessel substitutions resulted in repeat of crush testing
- MBR requirements lead to reconfiguration of the on-deck equipment
Lewek Constellation – Pipeline and Riser Installation

Pros:
• 2\textsuperscript{nd} job for vessel
• All systems tried and tested
• S-Lay Ops Crew experience – not risk averse regarding assist tug

Cons:
• Mobilization tied to Big Bend/Dantzler
• 2 kts current directly on the beam
Lewek Constellation
Weld Repair Rates – Spanning the 2 Projects

Noble Pipe Weld Repairs

- Big Bend 12" Repairs
- Big Bend 8" Repairs
- Big Bend SCR Repairs
- Gunflint 12" Repairs
- Gunflint 8" Repairs
- Gunflint SCR Repairs

Weld repair requirement decreased substantially from BB to GF project
### Big Bend Production

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<td>Repairs</td>
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<td>101</td>
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<td>Reject %</td>
<td>7.41%</td>
<td>7.39%</td>
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### Gunflint Production

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<th>12&quot;</th>
<th>8&quot;</th>
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<tr>
<td>Repairs</td>
<td>102</td>
<td>116</td>
<td></td>
</tr>
<tr>
<td>Reject %</td>
<td>3.73%</td>
<td>4.35%</td>
<td>7.73%</td>
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Weld reject rate decreased by almost 50% from BB to GF project
Total time: start as RB1 arrived at EMB to ready for sail.
Overall schedule improve from BB to GF.
Spooling speed improve from BB to GF project by making operation improvement.

Note: This chart only consider the reel spooling time only.
Reel Transfer Efficiency

Note: This chart shows the performance improvement since BB trip 2
Trip1 was done at KOS and reel lift was done with project MOB, exact reel lift was not recorded.
Pros

- Embedded client teams improved communications and exchange of ideas for optimization and efficiency between projects.
- PLET design + fabrication + installation with 1 TEAM
  - Consistency in analysis and concept.
  - Centralized fabrication management.
- Installation analysis on vessel to cover the loop current conditions in order to minimize downtime, improve reaction time and planning for changing conditions.

Cons

- Single vessel for 2 projects: The progression of work from one project to the next took some time to optimize the procedures and operations.
  - Schedule impacts were direct and connected between projects.
- Single site for 2 projects: The continuous nature of work resulted in a high-level of wear and tear on equipment.
  - Increased involvement and actions to avoid negative impacts from mechanical, quality and safety impacts were required.
Pipe Spooling

- Flowline and SCR pipe spooling performed at spoolbase in Ingleside, TX onto installation reels aboard transport barge. Installation location in MC724->MC948
- Each trip aboard barge included up to 54,500’ (4,800 metric tons) of 12”x8” pipe in pipe
- Dramatic reduction in weld defects throughout both projects
Pipe Spooling

Pros

✓ Barge spooling concept allows for spooling and installation operations to be independent from one-another (eliminating need for installation vessel to spool at dock)

✓ Flexibility with the spooling sequence of reels allowed for optimizations to be made to installation sequence offshore, speeding up installation times and mitigating potential delays

✓ Optimization of Spooling Operations
  • Pipe Initiation
  • Tailing Pipe
  • Increased productivity with the welding process
  • Improvement with coating repair times due to change in pipe clamp used at VTU

CON

✓ FJC cool down time not optimized to improve spooling time.
On completion of each spooling trip, the loaded reels were towed to the installation vessel (near-shore and offshore) and swapped with empty reels via heavy-lifts up to 2,200 metric tons.
Reel Transfer

Pros

- Reel transfer optimization resulting in 8 reels (4 full / 4 empty) transferred under 24 hours
  - Optimizations in Reel Lift Sequence with each subsequent transfer.
  - Optimizations in LCO Ballasting Plan based on consistent reel payloads and composition.
  - Transfers performed in shelter water during adverse weather and closer to field when weather permitted.

Cons

- Loop current impact on barge stability and heading control were factors in work criteria.
- Lazy swell (ground swell) at near-shore locations.
Gunflint Topside Pull-Ins & Precommissioning

• Pros
  ✓ SCR and Umbilical pull-in spreads designed for ease of installation. Both SCR and umbilical winch spreads utilized the same base skid which resulted in fewer offshore lifts made.
  ✓ Pre-commissioning allowed for the option of topside or subsea solutions.

• Cons
  ✓ No reliable as-built drawings of GS1 J-tubes. This contributed to additional work as J-tube metrology
  ✓ I-tube interface at base of GS1 was flush to keel, which was a constraint to ROV operations and installation of BSLM. Alternate solutions to be considered in the future (future platforms).
  ✓ Limited POB
  ✓ GS1 stability in loop current was a challenge to crane operations (boat to GS1 transfers).
  ✓ Cellar deck access at top of J-tube and I-tube was a challenge for some installation activities.
Conclusion

Would we do it again? YES
Overall cost savings ~ 20%
Minor to no schedule impacts
What would we do differently?

• Engage with installation contractor earlier
• Structure program to “mix” installation sites
• Redesign Gunflint subsea system to allow for installation flexibility
Project Overview: Gunflint

Subsea Field Development
Gulfstar 1 Pre-Pull in Prep Work

Umbilical Bend Stiffener Latch Mechanism (BSLM) installation

Lewek Ambassador

J-tube drifthead entering P-06 J-tube bellmouth

Messenger Wire Hung off at J-tube
Loop Current – Eddy Olympus

Wake From Eddy Olympus at Gulfstar 1 Platform
Loop Current – Umbilical and Riser Pull-ins

LARS with adjustable/rotation sheave/docking head

Schilling 150 HP ROV – Side Launched (left) and Moonpool Launched (Right)

Current Readings - LCN, GS1 @ 193', 508', 561'

- Unsuccessful dive/umbilical problems/could not leave top-hat
- Successful open water dive and/or marginal performance at BSLM
- Successful dive to BSLM with low thruster load and minimal/no hold on grab bars
Construction and GS1 Shut-in
Gunflint Phase 2 Heavy Lifts

All Phase 2 equipment requiring “Heavy Lift” support was set and located during May Shutdown. (Flash Gas Compressor, Production Deck Extension, and Bulk Oil Treater)

McDermitt DB-50 lifts of Production Deck Extension (Flash Gas Compressor in Foreground)

Production Deck Extension on GS1

Loadout of Bulk Oil Treater at Danos