Yamal LNG: Meeting the Challenges of Natural Gas Liquefaction in the Arctic

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Yamal LNG

- Yamal Peninsula, Russia
- South Tambey Field
  - 926 BCM (32.7 TCF)
- 16.5 mtpa LNG
  - 3 trains x 5.5 mtpa
  - 1.2 mtpa gas condensate
- JSC Yamal LNG
  - Novatek, Total, CNPC, Silk Road Fund
- Yamgaz
  - TechnipFMC, JGC, Chiyoda
Challenges

- Arctic Conditions
  - -50°C Ambient Temperature
  - Pile based foundation
  - Permafrost preservation
  - Modular construction in 10 fabrication yards
Liquefaction Project

- TechnipFMC Cryomax® – SRE NGL extraction process
- Air Products AP-C3MR™ liquefaction process
- Baker Hughes, a GE Company Frame 7 gas turbines, propane and MR compressors
NGL Extraction
TechnipFMC Cryomax® – SRE NGL extraction process

- Lean feed gas
- Remove C5+ and aromatics
- Recover C2 and C3 refrigerant
- Boost feed gas to 70 barg for liquefaction
- Faster commissioning and start-up
Liquefaction
Air Products’ AP-C3MR™ liquefaction process

• Air Products
  – Over 120 CWHEs for LNG
  – Over 90 operating LNG trains

• Largest capacity C3MR to date
  – Largest diameter CWHE
  – Largest single bundle weight

• BHGE for Air Products liquefaction processes
  – 60+ operating LNG trains
  – 80+ Frame 7 gas turbines
  – 220+ compressors
Compressor and Driver Arrangement

- Two gas turbine drivers
- Wide ambient temperature range
- Variable Precooling and MR power demands
Compressor and Driver Arrangement
2 x 50% Machinery Configuration

- Fully utilize gas turbine power
- Improved plant availability
- Higher turndown
Refrigerant Turbocompressor Technology

• Compressor Characteristics for 50% Flow
  – Shorter bearings span
  – Increased shaft stiffness
  – 30% smaller nozzle size
Refrigerant Turbocompressor Technology
Compressor Design

• Referenced Designs for
  – Casings
  – Impellers
  – Bearings
  – Dry gas seals
Refrigerant Turbocompressor Technology
Aerodynamics

- 2 x 50% machinery
  - Well Centered Operating Points

- Tip Mach Number
- Flow Coefficient

C3
Helper
Motor

LPMR
HPMR

String A
String B
2 x 50% Machinery Operation
Propane

- Liquid quench
- Inlet throttling valves
- Cross-connection
2 x 50% Machinery Operation Mixed Refrigerant

- Cross-connection
- Inlet throttling valves
Commissioning

• Maximize pre-commissioning in fabrication yards
  – High pressure leak tests

• Insulation to maintain warm defrost gas
  – Warm air / nitrogen used during construction phase
Plant Start-Up, Initial Operation and Performance Test

- Train 1 – November 2017
- Train 2 – July 2018
- Train 3 – November 2018
- 1 year ahead of schedule
- End of 2018
  - 113 LNG cargoes
  - 8.5 million tonnes of LNG
The record breaking success of Yamal LNG is the result of close collaboration between all of the project partners.