


Refrigeration Compressor Driver Selection and Technology Qualification Enhances Value for the Wheatstone Project

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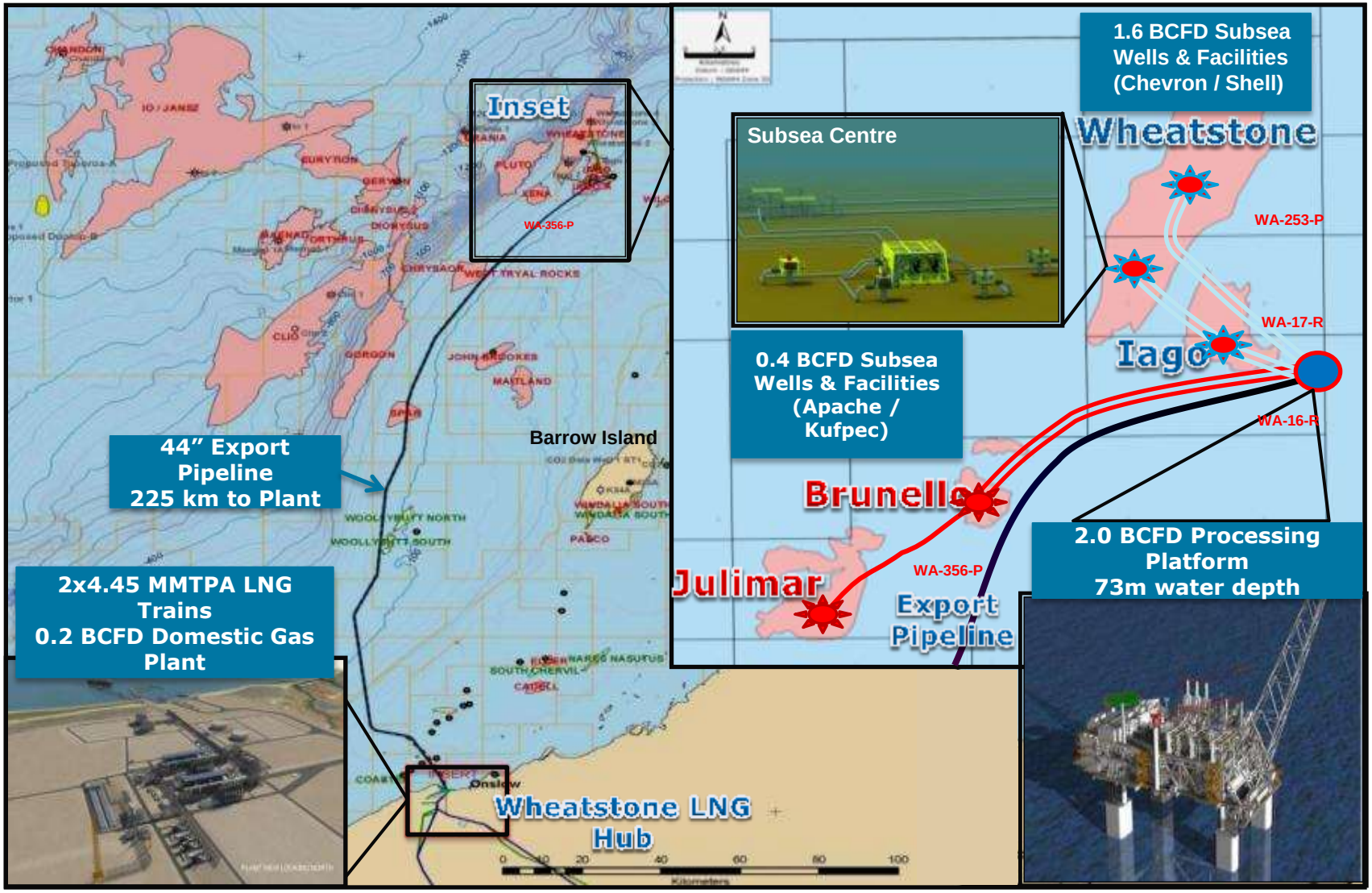
17 April 2013

Topics

- Project background
- Driver alternatives
- Driver selection
- Technology qualification
- Conclusions

Project background

Wheatstone Project

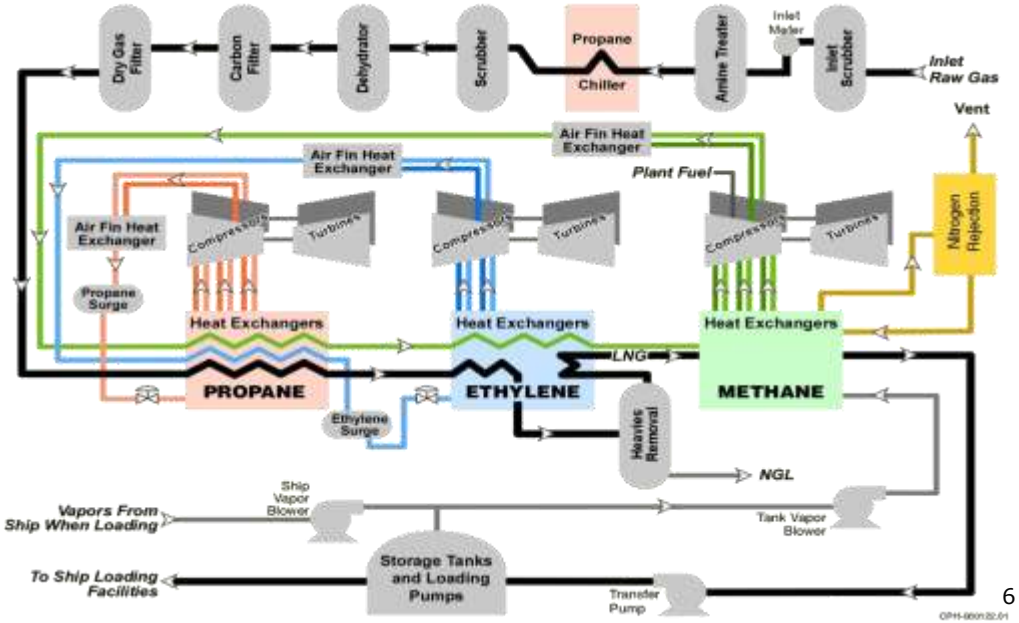


Plant location

- Ashburton North Strategic Industrial Area
- Located about 12 km SW of Onslow
  - Population about 450, increasing to 650 in winter
  - Primary industries agriculture (sheep), salt (Onslow Salt) and fishing

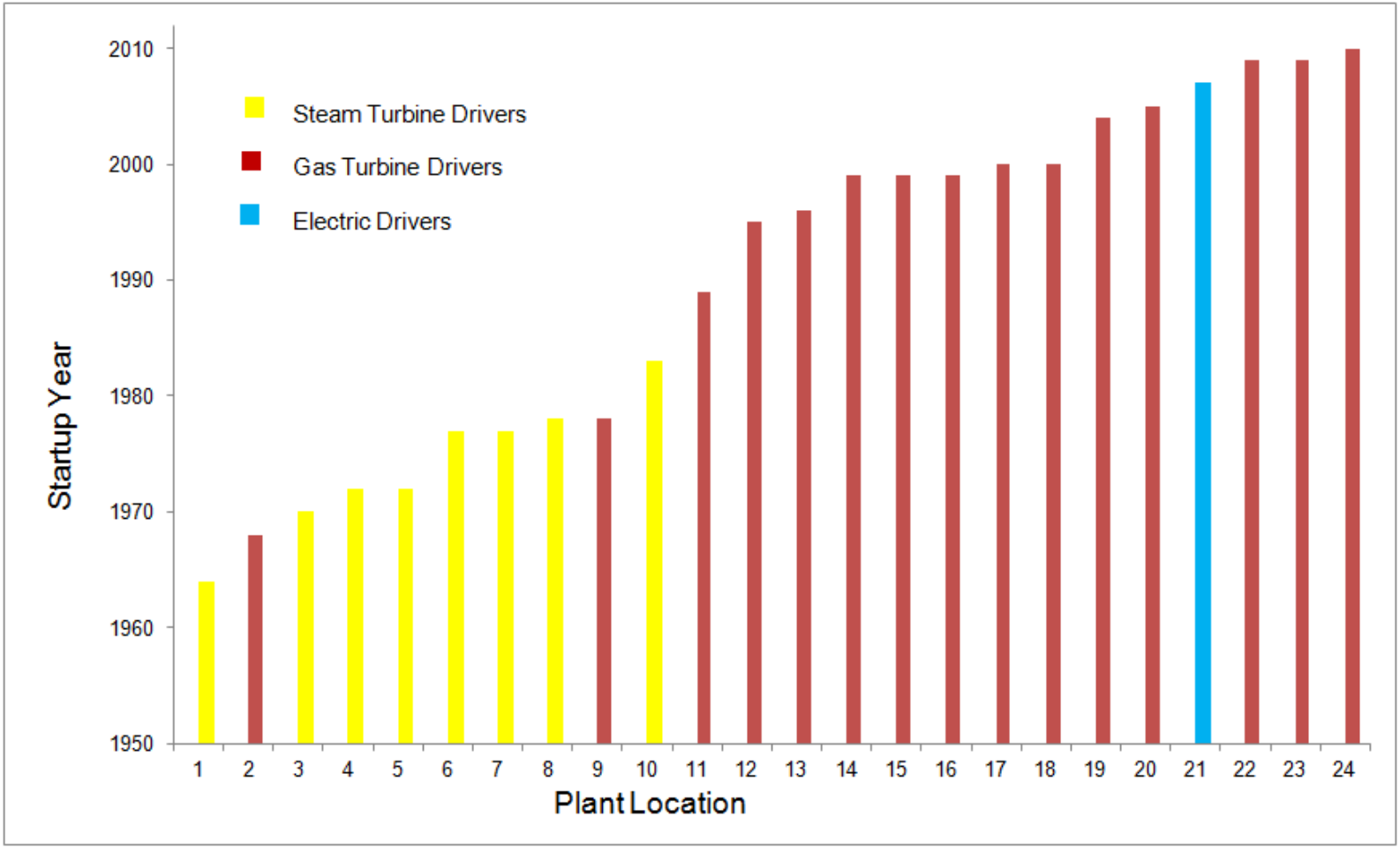
Onshore facilities

- 2 x 4.45 mtpa LNG trains; Condensate and domestic gas production
- ConocoPhillips Optimized Cascade® process
- Modular construction strategy
- 2x150,000 cum FC LNG tanks
- USD 29 billion investment
- Planned expansion to 25 mtpa of LNG



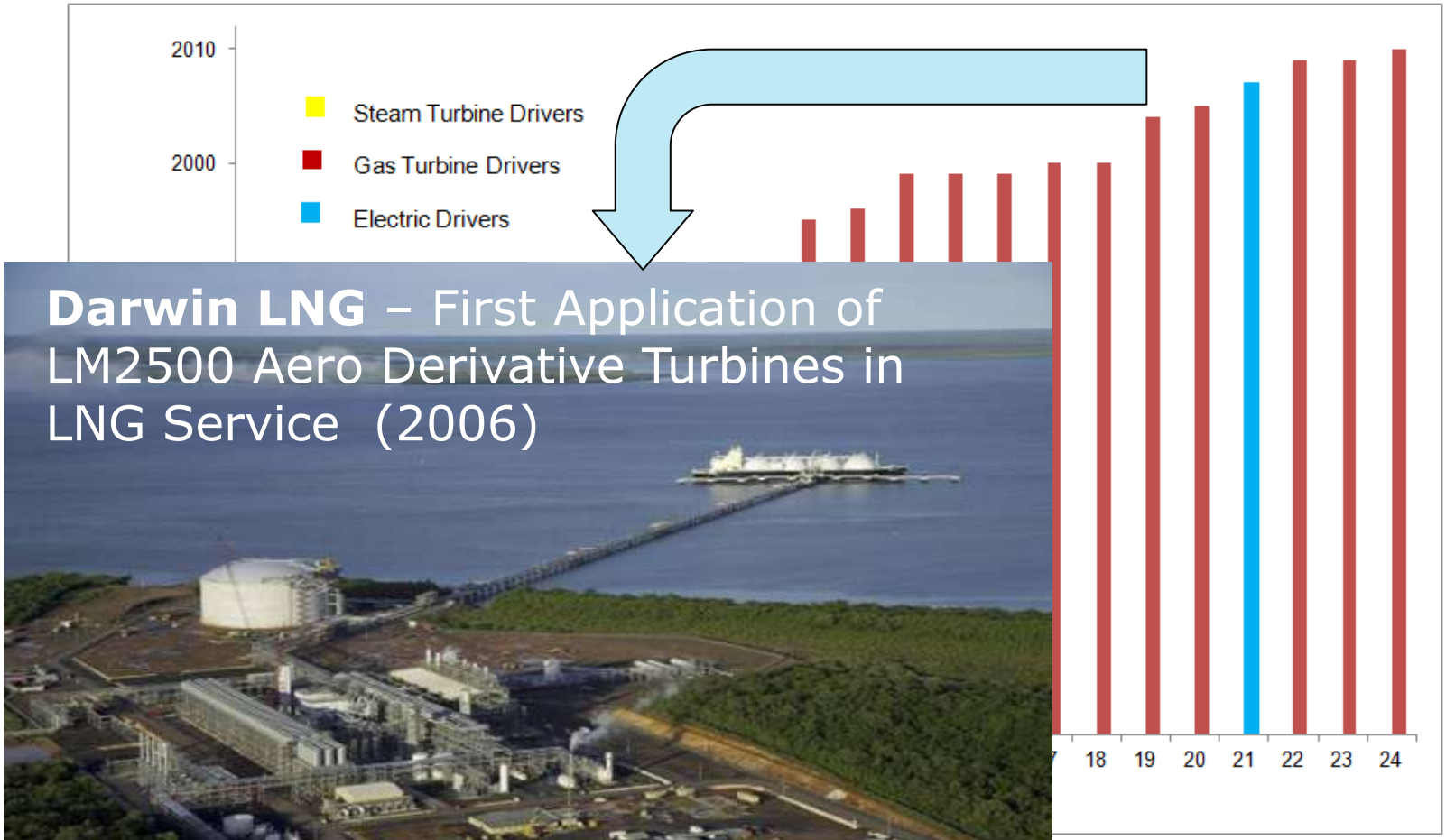
Driver alternatives

Evolution of drivers in LNG industry



First application of gas turbines

First application of LM2500 Aero Derivative Turbines



Darwin LNG – First Application of LM2500 Aero Derivative Turbines in LNG Service (2006)

Driver selection

Project specific factors influencing driver selection

Key project specific factors influencing driver study

- ✓ Fixed feed stream flow limiting ability to utilize excess driver power
- ✓ Compositional uncertainty with regards to feed stream nitrogen content requiring flexibility with available power
- ✓ Site ambient conditions; ambient temperature ranging from 13°C to 40°C *(extremes 5°C to 47°C)*
- ✓ Other criteria for selection include emissions, total installed cost, LNG Production, operating cost, technical/operational/schedule risk, etc

Driver study alternatives

i. 6 x LM2500+G4 with mechanical refrigeration for inlet air chilling (IAC)

ii. 6 x LM2500+G4 with Inlet Air Humidification (IAH)

iii. 7 x LM2500+G4 with no power augmentation

iv. 6 x LM6000PF with IAH

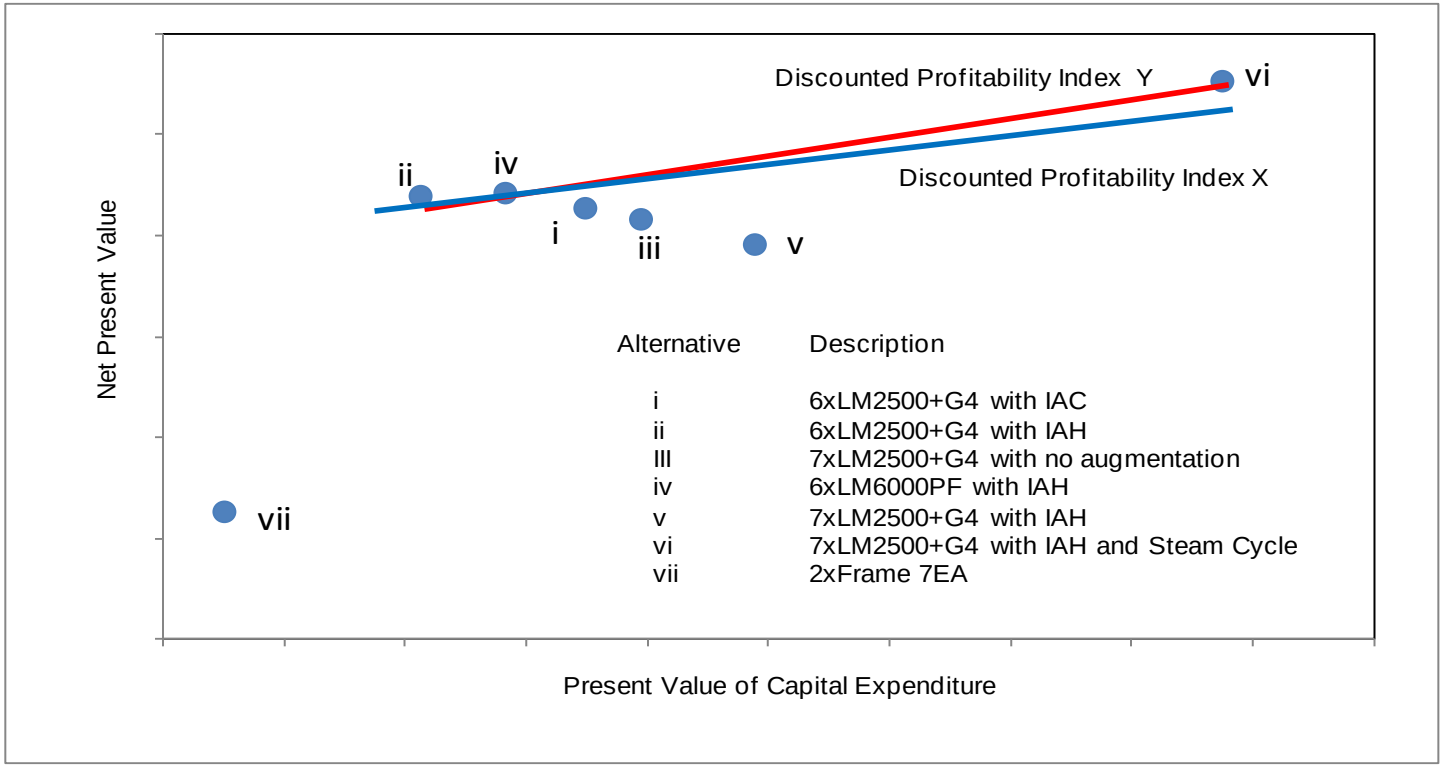
v. 7 x LM2500+G4 with IAH

vi. 7 x LM2500+G4 with IAH and HRSG and steam turbine power generation

vii. 2 x Frame 7EA and 2 x Frame 5D

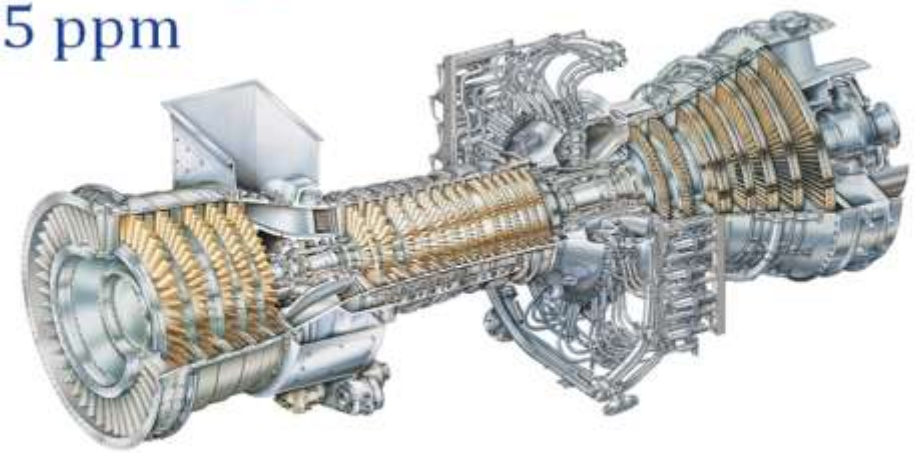
Selected driver – LM6000PF

- 6 x LM6000PF with IAH was the selected based on a combination of low TIC, attractive NPV and DPI
- Technical risk managed via a technology qualification plan



Technical qualification

LM6000-PF
15 ppm



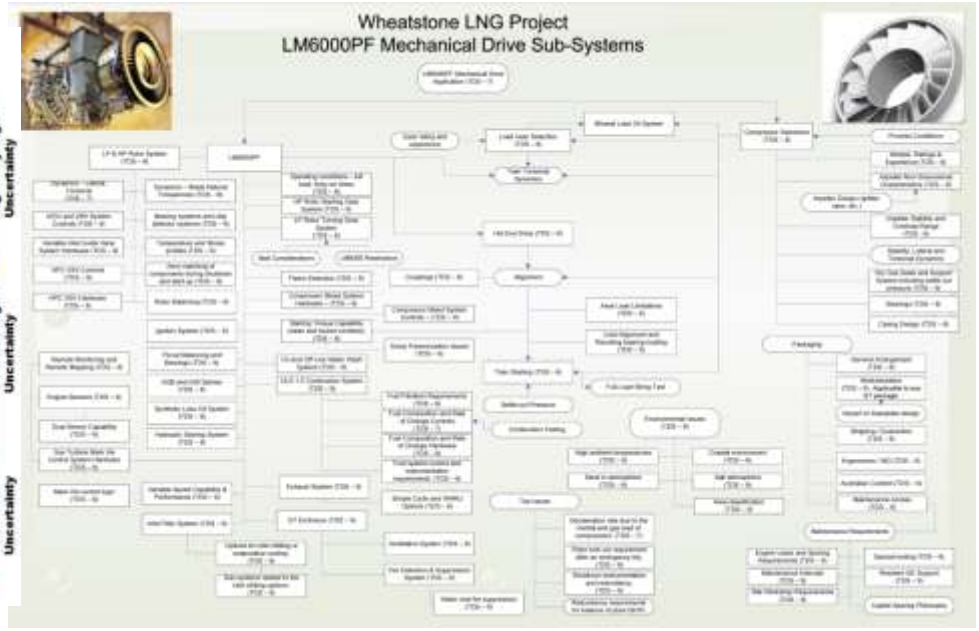
Chevron Technology Qualification Process

- Formal methodology and toolbox of resources
- Joint effort between Chevron, Bechtel, GE and CoP
- Identified systems/sub-systems for qualification
- LM6000 TQP completed in December 2009

TDS	Name	Description
1	Initiation	Basic principles observed and reported
2	Concept	Technology concept and/or application formulated
3	Proof of Concept	Analytical and experimental critical functions and/or characteristic proof of concept
4	Integration	Component and/or bench configured sub-system validation in laboratory environment
5	Demonstration	Component and/or bench configured sub-system validation in relevant "real world" environment
6	Prototype	System/sub-system model or prototype demonstration in a relevant environment
7	Pre-production	System prototype or system demonstration in the intended operating conditions and environment
8	Production	Actual system completed and qualified through test and demonstration in realistic operating environments
9	Field Proven	Actual system(s) proven through successful field operations

Strategic Research
Technology Development
Application

High-Very High Uncertainty
Med-Med High Uncertainty
Low - Med Uncertainty



Major TQP Activities/Findings

- Dynamic Simulations
  - Train shut-down and startup simulation by Bechtel
    - ✓ The compressor train takes over 20 seconds to decelerate to approximately 1800 rpm
  - LM6000PF engine simulation during train shut-down by GE using their engine simulator
    - ✓ Gas turbine can stop in less than 5 seconds without stall occurring within the axial turbine.
- Compressor selections for the base case design operating conditions
- Compressor capable of full pressure restart
- Train Torsional Analysis for the Methane compressor train

Conclusion

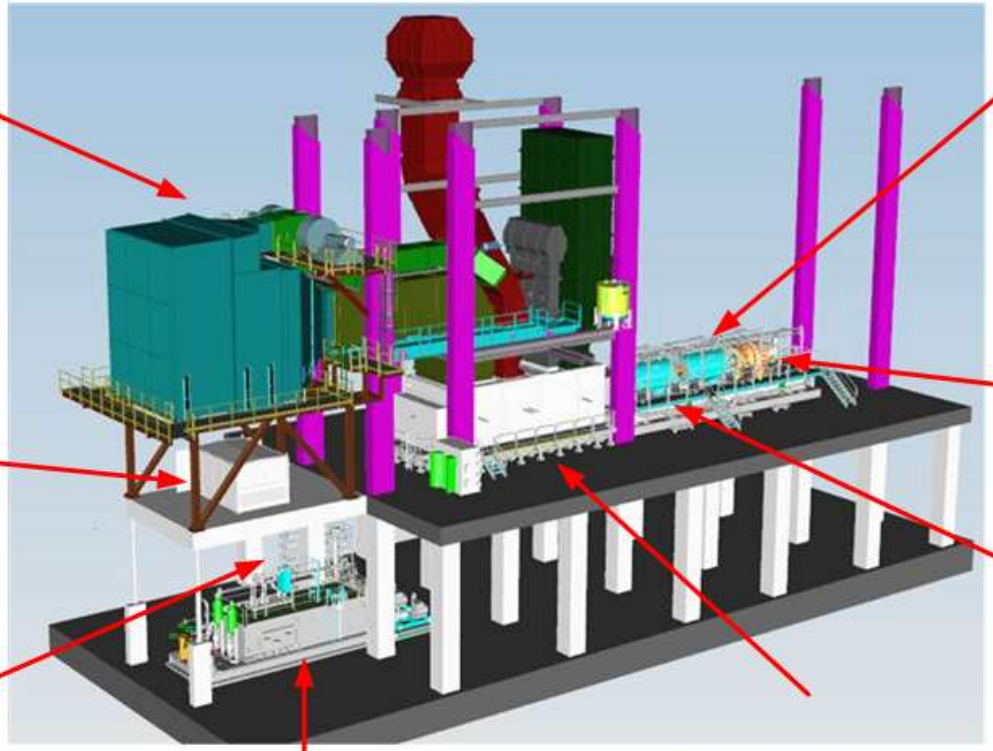
Technology Qualification Conclusions

- All major TQP risks and open action items have been addressed and closed
  - Design review
  - Modeling and Simulations
  - Quality control/inspections
  - Testing at Supplier Facilities
  - Field inspection and testing
  - Gas Turbine Performance Testing
  - Full load string testing

- LM6000PF – acceptable mechanical drive option for Wheatstone

Questions

Filter House Single Lifts



MP Compressor

Hydraulic Starting Skid

HP Compressor

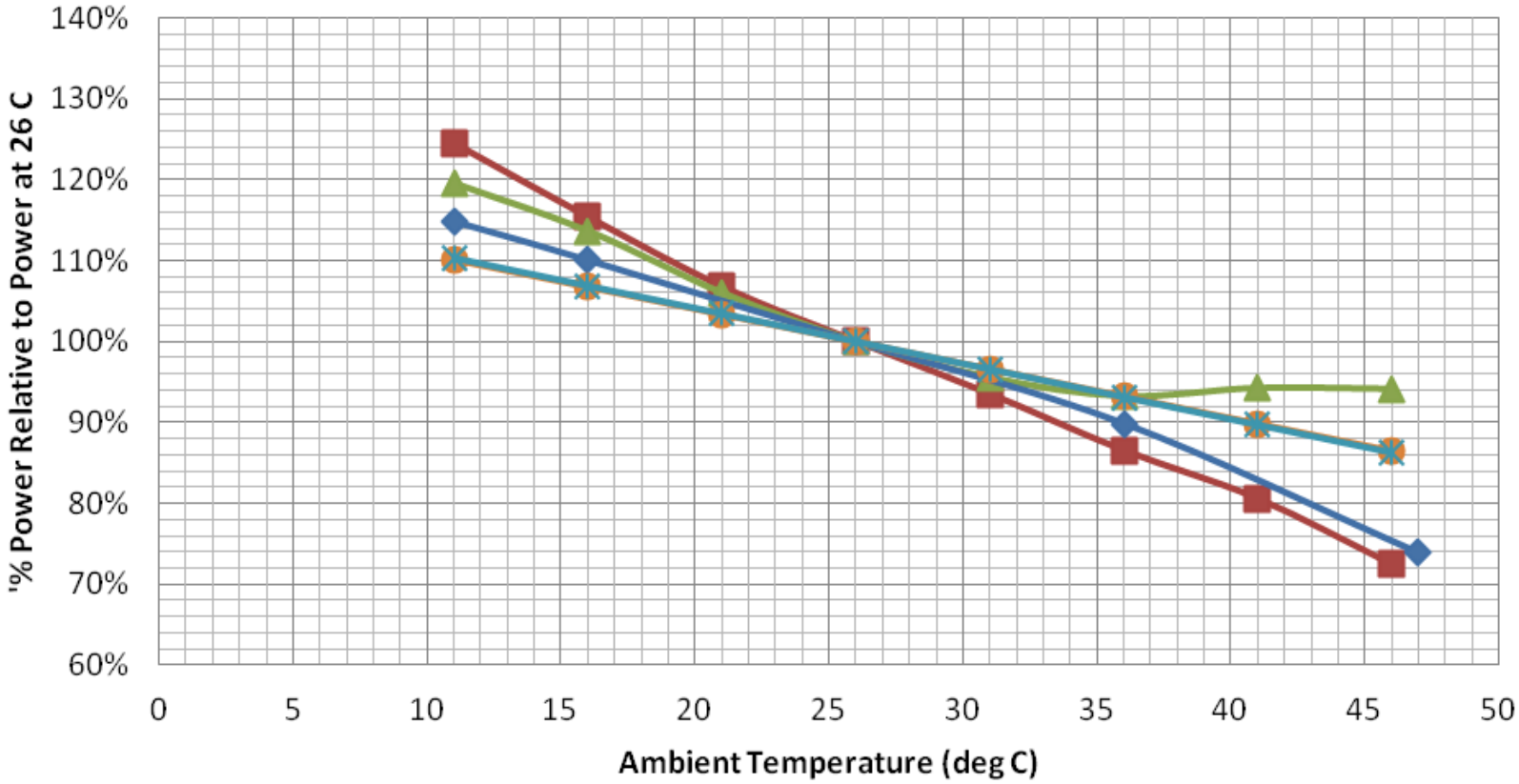
Fuel Gas Skid

LP Compressor

Lube Oil Skid

Turbine Enclosure

Ambient temperature impact on gas turbine performance



High ambient temperature operation options

- Overfiring of gas turbines
- High purity refrigerant propane
- Add sprint to propane LM6000 gas turbine
- Inlet mechanical chillers
- LiBr chiller package
- Helper motor for propane compressor gas turbine
- Compressor impellor technology with higher turndown capability