13-IAGT-203

20th SYMPOSIUM ON INDUSTRIAL APPLICATIONS OF GAS TURBINES

TM2500+ Power for Hydraulic Fracturing

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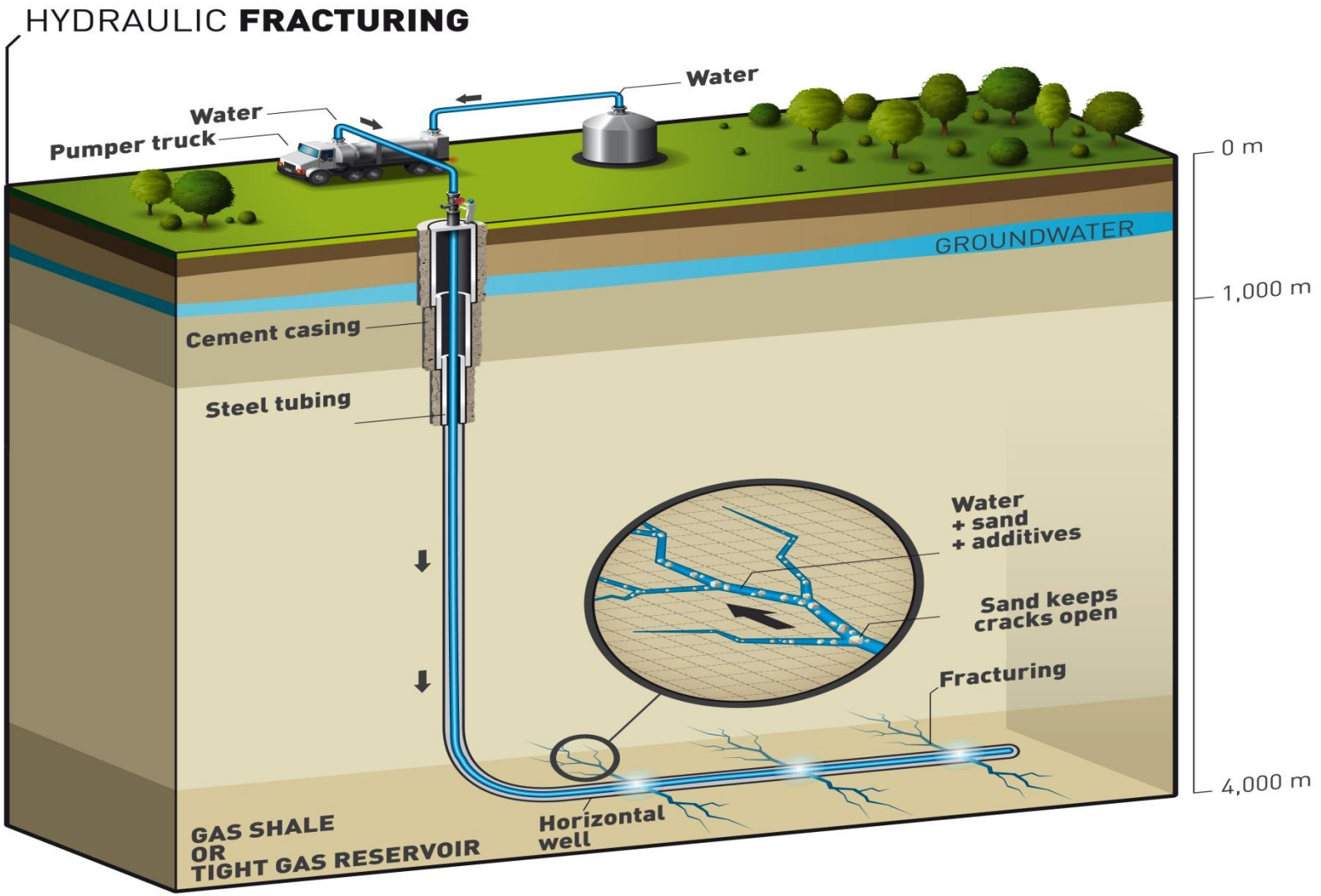
Fracking 101



http://en.skifergas.dk/technical-guide/what-is-hydraulic-fracturing.aspx

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Current Technology Hydraulic Fracturing Site

Michigan Department of Environmental Quality

Current Fracking Power Concerns

- "Hot fueling" safety
- Drill pad footprint, traffic
- Diesel CA$1.10/L – CNG CA$0.85 DLE*
- 60% max NG substitution rate
  - Pipeline quality NG/LNG
  - Less NG substituted if field gas
  - NG manifolds to multiple diesel trucks
  - Spark ignition recip's too heavy

*Diesel Liter Equivalent

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Current Technology Equipment

Evolutionary Well Services Equipment

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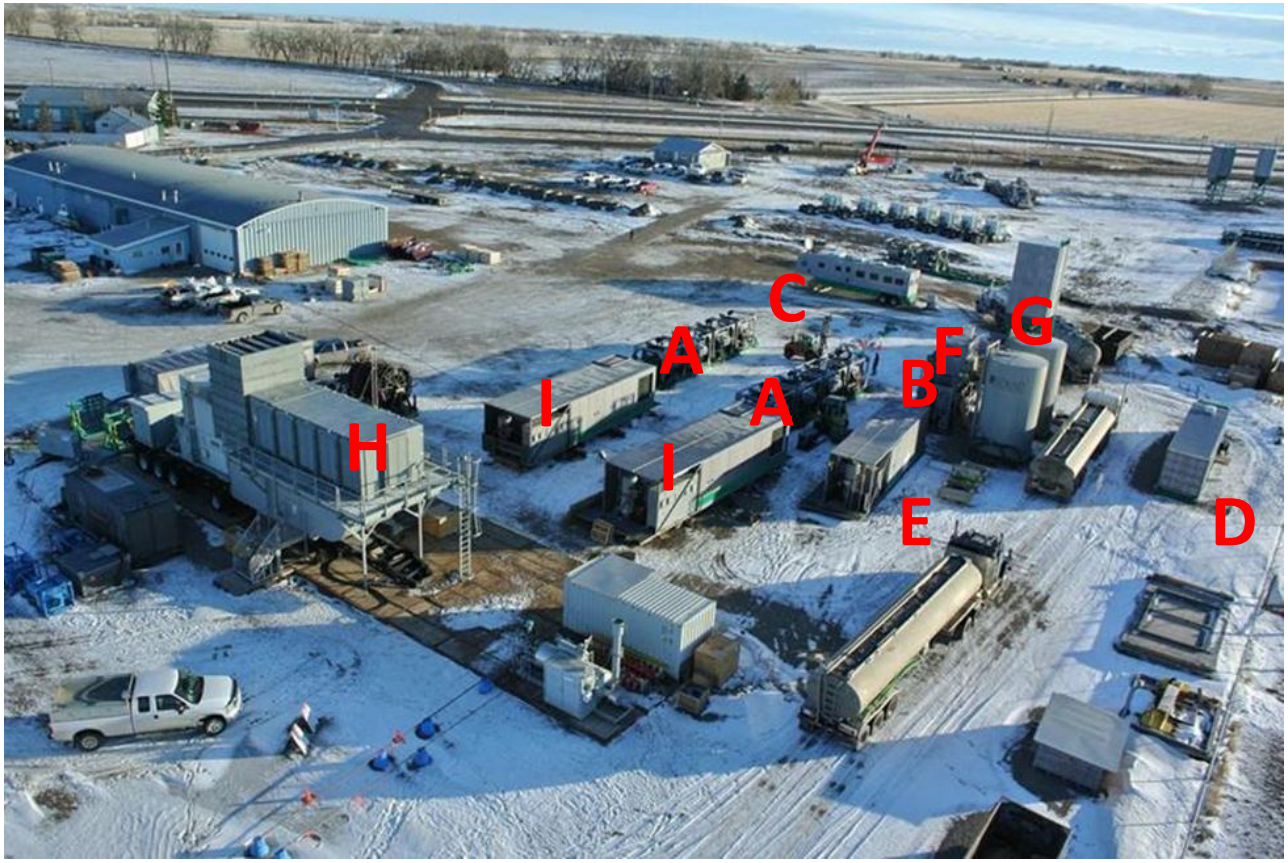
EWS Demonstration Hydraulic Fracturing Site



A) Frac Pump Modules
B) Blender
C) Mobile Data Van
D) Chem Addition Mod
E) Blender Mtr Contrl
F) Sand Conv Belt Mod
G) Sand Storage Mod
H) GE TM2500+ GTG
I) Pump Mtr Contrl

Lethbridge, Alberta

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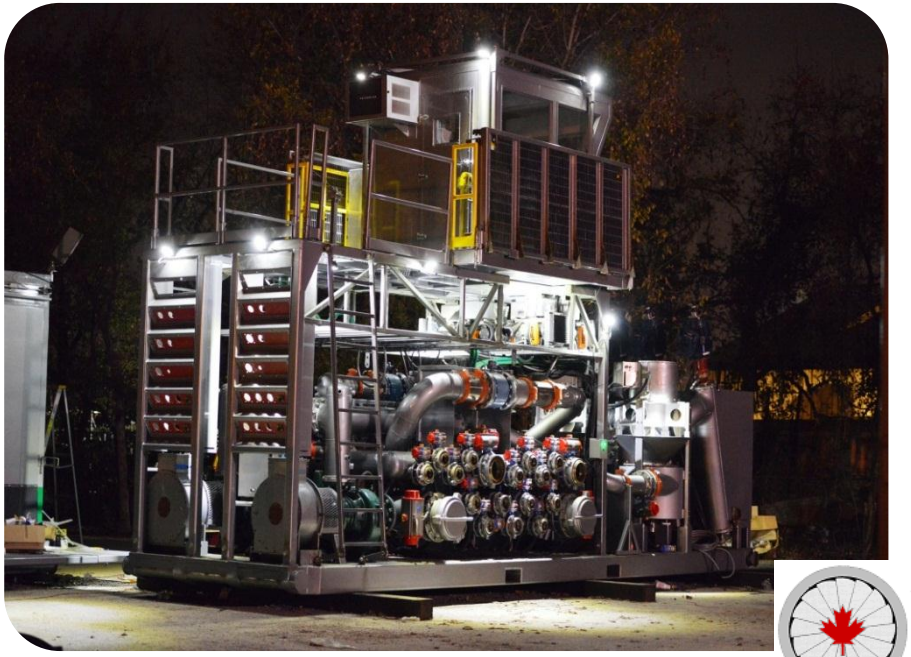
Material Handling

Mobile Modular Design

Electric Motor
Fracturing Pump
Blender



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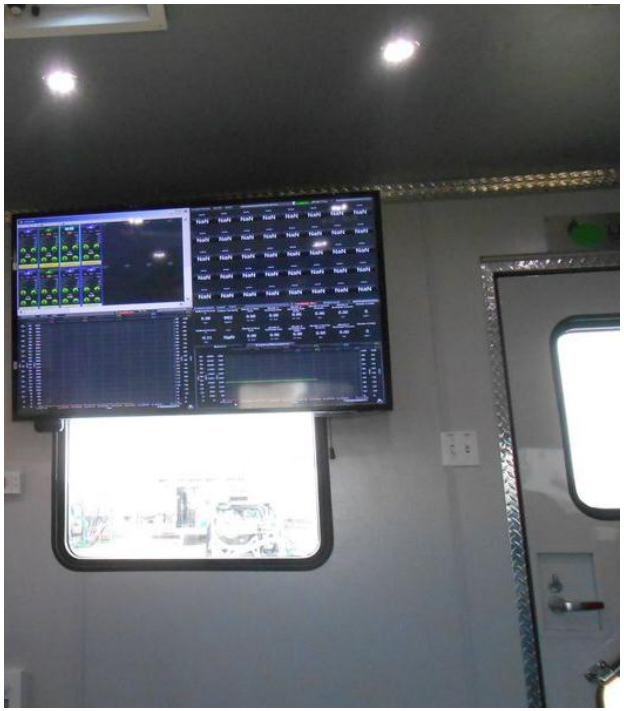
Control Building



Compressed Natural Gas (CNG) Fuel

Six hours endurance at 50% power for the first well

Natural gas from the first well then fuels subsequent wells

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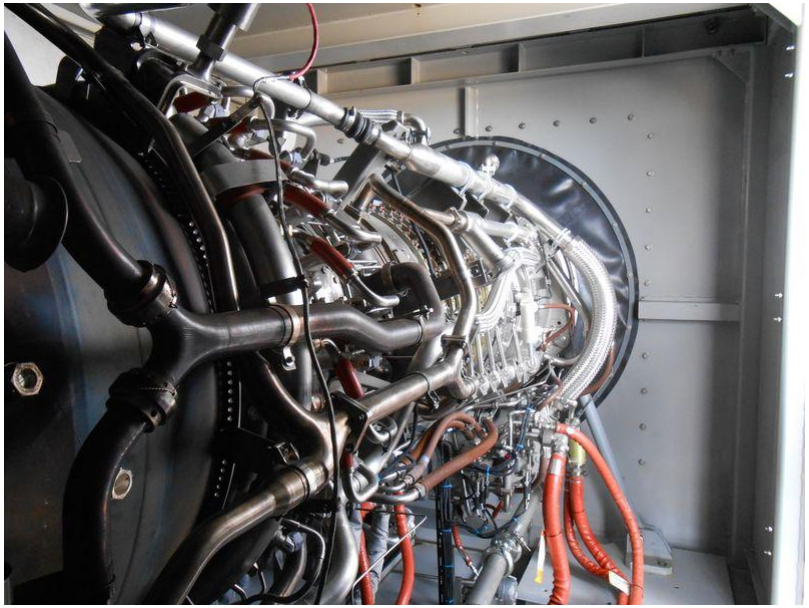
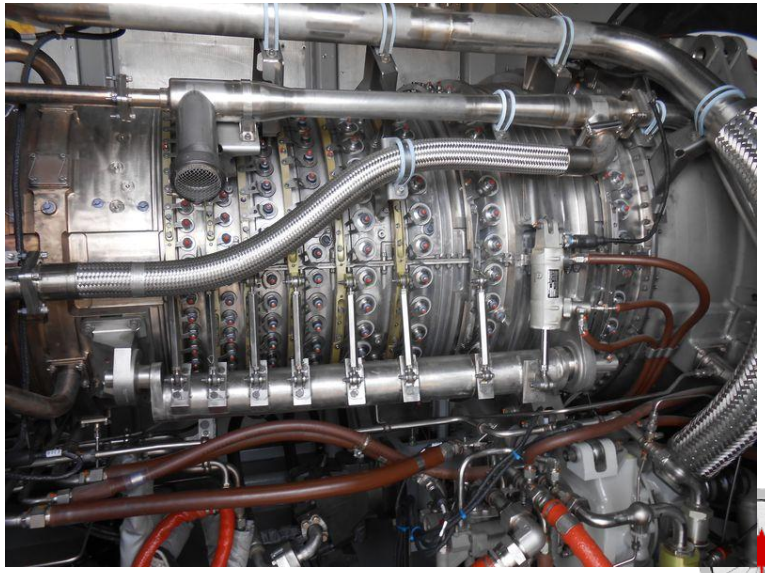
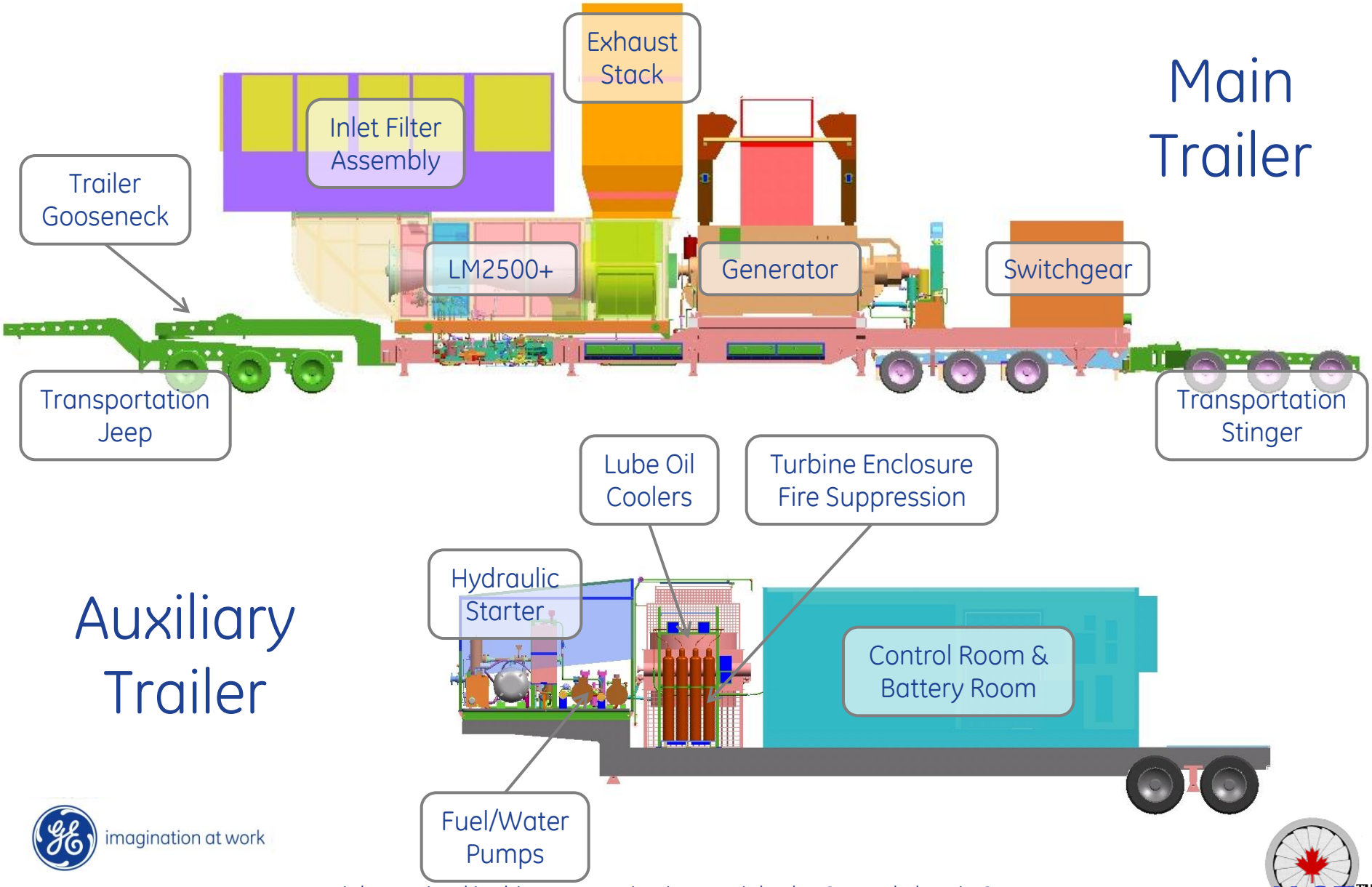
TM2500+ Gas Turbine





GE TM2500+ Design



Main Trailer

Auxiliary Trailer

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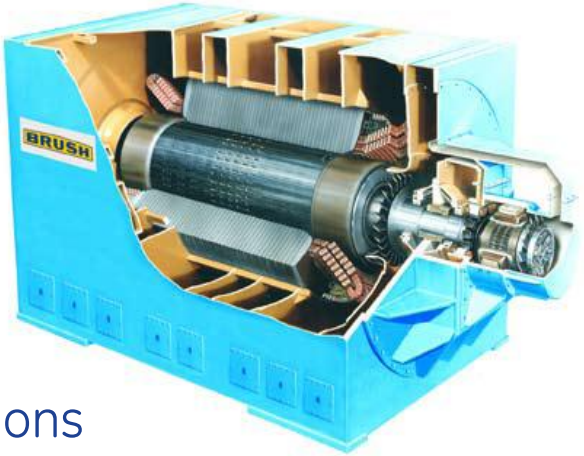
Primary Components

GE LM2500+ Gas Turbine

- Zero staged version of the LM2500
- 2000+ LM2500 turbines worldwide
- More than 67M operating hours

Brush Electrical Generator

- Air-cooled generator, brushless excitation
- Suitable for Class 1, Group D, Div. 2 areas
- 60Hz (13.8kV) and 50Hz (11.5kV) operation
- Rated at 32,550 kVA @ 0.90pf in ISO conditions



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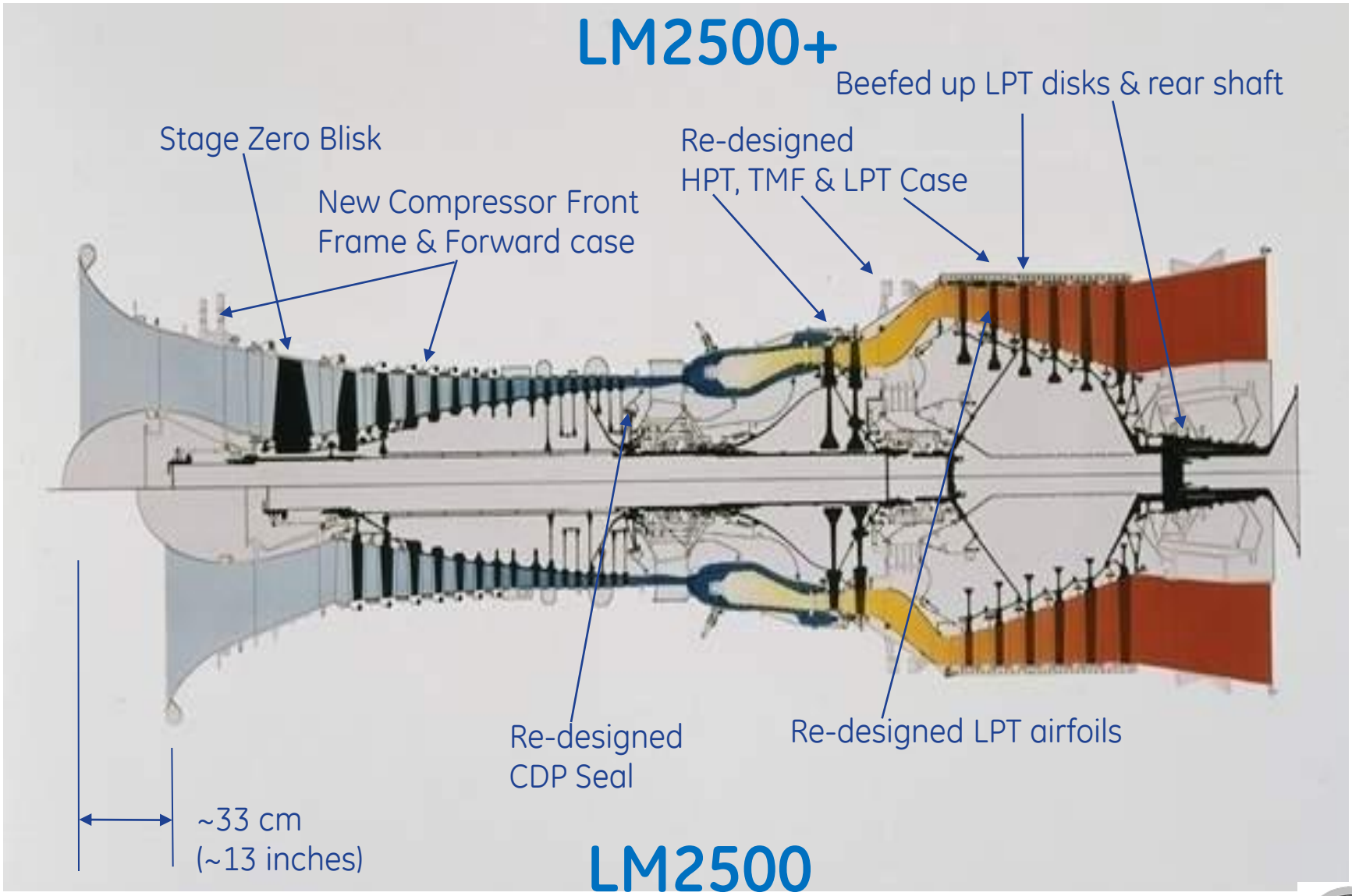
LM2500 vs. LM2500+ GT Centerlines



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TM2500+

- Up to 38% efficiency @ 100% load
- 10 min fast start
- Small Footprint 24m x 7m (78' x 21')

- Fleet availability
- Capable of SC application
- Offering turnkey solutions
- Blackstart capability

Attributes	TM2500+
Power Output ISO (MW)[1]	31
SC Efficiency (%) [1]	36.0
Nox Emissions (ppm)[1]	25
Emissions Control	Water
Footprint	24m x 7m
Noise Level	87 db
Fuel	Dual
Weight (kg)	90k

References:
1) All Power, heat rate, and efficiency @ ISO conditions with water injection at 60 Hz, natural gas fuel

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Customer Interface Requirements*

Fuel

- Gas supply pressure is 36 bar (+/- 1) (520 (+/- 20) PSIG) at a rate of 337 GJ/hr (320 MMbtu/hr)
- Liquid Fuel (diesel) supply pressure is 2 bar (+/-0.6), (30 (+/- 10) PSIG), up to 150 LPM (40 GPM) (max)

Water (for NOx suppression)

- Minimum supply pressure is 1 bar (15 PSIG) up to 106L (28 GPM) (max)

Foundation

- Site levelness less than 2m per 30m
- Adequate access/space for maneuvering the trailers

*These requirements represent general needs of a standard TM2500+ installation. Actual requirements could vary based on site location, site conditions, local ambient conditions, unit configuration, and many other factors.

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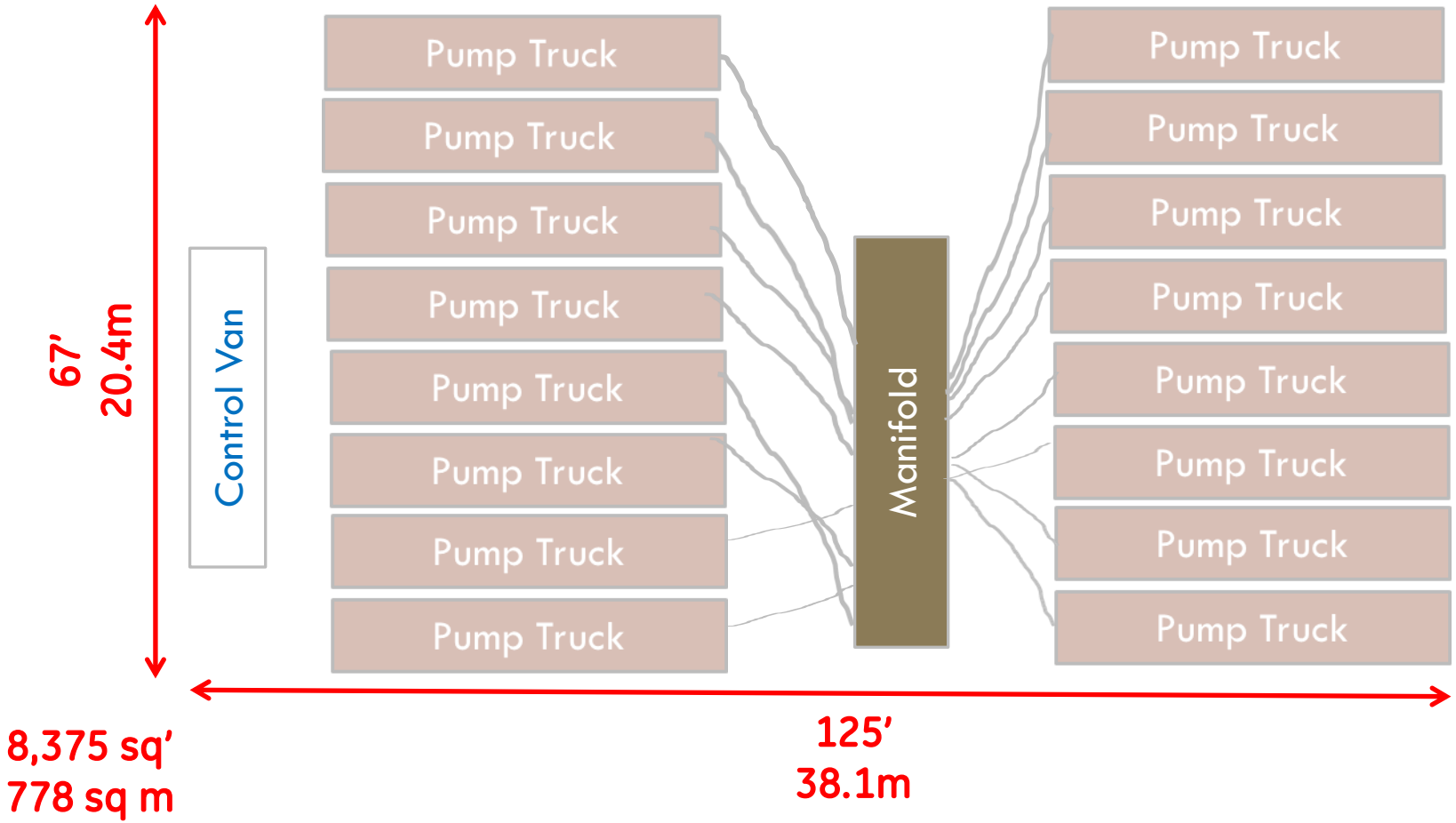
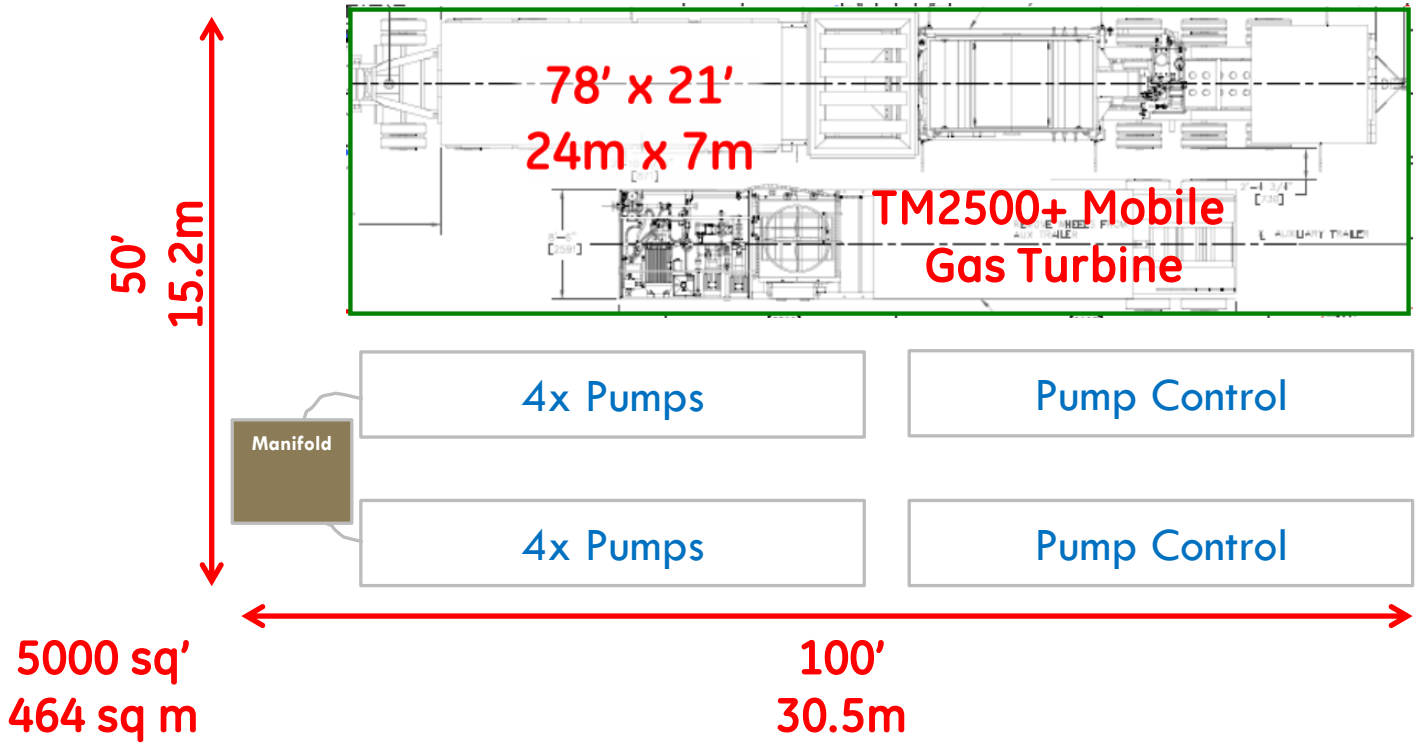
Small details make a big difference!



Conventional arrangement for a 15 MW site



40% less area required for power train and pumps using the EWS/GE System

System Comparison

	Diesel Truck Pumps	EWS Gas Turbine System
Prime Movers (15 MW)	16 Diesel Trucks	1 TM2500+
Pump Units	16	8
Fuel	Diesel	#2 Diesel/NG/CNG/LNG
Power Efficiency	38.9%	36.8% (incl -1% elec mtr)
Noise (max pwr)	105 dB*	90 dB
Nox Emissions	52.5 Kg/hr Diesel (dry)**	70.4 Kg/hr #2 Diesel (dry) 43.3 Kg/hr NG (dry) 13.0 Kg/hr #2 Diesel*** 7.6 Kg/hr NG***
Personnel	1 Controller 16 Pump Operators	2 Controllers 1 Gas Turbine Operator
Power/Pump Footprint	778 sq m (8,375 sq ft)	464 sq m (5000 sq ft)
People Infrastructure	5x	1x

* Engine surface noise with attenuated intake noise (filter) - BL (free-field sound pressure level Lp, 1m distance, ISO 6798)
** Tier 4 limits attained, with SCR exhaust treatment
*** 42 ppm #2 Diesel, 25 ppm Natural Gas, both with water injection

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Questions

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