

# Kalmar & LPG Power for Terminal Equipment

December 2004  
Don Lawrence

# Kalmar's mission statement

Kalmar's overriding mission is to provide solutions to make container and materials handling faster and more efficient. This commitment has driven Kalmar to become the leading global supplier of heavy-duty material handling equipment and services in the container, trailer and heavy industrial sectors.

To meet new and challenging market requirements, Kalmar will decisively expand its range of value-added services to further develop its position as being more than just a supplier of machines.

Being supported by the best global network in the industry is a basic prerequisite for a successful expansion into the service market for Kalmar.

By remaining at the forefront of both product technology and value adding services, Kalmar will sustain its position as the leading global solutions provider.

# Why we are here today...

- We must find new and innovative ways to reduce the environmental impact of terminal equipment.
- This can be facilitated through the application and improvement of existing products as well as through research and development of new technologies.
- All solutions must be evaluated and acceptable to Personnel and Terminal Operators.
- Solutions must be economically viable to engineer, build and support and should take into account foreseeable economics wherever possible. Resource depth, Blending or formulating, and handling, transportation, and dispensing issues.
- As Kalmar is committed to the preservation of our environment and it's resources, solutions should always be evaluated by their overall impact upon our planet.

# Possible solutions

- Replace fleets with more modern equipment in compliance with Federal Tier Two emissions level requirements
- Replace fleets with more modern and lower emissions equipment powered by On Highway, Current Year Model engines.
- Replace engines in existing equipment/trucks with tier two engines
- Replace engines in existing equipment/ trucks with On Highway, Current year model engines.
- **Replace fleets with alternative fuel powered equipment**
- Utilize after treatment systems for emissions reductions
- Invest in developing new systems or technologies, such as Hybrid or Electric, to replace and or reduce existing equipment.
- Some combination of the above

# Today's discussion:

## LPG: A power choice for today?



# Factors Favoring LNG/CNG Engines:

- LPG (propane) is  $C_3H_8$  with other compounds such as Isobutane and Butane.
- Readily, commercially available.
- Engine systems are already developed which utilize these fuels. (Cummins only offers us the B LPG Plus at this time).
- Proven technology with trained technical base.
- Many types of equipment are already engineered for these fuels.
- Fuel consumption in gallons per hour is about 2.5-3.8gallons per hour.(Cummins B LPG + 195HP/420lb/ft T)
- Based upon a 93 gallon usable tanks size this would limit to about 20-24 Hours on LPG vs about 24-30 on 50 gallons of Diesel.
- Others?

# Factors which may discourage:

- **Cost of Equipment option and emissions.**
- Cost of fuel and lack of performance with available engines
- Intervals between fueling stops.
- Will still require the use of after treatment systems
- May not be easily or cost effectively applied to existing equipment ; requires replacement at this time
- Costs for maintenance may be higher due to additional complexity, Engine life is largely undetermined, less common parts etc.
- **Difficulties arising from the need to locate larger tank or tanks on the vehicle which may affect the vehicle's size or maneuverability as well as cost and reliability.**
- Others?

# Cummins Engine Emissions per engine



	2004 EPA Std	2004 CARB	2004 CARB Optional Low NOx	Euro III Std
PM (g/bhp-hr)	0.10	0.10	0.03	0.075
NOx+NMHC (g/bhp-hr)	2.5	2.5	1.8	3.73
<u>L Gas Plus</u>	✓	✓	✓	✓
<u>C Gas Plus</u>	✓	✓	✓	✓
<u>B Gas Plus</u>	✓	✓	✓	✓
<u>B LPG Plus</u>	✓	✓	✗	✗
<u>B Gas International</u>	✗	✗	✗	✓

(with catalyst)

## Key:

**g/bhp-hr** = grams per brake-horsepower-hour

**PM** = Particulate Matter

**NOx** = Nitrogen Oxides

**NMHC** = Non-Methane Hydrocarbons



# Re-power Opportunities?

- Very likely not cost effective. Maybe on very new units where the net emission reduction would be minimal and therefore less desirable.
- Manufacturers providing a “kit” would be most desirable but the “short run” of such kits would make them expensive. Difficult to recoup the engineering costs etc.
- The more expensive the equipment the better the re-power might be; RTG’s, very large equipment etc.

# Lets talk about cost...

The cost of the LPG option on an Ottawa or Kalmar terminal tractor Includes:

Cummins ISB LPG Plus EPA with 195HP & 420Lb /ft of torque. Tanks (93 gallon net), Vaporizer system, safety valves, All required plumbing etc. and tank guard, Installation, CAC, Catalytic converter, Full Ottawa Kalmar and Cummins warranty. Full documentation and manuals.

# Makes good sense in terminal tractors?

- Kalmar Ottawa have produced the latest versions. Proven design
- Emissions controls are backed by Engine manufacturer's infrastructure. ( As opposed to after treatment systems companies)
- Low cost of fuel station, availability of fuel sources and fueling stations as well as support has helped convince some to go to propane.

# Fuel Station Cost?

- Negligible.
- LPG's single greatest asset is it's availability and it's acceptance as an old line alternative motor fuel.

# How About Fuel?

- Diesel equivalent costs vary widely.
- Some estimates around \$1.10 per gallon which puts it at roughly equivalent pricing to diesel.
- These costs and the fuel station costs should be obtained from the vendor such as Sound Energy Solutions or others.

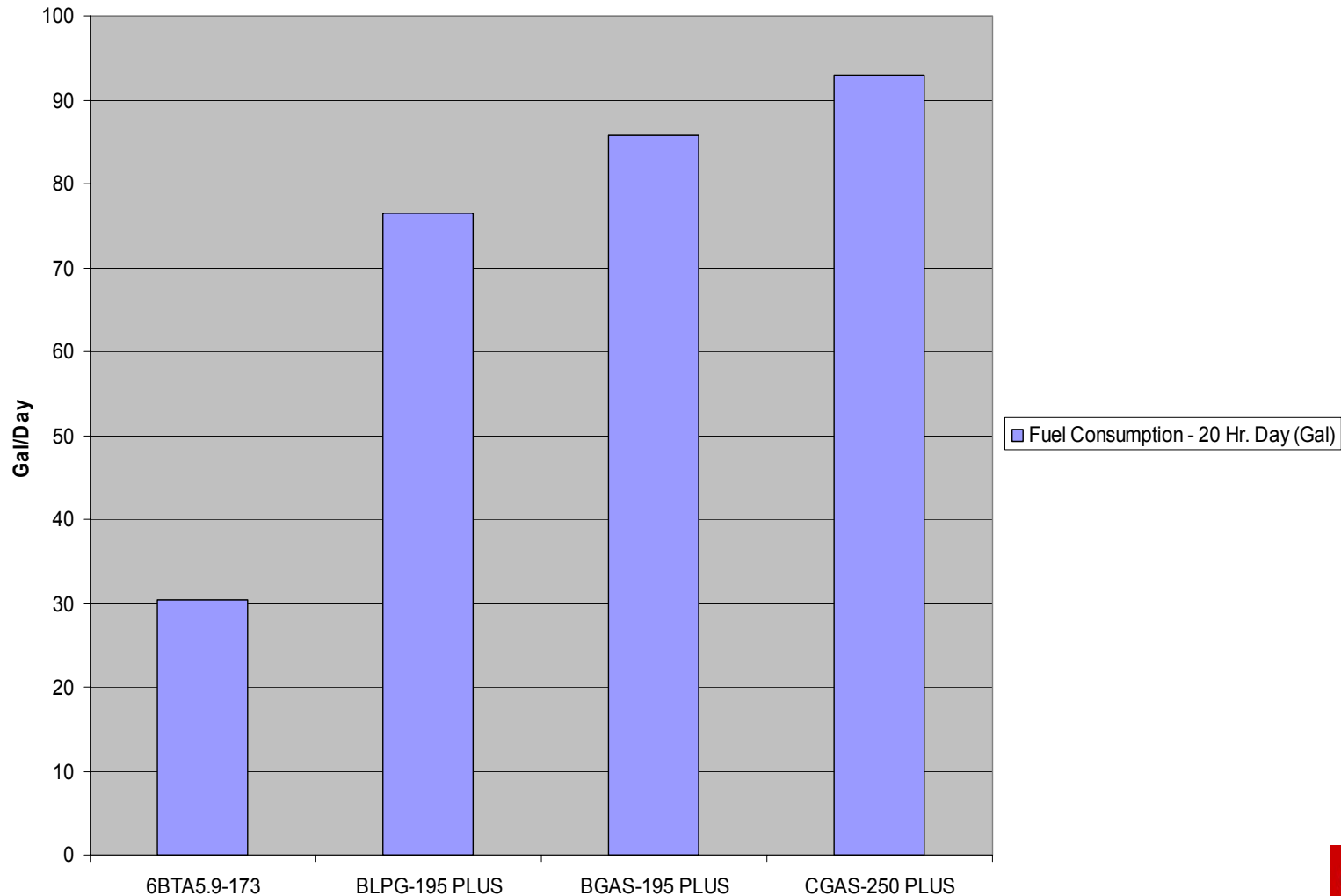
# General Specifications

## Engine Comparison

	<u>6BTA5.9-173</u>	<u>BLPG-195 PLUS</u>	<u>BGAS-195 PLUS</u>	<u>CGAS-250 PLUS</u>
Fuel Type	Diesel	Propane Gas	LNG	LNG
FR Rating			91134	
Horsepower	174@2200	195 @ 2600	195 @ 2800	250 @ 2400
Peak Torque	590@1500	420 @ 1600	420 @ 1600	750 @ 1400
Governed RPM	2400	2800	2800	2400
Transmission	MD3060P	MD3060P	MD3060P	MD3060P
Rear Axle Ratio	12.28:1	12.28:1	12.28:1	12.28:1
GCW (lbs) for SCAAN	125000	125000	125000	125000
Gradability	18.6	16.4	16.4	19.8
Maximum Reverse Speed @ rated RPM	3.8	5	5	4
Maximum Forward Speed @ rated RPM	21.46	27.3	27.3	23.41
Acceleration to max speed @ rated rpm (sec)	40.55	81.47	73.32	33.33
Engine Coolant Heat Rejection - BTU/min.	4607	6183	5886	5907
CAC Req'd	NO	YES	YES	YES
Exhaust catalyst	N/A	Required	Required	Required

# Engine Alternative Fuel Comparisons

## Fuel Consumption - 20 Hr. Day (Gal)



# Diesels Face More Stringent Standards in the future

- Tier three Off Highway begins in 2006 for 174hp and up to 301hp.
- Tier three MOH begins in 2007 for 100hp up to 173 hp
- 2007- On Highway standards become more stringent



# Thank You