



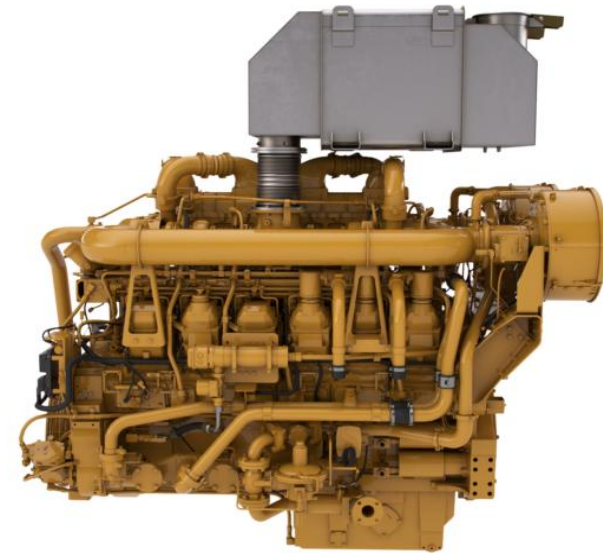
Caterpillar Oil & Gas

BUILT FOR IT.

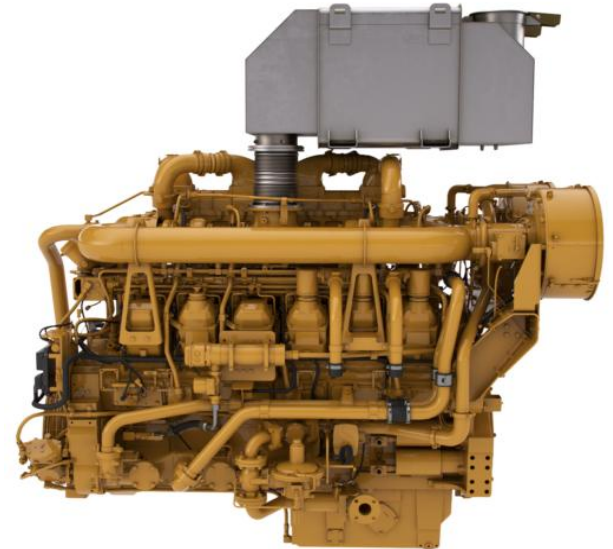
Dynamic Gas Blending For Well Service
Sales Toolkit



- DGB Overview
- Applications
- Kit Consist
- Gas Quality Requirements
- Features and Benefits
- Emissions Information /Certifications
- Ordering Flowchart
- Maintenance
- Competitive Comparison
- Marketing Material



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Value Message

Safely burn more gas more often with proven controls and product support from CAT

Critical Customer Requirement	Key Features of DGB Kit
Maximum Substitution	Unique Dual fuel timing map developed for maximum consistent substitution to 70% across wide speed and load range
Wide fuel Flexibility	850-1250BTU Capable while meeting Tier 2 Emissions Engine can run up to 2300BTU gas (non emissions compliance)
Engine Reliability, Durability	Components and controls designed to meet TBO and protect engine
Safety	CSA Compliant Gas train Components Safety features integrated in Controls Flame arrestors included as part of kit
Emissions Compliant solution	Diesel Oxidation Catalyst and muffler combined designed to meet US EPA Tier 2 Emissions
Warranty and Product Support	CAT Brand, WW Product support via Dealer Network, Parts Warranty

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Why Dynamic Gas Blending?

- High discrepancy between natural gas and diesel fuel prices
- Abundance of field gas in various shale plays worldwide
- Expanding infrastructure for gas delivery
- Lower operating Costs by burning inexpensive Natural Gas
- Maintain regulated emissions compliance

Gas Terminology

- Cat[®] Methane Number
 - A measure of a gaseous fuel's resistance to uncontrolled combustion ("detonation")
- Methane Content
 - Relative % of methane gas in a sample
- GERP is a program designed to provide site ratings, performance data, drawings, and pump curves for the gas compression industry.
- Gas fuel sample can be used to determine
 - Heating value
 - Methane number
 - Fuel contaminants
- Lower Heating Value
 - Gas engines can only produce power from LHV

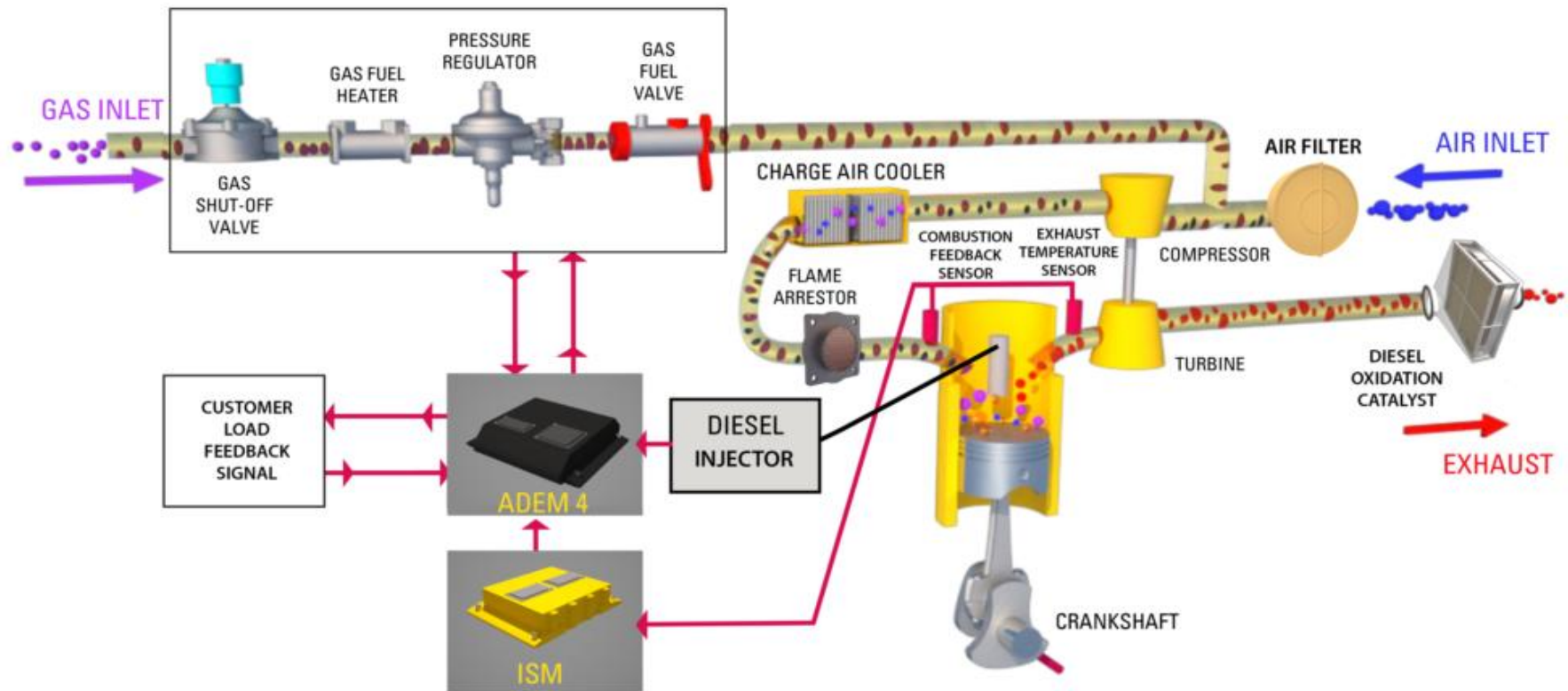
Constituent	Abbrev	Mole
Water Vapor	H2O	0.0000
Methane	CH4	88.0688
Ethane	C2H6	7.3050
Propane	C3H8	2.0032
Isobutane	iso-C4H10	0.4596
Norbutane	nor-C4H10	0.4677
Isopentane	iso-C5H12	0.1781
Norpentane	nor-C5H12	0.1344
Hexane	C6H14	0.1163
Heptane	C7H16	0.0681
Hydrogen Sulfide	H2S	0.0000
Nitrogen	N2	0.0501
Carbon Dioxide	CO2	1.1087
Carbon Monoxide	CO	0.0000
Hydrogen	H2	0.0000
Oxygen	O2	0.0000
Helium	HE	0.0000
Neopentane	neo-C5H12	0.0000
Octane	C8H18	0.0000
Nonane	C9H20	0.0000
Ethylene	C2H4	0.0000
Propylene	C3H6	0.0000
		Total: 100.0000

Calculated Fuel Properties		
Caterpillar Methane Number:		
		65.2
Lower Heating Value	(Btu/scf):	1017
Higher Heating Value	(Btu/scf):	1124
WOBBE Index	(Btu/scf):	1267
THC: Free Inert Ratio:		82.42
Total % Inerts (% N2, CO2, He):		1.1988%
RPC (%)	(To 905 Btu/scf Fuel):	100%
Compressibility Factor:		0.997
Stoich A/F Ratio (Vol/Vol):		10.58
Stoich A/F Ratio (Mass/Mass):		16.43
Specific Gravity (Relative to Air):		0.644
Specific Heat Constant (K):		1.298

Dynamic Gas Blending (DGB) Terminology

- **Natural Gas** is a general term used to describe hydrocarbon fuels that exist naturally in a gaseous state.
- **Pipeline Gas** is natural gas which is processed to a specification – generally >95% methane gas – equates to Cat Methane Number of >85
- **LNG/CNG** is liquefied/compressed (respectively) natural gas which is process to a specification – generally >95% methane gas – equates to Cat Methane Number of >85
- **Field Gas/Well Head Gas** refers to gas in its unprocessed, variable composition – % methane and Cat Methane Number vary. The gas is typically accompanied by liquids and particles which must be removed before supplied to an engine.
- **Associated Gas** is a byproduct of the production of oil and varies greatly in constituents and hydrocarbon composition – % methane and Cat Methane Number vary and fluctuate. The gas is removed from the oil and typically requires significant treatment to remove harmful components before being suitable for an engine.

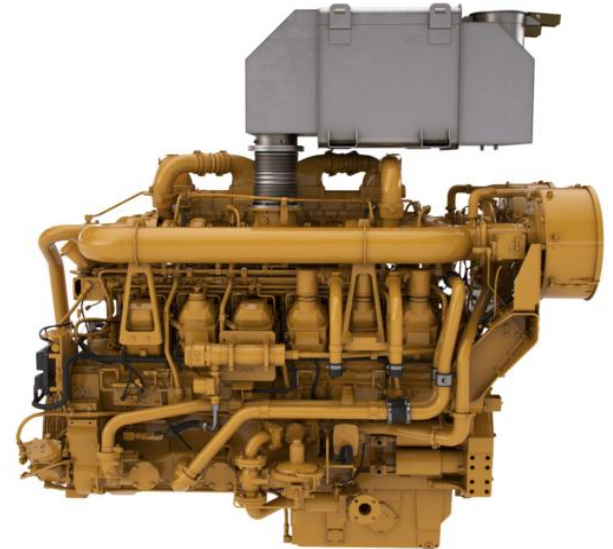
CAT DGB Overview



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- DGB Overview
- **Applications**
- Kit Consist
- Gas Quality Requirements
- Features and Benefits
- Emissions Information /Certifications
- Ordering Flowchart
- Maintenance
- Competitive Comparison
- Marketing Material



Dynamic Gas Blending Applications

Quercus Oil & Gas

Land Well Service Engine						
Engine Model - Aftercooler	Rated Power bhp (bkW)	Peak Torque (lb-ft)	Torque Rise (%)	Peak Torque Speed	Rated Speed	Operating Range
3512C HD -ATAAC	2250 (1678)	6,319	1.60%	1400	1900	600-1900
3512C HD -ATAAC	2250 (1678)	6,656	7%	1400	1900	600-1900
3512C HD -ATAAC	2500 (1865)	7,396	7%	1400	1900	600-1900
3512C HD - SCAC	2250 (1678)	6321	1.60%	1400	1900	700-1900
3512C HD - SCAC	2250 (1678)	6656	7%	1400	1900	700-1900
3512C HD - SCAC	2500 (1865)	7394	7%	1400	1900	700-1900

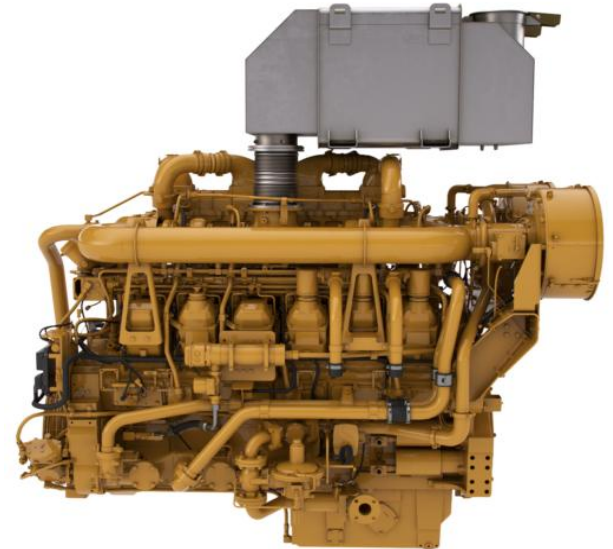
■ Key Product Features

- ATAAC and SCAC Cooling System
- Retrofit offering only
- 3512C HD Engines ONLY
- Maintain same performance as the diesel well Well Stimulation engine
- No impact to current cooling system design, maintain lug curve and lug up capability
- Emissions: US EPA Non-road Tier 2
- Integrate with Cat TH55, CX48 and TH48 transmission

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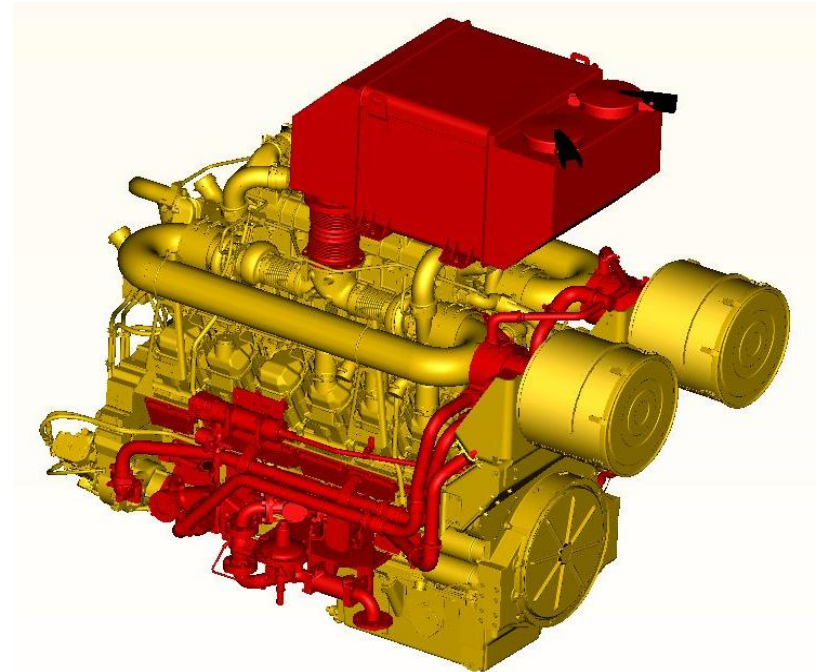
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Dynamic Gas Blending Kit Consist

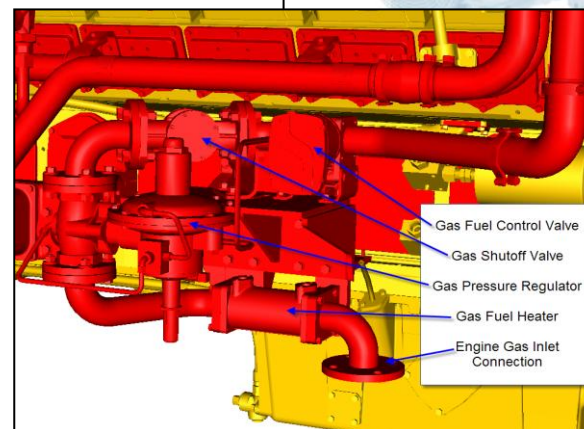
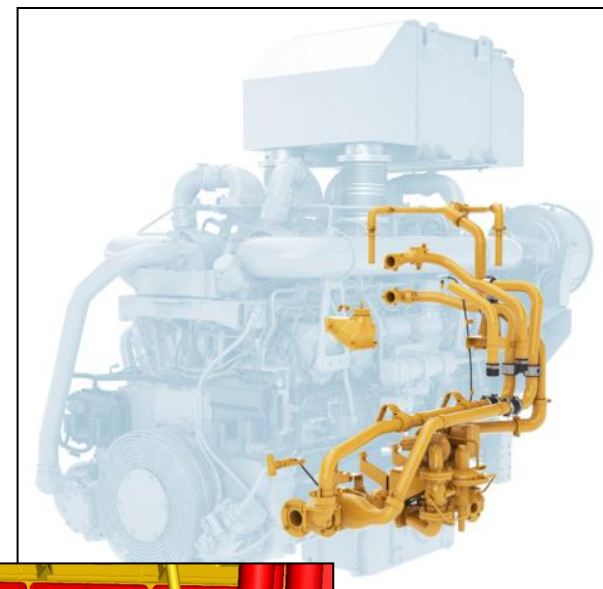
DGB Kit Includes:

1. Gas Train System
2. Engine Electronics Components
3. Redesigned Air Inlet Pipe
4. Diesel Oxidation Catalyst



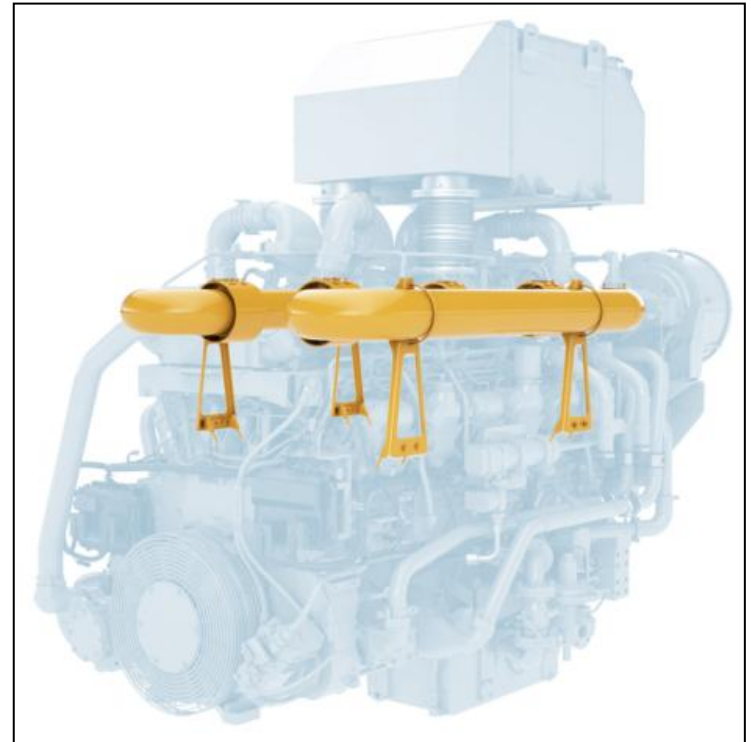
Engine Gas Delivery System

- Gas Supply Connection Point on right side of the engine
- Pressure and flow control components grouped and mounted to the engine as a single assembly
- Gas line routing designed to minimize interference
- Gas Fuel Delivery System Components:
 - **Low Pressure Regulator**
 - Fuel Control Valve
 - **Gas Shut Off Valve**
 - JW Fuel heater
 - **Customer connection**
- **100psi Inlet pressure capable System**
- **All Flanged connection (no Pipe thread)**



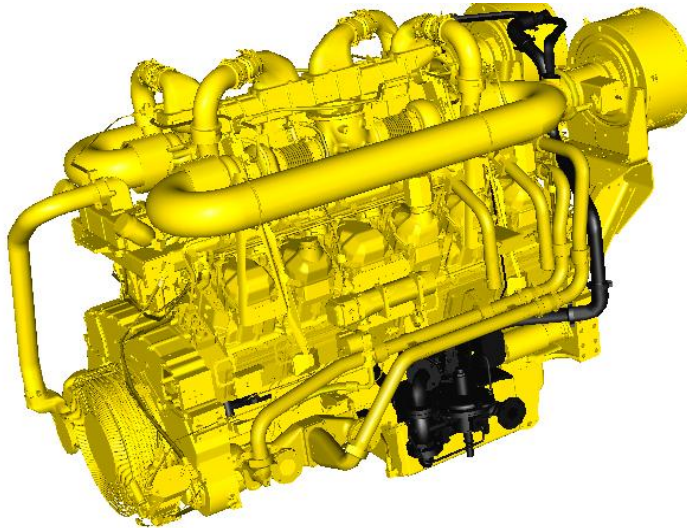
Gas Supply Connection to Air System

- To ensure proper gas / intake air mixture and balanced gas supply bank to bank, specific placement and design of the mixing tubes has been completed
- A 58 mm longer air tube is needed to provide a surface for the correct mounting location
- This requires new air inlet tubes (candy canes)



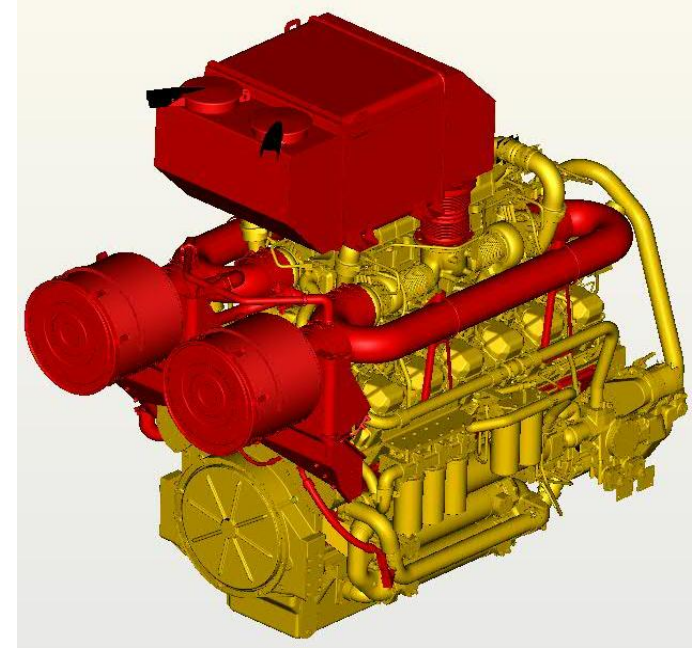
Gas Supply Air System

- For engines equipped with Air Shut Off Valves (ASOV) the increased length of the air lines moves the valves and air cleaners back.
- This requires new Air Filter Brackets



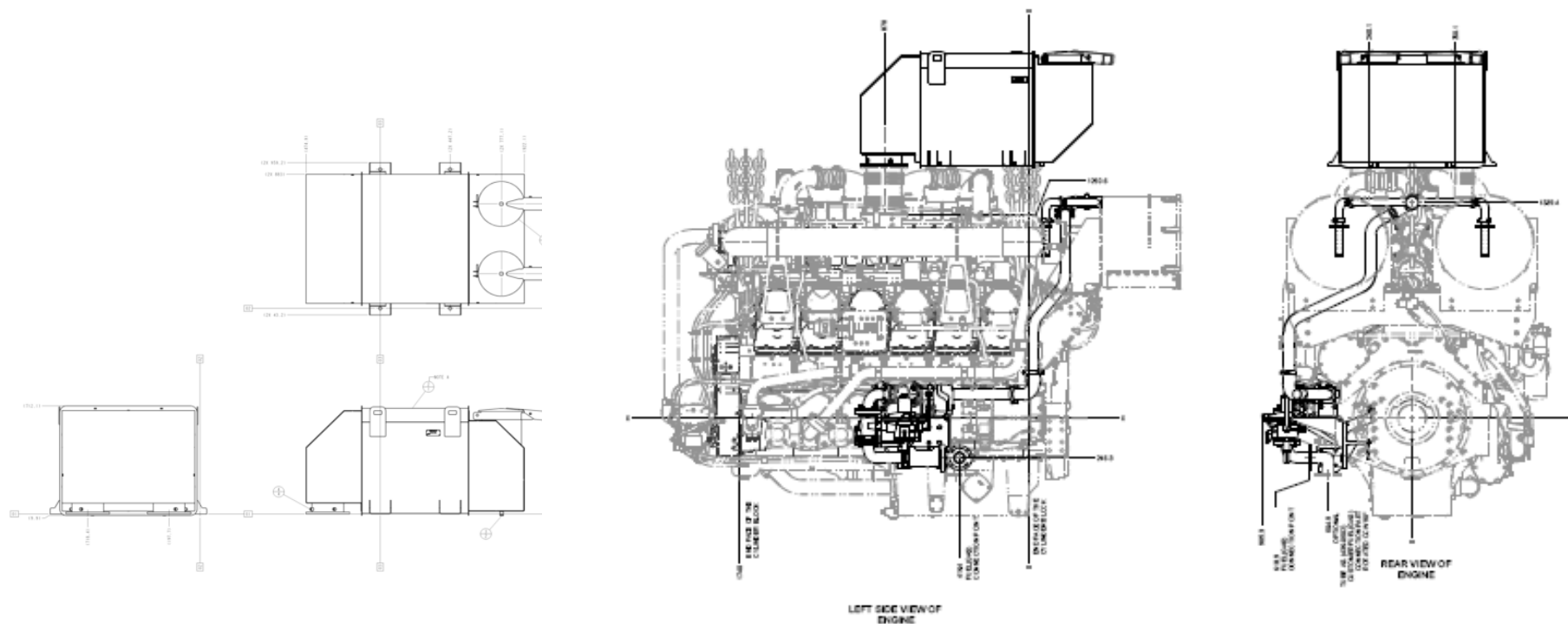
Aftertreatment

- DOC (Diesel Oxidation Catalyst) and Muffler
 - DOC + Muffler will be available for all US retrofit kits
 - Designed to match the overall space claim of the muffler but will require mounting redesign to handle new design
 - Additional muffler will not be required
- DOC Weight= 490lbs
- Sound attenuation capability: 13-15dba
- DOC must be wrapped to meet installation requirements



DOC Dimensions (USA ONLY)

Weight of DOC: 490 lbs

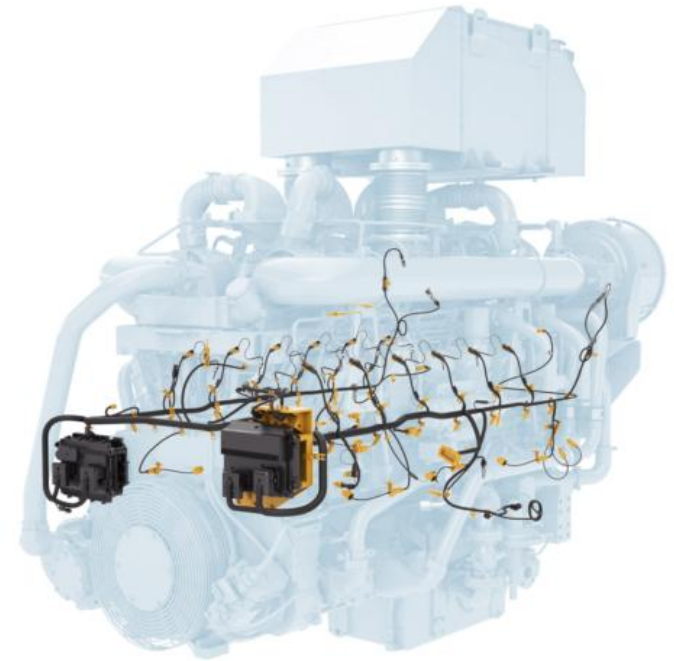


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Engine Electronic Components

- A4 Engine ECM and mounting Group
- New Engine harness
- ISM (Integrated Sensor Module)
 - Exhaust Gas Temp Sensors
 - Detonation Detection Sensors



Key to maintaining reliability and durability while maximizing substitution on lower quality gas

Electronic Updates

Caterpillar Oil & Gas



Engine Control (A4:E4)

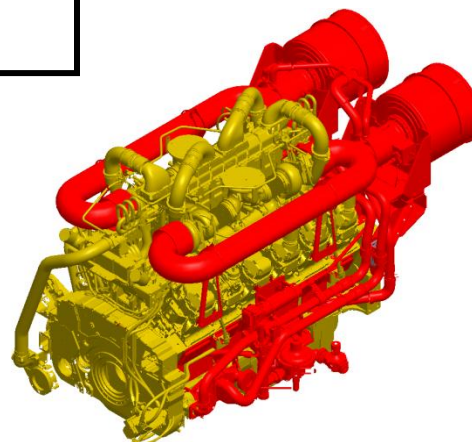
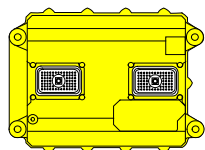
- Gaseous Flow Control
- Detonation Monitoring
- Diesel Injection Control
- Variable Speed Control
- Monitoring and Protection
- Start/Stop

Premium Software

- SEA: FPS Enabled
- Charge to Dealer

ISM

- DSP Based Detonation Sensing
- Exhaust Temperature Monitoring

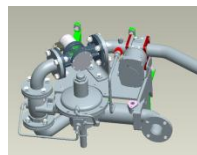


Well Stimulation Pump Output Power

- J1939 Load Signal from Customer
- Calculated from Pump Pressure and Speed

Gas Fuel Control Valves

- Fuel Control Valve
- High Pressure Gas Shutoff Valve (GSOV)



Gas Inlet Pressure

- Monitoring
- Protection



Speed/Timing

- Prime Path: CAM
- Leverage A3 Features

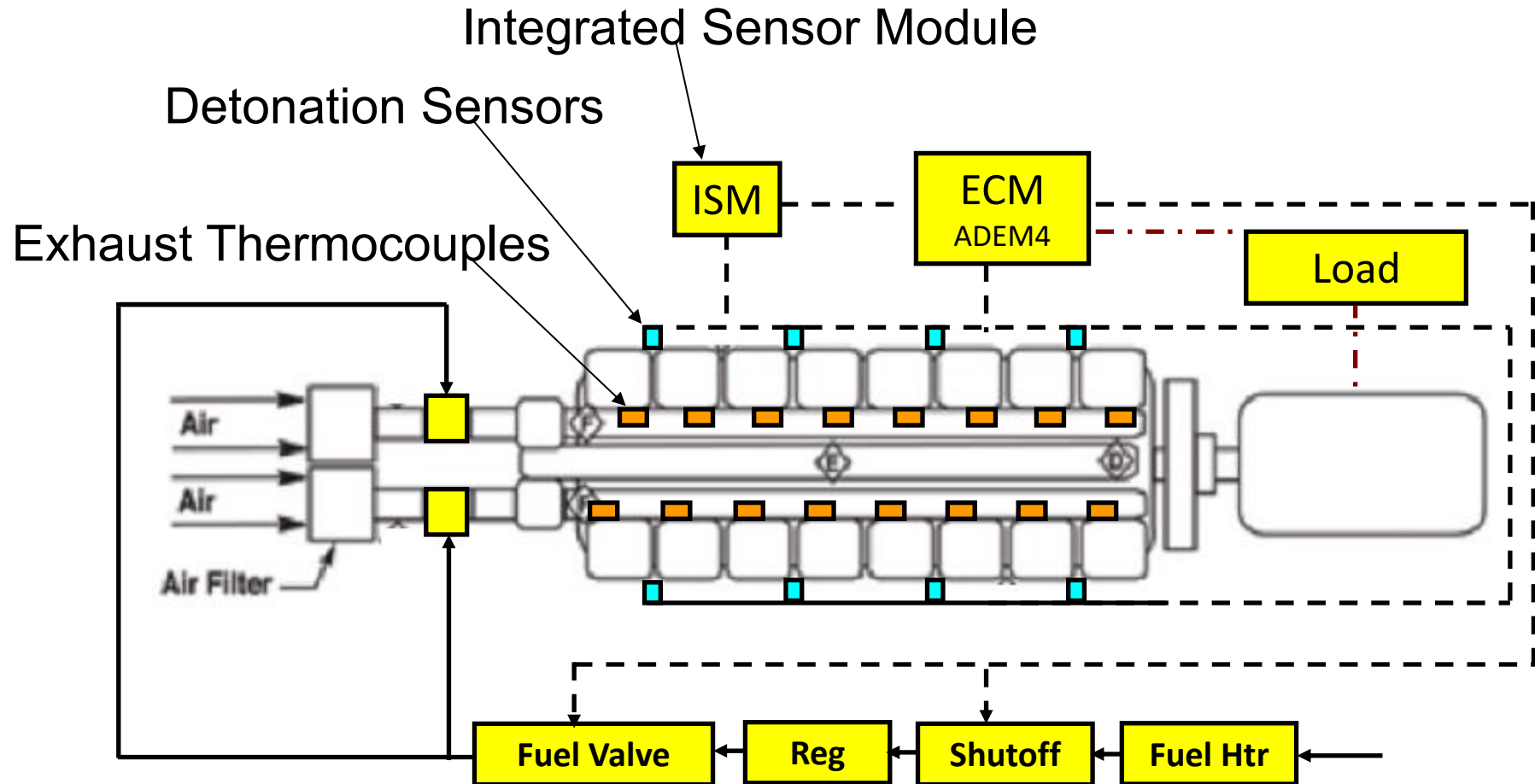


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Temperature and Detonation Sensors

Caterpillar Oil & Gas



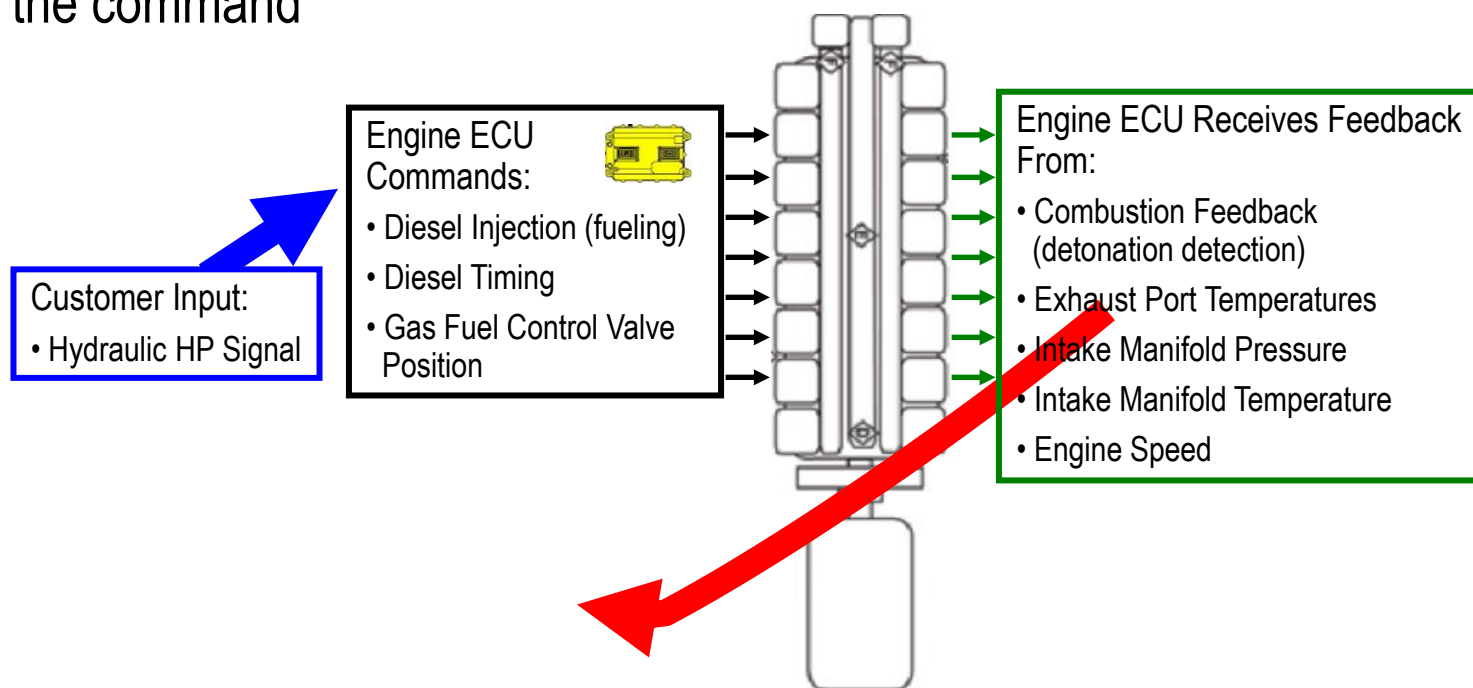
- Addition of Individual Cylinder Temperature sensors allows for monitoring the engine both in diesel and DGB mode

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Proprietary Cat Closed Loop Control System

- Closed loop controls refers to the system's ability to command specific system settings and then receive feedback which measures the results of the command



The COMMAND / MEASURE / FEEDBACK / ADJUST cycle is repeated multiple times per engine revolution

Load Signal Requirement

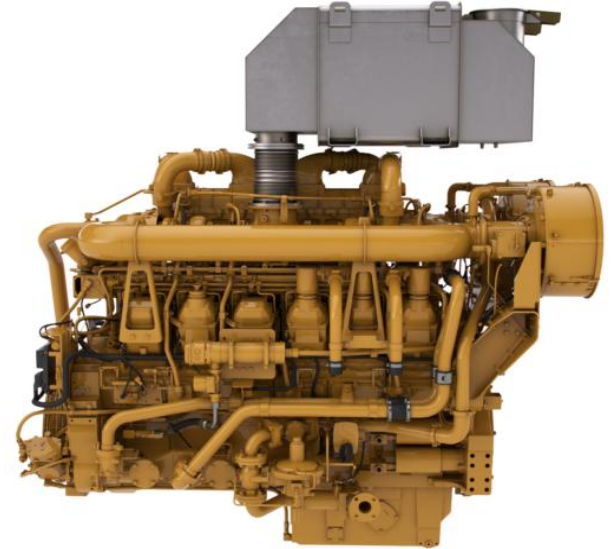
- Units: Watts
- PGN 65029
- SPN 2452
- 4 bytes
- Slope: 1 Watt/bit
- Range: -2,000,000,000 to +2,211,081,215
- Transmission rate: 100ms

Operator Interface Parameters

OPERATOR INTERFACE J1939 Parameters

- Engine Gas Fuel Percentage Command - Used to transmit requested information for engine torque and fuel rate. [PGN 61496, SPN 6386]
- Engine Gas Fuel Percentage – Actual substitution on a diesel/natural gas engine. [PGN 64712, SPN 6333]
- Engine Dual Fuel Mode Command - Request to enable dual fuel mode [PGN 61496, SPN 6792]
- Engine Dual Fuel Mode - Actual dual fuel mode, off or on [PGN 64712, SPN 6791]

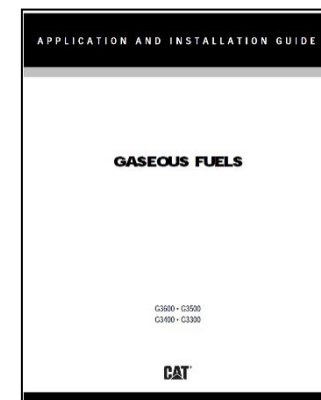
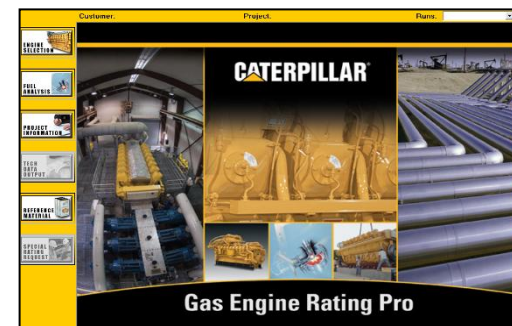
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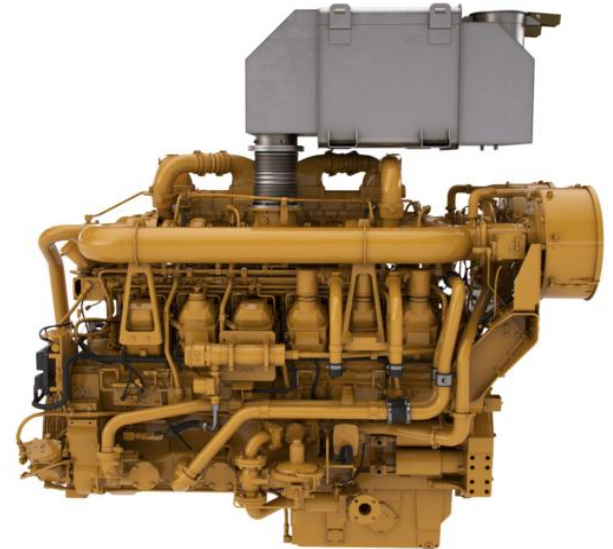
Supply Gas Quality Requirements

- DGB system can accept gasified LNG, CNG, pipeline, or associated field gas
- Recommended Lower Heating Value is between 850 and 1250* Btu/scf
 - Minimum Methane Number is 32MN
 - Clean, dry gas (Gaseous Fuels A&I guide LEBW4977)
 - Up to 10ppm H₂S (emissions certified kits)
- Supply gas pressure to DGB: 12 to 100 psi
- Supply gas temperature to DGB: 5.5 to 55 deg C

** Applicable to Emissions Certified Kit*



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Features and Benefits

1. Increased fuel cost savings via maximized substitution rate
2. Maintain Tier 2 Emissions Certification
3. Maintains Diesel Performance
4. Cat safety, reliability and durability
5. Limited manpower and commissioning requirements
6. CAT Warranty and Dealer Support

1. Increased Fuel Cost Savings via Maximized Substitution Rate

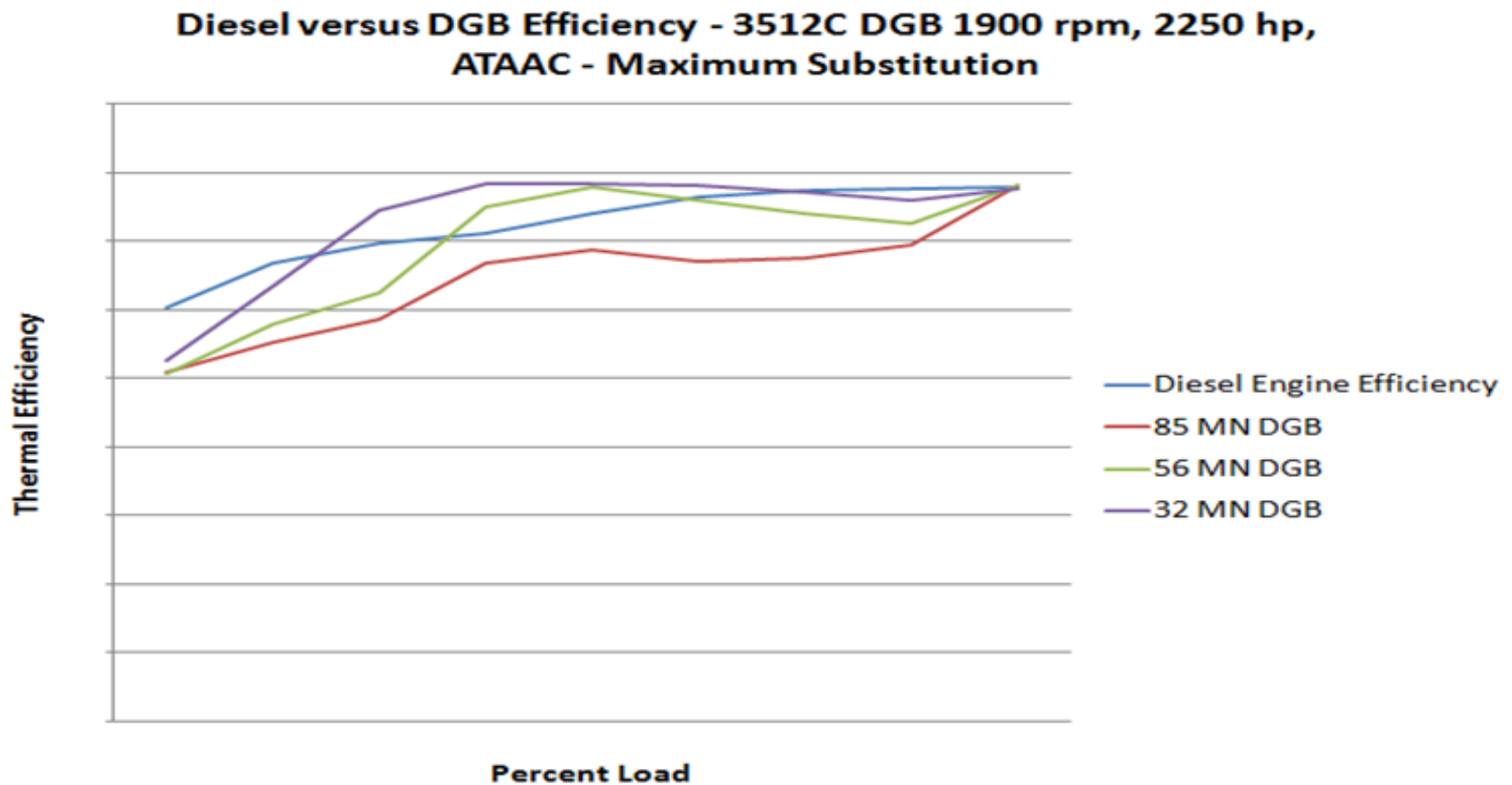
- Up to 70% Maximum Substitution
 - Maximum substitution up to 70% for 850-1250 Btu/scf while meeting Tier 2 emissions
- Dynamically adjusts and continues to substitute as fuel quality changes
 - Targeting capability of substituting up to 2300 Btu/scf; >30 MN
 - Substitution between 20-90% Load and 1300-1950 rpm
- Dynamically adjusts to avoid detonation and maintain substitution

*** Note: engine efficiency varies based on fuel quality and load.

Substitution % is based on diesel replaced. For an accurate estimate use the online “DGB Fuel Cost Estimator” to estimate savings:

<https://dgb.cat.com/Home.aspx>

Capable of LNG,
CNG and **Field Gas**



Thermal efficiency can increase or decrease based on fuel quality and load

Dynamic Gas Blending Fuel Quality

- Gas tolerance
 - Will accept CNG, gasified LNG, dry field gas
 - System automatically adjusts to changing ambient and fuel quality conditions
 - Up to 55% inerts
 - No customer input or gas analysis needed for operation
 - No recalibration required when equipment is moved or gas supply changes
 - Able to adapt gas usage in supply-limited applications
- Gas Mode Timing
 - Increases substitution capability 10-20% across all loads and fuels
 - After Market kits cannot replicate

2. Maintains Tier 2 Emissions

- Dynamic Gas Blending kit will retain the original emissions certifications of the engine
- Memo 1A to be used for retrofit kits shipped in July with plans to update the labeling of the engine when certification documentation is complete (Targeted 4Q 2013)

(g/kw-hr)	Estimated Emissions	Standard
Nox + NMHC	5.93	6.4

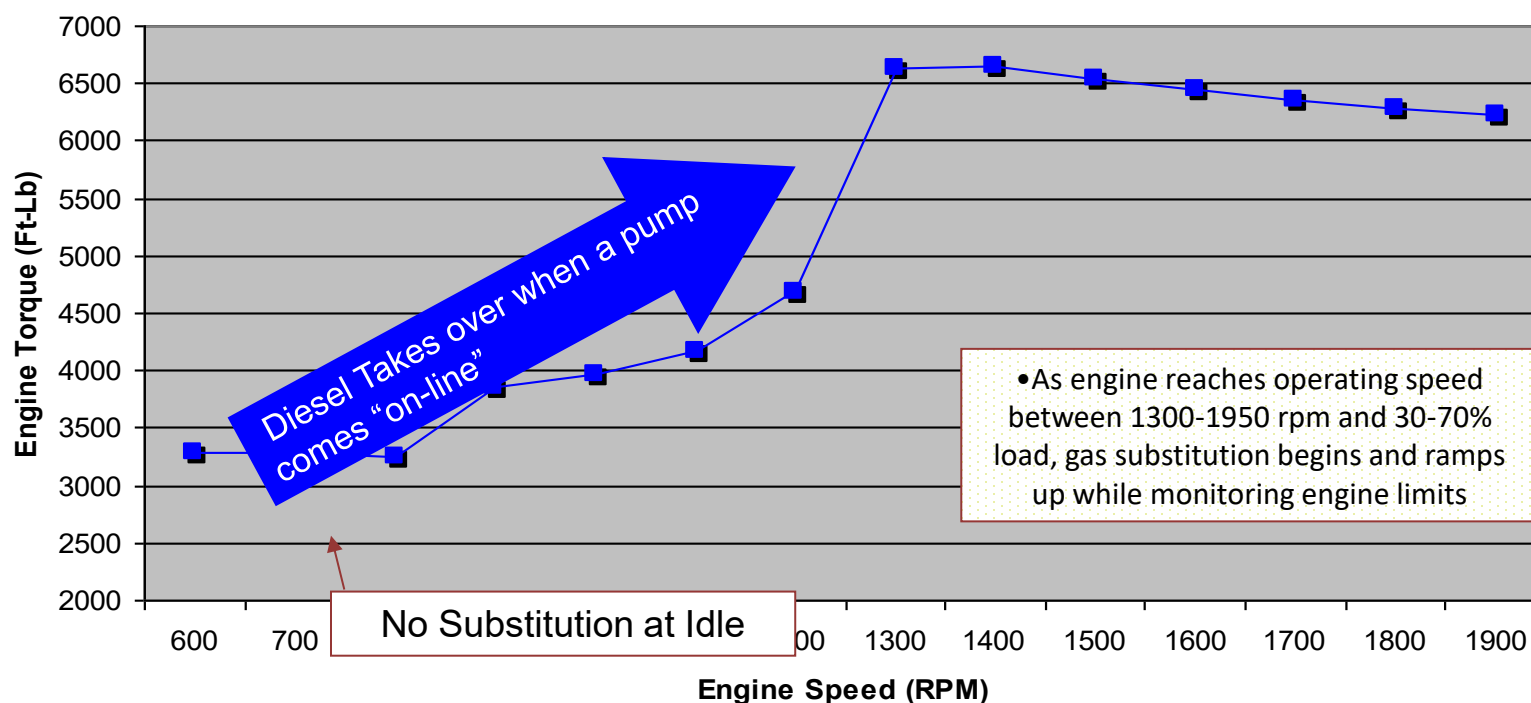
3. Maintains Existing Diesel Performance

- Power
 - Maintaining Rated HP at 2250 and 2500
 - Wide operating speed from 1300-1950 RPM
- Transient Performance same as diesel
 - Diesel fuel powers engine on load ramps until gas equilibrium catches up seconds later
 - Gas in inlet manifold is consumed within a couple of revolutions upon quick to neutral

***Note: Thermal efficiency can increase or decrease based on fuel quality and load.

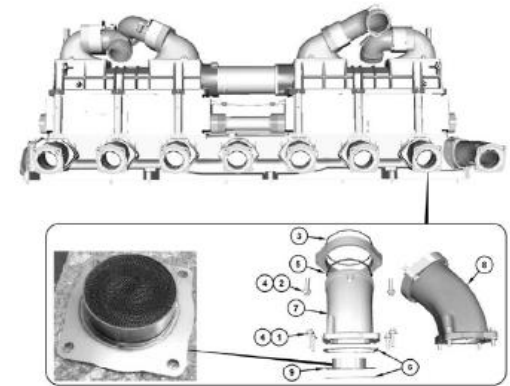
Maintains Diesel Performance

No Changes to Power and Transient Capability



4. CAT Safety, Reliability, Durability

- All Flanged connections vs. NPT
- Flame arresters per cylinder for safety/protection
- Electric gas components are CSA compliant
- Emergency Stop purge cycle when engine re-starts
- System supports use of Air shut-off valves
- Reliability
 - If any gas train component fails or gas supply fails the engine will automatically switch to full diesel mode and continue running
- Detection of fault codes on the gas system will shut the system down and revert engine to full diesel
- Single A4 ECM has additional engine monitoring features
 - Added I/O and Data logging capability
 - Faster processing speeds

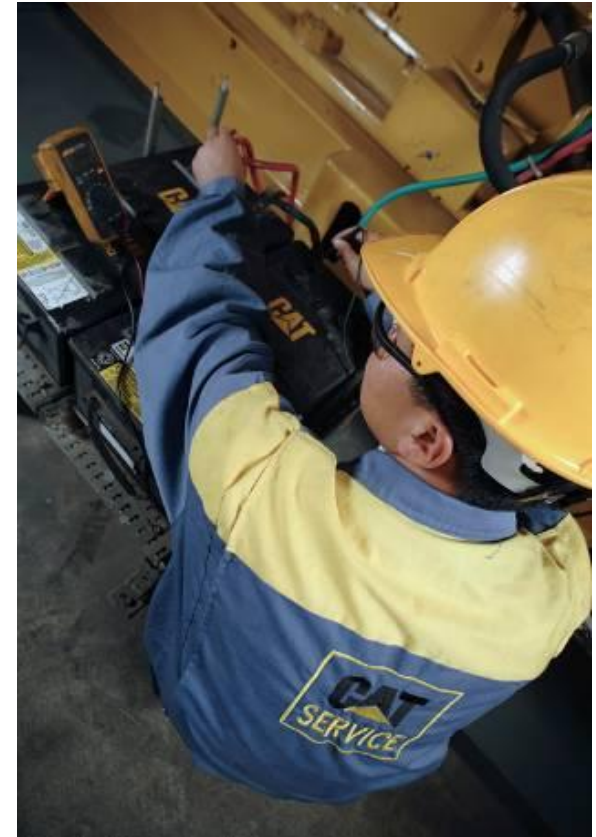


5. Limited manpower & commissioning requirements

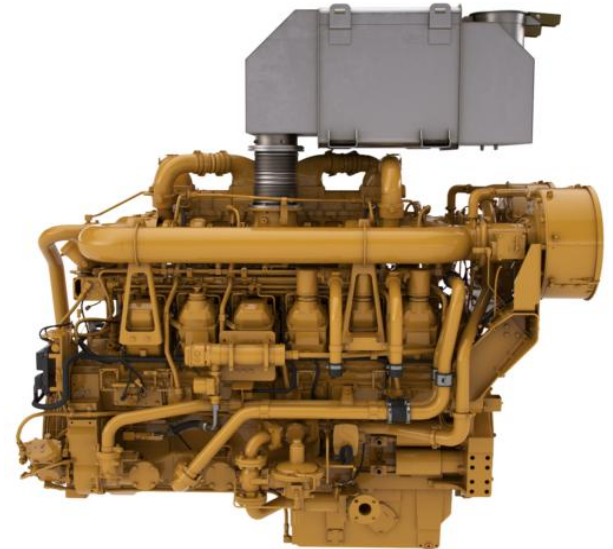
- No hardware or software adjustments as gas changes or moving sites
 - Will accept CNG, gasified LNG, dry field gas, propane
- Automatically adjusts to changes in incoming fuel quality → Minimal set up required
- Maintains current maintenance intervals on existing systems
- No additional maintenance required for gas train

6. CAT Warranty and Dealer Support

- Caterpillar factory warranty up to 1 year/unlimited hours for engine and DGB kit
- Additional 5 year/ 3000hr warranty associated with CARB Aftermarket Parts Certification
- World Wide Dealer Support of service and parts



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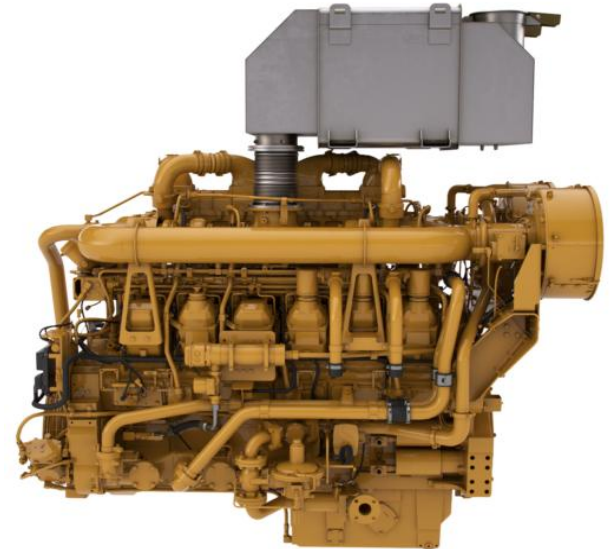
Emissions – U.S. Only

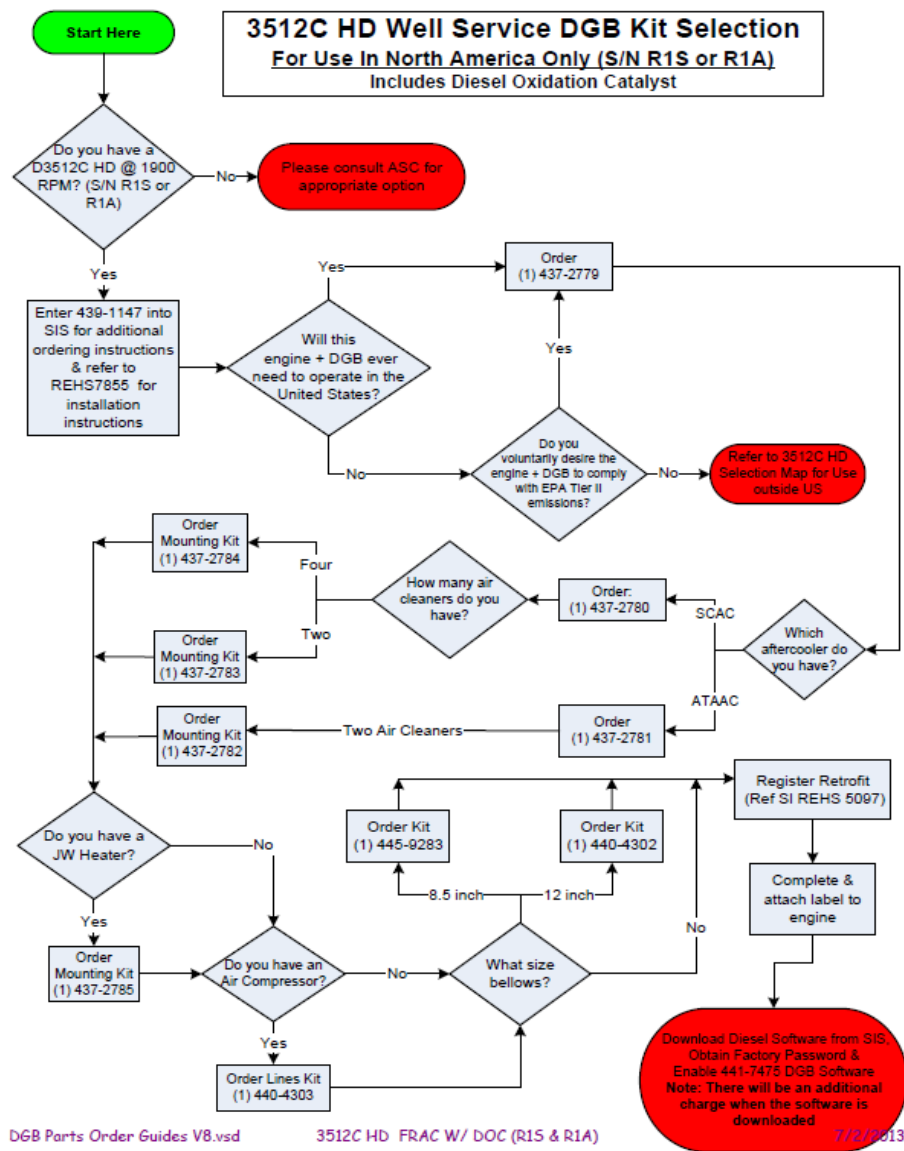
- Dynamic Gas Blending kit will allow the engine to maintain its original emissions certification
- Retrofit kits will include all emissions-driven equipment from factory
- California Air Resources Board (CARB) certification, recognized by EPA
- Memo 1A Data collected for Shipments through 3Q, Targeting 4Q 2013 for CARB Label
- Full emissions documentation will be available through TMI in 4Q 2013

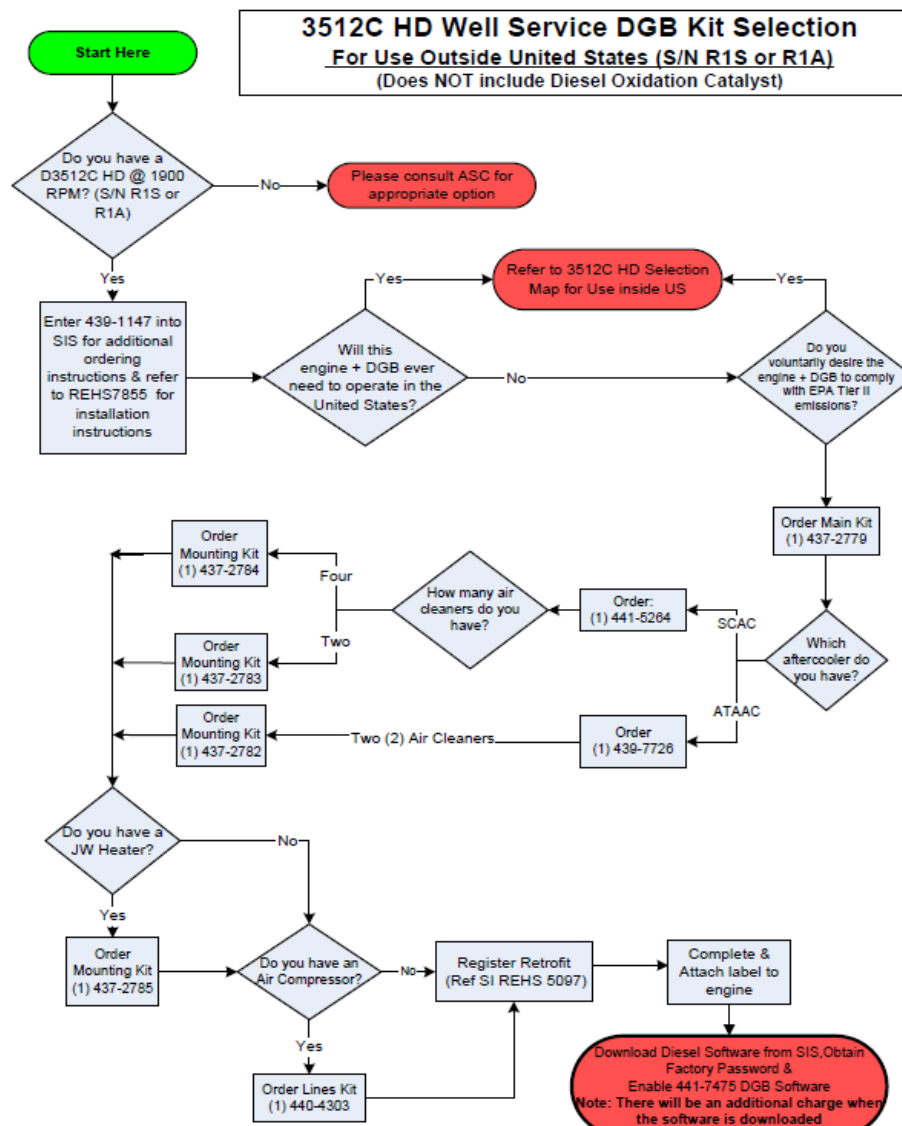
Diesel Oxidation Catalyst

- Required for DGB use in United States
- Reduces carbon monoxide produced by natural gas burned
- Will be supplied as part of certified retrofit kit and shipped loose

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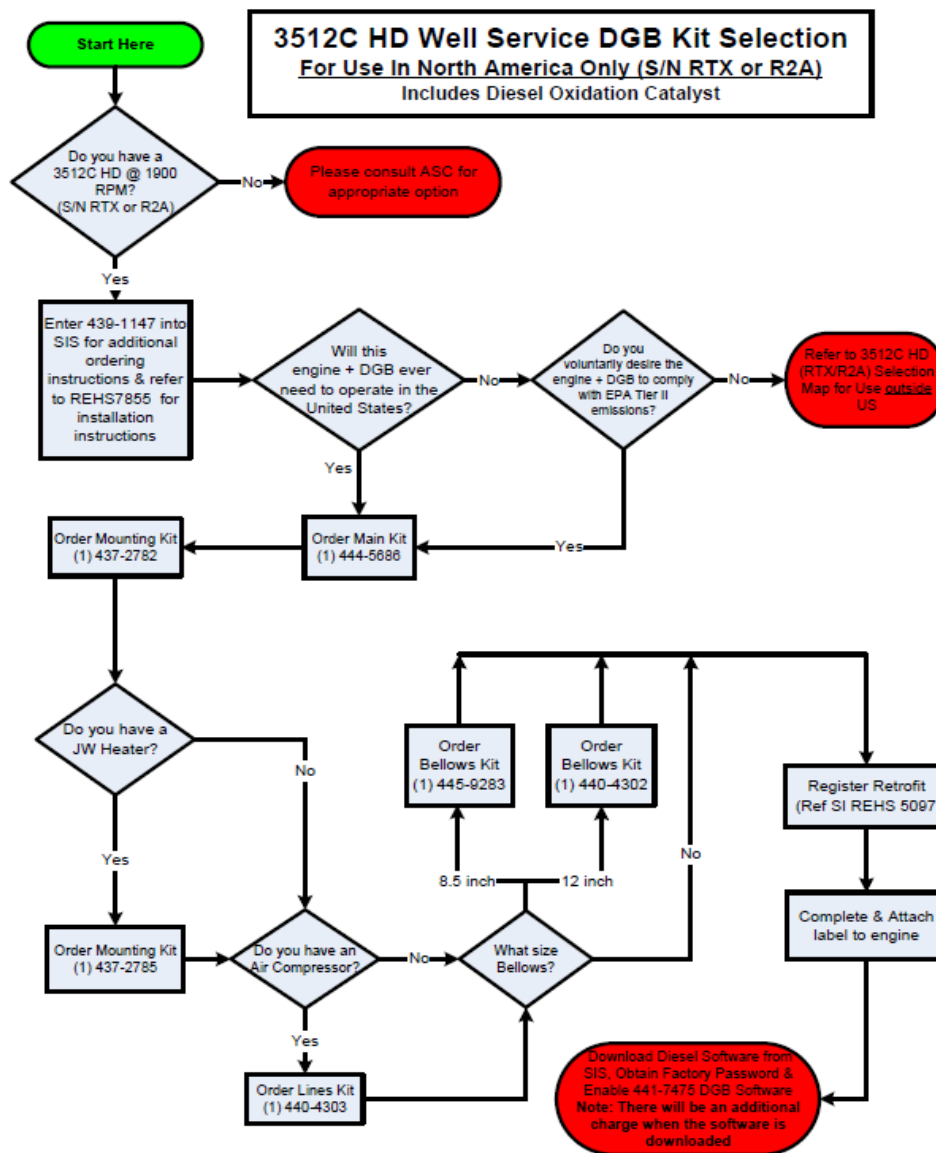


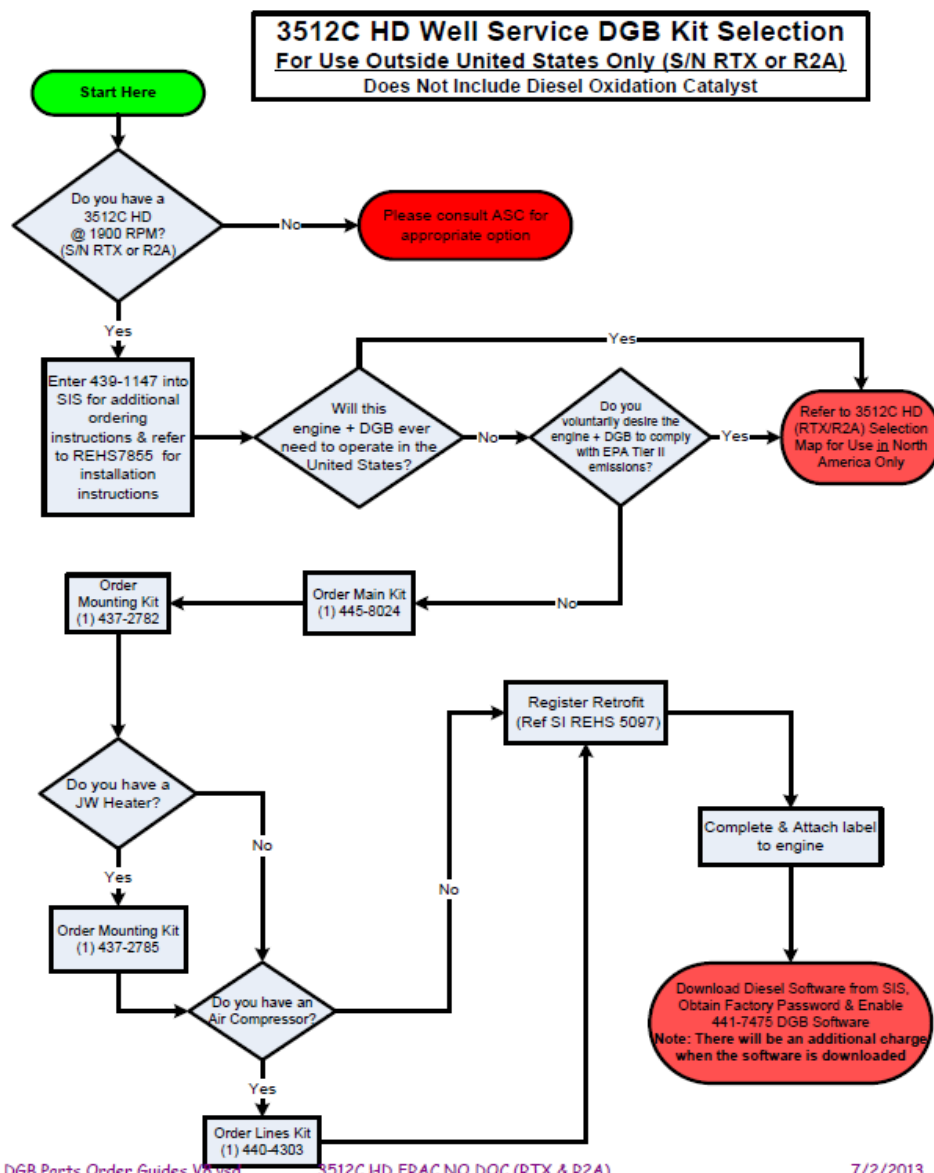


DGB Parts Order Guides V8.vsd

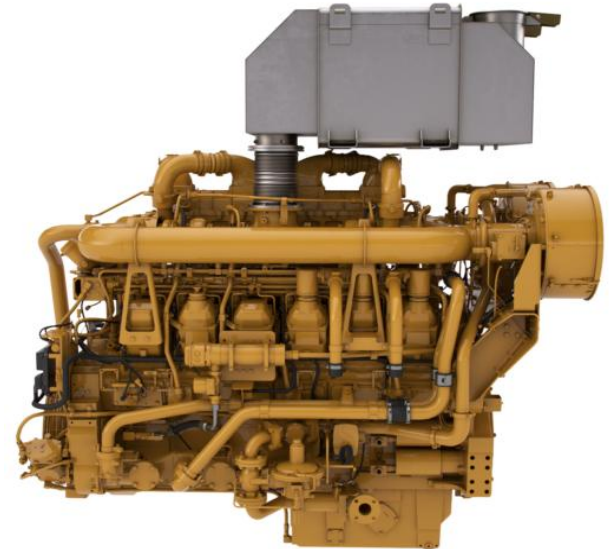
3512C HD FRAC NO DOC (R1S & R1A)

7/2/2013





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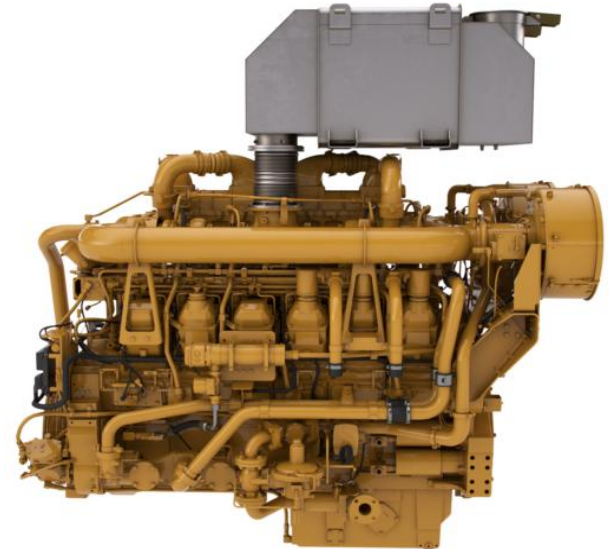


Dynamic Gas Blending Maintenance Intervals

- Maintains current maintenance intervals on existing systems
- No additional maintenance required for gas train



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Product Feature	Caterpillar	Competition
Maximum Substitution across wide operating range	• Max substitution of 70% • 850-1250BTU/SCF Gas • Wide speed range from 1300-1950rpm • Wide Load range: 20-90% load while substituting	• Narrow Speed range limited around 1900rpm (based on Drilling) • Limited fuel quality ~1050BTU/SCF
Emissions	• CARB Aftermarket parts certification • Meets Tier 2 Emissions with DOC for wide range of fuel quality • Emissions testing for C1 duty cycle	• Memo 1A • Tested for Drilling duty cycle • Well Stimulation Duty cycle
Diesel Performance	• No Change to diesel performance • Optimized timing in DGB mode • Seamless transition from diesel to gas mode	• No Change to diesel performance • No timing optimization • Reactive system
Safety, Reliability, Durability	• Flame Arrestors • CSA Compliant gas train • DGB designed with PCP in mind • Have Exhaust T/C and detonation sensors	• Limited T/C and detonation sensors • No knowledge of exceeding cylinder pressure
Limited Manpower and Commissioning	• Burns 850-1250BTU/SCF range @70% subs • No change to hardware or software • Capable of burning up to 2300BTU/SCF gas (non Tier 2 emissions)	• Limited gas tolerance ~1050BTU/SCF • Manual adjustment required
Warranty and	• 1 year/ unlimited hours Parts Warranty • 5yr/3000hr kit warranty as a part of CARB	

Greenman-APG



- Emission compliant only for limited rating/configuration
- Limited/zero ability to run on high MN gas, cannot handle high inert gases
- Non-factory 1 year warranty, only if engine is never serviced by non-APG technician
- Limited service and support coverage

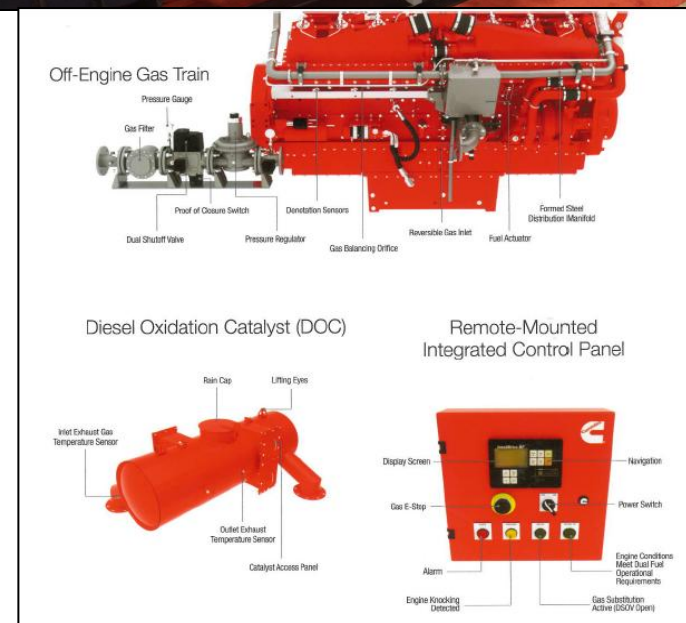
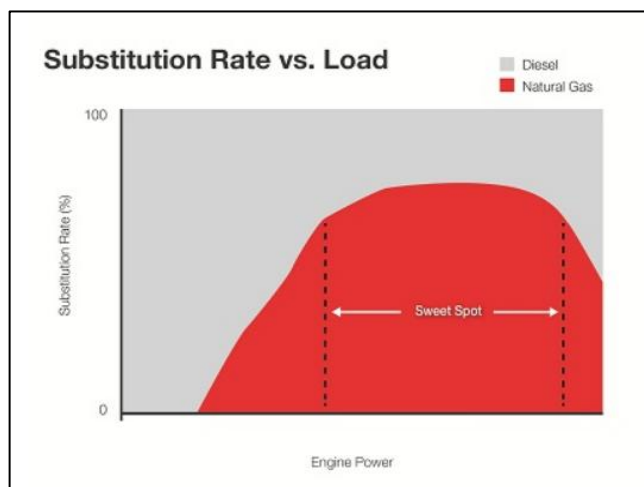
Altronic-GTI



- Not emissions compliant, no factory emissions certification
- Narrow speed and load range while substituting
- Limited/zero ability to run on high MN gas, cannot handle high inerts gases
- Non-factory warranty of 1 year or 1000 hours for new engines only

Cummins

- Ratings: 2250, 2500 for QSK50 Engines
- Actual Substitution rate 40-50%
- Limited fuel flexibility
- Limited Speed and load range



BUILT FOR IT.



DGB in the Field



Over 8000+ hours
accumulated in the
field from Demos



BUILT FOR IT.

3500 with Dynamic Gas Blending – Notable Project Experience & Success!

HALLIBURTON

First Well Stimulation Spread of 12 units Operating on LNG successfully substituting an average of 60%. Operating in Oklahoma

Schlumberger

Spread of 6 units currently in operation with CNG and maximum substitution Operating in Oklahoma



Additional units being tested 2500hp

- FTSI in Pennsylvania
- PTL in Oklahoma
- WFT in Oklahoma



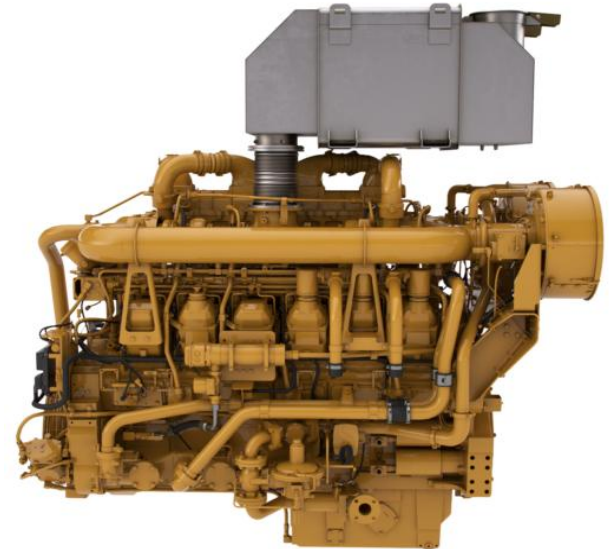
Lessons Learned

- Need for Higher Inlet Gas Pressure Capable System
- Eliminate NPT connections for Safety
- Operational understanding of load and speed profile of application → maximize substitution where it matters!

BUILT FOR IT.



- DGB Overview
- Applications
- Kit Consist
- Gas Quality Requirements
- Features and Benefits
- Emissions Information /Certifications
- Ordering Flowchart
- Maintenance
- Competitive Comparison
- **Marketing Material**



Technical Material for DGB Well Stimulation

- Installation Drawings
 - 2D & 3D Models – available upon request – Will not be loaded in EDDC
- A&I Guide - LEBW0026
- DGB Well Stimulation Owners Manual- LEB0025
- Warranty Bulletin: 3.23_R01
- Special Instruction: REHS7855

Parts Manual	SEBP5744
Service Manual	RENR9370
O&MM	SEBU8024-05
Schematics	RENR9372
Disassembly & Assembly (D&A)	RENR9365
System Operations, Test & Adjust (SOTA)	UENR4321
Specifications	RENR9362
Troubleshooting	UENR0572

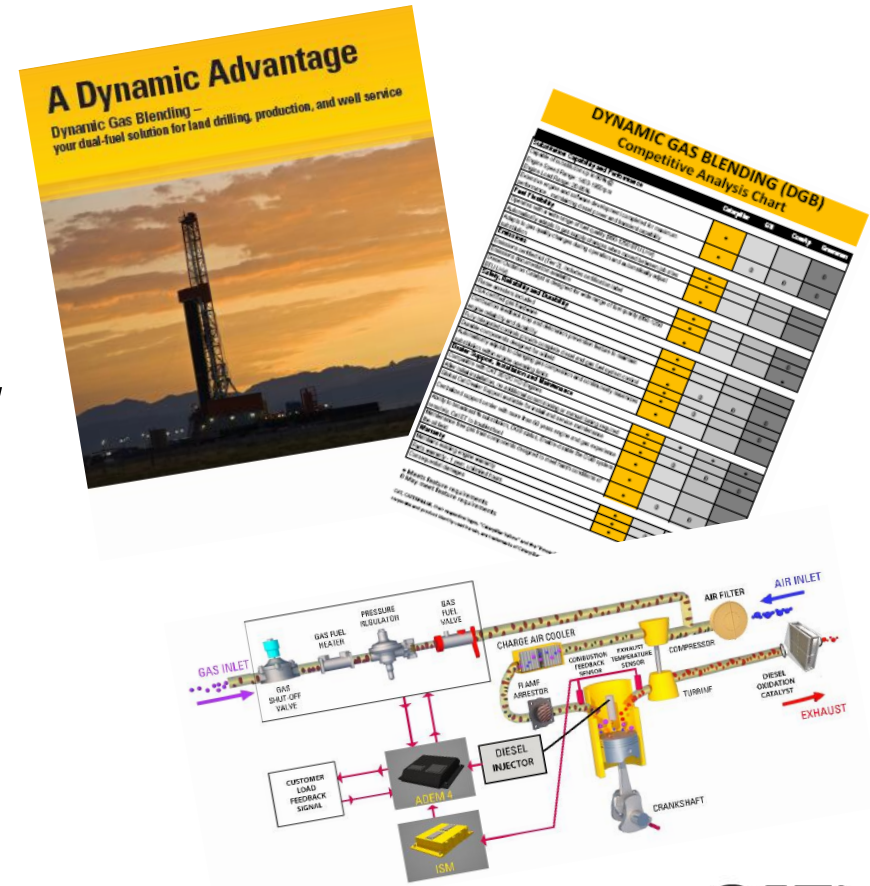
Marketing Material Available for DGB Well Stimulation

- Sales Toolkit: LESW0059
- DGB Brochure: LEDW0014
- DGB Flyer: LEPW0064
- IRM: PELJ1537
- Product News: LEXW0228
- Microsite: http://cc685.com/3500_dgb/
- Power Net: <https://engines.cat.com/cda/layout?m=615875&x=7>
- Competitive Analysis Summary

(<https://engines.cat.com/cda/files/4408132/7/DGB%20competitive%20analysis1.pdf>)

- Process Graphic

(<https://engines.cat.com/cda/layout?m=615877&x=7>)



Cat 3500 DGB – Power Net

<https://engines.cat.com/cda/layout?m=615877&x=7>

HOME	ELECTRIC POWER	INDUSTRIAL	MARINE	GLOBAL PETROLEUM	DISTRIBUTION DEVELOPMENT	RAILWAY	BUSINESS TOOLS
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Global Petroleum > Products > Well Servicing > Power for Well Servicing/Pump Packages > DGB for Well Service

Where Do I Find...

Press Releases

Events & Tradeshows

Marketing Communication Resources

Products

- » Drilling
- » Gas Compression
- » Production
- » Well Servicing
 - » Power for Well Servicing/Pump Packages
 - » C7-C18
 - » C27 / C32
 - » 3512
 - » Hazardous Location
 - » 3516C HD
 - » DGB for Well Service

» Marketing Materials

- » Well Stimulation Pumps
- » Dynamic Gas Blending
- » Transmissions
- » Power Solutions
- » IMO Tier III Portal
- » Regulations, Certificates, Tier 4

Application and Installation

Parts & Service

Hazardous Location/Safety

Partners for Success

Industry Info

Contacts

Web Change Request

DYNAMIC GAS BLENDING

for Well Service

The Dynamic Gas Blending system enables customers to lower their fuel costs by continuously modulating gas substitution. The system adjusts to changes in incoming fuel quality, allowing engines to maximize fuel savings while running on a variety of fuels.

News

Date	Title	Publication
01-May-2013	» Caterpillar Releases Dynamic Gas Blending Retrofit Kit for Well Stimulation Applications	Fort Mill Times

Spec Sheets

» [DGB Show Spec Sheet \(LEPW0064\)](#)

News

» [Energy Firms Switch to Natural-Gas Power](#)

» [Cat® Dynamic Gas Blending \(DGB\) Kit Now Available for Select Ratings](#)

» [Dual Fuel: Natural Gas Engine Technology](#)

Brochures and Presentations

» [Dynamic Gas Blending Value Story and Animation](#)

» [DGB Competitive Analysis](#)

» [DGB Brochure \(LEDW0014\)](#)

» [DGB Process Graphic](#)

Links

» [DGB Sales App - Download Instructions](#)

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Customer Website

http://cc685.com/3500_dgb/

DYNAMIC GAS BLENDING
SYSTEMS AND KITS

CAT

Dynamic Gas Blending:
Tomorrow's Power
Solution Today

HOME KEY APPLICATIONS ENGINE INFORMATION KEY ADVANTAGES UPGRADE KITS PRODUCT SUPPORT

Your Dynamic Advantage

DYNAMIC GAS BLENDING – WHERE PROFITABILITY MEETS RESPONSIBILITY

Flexible Control
Lower emission levels and operating costs with a single technology. Use gas when it's available and automatically modulate gas substitution when needed. Cat® Dynamic Gas Blending continuously adjusts to changes in incoming fuel quality and pressure, allowing your engines to run on a wide variety of fuels, from associated gas to gasified LNG, all while consistently maintaining your diesel power and transient performance.

- Lower fuel costs with up to 70%* replacement of diesel with gas
- Maintain existing service intervals and component life
- Improve display performance and troubleshooting capability with ADEM™ A4 and EMCP 4.4* controls
- Capability to reduce gas flaring by consuming dry field gas for less environmental impact
- Maintain original engine emissions certifications with retrofit kit

Your Cat dealer will help you implement a complete package or a retrofit kit compatible with your generator sets. Using existing Caterpillar gas engine hardware with no changes to core components, you can be up and running quickly with Dynamic Gas Blending.

* Differs for well service applications

Dynamic Gas Blending v1...
by Caterpillar Graphic Design @...

Start Prezi

Prezi

← →

FIND IT TODAY

Brochure

Show Flyer

Spec Sheet

Engine Upgrade kit

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