

**RYPOS**  
Active Diesel Emission Control Systems

**RYPOS** Presented by Frank S. DePetrillo  
MDEC 2007



***CARB Level 3 Plus Verified!!***  
Active Diesel Emission Control Systems

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Background/History of the Company

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## The Company

RYPOS Inc., a privately owned company founded in 1997, is engaged in research and development to design and construct an active/hybrid exhaust emission control system for the reduction of harmful emissions from Diesel engines.









New Rypos HQ, 260 Hopping Brook Road, Holliston, MA USA

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## Company History

1997	2001	2002	2003	2004	2007
8 Dunham Street, Attleboro, MA 820 Wellington Ave., Cranston, RI		3 Industrial Park Road, Medway, MA		3 Industrial Park Road, Medway, MA 260 Hopping Brook Road, Holliston, MA	
Basic research and proof of concept First prototype on pickup truck Second prototype on a 150kW Genset		Product development Third generation Test at Environment Canada First field test program		Product development Forth Generation Second field test program Applications Diesel generators Large engines Marine generators	
 		 		 	

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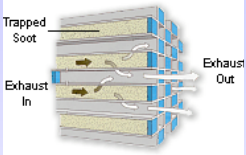


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# Technology Overview

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## Competitive Technologies

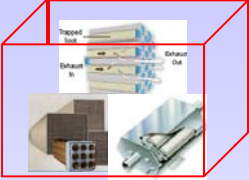
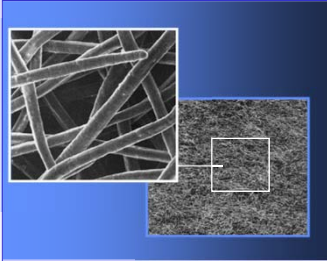
 <p style="text-align: center;"><b>Ceramic Cell Cordierite</b></p> <p style="text-align: center;"><i>Passive regeneration using oxidation catalyst</i></p> <ul style="list-style-type: none"> <li>• Uncontrolled regeneration</li> <li>• Sensitive to temperature</li> <li>• Indirect electrical heating</li> <li>• Active regeneration fuel injection-high fuel penalty</li> </ul>	 <p style="text-align: center;"><b>Silicon Carbide Ceramic Fibers</b></p> <p style="text-align: center;"><i>Passive regeneration using fuel additives</i></p> <ul style="list-style-type: none"> <li>• Uncontrolled regeneration</li> <li>• Sensitive to temperature</li> <li>• Indirect electrical heating</li> <li>• Active regeneration possible with fuel injection-high fuel penalty</li> </ul>	 <p style="text-align: center;"><b>Active Regeneration</b></p> <p style="text-align: center;"><i>Active regeneration using indirect electrical heating or fuel burner</i></p> <ul style="list-style-type: none"> <li>• Inefficient regeneration</li> <li>• Uses about 7kW-20KW for indirect heating</li> <li>• ~8-10% fuel penalty for fuel burner</li> </ul>
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## Outside the Box

### Sintered Metal Fibers

- o Electro-conductive
- o High porosity (up to 95%)
- o Low back pressure
- o Withstands high temperatures (1000°C)
- o Fast heating (low thermal mass)
- o High filtering efficiency
- o High surface area

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## Technology Analysis

After Treatment Device	Filter Media	Regeneration Method	Emission Reduction	Temperature Dependent	Fuel Type
Diesel Oxidation Catalyst (DOC)	• Metallic honeycomb structure coated with precious metal catalyst	• Not applicable	• SOF: $\geq 90\%$ • PM: $\geq 25\%$	Yes	Ultra Low Sulphur Diesel (ULSD)
Passive Diesel Particulate Filters (DPF)	• Porous ceramic, often used with FBCs	• Catalyst coating • FBCs	• PM: $\geq 90\%$ • CO & HC: 80%	Yes	ULSD
Active Diesel Particulate Filters	• Porous Ceramic • Sintered metal powder • Sintered metal fibers	• Fuel injection • Radiant heat • Direct heating of filter element	• PM: $\geq 90\%$ • CO & HC: 80%	No	Any
Fuel Borne Catalysts (FBC)	• Fuel additive – usually used with DOC	• Not applicable	• PM: 20% • CO & HC: 30%	Yes	ULSD
Selective Catalyst Reduction (SCR)	• Urea or ammonia injected into exhaust stream, often used with DPF	• Often used with DPF	• NOx: $\geq 90\%$	Yes	ULSD HFO MDO

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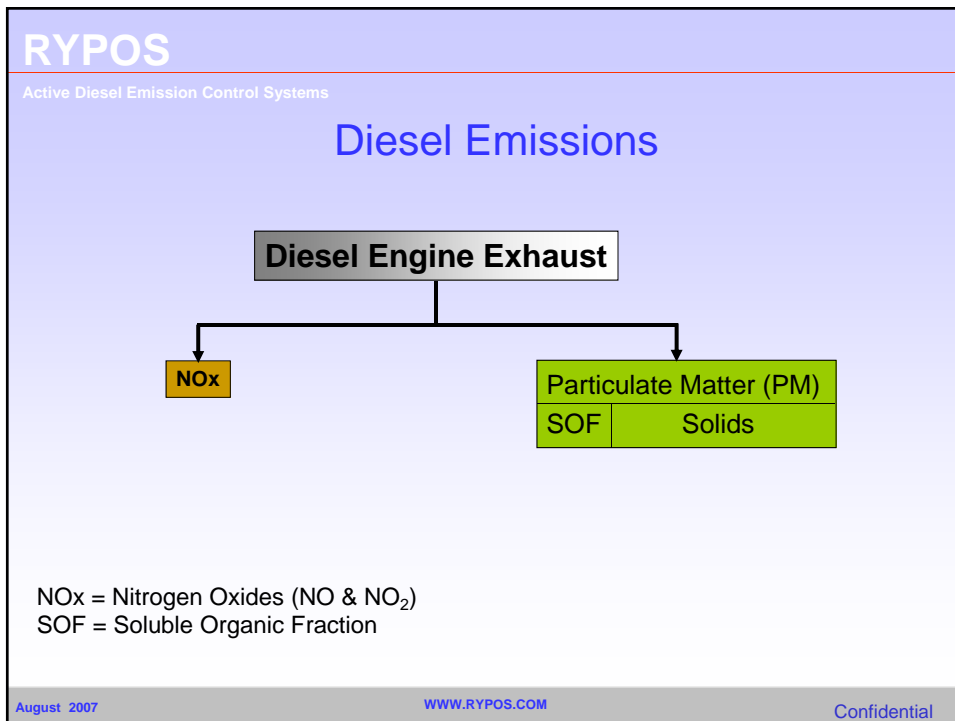
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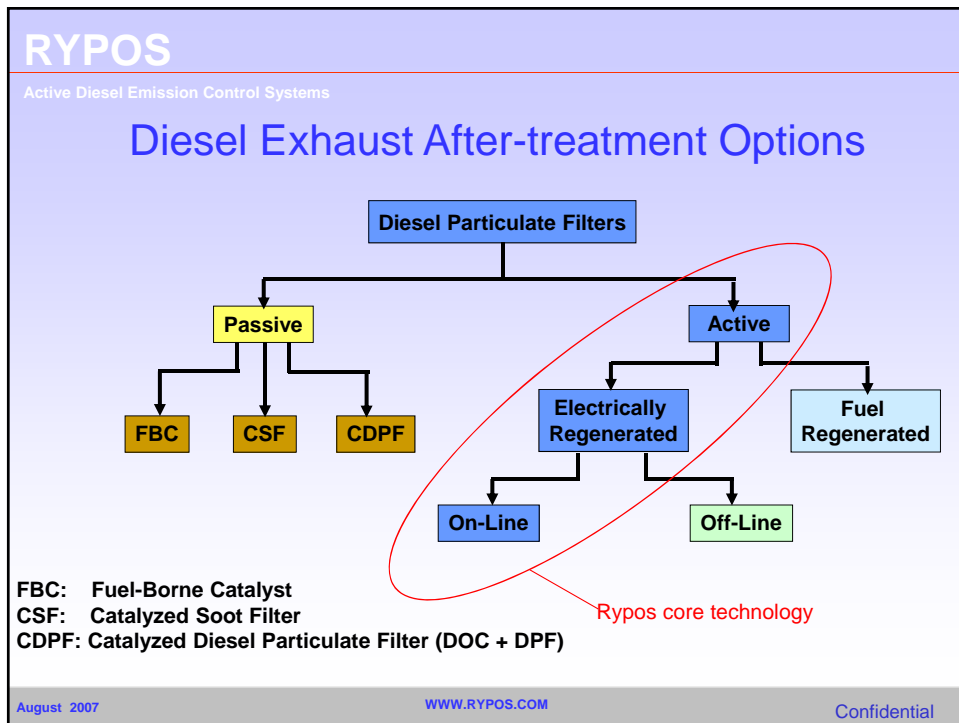
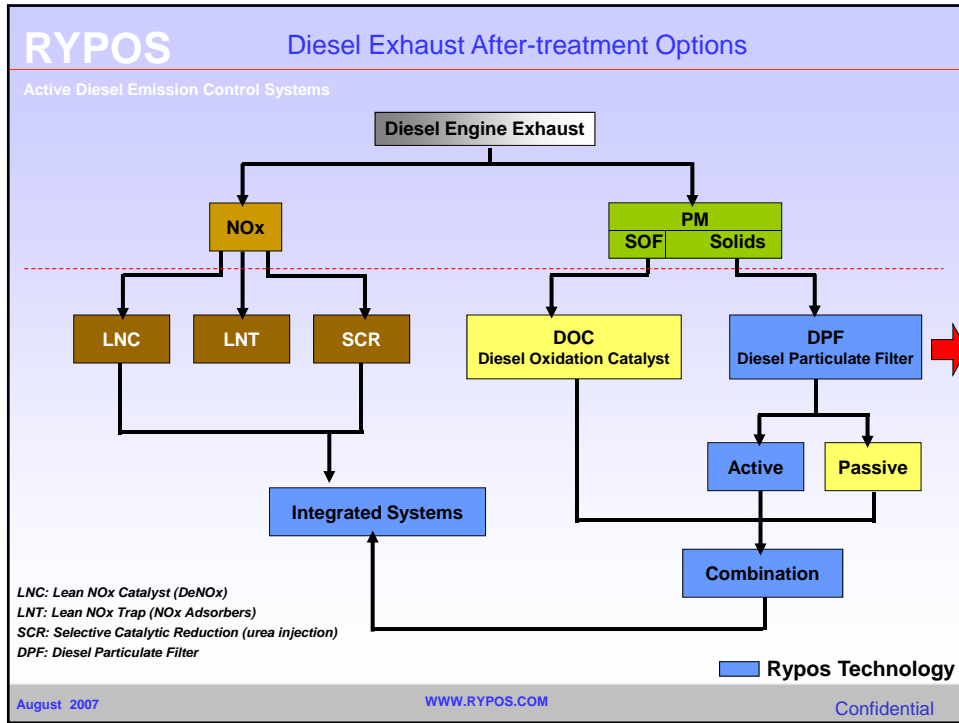
**Competitive Technologies-CARB Level 3 Comparison\***

Company	Product	Engine Type (Baseline PM)	Engine Size	Exhaust Temp for Regen.	Max. Minutes of Idle	Number of Cold Starts	Maint. Required (hourly cycle)	Level 3 Plus (≤ 30% NO <sub>2</sub> , future 20%)
RYPOS	HDPF/C Active	.2g/bhp-hr or 1996 or newer	>50HP	N/A-active, operates independent of exhaust temp	Not applicable-active	Not applicable-active	Visual inspection every 1000 hours	YES, reduces NO <sub>2</sub> up to 96%
Company B	DPF Passive	.4g/bhp-hr	<600HP (450kW)	300C w/40% load for 30% operating hrs.	240	24	Clean every 5000 hours	NO
Company C	DPF Passive	.4g/bhp-hr	N/A	300C w/40% load for 30% or 2 hours	720	24	Clean every 5000 hours	NO
Company D	DPF Passive	.2g/bhp-hr	N/A	400C at .2g/bhp-hr	720	24	Clean every 2000 hours	NO
Company E	DPF Passive	.2g/bhp-hr	N/A	400C for 30 min.	300	10	1500 w/500ppm 2000 w/15ppm	NO

\*Source: CARB Verified Technologies web page

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# RYPOS Technology Overview

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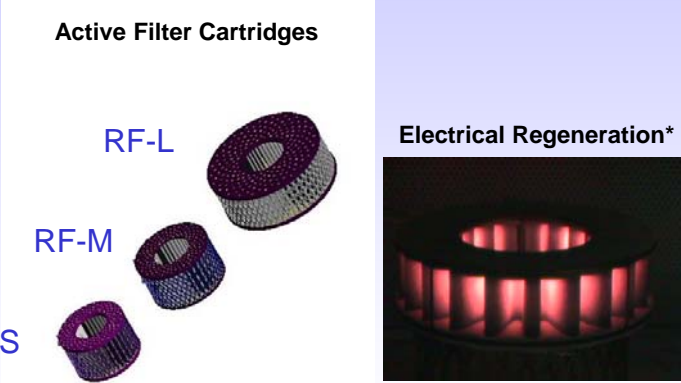
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## Active Filters

**Active Filter Cartridges**

RF-L  
RF-M  
RF-S

**Electrical Regeneration\***




*\*World's only Active Regeneration DPF where the FILTER element IS the HEATING element*

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## Microprocessor Control

- Automatic regeneration cycles
- Timing sequence, duty cycle
- Flow control and filter unit selection
- Pressure and temperature sensing can be used to initiate regeneration cycles
- Electronic switching of filter elements (automatic)
- Monitoring and remote display

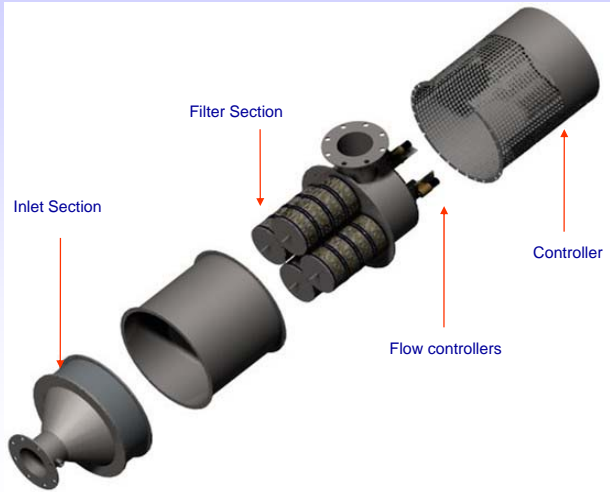


RYPOS  
UNIVERSAL CONTROLLER  
POWER MODULE

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## RYPOS Active Diesel Particulate Filter



Inlet Section

Filter Section

Flow controllers

Controller

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### RYPOS Active Hybrid Diesel Particulate Filter

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### RYPOS Active Diesel Particulate Filter


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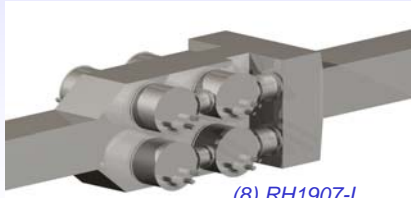
## Flexible System Configurations



*RH305-ML-C*  
Retrofit to Mining LHD equipment



*RH707-M-C*  
Retrofit to Terex V-12 760hp Earthmover




*(8) RH1907-L*  
Integrated solution with SCR system for PM and NOx reduction up to 90% for 18MW power generator

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## ADPF™ and HDPF/C™ by RYPOS

**ADPF™**



- Sintered metal fibers
- Active system
- Filter element is the heating element
- **Level 2 CARB Verification** for diesel generators with the following limitations:
  - Diesel sulfur content  $\leq$  500 ppm
  - PM emission level  $\leq$  0.4 g/bhp-hr

**HDPF/C™**



- Sintered metal fibers
- Active system with diesel oxidation catalysts
- Filter element is the heating element
- **Level 3 PLUS CARB Verification** for diesel generators with the following limitations:
  - Diesel sulfur content  $\leq$  15 ppm
  - PM emission level  $\leq$  0.2 g/bhp-hr

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## Independent Testing RYPOS HDPF/C Technology

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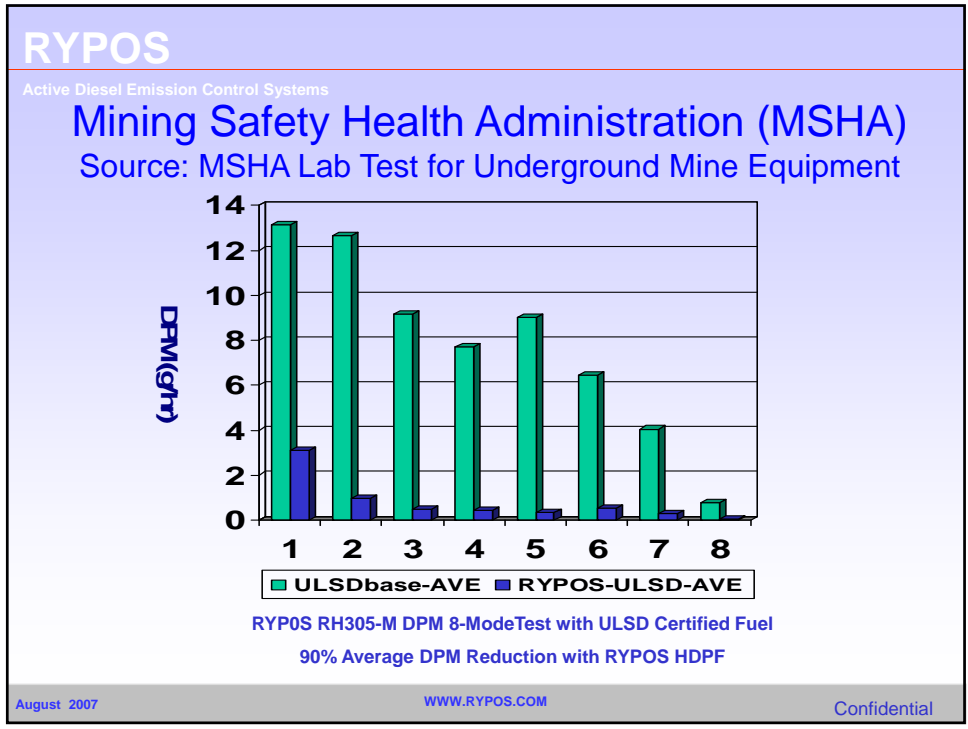
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### CARB Level III Testing for Stand-by Gensets

Emissions	* DEGREENED HDPF/C	* AGED HDPF/C
CO	84	94
NO2	42	96
THC	76	77
TPM	87	93

\* Source: Environment Canada, Emission Research and Measurement Division

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Typical RYPOS Customers


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**Bear Power Products/Fortune 50 Oil Refinery in California**  
3/2007

**Detroit Diesel**  
**1985 2-cycle**  
**Model 1033-7000**

(2) RYPOS RH404-M-C




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**Cummins West, Inc./City of San Jose, CA Central Service Yard**  
3/2007

**Cummins**  
**2006**  
**QST30-G5 NR2**  
**1000kW Genset**

RYPOS RH1207-L-C



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Milton CAT/Cincotta, Saugus, MA, 1/2006

**CAT 3412**  
**500kW**  
RYPOS RT-24



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Korean Coastal Power/Kangwonland Resort  
11/2005

**CAT 3516**  
**2000kW**  
(4) RYPOS  
RH1907-L-C



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**CARB/UC Riverside/NAVSEA Testing at Suisun Bay  
California 11/05 to present**

DDC 12V71 (2-cycle)  
Engine Year: 1974

Currently 2000+ hours of operation

Test Cycle: ISO 8178

**2 RA24-2C**



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**Croton Water Filtration Project, Bronx, NY  
2/2006**

**Terex TR-70 Quarry Trucks**

**DDC2000  
760 HP**

**RYPOS RH707-M-C**

- In full operation since March 2006
- Rypos sintered metal filter fiber more durable for shock and vibration versus ceramic substrates
- Active DPF reduces PM independent of exhaust temperature



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550kW Diesel Generator, WTC, New York, NY  
1/2004



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## The RYPOS Competitive Advantage

- Our sintered metal filter material *is both* the particulate filter AND the heating element
  - Industry leading energy efficiency: very low fuel penalty
- RYPOS HDPF/C can reduced up to 90% of TPM
  - CARB level 3 PLUS Verification (only technology with "Plus" designation for level 3)
- Intelligent microprocessor control
  - Filter cartridges are regenerated in real-time during normal system operation
- Modular system design
  - Scales from 100kW to 50MW for stationary generator sets
- Non-catalyzed regeneration of filter cartridges
  - Does not create (NO<sub>2</sub>) nitrogen dioxide, in fact it is reduced
- Low cost of ownership
  - Minimal system maintenance is required: can operate continuously in remote locations
- No requirement or specification for low temperature exhaust
  - Ideally suited for for stand-by generator sets or long periods of engine idle
- Not fuel grade dependent
  - Not necessary to utilize costly low sulfur diesel fuel or expensive fuel additives, system will perform to specification with fuel sulfur content up to 500ppm
- Low thermal mass of filter material
  - Highly efficiency, heats quickly, cools quickly

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## For formal RYPOS consultation please visit:

**<http://www.RYPOS.com/rfp.html>**

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