



Presentation to

CHP for Federal Facilities Workshop

August 10, 2006

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Charles Equipment Company

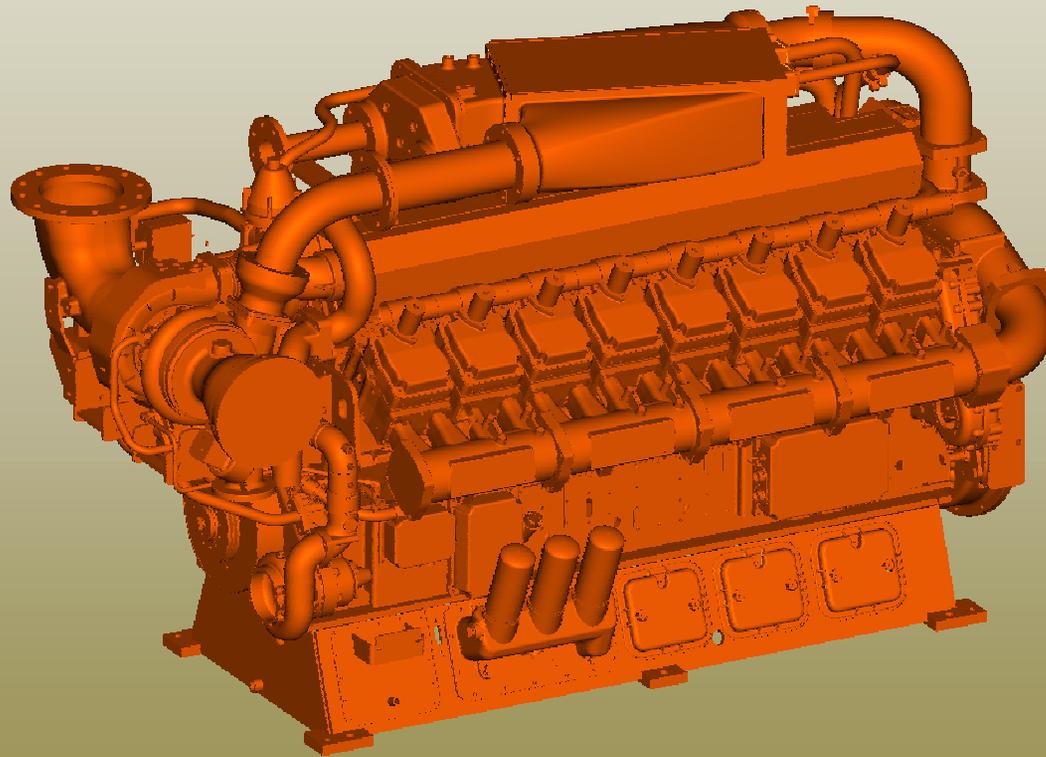


Company Information

- 46+ years REAL experience in Gas Distributed Generation
 - Technicians have over 175 years experience in switchgear
 - Technicians have over 350 years experience in gas engines
- Waukesha Factory's "Backyard"
 - Any part available within 4 hours
 - Waukesha support available within 4 hours



Reciprocating Engines





CHP Distributed Generation

- Efficient use of energy
 - on site
 - no transmission losses or constraints
 - energy conversion (mechanical)
 - 34 – 42%
 - heat recovery
 - hot water
 - low or high pressure steam



Driver of Choice: Natural Gas versus Diesel

- First Cost
- Maintenance Cost
- Fuel Cost



Natural Gas Advantages

- No onsite fuel storage
- SO₂ Risk: bearings and bushings erosion
- Environmental: lower emissions
- Higher efficiency
- Lower noise
- No particulate
- Economics: Peak shave and Continuous



Diesel Advantages

- Lower installed Costs
- Onsite fuel storage
- 100 % Load Step (better transient)
- NFPA 110 Compliant
- Life Safety Loads



Emissions

(Grams/Bhp-hr)	Natural Gas	Diesel
• NO _x :	.5 - 2	14
• CO:	1.5 - 3	1.5
• THC:		1.5
• NMHC	1 - 2	
• SO ₂ :		Traces
• PM ₁₀ :		Traces

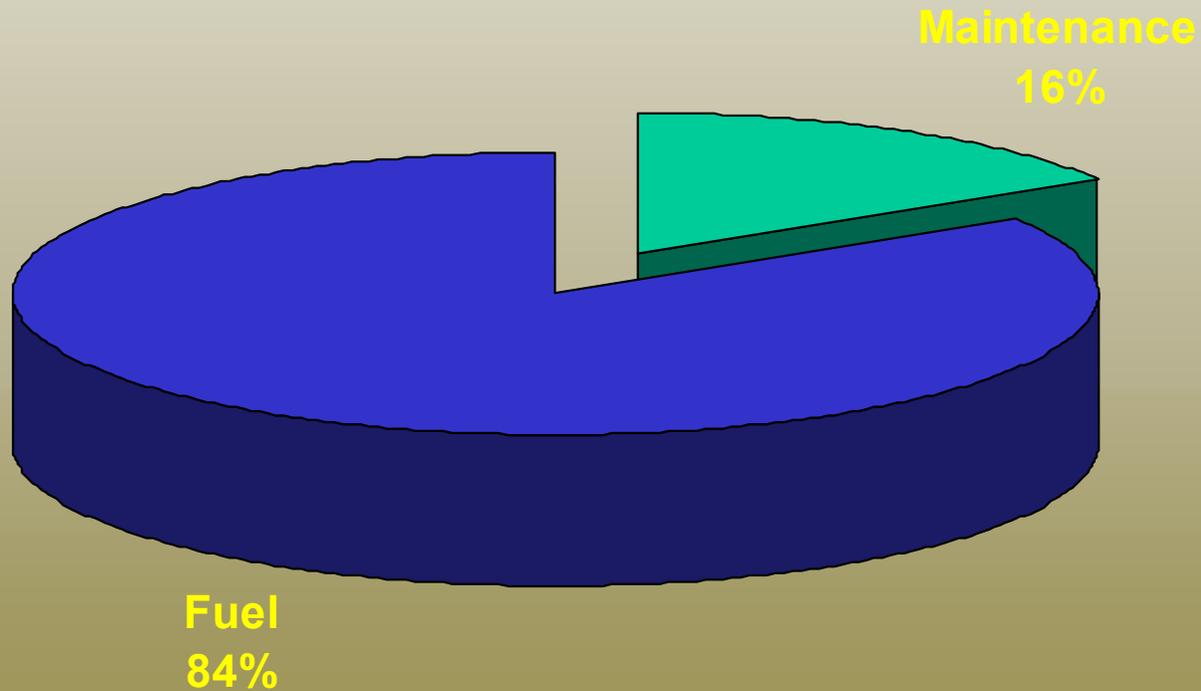


Service Offering

- Engineering
 - Assess customer needs.
 - Provide complete turn-key package for any application.
- Training
- Maintenance Programs
 - From oil changes to major overhauls. CEC can tailor programs for monthly, quarterly or semi-annual depending upon the application.
- Emergency Service
 - CEC provides 24-hour emergency service for engines, driven components and generators, not just those we sell.

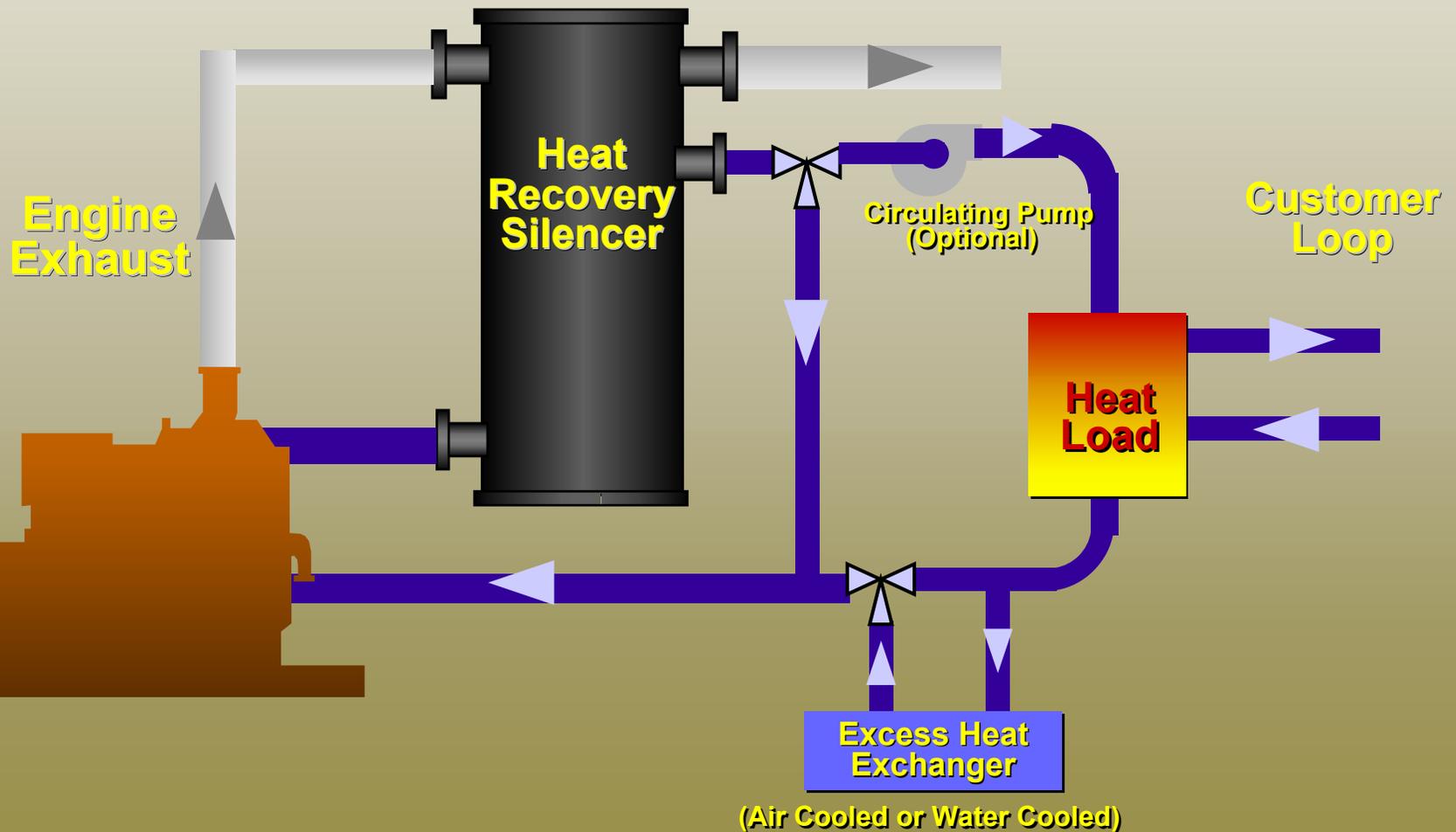


Life Cycle Costs





Typical CHP Utilizing the Exhaust and Jacket Water



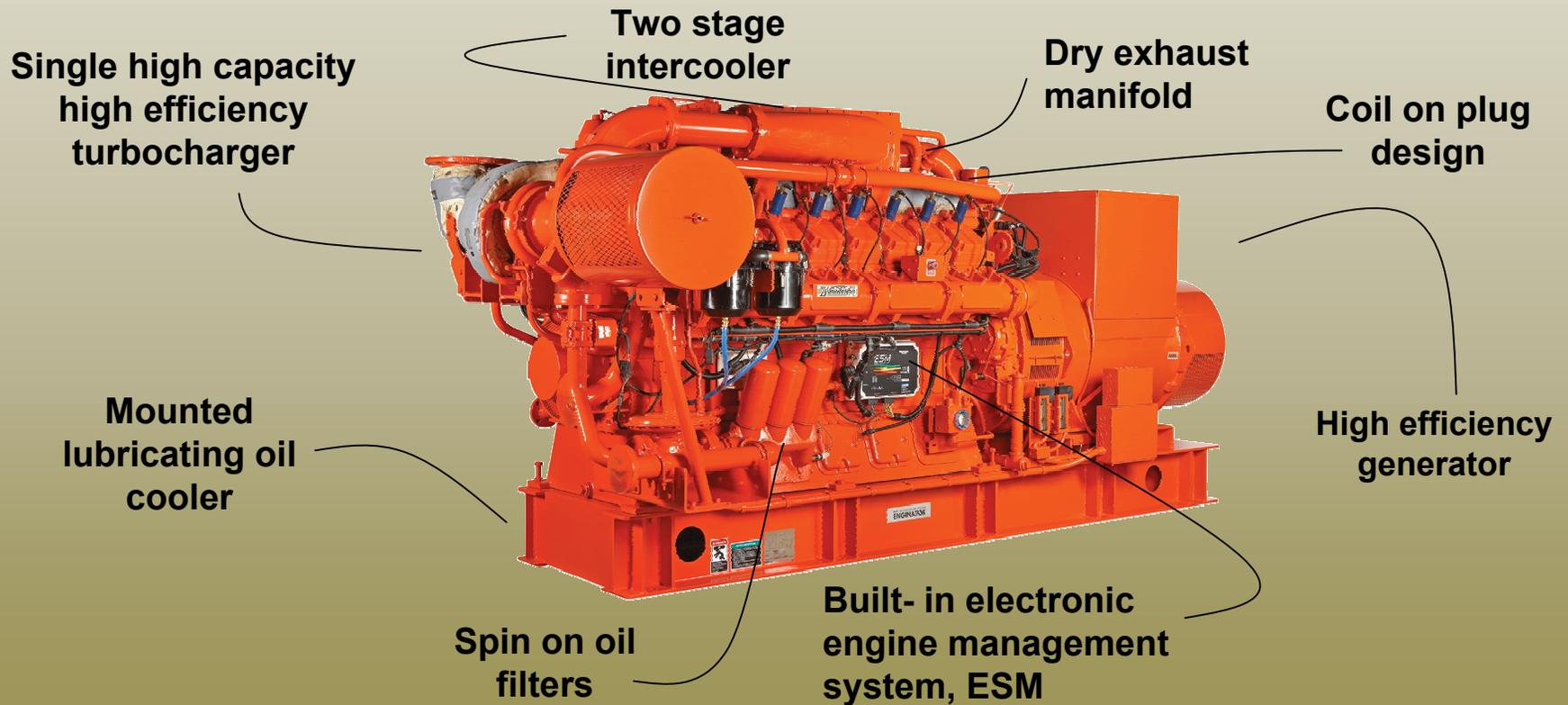


Miller Cycle Efficiency

- Through intake valve timing, compression ratio is 10:1 while expansion ratio is 14:1 resulting in low compression work, and high expansion output.
 - Provides comfortable knock margin and combustion pressure of 10:1 compression ratio.
 - Yields high efficiency benefit of 14:1 expansion ratio.



Compactness of Engines





Engine Performance

	60hz		50hz
Ratings:	1100kW		1000kW
Speed:	1800 rpm		1500 rpm
NOx:	1.0g	0.5g	½ TA Luft
BTE:	42.4%	41.1%	42.9%
Electrical Eff:	40.9%	39.6%	41.4%

Footprint

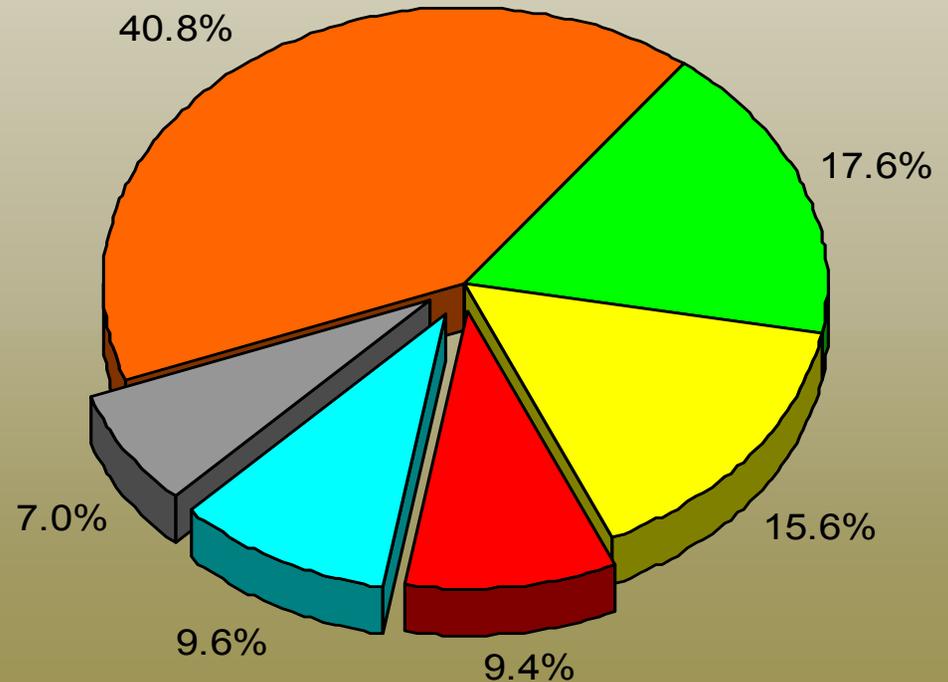
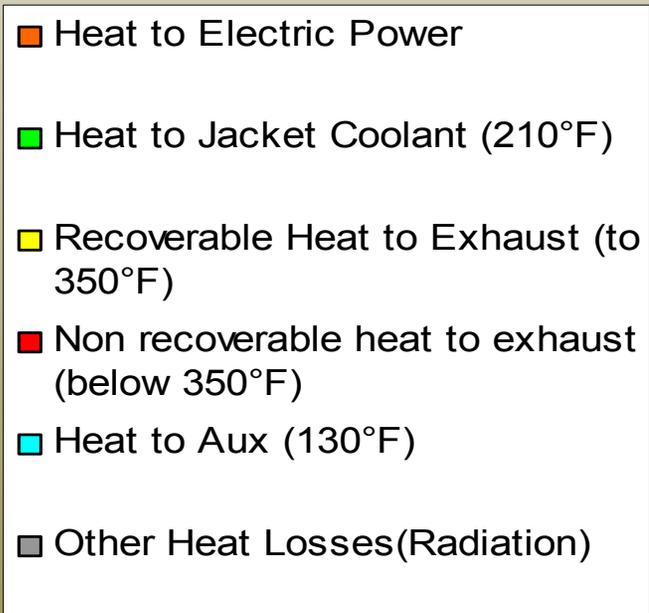
191”L x 85”W x 88”H

30,000 lbs





Waste Heat Recovery





Component Durability Observed

- Spark Plugs – 1500 hours
- Lube Oil – 1500 hours
- Cylinder Heads – 12,000 hours
- Power Cylinders – 24,000 hours
- Bearings – 24,000 hours



Product Comparison

60 Hz-1 g/bhp-hr NOx			
Make	Waukesha	Cat	GE Jenbacher
Model	APG1000	3512C	420
kW Rating	1100	1600	1063
Efficiency (electric)	41.0%	40.8	41.6%
Minimum Methane Number	80	80	75
Rated Altitude (ft)	1500	820	Sea level
Rated Air Temp. (°F)	100	77	77



Financial Comparison

	Natural Gas	Diesel
• Equipment (\$/kW):	350 - 600	300 - 400
• Installation Cost (\$/kW):	400 - 600	200 - 400
• Total Installed (\$/kW):	750 - 1200	500 - 800
• Fuel:	\$0.51/therm	\$2.10/gal
– Cost per kilowatt hour	\$0.0428/kwh	\$0.1533/kwh
– Cost per hour	\$47.08/hr	\$168.63/hr
• Lifecycle; 1MW (hrs):	12k; 36k	9k; 18
minor OH; major OH		
• Maintenance (\$/kW-hr)	\$0.006 - \$0.01	\$0.008 - 0.012
• Noise (dBA):	102 - 104	106 - 110



Maintenance Costs

- Lifecycle

- Oil, Spark Plugs, Planned

- Maintenance 1500hrs \$0.0038/kW-hr

- Top End 12,000hrs \$0.0010/kW-hr

- Major Overhaul 24,000hrs \$0.0028/kW-hr

- Total Estimated Lifecycle Cost \$0.0076/kW-hr

Note: Costs here do not include travel, meals, or lodging.



Elgin Community College



- 4,120 kW of Capacity
- 16,300 Lb/Hr of 15 PSIG Steam Production

- Qty - 4, Waukesha Model VHP5200GL
Rated 805 kW each
 - Ebullient Cooling System with 2,835 Lb/Hr of 15 PSIG Steam Each
- Qty -1, Waukesha Model VHP7100GSI
Rated 900 kW
 - Ebullient Cooling System with 4,960 Lb/Hr of 15 PSIG Steam





Municipal Digester – Blower Drive



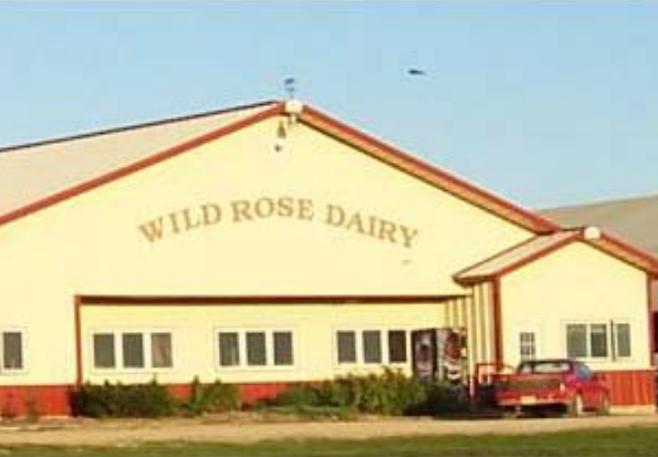
- 2063 BHP of Capacity on Natural Gas and Digester Gas
- Qty-1, Waukesha Model P9390GLU Dual Fuel
- Hot Water Heat Recovery from JW and Exhaust is about 5,557,000 Btu/Hr

Sanitary District of Hammond



Northwest Community Hospital Cogeneration





Wild Rose Dairy – 775 kW generator set with heat recovery in a container. Unit is in LaFarge, WI Commissioned in 2005

Charles EQUIPMENT CO.
Specialists in Engine Power Systems Since 1960



Janesville Landfill 3 MW Landfill Gas to Energy Facility



Rock River Water Reclamation District



- 2,475 kW of Capacity on Natural Gas and 2,250 kW of Capacity on Digester Gas
- Qty-3, Waukesha Model VGF48GLD Dual Fuel
 - Rated 825 kW on Natural Gas Each
 - Rated 750 kW on Digester Gas
- Hot Water Heat Recovery from JW and Exhaust is about 10,414,125 Btu/Hr Total
- Heat Recovered from JW and Exhaust is about 3,471,375 Btu/Hr each





Natural Gas Benefits Summary

- Economic Benefits
- Environmental Benefits
- Managed Customer Energy Costs



Questions?

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