

First Pan-American Symposium on Bargebuilding & Waterways
November 26 - 28, 2008 Montevideo, URUGUAY
Radisson Hotel



Repower of Old Mississippi River Pushboats at Parana and Paraguay Rivers

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Repower of Old Mississippi Pushboats



The Hidrovia Paraná-Paraguay is the most important waterway after the Amazonas river in South America.


This is the most important waterway because more than 6 million tons of bulk, general and liquid cargo are shipped by barge to or from Argentina, Brasil, Paraguay and Uruguay.

There are more than 1000 barges on the Hidrovia.

There are more than 100 workboats, divided between pushboats and auxiliary tugboats working at the river.

Many of them are old Mississippi pushboats with old EMD or GM engines with high diesel fuel and lube-oil consumption.

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Repower of Old Mississippi Pushboats

Situation Analysis:
Due to the fact that the pushboats have old EMD or GM engines and old gearboxes installed on board, the companies at the waterway have high diesel fuel and lube oil consumption, as well as problems with spare parts – low availability and high cost.

Estimated Fleet:
100 tugs, with 2-3 props. with 2-3 engines ranging from 1000-3000 hp per engine.

Project Basis:
The companies may repower the fleet with new marine diesel engines and gearboxes in the meantime they can build new ships specially adapted to the Parana-Paraguay river.
For this analysis, the pushboats are classified in two types of pushboats or projects:


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Repower of Old Mississippi Pushboats

- New Orleans Class
- Baton Rouge Class

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New Orleans Class

- Repower from 2 x 1750 hp to 2 x 2200 hp
- New power plant proposed:
- 2 x QSK60-M 2200 hp 1800 rpm + 2 new gearbox.
- 2 x KTA50-M2 2000 hp 1800 rpm + 2 new gearboxes
- 2 x KTA50-M2 1800 hp 1900 rpm + 2 new gearboxes

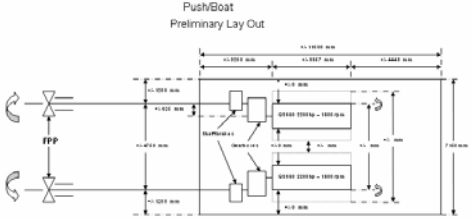
Comments: the pushboat will need an engineering evaluation regarding the current driveshaft and the new propellers.

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Repower of Old Mississippi Pushboats


PushBoat
Preliminary Lay Out



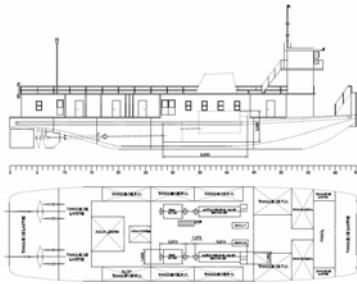
Note: This drawing is preliminary and approximate.
This drawing is not to scale.
This drawing is for information only.
All dimensions must be confirmed on each vessel in the class because all of the ships in each class are different.

Pushboat Project - Horizontal Offset

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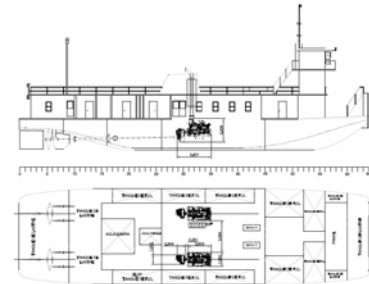


General Arrangement of an Old Mississippi Pushboat

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Repower of Old Mississippi Pushboats



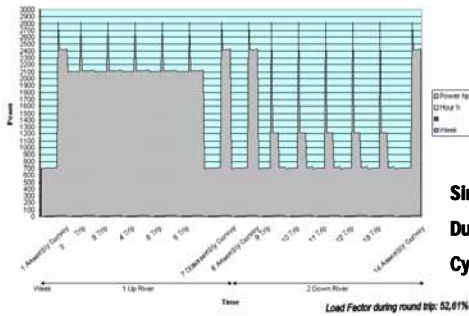
General Arrangement of the Repower of an Old Mississippi Pushboat

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Repower of Old Mississippi Pushboats

Duty Cycle P/B
Round Trip - 7 weeks



**Simulated
Duty
Cycle**

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Repower of Old Mississippi Pushboats

Duty Cycle for T.B.

Actual Power Plant: 2 x 16-645-E2 EMD 1750 hp
100% EMD's power = 1750 hp = 1304.07 kW
16-645-E7B EMD Fuel Consumption = 98.21 gal/hr = 239 gal/kWh
1 gal = 3,78541 liters
1 m³ = 264.172 gal

Hours of Operation	Percentage Load	Power Demand	Percentage Load	Number of Engines	Power Delivered	Fuel Consumption	Total Fuel Consumption	Pass / Fail
hr	%	hp	%		hp	gal/hr	gallons	
145	25	975	25	2	975	66	9,549	Pass
30	43	1505	43	2	1505	113	3,388	Pass
115	75	2625	75	2	2625	198	22,720	Pass
32	86	3010	86	2	3010	227	7,245	Pass
14	100	3500	100	2	3500	283	3,888	Pass
336							46,804	

The Diesel Oil price is an international price for the economic evaluation only

20 cycles per year >>>>	176 m ³ /cycle
20 cycles per year >>>>	148 tons/cycle
20 cycles per year >>>>	2,960 tons per year
USD 638 per ton >>>>	USD 1,888,398 per year
in 10 years >>>>	20,599 ton in 10 years
in 10 years >>>>	USD 18,883,081 in 10 years

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Repower of Old Mississippi Pushboats

Duty Cycle for T.B.

Actual Plant: 2 x 16-645-E2 EMD 1750 hp
100% EMD's power = 1750 hp = 1305 kW
Proposed: 2 x QSK60M 2200 hp 1800 rpm + new gearboxes with horizontal offset
QSK60M Fuel Consumption = 106 gal/hr = 403 l/h = 205 gal/kWh
QSK60M Output Power = 2200 hp = 1641 kW
1800 rpm = 839 g/h
1 gal = 3,78541 liters

Hours of Operation	Percentage Load	Power Demand	Percentage Load	Number of Engines	Power Delivered	Fuel Consumption	Total Fuel Consumption	Pass / Fail
hr	%	hp	%		hp	gal/hr	gallons	
145	25	975	25	2	1100	63	7,714	Pass
30	43	1855	43	2	1892	92	2,745	Pass
114	75	2625	75	2	3000	180	18,244	Pass
32	86	3010	86	2	3784	183	5,856	Pass
14	100	3500	100	2	4400	213	2,979	Pass
336							37,649	

Savings in Fuel Consumption in 10 years >>>> USD 3,628,617

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Duty Cycle for T.B.

Actual Plant: 2 x 16-645-E2 EMD 1750 hp
100% EMD's power = 1750 hp = 1305 kW
Proposed: 2 x QSK60M 2000 hp 1600 rpm + new gearboxes with horizontal offset
QSK60M Fuel Consumption = 96 gal/hr = 364 l/h = 149 gal/kWh
QSK60M Output Power = 2000 hp = 1491 kW
1600 rpm = 839 g/h
1 gal = 3,78541 liters

Hours of Operation	Percentage Load	Power Demand	Percentage Load	Number of Engines	Power Delivered	Fuel Consumption	Total Fuel Consumption	Pass / Fail
hr	%	hp	%		hp	gal/hr	gallons	
145	25	975	25	2	1000	48	6,967	Pass
30	43	1825	43	2	1700	87	2,479	Pass
114	75	2625	75	2	3000	144	16,671	Pass
32	86	3010	86	2	3440	165	5,259	Pass
14	100	3500	100	2	4000	192	2,031	Pass
336							34,004	

Savings in Fuel Consumption in 10 years >>>> USD 5,105,405

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Repower of Old Mississippi Pushboats

Duty Cycle for T.B.

Actual Plant: 2 x 16-445-E2 EMD 1750 hp
 100% EMO's power = 1750 Hp = 1305 kW

Proposed: 2 x KTA50M2 1800 hp 1900 rpm + new gearboxes with horizontal offset
 KTA50M2 Fuel Consumption = 84 gal/hr = 318 l/h
 KTA50M2 Output Power = 1800 Hp = 1342 kW
 1900 rpm = 838 g/h
 T.G.M. = 3.78541 liters

Hours of Operation	Percentage Load	Power Demand	Percentage Load	Number of Engines	Power Delivered	Fuel Consumption	Total Fuel Consumption	Pass / Fail
hr	%	hp	%	hp	gal/hr	gal/hr	gal/hr	Criteria
145	25	875	25	2	905	42	6,090	Pass
30	43	1505	43	2	1548	72	2,187	Pass
115	75	2625	75	2	2700	126	14,490	Pass
32	86	3010	86	2	3096	144	4,632	Pass
14	100	3500	100	2	3600	168	2,252	Pass
336							25,731	

113 m³/cycle
 94 m³/cycle
 20 cycles per year >>>> 1,880 tons per year
 US\$ 636 per ton >>>> USD 1,204,371 per year
 In 10 years >>>> 12,043,709 in 10 years
 In 10 years >>>> USD 6,840,272

Savings in Fuel Consumption in 10 years >>>> USD 6,840,272

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Repower of Old Mississippi Pushboats

Time Between Overhaul

Engine	Fuel	Rating	Application	Rated Fuel Consumption (RFC)	Assumed Power Factor (APF)
QSK50M	Diesel Oil	2200 hp 1800 rpm	Pushboat	106,4 gal/hr	52,65%

Life Cycle
Duty Cycle - Round Trip (Cycle)

24 hours per day
 14 days per cycle
 336 hours per round trip (C-Cycle)
 20 cycles per year
 6,720 hours per year
 67,200 hours in 10 years
 200 cycles in 10 years

Time Between Overhaul (TBO)

Cummins Cummins Inc. has established the following total fuel consumption to overhaul (TFCO) values for Cummins engines.

1,000,000 US gal

Using the following formula the TBO for marine engines can be determined:

$$TBO = \frac{TFCO}{APF \times RFC} = \frac{1,000,000}{52,65\% \times 106,4} = 17,851 \text{ hours}$$

If the service time per year is: 6,720 hours the life to overhaul is: 2,7 years

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Repower of Old Mississippi Pushboats

Baton Rouge Class

- Repower from 2 x 2750 hp to 2 x 2800 hp
- New power plant proposed:
- Diesel electric power plant (Siemens-Cummins)

Comments: the pushboat will need an engineering evaluation regarding the current driveshaft and the propellers (the propellers may be kept because they only have to deliver an additional 50 hp to the water).

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Repower of Old Mississippi Pushboats

Baton Rouge Class

- Diesel electric power plant (Siemens-Cummins)
- The diesel electric power plant consist in:
 - 2 electric motors for propulsion 2,08 MW - 900 rpm
 - 4 gensets (KTA50-D(M1) + Siemens 1FJ3)
 - 2 Masterdrive frequency converters
 - 2 transformers with filters for ship consumption
 - 1 Principal distribution panel for propulsion and for ship consumption

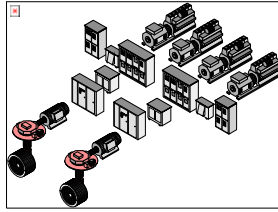
Comments: This power plant would use the current gearboxes and driveshafts.

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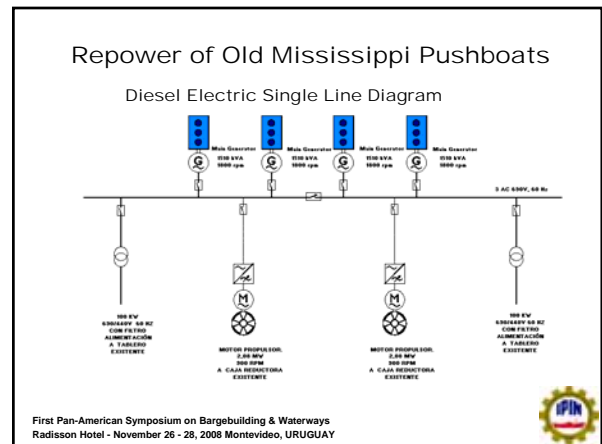
Repower of Old Mississippi Pushboats

Diesel Electric Propulsion System Components

- Main Diesel - Generators.
- Main Distribution Panel.
- Frequency converters.
- Electric propulsion, with driveshaft and f.p.p., c.p.p. or POD systems.
- Integrated Monitoring, Alarm and Control system.



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Repower of Old Mississippi Pushboats

Time Between Overhaul

Engine	Fuel	Rating	Application	Rated Fuel Consumption (RFC)	Assumed Excess Factor (APF)
KTA50-Q(M1)	Diesel Oil	1730 hp 1800 rpm	Pushboat	76.8 gal/h	52.61%

Life Cycle

Duty Cycle - Round Trip (Cycle)

24 hours per day
 14 days per cycle
 336 hours per round trip (Cycle)
 20 cycles per year
 6,720 hours per year
 67,200 hours in 10 years
 200 cycles in 10 years

Time Between Overhaul (TBO)

Cummins Cummins Inc. has established the following Total Fuel Consumption to Overhaul (TFCO) values for Cummins engines as follows:

720,000 US gal

Using the following formula the TBO for marine engines can be determined:

$$TBO = \frac{TFCO}{APF \times RFC} = \frac{720,000}{52.61\% \times 76.8} = 17,820 \text{ hours}$$

If the service time per year is: 6,720 hours the life to overhaul is: 2.7 years

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Repower of Old Mississippi Pushboats

Project Summary

		USD	
New Orleans Class (2 driveshafts)	KTA50M2	1200K	per ship
	QSK60M	1400K	per ship
Baton Rouge Class (2 driveshaft)		3300K	per ship

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Project Savings

		Inversion	Savings in 10 years
New Orleans Class	KTA50M2	1200K x 4	4800K
	QSK60M	1400K x 4	6800K x 4
Baton Rouge Class		3300K x 5	16500K
			6000K x 5
			21300K
			30000K
			58800K

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Delivery of engines and equipment

New Orleans Class	180/210	days
Baton Rouge Class	180/210	days

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Points to be supported along the rivers



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Repower of Old Mississippi Pushboats

Advantages of Repower with New Marine Diesel Engines and Gearboxes

- Put the fleet in a new standard
- Lower initial investments
- Fuel savings than old engines
- Savings in spare parts and maintenance (cost and availability)
- Maintain the same hull with low modifications:
 - update driveshafts and the propellers
 - update the propulsion and auxiliary systems
 - the operation of the plant is simple and cheaper

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- IPIN
- Universidad de la Marina Mercante
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- Cummins, Inc. – Marine Business Unit
- Cummins Argentina
- Cummins Uruguay
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