Inland Rivers Marine Engine Re-Power Emission Review

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Purpose

- Evaluate new marine EPA Tier regulations and how Tier II, III & IV Cummins Certified Re-powers can significantly impact our environment.

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Agenda

- EPA Marine Tier Regulations
- Future EPA Marine Tier levels
- Tier II Re-Power Vessel Case Studies
- Future Marine Products
- Conclusion

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EPA Marine Tier Regulations

- In the past decade, the EPA has introduced the following mandated marine emission regulations.
  - Tier I Expired End 2006 Annex VI to Marpol (73/78) or IMO
  - Tier II Expires End 2011
  - Tier III
  - Tier IV
- The current EPA Tier II enforcement is expected to expire in 2011 and Tier III will take effect for future Re-Power opportunities.

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EPA Marine Tier Regulations

- US EPA Marine Tier 1
  - 40 CFR 94 Dated 2/28/2003
- EPA Tier II Marine Regulation is enforceable on 20 May 2005 and may be retroactive for vessels built after January 1, 2000.
- The current EPA Tier II enforcement is expected to expire in 2011 and Tier III will take effect for future Re-Power opportunities.

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EPA - Implementation

U.S. EPA - Tier 2 and Tier 3**

Displacement (L/cyl)		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
< 0.9	>75kW	Tier 2					Tier 3						
0.9 - 1.2		Tier 2						Tier 3					
1.2 - 2.5		Tier 2							Tier 3				
2.5 - 3.5		Tier 2						Tier 3					
3.5 - 7.0		Tier 2					Tier 3						

** EPA Tier 2 and Tier 3 implementation based on displacement

U.S. EPA Tier 4***

kW	(HP)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
600-1399	805 - 1876											Tier 4	
1400-1999	1877 - 2681										Tier 4		
2000 - 3700	2682 - 4962								Tier 4				

*** EPA Tier 4 implementation based on maximum engine power

L/cyl	Engine
0.9 – 1.2	B-Series
1.2 – 2.5	C Series, M11
2.5 – 3.5	QSK/V Series
3.5 – 7.0	QSK60

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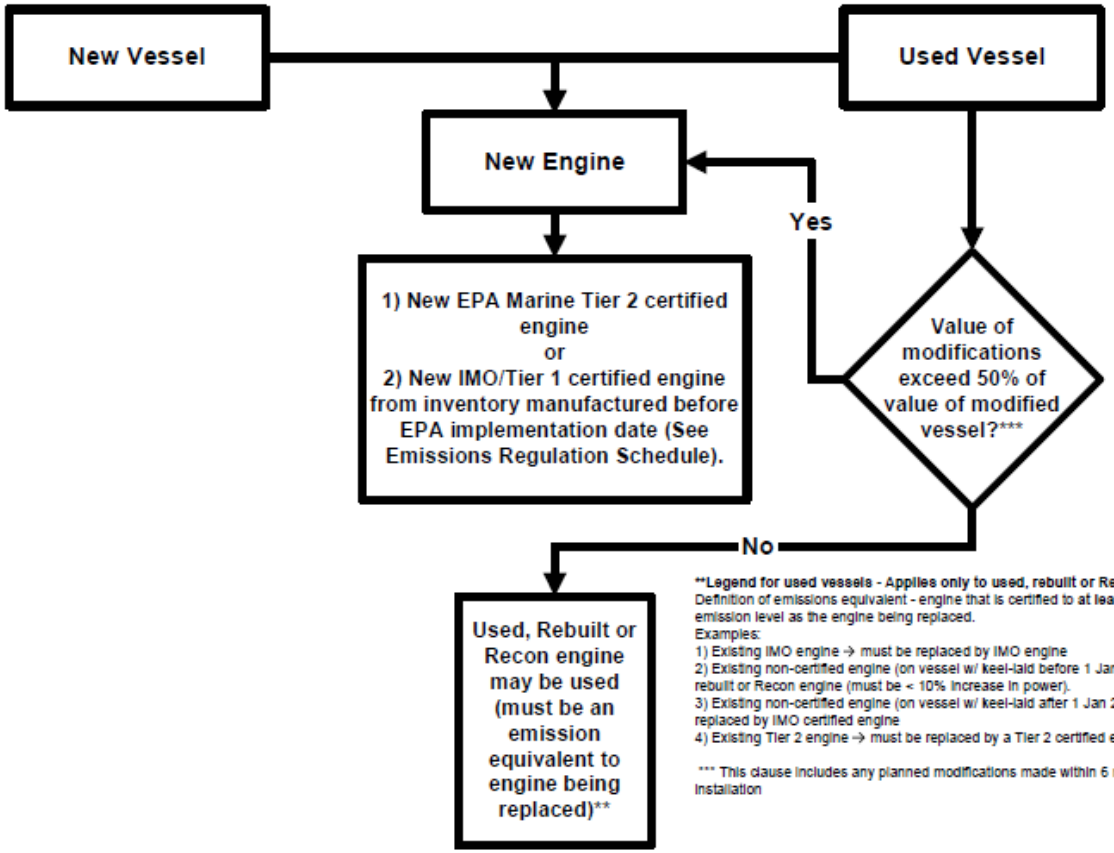
EPA Marine Tier Regulations

Tier 2 Decision Tree



**Legend for used vessels - Applies only to used, rebuilt or Recon engines.
Definition of emissions equivalent - engine that is certified to at least the same emission level as the engine being replaced.
Examples:
1) Existing IMO engine → must be replaced by IMO engine
2) Existing non-certified engine (on vessel w/ keel-laid before 1 Jan 2000 → any used, rebuilt or Recon engine (must be < 10% increase in power).
3) Existing non-certified engine (on vessel w/ keel-laid after 1 Jan 2000 → must be replaced by IMO certified engine
4) Existing Tier 2 engine → must be replaced by a Tier 2 certified engines.

*** This clause includes any planned modifications made within 6 months of engine installation

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Future EPA Marine Tier Levels

- On March 14, 2008, the US EPA signed the final rule for marine Tier 3 and Tier 4.
- Tier III is enforceable January 2012.
- Looking ahead, new marine EPA Tier III & IV regulations represent the most dramatic reduction of emission levels to date for the industry.

	Phase-in beginning	NOX	PM Reduction*
Tier 3**	2012	20%	50%
Tier 4	2014	80%	90%

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* Compared to Tier 2 standards

** 2009 implementation for product < 0.9 L/cyl and < 19kW

Tier II Re-Power Vessel Case Studies

- MV Anne Peters - *Ingram Barge*
- MV Trojan Warrior - *American Commercial Lines*
- MV Thelma Parker – *Tennessee Valley Towing*

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Tier II Re-Power Vessel Case Studies

MV Ann Peters - *Ingram Barge*

- 99’ x 32’ Lemay Barge & Supply
- Original Power 1974:

  T/S GM 8-645E2 1,000 HP
- Re-Power 2008:

  T/S Cummins QSK50-M 1,600 HP

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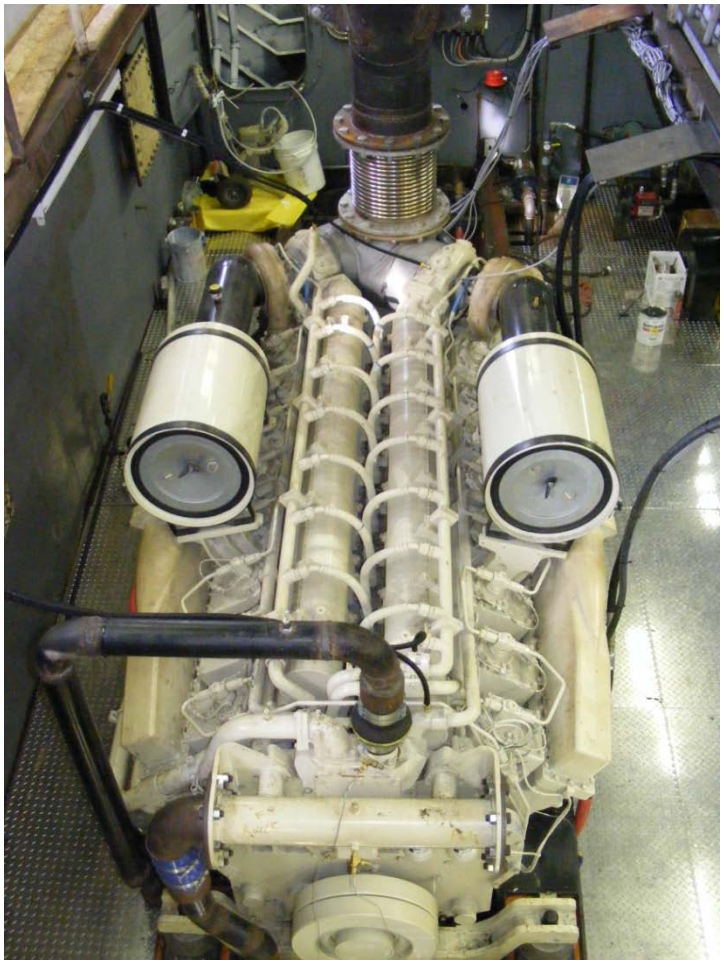
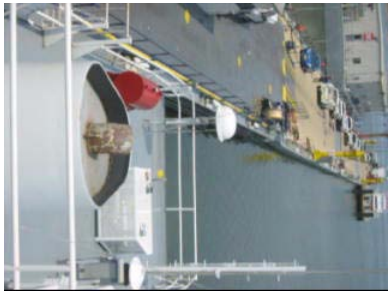
Tier II Re-Power Vessel Case Studies



MV Ann Peters - *Ingram Barge*



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Tier II Re-Power Vessel Case Studies

MV Ann Peters - *Ingram Barge*

EMD 8-645E2

	bsfc	NOx	PM
	(gal/kw-hr)	(g/kw-hr)	(g/kw-hr)
Brake Specific	0.074	18.41	0.553

		NOx	PM
Fuel Specific		(g/gal)	(g/gal)
(@ 7.1 lb/gal)		248.8	7.5

	Gal/Yr	NOx	PM
		(kg/yr)	(kg/yr)
Emissions/Yr	527,837	131,317	3,945

Cummins QSK50

	bsfc	NOx	PM
	(gal/kw-hr)	(g/kw-hr)	(g/kw-hr)
Brake Specific	0.071	6.53	0.09

		NOx	PM
Fuel Specific		(g/gal)	(g/gal)
(@ 7.1 lb/gal)		92.5	1.3

	Gal/Yr	NOx	PM
		(kg/yr)	(kg/yr)
Emissions/Yr	479,852	44,383	612

Fuel Savings Gal/Yr	47,985

Emissions Reductions in kg/yr for the vessel after repower

	Gal/Yr	NOx	PM
kg/yr		86,934	3,333
tons per yr (English)		95.8	3.7
% reduction	-9%	-66%	-84%

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Tier II Re-Power Vessel Case Studies

MV Trojan Warrior - *American Commercial Lines*

- 110’ x 34’ Dravo Corp.
- Original Power 1976:

  T/S GM 8-645E7B 1,600 HP
- Re-Power 2010:

  T/S Cummins QSK50-M 1,600 HP

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Tier II Re-Power Vessel Case Studies

MV Trojan Warrior- *ACL*

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Tier II Re-Power Vessel Case Studies

MV Thelma Parker – *Tennessee Valley Towing*

- 85’ x 32’ Orange Shipbuilding
- Original Power 1977:

  T/S F- M 38D8 1/8 1,000 HP
- Re-Power 2010:

  T/S Cummins QSK38-M 1,200 HP

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Tier II Re-Power Vessel Case Studies

MV Thelma Parker - *TVT*

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Tier II Re-Power Vessel Case Studies

MV Thelma Parker - *TVT*

- TVT's New Rule of Thumb:
- ½ the fuel consumption and 1/10 the oil as compared to similar EMD powered vessels

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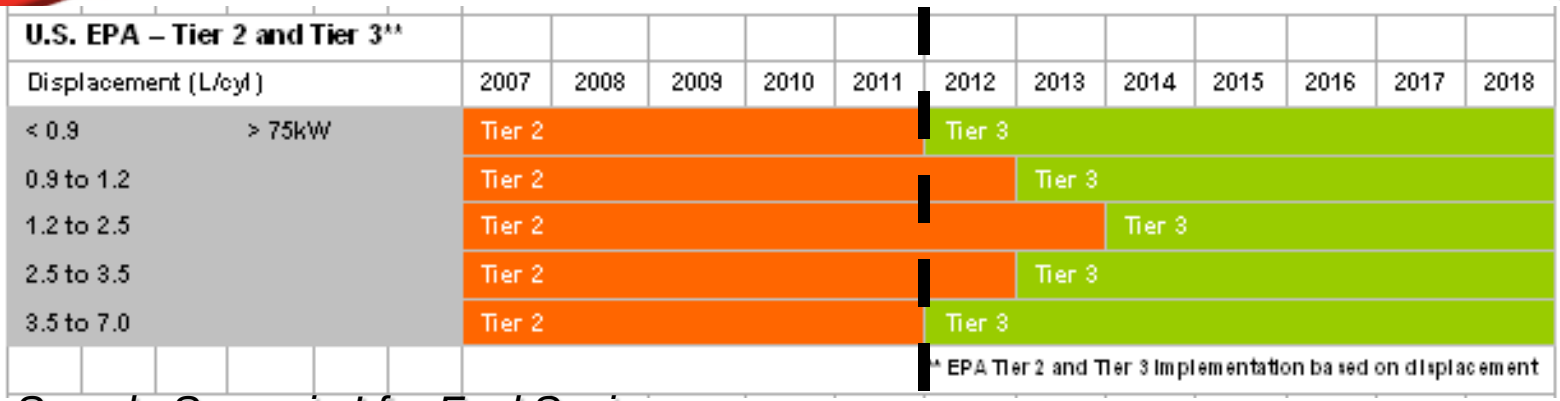
Tier II Re-Power Vessel Case Studies



Sample Scenario I for Fuel Savings

- Twin Screw vessel (1 Vessel, 2 Engines)
- Average Load Factor of Push boat = 48%

Predict 12-15% Fuel Penalty

Twin Screw Installation	Tier 2 Product	Tier 3 Product (Predicted)
Average Load Factor	48%	48%
Fuel Consumption (gal/hr @ rated)	99.4	114.31
Total Operating Hours per year	8,000	8,000
Fleet Fuel Consumption (Gallons/yr)	763,392	877901
Price of Fuel per Gal	$3.00	
Increased Consumption due to T3	114,509	
Yearly Cost penalty for twin screw	$343,526	

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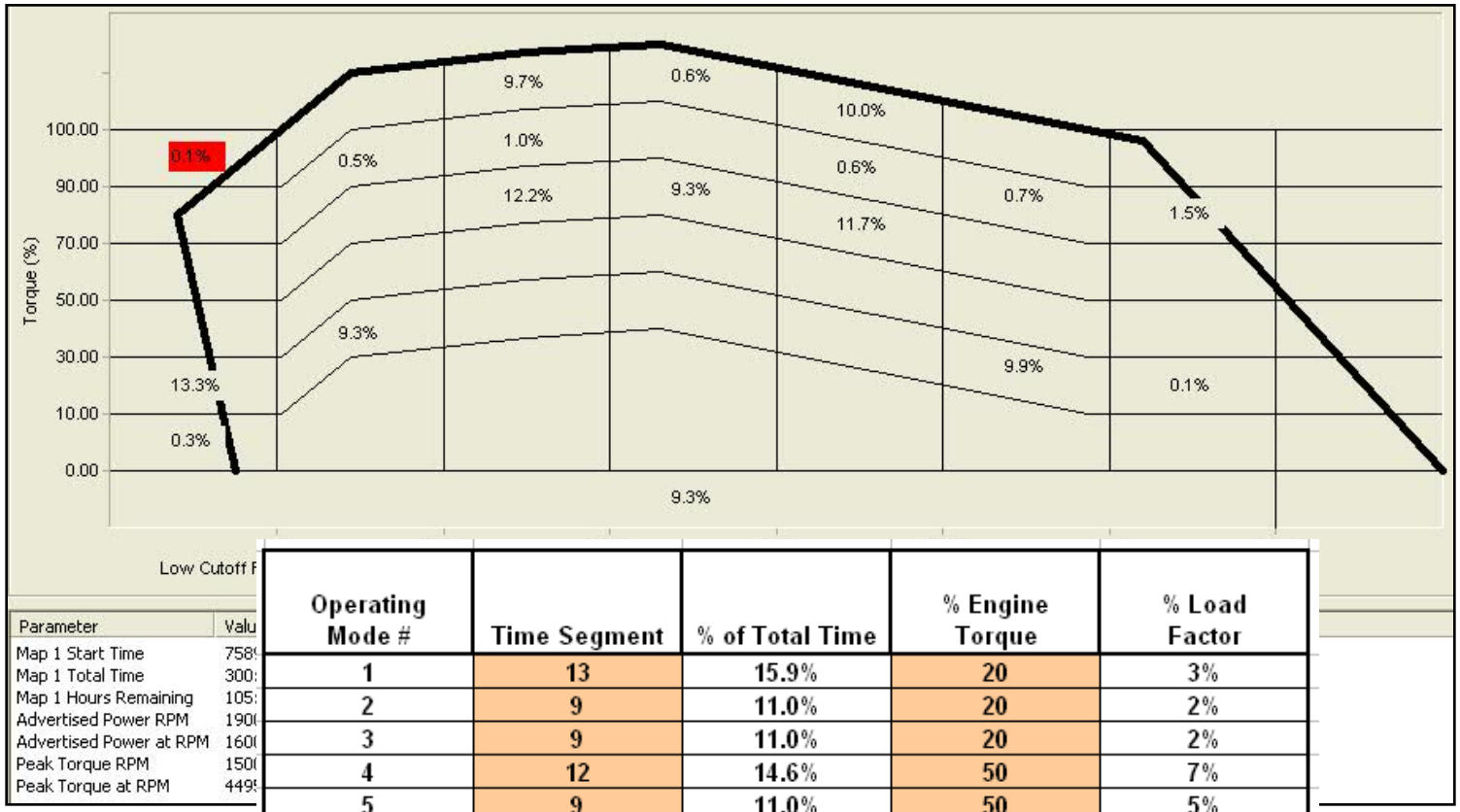
Tier II Re-Power Vessel Case Studies

- Average load factor ~48%



Parameter	Valu
Map 1 Start Time	758
Map 1 Total Time	300
Map 1 Hours Remaining	105
Advertised Power RPM	190
Advertised Power at RPM	160
Peak Torque RPM	150
Peak Torque at RPM	449

Operating Mode #	Time Segment	% of Total Time	% Engine Torque	% Load Factor
1	13	15.9%	20	3%
2	9	11.0%	20	2%
3	9	11.0%	20	2%
4	12	14.6%	50	7%
5	9	11.0%	50	5%
6	11	13.4%	50	7%
7	9	11.0%	90	10%
8	10	12.2%	90	11%
9				
10				
Totals:	82		Average Load Factor	47.9%

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Tier II Re-Power Vessel Case Studies

- Lube oil consumption penalty*:
  - **High speed engines consume less oil as compared to their medium speed counter parts.**
  - **Sample Scenario: Wartsila – 0.4g/kW-hr vs. CMI – 0.1% of Fuel Consumption**

	Medium Speed	Tier 2	Tier 3
Lube Consumption (gal/hr @ rated)	0.2891	0.047712	0.0548688
Total Operating Hours per year	8,000	8,000	8,000
Sample size Vessels	1	1	1
Fleet Lube Consumption (Gallons/yr)	4,625	763	878
Price of Lube per Gal	$8.00		
Savings in Lube Oil Consumption		3,862	3,747
Potential Savings over medium speed		**$30,893**	**$29,977**

* Theoretical estimates are based upon published numbers.

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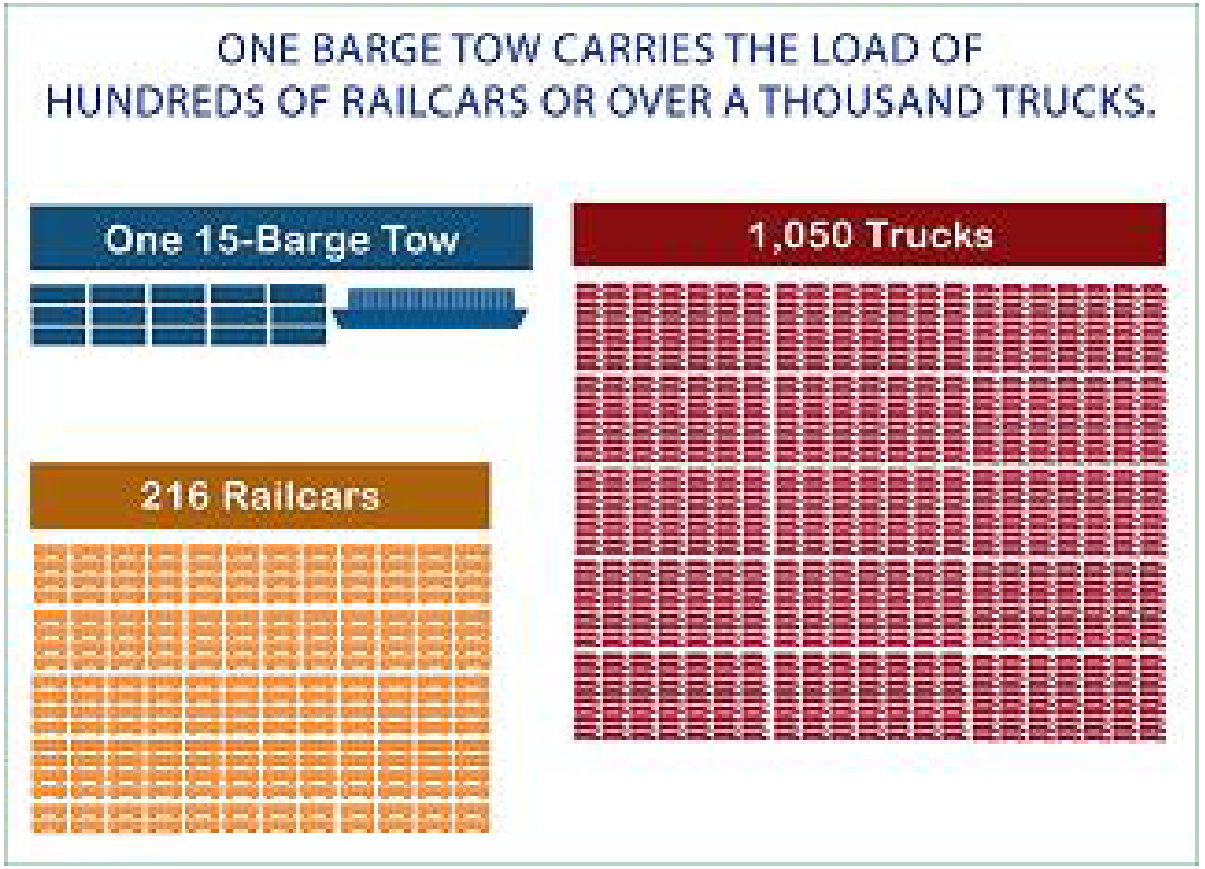
Tier II Re-Power Vessel Case Studies



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Future Marine Products

- Cummins product plan is designed to implement the right technology for each market we serve
- As we approach each set of implementation dates, Cummins plans to offer a complete line-up of engines certified to the new emission standards for Re Powers and New Build projects

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Conclusion

- Cummins is committed to meeting or exceeding clean air standards worldwide
- New marine emission regulations present a significant technological hurdle for engine manufacturers
- You can count on Cummins to provide information on the regulations for Re Power opportunities
- Cummins will have the Right product, utilizing the Right technology at the Right time.

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