

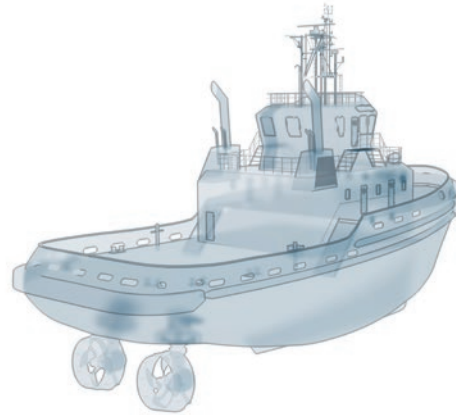
# HIGH SPEED SOLUTIONS FOR HARBOR AND TERMINAL TUGBOATS



## ALL THE PULL YOU NEED

Handle the heaviest loads in the toughest conditions with Cat® marine engines. Whether in the harbor or at your terminal, our dependable high-speed engines will help give you all the bollard pull you need. High-speed engines are particularly suitable for vessels that have variable power needs in terms of acceleration time, bollard pull and maneuverability.

Caterpillar is developing innovative propulsion solutions for harbor and terminal tugs, where high-speed diesel engines form part of a fully integrated propulsion system. Our products are designed and tested to reduce your overall costs—with low fuel consumption rates and longer maintenance intervals, your business will see more uptime, productivity and profit.



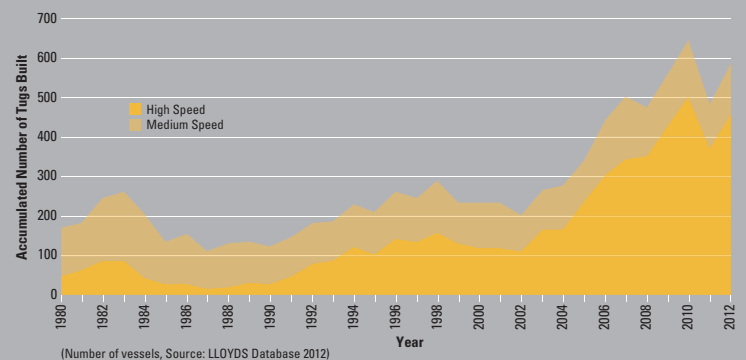
## THE PREFERRED OPTION

Making sure large vessels—sometimes carrying hazardous cargo—can safely navigate the waterways and get in and out their docks is a demanding business. In efforts to not keep a cargo vessel waiting, it may not be uncommon for you to arrive in advance as the ship makes its way up the river or is still being loaded. That means that many of your vessels are constantly running.

Though Harbor and Terminal tugboats operate an average of 1,000–3,000 hours per year, approximately 80% of that time is spent running at less than 20% of engine load. Subsequently, one important criterion when selecting the right engine for your tugboat is the load profile. In the 1980's, around 70% of the tugs built were equipped with medium-speed engines. Today, nearly 90% of the harbor and terminal tugs being built are equipped with high-speed engines.

Looking at third party data (*Fig. 1*), there is a clear shift from medium-speed engines to high-speed engines in harbor and terminal tugs:

**Fig. 1: High-speed engines are the number one choice in the Tug and Salvage industry**





## TRUE BENEFITS

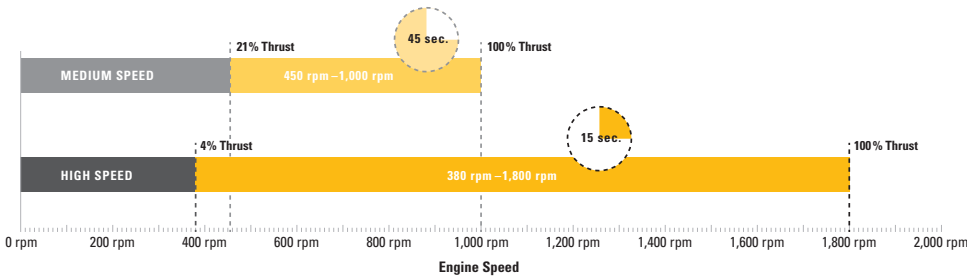
- Decades of high-speed experience in the tug market ensure maximum uptime and profitability.
- Superior response time and maneuverability give you an edge for close-quarters maneuvering and rough waters, enhancing safety.
- The better performance of Cat high-speed engines, reduced low-load fuel consumption, longer time between overhauls, and lower installation costs substantially reduce engine lifecycle costs.

# TIME TO MAXIMUM POWER

Demands for quick response from your vessel and increased safety in both normal operation or emergency situations may prompt you to consider high-speed diesel engine options. Compared to their medium-speed counterparts, high-speed engines have a wider operating band from idle to full load with much stronger acceleration, resulting in better performance and maneuvering. Generally, fuel economy is maximized when acceleration time is minimized (Fig. 2).

Another inherent cost advantage is the combination of a high-speed engine with a Fixed Pitch Propeller (FPP), whereas a medium-speed engine would require a more complex and cost-intensive installation of a slipping clutch or Controllable Pitch Propeller (CPP).

**Fig. 2: Acceleration time and operating RPM Band – a comparison at maximum power (0 – 100%)**



High-speed engines with a power range up to 1,800 rpm are able to accelerate from idle speed at 380 rpm (4 % thrust) to full load (100 % thrust) in a 15 sec. period, compared to the lower speed engine idling at 450 rpm (21 % thrust) to full load (100 % thrust) in 45 sec.

# SIZE AND WEIGHT

The task of creating a powerful tugboat can become daunting. Critical points for you could be a combination of equipment costs due to vessel shape, engine horsepower, physical size and weight of the engines, or even drive line components.

**Fig. 3: Installation of high-speed engines is less complicated with lower costs**

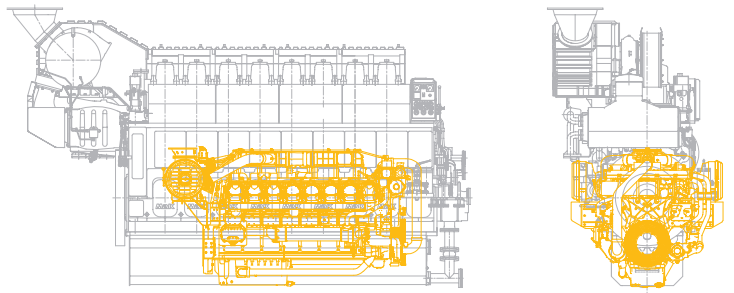
**High Speed Engine**

Dimensions: 100 %, Weight: 100 %

**Medium Speed Engine**

Dimensions: 225 %, Weight: 300 %

High-speed engines are typically three times smaller in size and weight compared to medium-speed engines (Fig. 3), providing you more space in the engine room for maintenance and likely making a larger vessel design unnecessary.



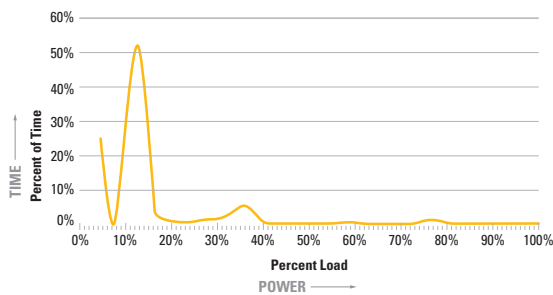
Further, high-speed engines reduce the maximum torque in drive line components such as shafts, bearings, clutches and flexible couplings. Components for your vessel will become smaller and lighter, ultimately reducing both the initial and long-term maintenance costs.

# FUEL CONSUMPTION

Similar to everyone else in the transportation business, you are likely experiencing the increasing challenges of fuel management. Needless to say, retanking can generate a huge invoice from your fuel supplier.

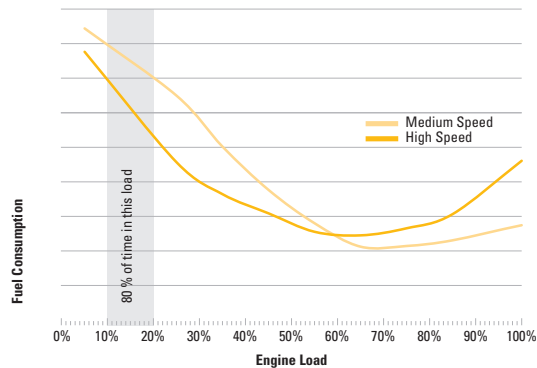
Cat high-speed engines are ideally suited for your tugboat and will provide excellent fuel economy. Since harbor and terminal tugboats spend most of their time at low load (Fig. 4), high-speed engines consume much less fuel at lower loads than do medium-speed engines (Fig. 5).

Fig. 4: Operational Profile – Harbor & Terminal Tugboats



Conversely, medium-speed engines are more efficient at high load, but the point where the fuel curves of high- vs. medium-speed engines cross is around 50–70% of full engine load.

Fig. 5: Relative Fuel Consumption 65T Harbor & Terminal Tugboat Solution



# OPERATIONAL COST

Many tugboat owners and operators have been trading water the past years. Like everywhere in the shipping industry, fuel prices have taken center stage. Increasingly, fuel efficiency is necessary to maintain your profitability, both now and in the future. Looking at the chart (Fig. 6), fuel costs represent approximately 90% of the overall operating costs for both high-speed and medium-speed engines. Service and spare parts costs are slightly more for high-speed engines, due to the fact that more cylinders have to be serviced and maintained than for a medium-speed engine. But the efficient fuel economy of a high-speed engine more than compensates for the additional maintenance cost. Looking at the relative running cost of high-speed and medium-speed engines over a 15-year period, it's clear to see that the operating costs for high-speed engines are lower, with savings between 10 and 12%. (Fig. 7)

Even if you cut out the lower initial costs of an engine, the high-speed engine operational cost is much more economical for harbor and terminal towage.

Fig. 6: Operational standard costs

Medium-Speed Harbor & Terminal Tugboat (2200 h/year)      High-Speed Harbor & Terminal Tugboat (2200 h/year)

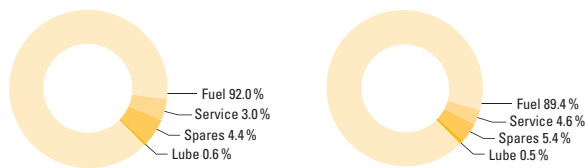
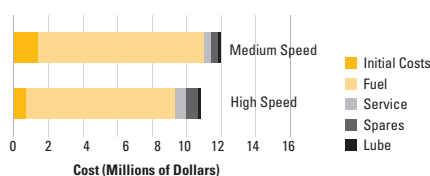


Fig. 7: Operational cost structure over a 15-year period



# THE ULTIMATE CHOICE

We're sure high-speed engines have tremendous benefits for harbor & terminal tugboats and are the right solution for you, but please review the chart (Fig. 8) if you still aren't convinced – it provides a quick overview of all the points highlighted in this brochure. High-speed engines are truly the best value for your business, providing more uptime, productivity, and profit.

In an ever-changing tugboat industry, the increasing demands for propulsion and energy efficiency drive owners and operators to invest greater financial resources into better, more efficient vessels and solutions. Caterpillar Marine has invested significantly into this field and is able to give owners and operators the ability to make educated decisions in the early design stage with operational requirements as the only input.

● Good ●● Better ●●● Best

**Fig. 8: Benefits of high-speed engines**

Harbor & Terminal Tugboats	High Speed Engine	Medium Speed Engine
Cost of Installation	●●●	●
Ease of Installation	●●●	●●
Capital Cost	●●●	●●
Fuel Consumption	●●●	●
Response Time (Maneuverability and Safety)	●●●	●●
Usable rpm Band (Idle – Full Speed)	●●●	●●
Emissions Level	●●●	●●●
Parts and Service Costs	●●	●●●
Reliability and Durability	●●●	●●●
Customer Service Network	●●●	●●●





## The Power You Need.

The Cat and MaK™ brands of Caterpillar Marine offer premier high- and medium-speed propulsion, auxiliary, and generator set solutions, as well as optional dual fuel, diesel-electric, and hybrid system configurations. With the launch of Caterpillar Propulsion our comprehensive and evolving product line gives customers one source for the most extensive engine power range available, complete propulsion systems, controllable pitch propellers, transverse and azimuth thrusters, and controls. Cat and MaK products and technologies are proven reliable and are built to last in all marine applications, demonstrating superior productivity and the lowest lifecycle cost.

The Cat Global Dealer Network, more than 2,200 global service locations strong, ensures that you'll have local expertise, highly-trained technicians, rapid parts delivery, and the proper equipment and services to keep you working – anytime, anywhere.

Construction, term, or repower financing through Cat Financial helps you make Cat and MaK power a reality. With our knowledge of customer needs, local markets, and legal and regulatory requirements, we've been providing tailored financing solutions and exceeding expectations since our start in 1986.

For more information and to find your local dealer, please visit our website: [MARINE.CAT.COM](http://MARINE.CAT.COM)

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