Advanced Development of Medium Speed Gas Engine Targeting to Marine

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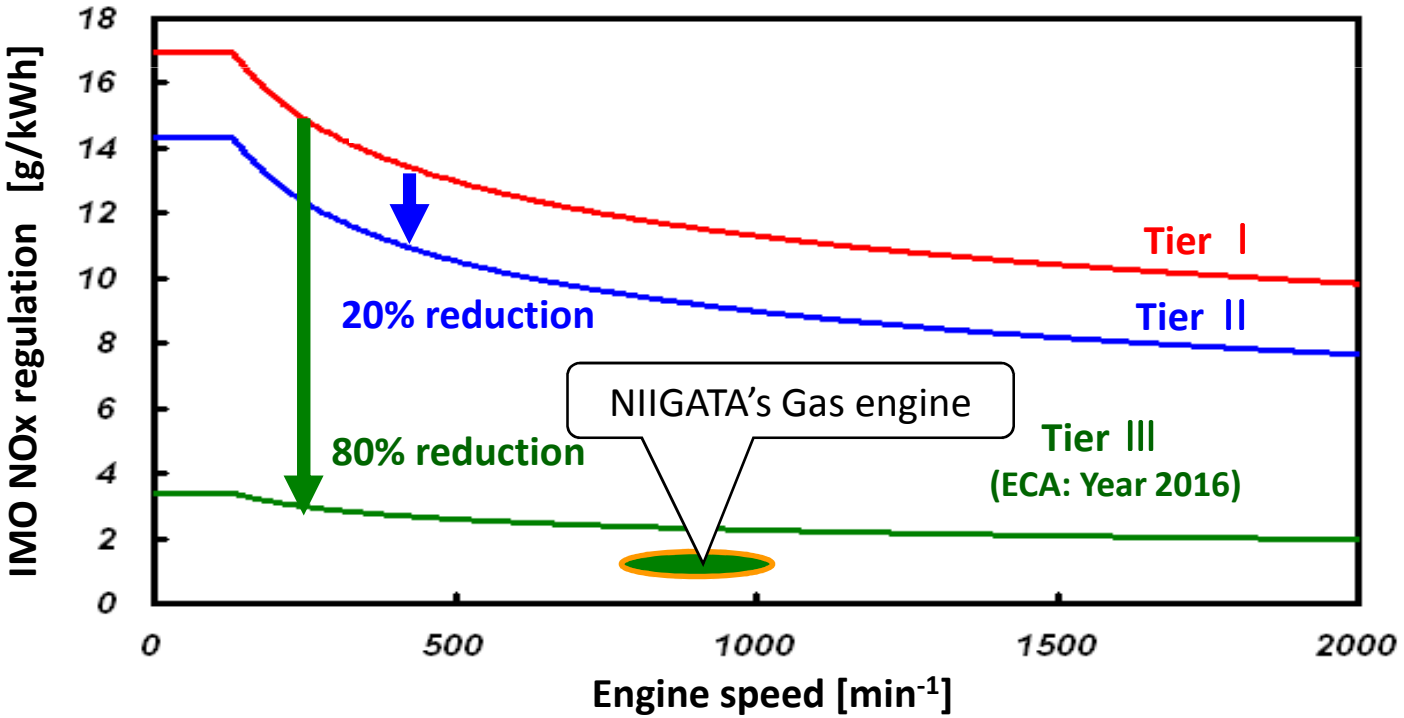
Background

- Nowadays, regulation of exhaust emission from engines is becoming more strict year by year in the marine field, and it is difficult to fulfill the regulation by diesel engine itself.

- Gas fuelled engines emit low NOx, therefore it is possible to satisfy the regulation by the engine itself.（One of solution）



New Marine Gas Engine

Gas-fueled engines for marine application

Related to IMO NOx emission standards

Niigata new gas engine is “dual-fuel engine”.

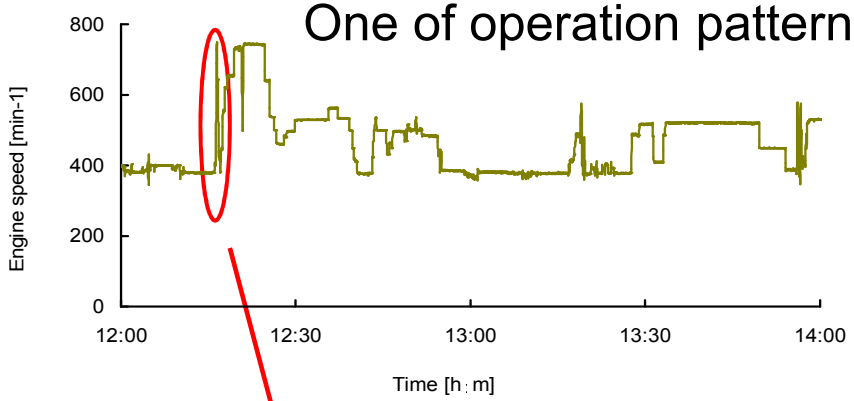
The engine can operate as an ordinary diesel engine and also as a gas engine. Even if one of the gas supply components malfunctions while operating in the gas mode, the ship can continue running by switching the engine to the diesel mode.

The dual-fuel engine provides redundancy for the ship’s propulsion system, which is one of the most important features for safety operation.

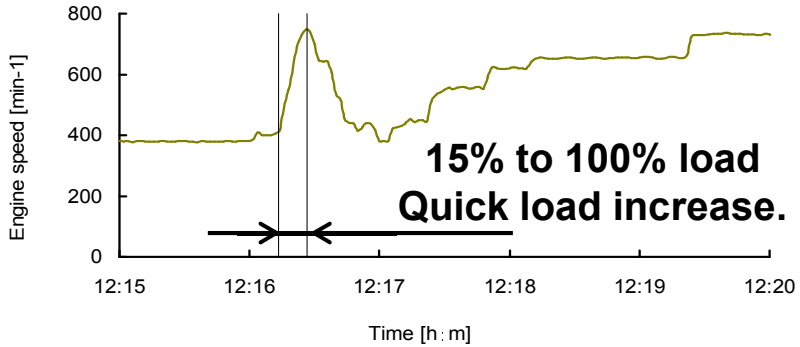
New Marine Gas Engine

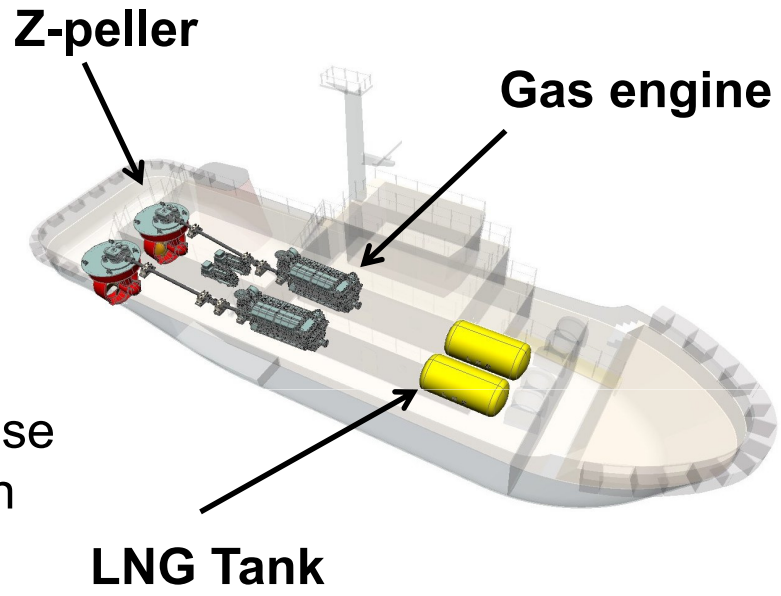
Target of ships

One of operation pattern



Maximum quick load increase
in above operation pattern

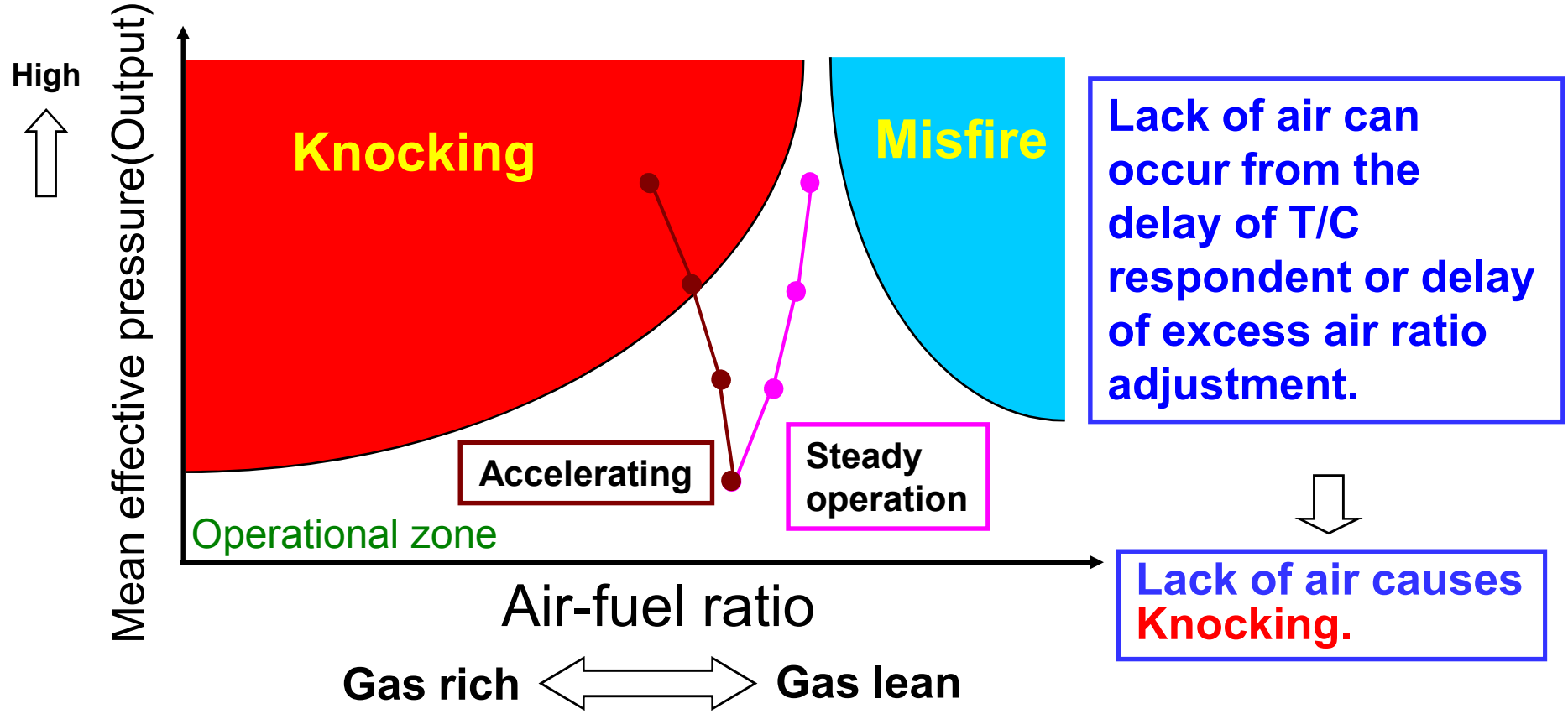




Tugboat with direct drive in heaver is target.

Quick load increase is demanded at tugboat operation.

Transient performance
（Excess air ratio during acceleration）



Lack of air can occur from the delay of T/C respondent or delay of excess air ratio adjustment.

Lack of air causes Knocking.

New Marine Gas Engine

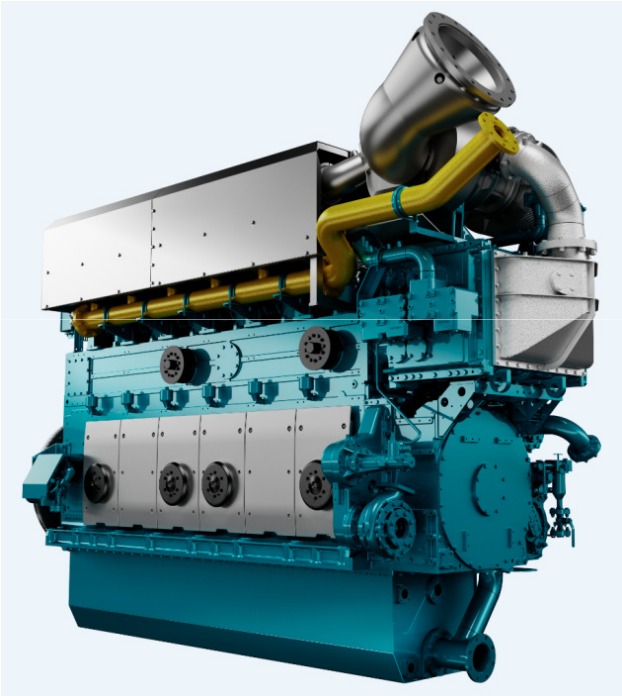
Gas mode

- ✓ IMO NOx Tier III compliant
- ✓ Same load transition characteristics as current diesel engine
- ✓ Same output and flexible mode change between diesel and gas at any load
- ✓ Quick mode change to diesel mode in case emergency
- ✓ Knocking free operation

Diesel mode

- ✓ IMO NOx Tier II compliant

Specification of Marine gas engine

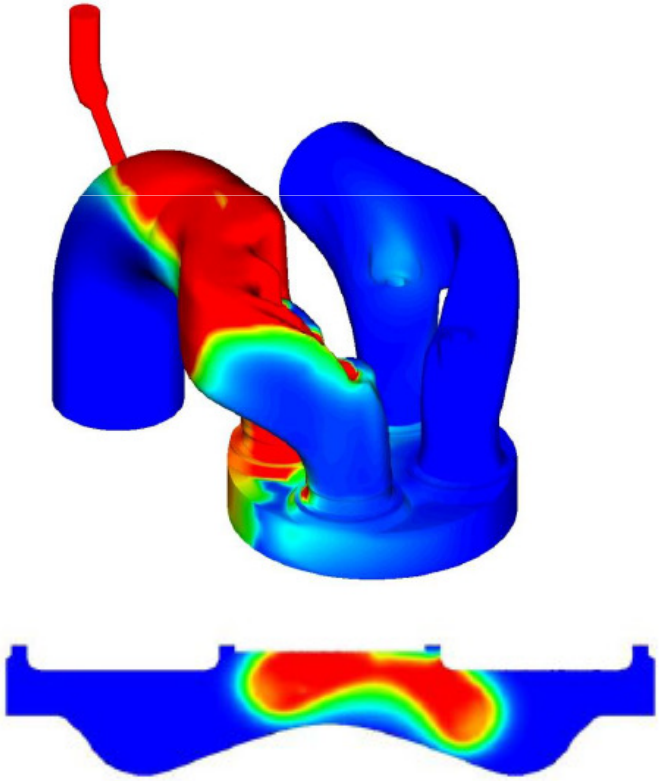


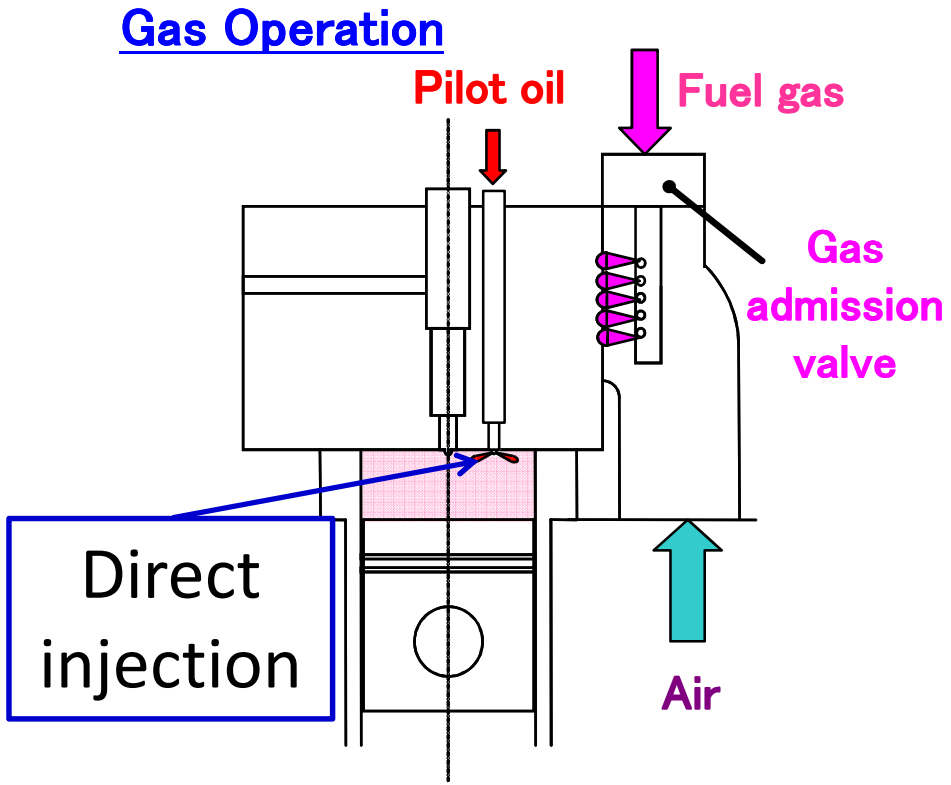
Items	Specification
Developed engine	6L28AHX-DF Dual fuel engine
Ignition method (gas mode)	Direct injection Micro pilot ignition
B.M.E.P.	2.0 MPa
Fuel gas	LNG, NG (gas phase) MN=65
Fuel oil	MDO

Key concept of ignition method

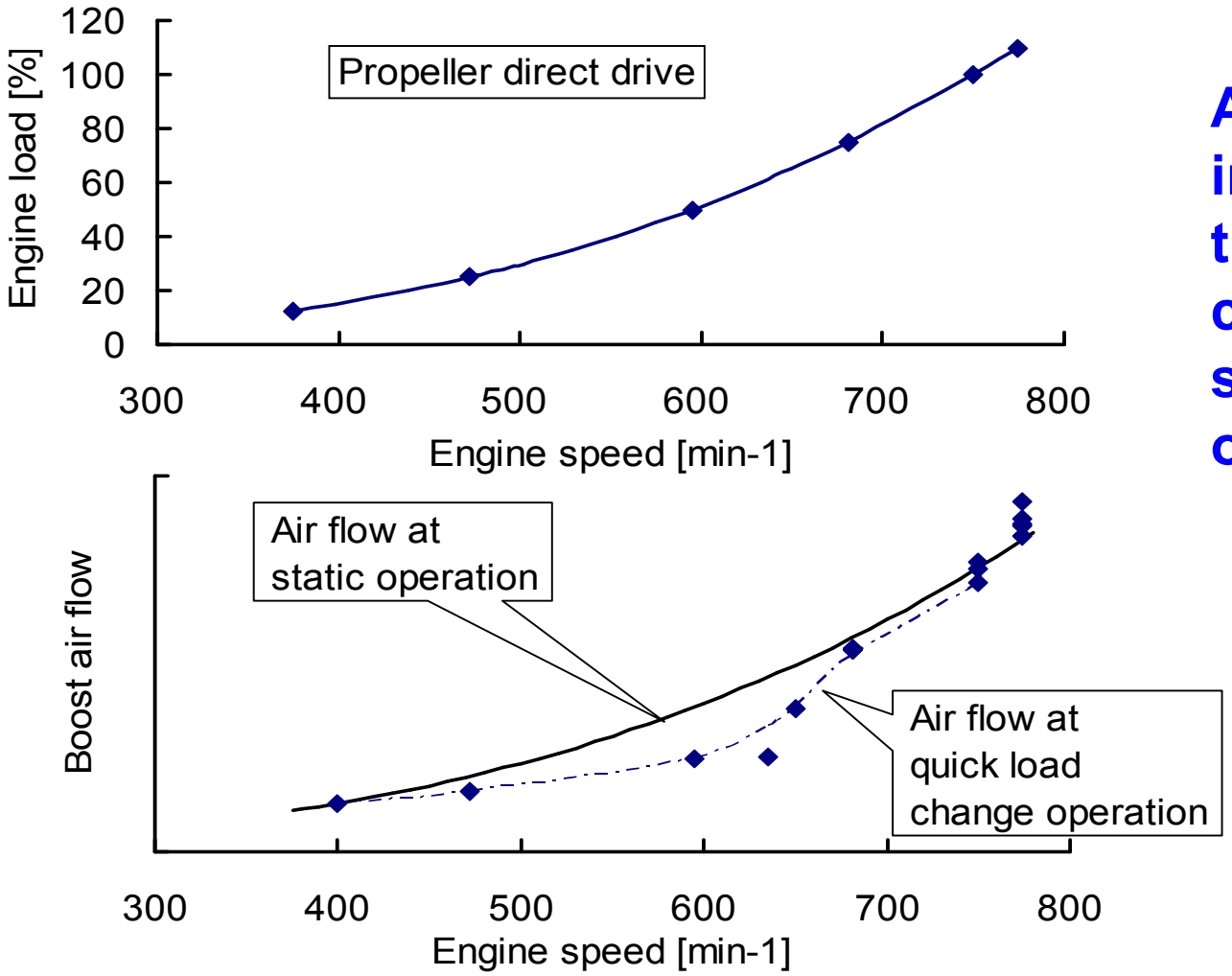
Utilization of simulation for certain combustion

The micro pilot combustion by direct injection was achieved with the utilization of simulation, designing appropriate injector specification and combustion chamber.



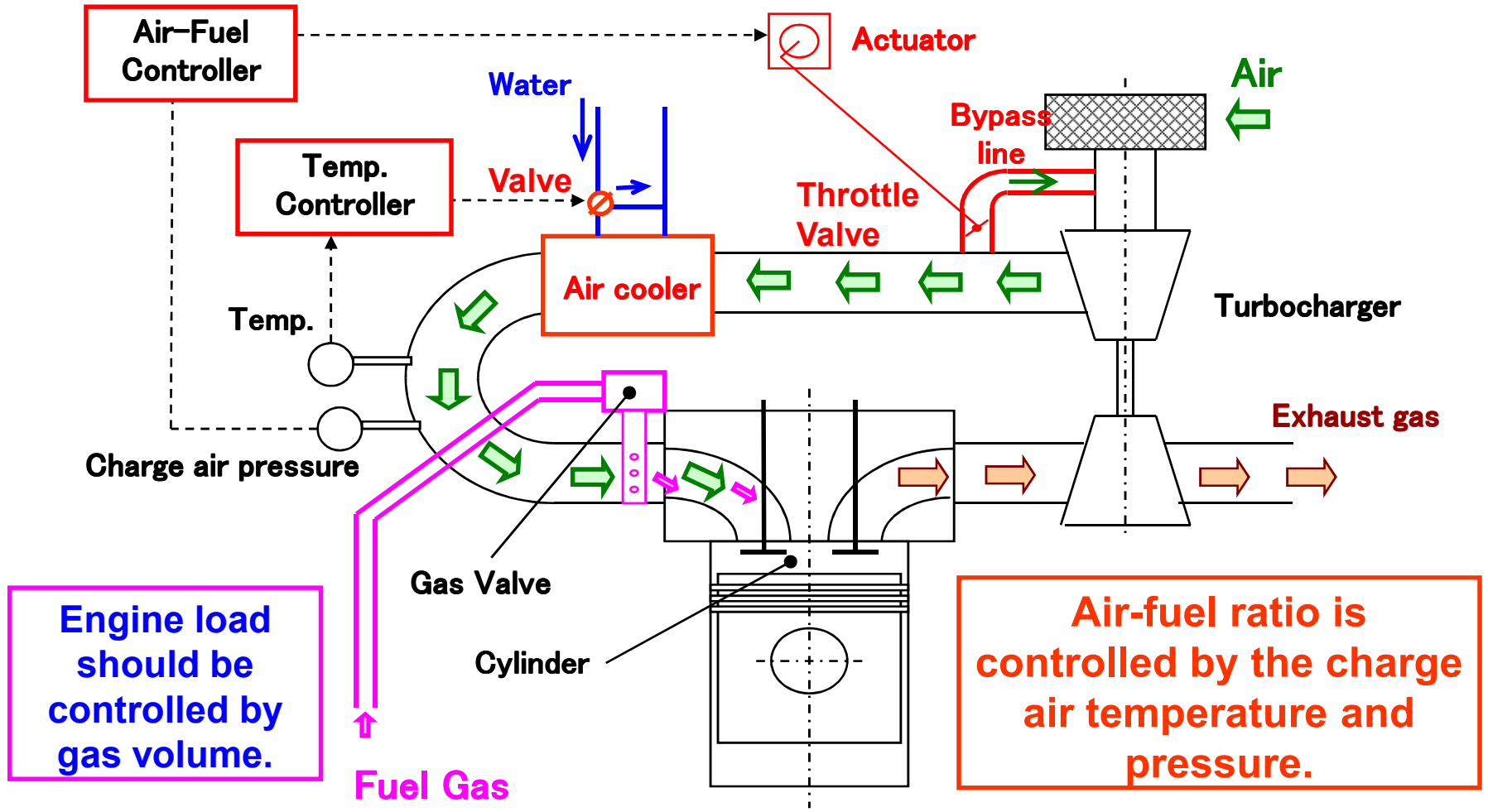


Quick load change operation

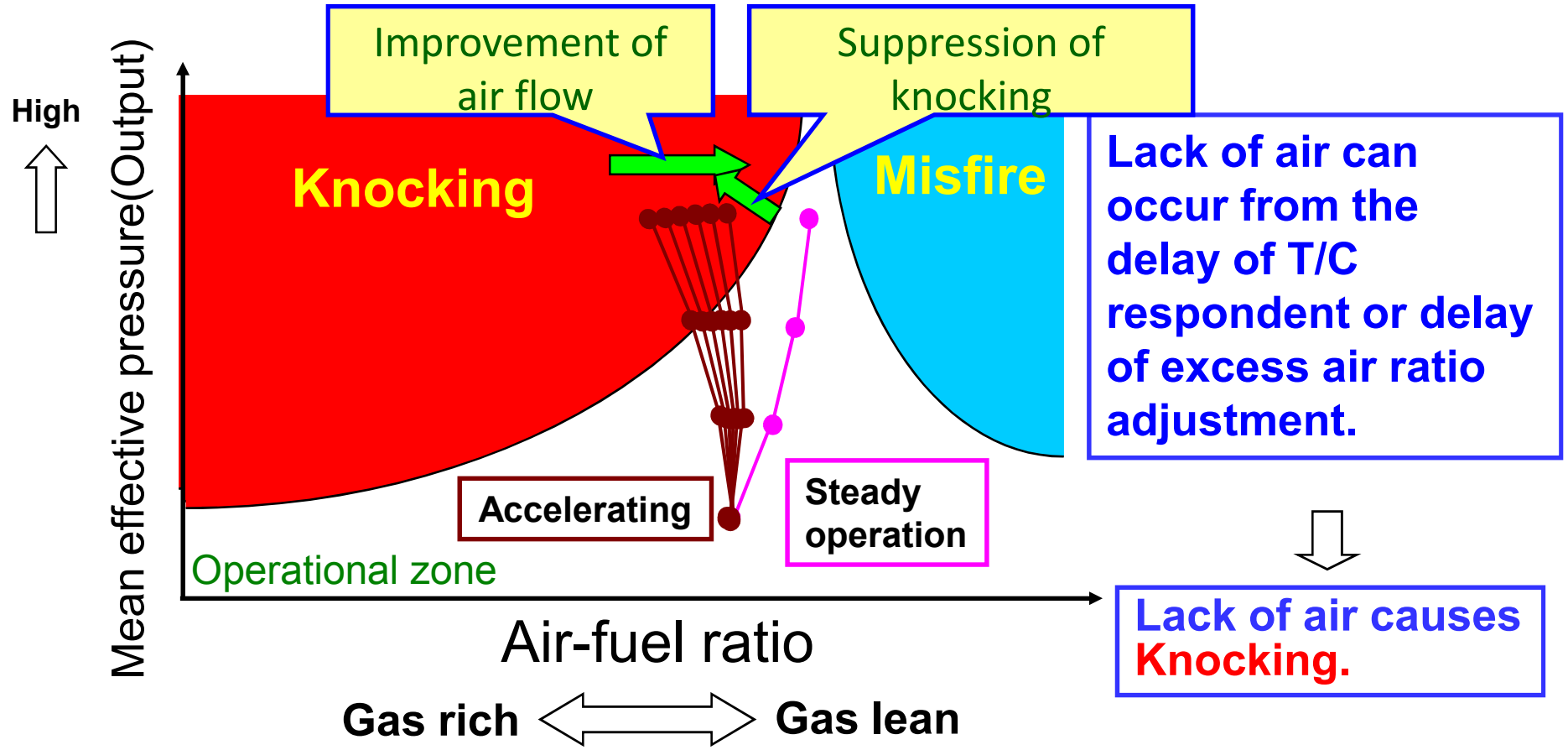


At quick load increase, turbocharger cannot supply a sufficient amount of air.

Air-fuel control



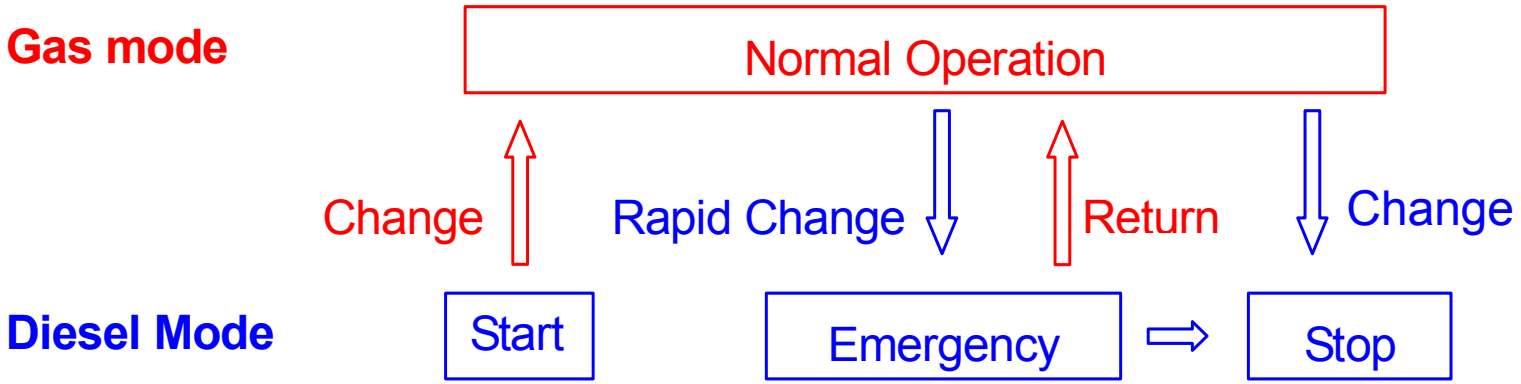
Transient performance
（Excess air ratio during acceleration）



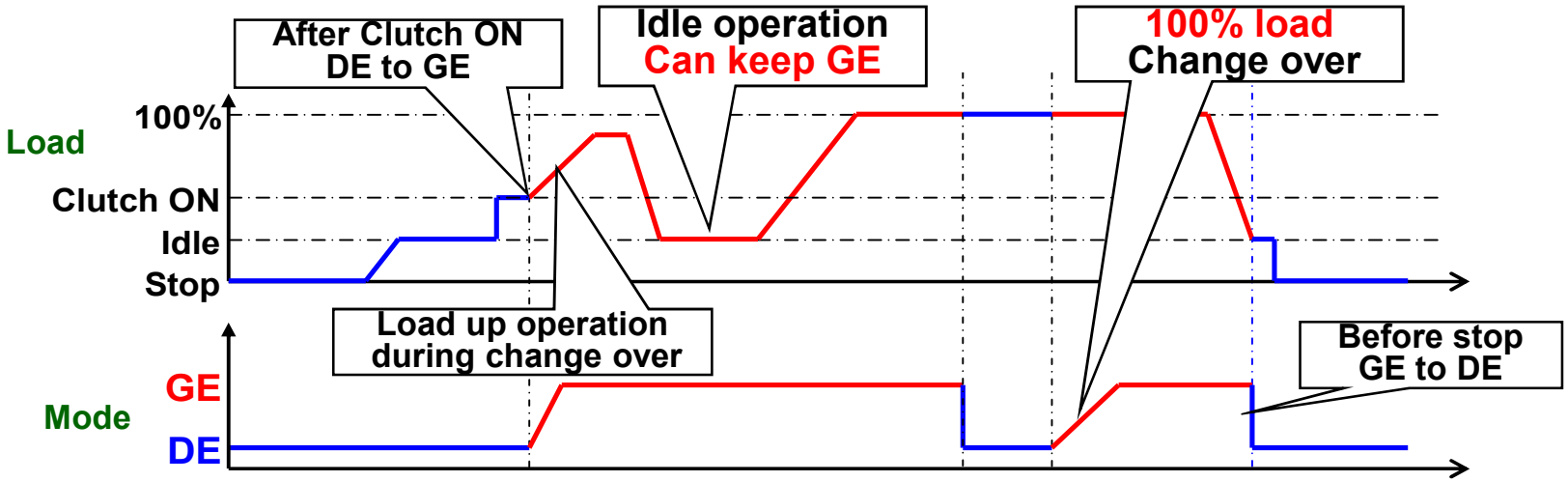
To improve transient performance , secure of sufficient air flow and suppression of knocking is necessary

Operation

Operation concept



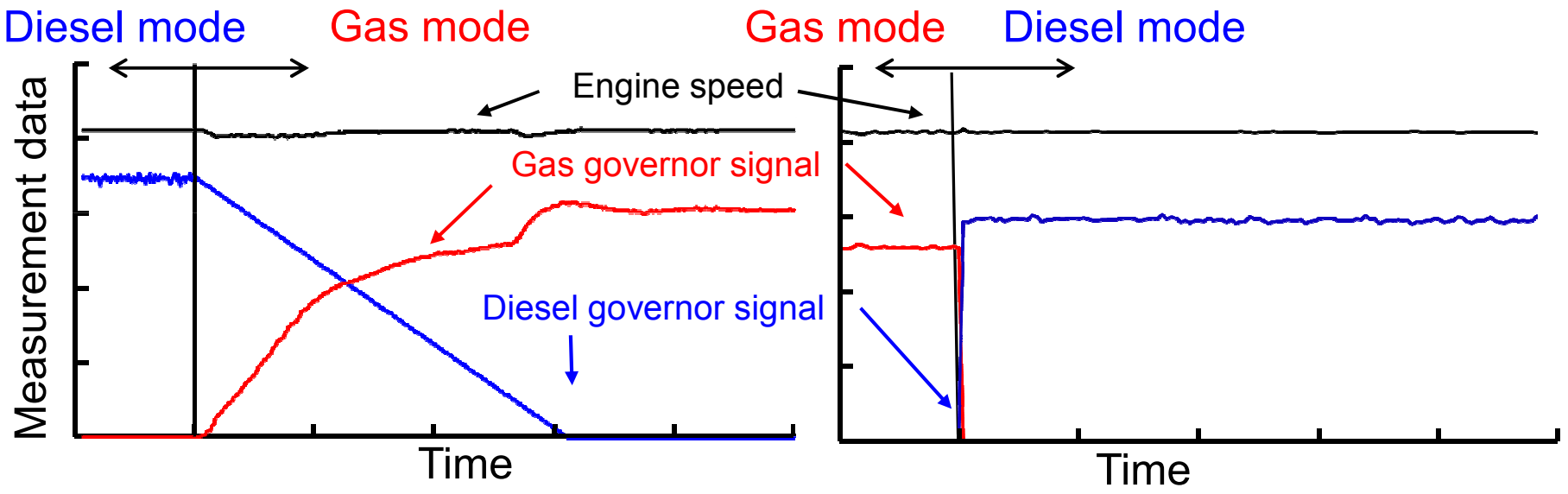
Operation pattern



Switching of engine operation mode

Normal gas mode change

Emergency diesel mode change

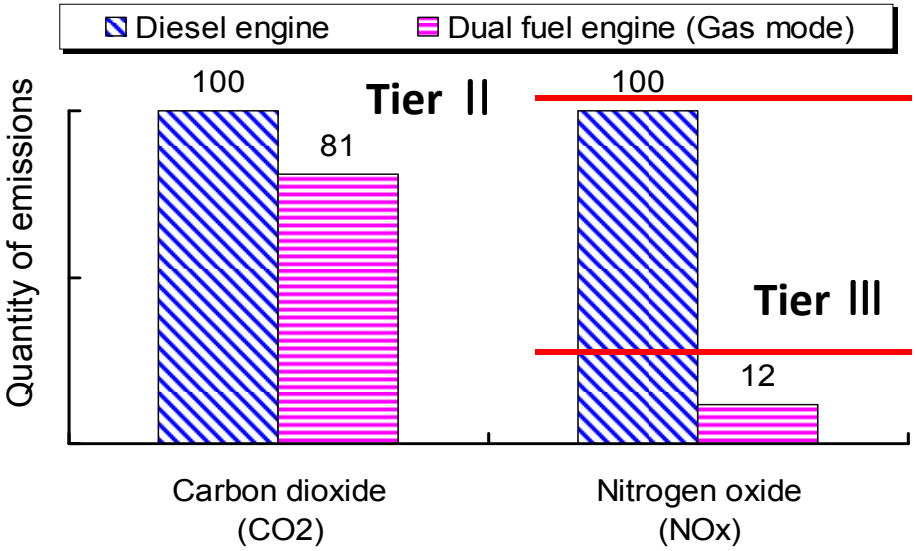


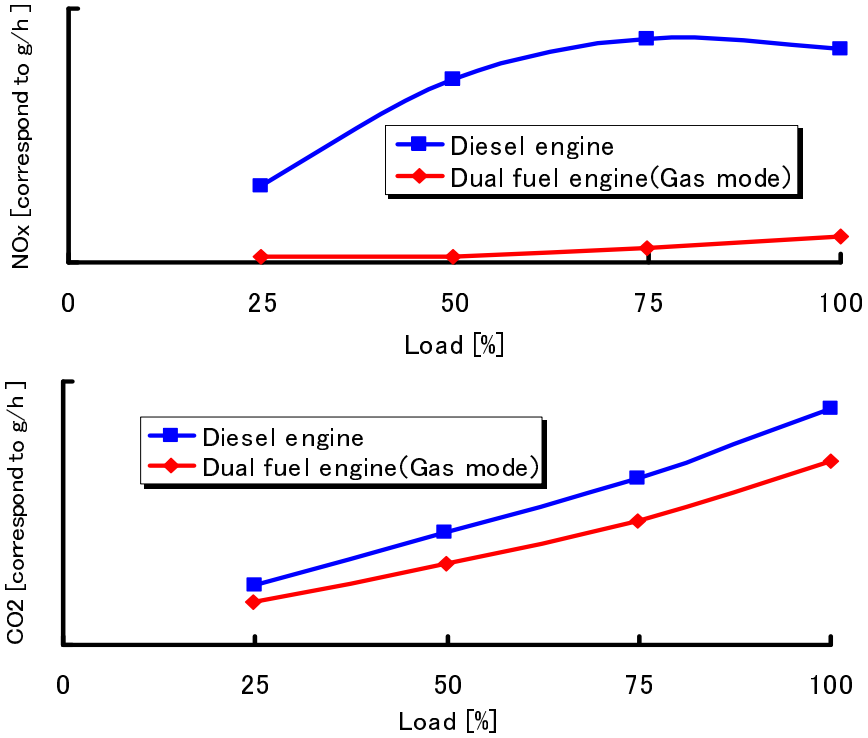
Realized mode change at 100% load

NOx emission characteristics

IMO NOx emission standards

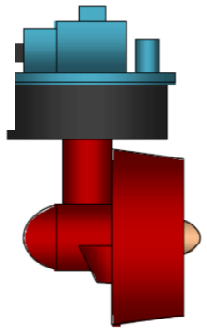
New engine satisfied NOx emission for IMO Tier Ⅲ with gas mode and Tier Ⅱ with diesel mode.

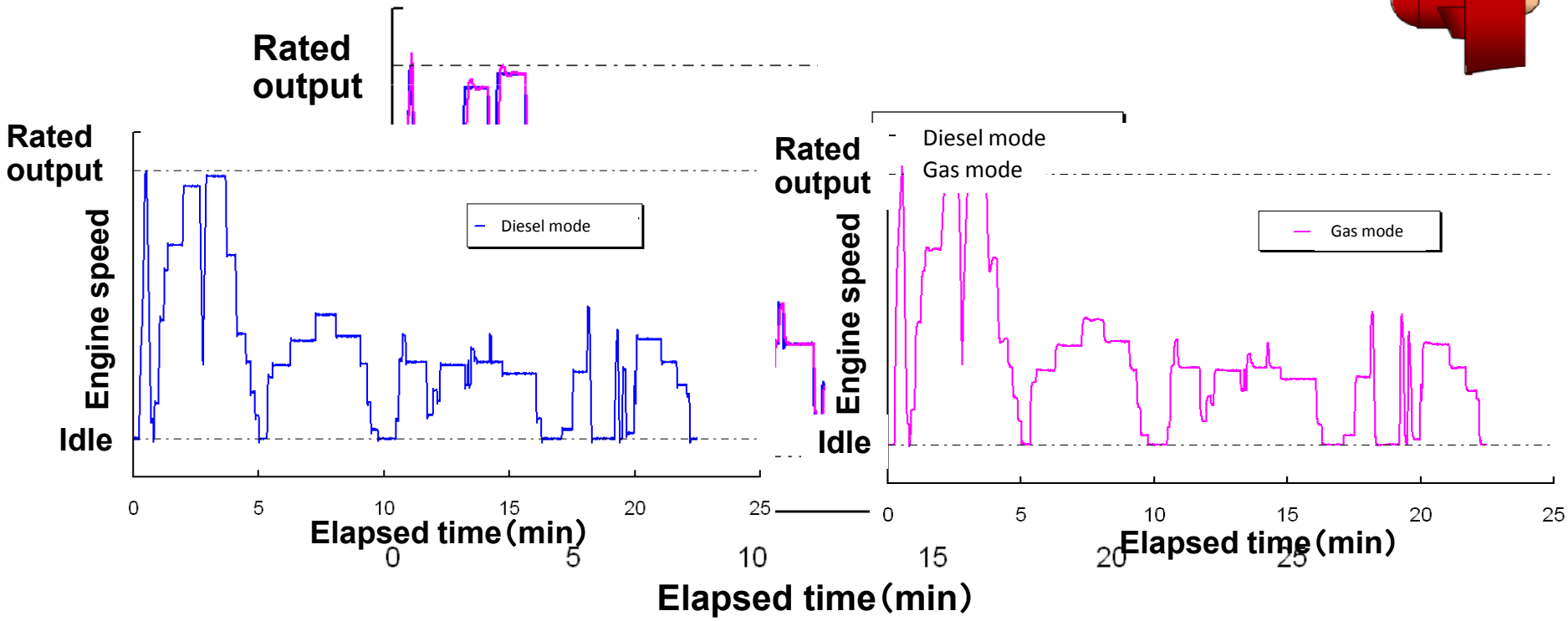




Ship handling demonstration（tug boat）

FPP direct connection is , which needs
supported(with marine gear) ce, was tested.





Conclusion

- In gas mode, finally NOx emission of IMO Tier Ⅲ was succeeded.
- Transient performance comparable to diesel engine was achieved in gas mode
- Niigata will deliver newly developed dual fuel engine to Japan's first LNG fuelled ship.
  This is the world's first built pure mechanical driven FPP LNG fuelled ship.

Thank you for your attention.

Acknowledgement

The Dual Fuel marine propulsion engine 6L28AHX-DF introduced today uses part of technology from the research development which was selected as a supported project of “Research project of CO2 reduction from marine vessels” by Ministry of Land, Infrastructure, Transport and Tourism, selected as a supported project by Nippon Kaiji Kyoukai(Class NK), selected as a joint research with Japan Ship Technology research association and financially supported by the NIPPON Foundation.

NIIGATA expresses sincere appreciation to these associations and foundation.

