TCS Bulletin for Marine equipment sector

Bulletin No. 004PB

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To; Respected customers,

How Does Boiler-burner React with IMO Tier-3 NOx Regulation?

We sincerely appreciate the respected customers' patronage.

Based on our communication with respected customers, we are explaining about **"IMO Tier-3 NOx regulation"**, including the boiler-burner-NOx value for reference, although the boiler-combustion is **NOT** any target of the regulation.

*One of solutions for reducing NOx is LNG utilization for fuel, VOLCANO has **more than 36 years' experience and history for oil/gas dual combustion** and LNG fuel use to boiler burners, installing boiler burners and small GCUs in approximately 180 LNG carries and LNG fuel carriers.

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I. IMO Tier III NOx regulation

NOx value is restricted only to **ECA area**,
applying to installed **marine diesel engine** in the ship

Tier III NOx regulation; **2.0g/kWh ～ 3.4g/kWh**

(convert to ppm; **900ppm ～ 1,525ppm**)

※Estimated from Oil Burner Actual Example

Applying to installed **marine diesel engine in the ship whose construction date on or after 1 JAN 2016**.

However excluding recreation-boat less than 24m length and the ship less than 750kW propulsion-output which was approved its exemption by the Flag State government.

When operated inside ECA, the NOx value should be as 80% reduction from Tier I.
When operated outside ECA, the NOx value should be as Tier II.

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<Reference>

“The NOx control requirements of Annex VI apply to installed marine diesel engine of over 130kW output power other than those used solely for emergency purposes irrespective of the tonnage of the ship construction date, a term in regulations 2.19 and hence 2.2 and within any particular Tier the actual limit value is determined from the engine’s rated speed:”

quoted from IMO “Nitrogen Oxides (NOx) – Regulation 13”
http://www.imo.org/en/OurWork/environment/pollutionprevention/airpollution/pages/nitrogen-oxides-(nox)-–-regulation-13.aspx

Tier	Ship construction date on or after	Total weighted cycle emission limit (g/kWh) n = engine’s rated speed (rpm)		
		n < 130	n = 130 - 1999	n ≥ 2000
I	1 January 2000	17.0	$45 \cdot n^{(-0.2)}$ e.g., 720 rpm – 12.1	9.8
II	1 January 2011	14.4	$44 \cdot n^{(-0.23)}$ e.g., 720 rpm – 9.7	7.7
III	1 January 2016	3.4	$9 \cdot n^{(-0.2)}$ e.g., 720 rpm – 2.4	2.0

II. Tier III, the influence on the boiler-burner (Oil Use)

Just referenced calculation for marine-use-boiler-burner in current,

describes 350ppm ⇒ 0.78g/kWh as NOx value.

Even if restriction was applied to boiler-burner,
the current value is much lower than restriction value.
NOx for current marine-use-boiler-burner 350 ppm ⇒ 0.78 g/kWh
※Assumption O_2=2.8%

Additionally,
NOx for land-use-boiler-burners (Oil Use);
150ppm ⇒ 0.33 g/kWh
can be achievable.
※Assumption O_2=2.8%

※Estimated from Boiler Actual Example

Because the target of Tier III is marine diesel engines, boiler-burners are not any target of TierⅢNOx regulation.

Boiler-burners would not get any influence from the Tier III countermeasures for diesel engines. The examples of the Tier III countermeasure are as below;

Countermeasure1 ：SCR（Selective Catalytic Reduction）

SCR is a system that utilizes chemical reaction between NH_3 and nitrogen compound which decomposes nitrogen compound into N_2 and water.

There is no influence on the boiler-burner because SCR is completed between a diesel engine and the engine exhaust gas route.

Countermeasure2：EGR（Exhaust Gas Recirculation）

EGR is a system in which a part of engine exhaust gas is re-sent into the combustion chamber through the exhaust cleaning apparatus.

Boiler-burners would not get any influence at all.

Countermeasures described above have no influence on boiler-burner when the exhaust gas line of engine and that of boiler are independently and separately designated.

However, in case of scrubber is installed and consequently the exhaust gas line of engine and that of boiler comes to be NOT separated but connected, the performance of boiler-burner would get influence by the fluctuation of back-pressure at boiler exhaust gas line, especially for larger capacity boiler.

In such case, it is important to take a measure in keeping back pressure stable in order to use burner safely.

The method of modification depends on the burner system, so please contact us for details.

Countermesure3: Utilizing LNG fuel

LNG fuel is effective for reducing NOx in diesel engines. However, there remains the concern about thermal NOx.

Therefore some countermeasure, such as lean-burn, would be needed.

When utilizing LNG for diesel engines, there would be no influence on boilers.

In the case that the boiler also utilizes LNG as its fuel, the boiler-burner could process Boil Off Gas/BOG in the LNG tank.

In this point, dual fuel boiler is useful.

The cases introducing dual fuel boiler-burner are currently increasing.

When utilizing LNG for dual fuel boiler in the existing vessel, the modification not only for the burner but also upstream in the vessel (FGSS supply system) is necessary.

VOLCANO recommends the customer to communicate well with the boiler maker or VOLCANO in the planning stage of LNG fuel supply system.

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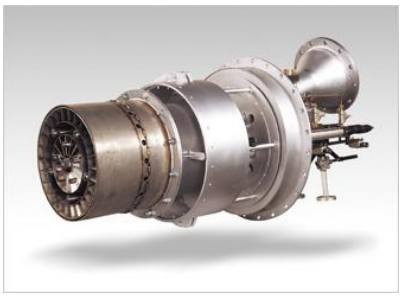


III. Low NOx countermeasure for the boiler-burner itself

As we mentioned in the above, IMO Tier III regulation for NOx would not require the Low NOx countermeasure in boiler-burners.

If more strict Low NOx regulation for boiler-burners will come, VOLCANO already has recordable experiences in land-use-boilers for reducing NOx

	Fuel	MGO		HFO	
	Evaporation Rate (ton/hour)	10	20	10	20
Assumption	Combustion	One Burner for one boiler			
	Oil Combustion Capacity (kg/h)	760	1540	760	1540
	Nitrogen content wt/%	0.01	0.01	0.15	0.15
	Furnace Liberation Rate	100x104Kcal/m^3hr or below			
	Air Temperature (℃)	45	45	45	45
	Exhausted Gas O_2 (%)	3	3	3	3
	Excess Air Ratio	1.15	1.15	1.15	1.15

Estimated Value of NO_X

Estimated Value of NO_X	(F.NO+T.NO)x1.1 ppm	209	221	292	305
	mg/Nm^3	429	454	599	626

Assumption O_2=3%

NOx (mg/Nm3) = NOx (ppm) x 2.053

IV. Summary

Just for your reference, we introduce the examples mentioned above as a summary.

TierⅢ NOx 2.0～3.4g/kWh is convert to
NOx for Oil Burner 900～1,525ppm

NOx for current marine-use-boiler-burner (Oil Use) 350 ppm ⇒ 0.78 g/kWh

NOx for current land-use-boiler-burner (Oil Use) 150ppm ⇒ 0.33 g/kWh
is achievable.
※Assumption O_2=3%

Method of Lower NOx：

・Utilizing LNG fuel（DF burner is needed）

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1. Low NO_X atomizer／ gas nozzle
2. EGR (Exhaust Gas Recirculation)
3. SI (Steam Injection）

} Suppression of combustion flame temperature

VOLCANO can provide solutions for coming more strict regulations, based on our experiences in the land-use-boiler.

Contact VOLCANO (on Marine Products, Parts and After-sales

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