6th CIMAC CASCADES Seminar

SAFETY DESIGN FOR MARINE GAS ENGINE

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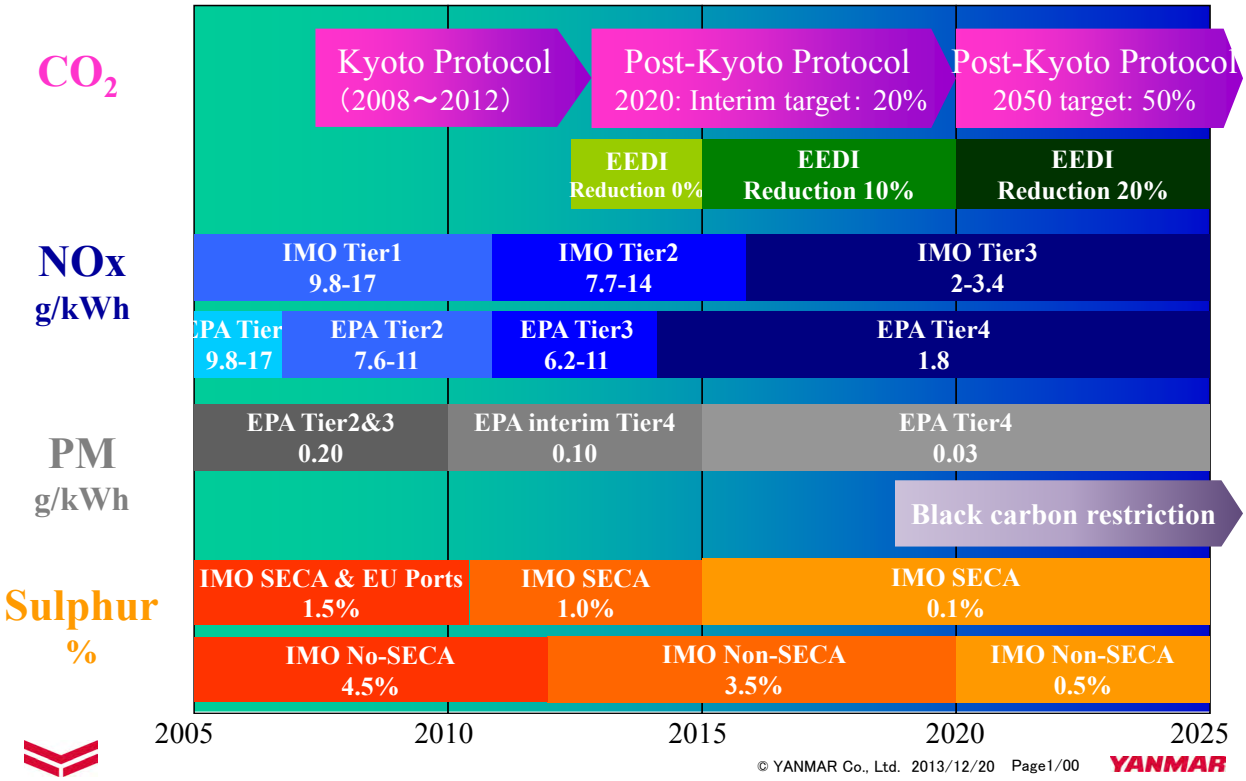
Emission restriction schedule



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Low emission technology for marine engine

No.	item	description	effect				Tasks to be solved
			NOx	SOx	PM	CO_2	
1	SCR	NOx deoxidization by the catalyst	◎	—	—	—	・Urea cost, maintenance ・Prevention of ammonia leakage
2	Scrubber	Removing SOx by seawater wash	△	◎	◎	—	・Purification of polluted seawater
3	EGR	Exhaust gas recirculation	○	—	×	×	・Engine durability ・Efficiency drop recovering
4	Emulsion	Combustion temperature decrease by emulsion fuel	○	—	○	—	・Mass pure water production device ・Engine durability
5	Gas engine	Operation by natural gas	◎	◎	◎	◎	・Fuel supply infrastructure ・Fuel storage in ships

Gas engine will be a one of the effective solution for reducing exhaust gas emission for marine engines.

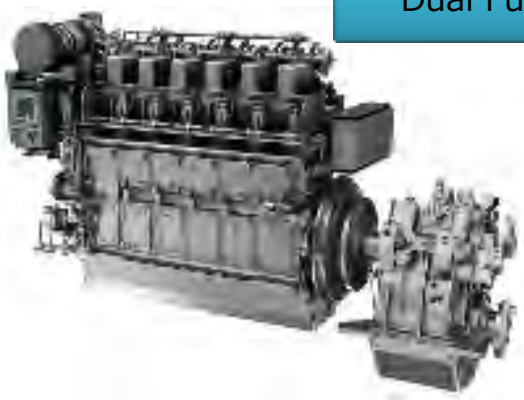
Development Policy of Marine Gas Engine

Base Engine

EY26 Marine Diesel Engine

Pure Gas

Dual Fuel

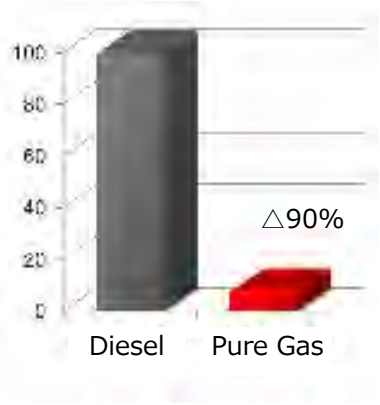


Achievement situation of gas engine performance

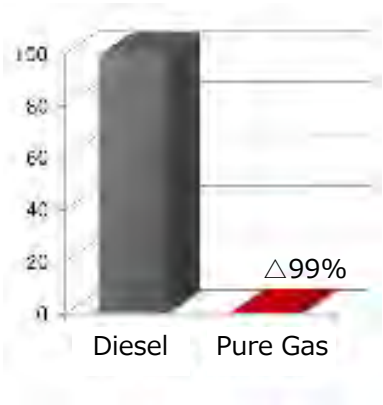
Emission

100=Diesel

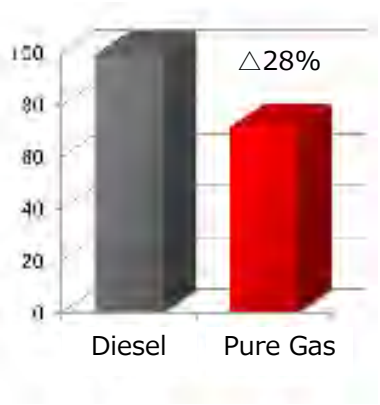
NOx



SOx・PM



CO_2



Safety design for marine gas engine

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Machinery space of gas engine

Select of machinery space ・・・ ESD protected machinery space
or
Gas safe machinery space

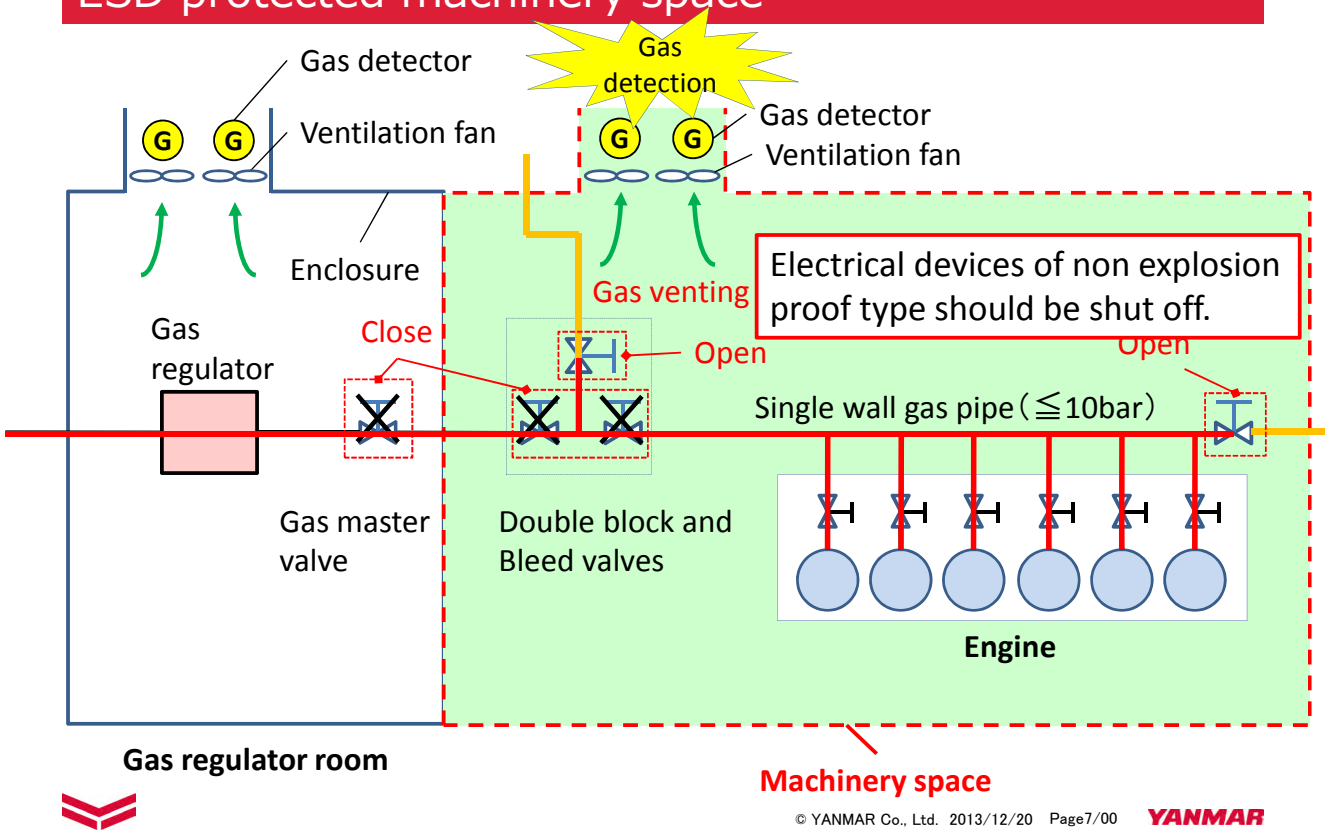
ESD protected machinery space

- Each machinery space is separated by a single bulkhead which can withstand the local explosion.
- One engine is installed in each machinery space.
- Fuel gas pipe is single wall（gas pressure ≦10bar）
- If gas leak in this space, the engine and gas supply are stopped and the electrical devices of non-explosion-proof type are shut off.
- A gas supply system is needed in each machinery space.
- 2 gas detectors are needed in each machinery space. etc…

Common requirement

- Double block valves(gas supply shut off) and bleed valve(gas vent) are needed in each gas supply system

ESD protected machinery space



Gas safe machinery space

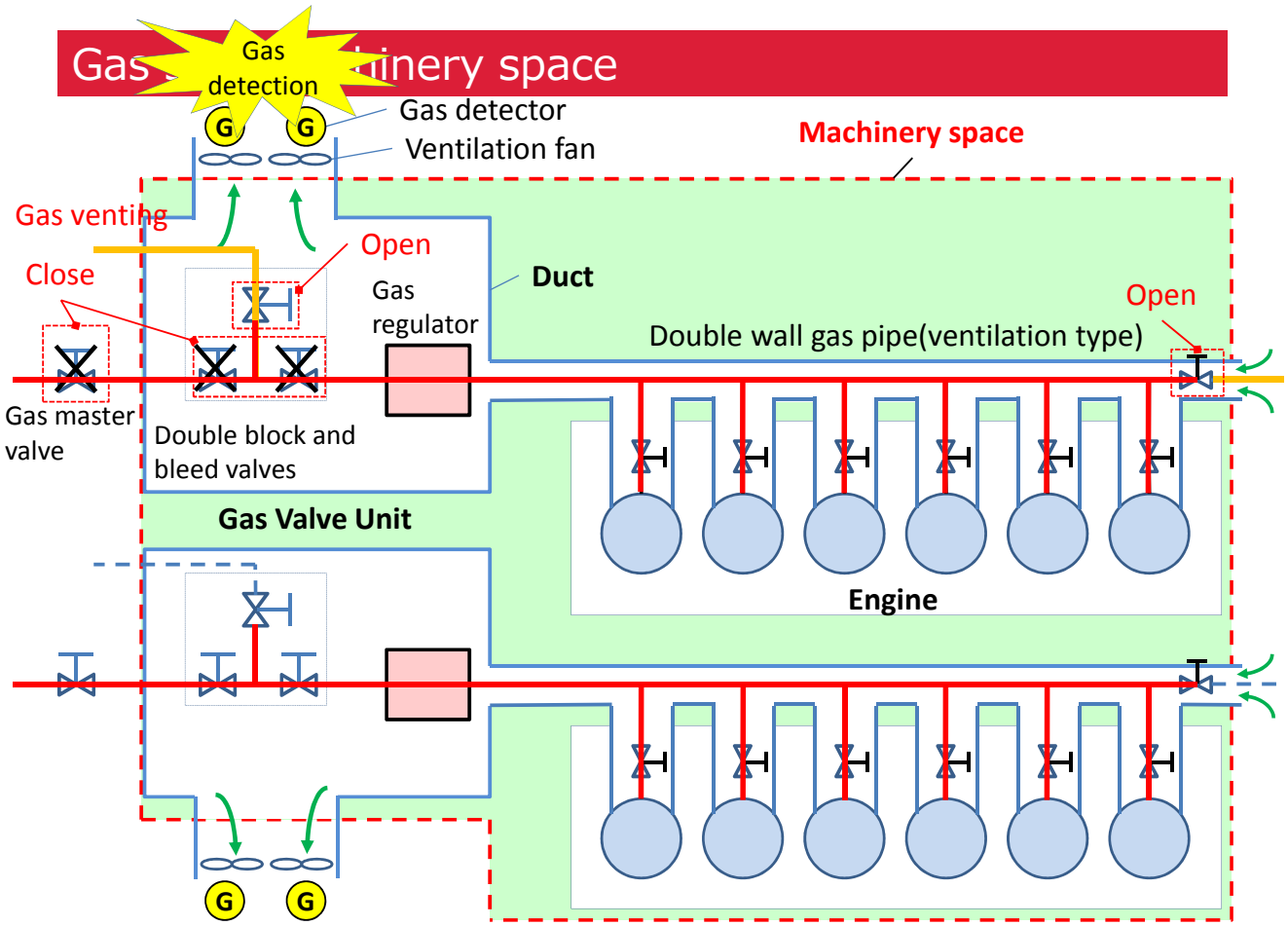
Gas safe machinery space

- Fuel gas pipe should be double wall structure or covered with duct.
  Inner pipe : Fuel gas
  Outer pipe : Ventilation air or inert gas
- Two or more engines can be installed in one machinery space.
  (Independent fuel gas supply system is needed in each engine)
- If pure gas engine, two or more fuel tanks are needed. etc…

Common requirement

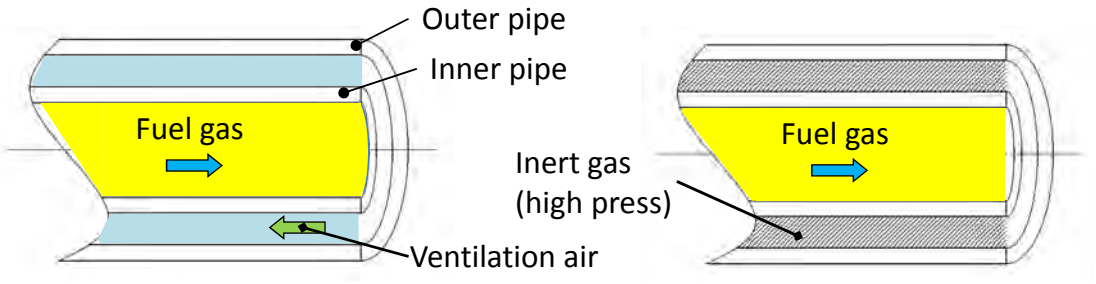
- Double block and bleed valves are needed in each gas supply system.

Recently, gas safe machinery space becomes a main trend.



Double wall pipe

・Structure of double wall pipe



1.Air venting with mechanical device

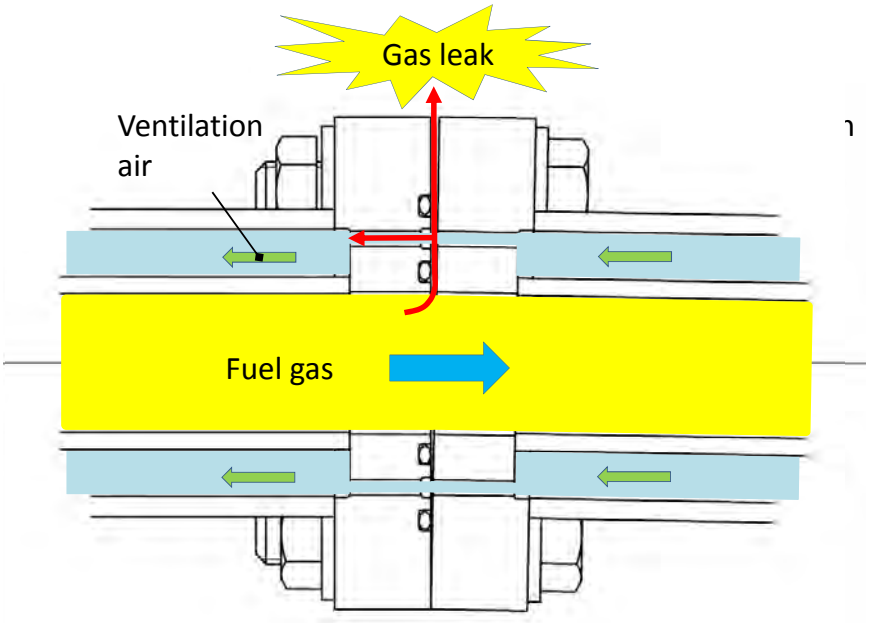
2.Inert gas filling
(≧ fuel gas pressure)

・Material of pipe : carbon steel, iron casting etc…

In the case of casting, some ribs support inner pipe and outer pipe are allowed.

Flange of double wall pipe

・Cross section of double wall pipe flange planned at first



In the case of this flange, measures no gas leak into the machinery space are needed when bolt is broken.

Classification of hazardous area

Hazardous area

ZONE0

Area in which flammable gas is present continuously or long time.

→ In fuel gas piping

ZONE1

Area in which flammable gas is likely to occur in normal operation.

→ ・ESD protected machinery space when gas leaks
・Ventilation space of double wall pipe(inside of outer pipe)

ZONE2

Area in which flammable gas is not likely to occur in normal operation and , if it does occur, will exist for a short period only.

Non-hazardous area

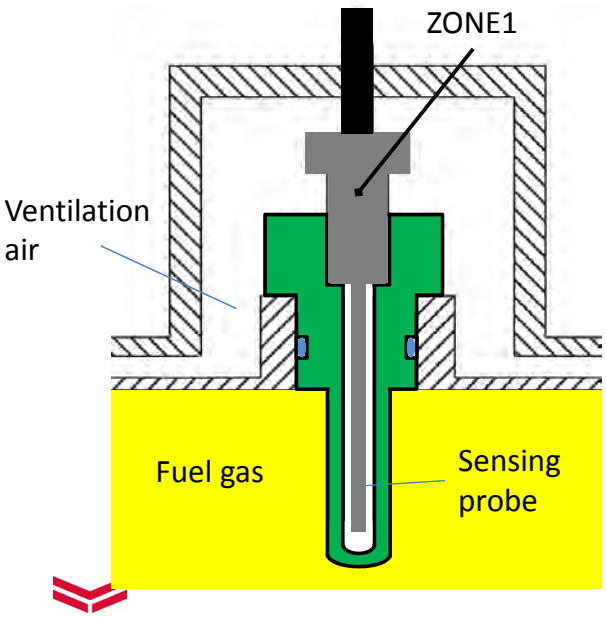
An area not considered to be hazardous , i.e. gas safe.

→Gas safe machinery space

Explosion proof of sensor and electrical device in double wall pipe

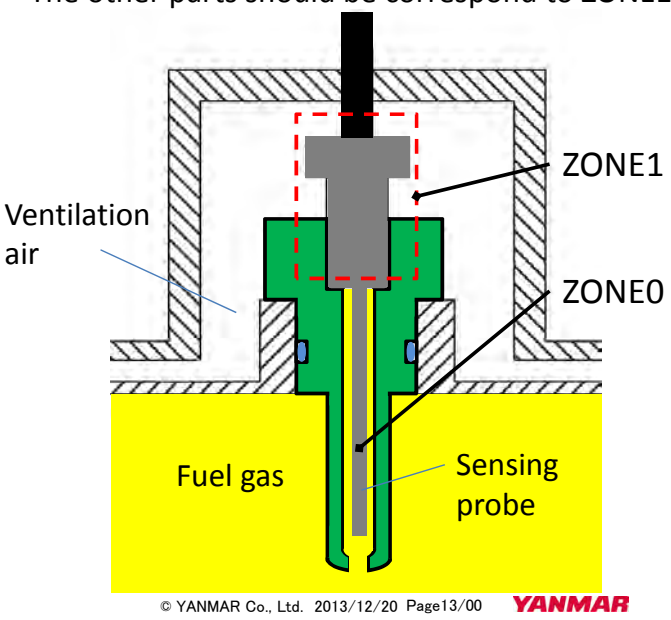
a) Sensor don't touch fuel gas directly

→Sensor should be correspond to ZONE1.



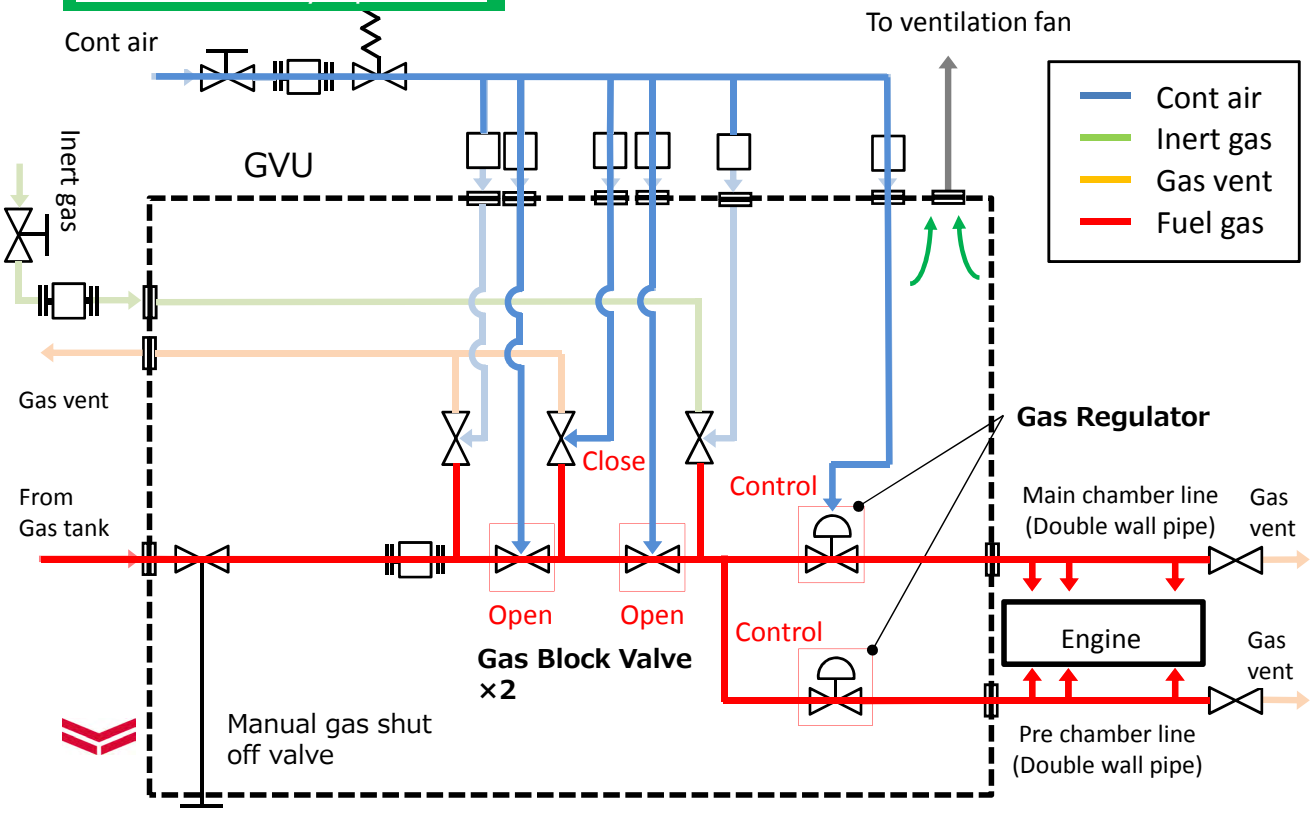
b) Sensor touch fuel gas directly

→Sensing probe should correspond to ZONE0.
The other parts should be correspond to ZONE1.



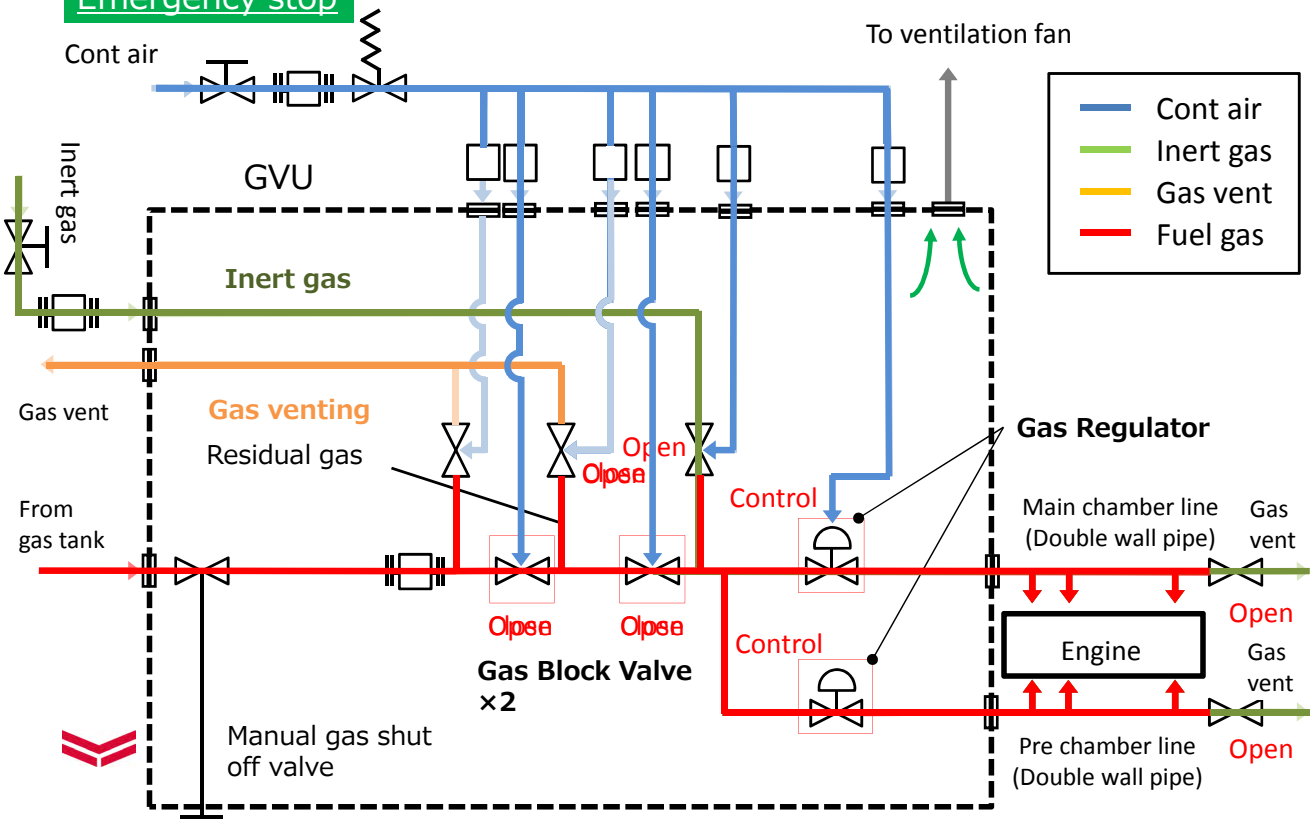
Gas flow line of GVU(Gas Valve Unit)

Start → Steady operation



Gas flow line of GVU(Gas Valve Unit)

Emergency stop



Others

- Relief valve of exhaust gas manifold
  Depending on a classification, it isn't required in its location.
  But, it is necessary to apply somewhere in the exhaust gas piping.

- Relief valve of charging air manifold
  In the case of premixing the fuel gas and charging air in the manifold or before, it is necessary.

Summary

- Design of marine gas engine should be corresponded to safety guideline. Machinery space should be select either ESD protected machinery space or gas safe machinery space.

- Double wall pipe or duct is needed in gas safe machinery space. And joints should be made a structure which no fuel gas leak into machinery space.

- Requirement level of explosion proof of sensors and electrical devices used in double wall pipe should be correspond ZONE 0 if it touch gas directly and ZONE 1 if it is separated from the gas.

- The common safety indicator(IGF code) is scheduled to be approved this year.