Quality Control of City Gas at Regasification Terminal

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Field Operation and Planning Sect.

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1.1.Self-introduction

Shuji YAMAMOTO

<at 3 LNG Regasification Terminals for 8 years >

- 2003-2004(S) Maintenance of Instruments
- 2005-2007(S) Renewal of Control system (DCS, F&G)
- 2008(O) Construction of Regasification Plant
- 2009~2010(N) Operation & Planning

(S) : Sodegaura LNG terminal
(O) : Ohgishima LNG terminal
(N) : Negishi LNG terminal

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1.2.Breif introduction of Tokyo Gas

<Business areas>

- （1） Regasification, supply and sales of city gas
- （2） Supply and sales of gas appliances
- （3） Energy services
- （4） Supply of electricity

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1.2.Breif introduction of Tokyo Gas

<Profile>

- Established in 1885 **(LNG, from 1969)**
- Capitalization 142 billion yen (1.2 billons Euro)
- Number of employees 15,539
- Net sales 1,416 billions yen (12 billions Euro)
- Gas sales volume 14 billions m^3
- Total length of gas pipeline 57,839 km
- Number of gas customers 10,637 thousands

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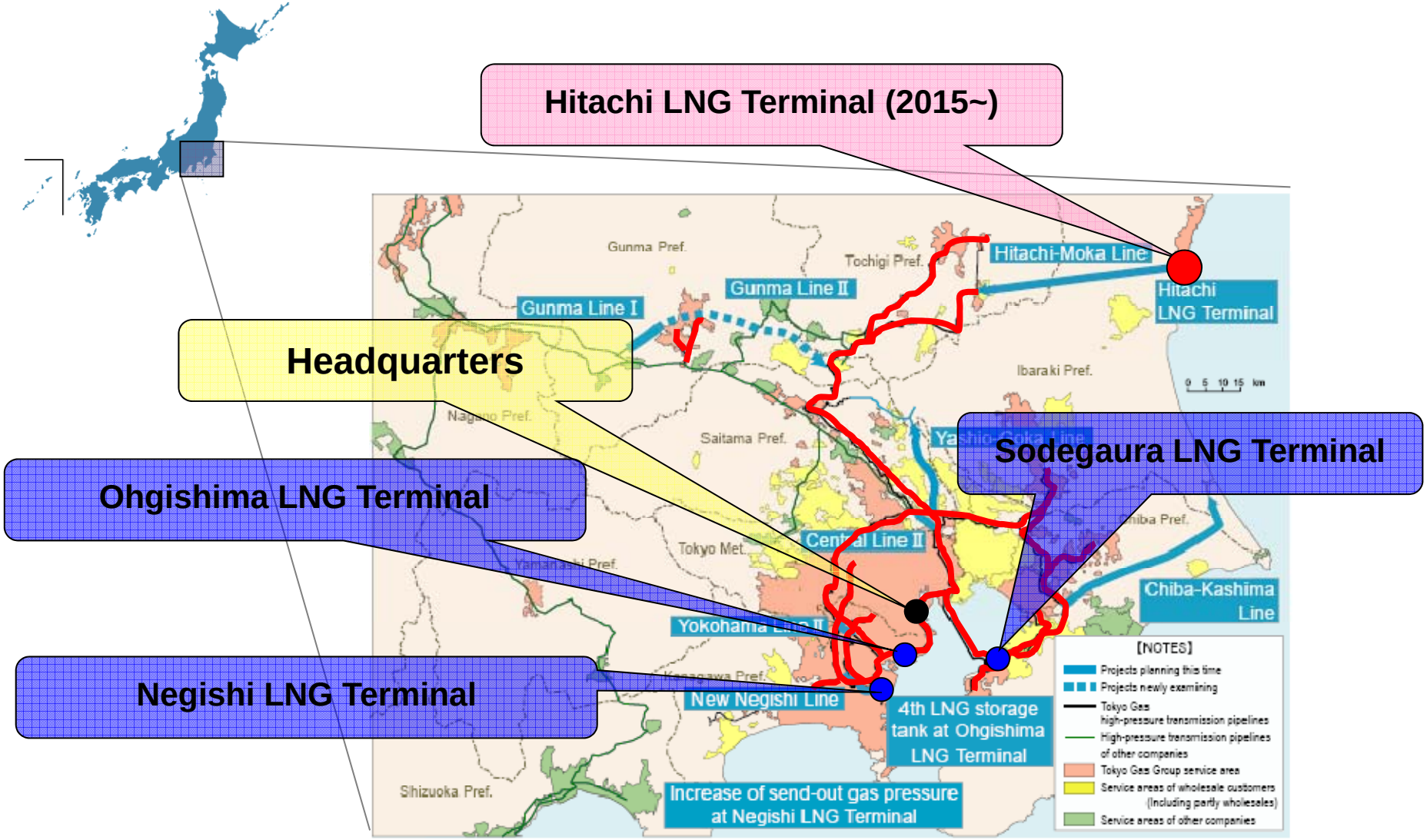
1.3.Outline of 3 LNG Terminals



1.3.Outline of 3 LNG Terminals

- Negishi — 1st LNG receiving terminal in Japan in 1969
- Ohgishima — the latest terminal in 3 terminals since 1998.
- Sodegaura — one of the largest terminal in the world since 1973

Negishi

Ohgishima

Sodegaura

1.3.Outline of 3 LNG Terminals

	Negishi	Ohgishima	Sodegaura
Number of jetties	1	1	3
Number of tanks	13	3	20
Capacity of tank [Ml]	1155	600	1610
Number of Vaporizers	14	10	33
Capacity of vaporizers [t/h]	1315	970	3180
Number of Employees	135	69	158
Number of Vessels ann	78	41	206
Total LNG ann [kt]	3275	2446	4577

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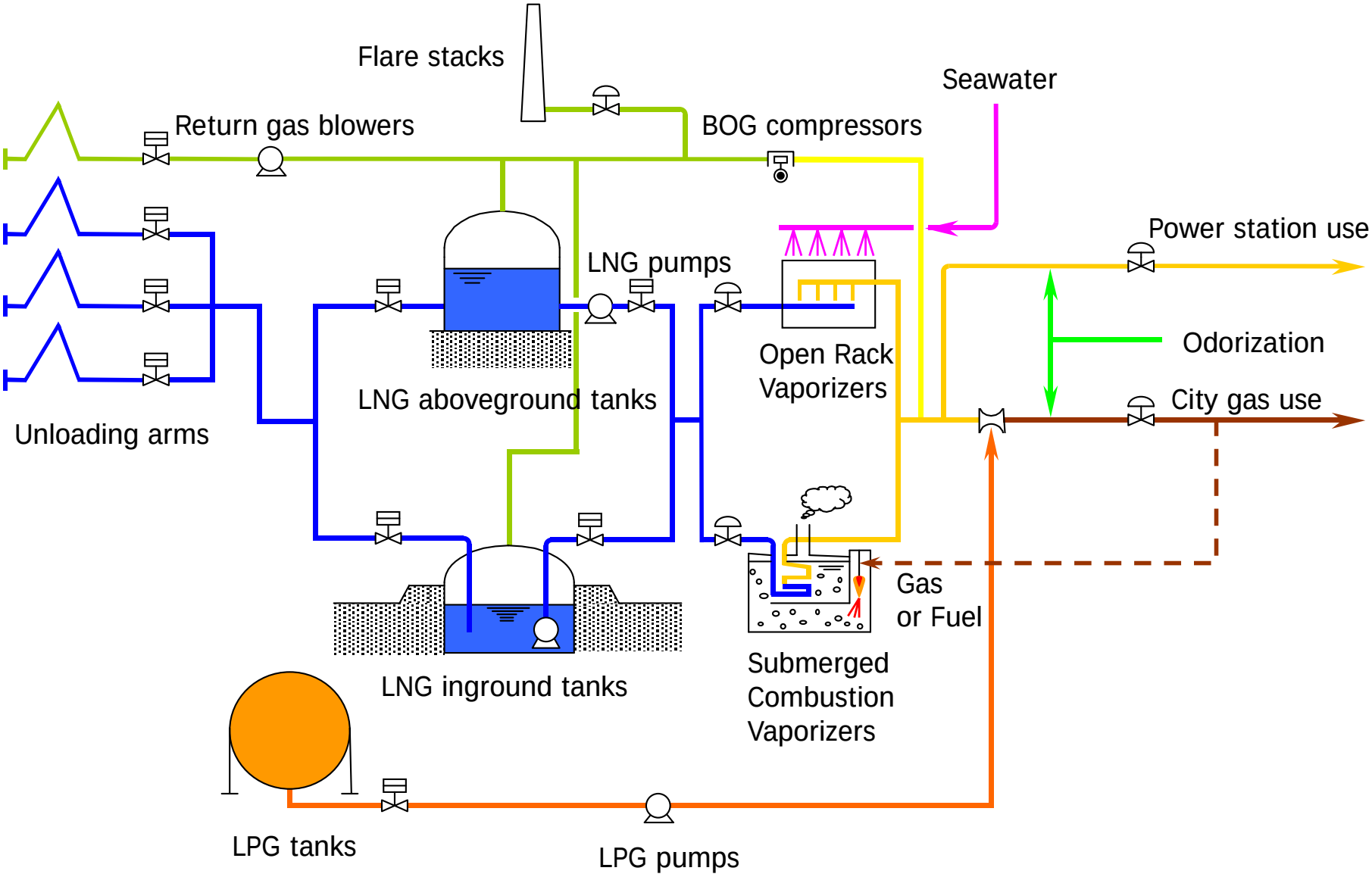
2.Gas Production Process



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3.Quality Control of City Gas

What's the quality of city gas of Tokyo Gas?

1. Pressure of Trunk Line
2. Calorific Value
3. Odorant

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3.1 Pressure of Trunk Line

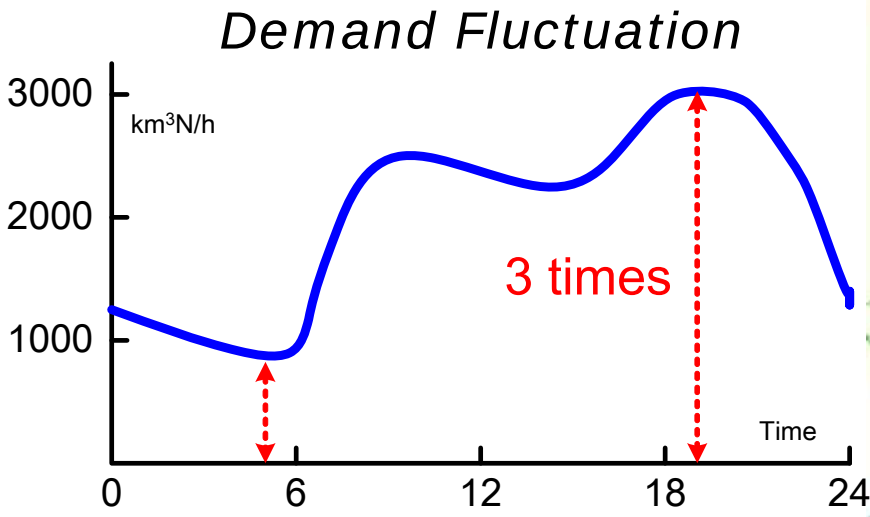
- **Demand fluctuation**

(3 times difference in a day)

- **Small absorber**

(30 small gas holders)

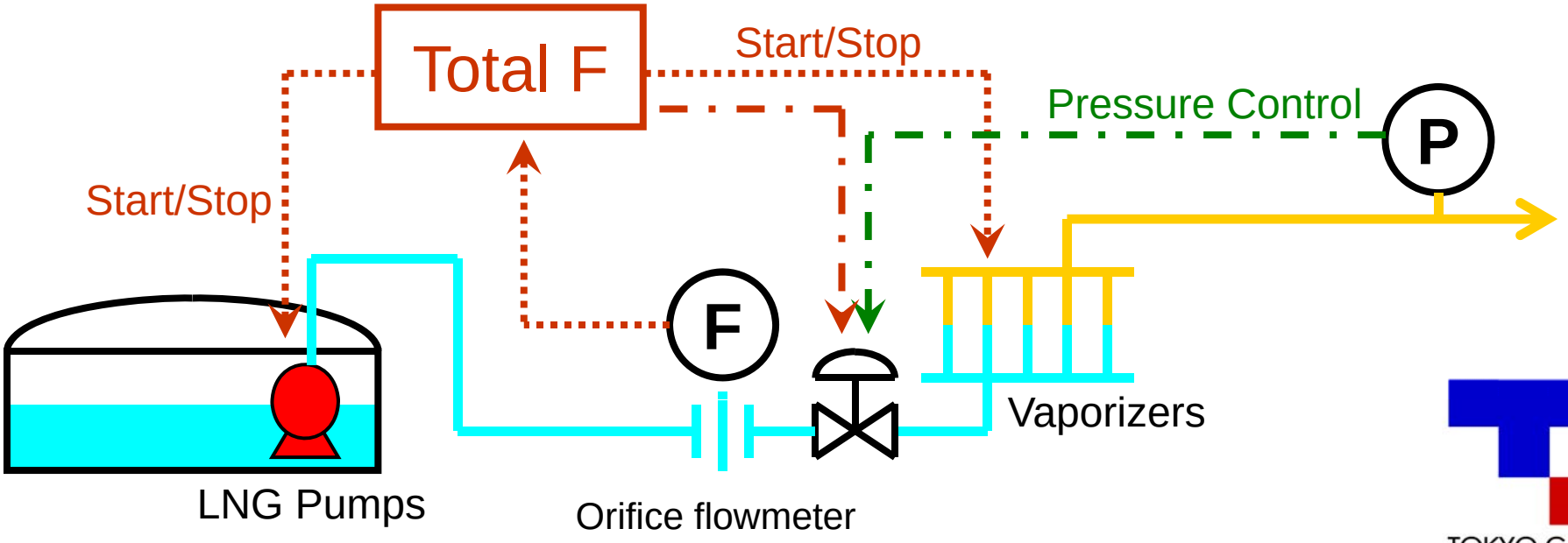
(no underground storage)



3.1 Pressure <Control>

Start/Stop

- **Automatic Control**
  - Pressure Control
  - Number of Pumps
  - Number of Vaporizers



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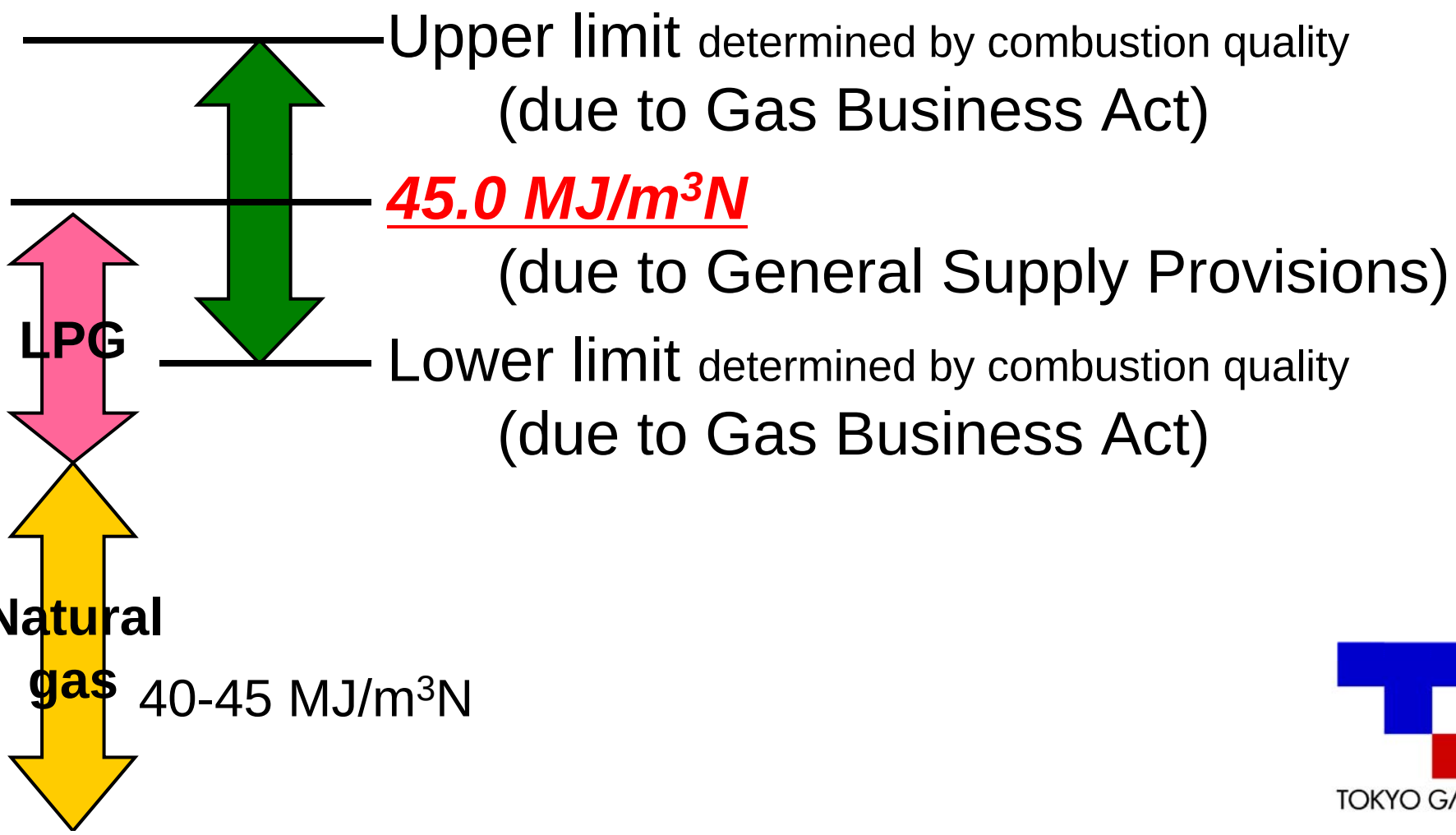
3.2 Calorific Value <Standard>



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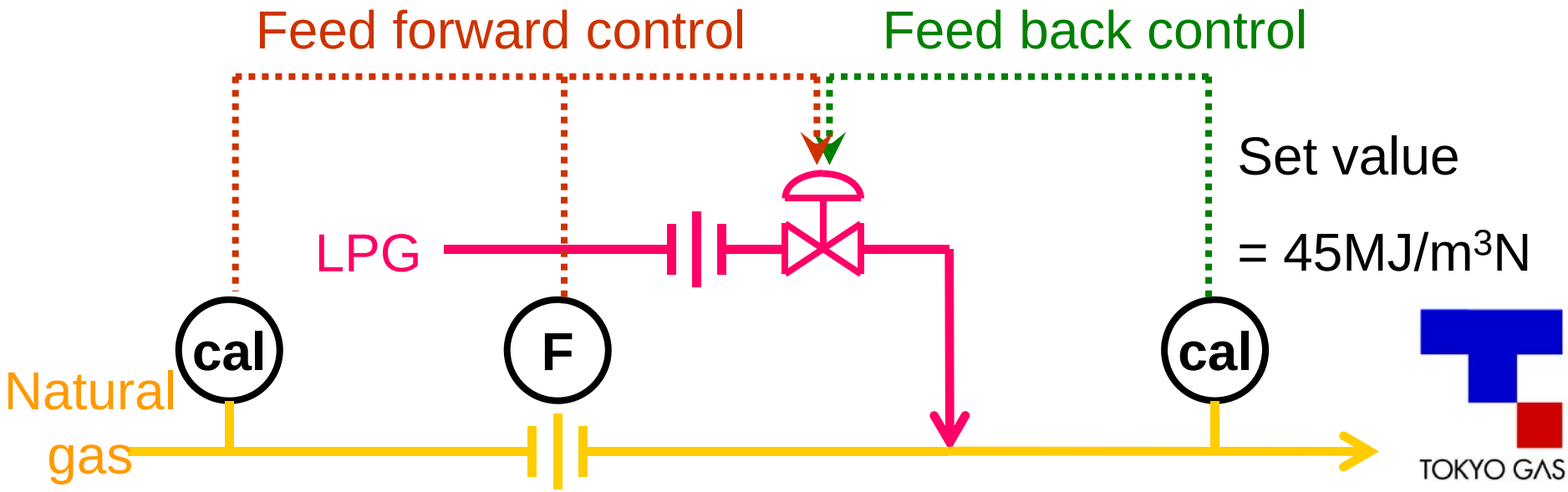
3.2 Calorific Value <Control>

- **Calorific Value Control**
  - Feed Forward Control
  - Feed Back Control



3.2 Calorific Value <Instrument>

- **Calorimeter for calorific value control**
  is required “Quick Response”.
  = Vibration type gas density analyzer

- **Calorimeter for guarantee of quality**
  is required “High Accuracy”.
  = Gas Chromatography

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3.2 Calorific Value <Issue>

- **Vibration type gas density analyzer**

<Principle>

Proportional relationship
between density and calorie of Hydrocarbon

<Issue>

Error caused by inert gas

(1 % of N_2 = 0.65 MJ/m^3N error)

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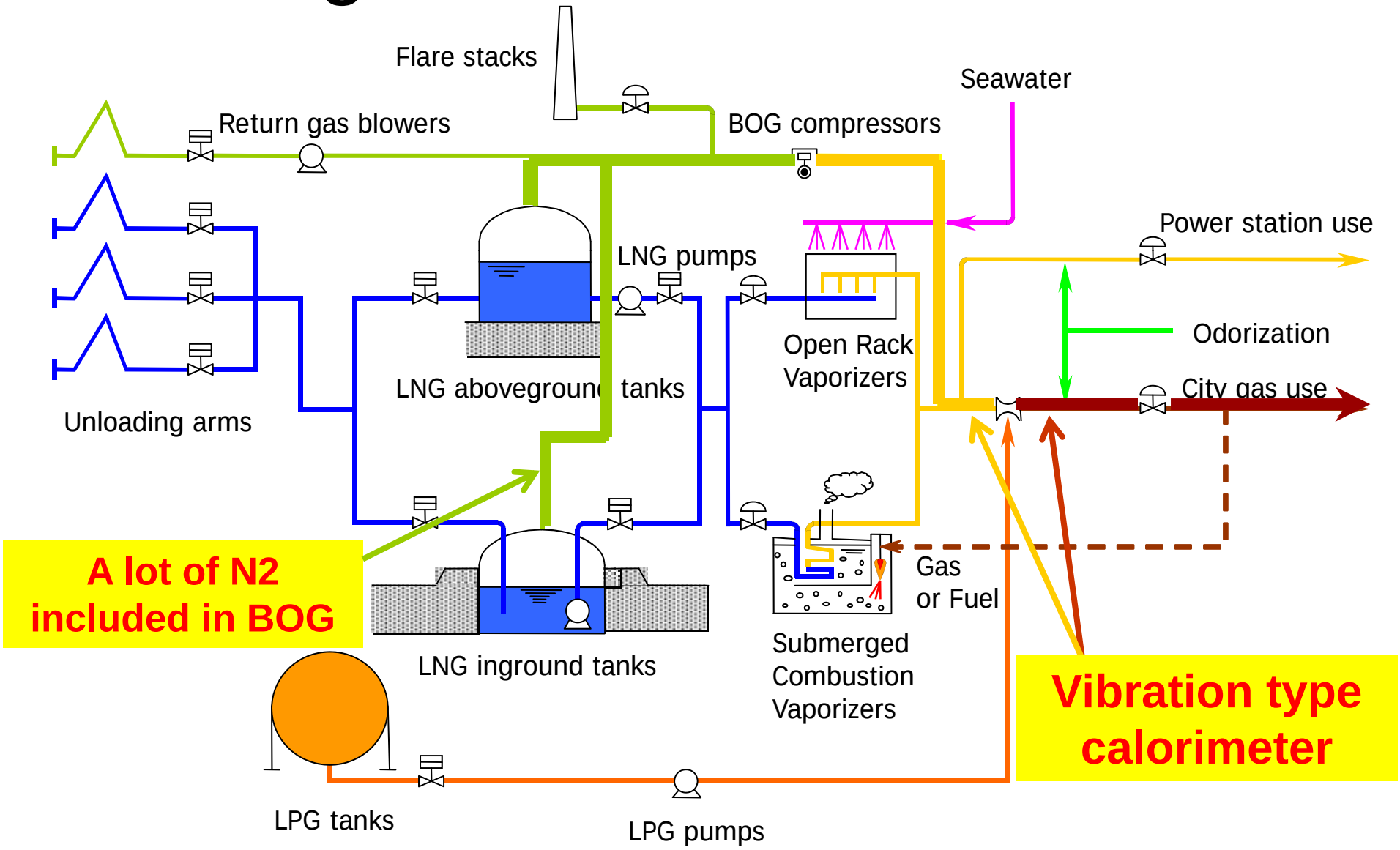
<Nitrogen in Boil Off Gas>



3.2 Calorific Value <Approach>

The error caused by N_2 can be removed by

<Combination of two types of calorimeter>

- **Vibration type gas density analyzer**
- **Optical Interferometric calorimeter**

<Principle>

Proportional relationship

between refractive index and calorie of hydrocarbon

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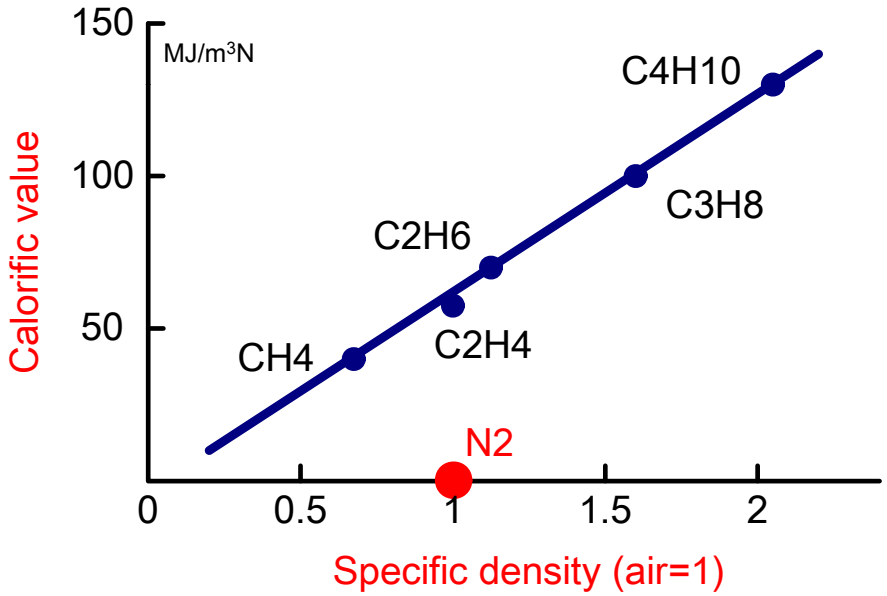
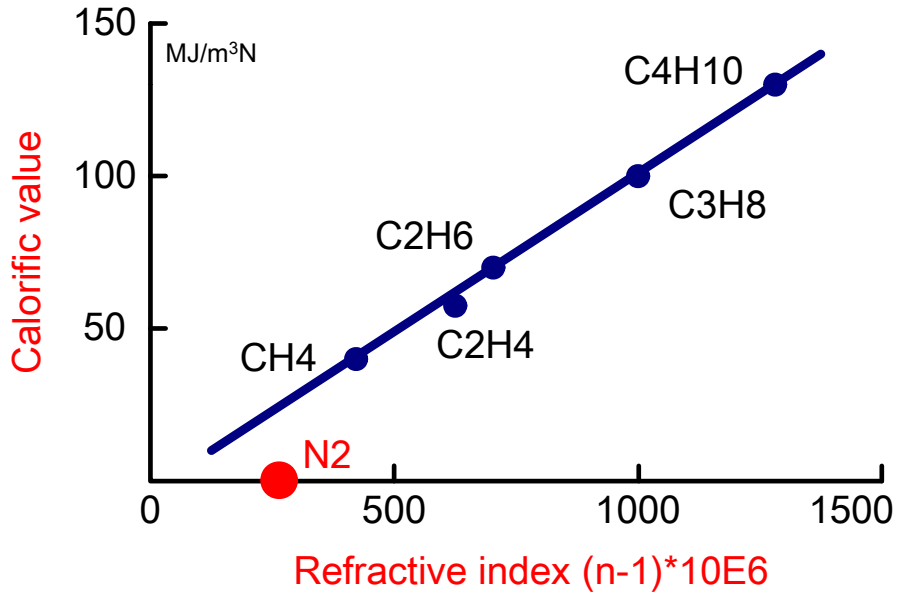
3.2 Calorific Value <Approach>

■ <Principle to remove the error>

Vibration type density analyzer



Optical Interferometric calorimeter



Nitrogen looks like to have…

65 MJ/m3N in vibration type density analyzer

26 MJ/m3N in optical interferomatic calorimeter

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3.2 Calorific Value <Approach>

- **<Principle to remove the error>**

$$Q = Q_{vibration} - kx_{N2}$$

$$Q = Q_{recractive} - k'x_{N2}$$

k : 0.65 MJ/m3N by 1% N_2

k': 0.26 MJ/m^3N by 1% N_2

x : contents of N_2 [%]

$$Q = Q_{recractive} - \frac{Q_{refractive} - Q_{vibraton}}{1 - k/k'}$$

Manufactured by RIKEN KEIKI Co., LTD

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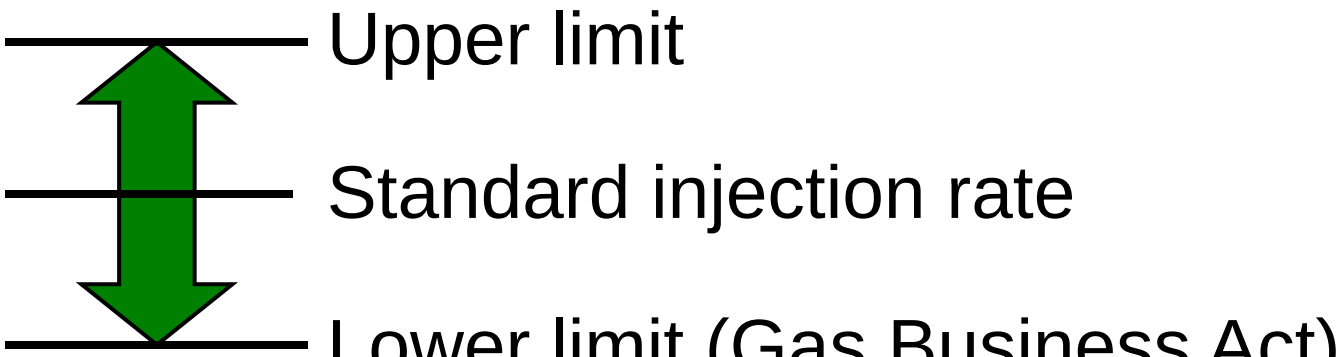
3.3 Odorant <Standard>

- **Odorant**

  TBM (Tertiary-Butyl Mercaptan)

  CH (CycloHexene)



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3.3 Odorant <Control>

■ Odorant Control

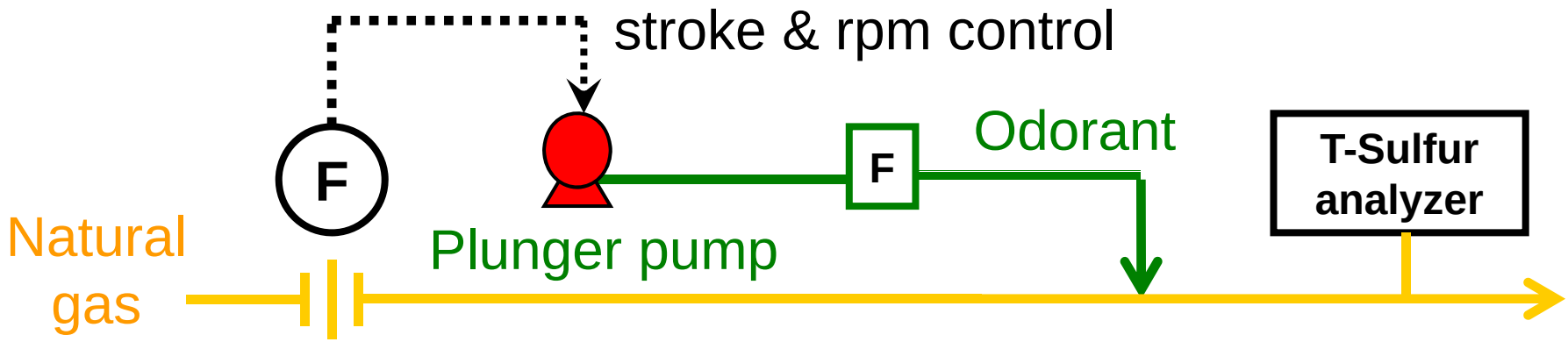
Pump Output Control According to the Natural Gas Flow Rate

(No Feed Back Control)

■ Measurement Points

Mass Flow Rate of Odorant

Total Sulfur in Odorized City Gas



3.3 Odorant <Instruments>

<Measurement Points>

- Flowmeter of Odorant
  is required to measure “Minute Mass Flow”.
  = Coriolis flowmeter

- Total Sulfur in Odorized City Gas
  is required to measure total sulfur
  = Ultraviolet Fluorescence Method sulfur analyzer

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Thank you for your kind attention !

Please contact me if you have any questions.

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