Kuwait 4th Flow Measurement Technology Conference

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Hilton Kuwait Resort

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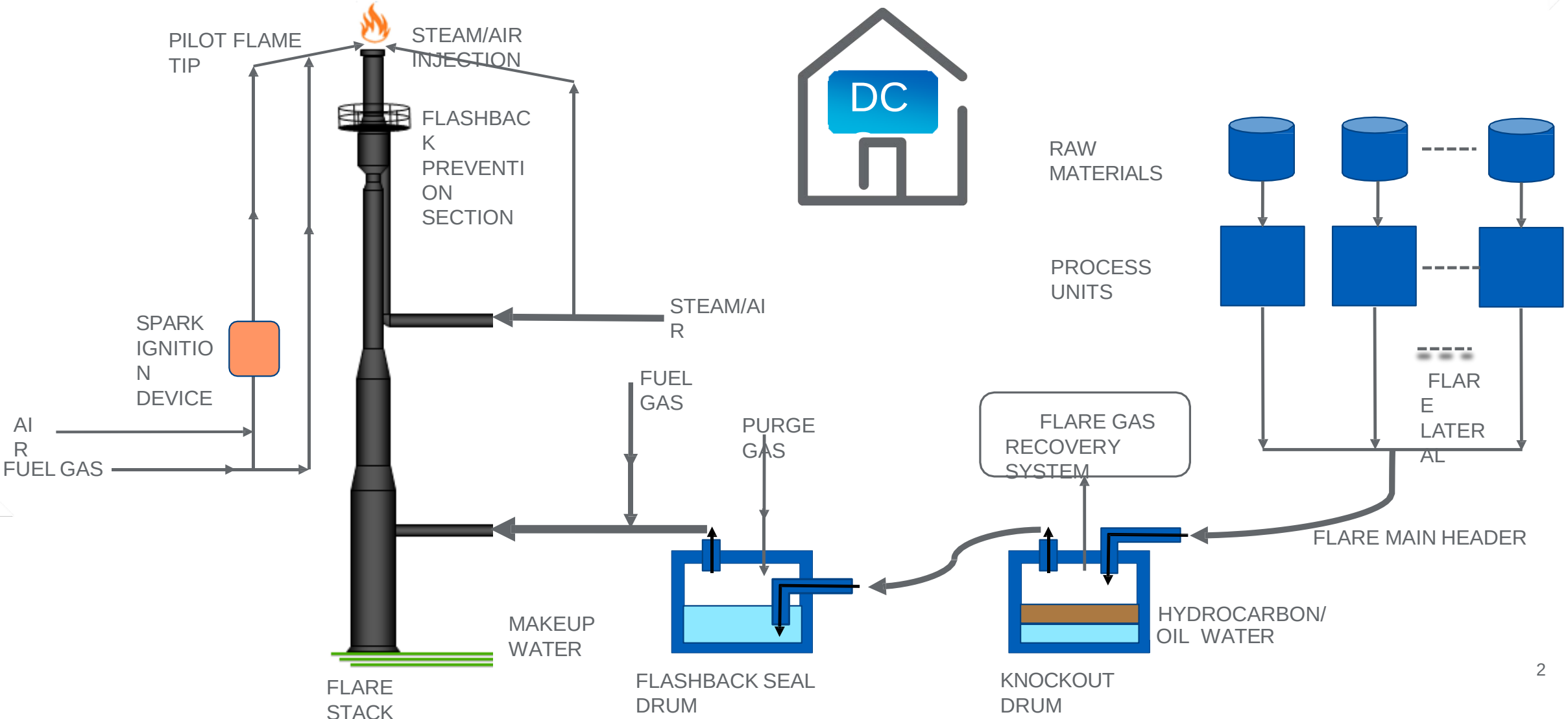
الراعـي الرسمـي

K.SABAPATHI

Sr Specialist

A Generalized View of A Typical Flare System



Flaring

- **Flaring is the controlled disposal by burning of gas that cannot be economically handled / processed or traded.**

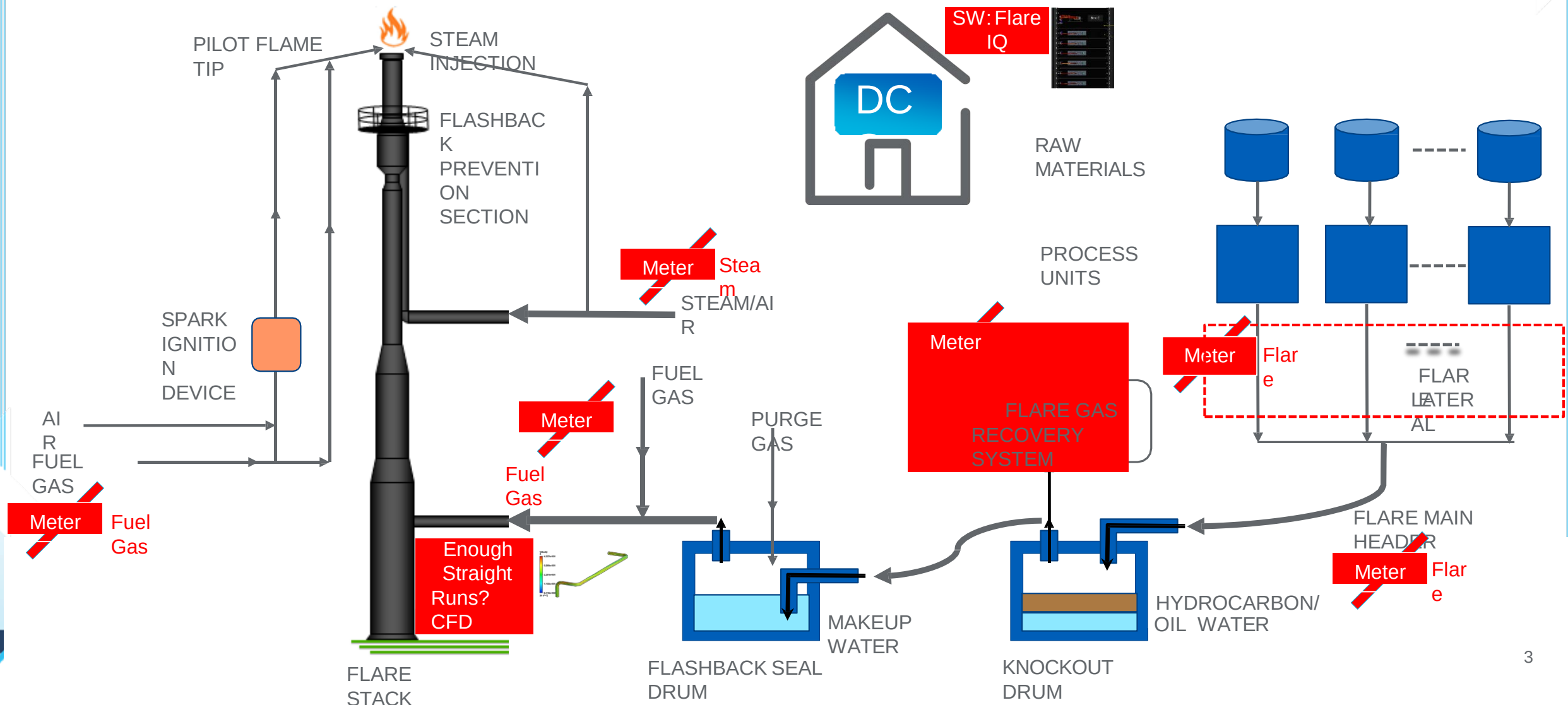
  Release of un-burnt gases directly to atmosphere is venting.

- **Flaring is a technical requirement for the safety of hydrocarbon handling or processing plants; it can be minimized to ALARP levels, but cannot be eliminated.**

- **Flaring is measured by volume and reported by volume and/or as % of gas produced. Emissions are reported by mass.**

Flare system purge-gas & flare-tip pilot fuel-gas are not accounted as flare gas but are considered as 'fuel consumption'

Flow Measurement in a Typical Flare System



Refinery Sector Rule

IMPLEMENTATION TIMELINE

2015 DECEMBER — Publish Date

2019 JANUARY — Compliance Requirement Date

OVERVIEW OF REGULATION

- Includes ALL sources, not just new sources
- Flares must control, maintain and demonstrate a 96.5% combustion efficiency or a 98% destruction efficiency
- Flares must maintain a minimum combustion zone Net Heating Value of 270 BTU/scf and report values every 15 minutes
- Flares must operate with no visible emissions, except for periods not to exceed a total of 5 minutes during any 2 consecutive hours
- Flare tip pilot flame must be maintained and velocities may not exceed 400 ft/s
- Operators must measure and control all assist flows to assure that the combustion zone stays above the minimum Net Heating value

TABLE 13 - CALIBRATION AND QUALITY CONTROL REQUIREMENTS FOR CPMS

Parameter	Minimum accuracy requirements
Temperature	%1±over normal measured range or 2.8 ˚C, whichever is greater
Flow rate for all flows other than flare vent gas	%5±over normal measured range or 0.5 GPM, whichever is greater for liquid flow %5±over normal measured range or 10 CFM, whichever is greater for gas flow %5±over normal measured range for mass flow
Flare vent gas flow rate	%20±of flow rate at velocities raging from 0.1 to 1 ft/s %5±of flow rate at velocities greater than 1 ft/s
Pressure	%5±over normal operating range or 0.12 kilopascals, whichever is greater
Net heating value by calorimeter	%2±of span
Net heating value by gas chromatograph	As specified in performance specification 9 of 40 CFR part 60, appendix B
Hydrogen analyzer	%2±over the concentration measured or 0.1 volume percent, whichever is greater

What is flare gas

- What are parameters required for design of flow meter
  - Do you know the quality of gas ?
    - Many gases , N2,H2,HC
  - Do you temperature of the line ?
    - -160 to 250 Deg C
  - Do you pressure of the line ?
    - 0 bar to 5 bar
  - Do you know the flow rate in the line ?
    - .02 MMSCFD to 200 MMSCFD

Objective & Overview

- Effect of Composition.
- Effect of Pipe & Effect of Impurities.
- Effect of very low pressure
- Effect of Turndown.
- Effect of Maintenance.

Composition

	Actual volume	Standard volume	Mass
Case 1—Propane increased			
Differential pressure meter	34%	34%	25%
Thermal flowmeter	2-15%	2-15%	35-45%
Velocity meter (optical, ultrasonic, vortex)	0%	0%	0%
Case 2—Hydrogen added			
Differential pressure meter	31%	31%	45%
Thermal flowmeter	100-300%	100-300%	300-700%
Velocity meter (optical, ultrasonic, vortex)	0%	0%	112%
Case 3—CO_2 increased			
Differential pressure meter	9%	9%	8%
Thermal flowmeter	2-5%	2-5%	15-20%
Velocity meter (optical, ultrasonic, vortex)	0%	0%	15%

Fouling effect in the line

Fig.17. Meter body covered with black grease

Grease and Oil create huge issue

Effect is very high in thermal mass flow meter

Less in ultrasonic meter

Liquid carryover will affect , therefor meter to be installed in single phase line

Low pressure & Flow

- Flare can have a very low flow (0.01 m/sec) and a low pressure drop across the meter (typically 0.5 psig is required), this can lead to non-axial and asymmetric flow. Laminar-turbulent transition flow introduces inaccuracy, and stratification (by sun or wind) can happen and affect the flow profile.
- flare header receive gas from seal drum which leads pulsating flows .

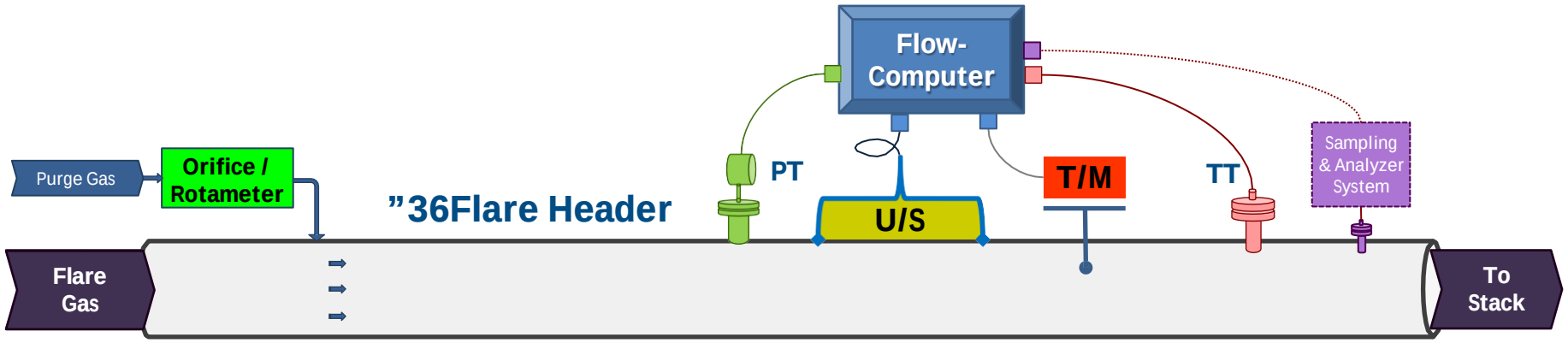
Very low pressure and flow and its impact

	HIGH & LOW FLOW (TURNDOWN(	LOW PRESSURE	DIRTY FLARES	VARYING COMPOSITION	FLOW PROFILES	COST
Pitot Tubes 	poor 10 to 1	poor P device	poor Prone to clog	poor Volumetric	good Averages across pipe	2,000$
Insertion Turbin 	poor 10 to 1	fair Minimum velocity	poor Prone to clog	poor Volumetric	poor Point measurement	1,000$
Insertion Vortex 	Poor Minimum velocity	good Multivariable	fair Sensor head can plug,	Poor. Need Composition	Poor , Point measurement	3,000$
Insertion Thermal 	good 1,000to 1	Fair,Op Pressure Calibration	poor Clean flares only	Poor Need Composition	good Point measurement	2,500$
Ultrasonic 	fair 1000 to 1	excellent Not affected	excellent External to pipe	good Infers density	fair Signal accross pipe	15,000$

Flare-Gas Flow-Metering Options

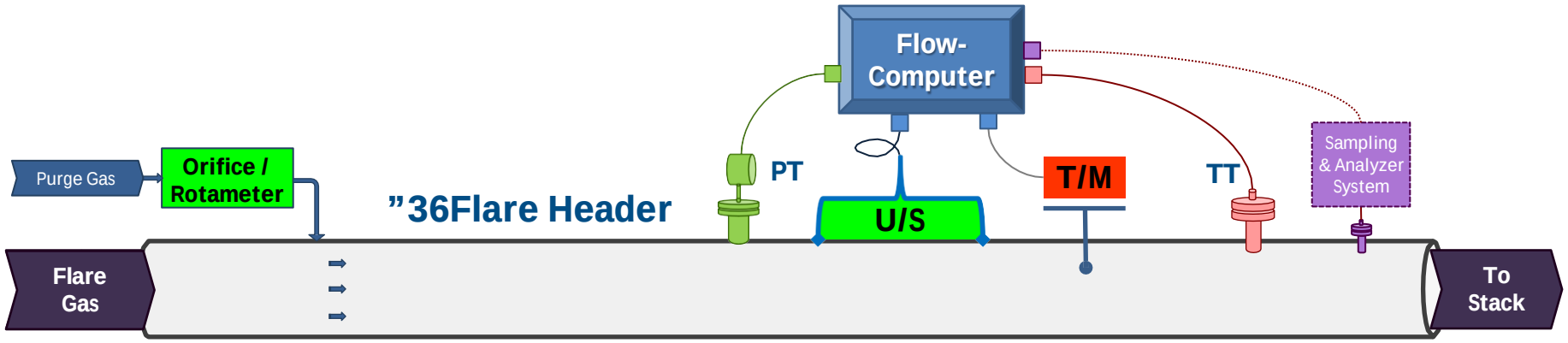
Type	Directly Reads	Turn-Down)within accuracy(	Typical Installed Uncertainy	Remarks
Thermal Mass-Flow	Mass Flow	Factory Set 100 : 1	% 1 +of Reading+ .0X % of Full Scale	Multiple meter to cover and low and high range. Not possible calibrate in the field
Ultrasonic (Intrusive(	Velocity	1 : 2500 <	Standard % 5 – 2 : High-Accuracy: 1 - 1.5%	Turn-down limited by gas velocity: max ~120 m/s min ~ 0.03 m/s
Optical	Velocity	1 : 1000	%2.5±of reading (1 – 100m/s(%7±of reading (0.1 to 1.0 m/s(	Tolerates higher gas velocities than other techniques

Illustration of Typical Expected Performance



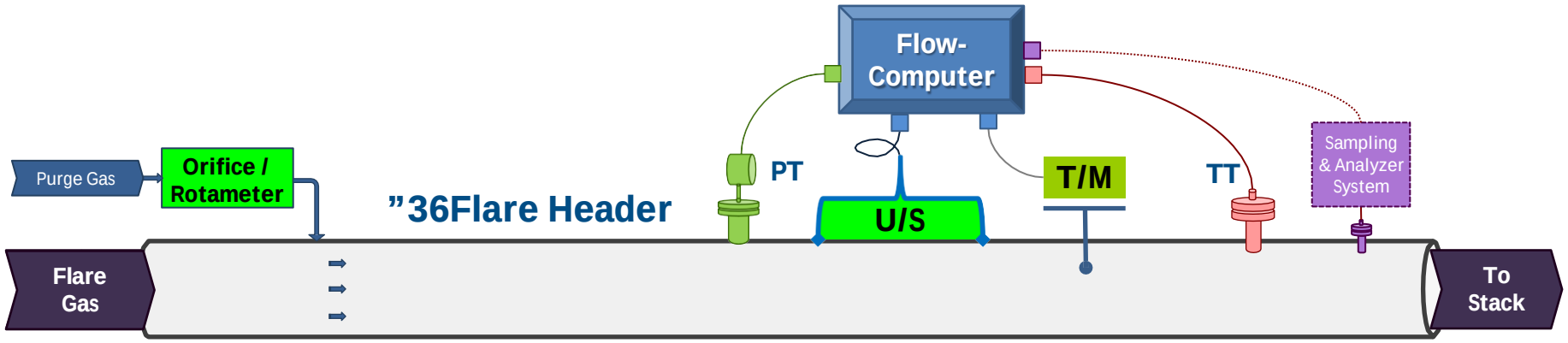
Process Condition	Occurrence Frequency	Actual Flow, MMACFD	Flow Velocity, Ft/s	Operating Turn-Down
Flare-Vendor Purge	24x 7	0.02 ~	0.03~	0.3 ~

Illustration of Typical Expected Performance



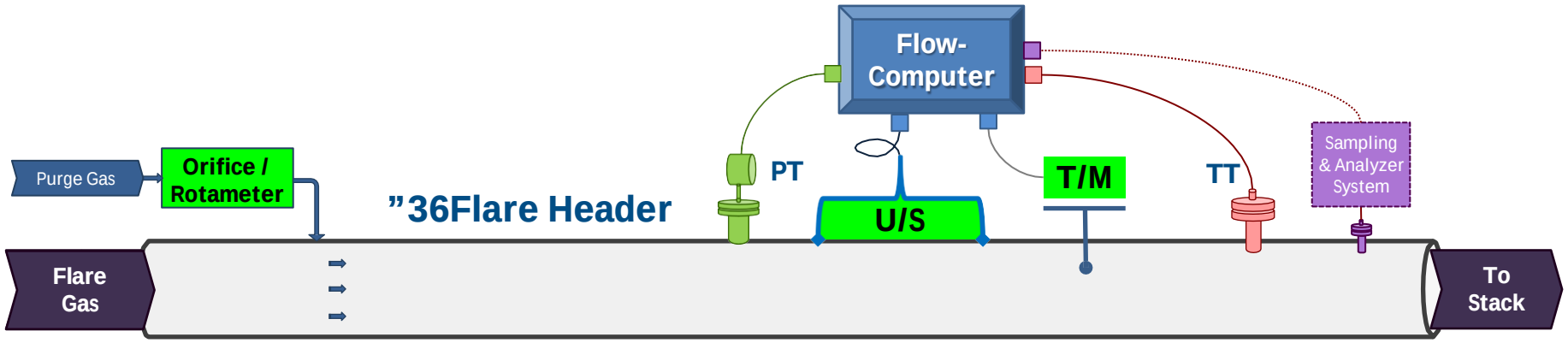
Process Condition	Occurrence Frequency	Actual Flow, MMASCFD	Flow Velocity, Ft/s	Operating Turn-Down
O/Stack Purge / Lit-Flare	24x 7	1.57 - 0.63	2.68 - 1.07	27 - 11

Illustration of Typical Expected Performance



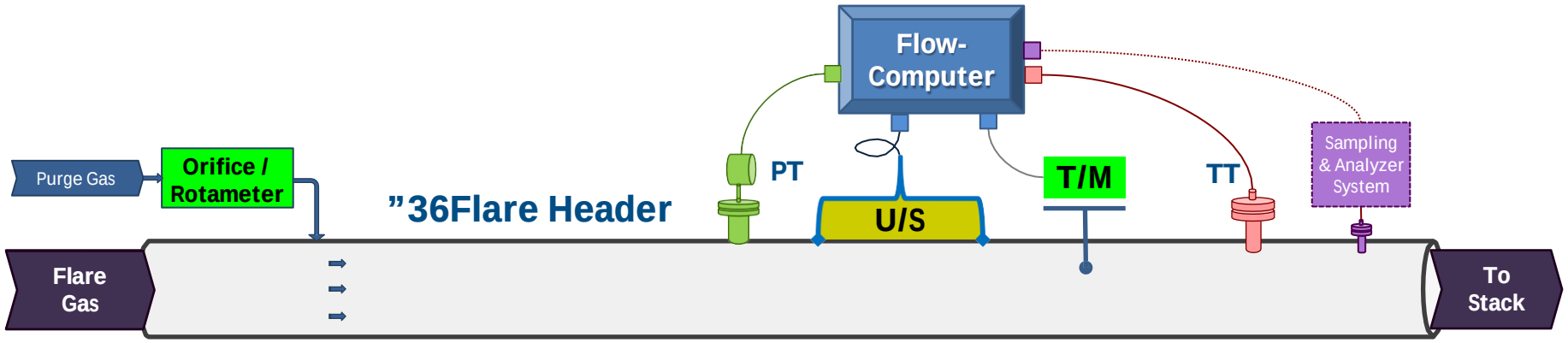
Process Condition	Occurrence Frequency	Actual Flow, MMACFD	Flow Velocity, Ft/s	Operating Turn-Down
1Unit Trips	Once Every Month	115 ~	196 ~	1966

Illustration of Typical Expected Performance



Process Condition	Occurrence Frequency	Actual Flow, MMACFD	Flow Velocity, Ft/s	Operating Turn-Down
2Units Trip	Once Every Two Months	177	302	3023

Illustration of Typical Expected Performance



Process Condition	Occurrence Frequency	Actual Flow, MMACFD	Flow Velocity, Ft/s	Operating Turn-Down
Plant Emergency	Once Every 2 Years	217	370	3707

THANK YOU