MAXUM process gas chromatograph monitors flaring emissions

Flexible and smart on-line GC solutions to comply with global flare measurement requirements

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We are committed to moving your performance forward

Valmet in brief

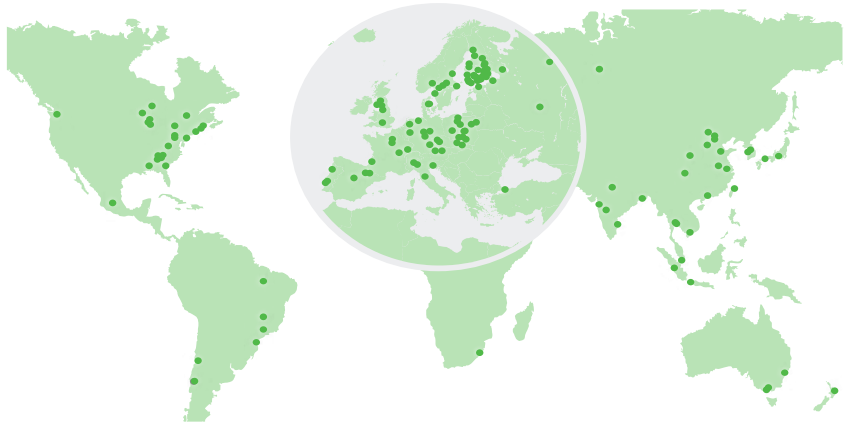
Global leader

with unique combination of technologies, services and automation to a variety of industries

Over 220 years
of industrial experience

5,532 MEUR
net sales 2023

28 R&D Centers



Over 19,000 professionals

- **Over 140** service centers
- **Over 130** sales offices
- **50** production units

Acknowledged leader in sustainability

MEMBER OF Dow Jones Sustainability Indices In Collaboration with RobecoSAM

Valmet

Valmet is an acknowledged leader in sustainability

360º approach to sustainability across value chain

Sustainability360° Agenda focus areas

Environment

We enhance circularity and environmental efficiency and reduce CO_2 emissions through the entire value chain. Valmet aims to enable fully carbon neutral production for its customers by 2030.

Social

We promote an engaging work environment, commit to the health and safety of our people and partners, and strive to be a responsible corporate citizen.

Governance

We follow ethical business practices, ensure a sustainable supply chain and report in a transparent manner.

Member of Dow Jones Sustainability Indices Powered by the S&P Global CSA

GOLD 2023 ecovadis Sustainability Rating

MSCI ESG RATINGS AAA

CDP A LIST 2023 CLIMATE

ISS QualityScore

ISS QualityScore

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Valmet’s process gas chromatography business

A world-leading GC, from a world-leading analyzer company!

Best-in-class technology
with more than 60 years of industry experience

Continuous investment
in development and product improvement

Innovative
multiple major technical innovations and “first to market” features

Blue-chip customer base
Major customers in every major country and world region

World’s largest installed base of process GCs
~40,000 units worldwide

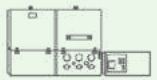
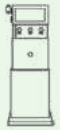
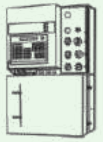
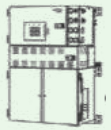
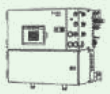
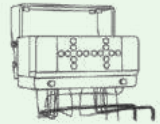
Committed, experienced employees
Strong organization of support personnel located worldwide

From a pioneer to a leading supplier in process gas chromatography

Unique corporate heritage and track record based on more than 60 years of industry expertise!

Historical ownership

Phillips 66 | Applied Automation | Applied Automation Hartmann & Braun | Elsag Bailey Process Automation | SIEMENS | Valmet

1950s	1960s	1970s	1980s	1990s	2000s	2010-2024	2024
							
First Process Gas Chromatograph (GC)	**Digital automation**	**Microprocessor-based GC**	**Serial networkability**	**PC / Densification**	**Platform Consolidation MAXUM II**	**Miniaturization**	
							
						Modularization / Digitalization	

Product innovations

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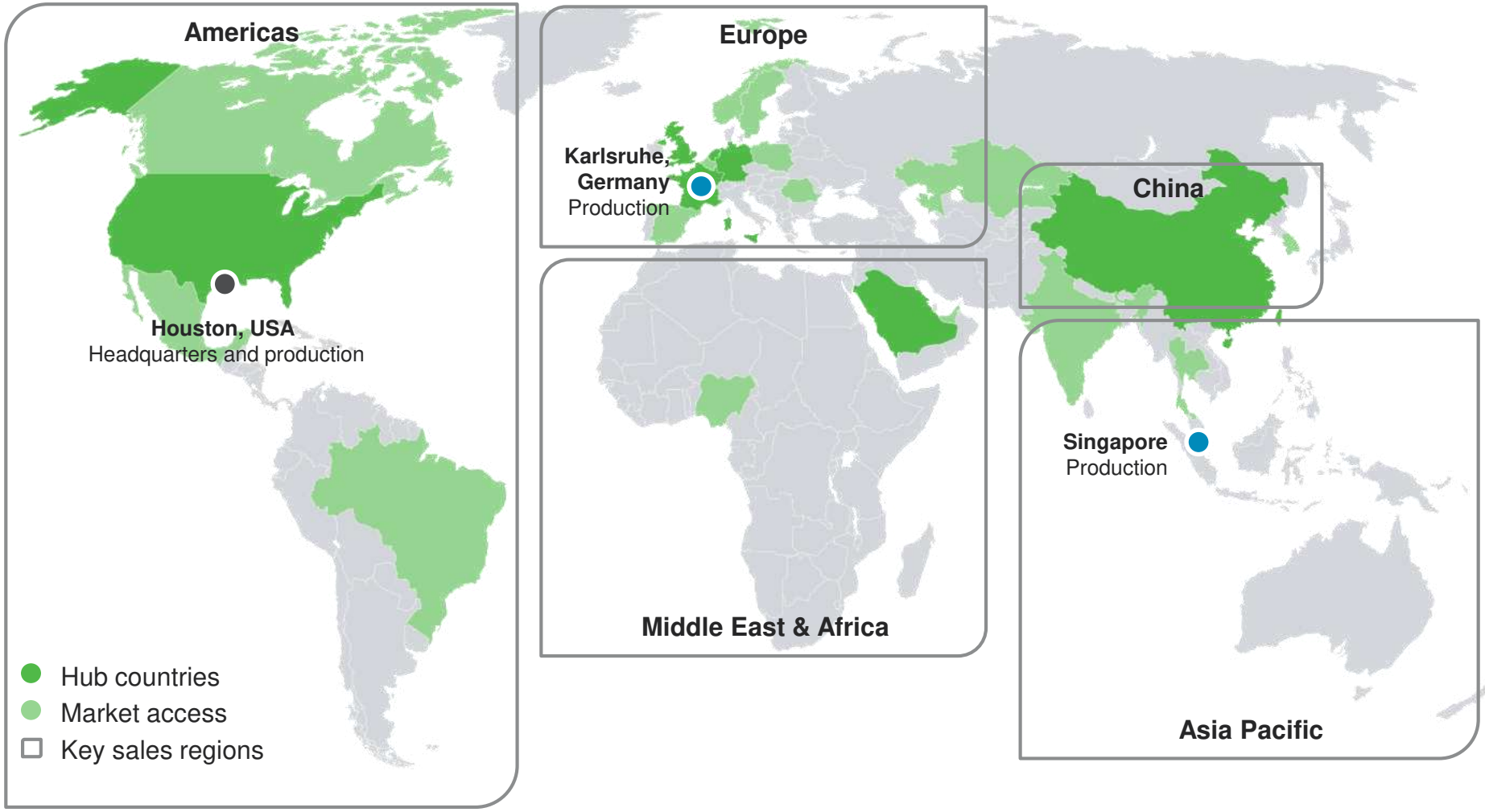
Comprehensive new set-up covers our customers around the world

Global set-up with three main hubs and focus regions / areas



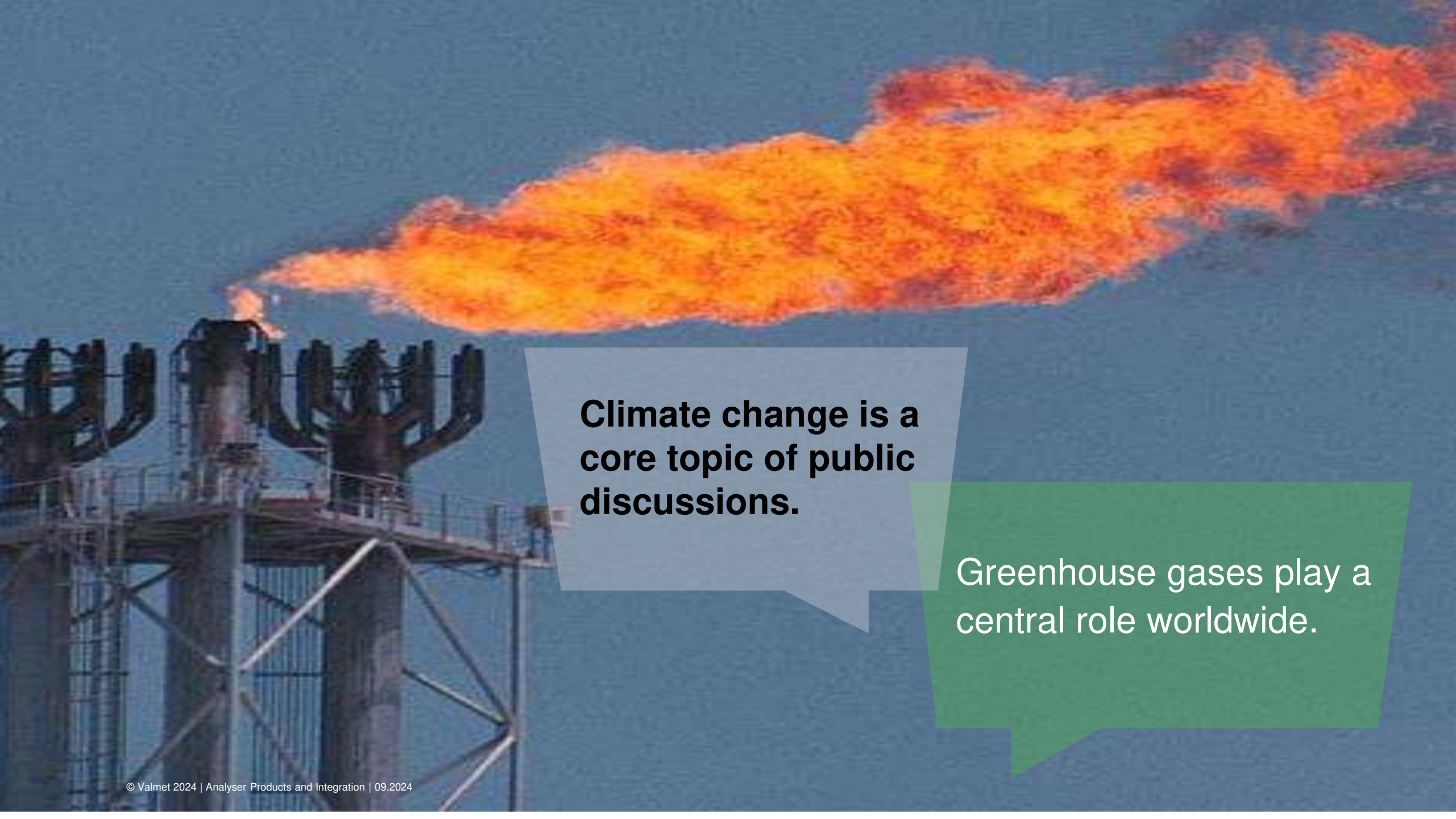
Valmet´s MAXUM II gas chromatographs

Worldwide solutions for today´s process analytical needs

2

Flare Gas Monitoring - Market and plant requirements

Rules and analytical measuring points



Climate change is a core topic of public discussions.

Greenhouse gases play a central role worldwide.

Flare Gases

A significant share of global greenhouse gas emissions comes from flare gas plants.

Press Note: *WASHINGTON, July 21, 2020 — Estimates from satellite data show global gas flaring increased to 150 bcm in 2019 levels not seen in more than a decade.*

Increasing global trend to monitor flare and fuel gas in the hydrocarbon processing industry (refineries, HPI) due to legal regulations.

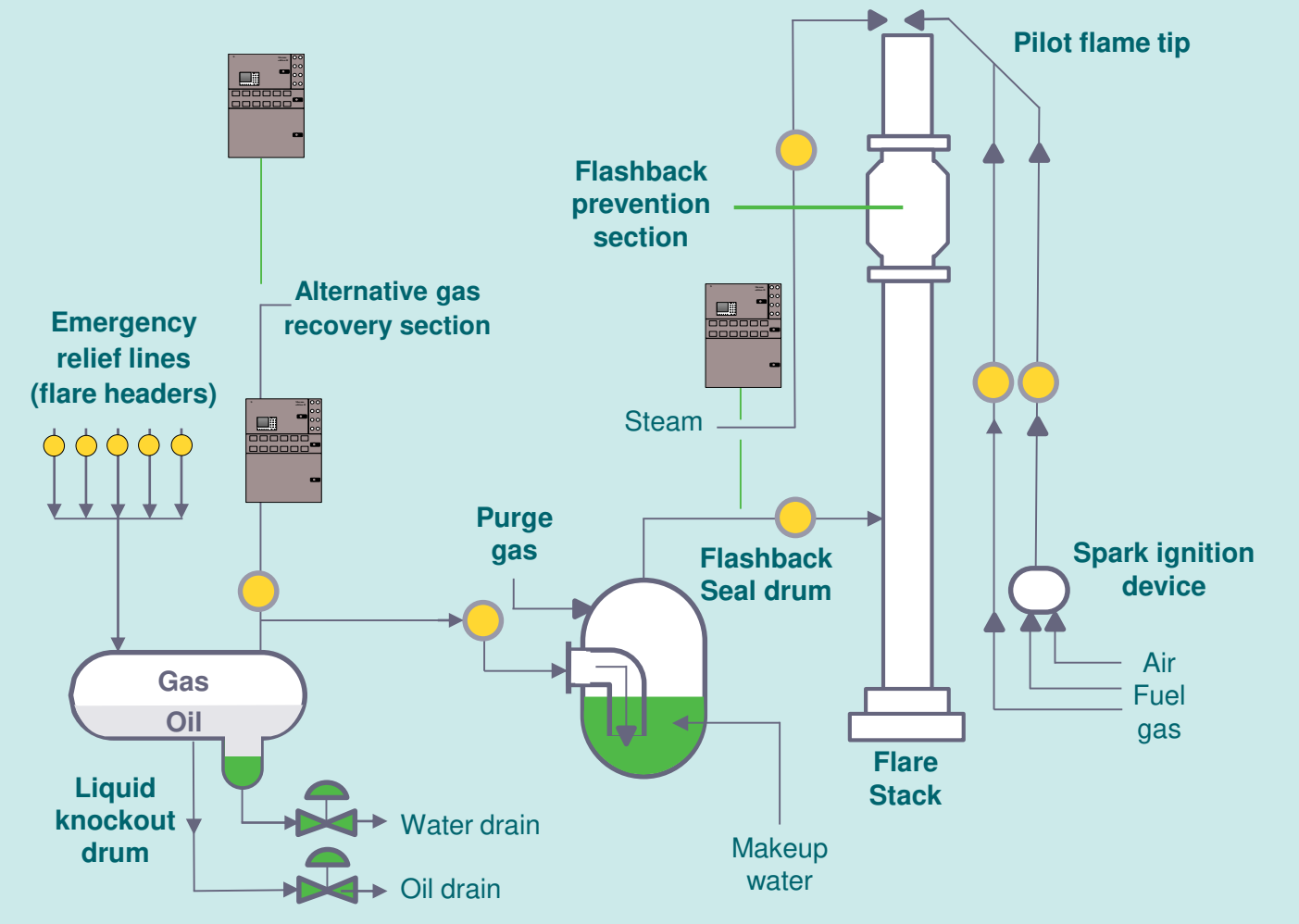
Worldwide broad market coverage of online flare gas analysis by Siemens GCs.

Flares
Rules and Measuring Points

- Plenty of T, P, F measurement points
- Various analytical measuring points

Rules in US	
RSR	Refinery Sector Rule 40CFR Part 63.670
HRVOC	TCEQ Chapter 115
Ja	EPA 40CFR 60 Sub Part Ja

Rules in Europe	
EU ETS	European Emission Trading Scheme
Nat. Impl.	DE: TEHG; UK: EEMS, FR: FRA20
Consents	Bilateral consent agreements Phase 3: Auctioning



Flare Monitoring Focuses On 3 Measurements

Compliance regulations

Sulfur compounds
- **Goal** is to reduce SOx emissions
- **Examples**: H_2S, Total Sulfur

BTU / CV
- **Goal** is complete burning of flare gas
- **Examples:** N_2 to C_{4+}

Olefin compounds
- **Goal** is to reduce Ozone
- **Examples:** Ethylene and other HRVOCs

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Flare - Analytical Requirements
US Rules with different sets of goals

Parameter	RSR	HRVOC
Objective	Combustion Efficiency	Olefin emission
Control	BTU in combustion zone	>300 BTU
Flow quantification	T, P, F	T, P, F
Measurement	All or H_2, C_2-C_5 N_2	C_2-C_4 Olefins as present H_2, N_2, C_1-C_5+, H_2O a.o.
Measurement frequency	minimum 4 results/hr.	minimum 4 results/hr.
Validation	BTU	individual components
	min. 60°C	min. 60°C
Validation frequency	mid point (single analysis)	weekly mid point (triplicate)
	quarterly low/mid/high	quarterly low/mid/high
Validation target	"All" or H_2 & n-Paraffins	Olefins, "all" or main BTU contributors

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Flares – Potential Measuring Components

Components	Range %
Hydrogen	0-100
Oxgen & Argon	0-100
Carbon Monoxide	0-100
Nitrogen	0-100
Methane	0-100
Carbon Dioxide	0-100
Ethane	0-100
H_2S	0-300 ppm
H_2S	0-100
Acetylene	0-100
Propane	0-100

Components	Range %
i - Butane	0-100
n - Butane	0-100
I-& 1-Butene	0-100
Tr-2-Butene	0-100
cis-2-Butene	0-100
1,3-Butadiene	0-100
i-C_{5+}	0-50
i-Pentane	0-50
n-Pentane	0-50
i-C_{6+}	0-20
Water	0-30
a.o. Benzene	0-10

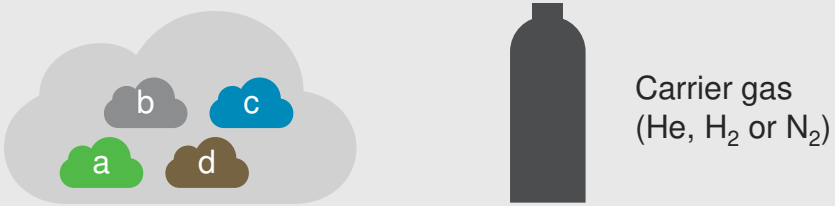
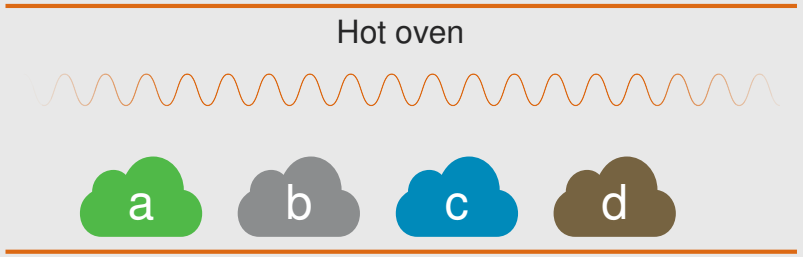
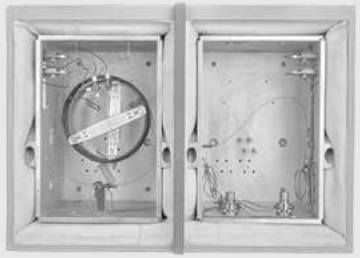
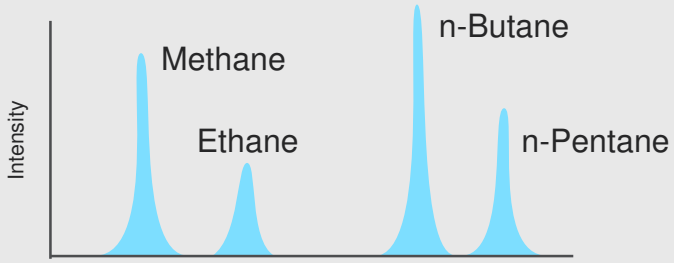
3

The analytical solution package

Sampling system and analyzer

Process gas chromatography

Operation principle - Main function and hardware

Injection		
Separation		
Detection		

Valmet MAXUM II process gas chromatograph

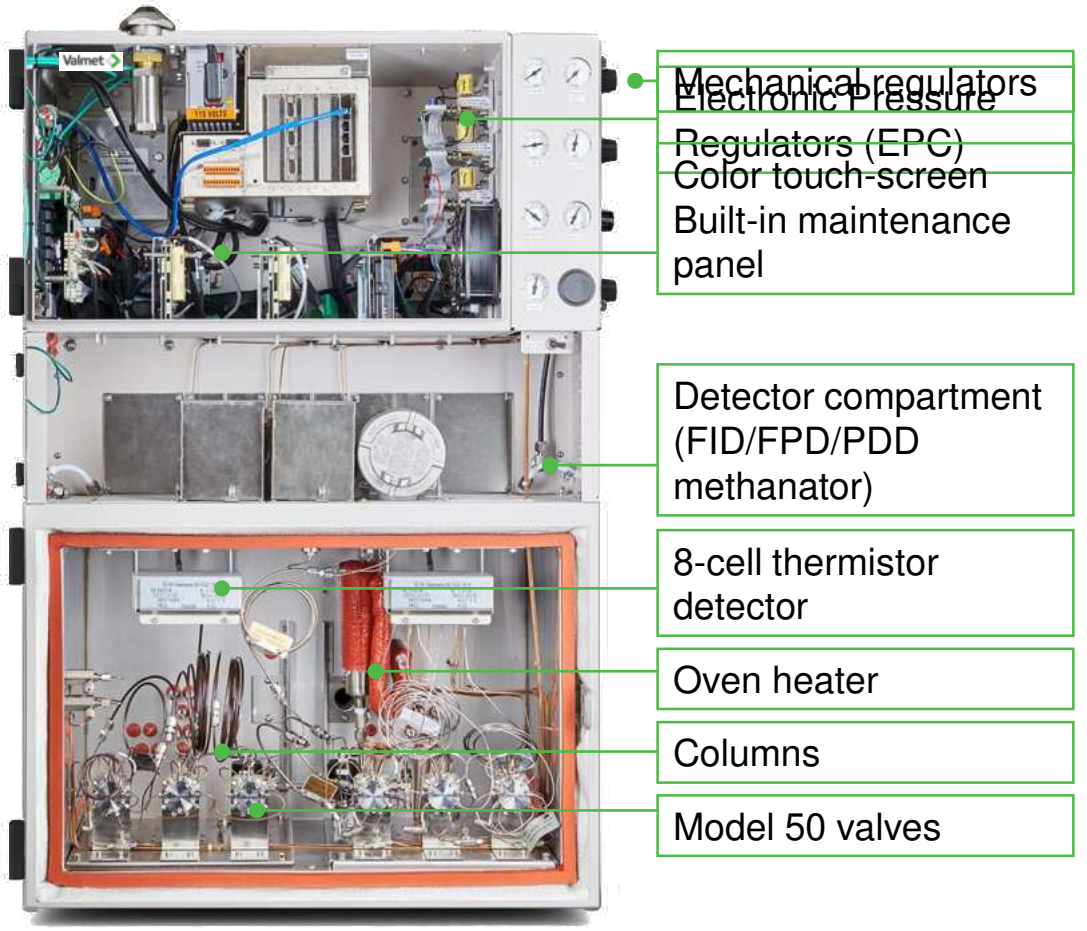
Design

Electronics compartment
High speed controller electronics and integrated Ethernet communications

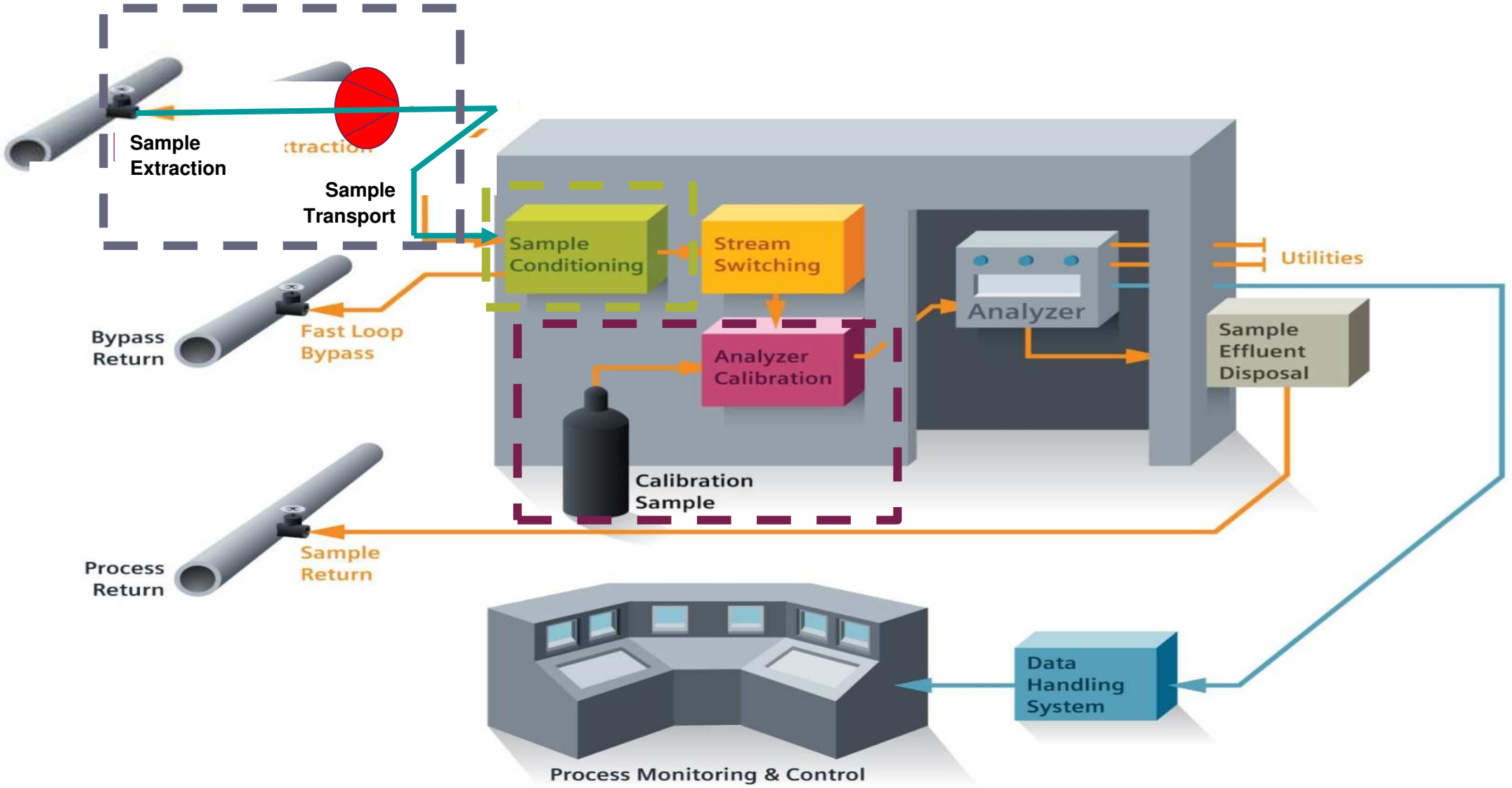
Separate detector compartment
Versatility and easy maintenance of flame-type detectors

Oven compartment (airbath type)
Large ovens for flexible applications

Extremely stable temperature control for tolerance of changing ambient conditions and easy maintenance access



Analyzer Measurement System



Flare Gas Monitoring System Integration Installation Examples Worldwide

Americas
US

Europe
Italy

Asia
Taiwan

Americas
US

System solution options

- Analyzer shelter
- Cabinet
- 3-sided enclosure

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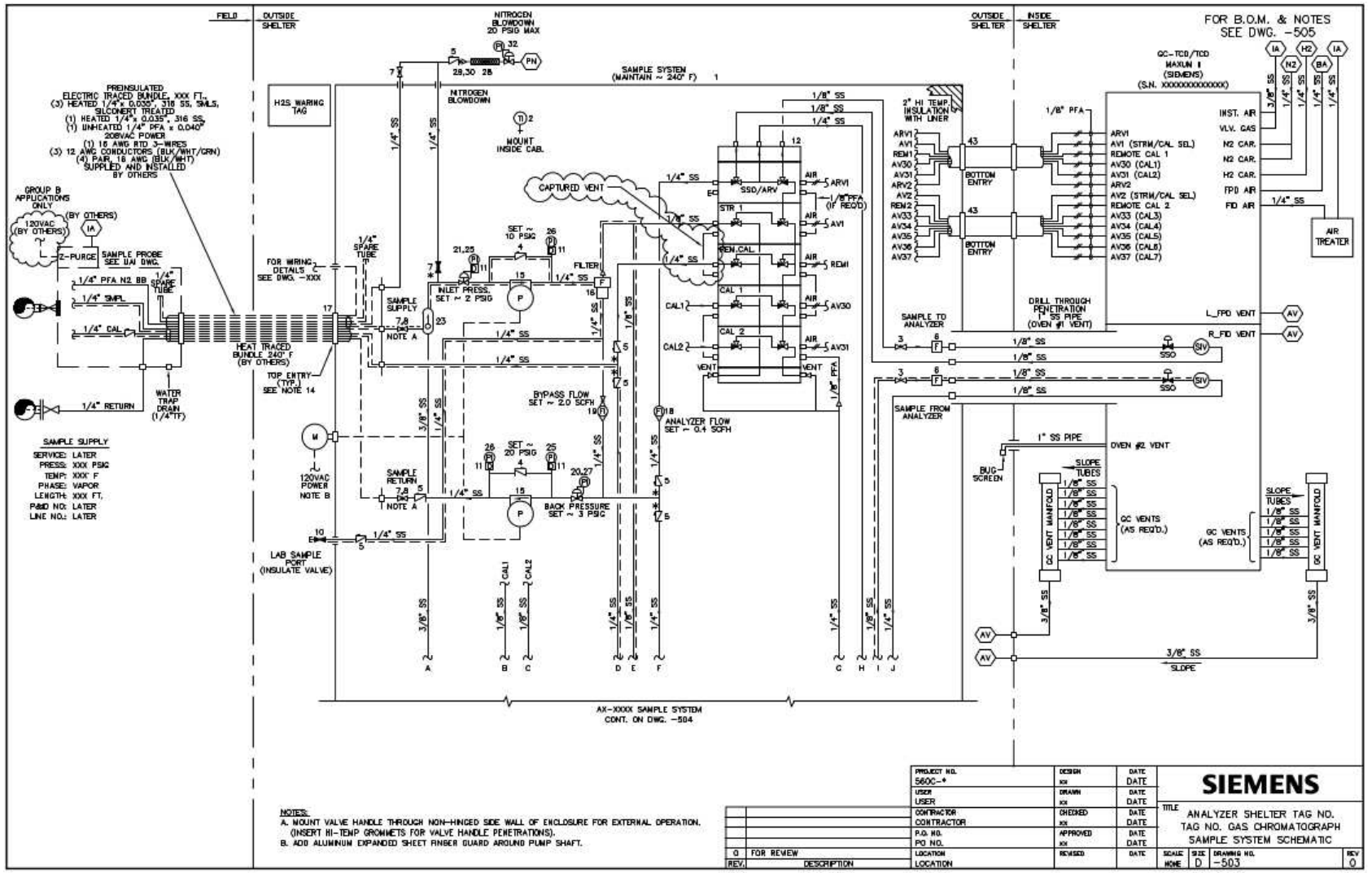
Example Field Installation

Example Flare GC Sample System

Design example in US

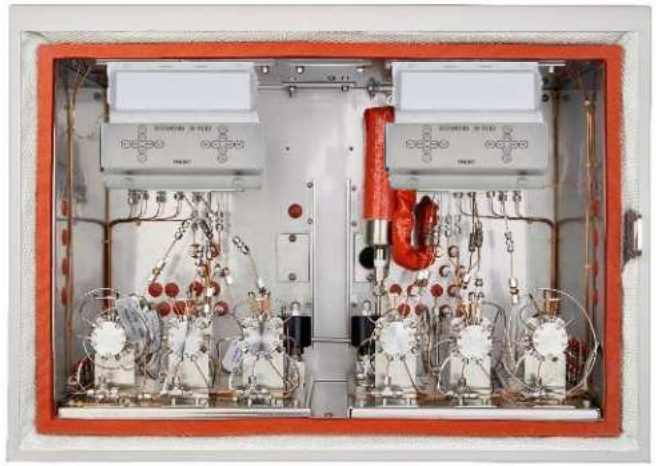


Sample system at 60°C

Sample system at 120°C

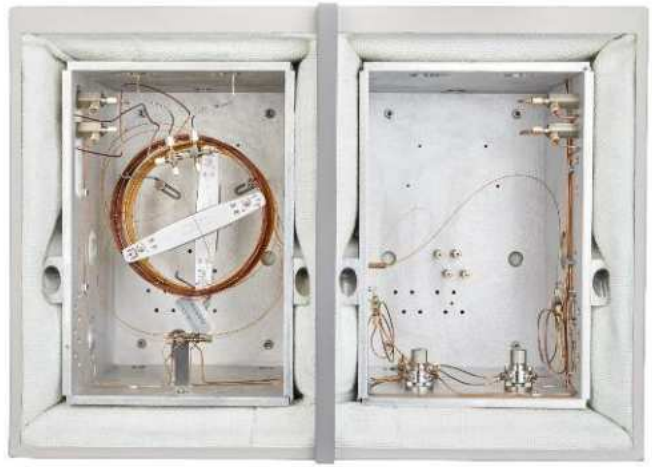
Multiple Process GC Designs For All Flare Measurement Situations

Airbath



- Large interior for easy maintenance
- Fast warm up and stabilization time
- Programmed temperature option
- Split oven compartment option

Airless

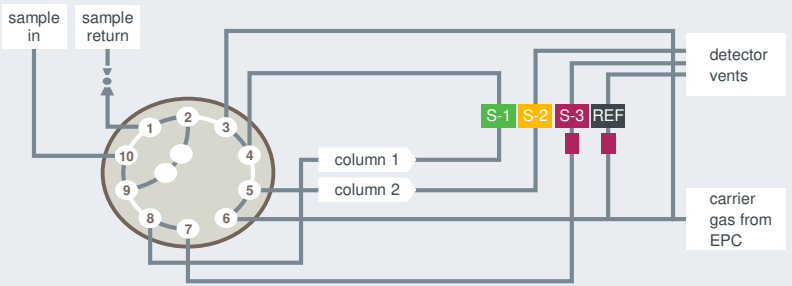


- No oven air required
- Suitable for remote installations
- Higher maximum operating temperature capability

Modular Oven Design Is Ideal For Simple Flare Applications

Maxum Platform

Modular Oven



The Modular Analytics concept opens new opportunity for process gas chromatography

- Removable analytics
- Pre-defined standard analytic trains
- Smaller footprint
- Faster delivery

On-line Process GC & Cycle Times

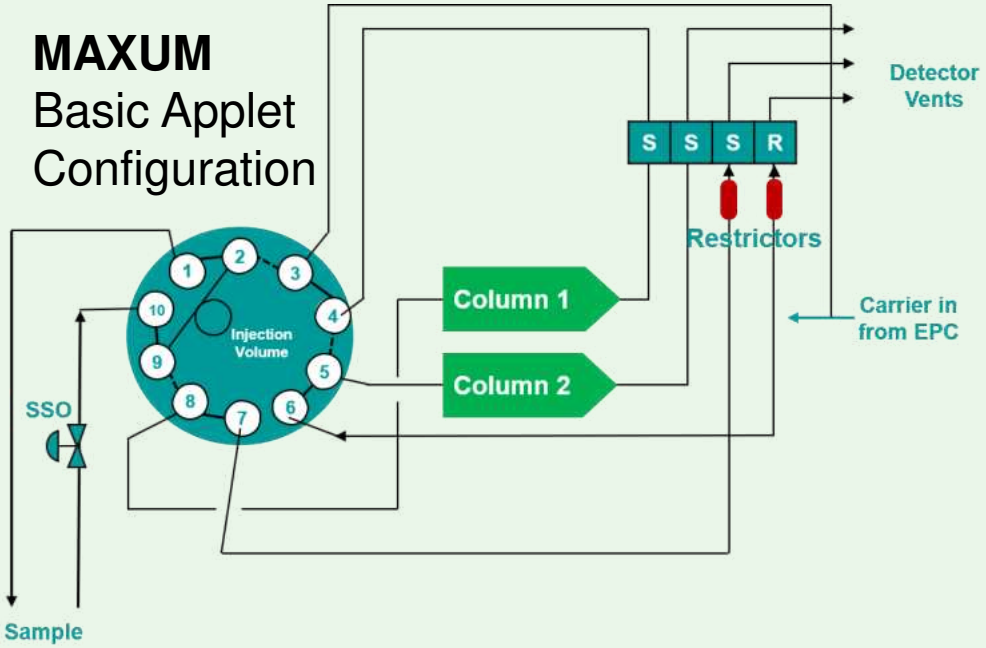
Measurement		Cycle Time (min)	Objective
Hydrogen		0.75	BTU Benefit
Nitrogen		1 - 1.5	Flowmeter
Air, C1-C4+		2	BTU
Air, C1-C5+		3	BTU
H2, N2, CO2, C1-C5+	Paraffins	3	BTU
H2, N2, CO, CO2, C1-C5+	Paraffins & Olefins	7.5	BTU
H2, N2, CO, CO2, C1-C5+	Paraffins & Olefins	7.5	BTU
H2S		3-5	Sulfur Emission
Total Sulfur		3	Sulfur Emission

On-line Process GC – Simplified

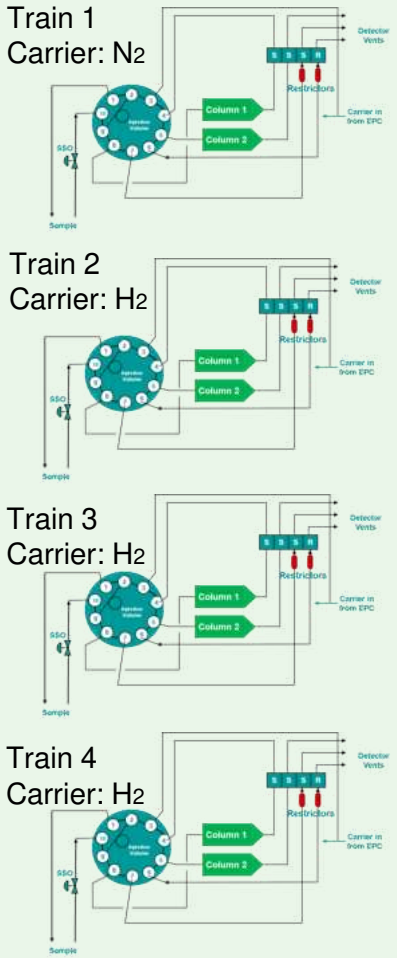
MAXUM Implementation Concept for Flare Gas Applications

Parallel Chromatography

MAXUM
Basic Applet
Configuration



MAXUM Gas Chromatograph using 4 Analytical Trains and 2 Carrier Gases



Configuration

Configuration using 4 analytical trains based on standardized “applet” configurations

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Implementation Concept for Flare Gas Applications

Flexible measuring tasks for various flare gas monitoring approaches

	Application (Components)	Required instrumentation
Basic Configuration	**CV and C6+ application:** H2, N2, O2, CO, CO2 CH4, C2H2, C2H4, C2H6 Sum C3, Sum C4, Sum C5, Sum C6+	**Four Analytical Trains:** 4 injection/blackflush valves 4 sets of micropacked columns Two 8-cell-TCDs
Optional Extensions to Basic Configuration	C3s individual	1 additional train (max. 6 trains/MAXUM)
	C4s individual	1 additional train (max. 6 trains/MAXUM)
	H2O or H2S	1 additional train There are plenty of T, p and flow as well as various analytical measuring points in place. (max. 6 trains/MAXUM)
	Benzene, Toluene, Xylenes (BTX)	1 additional train (max. 6 trains/MAXUM)
Optional Reductions of Basic Configuration	CV and C5+ application incl. H2S	3 Analytical trains, meets US flare gas regulation
	CV and C5+ application	2 Analytical trains, meets US flare gas regulation

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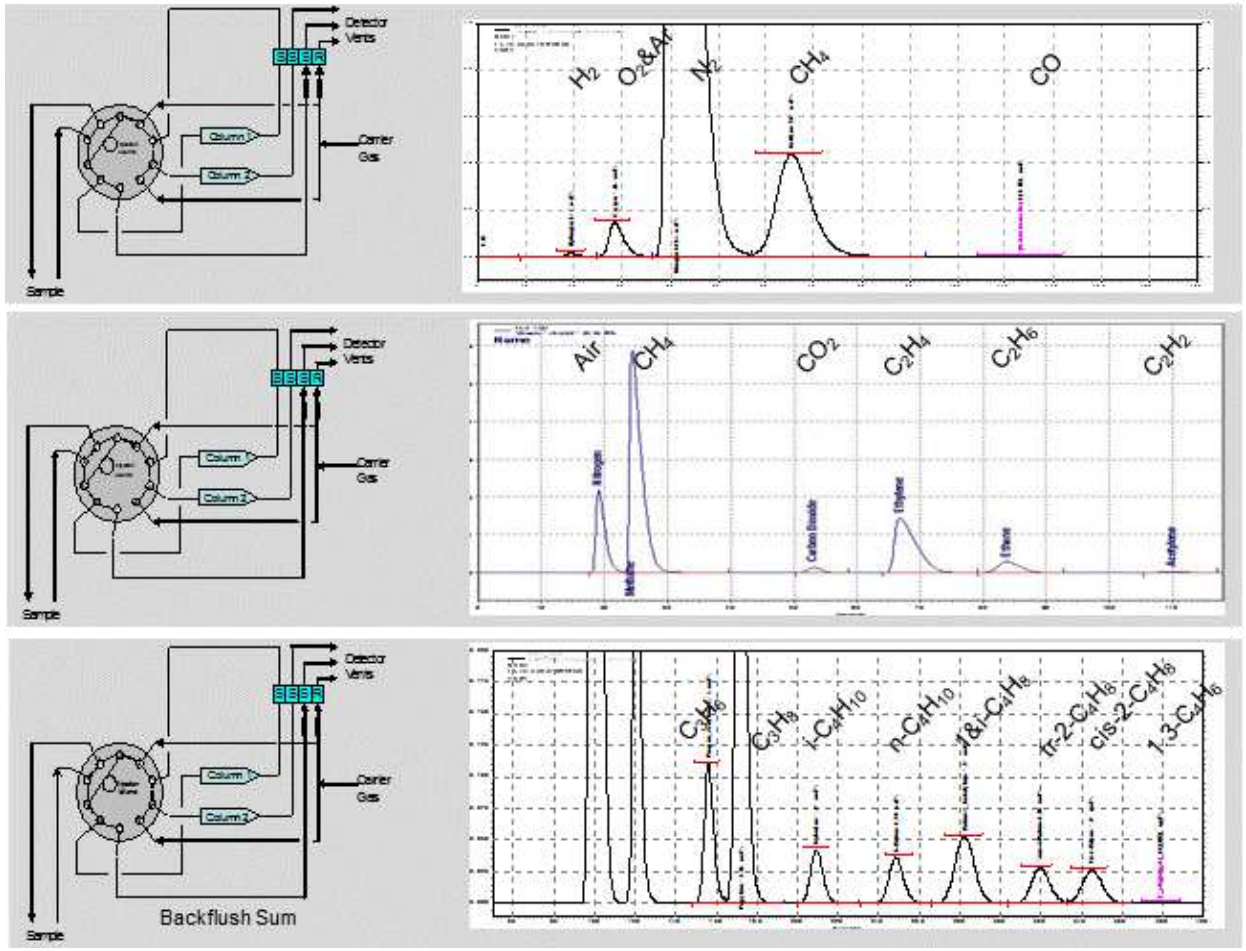
Online Process GC - Simplified



Parallel Chromatography

- Multi simple column trains
- Simple Backflush
- Multiple detectors
- Ease of Understanding
- Ease of Maintain
- Cycle time

Excellent Performance

High on-line time	97-99+%/a
Repeatable	RSD 0.2-0.6% (6 days)
Linear	R^2 0.9973-1 (0.01-100%)

MAXUM Compliance Testing

By independant testing house

EffecTech
Global Leaders in Gas Measurement

Fuel Gas Chromatograph

Calibration Report
for Fiscal Purposes and EU/ETS Compliance

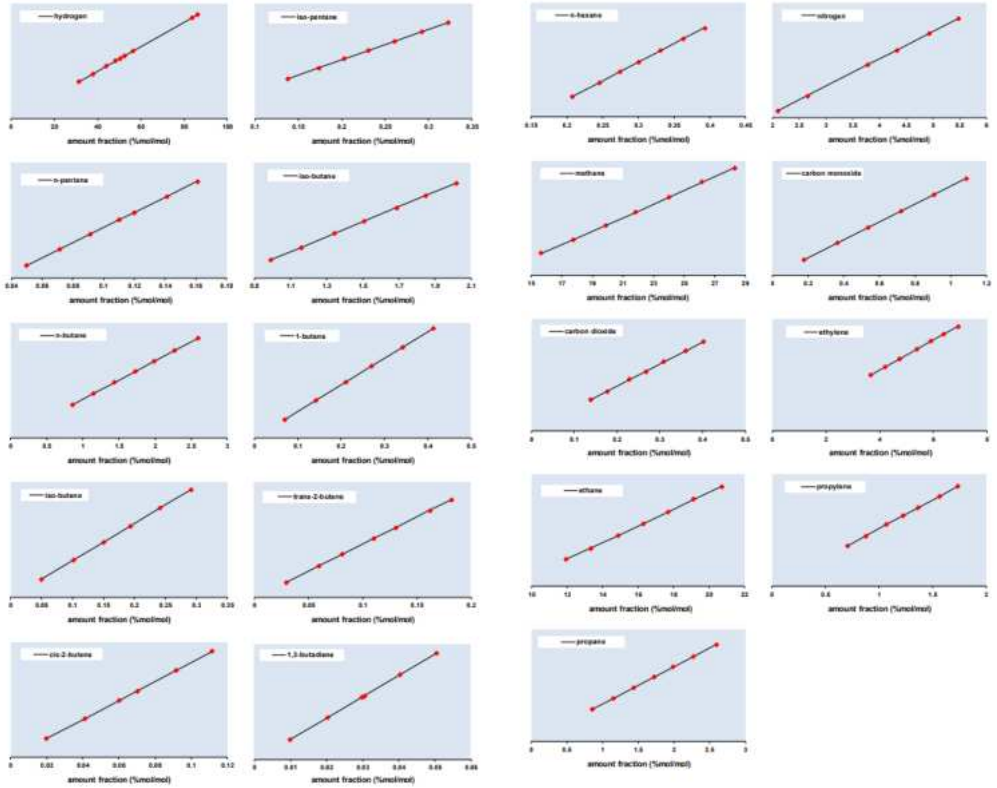
Siemens Maxum II -

Calibration Date
5-8 November 2018

prepared for the client

Figure 1 below show graphically the *calibration* functions for all components.

Figure 1 Calibration functions for all components



Summary

Multiple rules and customer requirements with similarities

- Proven solutions
- Turn-key measurement system including sample extraction, sample conditioning, analyzer, system packaging

Measurement system and analytical simplicity

Maintainability by user on-site

- Condensate slugs, changes / incidents require vendor support

Most popular flare measurement solution

- GC technology for speciation and optimization
- Over 500 Maxum GCs installed on flares globally

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Trusted supplier across the process industries

Petrochemicals

SASOL
Chevron Phillips Chemical Company LLC
ExxonMobil
BASF
lyondellbasell
Dow
Shell
INDORAMA CORPORATION
Formosa Plastics

Chemicals

Dow
BASF
Shell
SASOL
PRAXAIR
Making our planet more productive
Linde
AIR PRODUCTS

Gas Processing, LNG

FREEPORT LNG
KINDER MORGAN INC.
TARGA
Williams
ENTERPRISE PRODUCTS PARTNERS L.P.

Refining

PHILLIPS 66
TOTAL
Marathon Oil Corporation
Chevron
ExxonMobil
eni
Shell

Power, Environ. 3rd Party SI

Mississippi Power
Luminant ENERGY
GDF SUEZ
ENGIE
AltaGas
AEP
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FORWARD