BHGE Approach to Flare Control
Agenda

OVERVIEW OF REGULATIONS
NSPS, 40 CFR Part 60, Subpart Ja
Refinery Sector Rule 63.670

GE RSR SOLUTION

BHGE flare.IQ Technology Overview
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum accuracy requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>±1% over normal measured range or 2.8 °C, whichever is greater</td>
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</tbody>
</table>
| 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                                                                                |
Challenges for Flare Control

**Multivariable Control Scheme**
- Proper flare operation requires accurate demand of Steam and Supplemental Gas in order to maintain combustion efficiency and smokeless operation
- Variables are interdependent

**Automated Steam Control**
- Automatically maintain smokeless operation while balancing NHVcz > 270 BTU/scf
- Avoid manual control with operator over-steaming
- Requires leading indicator with real-time feedback

**Technology Limitations**
- Measurement latency associated with process analyzers
- No practical method for monitoring of NHVcz – requires fast response feedback of NHVvg, Qsteam, Qfuel, and Qflare
Generalized schematic of flare control
flare.IQ Field Validation Testing

DEMONSTRATED ACCURACY: 3-5% against Mass Spectrometer Reference
Nitrogen Purge flare.IQ Performance

DEMONSTRATED ACCURACY: 6% against Mass Spectrometer Reference

Demonstrated accuracy: 6% against Mass Spectrometer Reference.
flare.IQ Field Validation Testing

DEMONSTRATED ACCURACY: 3-5% against GC with time corrected data
BHGE flare.IQ Technology Overview
flare.IQ Logic Overview

**FLARE INPUTS**
- Qflare
- Pressure
- Temperature
- Sound Speed

**STEAM INPUTS**
- Qsteam
- Pressure
- Temperature

**FUEL INPUTS**
- Qfuel
- Pressure
- Temperature

**GAS CHROMATOGRAPH INPUTS:**
- XH2, XN2, XCO2, XH2O, NHVvg

**CALORIMETER INPUTS:**
- NHVvg

**CALCULATE:**
- $C_{measured}$
- to MWm
- to NHV

**USER INPUTS:**
- Qsteam (min, max)
- Qfuel (min, max)

**OUTPUT:**
- Qsteam_req
- Qfuel_req
- MW
- NHVcz
- Vtip

**CALCULATE:**
- Qsteam demand

**CALCULATE:**
- Qfuel demand

**COMPARE:**
- Vtip < Vtip_max
- NHVcz > 270 BTU/scf

**To DCS**
NHVvg from flare.IQ and GC in Customer Site

(GC output update rate ~ 10min)

DEMONSTRATED ACCURACY: <+/−5% against Gas Chromatograph Reference

![Graph showing a comparison between NHVvg from flare.IQ and GC in Customer Site](image)

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NHV from flare.IQ and Gas Chromatograph at Flare Upset Event
(GC output update rate ~ 10min)

FLARE.IQ’S FAST RESPONSE TO UPSET EVENT

NHV from Gas Chromatograph
NHV from FlareIQ
Iso-Butane

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NHV from flare.IQ and Gas Chromatograph at Flare Upset Event

(GC output update rate ~ 10min)

FLARE.IQ’S FAST RESPONSE TO UPSET EVENT
NHVcz with flare.IQ Control in Customer Site
(NHVcz Lower Limit = 300 BTU/SCF)
TIP VELOCITY CONTROLLED BELOW UPPER LIMIT

Vtip from flare.IQ and Vtip_upper_limit

Graph showing Vtip (ft/s) over time from 12:00 PM to 12:00 PM, with Vtip Upper Limit and Vtip from FlareIQ plotted.
flare.IQ Steam Model vs Steam from Incipient Smokeless Test

FLARE.IQ STEAM MODEL QUALITATIVELY AGREES WITH TEST RESULT

Flare.IQ Steam Model

Required Steam for Incipient Smokeless Point (test data)

Required Steam from Flare.IQ Model
Thank You

Questions?