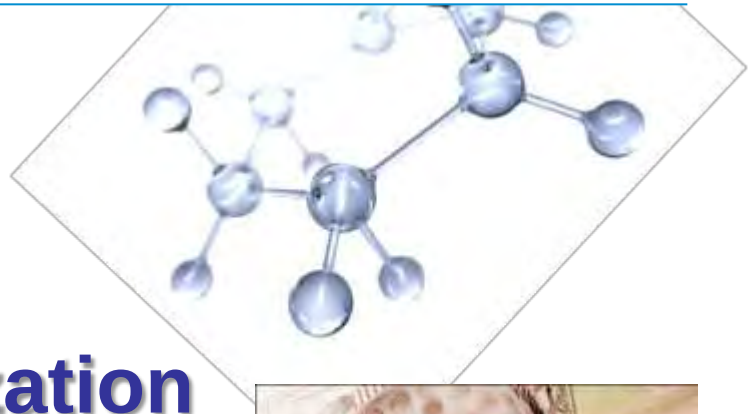
ExxonMobil Refining & Supply

ExxonMobil Chemical



Flare Steam-Assist Optimization

Judy M. Bigon
ExxonMobil Downstream/Chemicals SSH&E
October 31, 2012
Louisiana A&WMA Fall Conference

ExxonMobil Research and Engineering

Overview

- Case for action
- Flare steam-assist optimization
- Plant pilot study
- Early results and learnings

Case for Action

- New, credible flare test results show excess steam can adversely affect combustion efficiency
- Agencies & flare experts working to translate new data into monitoring/control requirements
- Rule development will take time
- New information cannot be ignored

Case for Action

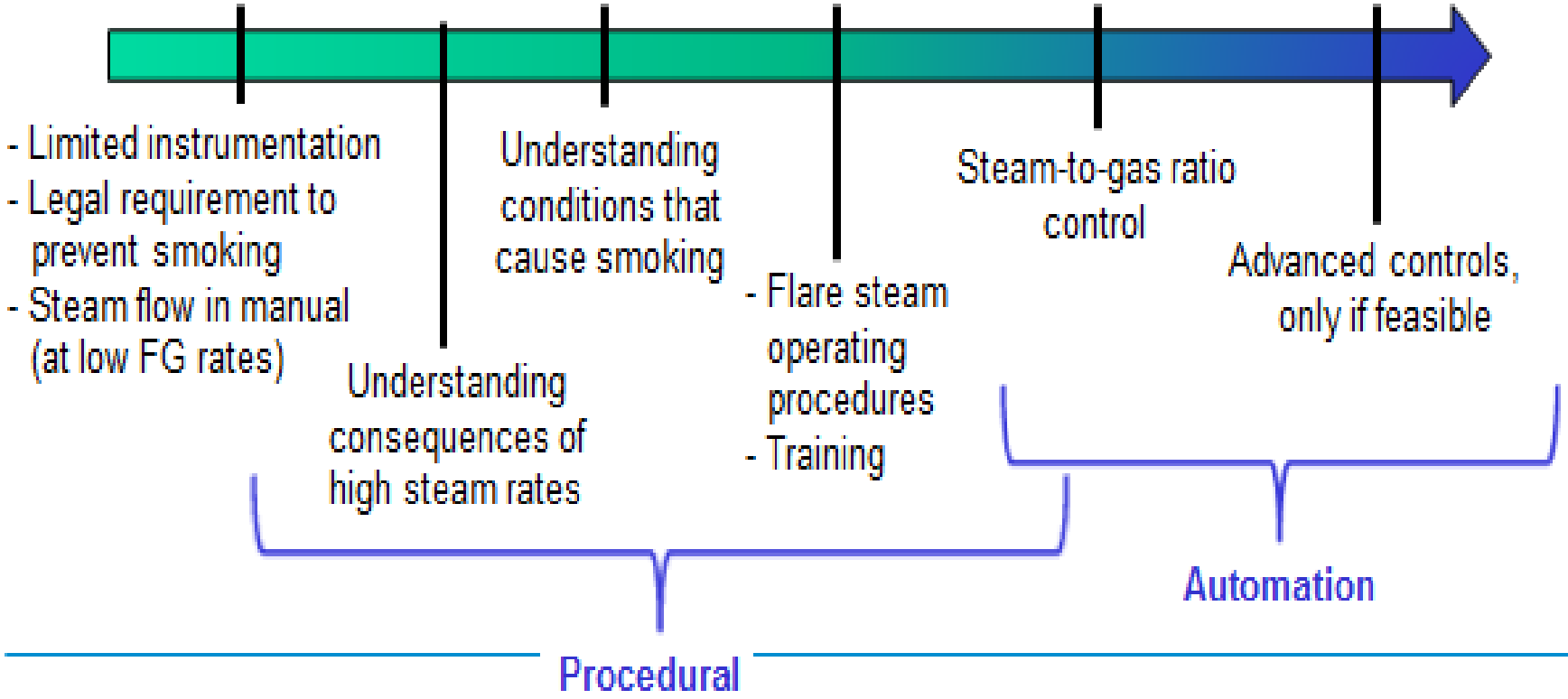
- **Industry trades informing the regulatory process**
  - Safety cannot be compromised
  - Potential $multi-billion cost across industries
  - Large flaring reductions must be considered
- **ExxonMobil proactively taking action**
  - Accounting for new information in flare operations
  - Supports continuing objective to minimize flare emissions
  - Learnings used to inform the regulatory process

Steam Optimization Basics

- **Focus on optimizing steam usage**
- **Focus on improvements using existing facilities**
  - Procedural
    - Education, procedure updates, training
  - Automation
    - Instrumentation, Distributed Control Systems

Steam Optimization Basics

- **Program objective is to move as far "to the right" as possible using existing facilities and improved procedures**



Steam Optimization Overview

- **Goals**
  - Evaluate flare steam usage while meeting prevailing regulatory requirements
  - Identify enhancements to flare procedures to minimize steam usage
- **Desired Outcomes**
  - Establish steam operating envelope that results in a smokeless visible flame
    - ➢ Presence of visible flame indicates high CE
  - Develop tools that will help achieve consistent operation within the envelope

Plant Application - Pilot Study

- **Organize Implementation Team**
  - Emissions control technology leader
  - Environmental engineer
  - Combustion expert
  - Federal air regulatory advisor
  - Plant personnel
    - Operations, applications, SHE

Plant Application - Pilot Study

- **Preparations and Data Collection**
  - Identified sources and typical/lowest rates of flare flows
  - Characterized relevant flare facilities
  - Compared data against installed equipment
  - Identified & addressed items before testing
    - Calibration of monitoring equipment
    - Maintenance/repair items

Plant Application - Pilot Study

- **Preparations and Data Collection**
  - Determined minimum required steam rate based on the higher of:
    - Equipment, operational, or configuration requirements
    - Minimum steam flow rate that is “controllable” and “measureable”
  - If possible, created DCS calculated tags based on existing instrumentation
  - Ensured understanding of desired flame appearance and environmental constraints

Plant Application - Pilot Study

Regulations do not allow visible emissions (smoke) for more than 5 minutes in a 2-hour period.	Flare at "incipient smoke point" – transient wisps of smoke. Maximum operating window.	Flare with visible, slightly "marbled" flame.	Flare with visible flame with some regions of transparency.	Flare with small, visible, transparent flame. Minimum operating window.	Flare with steam plume and no visible flame. Steam could be quenching the flame.
✗	✓	✓	✓	✓	✗

Visual Cue Card

Plant Application - Pilot Study

- **Evaluation Approach**
  - Performed field trials to determine flare operating envelope at typical flare gas rates
    - Established operating envelope as “incipient smoke point” to an “intermittently visible flame”
    - Adjusted steam rate along this continuum and tested automated steam controls, where available
    - Assessed different flare rates and “feeds”
      - Base load, cases with added gas, cases with varying compositions
    - Used instrumented parameters where available
  - Recorded information along full test continuum

Early Results

- **Identified limiting constraints to further optimizing steam rate with existing facilities**
- **Showed that existing infrastructure provides options for automatic steam control**
  - Steam-to-flare gas ratio (SFR) control possible for most flares
  - Combustion Zone Net Heating Value (CZNHV) control possible on some flares
  - Operating window between smoking and “no visible flame” can be very narrow

Early Results

- **Establishing operating envelope for steam usage on all continuous flares**
  - Goal: control to visible smokeless flame
- **Developing & implementing flare-specific operating procedures**
- **Training operators & setting expectations**

Early Learnings

- **Every flare system different, requiring unique and customized control strategy**
  - When objective clear, plant personnel find most reliable/cost-effective means to achieve it
  - Although “returns” early, some flares may be able to achieve objective with no new cap. investment
- **Accuracy/range of existing meters/analyzers for flare gas & steam flow rates are important elements of robust/reliable control scheme**
  - Accurate measurement of flare gas rate and steam rate at low rates is challenging

Early Learnings

- **Continuous heating value (BTU) analyzer may be necessary**
  - Depends on variability of flared gas heating value and regulatory requirements
  - Control using BTU analyzer & CZNHV may be necessary for flares with significant variation in flare gas rate
- **Steam valve position can be sufficient to determine SFR or CZNHV operating range for some flares**

Early Learnings

- **Operator/site training critical to improvement**
  - Operators need to understand risks and consequences of too much or too little steam
- **Objective of maintaining visible flame easily understood by everyone in organization**
- **Communication with community & neighbors about possible changes to flare appearance is part of education process**
  - Some agencies engaged in this education
    - http://www.tceq.texas.gov/publications/gi/gi-419.html/at_download/file

Questions??

Contact Information: judy.m.bigon@exxonmobil.com/281-360-6598