Excess Emissions: Flare Combustion Issues

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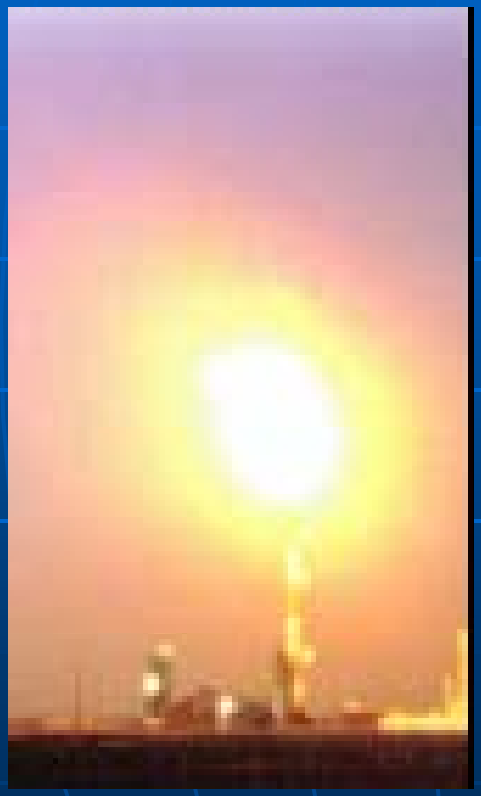
U.S. EPA – Region 5

Elevated Flares

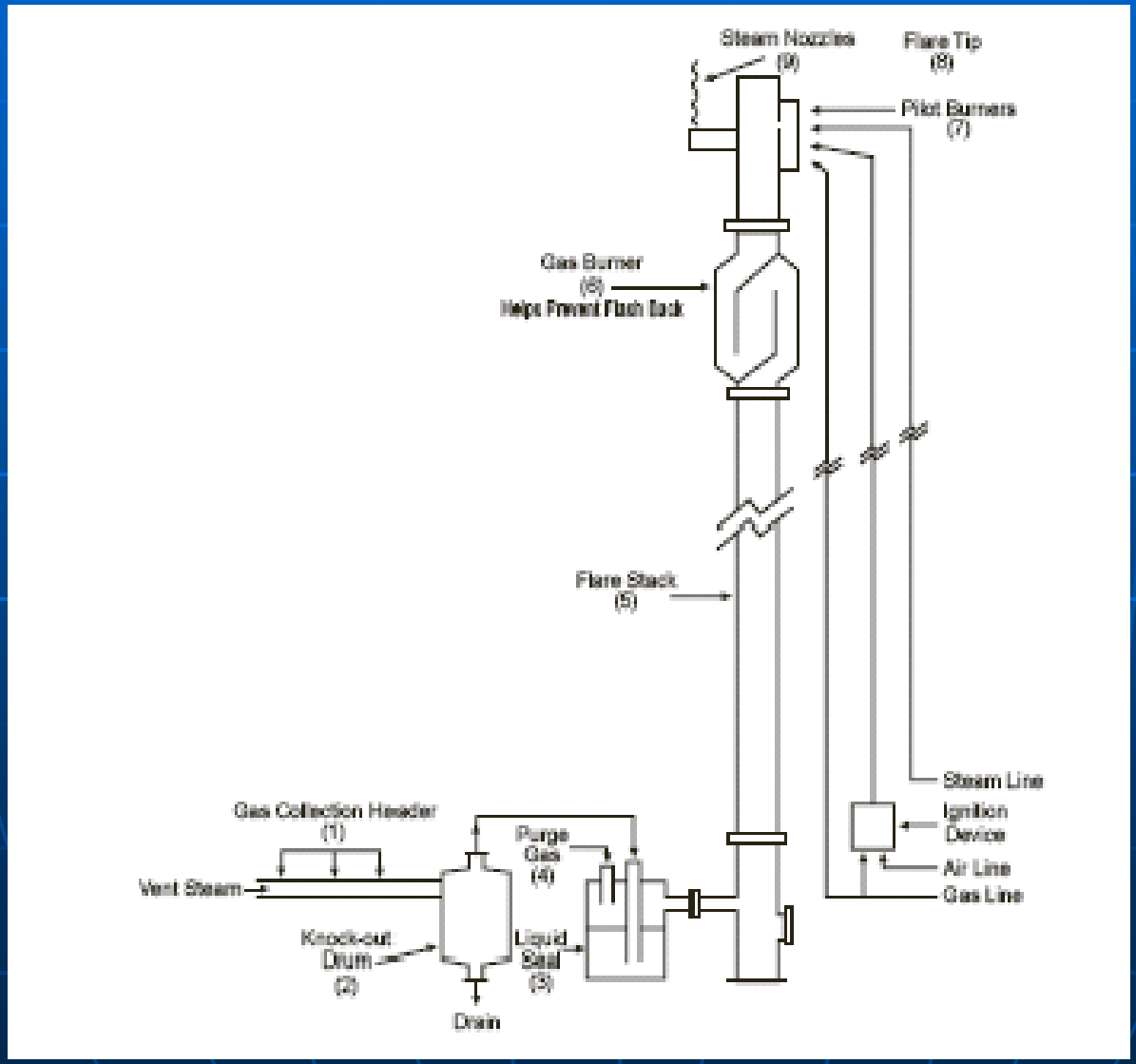


Photos: John Zink Company

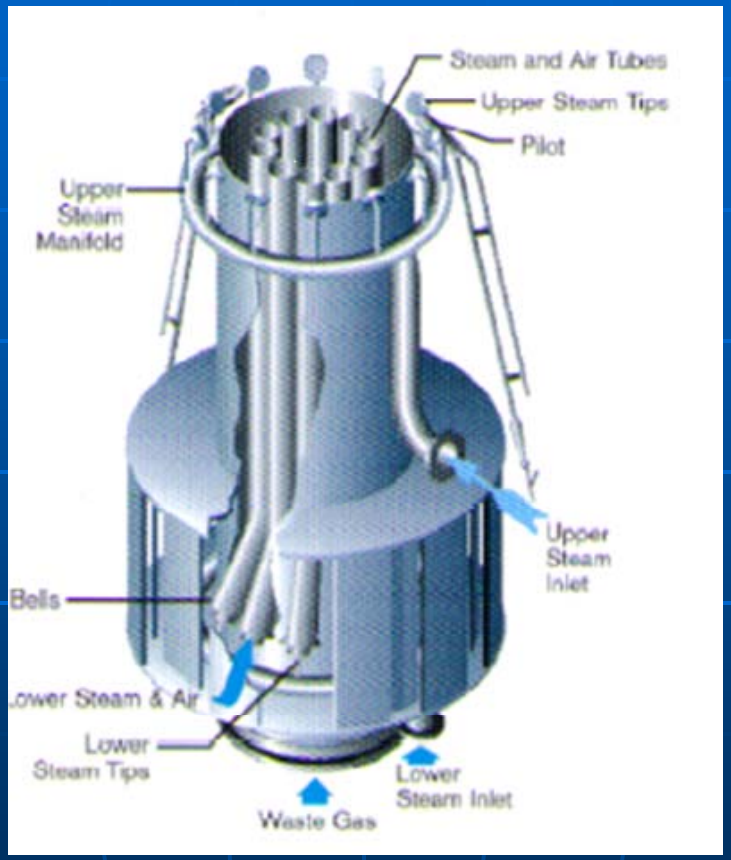
Types of Flares

- Elevated Flares
  - Unassisted
  - Assisted
    - Air Assisted
    - Steam Assisted
- Ground Flares

Elevated Flare



Flare Tip



Courtesy: John Zink Company

Proper Operation

- Pilot flame must be present
- Sufficiently low exit velocity
- Smokeless operation
  - Steam or air commensurate with organics
- Heat Content (> 300 BTU/scf)

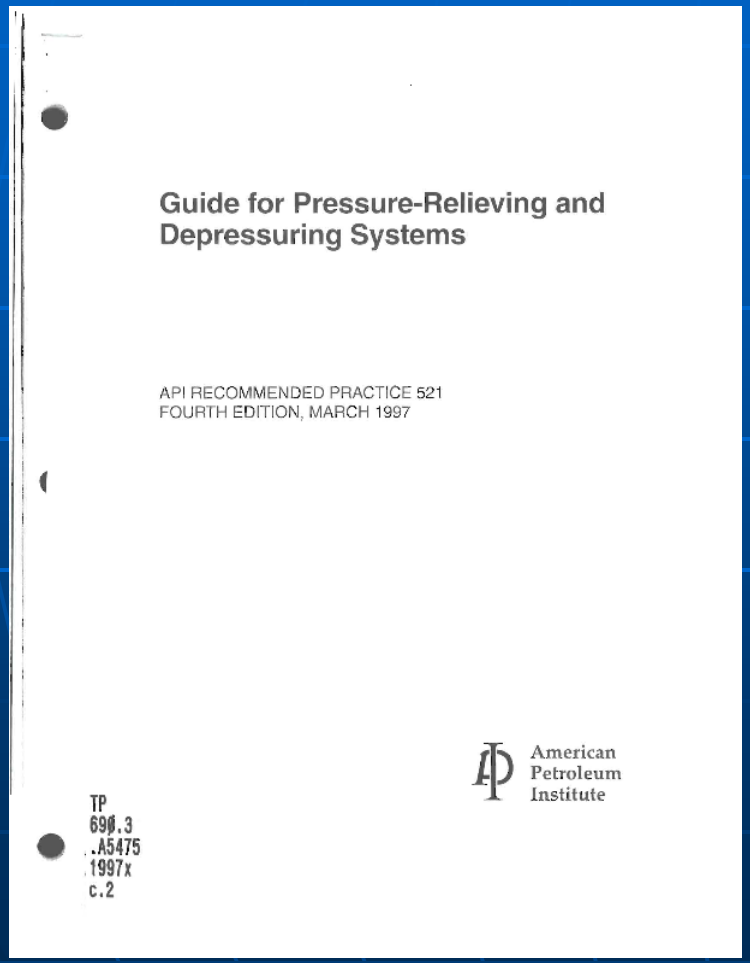
Practical Concerns

- Heat Content varies due to:
  - Batch operations
  - Multiple sources
- Combustion Efficiency reduced by:
  - Excess steam addition
    - Recommended steam addition provided by flare manufacturer
    - Typically near 1 lb steam/1 lb gas

Operations and Maintenance Manuals

- Recommend a Steam-to-Hydrocarbon Ratio
- List Design Conditions
  - Mass of hydrocarbon and associated mass of steam
- Minimum Steam Flow
  - Tip cooling

API 521



Guide for Pressure-Relieving and Depressuring Systems

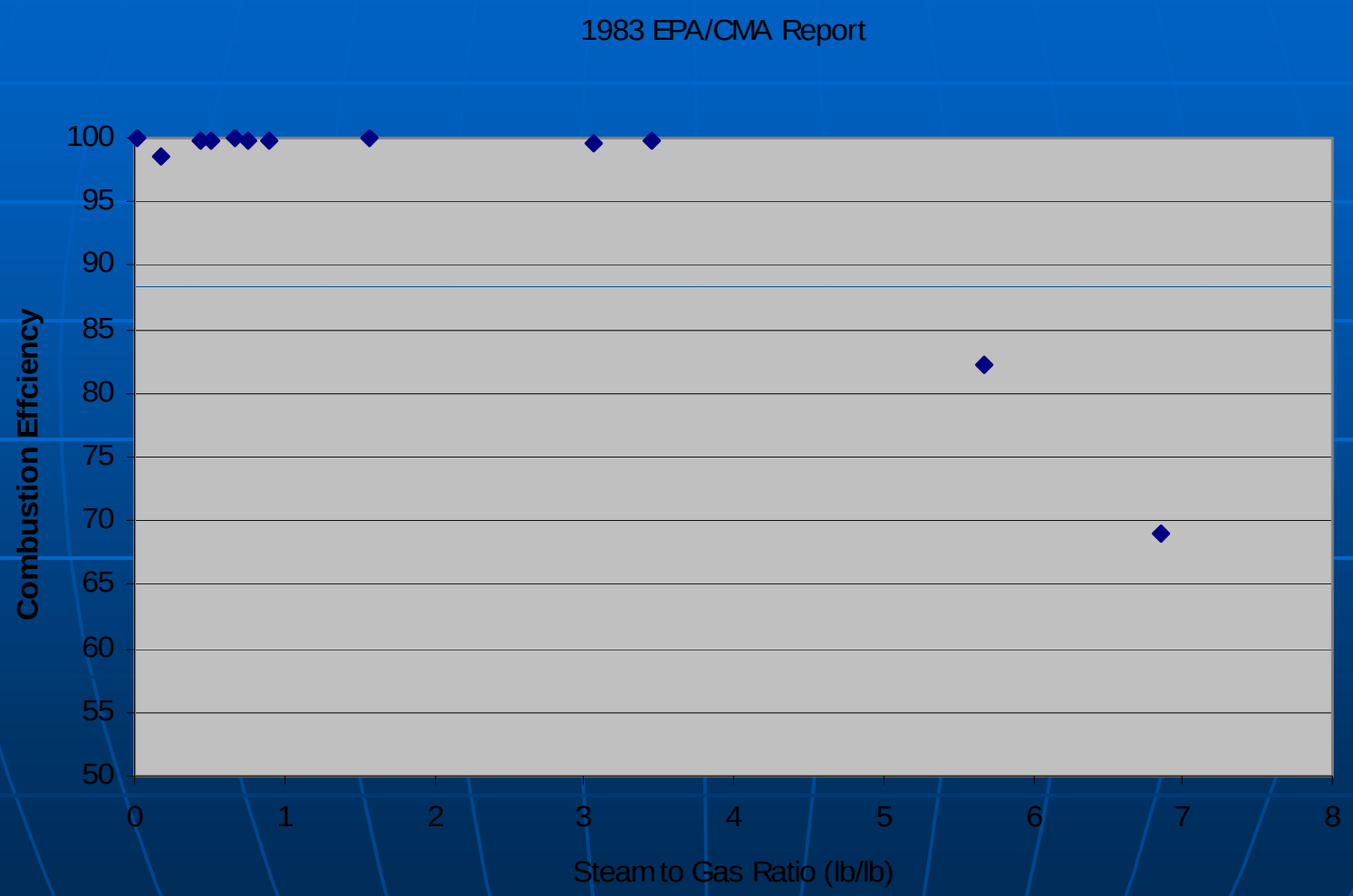
API RECOMMENDED PRACTICE 521
FOURTH EDITION, MARCH 1997

American Petroleum Institute

Table 10—Suggested Injection Steam Rates

Gases Being Flared	Steam Required (pound of steam per pound of gas)
Paraffins	
Ethane	0.10–0.15
Propane	0.25–0.30
Butane	0.30–0.35
Pentane plus	0.40–0.45
Olefins	
Ethylene	0.40–0.50
Propylene	0.50–0.60
Butene	0.60–0.70
Diolefins	
Propadiene	0.70–0.80
Butadiene	0.90–1.00
Pentadiene	1.10–1.20
Acetylenes	
Acetylene	0.50–0.60
Aromatics	
Benzene	0.80–0.90
Toluene	0.85–0.95
Xylene	0.90–1.00

Steam and Combustion Efficiency



Rules and Authority

- MACT
  - General provisions 63.11(b) for flares
  - General provisions 63.6(e) for minimizing emissions
  - Polymers & Resins, HON, Pharma, Refineries, etc.
- NSPS
  - General Provisions 60.18(b) for flares
  - General Provisions 60.11(d) for minimizing emissions
  - SOCMI, Polymers, Refineries, etc.
- SIP
  - State VOC reduction requirements
- Consent Decrees

Potential Violations

- Heat Content lower than 300 BTU/scf (63.11(b), 60.18(b))
- Destruction Efficiency specified in SIP (95%)
- Failure to use good air pollution control practices by steam addition in excess of design parameters (63.6(e), 60.11(d))

Potential Remedies

- Vapor Recovery System
- Vapor Capture and Periodic Purge to Flare
- Instrumentation
  - Heat Content (BTU/scf) instrument
  - Mass flow instrument (lb/hr)
  - Automated natural gas and steam addition

Region 5 Effort

- Batch Chemical Plants
  - 300 BTU/scf and excess steam violations
  - >560 TPY excess emissions at one facility
  - $675,000 instrument upgrade for two flares at another facility
- Refineries
  - Excess steam concerns

The End

- Your comments are welcome
- Brian Dickens

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