• Burners
• Flares
• Incinerators
• Combustion Systems

Example Aerial Inspection Surveys and Reports

Gas Plant Company

Example Aerial Inspection Surveys and Reports

Gas Plant Company

Activity: Aerial Inspection of Flare Stack and Tip
Site: [redacted]
For: [redacted]
By: [redacted]
Flight Date: [redacted]

With the advent of inexpensive, highly capable battery-operated drones, operators have the ability to conduct detailed, up-close inspections of flare equipment while the system remains online. Several advantages are gained such as being able to have an overhead view, inspect from elevations normally restricted from personnel, and closely inspect the dynamic operation of the combustion components.

The advantages of aerial inspections are being applied plant-wide to other elevated mechanical systems as a safe alternative to personnel-intensive reviews. The market has a host of inspection services adept at the mechanical review of structures, vessels, towers and other fixed equipment. However, due to the specialized knowledge related to combustion equipment, evaluation of the suitability and status of flares largely escapes the capabilities of more routine inspection services. It is of little value to have minimally consequential cracks and deformations on a flare tip identified, yet not get the perspective that will assess the root cause of the problems and guide the design and operation of the flare equipment.

Since the inspections are conducted online, they are dynamic in that a process or utility can be modulated under surveillance. By flexing the process and utility rates, a much more holistic understanding of the equipment status, failure mechanism and possible future design needs is achieved. Utilizing combustion professionals during aerial inspections adds another dimension of understanding of the equipment.

To demonstrate the advantages, the following excerpts from inspection services by Zeeco highlight times where critical combustion performance observations were made. These observations and insights are not likely to be recognized by an inspection vendor without combustion or flare design experience. Considering the unique experience and knowledge required for flare design, it is prudent to involve such expertise when evaluating the systems as well.

Flight #1	2016-06-30 14:41:04 Jun 13th, 2017 02:41PM	Air Time: **00:15:54**	Max Altitude (Feet): **132.5** Max Distance (Miles): **0.1**

[redacted]

Takeoff Lat/Long: [redacted]

Above Sea Level (Feet): **2753.4**

Battery Name: **MATRICE SET 2 (RED)**

Photos:	**60**	Videos:	**7**	Avg Wind:	**12.2**	Max Gust:	**23.6**
Ground Weather Summary:	**Clear**	Ground Temperature (f):	**91.8**	Ground Visibility (Miles):	**10**	Ground Wind Speed:	**19.3 mph**
Ground Wind Direction:	**170**	Cloud Cover:	**1%**	Humidity:	**40%**	Dew Point (f):	**64.0**
Pressure:	**29.7 in**	Rain Rate:	**0.00 in/h**	Rain Chance:	**0%**	Sunrise:	**06:42:18**
Sunset:	**20:51:26**	Moon Phase:	**Waning Gibbous**	Moon Visibility:	**74%**		

Flight #2	2016-06-30 11:58:30	Air Time: **00:03:10**	Max Altitude (Feet): **141.7** Max Distance (Miles): **0.1**

[redacted]

Takeoff Lat/Long: [redacted]

Above Sea Level (Feet): **2840.0**

Battery Name: **MATRICE SET 2 (RED)**

Photos:	**4**	Videos:	**1**	Avg Wind:	**11.1**	Max Gust:	**13.7**
Ground Weather Summary:	**Clear**	Ground Temperature (f):	**87.2**	Ground Visibility (Miles):	**10**	Ground Wind Speed:	**17.7 mph**
Ground Wind Direction:	**173**	Cloud Cover:	**14%**	Humidity:	**47%**	Dew Point (f):	**64.8**
Pressure:	**29.7 in**	Rain Rate:	**0.00 in/h**	Rain Chance:	**0%**	Sunrise:	**06:44:58**
Sunset:	**20:55:33**	Moon Phase:	**Waning Gibbous**	Moon Visibility:	**74%**		

Flight #3	2016-06-30 11:42:39	Air Time: **00:14:48**	Max Altitude (Feet): **169.9** Max Distance (Miles): **0.0**

[redacted]

Takeoff Lat/Long: [redacted]

Above Sea Level (Feet): **2840.0**

Battery Name: **MATRICE SET 2 (RED)**

Photos:	**61**	Videos:	**7**	Avg Wind:	**9.1**	Max Gust:	**15.5**
Ground Weather Summary:	**Clear**	Ground Temperature (f):	**86.4**	Ground Visibility (Miles):	**10**	Ground Wind Speed:	**17.9 mph**
Ground Wind Direction:	**172**	Cloud Cover:	**16%**	Humidity:	**49%**	Dew Point (f):	**65.0**
Pressure:	**29.7 in**	Rain Rate:	**0.00 in/h**	Rain Chance:	**0%**	Sunrise:	**06:44:58**
Sunset:	**20:55:33**	Moon Phase:	**Waning Gibbous**	Moon Visibility:	**74%**		

Flight #4	2016-06-30 09:44:27	Air Time: **00:13:01**	Max Altitude (Feet): **264.1** Max Distance (Miles): **0.0**

[redacted]

Takeoff Lat/Long: [redacted]

Above Sea Level (Feet): **2269.1**

Battery Name: **MATRICE SET 2 (RED)**

Photos:	**0**	Videos:	**0**	Avg Wind:	**9.6**	Max Gust:	**14.0**
Ground Weather Summary:	**Partly Cloudy**	Ground Temperature (f):	**80.5**	Ground Visibility (Miles):	**10**	Ground Wind Speed:	**17.6 mph**
Ground Wind Direction:	**161**	Cloud Cover:	**32%**	Humidity:	**63%**	Dew Point (f):	**66.9**
Pressure:	**29.8 in**	Rain Rate:	**0.00 in/h**	Rain Chance:	**0%**	Sunrise:	**06:46:06**
Sunset:	**20:54:40**	Moon Phase:	**Waning Gibbous**	Moon Visibility:	**74%**		

SURVEY EXCERPT 1: JUNE 30, 2016

Figure 1: Problematic smoke emanating directly from gas riser exit. No visible flame present

In review of the existing flare tip drawings and drone footage obtained [redacted] there are two (2) items that need to be understood and addressed by [redacted].

1. Existing Flare Tip Design
    a. Cause of Smoking
        i. The smoking observed by [redacted] at turndown rates is the result of internal burning. Internal burning is detected in the drone inspection video looking down into the flare tips vanes and further confirmed by the smoke emitted from the flare tip vanes, rather than the end of the flame itself. This smoking is not due to insufficient of assist air from the fan.
        ii. Smoking resultant from insufficient assist air would be emitted from a visible flame and would initiate from the end of the flame.

iii. The existing flare tip design promotes internal burning during most average wind events. During the inspection [redacted] attended, any wind over 10-12 MPH caused the combustion to stabilize inside the flare tip and emit smoke from the downwind flare tip vanes. The long vanes of the existing flare tip promote a chimney effect to be established during low flow conditions. [redacted] air-assisted flare tips utilize short vanes that allow the wind to dominate at turndown cases to push the flame out of the tip. [redacted] design does not promote the formation of a draft to feed internal combustion.

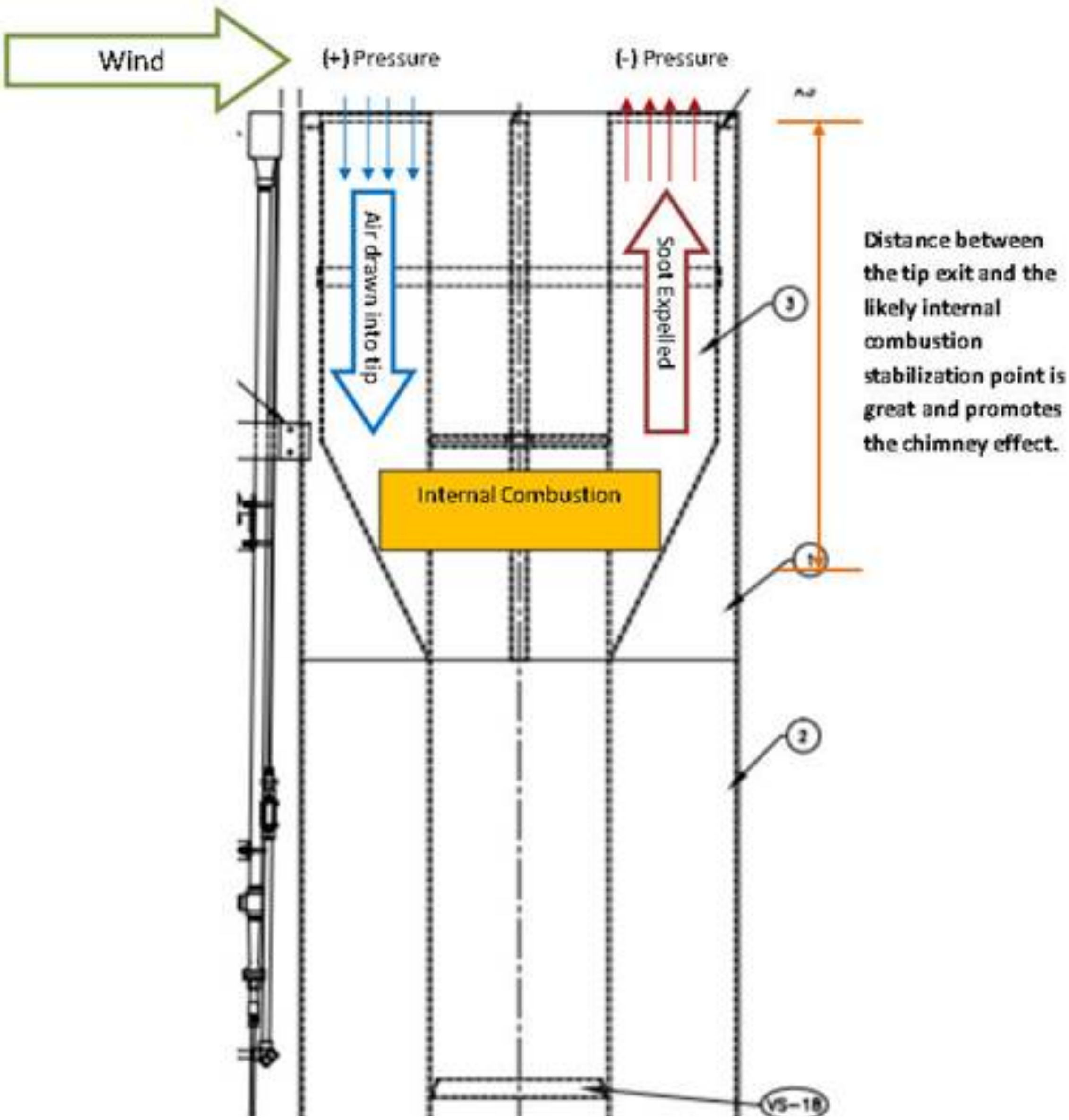


Figure 2: Existing Tip Burning Propensity

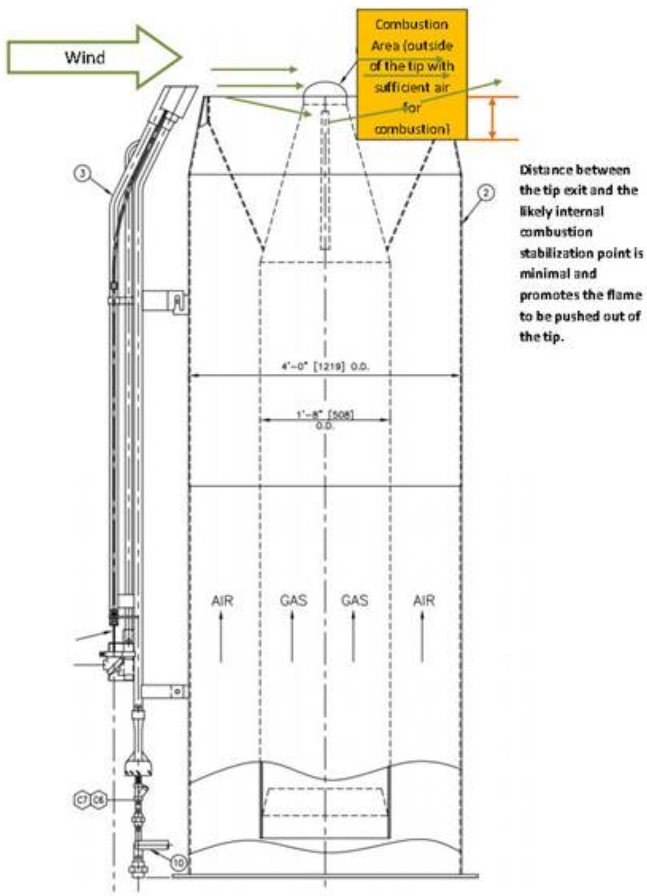


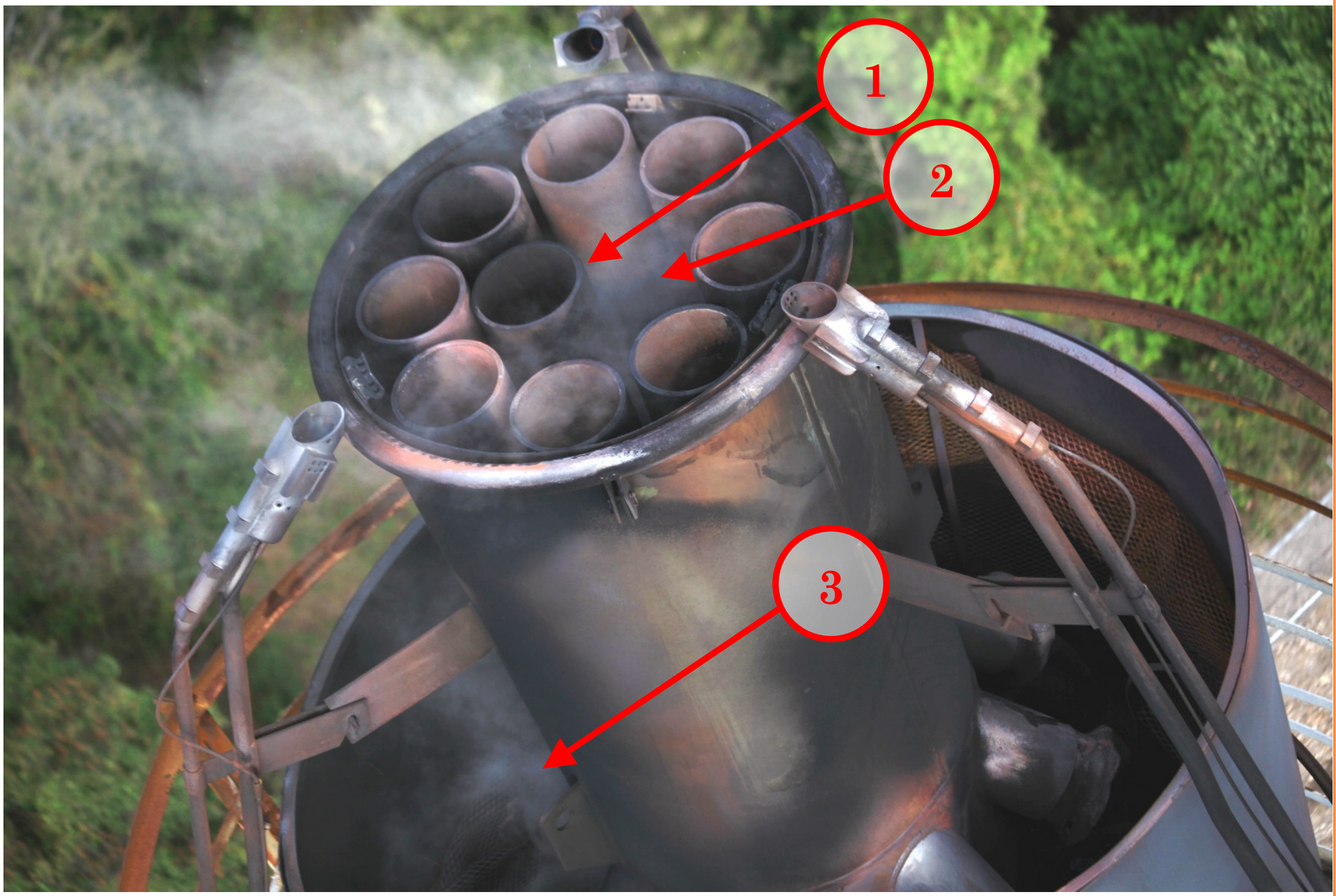
Figure 3: Revised design proposal to prevent internal burning

b. Metallurgy – The existing flare tip upper portion is manufactured of 304SS. [redacted] standard, as well as the industry standard, is to provide 310SS as the minimum metallurgy for all flare tips and flare pilots. 310SS is rated for higher temperature service than 304SS as well as offers better corrosion resistance than 304SS. With the significant internal burning taking place in the current tip, premature failure will be accelerated given the use of 304SS.

2. Combustion Zone Net Heating Value (NHV_{CZ})
   a. New regulations in the refinery sector rules state that the net heating value in the flare tip combustion zone (tip exit) should be 270 BTU/SCF in order to minimize venting (release of hydrocarbons) and insure the destruction of the hydrocarbons. This meaning the heating value of the mixture of flare gas and assist medium (air) should have an NHV_{CZ} of 270 BTU/SCF. [redacted] should investigate this moving forward as the existing fan is only able to turn down to 5 Hz and is likely diluting the mixture at minimum purge rates to an NHV_{CZ} of less than 270 BTU/SCF.
   b. Investigation can include the possibility of adding an inlet damper or smaller, secondary purge fan.

Survey Excerpt 2: October 18, 2012

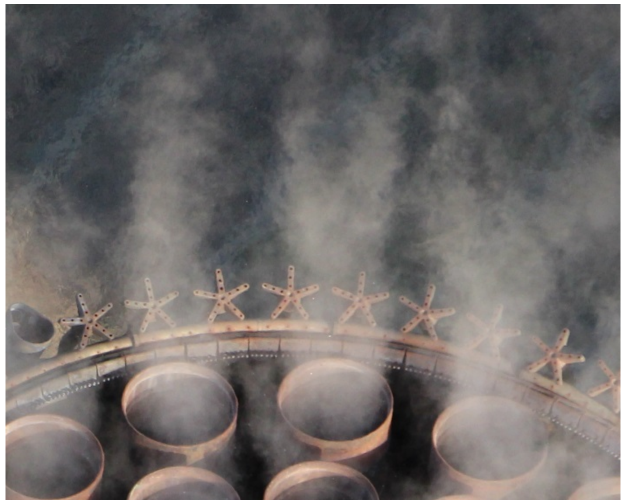
The assumption reported earlier is that no significant deformation is recognized as a result of the survey, and the tip has the possibility of remaining in service. Based on the below observations, Zeeco assess the equipment to have damage that necessitates its urgent repair or replacement:



1. The displacement of the center steam-air tube is significant. The connection of the steam tube to the barrel wall tends to be easily damaged by flame impingement. The transition of the tube as it penetrates the barrel at an angle to its final vertical trajectory is often made with a mitered weld, and this can also be susceptible to rapid damage in a capping or reverse-firing event. Knowing the delicate nature of this assembly, the displacement of the center tube is consistent with a break in one of these welds, not merely bending or sagging.

2. The most troublesome evidence of damage is the steam condensate apparently emanating from the flare tip barrel, not the steam injection tubes. Normal steam

patterns would have individual, equitable flows from each tube per the example picture below.



Instead, the steam pattern from the tip is ill-defined. The appearance, in conjunction with the evidence from the first point, is that a break in the tube is leaking steam and induced air into the flare tip barrel. This is reason for the urgency; flare gas and air can now exchange and mix somewhere other than the flare tip exit. Combustion can occur deep inside the tip and rapidly degrade the assembly, or worse flare gas can exit the steam tube and combust in the muffler in an uncontrolled manner.

3. In its original design condition, the steam injected into the lower tubes flows in its entirety into the inlet venturi and through the tube. No steam is released into the muffler. The steam observed in the muffler area is either coming from a) a break, leak or misalignment of the steam injection assembly, or b) a break or penetration of the inner steam tube at the shell penetration or miter. Considering the observations made in the above points 1 and 2, it is assumed the condensate in the muffler is a result of a compromise to the steam inner tube. As mentioned before, combustion can occur deep inside the tip and rapidly degrade the assembly, or worse flare gas can exit the steam tube and combust in the muffler in an uncontrolled manner

The above observations lead to the conclusion that there is a significant weld break either in the steam tube miter or the barrel penetration. In either case, flare gas may now combust in an unintended manner with certain impacts such as unknown flame stability, rapid degradation to the flare tip assembly, and likely damage to nearby equipment such as the platform and derrick assembly.