

## ภาคผนวกที่ 10

---

เอกสารข้อมูลอัตราการแผ่รังสีความร้อนของโครงการ  
และ Procedure Start-Stop Flare Stack  
และสถิติการใช้หอเผาทิ้ง (Flare)


## ZEECO, INC

CLIENT: PTT Asahi Chemical Co. Limited  
(PITAC)  
PLANT: AN AND MMA Project  
PROJECT: 07X5772A  
CLIENT P.O. NO: LOI#08P100A-F0005  
PTTAC DOC NO: Z4-0801.01-FK7.010A-011-M

ZEECO DOCUMENT NUMBER: 17678-1101  
ZEECO S.O: 17678

### FLARE SYSTEM

### RADIATION CALCULATIONS

<input checked="" type="checkbox"/> E: Work May proceed.	
<input type="checkbox"/> F: Work May proceed, Submit final drawings.	
<input type="checkbox"/> G: Revise and Resubmit. Work may proceed subject to incorporation of changes indicated.	
<input type="checkbox"/> H: Revise and Resubmit, Work may not Proceed.	
<input type="checkbox"/> I: Review Not Required, Work May proceed. Submit / Resubmit with _____ Days	
THIS REVIEW DOES NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY FOR ERRORS IN DESIGN	
By: 	Date: 7/17/09



REV	DATE	BY	APPROVED	DESCRIPTION
2	09-JUL-09	DLL	SLK	FOR APPROVAL
1	08-APR-09	DLL	KAN	FOR APPROVAL
0	31-MAR-09	DLL	KAN	FOR APPROVAL



## Zeeco, Inc.

Client: CTCL  
End User: Asahi Chemical  
Project Name: AN and MMA Project  
Client PO#: LOI#08P100A-F0005

Zeeco Document Number: 17678-1101 rev 2  
Zeeco Ref: SO 17678  
Date: July 9, 2009  
Location: Thailand

### Flare Height Sizing / Radiation Calculations

Rev	Date	By	Approved	Description



## Zeeco, Inc.

Client: CTCI Zeeco Document Number: T70439F-RAD-CALC  
End User: AN-MMA Zeeco Ref: T70439F Rev. Final  
Project Name: AN and MMA Project Date: July 9, 2009  
Client Ref: AN-MMA Location: Thailand

### Stack Height Calculations Per API RP-521 Fourth Edition, March 1997 Appendix 'C', Section C.3

#### Design Basis

Maximum Cumulative Allowable Radiation: 1,500 Btu/hr-ft<sup>2</sup>  
Solar Radiation (Included in Maximum Cumulative Allowable Radiation above): 300 Btu/hr-ft<sup>2</sup>

NOTE: API RP-521 radiation calculation does not include solar radiation, therefore the design basis for radiation used in these calculations shall be:

Max. Cumulative Allowable Radiation - Solar Radiation: 1500 - 300 = 1,200 Btu/hr-ft<sup>2</sup>

Wind Velocity: 30 ft/sec  
Flare Tip Diameter: 54 inches  
Flare Gas Flow: 220,460 lb/hr  
Flare Gas MW: 44.1  
Flare Gas Temperature: 122 Farenheit  
Relative Humidity: 60.8 %

Specified Radiation Point of Interest: 98.4ft (30) from base of flare stack

Rev	Date	By	Approved	Description



## Zeeco, Inc.

Client: CTCI Zeeco Document Number: T70439F-RAD-CALC  
End User: AN-MMA Zeeco Ref: T70439F Rev. Final  
Project Name: AN and MMA Project Date: July 9, 2009  
Client Ref: AN-MMA Location: Thailand

Basic Radiation Calculation Formula:  $D^2 = \tau FQ / 4 \Pi K$  where:

D = distance from center of flare flame to point of interest for radiation in feet  
 $\tau$  = fraction of heat intensity transmitted. (cannot be greater than 1.0) Value decreases with increase in humidity.  
F = fraction of total heat release emitted as radiant heat. This value is typically set by the flare system supplier based on testing data.  
Q = total heat release based on lower heating value of the gases being flares. This is expressed in Btu/hr units.  
 $\Pi$  = constant with value of 3.14159  
K = allowable or resultant radiation value at the point of interest given in Btu/hr-ft<sup>2</sup>  
R = radius from stack base to point of interest

D = unknown  
 $\tau$  = unknown  
F = 0.33  
Q = 4094569960 Btu/hr  
 $\Pi$  = 3.14159  
K = 1,200 Btu/hr-ft<sup>2</sup>  
R = 98.4ft (30m)

#### Calculation of Flame Center

##### Gas Discharge Velocity = U<sub>j</sub>

For the Zeeco flare tip, the exit velocity for this case is: U<sub>j</sub> = 42 ft/sec  
The design wind speed is: U<sub>a</sub> = 30 ft/sec

Therefore: U<sub>j</sub> / U<sub>a</sub> = 1.4

We also know that: M<sub>j</sub> = Flare Gas MW = 44.1  
And that: M<sub>a</sub> = Ambient Air MW = 29

Therefore: M<sub>j</sub> / M<sub>a</sub> = 1.521

Rev	Date	By	Approved	Description



## Zeeco, Inc.

Client: CTCI  
End User: AN-MMA  
Project Name: AN and MMA Project

Zeeco Document Number: T70439F-RAD-CALC  
Zeeco Ref: T70439F Rev. Final  
Date: July 9, 2009

Client Ref: AN-MMA

Location: Thailand

### Calculation of Flame Center (Continued)

Reference: API RP-521, Appendix C.3, Location of Flame Center C.3.3.

$$CL = C_{L1} (U_f/U_a) \times (M_f/M_a)$$

$C_{L1} = 0.021$  (for the 44.1MW flare gas on this project) = L.E.L. (As Required by NCRA)

$$CL = 0.021 (42 / 30) \times (44.1 / 29)$$

$$CL = 0.045$$

$$djR = dj(U_f/U_a) \times (Ta/Tj \times Mj)^{1/2}$$

$$djR = (54/12) (42/30) \times (520/582 \times 44.1)^{0.5}$$

$$djR = 40$$

From Figure C-2a:  $X_c = 179.7$  ft  
From Figure C-3a:  $Y_c = 36.7$  ft

Rev	Date	By	Approved	Description



## Zeeco, Inc.

Client: CTCI  
End User: AN-MMA  
Project Name: AN and MMA Project

Zeeco Document Number: T70439F-RAD-CALC  
Zeeco Ref: T70439F Rev. Final  
Date: July 9, 2009

Client Ref: AN-MMA

Location: Thailand

### Calculation of Flare Stack Height

$$D = [(\tau \times F \times Q) / (4 \times 3.14159 \times K)]^{1/4}$$

$$\tau = 0.79 \times (100/r)^{1/16} \times (100/D)^{1/16}$$

Solving for D using tau is an iterative process, typically started at tau = 1.0.

$$\text{For: } r = 61 \% \text{ and } D = 271 \text{ ft}$$

$$\tau = 0.766$$

$$\text{Checking D, using calculated tau: } D = [(0.766 \times 0.33 \times 4094569960 \text{ Btu/hr}) / (4 \times 3.14159 \times 1200)]^{0.5}$$

$$D = 262 \text{ ft}$$

### Determination of Flare Stack Height

Referencing API RP-521, Appendix 'C', C.3.5

Stack Height is defined as "H".

$$H = D - Y_c$$

$$H = 262 - 36.7 = \underline{225.3 \text{ feet tall}} \quad \underline{68.7m}$$

The above height (H), is the height of the flare stack required to meet the required radiation at any grade level location.

If there is a specific point of interest for radiation on this project, proceed to the next section.

Rev	Date	By	Approved	Description



## Zeeco, Inc.

Client: CTCI  
End User: AN-MMA  
Project Name: AN and MMA Project

Zeeco Document Number: T70439F-RAD-CALC  
Zeeco Ref: T70439F Rev. Final  
Date: July 9, 2009

Client Ref: AN-MMA  
Location: Thailand

### Determination of Flare Stack Height Using a Specific Point of Interest

From Figure C.1 of the API RP-521, we know the following:

$$D^2 = R'^2 + H'^2$$
$$H' = H + Y_c$$
$$R' = R - X_c$$

Solving for R', we get:  $R' = 98.4 - 179.7 = -81.3$  feet

Now, solving for H':  $H' = (D^2 - R'^2)^{1/2} = (271.3^2 - (-81.3)^2)^{0.5}$

$$H' = 249 \text{ feet (75.9m)}$$

Therefore, the stack height required is:

$$H = H' - Y_c$$

$$H = 249 - 36.7$$

$$\underline{H = 212.3 \text{ feet tall (64.7m)}}$$

Rev	Date	By	Approved	Description



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18

จัดทำโดย

Prepared By

ทบทวนโดย

Reviewed By

อนุมัติใช้โดย

Approved By

หน่วยงานเจ้าของเอกสาร

Department/Division



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18





## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



**PTT Asahi Chemical Company Limited**

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



**PTT Asahi Chemical Company Limited**

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18



## PTT Asahi Chemical Company Limited

Title: Start-Stop Flare stack (VR-220)

Document No: WI-AN-8063

Revision No: 1

Effective date: 16-Jul-18

สถิติการใช้งานอุปกรณ์ห่อเผา (Flare) ในกรณีฉุกเฉิน ย้อนหลัง 3 ปี ตั้งแต่ปีพ.ศ. 2563 – 2565  
บริษัท พีทีที อาซาฮี เคมิคอล จำกัด

ปี	สถิติการใช้งานอุปกรณ์ห่อเผา (Flare) ในกรณีฉุกเฉิน (ครั้ง)	ระยะเวลา	สาเหตุ
2563	0	-	-
2564	0	-	-
2565	0	-	-