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An Approach to Onshore Facility Hazard Analysis

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Abstract

Onshore oil and gas operators face challenging cost efficiency targets while pressing for higher production volumes. Within this tension is a need to reduce planned facility foot prints while maintaining primary focus of personnel and environmental protection. This will be examined in this paper.

Introduction

Onshore oil and gas operators face challenging cost efficiency targets while pressing for higher production volumes. Within this tension is a need to reduce planned facility foot prints while maintaining primary focus of personnel and environmental protection.

Methodology

To understand whether a planned layout or current facility is safe, hazard identification and assessment are carried out. Most onshore operators today have a large mix of facilities:

- Unmanned wellhead sites
- Unmanned tank farm operations
- Mid-sized manned collection and distribution facilities (PSM facility)
- Larger manned well-fluid treatment facilities (PSM facility)

With portfolios of possibly hundreds of facility locations and multiple stakeholders who expect a safe and cost effective design, efficient assessments which leverage complimentary methodologies to exercise hazard assessments. Two prevailing methods are:

- Generally Accepted Practices (GAP) spacing tables provided in GAP.2.5.2, "GAP Guidelines - Oil and Chemical Plant Layout and Spacing", September 2007;and
- OSHA 29 CFR 1910.119 mandated facility siting methodologies per American Petroleum Institute Recommended Practice 752, "Management of Hazards Associated with Location of Process Plant Buildings", Third Edition, December 2009 and American Petroleum Institute Recommended Practice 753, "Management of Hazards Associated with Location of Process Plant Portable Buildings", First Edition, June 2007 (API RP 752/753).

The GAP methodology primarily assesses physical assets while the latter addresses personnel protection within structures. Accepted applications of these two methods are summarized in Figure 1.

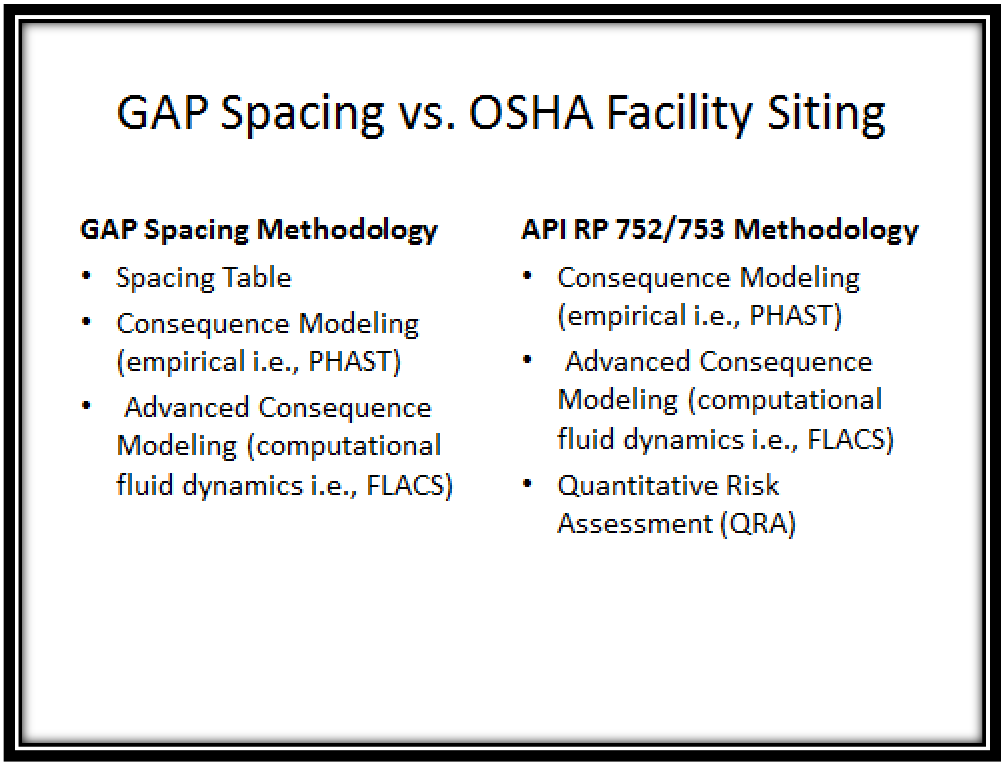

Figure 1. Comparison of steps to perform GAP asset based siting and OSHA based facility siting for personnel in occupied structures using API RP 752/753.

GAP spacing tables

In addition to protecting personnel and the environment, operators are pressed to meet insurance standards that focus on asset protection. Historically, recommended spacing guidelines for facility siting have been published by Global Asset Protection (GAP) Guidelines – Oil and Chemical Plant Layout and Spacing.

	Service Buildings	Motor Control Centers And Electrical Substations	Utilities Areas	Cooling Towers	Control Rooms	Compressor Buildings	Large Pump Houses	Process Units Moderate Hazard	Process Units Intermediate Hazard	Process Units High Hazard	Atmospheric Storage Tanks	Pressure Storage Tanks	Refrigerated Storage Tanks Dome Roof	Flares	Unloading And Loading Racks	Fire Water Pumps	Fire Stations
Service Buildings	/																
Motor Control Centers And Electrical Substations	/	/															
Utilities Areas	50	50	/														
Cooling Towers	50	50	100	50 ①													
Control Rooms	/	/	100	100	/												
Compressor Buildings	100	100	100	100	100	30											
Large Pump Houses	100	100	100	100	100	30	30										
Process Units Moderate Hazard	100	100	100	100	100	30	30	50									
Process Units Intermediate Hazard	200	100	100	100	200	50	50	100	100								
Process Units High Hazard	400	200	200	200	300	100	100	200	200	200							
Atmospheric Storage Tanks	250	250	250	250	250	250	250	250	300	350	*						
Pressure Storage Tanks	350	350	350	350	350	350	350	350	350	350	*	*					
Refrigerated Storage Tanks Dome Roof	350	350	350	350	350	350	350	350	350	350	*	*	*				
Flares	300 ②	300	300	300	300	300	300	300	300	300	300	400	400	/			
Unloading And Loading Racks	200	200	200	200	200	200	200	200	200	300	250	350	350	300	50		
Fire Water Pumps	50	50	50	50	50	200	200	200	300	300	350	350	350	300	200	/	
Fire Stations	50	50	50	50	50	200	200	200	300	300	350	350	350	300	200	/	/

1 ft = 0.305 m
/ = no spacing requirements
* = spacing given in Table 3

Examples:
① 50 ft separation between two cooling towers
② 300 ft separation between service building and flare

TABLE 1. Inter-Unit Spacing Recommendations For Oil And Chemical Plants.

Figure 2. Reproduced from Table 1: GAP.2.5.2, "GAP Guidelines - Oil and Chemical Plant Layout and Spacing", September 2007.

Facility Siting

OSHA 29 CFR 1910.119 calls for facilities that are subject to Process Safety Management (PSM) to conduct process hazard analyses to address hazards of the process by understanding consequences of engineering and administrative control failures. Also an understanding of how these failure consequences could affect facility siting is evaluated. Facility siting then typically focuses on estimating consequence impacts of process failures on manned structures (See API 752/753).

Commonalities

Consequence based spacing evaluation for facility layouts can be used as a next step in lieu of GAP table spacing distances for facilities to demonstrate where spacing distance between facility equipment are too conservative. These serve to provide evidence to support an adjustment in the spacing if any new or alternative configuration is still safe. For an API 752/753 facility siting, this type of analysis is the initial course of action. Both of the evaluations can end with empirically driven, phenomenological modeling (i.e., PHAST).

When initial consequence based evaluation isn't successful, or if further refinement is warranted, advanced modeling tools may be used such as with computational fluid dynamics (cfd) software (e.g., KFX and FLACS).

Example: When GAP spacing tables are not met between equipment, consequence modeling is performed to assess if fire hazards have the potential to cause escalation between equipment areas. When assessing a facility for OSHA compliance, consequence modeling is performed to assess fire hazards on occupied buildings, with advanced methods such as cfd used when heat fluxes exceed threshold requirements. Figure 3 and Figure 4 are displayed for illustrative purposes only, where the former used PHAST and latter KFX to model jet fire effects on either equipment to support a GAP type asset study or an occupied building in an OSHA conforming API RP 752/753 study. Note: while the facilities and fires modeled are different, the general tenor are similar. The upshot is that using either method, modeling can be performed with variable data (e.g. wind, process conditions) with a cfd option also taking into account the impact of structures on radiation and variation in some variable data (e.g., wind change due to structures).

Figure 3. Thermal radiation isopleths depicting heat flux for a jet fire using PHAST (illustrative purposes only).

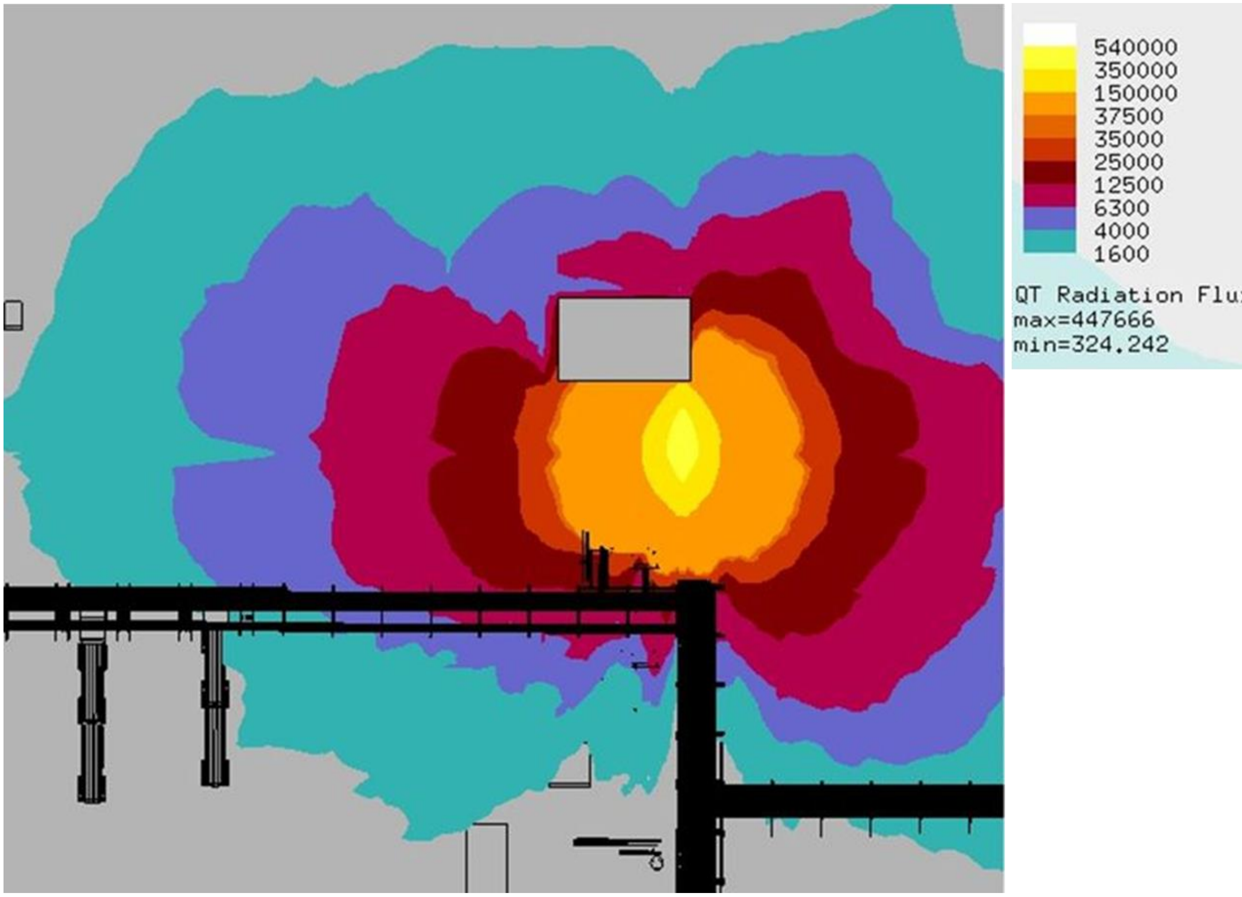

Figure 4. Thermal radiation isopleths depicting heat flux for a jet fire using cfd KFX (illustrative purposes only).

Often the use of more rigorous modeling methods permit facilities to have their footprint safely and appropriately altered which can lead to substantial savings in land and equipment (e.g., piping, wiring, etc.).

Lessons from Application

Site leadership involvement and buy in from the beginning of an assessment is paramount. They are able to set the tone for site visits to confirm and develop analysis assumptions. Once on site, verifying facility information is accurate, such as, process stream data and physical location of equipment, buildings and people. Getting a clear understanding of the topography is also important when building computational simulation geometries. While on site, interviewing operators is very helpful in sharing what the study is about and how it can help answer questions they may have about the facility's hazards. Previous incidents can be discussed and brought up during the site visit to meet API RP's requirements for facility siting. All in all, uniting stakeholders with practitioners produces the most beneficial studies.

Conclusions

The facility hazard analysis often provided insight to operations personnel which shifted the locations of mobile manned structures and settled open safety issues around existing facility designs. With leadership's support, these studies were very successful and effective in studying the science of facility hazards while connecting the results to a tangible, heightened safety awareness and culture of the facilities in review.