API 521 8th Edition Ballot

Flare Sizing Guidance Moved from API STD 521 to API STD 537 (Work Item 7)

Instructions to Voters/Commenters

- Please limit your comments to the red-lined portions of the ballot only.
    - Red indicates new text.
- Background information is provided following the proposed text changes.
- If you are voting negative with multiple comments, please indicate which comment(s) is the reason for your negative vote, otherwise API's balloting system will categorize all of your comments as negative.

Thanks to Abdul Aldeeb and the work group for their efforts.

Melissa Marashi (Chevron)
David Fenton (ExxonMobil)

API 521 Task Force Chairs

Proposed Change Ballot:

5.7 Disposal to Flare

5.7.1 General

The primary function of a flare is to use combustion to convert flammable, toxic, or corrosive vapors to less objectionable compounds. Selection of the type of flare and the special design features required are influenced by several factors, including the availability of space; the characteristics of the flare gas, namely, composition, quantity and pressure level; economics, including both the initial investment and operating costs; and public relations. Public relations can be a factor if the flare can be seen or heard from residential areas or navigable waterways. Other topographic considerations include elevations of land and neighboring land, elevations of equipment (especially where personnel might need to be present), and proximity to utility and electrical systems (e.g. electric lines or control wire runs). The designer needs to know these and other factors in the determination of noise, thermal radiation, liquid carryover, and vapor dispersion. For example, a flare near a hill or in a valley can be influenced by wind direction and downward turbulence. Note that flares are considered pollution-abatement equipment and are usually subject to environmental regulations and permitting requirements for their use and location.

Flare stack sizing includes parameters, such as flare stack diameter and height, that impact disposal system design. The pressure drops across the flare stack and tip including accessories (e.g., seals) shall be included in the hydraulic assessments to ensure PRDs backpressure limitations are not exceeded. This pressure drop will vary depending upon flare stack size and flare tip type as well as the fluid flow and properties. For example, pressure drops as 14 kPa (2 psi) have been satisfactorily used at the flare tip; however, special-duty high-pressure flares can operate at around 700 kPa (100 psi) or higher.

Flare design requires both API 537 and API 521. Flare design aspects include, but are not limited to:

a) combustibility of the fluid being flared (see F.1.1);

b) thermal radiation (see 5.7.2 and F.2);

c) flame stability (see API 537);

d) flaring toxic gases (see 5.7.3);

e) destruction efficiency (see API 537);

f) combustion methods (see 5.7.4);

g) smoking/smokeless performance (see API 537);

h) cautions on freezing and icing in flares (see 5.7.5);

i) flare noise (see API 537);

j) flare tip pressure drop (see API 537);

k) purging/air ingress/flashback prevention (see API 537 and 5.7.6);

l) ignition system (see API 537);

m) liquid seal drums (see 5.7.7);

n) liquid removal (knockout drums) (see 5.7.8);

o) siting and safe dispersion for loss of flame/safe dispersion of combustion products (see 5.7.9);

p) flare gas recovery systems (see 5.7.10);

q) mechanical design, operation, and maintenance of flare equipment (see API 537);

r) flare stack sizing (see API 537).

API 537 also provides datasheets for exchanging both process and mechanical design information.

An example for sizing the flare stack is given in C.2. This example applies the preliminary screening equations for thermal radiation given in F.2.

Action Description:

#	Source	Section	Comment	Proposed Change	Volunteer	Status
7	Fall 2019 API 521 Meeting	5.7.5.1-5.7.5.4	Abdul Aldeeb confirmed that guidance removed from API 521 to be included in API 537 was not part of the API 537 draft.	Develop new paragraphs in Section 5.7.1 to retain some safety-related guidance from the sections removed from API 521 but not included in API 537 including details similar to those in 5.7.5.1 – 5.7.5.4, e.g., flare stack diameter, height, disposal system header design, and pressure drop across the flare stack and tip. Per Action Item 2017-01, draft a section to be included in API 521 that would briefly discuss sizing the flare and refer to API 537 for details on performing sizing.	A Aldeeb (lead); R. Maskell, E. Vatland Johansen, B. Beck, J. Burgess; Wren Mills	11/2023: Text will be balloted prior to next meeting.

Background:

Flare system sizing guidance in **API STD 521 6th Edition Section 5.7.5 has been moved** to API STD 537 3rd Edition, Addendum 1, Annex G, Section G.5, as following:

API 521, 6th Edition	API 537 Annex G
5.7.5.1 General	G.5.1
5.7.5.2Flare Stack Diameter	G.5.2
5.7.5.3 Flare Stack Height	G.5.3
5.7.5.4 Flare Tip Pressure Drop	G.5.4

Some of the moved guidance included safety-related considerations that should be highlighted or referenced in API STD 521 to ensure that the user takes such considerations when evaluating the adequacy and performance of the flare and header system and PRD backpressure, as following:

Section 5.7.5.1 provides general guidance on flame retainers impact on restricting flow area, which should be accounted for in the flare and header sizing. In addition, this may impact PRD backpressure calculations.

Section 5.7.5.2 provides guidance on normal flare tip and high-pressure flares pressure drops. This guidance is relevant to flare header system pressure/hydraulics design and analysis, which is part of API 521. User should account for such pressure drops adequacy of flare and header system and PRD backpressure calculations.

Section 5.7.5.3 addresses the flare stack height in relation to flare radiation requirements in Section 5.7.2 in API STD 521 and concerns resulting from extinguished flame.

Section 5.7.5.4 provides guidance on impact of pressure drop across flare tip and accessories. This is relevant to the flare header design to ensure PRD backpressure limitations are not exceeded.

API STD 521 6th Edition Section 5.7.5

5.7.5 Sizing

5.7.5.1 General

Factors governing the sizing of flares are covered in 5.7.5.2 and 5.7.5.3. General considerations involved in the calculation of these requirements are discussed in 5.7.1 through 5.7.4. Examples covering the full design of a flare stack are given in C.2. Note that flare diameter calculations are based on a basic flare. Most commercial flares have flame retainers that restrict flow area by 2 % to 10 %, which should be accounted for in the flare and header sizing.

5.7.5.2 Flare Stack Diameter

Flare stack diameter is generally sized on a velocity basis, although pressure drop should be checked. A stack velocity (not flare tip velocity) of up to 0.5 Mach is typically allowed for a peak, short-term, infrequent flow for both low- and high-pressure flares. This depends on the following:

a) volume ratio of maximum conceivable flare flow to anticipated average flare flow;

b) probable timing, frequency, and duration of those flows;

c) design criteria established for the project to stabilize flare burning.

Sonic velocity operation can be appropriate for high-pressure flare tips but not within the flare stack. Smokeless flares should be sized for the conditions under which they are to operate smokelessly. Equation (32) or Equation (33) can be used to calculate the Mach number (see 5.5.5). Velocity limitations imposed by regulatory agencies (see Bibliographic Item [59]) might not apply to flares in emergency relief service.

Pressure drops as large as 14 kPa (2 psi) have been satisfactorily used at the flare tip. Modern conventional flare tips with proper flame stabilization can operate well above this level. Most flare vendors also have a line of special-duty high-pressure flares that can operate at gauge pressures around 700 kPa (100 psi) or higher. This general class of flare designs is recognized by API 537 [8] and usually operates smokelessly without steam or air assistance. Too low a tip velocity can cause heat and corrosion damage. The burning of the gases becomes quite slow, and the flame is greatly influenced by the wind. The low-pressure area on the downwind side of the stack can cause the burning gases to be drawn down along the stack for 3 m (10 ft) or more. Mechanical details of flare burners relating to stack downwash effect can be found in API 537.

5.7.5.3 Flare Stack Height

The flare stack height is generally based on the radiant-heat intensity generated by the flame. Equation (45) in 5.7.2.3.3 applies. The recommended levels of radiation intensity, K, are given in Table 12.

The quality of combustion affects the radiation characteristics. Use of the fraction of heat radiated, F, based on the U.S. Bureau of Mines data given in Table 13, is considered to result in a reasonable but conservative stack height.

Another factor to be considered is the effect of wind in tilting the flame, thus varying the distance from the center of the flame, which is considered to be the origin of the total radiant-heat release, with respect to the plant location under consideration. A generalized curve for approximating the effect of wind is given in Figure 7.

Where there is concern about the resulting atmospheric dispersion (both flammable and toxic) if the flare were to be extinguished, dispersion analyses (see 5.7.10.2) may be used to calculate the probable concentration at the point in question and required flare height.

5.7.5.4 Flare Tip Pressure Drop

The pressure drop across the flare tip including accessories (e.g. seals) shall be included in the hydraulic assessments to ensure backpressure limitations are not exceeded. This pressure drop will vary depending upon flare tip type as well as the fluid flow and properties. Higher pressure drops across the flare tip generally promote combustion performance (including smokeless performance) but increase the backpressure on the PRDs. Consult the manufacturer for specific details.