Venting Atmospheric and Low-Pressure Storage Tanks

Nonrefrigerated and Refrigerated

非制冷/制冷常压与低压储罐的通气

API STANDARD 2000

FIFTH EDITION, APRIL 1998

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当今环境伙伴关系战略

API（美国石油学会）

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· To promote these principles and practices by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of similar raw materials, petroleum products and wastes.
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Manufacturing, Distribution and Marketing Department

制造、发布与市场营销部

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FOREWORD 前言

This standard covers the normal and emergency vapor venting requirements for aboveground liquid petroleum storage tanks and aboveground and underground refrigerated storage tanks designed for operation at pressures from vacuum through 15 pounds per square inch gauge (1.034 bar gauge). Discussed in this standard are the causes of overpressure or vacuum; determination of venting requirements; means of venting; selection, installation, and maintenance of venting devices; and testing and marking of relief devices.

本标准涵盖了储罐在正常和紧急条件下的蒸气通气要求，适用于地上液体石油储罐及地上和地下制冷储罐，设计压力从真空到 15 磅/每平方英寸表压（1.034 bar 表压）。本标准讨论了超压或真空的原因；通气要求的确定；通气方法；通气装置的选择、安装和维修以及泄放装置的测试和标识。

This standard has been developed from the accumulated knowledge and experience of qualified engineers in the petroleum-processing industry and its related industries. The vapor venting requirements in this standard are based on studies using hexane. Intended for petroleum products, this standard may be applied to other materials; however, sound engineering analysis and judgment should be used whenever this standard is applied to other materials.

本标准是根据石油加工行业及其相关行业内资深工程师积累的知识与经验而制定的。本标准中蒸气通气要求是基于用正己烷进行的研究。旨在用于石油产品，本标准也可以用于其它物料；然而，当本标准适用于其它物料时应进行合理的工程分析和判断。

Engineering studies of a particular tank may indicate that the appropriate venting capacity for the tank is not the venting capacity estimated in accordance with this standard. The many variables associated with tank venting requirements make it impractical to set forth definite, simple rules that are applicable to all locations and conditions. Larger venting capacities maybe required on tanks in which liquid is heated, on tanks that receive liquid from wells or traps, and on tanks that are subjected to pipeline surges. Larger venting capacities may also be required on tanks that use flame arresters or have other restrictions that may build up pressure under certain conditions.

对某一特定储罐的工程研究可能表明，适合该罐的通气能力并不是按本标准所估算的通气能力。与储罐通气要求相关的诸多变量使得制定一个适用于所有位置与条件的，既明确又简单的规则是不现实的。储存加热液体的储罐、从油井或油槽接收液体的储罐、或受管道物料波动影响的储罐，可能需要较大的通气能力。使用阻火器的储罐或有其它限制在特定条件下可能会产生压力积聚的储罐，也可能需要较大的通气能力。

This standard does not apply to external floating roof tanks or free vented internal floating roof tanks.

本标准不适用于外浮顶罐和自由通风的内浮顶罐。

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Asbestos is specified or referenced for certain components of the equipment described in some API standards. It has been of extreme usefulness in minimizing fire hazards associated with petroleum processing. It has also been a universal sealing material, compatible with most refining fluid services.

石棉是一些API标准中所列设备的特定部件的指定或参考材料。石棉在最大程度地降低与石油加工相关的火灾危险性方面极其有用，它还是一种与大多数精炼流体应用相容的通用密封材料。

Certain serious adverse health effects are associated with asbestos, among them the serious and often fatal diseases of lung cancer, asbestosis, and mesothelioma (a cancer of the chest and abdominal linings). The degree of exposure to asbestos varies with the product and the work practices involved.

石棉会对人体健康产生某些严重的不良影响，其中严重的并且通常会致命的疾病有肺癌、石棉肺和间皮瘤（一种胸腹膜癌）。接触石棉的程度因产品和相关工作实践而异。

Consult the most recent edition of the Occupational Safety and Health Administration(OSHA), U.S. Department of Labor, Occupational Safety and Health Standard for Asbestos, Tremolite, Anthophyllite, and Actinolite, 29*Code of Federal Regulations* Section 1910.1001;the U.S. Environmental Protection Agency, National Emission Standard for Asbestos, 40 *Code of Federal Regulations* Sections 61.140 through 61.156; and the U.S. Environmental Protection Agency (EPA) rule on labeling requirements and phased banning of asbestos products (Sections 763.160-179).

请参考以下法规：美国劳工部职业安全卫生管理局的最新版“石棉、透闪石石棉、直闪石石棉及阳起石的职业安全与卫生标准”（联邦法规第29章第1910.1001节）、美国环境保护署的“石棉排放国家标准”（联邦法规第40章第61.140~ 61.156节）以及美国环境保护署对石棉产品的标识要求与定相禁止的规定（第763.160-179节）。

There are currently in use and under development a number of substitute materials to replace asbestos in certain applications. Manufacturers and users are encouraged to develop and use effective substitute materials that can meet the specifications for, and operating requirements of, the equipment to which they would apply.

目前有许多已经投用和处于开发中的替代材料，可用来替代某些应用中的石棉。鼓励制造商和用户来开发并使用有效的替代材料，使之符合其可能适用设备的规范与操作要求。

SAFETY AND HEALTH INFORMATION WITH RESPECT TO PARTICULAR PRODUCTS OR MATERIALS CAN BE OBTAINED FROM THE EMPLOYER, THE MANUFACTURER OR SUPPLIER OF THAT PRODUCT OR MATERIAL, OR THE MATERIAL SAFETY DATA SHEET.

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Venting Atmospheric and Low-Pressure Storage Tanks 常压与低压储罐的通气

0 Introduction 引言

The venting requirements provided in this standard are based on studies of hexane stored in steel tanks. Sound engineering judgment should be applied when extrapolating these results to other liquids and nonmetallic tanks.
本标准中所提供的通气要求是基于对存储在钢制储罐中已烷的研究。如果这些研究结果应用于其它液体和非金属储罐时，应作合理的工程设计判断。

Detailed engineering studies of a particular tank and its operating conditions may indicate that the appropriate venting capacity for the tank is not the venting capacity estimated in accordance with this standard. If a tank’s operating conditions could deviate from those used in developing this standard, detailed engineering studies should be performed.
对特定的储罐和其操作条件的详细设计研究可能表明储罐合适的通气能力并不是根据本标准所估计出来的通气能力。如果一个储罐的操作条件与那些用于制定本标准的操作条件有差别，则应进行详细的工程设计研究。

1 Scope 范围

This standard covers the normal and emergency vapor venting requirements for aboveground liquid petroleum or petroleum products storage tanks and aboveground and underground refrigerated storage tanks designed for operation at pressures from vacuum through 15 pounds per square inch gauge(1.034 barg). Discussed in this standard are the causes of overpressure or vacuum;determination of venting requirements; means of venting; selection, installation, and maintenance of venting devices; and testing and marking of relief devices.
本标准涵盖了操作压力从负压到 15 磅/平方英尺表压（1.034 巴表压）的地上液体石油或石油产品储罐以及地下与地上制冷储罐的正常和紧急气体通气要求。本标准对超压或负压的原因、通气要求的确定、通气方式、通气设备的选择、安装与维护以及泄压装置的测试和标记进行了讨论。

2 References 参考文件

Unless otherwise specified, the referenced sections of the most recent editions or revisions of the following standards, codes, and specifications shall, to the extent specified herein, form a part of this standard.
除非另有规定，否则以下标准、规范和说明书的最新版或修订版的参考章节在本文所规定的范围内都是本标准的一部分。

2.1 STANDARDS 标准

API 美国石油协会
Std 620 Design and Construction of Large, Welded, Low-Pressure Storage Tanks
Std 620 大型焊接低压储罐的设计与施工
Std 650 Welded Steel Tanks for Oil Storage
Std 650 钢制焊接石油储罐
Std 2510 Design and Construction of Liquefied Petroleum Gas (LPG) Installations
Std 2510 液化石油气体设施的设计与施工
ASME[1] 美国机械工程师学会
PTC19.5 Fluid Meters: Interim Supplement on I struments and Apparatus, Part II-“Application”
PTC 19.5 流量计：仪器和装置的临时增补规范,第 II 部分—“用途”
PTC 25 Pressure Relief Devices 泄压设备
Boiler & Pressure Vessel Code, Section VIII, Division 1, Rules for Construction of

Pressure Vessels 锅炉及压力容器规范，第 VIII 卷第 1 册，压力容器制造准则

2.2 OTHER REFERENCES 其它参考文件

API

RP 520 Sizing, Selection, and Installation of Pres sure-Relieving Devices in Refineries, Part I—“Sizing and Selection”
RP 520 炼油厂泄压装置的尺寸计算、选型与安装.第 1 部分:尺寸计算与选型
RP 521 Guide for Pressure-Relieving and Depressuring Systems
RP 521 泄压和减压系统指南
RP 576 Inspection of Pressure-Relieving Devices
RP 576 泄压装置的检验
Publ 2210 Flame Arresters for Vents of Tanks Storing Petroleum Products
Publ 2210 石油产品储罐通气口阻火器
RP 2350 Overfill Protection for Petroleum StorageTanks
RP 2350 石油储罐的过量充装防护
Bull 2521 Use of Pressure-Vacuum Vent Valves for Atmospheric Pressure Tanks to Reduce Evaporation Loss
Bull 2521 常压储罐使用压力-真空排气阀以降低蒸发损耗

3 Definition of Terms 术语定义

For the purposes of this standard, the following definitions apply:以下定义适用于本标准：

3.1 **accumulation**: The pressure increase in a tank over its maximum allowable working pressure when the vent valve is relieving(expressed in pressure units or percentage of the maximum allowable working pressure). Maximum allowable accumulations are typically established by applicable codes for operating and fire contingencies.
积聚压力：当通气阀释放时储罐中压力增大超过其最大允许工作压力（用压力单位或最大允许工作压力的百分比表示）。最大允许积聚压力通常由适用标准制定，用于操作和消防应急。

3.2 **barrel**: A liquid unit of measure equal to 42 US gallons (0.159 cubic meters).
桶：一种液体计量单位，相当于 42 US 加仑（0.159 立方米）。

3.3 **BTU**: British Thermal Unit, a unit of heat that will increase the temperature of one pound of water one degree Fahrenheit.
BTU：英国热量单位，1BTU 就是把一磅水的温度升高 1 华氏度所需的热量。
3.4 **emergency venting:** The venting required when an abnormal condition, such as ruptured internal heating coils or an external fire, exists either inside or outside of a tank.
紧急通气：当储罐内部或外部出现异常情况(例如内部加热盘管破裂或外部着火)时所需的通气。

3.5 **nonrefrigerated tank**: A container that stores material in a liquid state without the aid of refrigeration either by evaporation of the tank contents or by a circulating refrigeration system. Generally, the storage temperature will be close to or higher than ambient temperature.
非制冷罐：一种无需通过罐内物质汽化或循环制冷系统制冷来存储液态物料的容器。

3.6 **normal venting**: The venting required because of operational requirements or atmospheric changes.
正常通气：因操作需要或大气变化所需的通气。

3.7 **overpressure:** The pressure increase at the valve inlet above the set pressure, when the valve is relieving, expressed in pressure units or as a percentage of the set pressure. It is the same as accumulation when the valve is set at the maximum allowable working pressure and the inlet piping losses are zero.

过压：当阀门释放时，阀门入口处压力增大超过设定压力，用压力单位或者设定压力的百分比表示。当阀门被设定在最大允许工作压力并且入口管线损失为零时，它与积聚压力是相同的。

3.8 petroleum：**Crude oil.**

3.8 **石油：**原油；

3.9 **petroleum products:** Hydrocarbon materials or other products derived from crude oil.

3.9 **石油产品：**从原油中得到的烃类或其它产品。

3.10 **PV valve：**A weight-loaded, pilot-operated, or spring- loaded valve, used to relieve excess pressure and/or vacuum that has developed in a tank.

3.10 **呼吸阀：**一种重力荷载、先导式或弹簧式阀门，用于泄放储罐中形成的超压及/或真空。

3.11 **rated relieving capacity:** The flow capacity of a relief device expressed in terms of air flow at standard conditions (SCFH or Nm3/h) at a designated pressure or vacuum.

3.11 **额定泄放量：**在标准条件(SCFH 或 Nm3/h)、设计压力或设计真空下，以空气流量表示的泄放装置的流量。

3.12 **refrigerated tank：**A container that stores liquid at a temperature below atmospheric temperature with or without the aid of refrigeration either by evaporation of the tank con- tents or by a circulating refrigeration system.

3.12 **制冷储罐：**一种在环境温度下存储液态物料的容器，它可采用也可以不采用罐内物质汽化或循环制冷系统来制冷。

3.13 **relief device：**Any device used to relieve excess pressure and/or vacuum that has developed in a tank.

3.13 **泄压装置：**用于泄放罐内形成的超压和/或超真空的一种装置。

3.14 **relieving pressure:** The pressure at the inlet of a relief device when it is flowing at the required relieving capacity.

3.14 **泄放压力：**在要求的泄放量下，泄放装置的入口压力。

3.15 **required flow capacity:** The flow capacity of a relief device required to prevent excessive overpressure or vacuum in a tank under the most severe operating or emergency conditions.

3.15 **要求的流量：**为防止储罐在最苛刻的操作条件或紧急情况下过度超压或超真空，泄放装置所要求的流量。

3.16 **SCFH：**Standard cubic feet of air or gas per hour(same as free air or free gas) at a temperature of 60°F(15.6°C) and a pressure of 14.7 pounds per square inch absolute (1.014 bar absolute).

3.16 **SCFH：**在 60°F(15.6°C)的温度和 14.7lb/in^2(1.014barg)的压力下，每小时标准立方英尺的空气或气体（与自由空气或自由气体相同）。

3.17 **Nm3/h：**Normal cubic meters of air or gas per hour at a temperature of 0°C and pressure of 1.014 bar.

3.17 **Nm3/h:** 在 0°C 温度和 1.014bar 压力下，标准立方米的空气或气体。

3.18 **set pressure：**The gauge pressure at the device inlet at which the relief device is set to start opening under service conditions (measurable lift begins).

3.18 **设定压力：在运行条件下，**泄放装置刚开始打开时的入口表压（从开始升起时测得)。

3.19 **thermal inbreathing:** The movement of air or blanketing gas into a tank when vapors in the tank contract or con-dense as a result of weather changes conditions (e.g., a decrease in atmospheric temperature).

3.19 **热吸入：**由于天气状况的变化（例如环境温度降低）导致罐内气体压缩或冷凝，使得空气或隔离保护气体进入储罐。

3.20 **thermal outbreathing：** The movement of vapors out of a tank when vapors in the tank expand and liquid in the tank vaporizes as a result of weather changes (e.g., an increase in atmospheric temperature).

3.20 **热呼出：**由于天气状况的变化（例如环境温度升高）导致罐内气体膨胀和液体汽化，使得蒸气离开储罐。

3.21 **wetted area：** The surface area of a tank exposed to liquid on the interior and heat from a fire on the exterior.

3.21 **润湿面积：**内部接触液体而外部受到火焰加热的那部分储罐表面面积。

4 Nonrefrigerated Aboveground Tanks 非制冷地上储罐

4.1 GENERAL 概述

This section covers the normal and emergency venting requirements for nonrefrigerated aboveground liquid petroleum or petroleum products storage tanks. Discussed in this section are the causes of overpressure or vacuum；determination of venting requirements;means of venting;selection, installation, and maintenance of venting devices; and testing and marking of relief devices.

本节包括了非制冷地上液体石油储罐或石油产品储罐在正常和紧急情况下的通气要求。本节讨论了产生超压或真空的原因、确定通气要求、通气方法、通气装置的选择、安装与维护以及通气装置的测试与标记。

4.2 CAUSES OF OVERPRESSURE OR VACUUM 超压和真空的原因

4.2.1 General 概述

When the possible causes of overpressure or vacuum in a tank are being determined, the following circumstances must be considered:

在确定储罐超压或真空的原因时，一定要考虑以下几点：

a. Liquid movement into or out of the tank.

a. 液体出入储罐；

b. Tank breathing due to weather changes (e.g., pressure and temperature changes).

b. 由于天气变化 (例如压力和温度的变化）引起的储罐呼吸；

c. Fire exposure.

c. 火灾暴露；

d. Other circumstances resulting from equipment failures and operating errors.

d. 由于设备故障或操作错误而导致的其它情况。

Some of these circumstances are described more fully in Sections 4.2.2 through 4.2.5.There may be additional circumstances that should be considered by the designer but are not included in this standard.

在 4.2.2~4.2.5 节将对部分上述情况进行详细介绍。设计者还应考虑一些其它情况，但不在本标准范围之内。

4.2.2 Liquid Movement Into or Out of a Tank 液体出入储罐

Inbreathing will result from the outflow of liquid from a tank. Outbreathing will result from the inflow of liquid into a tank and from the vaporization, including flashing of the feed liquid, that will occur because of the inflow of the liquid. Flashing of the feed liquid can be significant for feed that is near or above its boiling point at the pressure in the tank.

液体流出储罐会导致吸入。液体流入储罐和汽化（包括进料液体的闪蒸）会导致呼出。如果进料温度接近或高于罐内压力下其沸点时，进料的闪蒸会比较明显。

4.2.3 Weather Changes 天气变化

Inbreathing will result from the contraction or condensation of vapors that is caused by a decrease in atmospheric temperature or other weather changes, such as wind changes, precipitation, etc. Outbreathing will result from the expansion and vaporization that is caused by an increase in atmospheric temperature or weather changes (thermal breathing).

由于气温降低或其它天气变化（如风、降雨等），会使气体压缩或冷凝而导致储罐吸入。由于环境温度升高或其它天气变化，引起气体膨胀和汽化，会导致储罐呼出。

4.2.4 Fire Exposure 火灾暴露

Outbreathing will result from the expansion of the vapors and vaporization of the liquid that occurs when a tank absorbs heat from an external fire.

当储罐吸收外部火源来的热量而造成液体汽化以及气体膨胀，将导致储罐呼出。

VENTING ATMOSPHERIC AND LOW-PRESSURE STORAGE TANKS

常压和低压储罐的通气

4.2.5 Other Circumstances 其它情况

4.2.5.1 General 概述

When the possible causes of overpressure or vacuum in a tank are being determined, other circumstances resulting from equipment failures and operating errors must be considered and evaluated by the designer. Calculation methods for these other circumstances have not been provided in this standard.

在确定一台储罐过压或真空的可能原因时，设计者要考虑和评估由于设备故障或操作错误所产生的其它情况。这些情况的计算方法在本标准中未提供。

4.2.5.2 Pressure Transfer Blowoff 压力输送的排气

Liquid transfer from other vessels, tank trucks, and tank cars may be aided or accomplished entirely by pressurization of the supply vessel with a gas, but the receiving tank may counter a flow surge at the end of the transfer due to vapor breakthrough. Depending on the pre-existing pressure and free head space in the receiving tank, the additional gas volume may be sufficient to overpressure the tank. The controlling case is a transfer that fills the receiving tank so that little head space remains to absorb the pressure surge. A similar situation can be encountered during line pigging if a vapor chaser is used after the pigging device.

从其它容器、罐车和槽车输送液体完全可以通过气体对供给容器加压来辅助或实现，但在输送末期由于气体逃逸，接收罐可能会发生流量波动。基于接受罐中的已有压力和顶部自由空间，此额外的气体量有可能足以使接收罐过压。控制方案是：在接收罐内安装一个转向器，以便留有少量顶部空间吸收压力波动。在清管期间，如果清管装置后使用一个气体驱逐器，就会遇到类似的情况。

4.2.5.3 Inert Pads and Purges 惰性气封与吹扫

Inert pads and purges are provided on tanks to protect the contents of the tanks from contamination, maintain nonflammable atmospheres in the tanks, and suppress vapor emissions from the tanks. An inert pad and purge system normally has a supply regulator and a back pressure regulator to maintain interior tank pressure within a narrow range. Failure of the supply regulator can result in unrestricted gas flow into the tank, reduced gas flow, or complete loss of the gas flow. Failure of the back pressure regulator could result in over- pressure.

对储罐提供惰性气封与吹扫以保护储罐内物料不受污染、维持储罐内的不可燃环境并抑制储罐的气体排放。惰性气封与吹扫系统通常有一个供气调节阀和一个背压调节阀来把罐内压力维持在较窄的范围内。供气调节阀故障会导致气体不受限制的进入储罐、气体流量下降或者气体流量完全中断。背压调节阀故障可能会导致过压。

4.2.5.4 External Heat Transfer Devices 外部传热装置

Steam, tempered water, and hot oil are common heating media for tanks whose contents must be maintained at elevated temperatures. If failure of a tank's supply control valve, temperature sensing element, or control system causes the flow of heating medium to the tank's jacket to increase, vaporization of the liquid stored in the tank can occur. When aporization occurs, the resulting overpressure must be relieved.

蒸汽、调温水和热油是储罐物料维持高温的普通加热介质，如果一台储罐的进料控制阀、测温元件或控制系统故障，导致进入储罐夹套的加热介质流量增加，则储罐内储存的液体会发生汽化。如果发生汽化，产生的过压必须泄放。

If a tank maintained at elevated temperatures is empty, excessive feed vaporization may result when the tank is filled. If the temperature control system of the tank is active with the sensing element exposed to vapor, the tank's heating medium may be circulating at maximum rate with the tank wall at maximum temperature. Filling during such conditions may result in excessive feed vaporization. The excessive feed vaporization would stop as soon as the walls cooled and the fluid level covered the sensing element.

如果一台高温储罐是空的，则储罐加料时就可能会导致过度进料汽化。如果测温元件接触气体而启动了温度控制系统，储罐的加热介质就可能会以最大流量循环，罐壁处在最高温度下。在这种情况下加料可能会导致过度进料汽化。一旦罐壁冷却并且液位淹没测温元件，则过度进料汽化将停止。

For a tank with a cooling jacket or coils, liquid vaporization as a result of the loss of coolant flow must be considered.

对一台带冷却夹套或盘管的储罐来说，必须考虑冷却剂流量损耗导致的液体汽化。

4.2.5.5 Internal Heat Transfer Devices 内部传热装置

Mechanical failure of a tank's internal heating or cooling device can expose the contents of the tank to the heating or cooling medium used in the device. In low-pressure tanks, it can be assumed that the flow direction of the heat transfer medium will be into the tank when the device fails. Chemical compatibility of the tank contents and the heat transfer medium must be considered. Relief of the heat transfer medium(e.g.,steam) may be necessary. The disposition of the tank contents until the device can be repaired or replaced must also be considered.

储罐内部加热或冷却装置的机械故障会使罐内物料接触到所用的加热或冷却介质。在低压罐中，可以假设当传热装置机械故障时传热介质会流向罐内。必须考虑罐内物料和加热介质的相容性，有可能需要泄放传热介质（如蒸汽）。在装置修理或更换前，必须考虑储罐内物料的处置。

4.2.5.6 Vent Treatment Systems 放空气处理系统

If vapor from a tank is collected for treatment or disposal by a vent treatment system, the vent collection system may fail. This failure must be evaluated. Failures affecting the safety of a tank can include back pressure developed from problems in the piping (liquid-filled pockets and solids build-up), other equipment relieving into the header, or blockage due to equipment failure. An emergency venting device that relieves to atmosphere, set at a higher pressure than the vent treatment system, is normally used. For toxic or hazardous vapors, a fail- safe vent treatment system should be considered.

如果储罐产生的气体由放空气处理系统收集起来进行处理或排放，放空气收集系统有可能故障，必须对这种故障进行评估。影响储罐安全的故障包括管路问题（如充液袋形或固体积聚）形成的背压、其

它设备泄放到总管或设备故障造成的堵塞。通常使用一个紧急通气装置向大气泄放，其设定压力高于放空气处理系统。对有毒或危险气体，应考虑使用故障安全放空气处理系统。

4.2.5.7 Utility Failure 公用系统故障

Local and plant-wide power and utility failures must be considered as possible causes of overpressure or vacuum. Loss of electrical power will directly affect any motorized valves or controllers and may also shut down the instrument air supply. Also, cooling and heating fluids may be lost during an electrical failure.

就地或整个装置电力中断和公用系统故障必须作为过压或真空的可能原因进行考虑。停电会直接影响所有电动阀或控制器，也会关停仪表风。而且，电力中断也可能导致冷却或加热流体的损失。

4.2.5.8 Change in Temperature of the Input Stream to a Tank 进罐物料的温度变化

A change in the temperature of the input stream to a tank brought about by a loss of cooling or an increase in heat input may cause overpressure in the tank.

由于冷却损失或输入热量增加致使进罐物料的温度发生变化，这可能会导致储罐过压。

4.2.5.9 Chemical Reactions 化学反应

The contents of some tanks may be subject to chemical reactions, which may generate heat and/or vapors. Some examples of chemical reactions may include inadvertently adding water to acid or spent acid tanks thereby generating steam and/or vaporizing light hydrocarbons, runaway reactions of phenol tanks, etc. In some cases, the material may foam, causing two phase relief. Technology developed by the Design Institute for Emergency Relief (DIERS) may be used to evaluate these cases.

某些储罐内的物料可能会发生化学反应，产生热量和/或气体。例如，一些化学反应可能包括：不小心往酸或废酸储罐里加入了水从而生成了蒸汽、轻烃汽化、苯酚储罐反应失控等。在某些情况下，材料会起泡沫，产生两相泄放。可利用紧急救援系统设计院（DIERS）开发的技术来评估这些情况。

4.2.5.10 Liquid Overfill Protection

4.2.5.10 液体过量充装防护

For information on liquid overfill protection, see API Standards 620, 2510, and API Recommended Practice 2350. Liquid overfill shall be prevented by providing positive design and operation steps, such as two reliable and repairable level instruments and an independent high-level alarm that independently stop the filling operation by closing the filling valves.

关于液体过量充装防护信息**,** 参见标准 API620、API2510 及 API 推荐规程 2350。通过提供正确的设计和操作步骤来防止液体过量充装，例如**:**两个可靠并可维修的液位计以及一个独立的高液位报警器（它能通过关闭充装阀而独立停止充装操作）。

4.2.5.11 Atmospheric Pressure Changes

4.2.5.11 大气压变化

A rise or drop in barometric pressure is a possible cause of vacuum or overpressure in a tank.

4.2.5.11 大气压升高或降低可能导致罐内产生真空或超压。

4.2.5.12 Control Valve Failure

4.2.5.12 控制阀故障

Failure of a control valve on the liquid line to a tank must be considered because such a failure may overload heat exchange equipment and cause high temperature material to be admitted to the tank. A control valve failure may also cause the liquid level in a pressurized vessel feeding liquid to a tank to drop below the vessel outlet nozzle, allowing high pressure vapor to enter the tank.

必须考虑储罐液体注入管线上的控制阀发生故障的情况，因为一旦该阀发生故障就有可能引起换热器超负荷，从而向储罐内注入高温物料。控制阀故障还会导致向储罐供液体料的压力容器液位降低到其出口管嘴以下，使得蒸气从压力容器压入储罐。

4.2.5.13 Steam Out

4.2.5.13 蒸汽吹出

If an uninsulated tank is filled with steam, the condensing rate due to ambient cooling may exceed the venting rates specified in this standard. Other steps, including large vents (open

man ways) and slowly cooling the tank, are necessary to prevent excessive internal vacuum.
如果制冷罐的未保温部分充满蒸汽，由于环境冷却，冷凝速率会超过本标准规定的通气速率。为防止罐内真空过高，需要采取其他措施，包括大的通气口(敞开的人孔)和缓慢冷却储罐。

4.2.5.14 Uninsulated Tanks

4.2.5.14 非保温储罐

Uninsulated tanks with exceptionally hot vapor spaces may exceed the venting requirements in this standard during a rain storm. Vapor contraction may cause excessive vacuum. An engineered review of heated uninsulated tanks with vapor space temperatures above 120°F (48.9°C) is recommended.
在发生暴雨时，该标准中的未保温储罐热气体空间可能会超过本标准中的通气能力，蒸汽收缩可能会造成过度真空，建议对气体空间温度高于 120°F (48.9°C)的加热未保温储罐进行工程审查。

4.3 DETERMINATION OF VENTING REQUIREMENTS

4.3 通气要求量的确定

4.3.1 General

4.3.1 概述

Venting requirements are given for the following conditions:
通风要求量考虑以下情况：

a. Inbreathing resulting from maximum outflow of liquid from the tank.
a. 自储罐的液体最大流出量而产生的吸入量。
b. Inbreathing resulting from contraction or condensation of vapors caused by maximum decrease in vapor space temperature (thermal breathing).
b. 最大气体空间温度降低引起气体收缩或冷凝而产生的吸入量（热呼吸）。
c.Outbreathing resulting from maximum inflow of liquid into the tank and maximum vaporization caused by such inflow.
c. 到储罐的液体最大流入量和此流量引起的最大汽化量而产生的呼出量。
d. Outbreathing resulting from expansion and vaporization that result from maximum increase in vapor space temperature (thermal breathing).
最大气体空间温度升高引起的膨胀与汽化而产生的呼出量。
e. Outbreathing resulting from fire exposure.
e.暴露于火源而产生的呼出量。

Although design guidelines are not presented in this standard for other circumstances discussed in Section 4.2.5, they should be considered.
虽然本标准未对 4.2.5 节中论述的其它情况提出设计指导方针，但应对其加以考虑。

4.3.2 Requirements for Normal Venting Capacity 正常通气能力的要求

The total normal venting capacity shall be at least the sum of the venting requirements for liquid movement and thermal effect; however, the required capacity may be reduced for products volatility is such that vapor generation or condensation within the permissible operating range of tank pressure will provide all or part of the venting requirements. In cases in which noncondensables are present, this should be taken into account. A summary of the venting requirements for inbreathing and outbreathing due to liquid movement out of and into a tank and thermal effects are shown in Tables 1 and 2. These requirements are discussed in Sections 4.3.2.1 and 4.3.2.2
总的通风能力应该至少是液体流动量及热效应的总和，对于那些在储罐的操作压力范围内会产生蒸汽或蒸汽冷凝的物质来讲，其挥发性影响到通风量，使其能力会降低。同时要考虑到存在的不可压缩物质。在表 1 和表 2 中，简单介绍了由储罐内流体的输入及输出和热效应造成的吸入和排出的风量要求。将在 4.3.2.1 章及 4.3.2.2 章中将对这些要求进行讨论。

Table 1A—Normal Venting Requirements
(SCFH of Air per Barrel per Hour of Liquid Flow)
表 1A—正常排气要求（空气单位立方英尺/小时，流体每桶/小时）

A 英文单位

Flash Point/Boiling(a) 闪点/沸点	Inbreathing 吸入		Outbreathing 排出	
	Liquid Movement Out 液体流出	Thermal 热量	Liquid Movement In 液体流入	Thermal 热量
Flash Point≥100°F 闪点≥100F	5.6	See Table 2A 见表 2A	6	See Table 2A 见表 2A
Boiling Point ≥ 300°F 沸点≥300F	5.6	See Table 2A 见表 2A	6	See Table 2A 见表 2A
Flash Point < 100°F 闪点<100F	5.6	See Table 2A 见表 2A	12	See Table 2A 见表 2A
Boiling Point < 300°F 沸点<300F	5.6	See Table 2A 见表 2A	12	See Table 2A 见表 2A

(a):Data on flash point or boiling point may be used. Where both are available, use flash point (See Appendix A).
可能会用到闪点和沸点相关数据。当两者都可用时，使用闪点（见附件 A）

Table 1B—Normal Venting Requirements
(Nm3/hr of Air per Cubic Meter per Hour of Liquid Flow) B. Metric Units
表 1B-普通排气需求
（Nm3/hr 的空气每立方米每小时的液体流动）B

B 公制单位

Flash Point/Boiling (a) 闪点/沸点	Inbreathing 吸入		Outbreathing 排出	
	Liquid Movement Out 液体流出	Thermal 热量	Liquid Movement In 液体流入	Thermal 热量
Flash Point≥37.8℃闪点≥37.8℃	0.94	See Table 2B 见表 2B	1.01	See Table 2B 见表 2B
Boiling Point ≥148.9℃沸点≥148.9℃	0.94	See Table 2B 见表 2B	1.01	See Table 2B 见表 2B
Flash Point < 37.8℃闪点<37.8℃	0.94	See Table 2B 见表 2B	2.02	See Table 2B 见表 2B
Boiling Point <149℃F 沸点<149℃	0.94	See Table 2B 见表 2B	2.02	See Table 2B 见表 2B

(a):Data on flash point or boiling point may be used. Where both are available, use flash point (See Appendix A).
可能会用到闪点和沸点相关数据。当两者都可用时，使用闪点（见附件 A）

4.3.2.1 Inbreathing (Vacuum Relief)

4.3.2.1 吸入（真空释放）

4.3.2.1.1 The requirement for venting capacity for maxi- mum liquid movement out of a tank should be equivalent to 5.6 SCFH of air for each 42 US gallon barrel (0.94 Nm3/h of air for each cubic meter) per hour of maximum emptying rate for liquids of any flash point.

4.3.2.1.1 最大的液体流出罐的通风能力要求应相当于 5.6 SCFH（标准立方英尺每小时）的空气流过一个 42 加仑装的桶（ 0.94 Nm3/ h 每立方米空气）每小时最大排空率可用于任何闪点的液体。

4.3.2.1.2 The requirement for venting capacity for thermal inbreathing for a given tank capacity for liquids of any flash point should be at least that shown in Column 2 of Table 2. An engineering review should be conducted for heated un-insulated tanks where the vapor space temperature is maintained above 120°F (48.9°C) (see Section 4.2.5.14).

4.3.2.1.2 对于一个用任意液体闪点给定的储罐能力，热吸入时的通风能力要求应至少列在表 2 的第 2 栏中。工程审查应当控制加热的非绝缘储罐水蒸汽空间温度保持在高于 120 °F（ 48.9 ℃ ）（见 4.2.5.14 节 ） 。

4.3.2.2 Out-breathing (Pressure Relief) for Liquid With a Flash Point Above 100°F (37.8°C)

4.3.2.2 排气（压力释放）对于闪点高于 100°F (37.8°C)的液体

4.3.2.2.1 The requirement for venting capacity for maxi- mum liquid movement into a tank and the resulting vaporiza- tion for liquid with a flash point of 100°F (37.8°C) or above or a normal boiling point of 300°F (148.9°C) or above should be equivalent to 6 SCFH of air for each 42 US gallon barrel (1.01 Nm3/h per cubic meter) per hour of maximum filling rate.

4.3.2.2.1 对于以最大液体流动流入储罐和由此产生的蒸汽化的闪点为 100°F (37.8°C)或更高或者正常沸点为 300°F (148.9°C)或更高的液体的通风能力的要求相当于，6 SCFH 的空气流过一个 42 加仑装的桶（ 1.01 Nm3/ h 每立方米空气），以每小时最大装满率核算。

Note: Protection against liquid overfilling is not covered in this stan- dard, but it is covered in API Standard 620 and in API Recom- mended Practice 2350.

注意：液体过溢保护并没有在这个标准中涵盖到，而是在 API 标准 620 和 API 实用推荐 2350 中被涵盖到。

4.3.2.2.2 The requirement for venting capacity for thermal outbreathing, including thermal vaporization, for a given tank capacity for liquid with a flash point of 100°F (37.8°C) or above or a normal boiling point of 300°F (148.9°C) or above should be at least that shown in Column 3 of Table 2.

4.3.2.2.2 对于一个用闪点为 100°F (37.8°C)或更高或者正常沸点为 300°F (148.9°C)或更高的液体给定的储罐能力，热排出时的通风能力要求应至少列在表 2 的第 3 栏中。

4.3.2.3 Outbreathing (Pressure Relief) for Liquid With a Flash Point Below 100°F (37.8°C)

4.3.2.3 排气（压力释放）对于闪点低于 100°F (37.8°C)的液体

4.3.2.3.1 The requirement for venting capacity for maxi- mum liquid movement into a tank and the resulting vaporiza- tion for liquid with a flash point below 100°F (37.8°C) or a normal boiling point below 300°F (148.9°C) should be equivalent to 12 SCFH of air for each 42 US gallon barrel (2.02Nm3/h per cubic meter) per hour of maximum filling rate (see Appendix A for the basis of this requirement).

4.3.2.3.1 对于以最大液体流动流入储罐和由此产生的蒸汽化的闪点为小于 100°F (37.8°C)或者正常沸点为小于 300°F (148.9°C)的液体的通风能力的要求相当于，12 SCFH 的空气流过一个 42 加仑装的桶（ 2.02 Nm3/ h 每立方米空气），以每小时最大装满率核算。（见附录 A 中要求的基础条件）

A tank into which liquid is fed at or near the boiling point at the tank pressure may require an outbreathing capacity that is higher than the capacity indicated above or in Table 1. The values presented above and in Table 1 are based on vaporization of 0.5 persent of the feed liquid; significantly higher vaporization rates can occur if the feed is above the boiling point. For instance, with hexane, 0.4 percent of the feed can vaporize for every 1°F (0.56°C) above the boiling point at tank pressure.

罐压下，液体在其沸点或沸点附近注入储罐时有可能要求的呼出量比上面所指的要高。上面和表 1 中所示数值是基于进液汽化率为 0.5%。如果进料的温度高于其沸点，汽化率会更高。以己烷为例：在罐压下，每高于沸点 1°F (0.56°C)，进料汽化率就会增加 0.4%。

Note: Protection against liquid overfilling is not covered in this stan- dard, but it is covered in

API Standard 620 and in API Recom- mended Practice 2350.
注释：本标准未包括液体过量充装防护，但在 API 620 和 API 推荐规程 2350 中有。

4.3.2.3.2 The requirement for venting capacity for thermal outbreathing, including thermal vaporization, for a given tank capacity for liquid with a flash point below 100°F (37.8°C) or a normal boiling point below 300°F (148.9°C) should be at least that shown in Column 4 of Table 2.
4.3.2.3.2 对于一个用闪点为小于 100°F (37.8°C)或者正常沸点为小于 300°F (148.9°C)的液体给定的储罐能力，热排出时的通风能力要求应至少列在表 2 的第 4 栏中。
4.3.3 Requirements for Emergency Venting Capacity for Tanks Subject to Fire Exposure.
4.3.3:储罐遭遇到火灾威胁时的紧急通风能力要求
When storage tanks are exposed to fire, the venting rate may exceed the rate resulting from a combination of normal thermal effects and liquid movement. In such cases, the construction of the tank will determine whether additional venting capacity must be provided.
当油罐暴露在火灾中时，排气比率可能超过由正常热效应和液体流动共同导致的比率。在这种情况下，储罐的结构将决定是否需要提供附加的排气能力。

4.3.3.1 Tanks With Weak Roof-to-Shell Attachment
4.3.3.1: 壳体和上盖连接不够紧密的储罐
On a fixed-roof tank with a weak (frangible) roof-to-shell attachment as described in API Standard 650, the roof-to-shell connection will fail preferentially to any other joint and the excess pressure will be safely relieved if the normal venting capacity should prove inadequate. For a tank built to these specifications, consideration need not be given to any additional requirements for emergency venting; however, additional emergency vents may be used to avoid failure of the joint. Care should be take to ensure that the requirement for a frangible roof-to-shell attachment are met, particularly on a smaller tank.
在一个有盖的如 API 标准中描述的壳体和上盖连接不够紧密的（易碎的）储罐上，如果正常排气能力证明不够的话，盖和壳体的连接会比其它连接更容易断裂，然后超额的压力会被安全地释放。对于一个按照这些详细说明建造的储罐，不用考虑任何附加紧急排气要求，然而，附加的紧急放空口习惯于用来避免连接失败。应该注意的是要确保满足那些罐顶和罐壁弱连接罐附件的要求，尤其是小的罐。

表 2A—热排放量的需要量				
A.英制单位				
Tank Capacity 罐容量		Inbreathing (Vacuum) 吸入 (真空)	Out breathing 呼出	
Column 1 [d] 第 1 栏 [d]		Column 2 [a] 第 2 栏 [a]	Column 3 [b] 第 3 栏 [b]	Column 4 [c] 第 4 栏 [b]
			Flash Point≥100°F or Normal Boiling Point ≥300°F 闪点≥100°F 或 正常沸点<300°F	Flash Point＜100°F or Normal Boiling Point＜300°F 闪点＜100°F 或 正常沸点<300°F
Baeerls 桶数	Gallons 加仑数	SCFH Air 空气（SCFH）	SCFH Air 空气（SCFH）	SCFH Air 空气（SCFH）
60	2,500	60	40	60
100	4,200	100	60	100
500	21,000	500	300	500
1,000	42,000	1,000	60	1,000
2,000	84,000	2,000	1,200	2,000
3,000	126,000	3,000	1,800	3,000
4,000	168,000	4,000	2,400	4,000
5,000	210,000	5,000	3,000	5,000

10,000	420,000	10,000	6,000	10,000
15,000	630,000	15,000	9,000	15,000
20,000	840,000	20,000	12,000	20,000
25,000	1,050,000	24,000	15,000	24,000
30,000	1,260,000	28,000	17,000	28,000
35,000	1,470,000	31,000	19,000	31,000
40,000	1,680,000	34,000	21,000	34,000
45,000	1,890,000	37,000	23,000	37,000
50,000	2,100,000	40,000	24,000	40,000
60,000	2,520,000	44,000	27,000	44,000
70,000	2,940,000	48,000	29,000	48,000
80,000	3,360,000	52,000	31,000	52,000
90,000	3,780,000	56,000	34,000	56,000
100,000	4,200,000	60,000	36,000	60,000
120,000	5,040,000	68,000	41,000	68,000
140,000	5,880,000	75,000	45,000	75,000
160,000	6,720,000	82,000	50,000	82,000
180,000	7,560,000	90,000	54,000	90,000

[a]For tanks with a capacity of 20,000 barrels (3,180 cubic meters) or more, the requirements for the vacuum condition are very close to the theoretically computed value of 2 SCFH of air per square foot (0.577 Nm3/h per square meter) of total shell and roof area. For tanks with a capacity of less than 20,000 barrels (3,180 cubic meters), the requirements for the vacuum condition have been based on 1 SCFH of air for each barrel of tank capacity (0.169 Nm3/h per cubic meter). This is substantially equivalent to a mean rate of temperature change of 100°F (37.8°C) per hour in the vapor space (see Appendix A). An engineering review should be conducted for uninsulated tanks where the vapor space temperature is maintained above 120°F (48.9°C) (see 4.2.5.14).

[a] 对于容量为 20,000 桶(3,180 立方米)或更大的罐,真空条件的需要量非常接近每平方英尺总壳体和罐顶面积为 2 SCFH（标准立方英尺/小时）空气 (0.577Nm3/h/平方米)的理论计算值。对于容量小于 20,000 桶(3,180 立方米)的罐,真空条件的需要量是基于每桶罐容量为 1SCFH 空气(0.169Nm3/h /立方米)。这基本上等于蒸汽空间 100°F(37.8°C) /小时的温度变化的平均速率（见附录 A）。对于蒸汽空间温度保持在 120°F(48.9°C)以上的无保温罐应进行工程设计审查(见 4.2.5.14)。

[b] For stocks with a flash point of 100°F (37.8°C) or above, the outbreathing requirement has been assumed to be 60 percent of the inbreathing requirement. The roof and shell temperatures of a tank cannot rise as rapidly under any condition as they fall, for example, during a sudden cold rain.

[c] 对于闪点为 100°F(37.8°C)或更高的原料，已假设呼出需要量为吸入需要量的 60%。任何条件下罐顶和壳体温升都不能和温降一样快，例如突降冷雨时。

cFor stocks with a flash point below 100°F (37.8°C), the outbreathing requirement has been assumed to be equal to the inbreathing requirement to allow for vaporization at the liquid surface and for the higher specific gravity of the tank vapors.

[c] 对于闪点低于 100°F(37.8°C)的原料,已假设呼出需要量等于吸入需要量，允许液面汽化及形成比重更大的罐蒸汽。

d Interpolate for intermediate tank sizes. Tanks with a capacity of more than 180,000 barrels (30,000 cubic meters) require individual study. Refer to Appendix A for additional information about the basis of this table.

[d] 添加中间罐尺寸。容量大于 180,000 桶 (30,000 立方米) 的罐需要单独研究考虑。关于本表基础内容的补充信息参见附录 A。

表 2B—热排放量的需要量			
A.米制单位			
Tank Capacity 罐容量	Inbreathing (Vacuum) 吸入(真空)	Out breathing 呼出	
Column 1 [d] 第 1 栏 [d]	Column 2 [a] 第 2 栏 [a]	Column 3 [b] 第 3 栏 [b] Flash Point≥37.8℃ or Normal Boiling Point ≥148.9℃ 闪点≥37.8℃或正常沸点≥148.9℃	Column 4 [c] 第 4 栏 [b] Flash Point＜37.8℃ or Normal Boiling Point ＜148.9℃ 闪点＜37.8℃或正常沸点<148.9℃
Cubic Meter 立方米	Nm^3/h	Nm^3/h	Nm^3/h
10	1.69	1.01	1.69
20	3.37	2.02	3.37
100	16.90	10.10	16.90
200	33.70	20.20	33.70
300	50.60	30.30	50.60
500	84.30	50.60	84.30
700	118.00	70.80	118.00
1000	169.00	101.00	169.00
1500	253.00	152.00	253.00
2000	337.00	202.00	337.00
3000	506.00	303.00	506.00
3180	536.00	388.00	536.00
4000	647.00	472.00	647.00
5000	787.00	537.00	787.00
6000	896.00	602.00	896.00
7000	1003.00	646.00	1003.00
8000	1077.00	682.00	1077.00
9000	1136.00	726.00	1136.00
10000	1210.00	807.00	1210.00
12000	1345.00	888.00	1345.00
14000	1480.00	969.00	1480.00
16000	1615.00	1047.00	1615.00
18000	1745.00	1126.00	1745.00
20000	1877.00	1307.00	1877.00
25000	2179.00	1378.00	2179.00
30000	2495.00	1497.00	2495.00

[a]For tanks with a capacity of 20,000 barrels (3,180 cubic meters) or more, the requirements for the vacuum condition are very close to the theoretically computed value of 2 SCFH of air per square foot (0.577 Nm3/h per square meter) of total shell and roof area. For tanks with a capacity of less than 20,000 barrels (3,180 cubic meters), the requirements for the vacuum condition have been based on 1 SCFH of air for each barrel of tank capacity (0.169 Nm3/h per cubic meter). This is substantially equivalent to a mean rate of temperature change of 100°F (37.8°C) per hour in the vapor space (see Appendix A). An engineering review should be conducted for uninsulated tanks where the vapor space temperature is maintained above 120°F (48.9°C) (see 4.2.5.14).

[a] 对于容量为 20,000 桶(3,180 立方米)或更大的罐,真空条件的需要量非常接近每平方英尺总壳体和罐顶面积为 2 SCFH（标准立方英尺/小时）空气 (0.577Nm3/h/平方米)的理论计算值。对于容量小于 20,000 桶(3,180 立方米)的罐,真空条件的需要量是基于每桶罐容量为 1SCFH 空气(0.169Nm3/h /立方米)。这基本上等于蒸汽空间 100°F(37.8°C) /小时的温度变化的平均速率（见附录 A）。对于蒸汽空间温度保持在 120°F(48.9°C)以上的无保温罐应进行工程设计审查(见 4.2.5.14)。

[b] For stocks with a flash point of 100°F (37.8°C) or above, the outbreathing requirement has been assumed to be 60 percent of the inbreathing requirement. The roof and shell temperatures of a tank cannot rise as rapidly under any condition as they fall, for example, during a sudden cold rain.

[c] 对于闪点为 100°F(37.8°C)或更高的原料，已假设呼出需要量为吸入需要量的 60%。任何条件下罐顶和壳体温升都不能和温降一样快，例如突降冷雨时。

cFor stocks with a flash point below 100°F (37.8°C), the outbreathing requirement has been assumed to be equal to the inbreathing requirement to allow for vaporization at the liquid surface and for the higher specific gravity of the tank vapors.

[c] 对于闪点低于 100°F(37.8°C)的原料,已假设呼出需要量等于吸入需要量，允许液面汽化及形成比重更大的罐蒸汽。

d Interpolate for intermediate tank sizes. Tanks with a capacity of more than 180,000 barrels (30,000 cubic meters) require individual study. Refer to Appendix A for additional information about the basis of this table.

[d] 添加中间罐尺寸。容量大于 180,000 桶 (30,000 立方米) 的罐需要单独研究考虑。关于本表基础内容的补充信息参见附录 A。

4.3.3.2 Tanks Without Weak Roof-to-Shell Attachment

4.3.3.2 不带罐顶与罐壁弱连接附件的罐

When a tank is not provided with a weak roof-to-shell attachment as described in 4.3.1.1, the procedure given in-4.3.3.2.1 through 4.3.3.2.6 shall govern in evaluating the required venting capacity for fire exposure.

当一个罐没有如 4.3.1.1 所描述的带有罐顶和罐壁弱连接附件时，条款 4.3.3.2.1 至 4.3.3.2.6 叙述的程序将给出火灾情况下放空能力的估算值

4.3.3.2.1 For tanks subject to fire exposure, the required venting capacity shall be determined by Equation 1A or 1B.

火灾情况下的储罐所需要的泄放量问题可以通过公式 1A 或 1B 确定.

A. English Units

A.英制单位

$$SCFH = 3.091 \times \frac{QF}{L} \times \left(\frac{T}{M}\right)^{0.5} \qquad (1A)$$

where
SCFH = venting requirement, in standard cubic feet per hour of air,
Q = heat input from fire exposure, in BTU per hour. Heat input is provided in Figure B-1 of Appen- dix B or the following summary:
式中：
SCFH（标准立方英尺/小时） = 放空要求，标准立方英尺空气/小时
Q（热量） = 火灾输入的热量, BTU /小时. 热量输入值由附录 B 的表 B-1 里或者以下表为基础的。

Wetted Surface Area (square feet) 湿润表面	Design Pressure (psig) 设计压力	Heat Input (Btu/hr) 输入热量
＜200	≤15	Q = 20,000A
≥200 and ＜1000	≤15	$Q = 199{,}300A^{0.566}$
≥1000 and ＜2800	≤15	$Q = 963{,}400A^{0.338}$
≥2800	between 1 psig and 15 在 1 到 15 之间	$Q = 21{,}000A^{0.82}$
≥2800	≤1	Q = 14,090,000

A = wetted surface area of the tank, in square feet
(see Table 3A, Footnotes a and b),
A = 罐的润湿表面，用平方英尺表示
(见表 3A，脚注 a 和 b)；
F = environmental factor from Table 4A. Credit may be taken for only one environmental factor,
F = 表 4A 是环境因子.说明部分是针对只有一个环境因子的；
L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in BTU per pound,
L = 罐内储存液体在泄放温度和压力下的汽化潜热, BTU/磅；
T = temperature of the relieving vapor, in degrees Rankine. It is normally assumed that The temperature of the relieving vapor corresponds to the boiling point of the stored fluid at the relieving pressure；
T = 泄放蒸汽的温度,以兰金温标表示。. 通常假定泄放蒸汽的温度与储存液体在泄放压力下的沸点温度等同。
M = molecular weight of the vapor being relieved.
M = 泄放蒸汽的分子量。

B. Metric Units
B.米制单位

$$Nm^3/h = 881.55 \times \frac{QF}{L} \times \left(\frac{T}{M}\right)^{0.5} \qquad (1B)$$

Where
式中
Nm3 / h = venting requirement, in normal cubic meters per hour of air,
Nm3 / h=泄放要求，标准立方米/小时
Q = heat input from fire exposure, in Watts. Heat input is provided in the following summary:
Q =火灾传入的热量，瓦特。传入热量的计算以下表为基础的。

Wetted Surface Area (square m^2) 湿润表面	Design Pressure (barg) 设计压力	Heat Input (Watts) 输入热量
＜18.6	≤1.034	Q = 63150A
≥18.6 and ＜93		$Q = 224200A^{0.566}$
≥93 and ＜260		$Q = 630400A^{0.338}$

≥260	between 0.07 and 1.034 在 0.07 到 1.034 之间	$Q = 43200A^{0.82}$
≥260	≤1	Q = 4129700

A = wetted surface area of the tank, in square meters (see Table 3B, Footnotes a and b),
A = 储罐的润湿表面,平方米 (见 表 3B, 脚注 a 和 b),
F = environmental factor from Table 4A. Credit may be taken for only one environmental factor,
F = 从 表 4B 查得的环境因子说明部分是针对只有一个环境因子的;
L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in kilo- joules/kilogram (kJ/kg),
L = 罐内储存液体在泄放温度和压力下的汽化潜热，千焦耳/千克(kJ/kg),
T = temperature of the relieving vapor, in degrees Kelvin. It is normally assumed that the temperature of the relieving vapor corresponds to the boiling point of the stored fluid at the relieving pressure,
T = 泄放蒸汽的温度,以兰金温标表示。. 通常假定泄放蒸汽的温度与储存液体在泄放压力下的沸点温度等同。
M = molecular weight of the vapor.
M = 泄放蒸汽的分子量。

4.3.3.2.2 Where a lesser degree of accuracy can be toler- ated, the required venting capacity can be determined from Table 3 or Equation 2A or 2B, as indicated in the following summary:
4.3.3.2.2 这里允许较低的准确度。从表 3 或等式 2A 或 2Bt 可以确定所需要的泄放能力，如下简表所示

For English Units:
对英制单位:

Wetted Surface Area (square feet) 湿润表面	Design Pressure (psig) 设计压力	Required Venting Capacity (SCFH)) 输入热量
＜2800	≤15	See Table 3Aand 4.3.3.2.3 见表 3A 和 4.3.3.2.3
≥2800	≤1	742000 (See 4.3.3.2.3) (见 4.3.3.2.3)
≥2800	Between 1 and 15 1 和 15 之间	Equation 2A 等式 2A

Table 3A—Emergency Venting Required for Fire Exposure Versus Wetted Surface Area[c]
表 3A-火灾暴露时润湿表面积与要求的紧急通气能力

A. English Units A.英制单位

Wetted Area[a] (square feet) 润湿面积	Venting Requirement (SCFH)放空要求	Wetted Area[a] (square feet) 润湿面积	Venting Requirement (SCFH)放空要求
20	21,100	350	288,000
30	31,600	400	312,000
40	42,100	500	354,000
50	52,700	600	392,000
60	63,200	700	428,000
70	73,700	800	462,000

80	84,200	900	493,000
90	94,800	1,000	524,000
100	105,000	1,200	557,000
120	126,000	1,400	587,000
140	147,000	1,600	614,000
160	168,000	1,800	639,000
180	190,000	2,000	662,000
200	211,000	2,400	704,000
250	239,000	2,800	742,000
300	265,000	>2800[b]	---

Table 3B—Emergency Venting Required for Fire Exposure Versus Wetted Surface Area[c]
火灾暴露时润湿表面积与要求的紧急通气能力

B. Metric Units A.公制单位			
Wetted Area[a] (square meters) 润湿面积	Venting Requirement (Nm^3/h)放空要求	Wetted Area[a] (square meters) 润湿面积	Venting Requirement (Nm^3/h) 放空要求
2	608	35	8086
3	913	40	8721
4	1,217	45	9322
5	1,521	50	9895
6	1,825	60	10,971
7	2,130	70	11,971
8	2,434	80	12,911
9	2,738	90	13,801
11	3,347	110	15,461
13	3,955	130	15,751
15	4,563	150	16,532
17	5,172	175	17,416
19	5,780	200	18,220
22	6,217	230	19,102
25	6,684	260	19,910
30	7,411	>260[b]	Ñ

[a] The wetted area of a tank or storage vessel shall be calculated as follows:

a 储罐或储存容器的润湿面积应如下计算：

Sphere and Spheroids——The wetted area is equal to 55 percent of the total surface area or the surface area to a height of 30 feet (9.14 meters) above grade, whichever is greater.

球罐与扁球形罐-润湿面积等于储罐总表面积的 55%或到地上高度为 30 英尺(9.14 米)的那部分储罐表面积（取两者中数值较大的）。

Horizontal Tanks——The wetted area is equal to 75 percent of the total surface area or the surface area to a height of 30 feet (9.14 meters) above grade, whichever is greater.

卧式储罐-润湿面积等于储罐总表面积的 75%或到地上高度为 30 英尺(9.14 米)的那部分储罐表面积（取两者中数值较大的）。

Vertical Tanks ——The wetted area is equal to the total surface area of the vertical shell to a

height of 30 feet (9.14 meters) above grade. For a vertical tank setting on the ground, the area of the ground plates is not to be included as wetted area. For a vertical tank supported above grade, a portion of the area of the bottom is to be included as additional wetted surface. The portion of the bottom area exposed to a fire depends on the diameter and elevation of the tank above grade. Engineering judgment is to be used in evaluating the portion of the area exposed to fire.
立式储罐-润湿面积等于到地上高度为 30 英尺(9.14 米)那部分立式壳体的总表面积。对于安装在地面上的立式储罐，底板面积不包括在润湿面积内；对于立式高架储罐，一部分底面积将作为附加润湿面积包括在内。暴露于火灾的那部分底面积取决于储罐直径和离地高度。在评估暴露于火灾的那部分底面积时，要进行工程计算与判断。
For wetted surfaces larger than 2,800 square feet (260 square meters), see Sections 4.3.3.2.2 and 4.3.3.2.3.
[b] 对于大于 2,800 平方英尺(260 平方米)的润湿表面，见 4.3.3.2.2 和 4.3.3.2.3 部分。

Note:注：
Table 3 and the constants 1107 and 208.2 in Equations 2A and 2B respectively were derived from Equation 1 and Figure B-1 by using the latent heat of vaporization of hexane (144 BTU per pound or 334,900 J/kg) at atmospheric pressure and the molecular weight of hexane (86.17) and assuming a vapor temperature of 60°F(15.6°C). This method will provide results within an acceptable degree of accuracy for many fluids having similar properties (see Appendix B).
表 3 和公式 2A 与 2B 中的常数 1107 与 208.2 分别得自于公式 1 和图 B-1，方法是采用常压下已烷的汽化潜热为 144 BTU/lb(或 334900J/kg)、分子量为 86.17，并且假定其蒸气温度为 60°F(15.6°C)。对于具有相似性质的许多流体，此方法提供的结果精确度是可以接受的（参见附录 B）。

Table 4A—Environmental Factors for Nonrefrigerated Aboveground Tanks
表 4A—不冷却地上储罐的环境因子

A. English Units　　A．英制单位

Tank Design/Configuration 储罐设计/构造	Insulation Conductance (BTU/hr ft °F) 导热系数	Insulation Thickness (in) 绝热层厚度	F Factor F 因子
Bare metal tank 裸金属罐	--	0.0	1.0
Insulated tank[a] 绝热罐[a]	4.0	1.0	0.3[b]
Insulated tank[a] 绝热罐[a]	2.0	2.0	0.15[b]
Insulated tank[a] 绝热罐[a]	1.0	4.0	0.075[b]
Insulated tank[a] 绝热罐[a]	0.67	6.0	0.0375[b]
Insulated tank[a] 绝热罐[a]	0.5	8.0	0.03[b]
Insulated tank[a] 绝热罐[a]	0.4	10.0	0.025[b]
Insulated tank[a] 绝热罐[a]	0.33	12.0	see note c 见注释 c
Concrete tank or fireproofing 混凝土罐或耐火罐	--	--	1.0
Water-application facilities[d] 喷淋设施[d]	--	---	1.0
Underground storage 地下储罐	--	--	0.0
Earth-covered storage above grade 覆土储罐	--	--	0.0
Impoundment away from tand[f] 远离事故存液池的储罐[f]	--	--	0.5

Notes 注释:
[a]The insulation shall resist dislodgment by fire-fighting equipment, shall be noncombustible, and shall not decompose at temperatures up to
1000°F (537.8°C). The user is responsible to determine if the insulation will resist dislodgment by

the available fire-fighting equipment. If the insulation does not meet these criteria, no credit for insulation shall be taken. The conductance values are based on insulation with a thermal conductivity of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness). The user is responsible for determining the actual conductance value of the insulation used. The conservative value of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness) for the thermal conductivity is used.

[a] 绝热层应能承受消防设施重量，应为非可燃物，并且应在 1000°F(537.8°C)不发生分解。用户负责确定绝热层是否可以承受消防设施; 如果绝热层不符合标准, 没有合适的绝热材料可选,可以采用每英寸厚度传热系数 4BTU/hr·ft2(每厘米厚度绝热材料传热系数 9w/m2·℃) 的绝热材料为基准。 用户负责确定所用绝热材料实际导热系数值。 通常选用绝热材料导热系数保守值是每英寸厚度 4BTU/hr·ft2(每厘米厚度绝热材料传热系数 9w/m2·℃).

[b]These F factors are based on the thermal conductance values shown and a temperature differential of 1600°F (888.9°C) when using a heat input value of 21,000 BTU per hour per square foot (66,200 Watts per square meter) in accordance with the conditions assumed in API Recommended Practice 521. When these conditions do not exist, engineering judgment should be used to select a different F factor or to provide other means
for protecting the tank from fire exposure.

[b] 这些 F 因子基于在 API 推荐实例 521 条件下，假定供入 21000BTU/hr·ft2(66,200W/m2)热量，温度变化 1600°F(888.9°C)给出的传热系数值。当实际情况偏离这些条件时，用工程经验判断选择不同的 F 因子，或者提供其他方法来保护储罐暴露在明火中。

[c]Use the F factor for an equivalent conductance value of insulation.

[c] 用 F 因子确定绝热材料当量传热系数。

[d]Under ideal conditions, water films covering the metal surfaces can absorb most incident radiation. The reliability of water application depends
on many factors. Freezing weather, high winds, clogged systems, undependable water supply, and tank surface conditions can prevent uniform water coverage. Because of these uncertainties, no reduction in environmental factors is recommended; however, as stated previously, properly applied water can be very effective.

[d] 在理想条件下，水膜覆盖金属表面可以吸收大部分突发情况的辐射热。消防水的可靠性取决于很多因素。结冰天气，大风，堵塞的系统，不可靠的供水系统，储罐表面条件阻碍水膜形成等。由于这些不确定性，不推荐减小环境因子；但是，就像前面提到的状态，实用的消防水系统是非常有效的。

[e]Depressuring devices may be used, but no credit shall be allowed in sizing the venting device for fire exposure.

[e] 可以设置卸压系统，但是没有规范确定火灾情况下放空系统大小。

[f]The following conditions must be met: A slope of not less than 1 percent away from the tank shall be provided for at least 50 feet (15 meters)
toward the impounding area; the impounding area shall have a capacity that is not less than the capacity of the largest tank that can drain into it;
the drainage system routes from other tanks to their impounding areas shall not seriously expose the tank; and the impounding area for the tank
as well as the impounding areas for the other tanks (whether remote or with dikes around the other tanks) shall be located so that when the area
is filled to capacity, its liquid level is no closer than 50 feet (15 meters) to the tank.

[f] 以下情况必须考虑：应设置至少 50 英尺（15 米）不小于 1%坡度的斜坡到事故存液池；事故存液池容积应不小于最大罐罐容；从其他罐来的排水通道不应暴露在该罐区；和其他罐共用事故存液池（远距离或环绕其他罐区的隔堤）充满液体时，液面离罐的距离不能少于 50 英尺（15 米）。

Table 4B—Environmental Factors for Nonrefrigerated Aboveground Tanks 表 4B—不冷却地上储罐的环境因子			
B. Metric Units B．公制单位			
Tank Design/Configuration 储罐设计/构造	Insulation Conductance (Watts/m^2°K) 导热系数	Insulation Thickness (cm) 绝热层厚度	F Factor F 因子
Bare metal tank 裸金属罐	---	0.0	1.0
Insulated tank[a] 绝热罐[a]	22.7	2.5	0.3[b]
Insulated tank[a] 绝热罐[a]	11.4	5.0	0.15[b]
Insulated tank[a] 绝热罐[a]	5.7	10.0	0.075[b]
Insulated tank[a] 绝热罐[a]	3.80	15.0	0.0375[b]
Insulated tank[a] 绝热罐[a]	2.8	20.0	0.03[b]
Insulated tank[a] 绝热罐[a]	2.3	25.0	0.025[b]
Insulated tank[a] 绝热罐[a]	1.90	30.0	see note c 见注释 c
Concrete tank or fireproofing 混凝土罐或耐火罐	--	--	1.0
Water-application facilities[d] 喷淋设施[d]	--	--	1.0
Underground storage 地下储罐	--	--	0.0
Earth-covered storage above grade 覆土储罐	--	--	0.0
Impoundment away from tand[f] 远离事故存液池的储罐[f]	--	--	0.5

Notes 注释:

[a]The insulation shall resist dislodgment by fire-fighting equipment, shall be noncombustible, and shall not decompose at temperatures up to
1000°F (537.8°C). The user is responsible to determine if the insulation will resist dislodgment by the available fire-fighting equipment. If the insulation does not meet these criteria, no credit for insulation shall be taken. The conductance values are based on insulation with a thermal conductivity of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness). The user is responsible for determining the actual conductance value of the insulation used. The conservative value of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness) for the thermal conductivity is used.

[a]绝热层应能承受消防设施重量，应为非可燃物，并且应在 1000°F (537.8°C)不发生分解。用户负责确定绝热层是否可以承受消防设施；如果绝热层不符合标准，没有合适的绝热材料可选,可以采用每英寸厚度传热系数 4BTU/hr•ft2(每厘米厚度绝热材料传热系数 9w/m2•℃) 的绝热材料为基准。用户负责确定所用绝热材料实际导热系数值。 通常选用绝热材料导热系数保守值是每英寸厚度 4BTU/hr•ft2(每厘米厚度绝热材料传热系数 9w/m2•℃).

[b]These F factors are based on the thermal conductance values shown and a temperature differential of 1600°F (888.9°C) when using a heat input value of 21,000 BTU per hour per square

foot (66,200 Watts per square meter) in accordance with the conditions assumed in API Recommended Practice 521. When these conditions do not exist, engineering judgment should be used to select a different F factor or to provide other means
for protecting the tank from fire exposure.
[b] 这些 F 因子基于在 API 推荐实例 521 条件下，假定供入 21000BTU/hr•ft2(66,200W/m2)热量，温度变化 1600°F(888.9°C)给出的传热系数值。当实际情况偏离这些条件时，用工程经验判断选择不同的 F 因子，或者提供其他方法来保护储罐暴露在明火中。
[c]Use the F factor for an equivalent conductance value of insulation.
[c] 用 F 因子确定绝热材料当量传热系数。
[d]Under ideal conditions, water films covering the metal surfaces can absorb most incident radiation. The reliability of water application depends
on many factors. Freezing weather, high winds, clogged systems, undependable water supply, and tank surface conditions can prevent uniform water coverage. Because of these uncertainties, no reduction in environmental factors is recommended; however, as stated previously, properly applied water can be very effective.
[d] 在理想条件下，水膜覆盖金属表面可以吸收大部分突发情况的辐射热。消防水的可靠性取决于很多因素。结冰天气，大风，堵塞的系统，不可靠的供水系统，储罐表面条件阻碍水膜形成等。由于这些不确定性，不推荐减小环境因子；但是，就像前面提到的状态，实用的消防水系统是非常有效的。
[e]Depressuring devices may be used, but no credit shall be allowed in sizing the venting device for fire exposure.
[e] 可以设置卸压系统，但是没有规范确定火灾情况下放空系统大小。
[f]The following conditions must be met: A slope of not less than 1 percent away from the tank shall be provided for at least 50 feet (15 meters)
toward the impounding area; the impounding area shall have a capacity that is not less than the capacity of the largest tank that can drain into it;
the drainage system routes from other tanks to their impounding areas shall not seriously expose the tank; and the impounding area for the tank
as well as the impounding areas for the other tanks (whether remote or with dikes around the other tanks) shall be located so that when the area
is filled to capacity, its liquid level is no closer than 50 feet (15 meters) to the tank.
[f] 以下情况必须考虑：应设置至少 50 英尺（15 米）不小于 1%坡度的斜坡到事故存液池；事故存液池容积应不小于最大罐罐容；从其他罐来的排水通道不应暴露在该罐区；和其他罐共用事故存液池（远距离或环绕其他罐区的隔堤）充满液体时，液面离罐的距离不能少于 50 英尺（15 米）。

$$SCFH = 1107FA^{0.82} \qquad (2A)$$

Where
式中：
SCFH = venting requirement, in standard cubic feet per hour of air,
SCFH =通风量，标准立方英尺空气/小时。
F = environmental factor from Table 4A. Credit may be taken for only one environmental factor,
F =表 4A 中的环境因子，仅仅是来自环境的一个因素。
A = wetted surface area, in square feet (see Table 3A, Footnote a).
A =湿表面积，每平方英尺（见表 3A 底部注释 a）
Note: Equation 2A is based on
注意：公式 2A 是以下式为基础

$$Q = 21{,}000A^{0.82}$$

Or
或
For Metric Units:
对于公制单位：
.

Wetted Surface Area (square mm) 湿润表面	Design Pressure (barg) 设计压力	Required Venting Capacity (Nm^3/h) 需要通气量
＜260	≤1.034	See Table 3B and 4.3.3.2.3 见表 3B 和 4.3.3.2.3 条
≥260	≤0.07	19910
≥260	Between 0.07 and 1.034	Equation 2B 等式 2B

$$Nm3 / h = 208.2FA^{0.82} \qquad (2B)$$

Where
式中：
Nm3 / h = venting requirement, in normal cubic meters per hour of air,
Nm3 / h =通风量，标准立方米空气/小时
F = environmental factor from Table 4B. Credit
F =表 4B 中的环境因子，仅仅是来自环境的一个因素。
A = wetted surface area, in square meters (see Table 3B, Footnote a).
A =湿表面积，每平方米（见表 3B 底部注释 a）
Note: Equation 2B is based on
注意：公式 2B 是以以下式为基础的：
$Q = 43{,}200A^{0.82}$

The total heat absorbed, Q, is in BTU per hour for Equation 2A and in Watts for Equation 2B. Table 3 and the constants 1107 and 208.2 in Equations 2A and 2B, respectively,were derived from Equation 1A and Figure B-1 by using the latent heat of vaporization of hexane (144 BTU per pound or 335,000 J/kg) at atmospheric pressure and the molecular weight of hexane (86.17) and assuming a vapor temperature of 60°F (15.6°C). This method will provide results within an acceptable degree of accuracy for many fluids having similar properties (see Appendix B).
公式 2A 以 BTU 计的每小时吸收热量和公式 2B 以瓦特计的热量用 Q 表示，表 3 和公式 2A、2B 中的常数 1107、208.2 分别来自公式 1A 和图 B-1，以大气压下己烷（分子量为 86.17）汽化潜热表示（144BTU 每磅或 335，000J/kg），假设汽化温度为 60°F（15.6°C）。这个方法对很多流体可得到可靠得精确度（胶附录 B）。

4.3.3.2.3 The total rate of venting determined from Table 3 may be multiplied by an appropriate environmental factor, F, selected from Table 4, but credit may be taken for only one environmental factor.
4.3.3.2.3 总的通风能力取决于表 3 数据乘以一个适当的表 4 的仅仅来自环境的环境因子。

4.3.3.2.4 Full credit may be taken for the venting capacity provided for normal venting, since the normal thermal effect can be disregarded during a fire. Also, it can be assumed that there will be no liquid movement into the tank.
4.3.3.2.4 可靠性来自正常通风下的通风量，因为通常热效应与火无关，即假设罐体内无流体流动。

4.3.3.2.5 If normal venting devices are inadequate, additional emergency venting devices of the type described in Section 4.4.2 shall be provided so that the total venting capacity is at least equivalent to that required by Table 3 or Equation 1 or 2.
4.3.3.2.5 如果正常通风量不足，就必须添加 4.4.3 描述的额外的通风设备，使的总的通风能力至少等于表 3 或公式 1 或公式 2 要求的量。

4.3.3.2.6 The total venting capacity shall be based on the pressure indicated in Section 4.5.1.
4.3.3.2.6 总的通风能力是以 4.5.1 部分所列要求为基础的。

4.4 MEANS OF VENTING
4.4 通风的含义
4.4.1 Normal Venting

4.4.1 正常通风

Normal venting for pressure and vacuum shall be accomplished by a PV valve or an open vent with or without a flame-arresting device in accordance with the requirements of Sections 4.4.1.1 through 4.4.1.5. Relief devices equipped with a weight and lever are not recommended.

正常通风的压力和真空度取决于设备的设计值，或者一个开放箱体内或外部压力与 4 .4.1.1 到 4.4.1.5 部分的设备的是一致的。

4.4.1.1 Any relief device, shall be designed so that it will protect the tank in the event of failure of any essential part.

4.4.1.1 应该设计减压装置，以防万一任何一个微小部分损坏。

4.4.1.2 PV valves are recommended for use on atmospheric storage tanks in which petroleum or petroleum products with a flash point below 100°F (37.8°C) are stored and for use on tanks containing petroleum or petroleum products where the fluid temperature may exceed the flash point. A flame arrester is not considered necessary for use in conjunction with a PV valve venting to atmosphere because flame speeds are less than vapor velocities across the seats of PV valves (see API Publication 2210).

4.4.1.2 推荐设备的设计值可用于常压贮存低于其闪点 100F（37.8C）和低于其闪点的石油或石油产品，用于连接具有设计值的推荐设备和大气的管路不必考虑装设火焰清除器，因为火焰速度低于蒸气流过具有设计值设备的速度。

4.4.1.3 Open vents with a flame-arresting device may be used in place of PV valves on tanks in which petroleum or petroleum products with a flash point below 100°F (37.8°C) are stored and on tanks containing petroleum and petroleum products where the fluid storage temperature may exceed the flash point.

4.4.1.3 火焰清除器可用于具有设计值的闪点低于 100°F (37.8°C)和温度有可能高于闪点石油或石油产品贮罐。

4.4.1.4 Open vents without flame arresters may be used to provide venting capacity for any of the following:

4.4.1.4 开放箱体的火焰清除器应能提供下列的通风能力：

a. For tanks in which petroleum or petroleum products with a flash point of 100°F (37.8°C) or above are stored, provided the contents are not heated and the fluid temperature remains below the flash point.

a.贮存闪点等于或高于 100°F (37.8°C)的石油或石油产品箱体，通风量足够并且流体温度低于闪点。

b. For heated tanks in which the storage temperature of the petroleum and petroleum products is below the flash point.

b. 贮存石油或石油产品的热箱体温度要低于其闪点。

c. For tanks with a capacity of less than 59.5 barrels (9.46 cubic meters) [2,500 US gallons (9,460 liters)] used for storing any product.

c.对于容量小于 59.5 桶(9.46 立方米) [2,500 美国加仑(9,460 升)]的箱体。

d. For tanks with a capacity of less than 3,000 barrels (477 cubic meters) [126,000 US gallons (477,000 liters)] used for storing crude oil.

d. 对于容量小于 3,000 桶((477 立方米) [126,000 美国加仑(477,000 升)]的原油箱体。

4.4.1.5 In the case of viscous oils, such as cutback and penetration-grade asphalts, where the danger of tank collapse resulting from sticking pallets or from plugging of flame arresters is greater than the possibility of flame transmission into the tank, open vents may be used as an exception to the requirements of Sections 4.4.1.2 and 4.4.1.3 for PV valves or flame-arresting devices.

4.4.1.5 当储存粘性油品（如稀释沥青或针入度等级沥青）时，由于阀盘粘连或阻火器堵塞而导致瘪罐的危险大于火焰传入储罐的可能性时，作为 4.4.1.2 节和 4.4.1.3 节中有关呼吸阀或阻火器要求的一个特例，可以采用开口通气管。

4.4.1.6 A discussion of the types and operating characteristics of venting devices can be found in Appendix C.

4.4.1.6 附录 C 中讨论了通气装置的类型与操作特性。

4.4.1.7 In areas with strict fugitive emissions regulations, open vents may not be acceptable and vent device selection should consider maximum leakage requirements during periods of normal tank operation.

4.4.1.7 在严格管制无组织排放的区域，可能不许用开口通气管，选择通气装置时应考虑储罐正常操作期间的最大泄漏要求。

4.4.2 Emergency Venting 紧急通气

Emergency venting may be accomplished by the use of the following:

可以采用以下方法进行紧急通气：

a. Larger or additional open vents as limited by Sections 4.4.1.2 and 4.4.1.3.

a 采用比 4.4.1.2 节和 4.4.1.3 节中所限更大的开口通气管或增设开口通气管。

b. Larger or additional PV valves.

b 呼吸阀改大或增加。

c. A gauge hatch that permits the cover to lift under abnormal internal pressure.

c 当内压异常时，量油口允许盖打开。

d. A manhole cover that lifts when exposed to abnormal internal pressure.

d 在内压异常的情况下，人孔盖打开。

e. A connection between the roof and the shell that is weaker than the weakest vertical joint in the shell or the shell-to-bottom connection.

e 顶-壳连接比壳的最弱立板连接或者壳-底连接还弱。

Note: A tank with a frangible roof-to-shell attachment, as described in API Standard 650, does not require emergency venting devices. Care should be taken to ensure that the requirements for a frangible roof-to-shell attachment are met, particularly on a smaller tank, before this method of emergency venting is used.

注释：按 API Std 650 中所述，顶-壳弱连接的储罐不要求紧急通气装置。但在采用这种紧急通气方法之前，应注意确保达到顶-壳弱连接的要求，特别是小型罐。

f. Other forms of construction that can be proven to be comparable for the purposes of pressure relief.

f 经证明能达到泄压目的的其他结构形式。

g. A rupture disk device.

g 爆破片。

4.5 SELECTION, INSTALLATION, AND MAINTENANCE OF VENTING DEVICES

4.5 通气装置的选择、安装与维护

4.5.1 Total Venting Requirements 通气总要求量

4.5.1.1 Pressure 压力

4.5.1.1.1 The pressure relief device or emergency venting device shall be suitable to relieve the flow capacity required for the largest single contingency or any reasonable and probable combination of contingencies; however, the required capacity may be reduced for products whose volatility is such that vapor condensation within the permissible operating range of tank pressure will provide all or part of the venting requirements. In cases in which noncondensables are present, this should be taken into account.

4.5.1.1.1 泄压装置或紧急通气装置应能适于排放最大单次意外事故要求的流量，或多次意外事故可能的合理组合所要求的流量。然而，要求能力对某些产品可能会降低，这些产品的挥发性应是：在允许的储罐操作压力范围内其蒸气冷凝将提供全部或部分通气要求量。当有不凝物存在时，应考虑这点。

4.5.1.1.2 Consultation between the tank designer, the person specifying the venting devices, and the venting device manufacturer is strongly recommended to ensure that the venting devices are compatible with the tank design. The set or start-to-open pressure often must be lower than the design pressure of the tank to allow for adequate flow capacity of the devices. The operating pressure should be lower than the set pressure to allow for normal variations in pressure caused by changes in temperature and by other factors that affect pressure in the tank vapor space. The set pressure and relieving pressure must be consistent with the requirements of the standard according to which the tank was designed and fabricated. Some standards present specific requirements, but others may not.

4.5.1.1.2 强烈建议储罐设计者、规定通气装置的人员和通气装置制造商之间进行协商，以确保通气装置和储罐设计相符。通气装置的设定压力和开启压力必须小于储罐的设计压力，以保证装置有足够的流量。操作压力应低于设定压力，以便当温度变化或其他因素影响罐内气相空间压力时，使罐压能在正常范围内波动。设定压力和泄放压力必须与储罐设计和制造的标准要求相符。有些标准提出了具体要求，有些标准可能没有。

4.5.1.1.3 Requirements for pressure relieving devices for tanks that are designed and fabricated in accordance with API Standard 620 are provided in Section 6 of API Standard 620. The pressure setting of a pressure-relieving device shall not exceed the maximum pressure that can exist at the level where the device is located when the pressure at the top of the tank equals the nominal pressure rating for the tank and the liquid contained in the tank is at the maximum design level.

4.5.1.1.3 按照 API Std 620 设计和制造的储罐泄压装置要求见 API Std 620 第 6 章。当罐顶压力等于罐的公称压力并且罐内液位在最高设计液位时，泄压装置的设定压力不得超过它所.处位置的最大压力。

Under normal conditions, pressure-relieving devices must have sufficient flow capacity to prevent the pressure from rising more than 10 percent above the maximum allowable working pressure. Under fire emergency conditions, the devices shall be capable of preventing the pressure from rising more than 20 percent above the maximum allowable working pressure.

在正常条件下，泄压装置必须有足够的流量，以防止工作压力超出最大允许工作压力 10%以上，在火灾紧急情况下，泄压装置应能防止压力超出最大允许工作压力 20%以上。

4.5.1.1.4 API Standard 650 is not as definitive as API Standard 620 in presenting venting requirements. Appendix F of API Standard 650 states that the pressure relief devices for tanks designed for low internal pressures shall be sized and set so that at the rated capacity of the devices, the internal pressure of each tank under any normal operating condition shall not exceed the internal design pressure or the maximum design pressure. These pressures are defined specifically in Appendix F of API Standard 650.

4.5.1.1.4 API Std 650 没有像 API RP 520 那样明确地提出通气要求。API Std 650 的附录 F 规定低压储罐泄压装置的尺寸及设定压力应设计成：在泄压装置的额定排量下，正常操作条件下每台储罐的内压不得超过设计内压或最大设计压力。这些压力在 API Std 650 附录 F 中有明确的规定。

For other API Standard 650 tanks, the pressure relief devices selected should limit the pressure in the tanks to prevent excessive lifting and flexing of the roofs of the tanks. Lifting and flexing of the roof of a tank is a condition that is determined by the weight of the roof. The total force caused by internal pressure should not exceed the weight of the roof and attachments, such as platforms and handrails. For example, the pressure should be limited to approximately 1.4 inches of water column (3.5 mbarg) for a 3/16 inch (4.76 mm) carbon steel roof.

对于其它 API Std 650 储罐，选定的泄压装置应限制罐内压力，以防止罐顶过度升起与弯曲。罐顶升起或弯曲由罐顶重量决定。由内压产生的总力不得超过罐顶加上附件(如平台和扶手)的重量。例如，4.76mm(3/16in)厚碳钢罐顶的压力应限制在大约 1.4in 水柱(3.5mbarg)。

4.5.1.2 Vacuum 真空

A vacuum relief device shall be installed to permit the entry of air,or another gas or vapor,to avoide xcessive vacuum that may result; however,the required capacity may be reduced for products whose volatility is such that vapor generation within the permissible operating range of tank pressure will provide all or part of the venting requirements. In cases in which noncondensables are present, this should be taken into account.

应安装一个真空泄放装置以便空气、其他气体或蒸汽进入罐内,防止真空过低；但如果在储罐容许操作压力范围内产品挥发而产生的蒸气能提供全部或部分通气要求量，则该产品所需的泄放能力可以减少。当存在不凝物时，要考虑这点。

The vacuum relief device shall be suitable to relieve the flow capacity required for the largest single contingency or any reasonable and probable combination of contingencies. It is permissible to reduce the requirement for vacuum relief capacity by the rate of vaporization that results from minimum normal heat gain to the contents.A gas-repressuring line with a suitable control and source of gas may be provided toavoid drawing air into the tank.The design of a gas re-pressuringsystem to eliminate the requirement for vacuum relief valves beyond the scope of this standard and should be considered only when the induction of air represents a hazard equal to or greater than failure of the tank.

真空泄放装置应能泄放最大单次意外事故或多次意外事故可能合理组合所要求的流量。允许根据罐内物料最低正常得热而产生的汽化量来降低真空泄放能力要求。可能要配备一根带适当控制和气源的气体加压管线，以免把空气抽入罐内。设计一个气体加压系统来消除对真空泄放阀的要求不在本标准范围之内，只有当空气进入产生的危害等于或大于储罐故障时，才考虑设计此系统。

In general, the set and relieving pressures for vacuum relief are established to prevent damage to a tank and must limit vacuum to a level no greater than that fo rwhich a tank has been designed. The vacuum relieving devices of a tank shall be set to open at a pressure or vacuum that will ensure that the vacuum in thetank will not exceed the vacuum for which the tank has been designed when the inflow of air through the devices is at its maximum specified rate.

一般来说，确定真空泄放阀的设定和泄放压力是为了防止储罐损坏，并且储罐真空度必须限制在不大于其设计值。当空气以其最大设计速率进入储罐时，储罐的真空泄压装置应在设置的真空或压力下开启，以确保罐内真空度不超过其设计真空度。

4.5.2 Installation of Pressure and Vacuum Relief Devices：

4.5.2 压力和真空泄放装置的安装：

Pressure and vacuum relief devices shall be installed to:

安装压力和真空泄放装置应：

A. Provide direct communication with the vapor space and not be sealed off by he liquid contents of the tank.

A：直接与气相空间连通，且不被罐内液体封住。

B：Protect the tank from the closure of a block valve or valves installed between the tank and the pressure or vacuum relief device or between the pressure or vacuum relief device and the discharge outlet. This may be done by locking or sealing the block valves open without installing excess relief capacity or by providing excess pressure or vacuum relief capacity with multiple -way valves, interlocked valves, or sealed block valves arranged so that isolating one pressure or vacuum elief device will not reduce the remaining relief capacity below the required relief capacity.

B：切断阀或安装在储罐与压力或真空泄压装置之间的阀门、安装在压力或真空泄压装置与排放口之间的阀门关闭时，能够保护储罐。可通过以下方法进行：把切断阀锁定或封闭在打开位置，而不安装过量的泄放能力；或通过配备多路阀、联锁阀或密封切断阀提供过量的压力或真空泄放能力，这样切断一个压力或真空泄放装置后不会使余下的排放能力降到要求的泄放能力之下。

C:Ensure that the inlet and outlet assemblies, including any block valves, will permit the relief device to provide the required flow capacity. Inlet pressure losses developed during relief conditions must be taken into account when sizing the pressure and vacuum relief devices. The inlet pipe penetration into the vessel, the pressure drop across any block valves used. upstream of the venting device, and the inlet piping must be considered when determining these losses.

C：确保入口/出口组件（包括所有切断阀）都能使泄放装置提供所需的流量。在对压力和真空泄放装置选型时，必须要考虑泄放情况下形成的入口压力损失。在确定这些损失时，进入容器的入口管、通气装置上游所用的切断阀压降以及入口管线都必须考虑。

4.5.3 Discharge Piping：排放管：

4.5.3.1 Discharge piping from the relief devices or common discharge headers shall be installed to:
安装压力和真空泄放装置的排放管或公用的排放总管应：

a. Lead to a safe location.
a：引到一个安全的地点；

b. Be protected against mechanical damage.
b：加以保护，防止机械损坏；

c. Exclude or remove atmospheric moisture and condensate from the relief devices and associated piping. This may be done by the use of loose-fitting rain caps or drains, but an accounting must be made of the pressure loss effects of these items. Drains, if provided, shall be installed to prevent possible flame impingement on the tanks, piping, equipment, and structures.
c：可以用松配合的防雨帽或排水沟来除去泄放装置和相关管线上的水分与冷凝液， 但是必须核算这几项的压力损失影响。如果有排水沟，其安装应防止对储罐、管道、设备和结构件产生火焰冲击。

d. Discharge in areas that(1) will prevent flame impingement on personnel,tanks, piping, equipment, and structures, and (2) will prevent vapor entry into enclosed spaces.
d：排放区应(1)防止对人员、储罐、管道、设备和结构件产生火焰冲击，（2）防止蒸气进入封闭空间。

e. Prevent air from recirculating into the valve body during relief conditions to prevent ice from forming when the relief temperature is below 32°F (0°C).
e：当泄放温度低于 32°F (0°C)时，防止泄放条件下空气再循环进入阀体，以免结冰。

f. Prevent vapor from the tank from freezing.
f：防止储罐蒸气冻结。

4.5.3.2 When a tank is located inside a building, the tank's venting devices shall discharge to the outside of the building. A weak roof-to-shell connection shall not be used as a means for emergency venting a tank inside a building.
4.5.3.2 当罐子位于建筑内时，储罐通气装置应向建筑物外排放。顶-壳弱连接不得用作建筑物内储罐的紧急通气方法。

4.5.3.3 Relief device discharge lines from one or more tanks may be connected to a common discharge header, provided the header complies with the other provisions of this paragraph. Liquid traps that can introduce sufficient back pressure to prevent relief devices from functioning properly shall be avoided. Other vents, drains, bleeders, and relief devices shall not be tied into the common discharge header if back pressures be developed that prevent the relief devices on the tank from functioning properly. Back pressures developed during relief conditions must be taken into account when sizing the discharge header, sizing the relief devices, and compensating the set pressure of unbalanced relief devices (see API Recommended Practice 521).
4.5.3.3：只要排放总管遵守本章节的其他规定，一个或几个储罐的泄压装置出口管线可以接到一个共用的排放总管。应避免使用集液器，因为它会产生过多背压阻止泄放装置正常运行。如果形成的背压阻止罐上减压泄放装置正常运行，则其他的放空口、排凝口、放液阀和泄放装置不得连到共用的排放总管。在排放总管选型、泄放装置选型以及补偿非平衡泄压装置设定压力时，应考虑泄放期间形成的背压（见 API 推荐规程 Std 521）。

4.5.4 Set Pressure Verification.
4.5.4 设定压力的校验

The set pressure of all pressure and vacuum relief devices should be verified by testing before the devices are placed in operation.
所有压力和真空泄放装置在投入使用前，应通过实验对其设定压力进行校验。

4.5.5 Materials of Construction Materials for a relief device and its associated piping shall be selected for the stored-product service temperatures and pressures at which the device and its piping are intended to operate. Also, the materials should be compatible with the product stored in the tank and with any products formed in the vicinity of the relief device during discharge.
4.5.5 结构材料：泄放装置及其相关管线的结构材料选择，应能确保在储存产品工作温度和压力下该

装置及其相关管线可以运行。另外， 材料应和罐内产品相容，也应和排放时泄放装置附近形成的所有产物相容。

4.5.6 Maintenance

4.5.6 维护

For recommended maintenance and inspection procedures, see API Bulletin 2521 and API Recommended Practice 576.
推荐的维护与检查程序，参见 API 公告 2521 与 API 推荐操作规程 576。

4.6 TESTING AND MARKING OF VENTING DEVICES

4.6 通气装置的测试与标记

4.6.1 Testing of Venting Devices

4.6.1 通气装置的测试

4.6.1.1 Determination of Capacity

4.6.1.1 能力的确定

The capacity of venting devices shall be established by the test methods described in Sections 4.6.1.1.1, 4.6.1.1.2, or 4.6.1.1.3 or by the calculation method described in 4.6.1.1.4. For the test methods described in, Sections 4.6.1.1.1, 4.6.1.1.2, and 4.6.1.1.3,the testing facilities, methods, and procedures and the person supervising the tests shall meet the applicable requirements described in this paragraph (4.6.1) and in ASME PTC 25; if there is a conflict, the requirements in this paragraph shall govern.
通气装置能力应通过 4.6.1.1.1、4.6.1.1.2 或 4.6.1.1.3 部分中所述的测试方法,或者 4.6.1.1.4 中所述的计算方法进行确定。对于.6.1.1.1、 4.6.1.1.2 和 4.6.1.1.3 部分中所述的测试方法，其测试设施、方法、程序及测试的人员监督应满足本段（4.6.1）和 ASME PTC 25 中描述的适用要求。
The test report shall describe how the venting device was mounted and tested as well as describe the inlet and outlet piping. If any fluid other than air is used in the test, the name of the fluid actually used along with the fluid's temperature and its specific gravity at standard conditions shall be noted on the test report.
测试报告应对通气装置的安装与测试以及进出口管线进行描述。如果测试中使用的不是空气而是任何流体，应在测试报告中对实际所使用的流体名称及其在标准状态下的温度和比重进行说明。

4.6.1.2 Coefficient of Discharge Method: Specific Design of Three or More Sizes

4.6.1.2 排放系数法：三种或三种以上尺寸的具体设计

For a specific design with geometrically similar flow paths, a coefficient of discharge may be established for the line of venting devices by using the following procedure.
对于带有几何类似流程的具体设计，可以使用下列程序确定通气装置管道的排放系数。
At least three devices for each of three different sizes (a total of nine devices) shall be tested, each at a different pres- sure. At least one of the test pressures shall be the minimum design pressure or vacuum for the design, and one of the test pressures shall be the maximum design pressure or vacuum. The other test pressures shall be evenly distributed between the minimum and maximum design pressures. All of the test pressures shall be those where lift of the seat disk is sufficient for the nozzle to control the flow or where the seat disk lifts to a fixed stop.
三种不同类型尺寸，每种应至少测试三台装置（共九台装置），每种测试压力不应相同。应至少有一种测试压力为最小设计压力或者设计的真空，并且有一种测试压力为最大设计压力或真空。其他测试压力应在最大与最小设计压力之间平均分布。所有的测试压力均应能够提升阀座使管口控制流量，或者将阀座提升到固定高度。
The coefficient of discharge for each test shall be determined by Equation 3:
每种测试的排放系数应由方程 3 确定。

$$K = \frac{\text{Actual Flow (实际流量)}}{\text{Theoretical Flow (理论流量)}} \qquad (3)$$

Where

此处
K=coefficient of discharge of the device.
K=装置的排放系数
Theoretical flow shall be determined by:
理论流量的确定由：
A. English Units
A. 英制单位

$$SCFH = 278{,}700\ P_1 A \sqrt{\frac{k}{MTZ(k-1)}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{k}} - \left(\frac{P_2}{P_1}\right)^{\frac{k+1}{k}}\right]} \quad (4A)$$

Where
此处
SCFH = theoretical flow rate, in standard cubic feet per hour of test medium (typically air),
SCFH =理论流量，以测试介质（典型为空气）的标准立方英尺每小时计算，
A = minimum flow area of device, in square inches,
A =装置的最小流动面积，以平方英寸计算，
*P*1 = pressure at device inlet, in pounds per square inch absolute,
*P*1 =装置入口压力，以磅每平方英尺绝对压力计算，
*P*2 = pressure at device outlet, in pounds per square inch absolute,
*P*2 =装置出口压力，以磅每平方英尺绝对压力计算，
k = ratio of specific heats of test medium,
k =测试介质的比热比，
T = absolute temperature at device inlet(°F + 460),
T =装置入口绝对温度(°F + 460),
M = molecular weight of test medium,
M =测试介质的分子量
Z = compressibility factor, evaluated at inlet conditions(if unknown, use *Z* = 1.0).
Z =压缩因数，入口条件下求得的值（如果未知，使用 Z=1.0）

B. Metric Units
B. 公制单位

$$Nm^3/h = 12{,}503 P_1 A \sqrt{\frac{k}{MTZ(k-1)}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{k}} - \left(\frac{P_2}{P_1}\right)^{\frac{k+1}{k}}\right]} \quad (4B)$$

Where
此处
*Nm*3 / *h* = theoretical flow rate, in normal cubic meters per hour of test medium (typically air),
*Nm*3 / *h* =理论流量，以测试介质（典型为空气）的标准立方米每小时计算
A = minimum flow area of device, in square centimeters,
A =装置最小流动面积，以平方厘米计算
*P*1 = pressure at device inlet, in bar absolute,
*P*1 =装置入口压力，以绝对压力计算
*P*2 = pressure at device outlet, in bar absolute,
*P*2 =装置出口压力，以绝对压力计算
k = ratio of specific heats of test medium,
k =测试介质的比热比
T = absolute temperature at device inlet (°K)，
T =装置入口的绝对温度

M = molecular weight of test medium,
M =测试介质的分子量
Z = compressibility factor, evaluated at inlet conditions(if unknown, use *Z* = 1.0).
Z =压缩因数，入口条件下求得的值（如果未知，使用 Z=1.0）

A best fit curve of the coefficient of discharge of the devices tested versus the absolute pressure ratio across each device shall be plotted. All measured coefficients shall fall within ±5 percent of the curve (see Figure 1). The flow capacity for any pressure within the test pressure range shall be calculated by multiplying the theoretical flow for that pressure ratio by 95 percent of the corresponding coefficient of discharge for that pressure ratio as determined by the best fit curve.
绘制所测装置排放系数与每个装置绝对压力比的最合适曲线图。所有测得的系数均应在曲线±5%范围内（见图表 1）。测试压力范围内的任何压力对应的流量计算，应通过将此压力比的理论流量，乘以由最合适曲线确定的此压力比所对应排放系数的 95%得出。

All measured coefficients shall fall within ±5 percent of the curve (see Figure 1). The flow capacity for any pressure within the test pressure range shall be calculated by multiplying the theoretical flow for that pressure ratio by 95 percent of the corresponding coefficient of discharge for that pressure ratio as determined by the best fit curve.
所有的测试的系数误差都应该在正负 5%之间（见图 1）。在测试压力范围内的任意压力下的流量都应乘以理论流速，因为 95%协同卸料系数符合该种压力下的最佳拟合曲线。

4.6.1.2.1 Coefficient of Discharge Method: Individual Valve Method
4.6.1.2.1 卸料系数法：独立阀门法

A coefficient of discharge may be established for each size of device by using the following procedure.
按照以下步骤，可对每一种尺寸的装置实施卸料系数法。

Four devices for each combination of pipe size and orifice size shall be tested, each at a different pressure. At least one of the test pressures shall be the minimum design pressure or vacuum, and one of the test pressures shall be the maximum design pressure or vacuum. The other test pressures shall be
evenly distributed between the minimum and maximum design pressures. All of the test pressures shall be those where lift of the seat disk is sufficient for the nozzle to control the flow or where the seat disk lifts to a fixed stop.
在不同的压力下，4 台设备的每一个连接部分的管口尺寸和孔口尺寸都需要进行测试。测试压力至少一种需选择最小设计压力或者真空，一种为最大设计压力或真空。其他设计压力需在最大和最小设计压力之间平均分布。所有的测试压力应在阀座的抬起高度可以满足喷嘴来控制流动或是阀座的提升高度是固定的情况下。

The coefficient of discharge for each device shall be determined as described in Section 4.6.1.1.1. A best fit curve of the coefficient of discharge of the devices tested versus the absolute pressure ratio across each device shall be plotted. All measured coefficients shall fall within ±5 percent of the curve. The flow capacity for any pressure within the test pressure range shall be calculated by multiplying the theoretical flow described in Section 4.6.1.1.1 for that pressure by 95 percent of the corresponding coefficient of discharge for that pressure ratio as determined by the best fit curve.
每台设备的卸料系数需满足 4.6.1.1.1 中的要求。设备的卸料系数测试拟合曲线应该与绝对压力成比例。所有的测试系数应在正负 5%之间。在测试压力范围内的任意压力下的流量都应 4.6.1.1.1 中的理论流速，因为 95%协同卸料系数符合该种压力下的最佳拟合曲线。

4.6.1.2.2 Flow Capacity Method: Specific Design Type
4.6.1.2.2 流量法：特殊设计类型

For a specific design type, at least one production venting device of every size shall be flow tested. Each venting device shall be set at its minimum design pressure or vacuum, and flow measurements shall be made at sufficient increments above set pressure or vacuum to establish a flow capacity
curve. These measurements shall be made at pressures in the vicinity of the opening points, particularly at 1.10, 1.20, 1.50, and 2.0 times the opening pressure and 1.50 and 2.0 times the opening point on vacuum, to establish the flow capacity at these points. In addition, the flow capacity shall be measured
where lift of the seat disk is just sufficient for the nozzle to control the flow or where the seat disk lifts

to a fixed stop. This data may also be used to establish a flow capacity curve for set pressures or vacuums greater than the maximum pressure tested, provided it can be demonstrated that the extrapolation of the data is valid.

对于特殊的设计类型，至少一个产品的的每一个型号的防空设备都需要流量测试。每一个放空设备都需要选择在其最小设计压力或真空的情况下，流量的测试应在设计压力或真空条件下留有余量用以确定流量曲线。这些测试应在开启点附件的压力进行，特别是在开启压力的 1.10 倍，1.20 倍，1.50 倍和 2.0 倍，和真空开启点的 1.50 倍和 2.0 倍时，进而测定在这些点的流量。同时，流量测试还应该在阀座提升高度刚好满足管口控制流量的情况下或者阀座提升高度是固定的情况下。这些数据表可以用来确定在设计压力或真空高于最大压力试验时的流量曲线。也用来论证外推数据的准确性。

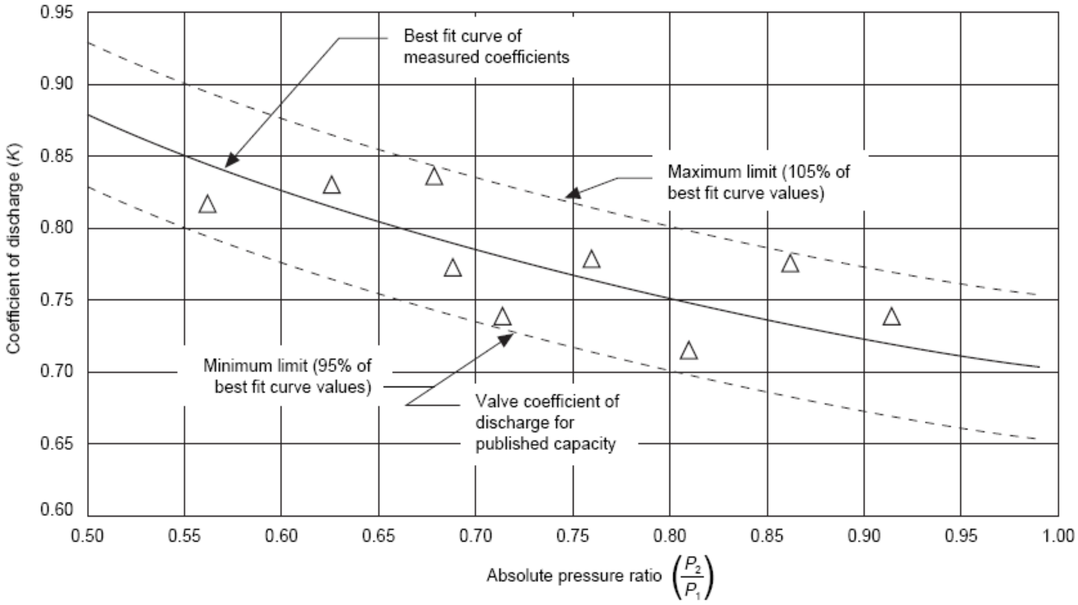

Figure 1—Typical Ratio Limits for Capacity Testing of Venting Devices Using the Coefficient of Discharge Method

图 1—放空设备卸料系数法能力测试的典型比例限定图

4.6.1.2.3 Calculation Method: Manhole Covers 计算方式：人孔盖板

The flow capacity for any pressure in which full lift of a manhole cover occurs can be calculated by multiplying the theoretical flow described in Section 4.6.1.1.1 by 0.5.

对于在任何压力下能够完全提起人孔盖板的流量,可以用 4.6.1.1.1 部分所述的理论流量乘以 0.5 来计算。

4.6.1.3 Test Tank 测试罐

4.6.1.3.1 The test tank shall be constructed to prevent high velocity jets from impinging on the venting device.

测试罐的结构应能防止通气装置对其产生的高速冲击。

4.6.1.3.2 Pulsations in the test medium supply shall be dampened to avoid errors in flow metering.

测试介质的供给应避免脉动，以免流量计量出。

4.6.1.4 Mounting of the Venting Device for Testing 测试时通气装置的安装

4.6.1.4.1 To minimize the effect of entrance losses, the venting device shall be mounted on the top of the test tank at a location near the center of an area that is essentially flat. The flat area shall have a diameter at least five times greater than the nominal diameter of the device tested.

为减少入口损失,通气装置应安装在测试罐顶部靠近中心的一个基本平坦的区域.此平坦区域的直径应当至少为被测试装置公称直径的五倍。

4.6.1.4.2 The venting device shall be mounted for testing on a straight-pipe nipple that has the same nominal diameter as the venting device and a length 1.5 times the nominal pipe size. The pipe nipple shall squarely enter the top of the test tank near the center of the flat portion, with the end of the nipple machined to an angle of 90 degrees with the axis and flush with the inside of the tank. Rounding of the entrance edge shall not exceed a radius of 0.031 inch (0.80 millimeter).

测试时，通气装置应当安装在和通气装置具有相同公称直径的直管短节上。此短节的长度为管道公称直径的 1.5 倍。此管道短节应垂直进入测试罐顶部并且靠近平坦区域中心，短节端头应机加工成与轴线成 90 度角并且与罐内壁平齐。进口边角倒圆，半径不超出 0.031 英寸(0.80 毫米)。

4.6.1.5 Flow Metering 流量的计量

4.6.1.5.1 Air or another suitable gas shall be employed in testing the venting device.

应采用空气或其他合适的气体来测试通气装置。

4.6.1.5.2 The air or gas flow shall be measured in accordance with ASME PTC 19.5.

应按照 ASME PTC19.5 来测量空气或气体的流。

4.6.1.6 Capacity Data 通气能力数据

4.6.1.6.1 The capacity data shall be presented in the form of curves or tables that give the volume of flow through the venting device versus pressure or vacuum at the tank connection. The data should indicate the pressure or vacuum at which lift of the seat disk is sufficient for flow through the venting device to be controlled by the nozzle or where the seat disk lifts to a fixed stop. The data should indicate the pressure or vacuum where the venting device closes. The capacity for a pilot-operated venting device that opens fully at set pressure or vacuum may be expressed as a coefficient that is the ratio of the flow of the venting device to the flow of a theoretically perfect device with the same minimum flow area.

通气能力应使用曲线或者表格的方式来表示，给出通过通气装置的流量与储罐连接处的压力或真空度之间的关系。此数据应能指明：在多大的压力或者真空度下，由管嘴控制的流量在通过通气装置时足以提起阀盘，或者会使阀盘升到一个固定停止位。此数据还应能显示通气装置关闭时的压力或真空度。对于在设定压力或真空度下全开的先导式通气阀，其通气能力可用一个系数来表示，此系数为在相同的最小流通面积条件下,通气装置的流量与理想装置的流量之比。

4.6.1.6.2 The capacity shall be expressed in terms of SCFH at 60°F, or Nm3/h at 0°C, of air.

通气能力应用 60 华氏度时标准立方英尺每小时或者零摄氏度时标称立方米每小时的空气来表示。

4.6.1.6.3 Pressures shall be expressed in ounces per square inch, psig, inches of water, mbarg, barg, or millimeters of water.

压力应用盎司每平方英寸、帕斯卡每平方英寸(表压)、英寸水柱、毫巴、巴、或者毫米水柱来表示。

4.6.2 Marking of Venting Devices 通气装置的标记

Each venting device shall be plainly marked by the manufacturer with the required data so that the marking will not be obliterated in service. The marking may be placed on the device or on a plate or plates securely fastened to the device. The required data may be stamped onto, etched in, impressed on, or cast in the device or nameplate.Although additional units may be shown, the marking shall, as a minimum, include the following:

每个通气装置均应由制造商在其上标出所要求的数据，此标志应清晰可见并在使用中不会被抹掉.可直接在通气装置或板上进行标记,或者在固定于装置的金属牌上进行标记。相关数据可压印、蚀刻、铭刻或者铸在通气装置或其铭牌上。 可能标志上会包含其他内容,但是以下几点必须标上:

a. The name or identifying trademark of the manufacturer. 制造商的名称或者识别商标

b. The manufacturer's design or type number. 制造商的设计或类型编号

c. The pipe size of the device inlet. 该装置的入口管径

d. The set pressure and/or vacuum, where applicable, shall be expressed in the units of measure specified in Section 4.6.1.6.3.

设定压力和/或真空度（如适用）用 4.6.1.6.3 节中规定的量度单位表示)。

e. The rated capacity of air at the indicated relieving pressure in SCFH at 60°F or in Nm3/h at 0°C.

指定泄放压力下的空气额定排量，单位为 SCFH @60°F 或 Nm3/h@0°C。

f. The relieving pressure and/or vacuum, in the units of measure specified in 4.6.1.6.3.

泄放压力和/或真空度，用.6.1.6.3 中规定的量度单位来表示。

5 Refrigerated Aboveground and Belowground Tanks 地上或地下低温储罐

5.1 GENERAL 概述

This section covers the normal and emergency vapor venting requirements for refrigerated liquid petroleum products storage tanks designed for operation at pressures from vacuum through 15 pounds per square inch gauge (1.034 barg). A refrigerated liquid petroleum products storage tank may be the inner tank of a double-roof, double-wall tank; a double- wall tank with a suspended deck; or a single-wall tank with or without a suspended deck. Discussed in this section are the causes of overpressure or vacuum; determination of venting requirements; means of venting; selection, installation, and maintenance of venting devices; and testing and marking of relief devices.

此部分包括低温液态石油产品储罐的正常及紧急通气要求，设计操作压力是从真空到 15 磅/平方英寸(1.034 巴表压)。低温液态石油产品储罐可以是双顶双壁型储罐的内罐,也可以是浮顶双壁罐,或者是不带浮顶的单壁罐。本节讨论了产生过压或真空的原因、确定通气要求、通气方法、通气装置的选择、安装和维护以及泄压装置的测试和标记。

5.2 CAUSES OF OVERPRESSURE OR VACUUM 过压或真空的原因

5.2.1 General 概述

When the possible causes of overpressure or vacuum in a refrigerated tank are being determined, the following circum- stances must be considered:

在确定低温罐产生过压或真空的可能原因时，必须考虑以下几种情况:

a. Liquid movement into or out of the tank. 液体进出储罐

b. Weather changes (e.g., temperature and pressure changes). 气候变化(如温度和气压变化)

c. Fire exposure. 暴露于火源

d. Other circumstances resulting from equipment failures and operating errors.

设备故障和操作错误导致的其它情况。

Some of these circumstances are described more fully in Sections 5.2.2 through 5.2.5. There may be additional circumstances that should be considered and evaluated by the designer but are not included in this standard.

这些情况有些在 5.2.2~5.2.5 节进行了详述。可能还有一些设计者应考虑评价的其它情况，但不包括在本标准之内。

5.2.2 Liquid Movement Into or Out of a Tank

5.2.2 液体进出储罐

Inbreathing may result from the outflow of liquid or vapor from a tank. Outbreathing may result from the inflow of liquid into a tank and from the vaporization, including flashing of the feed liquid, that will occur because of the inflow of the liquid.

液体或蒸气从储罐流出有可能导致吸入。液体流入储罐和汽化（包括进料液体的闪蒸）会导致呼出。

Flashing of the feed liquid can be significant for feed that is near or above its boiling point at the pressure in the tank.Vapors generated during the filling operation also may come from a warm fill, from inlet piping heat leak, inlet pump work, cool down of the tank and fill line, and vapors displaced by the incoming liquid.

如果进料温度接近或高于罐内压力下其沸点时，进料的闪蒸会比较明显。充装期间产生的蒸气有可能来自热的充装液、进料管线的热量泄漏、进料泵的运行、储罐和充装管线的降温以及蒸汽被进液所转换。

5.2.3 Weather Changes 天气变化

Vacuum can develop in a tank when the ambient conditions (temperature, wind, precipitation, etc.) change and cause a reduction in the temperature and vapor pressure of the liquid in the tank.

当周围环境（温度、风向、降水等）变化时，在储罐内会产生真空，并引起罐内温度和罐内液体的蒸汽压下降。

5.2.4 Fire Exposure

5.2.4 失火

Outbreathing will result from the expansion of the vapors and evaporation of the liquid that occur when a tank absorbs heat from an external fire.

当储罐从外部的失火中吸收热量时，呼出也产生于蒸汽的膨胀和液体的蒸发。

5.2.5 Other Circumstances
5.2.5 其他情况

5.2.5.1 General
5.2.5.1 概述

When the possible causes of overpressure or vacuum in a tank are being determined, other circumstances resulting from equipment failures and operating errors must be considered and evaluated by the designer. Calculation methods for these other circumstances have not been provided in this standard.

当在储罐内产生超压和真空的可能原因被确定，其他的产生于设备故障和操作失误的情况必须被设计人员考虑和评估。在这个标准里每有提供这些其他情况的计算方法。

5.2.5.2 Pressure Transfer Blowoff
5.2.5.2 压力交换释放

Liquid transfer from other vessels, tank trucks, and tank cars may be aided or accomplished entirely by pressurization of the supply vessel with a gas, but the receiving tank may encounter a flow surge at the end of the transfer due to vapor breakthrough.

液体的转移来自其他容器、罐车、槽车可以是自动的，或者是完全通过气体增压原料容器获得，但是接收罐在进料末期遇到喷溅导致液体蒸汽的喷出。

Depending on the preexisting pressure and free head space in the receiving tank, the additional gas volume may be sufficient to overpressure the tank.

根据先前的压力和接收罐的顶部空间，增加的气体体积足以超出储罐。

The controlling case is a transfer that fills the receiving tank so that little head space remains to absorb the pressure surge.

控制实例是通过一个中间罐，用来满足储罐内狭小的顶部空间来吸收激增的压力。

A similar situation can be encountered during line pigging if a vapor chaser is used after the pigging device.

如果在清洗装置后用蒸汽清扫，在管道内也会遇到类似的情形。

5.2.5.3 Inert Pads and Purges
5.2.5.3 惰性气封与吹扫

Inert pads and purges are provided on tanks to protect the contents of the tanks from contamination, maintain nonflammable atmospheres in the tanks, and suppress vapor emissions from the tanks. An inert pad and purge system normally has both a supply regulator and a back-pressure regulator to maintain interior tank pressure within a narrow range. Failure of the supply regulator can result in unrestricted gas flow into the tank, reduced gas flow, or complete loss of the gas flow. Failure of the back pressure regulator could result in overpressure.

对储罐提供惰性气封与吹扫以保护储罐内物料不受污染、维持储罐内的不可燃环境并抑制储罐的气体排放。惰性气封与吹扫系统通常有一个供气调节阀和一个背压调节阀来把罐内压力维持在较窄的范围内。供气调节阀故障会导致气体不受限制的进入储罐、气体流量下降或者气体流量完全中断。背压调节阀故障可能会导致过压。

5.2.5.4 Heat Transfer Devices
5.2.5.4 传热装置

For a tank with a cooling jacket or coils, liquid vaporization, resulting from the loss of coolant flow must be considered.
对于有冷却夹套或者盘管的储罐，必须考虑冷剂流量损失所导致的液体汽化。

5.2.5.5 Internal Heat Transfer Devices
5.2.5.5 内部传热装置

Mechanical failure of a tank's internal cooling device can expose the contents of the tank to the cooling medium used in the device. In low-pressure tanks, it can be assumed that the flow direction of heat transfer medium will be into the tank when the device fails. Chemical compatibility of the tank contents and the heat transfer medium must be considered.
储罐内部冷却装置的机械故障会使罐内介质接触到装置中所用的冷却介质。在低压罐中，可以假设当传热装置机械故障时传热介质会流向罐内。必须考虑罐内物料和加热介质的相容性。

In addition to the consideration in Section 5.2.5.4, internal cooling devices have other potential causes for overpressure or vacuum that must be considered. The disposition of the tank contents until the device can be repaired or replaced must also be considered.
除了 5.2.5.4 节中的考虑事项外，必须考虑可能引起超压或真空的其它内部冷却装置原因。在装置修理或更换前，必须考虑储罐内物料的处置。

5.2.5.6 Vent Treatment Systems
5.2.5.6 放空气处理系统

If vapor from a tank is collected for treatment or disposal by a vent treatment system, the vent collection system may fail. This failure must be evaluated.
如果储罐产生的气体由放空气处理系统收集起来进行处理或排放，放空气收集系统有可能故障，必须对这种故障进行评估。

Failures affecting the safety of a tank can include back pressure developed from problems in the piping (liquid-filled pockets and solids buildup), other equipment relieving into the header, or blockage due to equipment failure.
影响储罐安全的故障包括管路问题（如充液袋形或固体积聚）形成的背压、其它设备泄放到总管或设备故障造成的堵塞。

An emergency venting device that relieves to atmosphere, set at a higher pressure than the vent treatment system, is normally used. For toxic or hazardous vapors, a fail-safe vent treatment system should be conside.
通常使用一个紧急通气装置向大气泄放，其设定压力高于放空气处理系统。对有毒或危险气体，应考虑使用故障安全放空气处理系统。

5.2.5.7 Utility Failure
5.2.5.7 公用系统故障

Local and plant-wide power and utility failures must be considered as possible causes of overpressure or vacuum. Loss of electrical power will directly affect any motorized valves or controllers and mayalso shut down the instrument air supply. Also, cooling fluids may be lost during an electrical failure.
就地或整个装置电力中断和公用系统故障必须作为过压或真空的可能原因进行考虑。停电会直接影响所有电动阀或控制器，也会关停仪表风。而且，电力中断也可能导致冷却介质的损失

5.2.5.8: Change in Temperature of the Input Stream to a Tank
5.2.5.8: 进罐物料的温度变化

A change in the temperature of the input stream to a tank brought about by a loss of cooling or an increase in heat input may cause overpressure in the tank. A reduction in vapor pressure brought about by the introduction of sub-cooled product into the vapor space may create a vacuum condition.

由于冷却损失或输入热量增加致使进罐物料的温度发生变化，这可能会导致储罐过压。蒸气空间引入过冷产品致使蒸气压降低会产生真空。

Note: Relief valves are normally not sized to relieve vapors generated during “rollover.” Although vapors generated during rollover are a source of potential overpressure, there are no generally recognized methods available for calculating the relieving requirements of these vapors. Proper design and operation of the storage system are essential whenever an attempt is made to prevent rollover (see Section 9 of API Standard 2510).
注释：泄放阀的选型一般不考虑“翻滚现象”所产生蒸汽的排放。虽然这也是导致超压的内在原因，但还没有一个公认的方法来计算这部分蒸汽的排放要求。贮藏系统的正确设计和操作是防止“翻滚现象”的根本。(见 API 2510 第 9 部分) 。

5.2.5.9：Chemical Reactions
5.2.5.9: 化学反应:

The contents of some tanks may be subject to chemical reactions, which may generate heat and/or vapors. Some examples of chemical reactions may include inadvertently adding water to acid or spent acid tanks thereby generating steam and/or vaporizing light hydrocarbons, runaway reactions of phenol tanks, etc. In some cases, the material may foam, causing two phase relief. Technology developed by the Design Institute for Emergency Relief (DIERS) may be used to evaluate these cases.
某些储罐内的物料可能会发生化学反应，产生热量和/或气体。例如，一些化学反应可能包括：不小心把水加到了酸罐或废酸罐里从而生成了蒸汽、轻烃汽化、苯酚储罐反应失控等。在某些情况下，材料会起泡沫，产生两相泄放。可利用紧急救援系统设计院（DIERS）开发的技术来评估这些情况。

5.2.5.10 Heat In-leak
5.2.5.10 热量渗入:
Heat in-leak to a refrigerated tank can cause overpressure in the tank.
热量渗入制冷罐时会导致罐内超压。

5.2.5.11 Liquid Overfill Protection
5.2.5.11 液体过量充装防护

For information on liquid overfill protection, see API Standards 620, 2510, and API Recommended Practice 2350. Liquid overfill shall be prevented by providing positive design and operation steps, such as two reliable and repairable level instruments and an independent high-level alarm that independently stop the filling operation by closing the filling valves.
关于液体过量充装防护信息，参见标准 API620、API2510 及 API 推荐规程 2350。通过提供正确的设计和操作步骤来防止液体过量充装，例如:两个可靠并可维修的液位计以及一个独立的高液位报警器（它能通过关闭充装阀而独立停止充装操作）。

5.2.5.12 Atmospheric Pressure Changes
5.2.5.12 大气压变化

A rise or drop in barometric pressure is a possible cause of vacuum or overpressure in a tank.
大气压升高或降低可能导致罐内产生真空或超压。

5.2.5.13 Control Valve Failure
5.2.5.13 控制阀故障

Failure of a control valve on the liquid line to a tank must be considered because a control valve failure may adversely affect the flow of material to a tank. A control valve failure may cause the liquid flow rate to a tank to increase, and an increased liquid flow rate may overload a cooler, causing higher temperature material to be admitted to the tank. A control valve failure may also

cause the liquid level in a pressurized vessel feeding liquid to a tank to drop below the outlet nozzle, allowing vapor from the vessel to be pressured into the tank.
必须考虑储罐液体注入管线上的控制阀发生故障的情况，因为控制阀故障可能会对进罐的物料流量产生不利影响。控制阀故障会导致进罐液体流量增加，而液体流量增加会使冷却器超负荷，使进罐的物料温度升高。控制阀故障还会导致向储罐供液体料的压力容器液位降低到其出口管嘴以下，使得蒸气从压力容器压入储罐。

5.2.5.14 Steam Out
5.2.5.14 蒸汽吹出

If an un-insulated portion of a refrigerated tank is filled with steam, the condensing rate due to ambient cooling will exceed the venting rates specified in this standard. Other steps including large vents (open man-ways) and slowly cooling the tank are necessary to prevent excessive internal vacuum.
如果制冷罐的未保温部分充满蒸汽，由于环境冷却，冷凝速率会超过本标准规定的通气速率。为防止罐内真空过高，需要采取其他措施，包括大的通气口(敞开的人孔)和缓慢冷却储罐。
5.2.5.15 Pump Recycle
5.2.5.15 泵循环
Vapors generated during the operation of a pump on recycle or during recirculation can cause tank overpressure.
在泵循环或再循环操作期间产生的气体会导致罐超压。

5.3 DETERMINATION OF VENTING REQUIREMENTS
5.3 通气要求量的确定

5.3.1 General
5.3.1 概述

Although design guidelines are not presented in this standard for other circumstances discussed in Section 5.2.5, they should be considered. Venting requirements are given for the following conditions:
虽然本标准未对 5.2.5 节中论述的其它情况提出设计指导方针，但应该考虑这些情况。由下列情况确定通气要求量：

a. Inbreathing resulting from maximum outflow of liquid from the tank.
a. 自储罐的液体最大流出量而产生的吸入量。

b. Out-breathing resulting from maximum inflow of liquid into the tank and maximum vaporization caused by such inflow.
b. 到储罐的液体最大流入量和此流量引起的最大汽化量而产生的呼出量。

c. Out-breathing resulting from fire exposure.
c. 暴露于火源而产生的呼出量。

5.3.2 Requirements for Normal Venting Capacity
5.3.2 正常通气能力的要求:

5.3.2.1 The pressure relief devices shall be suitable to relieve the flow capacity determined for but not limited by the largest single contingency or any reasonable and probable combination of contingencies, assuming that all of the outlets from a tank are closed.
5.3.2.1 假设储罐所有的出口都已关闭，泄压装置应适于泄放（但不限于）通过最大单次意外事故或多次意外事故可能的合理组合而确定的流量。

5.3.2.2 The vacuum relief devices shall be suitable to relieve the flow capacity determined for but not limited by the largest single contingency or any reasonable and probable combination of contingencies. It is permissible to reduce the requirement for vacuum relief capacity by the rate of vaporization that results from minimum normal heat gain to the contents. A gas re-pressuring line with a suitable control and source of gas may be provided to avoid drawing air into the tank. If a gas-re pressuring system is used, it shall be used in addition to the vacuum relief devices, and no capacity credit shall be allowed.

5.3.2.2 真空泄放装置应适于泄放最大单次意外事故或多次意外事故可能的合理组合所要求的流量。允许根据罐内物料最低正常得热而产生的汽化量来降低真空泄放能力要求。可配备一根带适当控制和气源的气体加压管线，以免把空气抽入罐内。如果采用了气体加压系统，它应作为真空泄放装置的辅助装置，但不得因此而降低泄放装置的泄放能力。

5.3.2.3 The requirement for venting capacity for maximum liquid movement out of a tank should be equivalent to 5.6 SCFH of air for each 42 US gallon barrel (0.94 Nm3/h per cubic meter) per hour of maximum emptying rate for liquids of any flash point.

5.3.2.3 任何闪点的液体流出储罐所要求的通气量，应相当于最大排液流量为 42 美加仑/小时，通气量为 5.6 SCFH（排液量最大为 1 立方厘米/小时，通气量为 0.94Nm3）。

5.3.2.4 The requirement for venting capacity for maximum liquid movement into a tank and the resulting vaporization should be equivalent to 12 SCFH of air for each 42 US gallon barrel (2.02 Nm3/h per cubic meter) per hour of maximum filling rate (see Appendix A for the basis of this requirement).

5.3.2.4 最大液体进罐量以及产生汽化所需的通气量，应相当于最大充装速率为 42 美加仑/小时时，通气量为 12 SCFH(2.02Nm3/h/cm3)。（此要求量的依据见附录 A）。

A tank into which liquid is fed at or near the boiling point at the tank pressure may require an out-breathing capacity that is higher than the capacity indicated above. The values presented above are based on vaporization of 0.5 percent of the feed liquid; significantly higher vaporization rates can occur if the feed is above the boiling point. For instance, with hexane, 0.4 percent of the feed can vaporize for every 1°F (0.56°C) above the boiling point at tank pressure.

罐压下，液体在其沸点或沸点附近注入储罐时有可能要求的呼出量比上面所指的要高。上面所示数值是基于进液汽化率为 0.5%。如果进料的温度高于其沸点，汽化率会更高。以己烷为例：在罐压下，每高于沸点 1°F (0.56°C)，进料汽化率就会增加 0.4%。

Note: Protection against liquid overfilling is not covered in this standard, but it is covered in API Standard 620 and in API Recommended Practice 2350.

注释：本标准未包括液体过量充装防护，但在 API 620 和 API 推荐规程 2350 中有。

5.3.3 Requirements for Emergency Venting Capacity for Tanks Subject to Fire Exposure

5.3.3 储罐暴露于火灾时的紧急通气能力要求

When storage tanks are exposed to fire, the venting rate may exceed the rate resulting from other conditions. The procedures in Sections 5.3.3.1 and 5.3.3.2 shall be used to evaluate the required venting capacity for tanks subject to fire exposure.

当储罐暴露于火灾时，需要的通气量可能会超过其他情况下所需的通气量。应采用第 5.3.3.1 节和第 5.3.3.2 节中的步骤来估算储罐暴露于火灾时所需的通气量。

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5.3.3.1 Emergency Venting for Fire Exposure for Single-Wall Refrigerated Storage Tanks

5.3.3.1 暴露于火灾的单壁制冷储罐的紧急通气

For tanks subject to fire exposure, the required venting capacity shall be determined by Equations 5A or 5B.

对于暴露于火灾的储罐，所需通气能力应由方程 5A 或 5B 来确定。

A. English Units

A. 英制单位:

$$SCFH = 3.091 \times QF/L \times (T/M)^{0.5} \qquad (5A)$$

Where
式中

SCFH = Venting requirements in standard cubic feet per hour or air,
SCFH=通气要求,单位是每小时标准立方英尺的空气量.

(这里的 or 应该是 of,请看 PDF 总第 23 页的解释)

Q = heat input from fire exposure, in BTU per hour. Heat input is provided in Figure B-1 of Appendix B or the following summary:
Q= 从受火处输入的热量，单位用 BUT(英国热量单位)/小时.附录 B 的图 B-1 或下面的总结部分提供了输入的热量。

wetted surface area (Square feet) 湿面积(平方英寸)	Design Pressure (psig) 设计压力(磅/平方英寸)	Heat input (Btu/hr) 输入热量 (Btu/小时)
□ 200	≤15	Q=20,000A
≥200 and <1000	≤15	Q=199,300A^0.566
≥1000 and <2800	≤15	Q=963,400A^0.338
≥2800	≤15	Q=21,000A^0.82

A = wetted surface area of the tank, in square feet (see the footnotes for Table 5A),
A= 罐子的湿面积，单位用平方英尺（见表 5A 的注脚），

F = environmental factor from Table 6A. Credit may be taken for only one environmental factor,
F= 表 6A 中的环境因素。只采用一个可信的环境因素；

L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in BTU per pound,
L= 在泄放压力和温度下，储存物料的汽化潜热，单位用 BUT/磅；

T = temperature of the relieving vapor, in degrees Rankine. It is normally assumed that the temperature of the relieving vapor corresponds to the boiling point of the stored fluid at the relieving pressure,
T=泄放蒸气的温度，兰氏温度。通常假定泄放蒸气的温度对应于泄放压力下储存流体的沸点。

M = molecular weight of the vapor being relieved.
M= 被泄放蒸汽的分子量

B. Metric Units
B. 公制单位

Nm3/h=881.55Xqf/Lx(T/M)^0.5 (5B)

Where
式中

Nm3/h = venting requirement, in normal cubic meters per hour of air,
Nm3/h= 放空要求，单位通常用每立方米的空气量,

Q = heat input from fire exposure, in watts. Heat input is provided in Figure B-1 of Appendix B or the

following summary:
Q=从受火处输入的热量，单位用瓦特.附录 B 的图 B-1 或下面的总结部分提供了输入的热量。

wetted surface area (Square mm) 湿面积(平方毫米)	Design Pressure (psig) 设计压力 (巴)	Heat input (Btu/hr) 输入热量（瓦特)
□ ι□˜ □	≤1.034	Q=63,150A
≥18.6 and <93	≤1.034	Q=224,200A^0.566
≥93 and <260	≤1.034	Q=630,400A^0.338
≥260	≤1.034	Q=43,200A^0.82

A= wetted surface area of the tank, in square meters (see Footnotes for Table 5B),
A=罐子的湿面积，单位用平方米（见表 5B 的注脚），

F = environmental factor from Table 6B. Credit may be taken for only one environmental factor,
F= 表 6B 中的环境因素。只采用一个可信的环境因素；

L = latent heat of vaporization of the stored liquid at the relieving pressure and temperature, in kJ/kg,
L= 在泄放压力和温度下，储存物料的汽化潜热，单位用千焦/千克；

T=temperature of the relieving vapor, in degrees Kelvin. It is normally assumed that the temperature of the relieving vapor corresponds to the boiling point of the stored fluid at the relieving pressure,
T=泄放蒸气的温度，绝对温标。通常假定泄放蒸气的温度对应于泄放压力下储存流体的沸点。

M = molecular weight of the vapor being relieved.
M= 被泄放蒸汽的分子量

5.3.3.1.2 Where a lesser degree of accuracy can be tolerated, the required venting capacity can be determined from Table 5 or Equation 5, as indicated in the following summary:
5.3.3.1.2 在不要求非常精确的情况下，要求的通气能力可由表 5 或方程式 5 确定，如下面的汇总表所示：

For English Units:
英制单位：

Wetted Surface Area (square feet)润湿表面积（平方米)	Design Pressure (psig) 设计压力 (psig)	Required Venting Capacity (SCFH) 必需排放能力(SCFH)
<2800	≤15	Table 5A and 5.3.3.1.3 表 5A 及 5.3.3.1.3
≥2800	≤15	Equation 5A 方程 5A

$$SCFH = 1107FA0.82 \qquad (6A)$$

where
其中

SCFH = venting requirement, in standard cubic feet per hour of air,
SCFH = 排放要求,SM3/H

F = environmental factor from Table 6A. Credit may be taken for only one environmental factor,

F = 6A 中的环境因子. 仅有一个环境因子可信,

A = wetted surface area, in square feet (see Table 5A,Footnote a).
A = 润湿表面积, m2(见表 5A, 脚注 a).

Note: Equation 6A is based on
注意: 方程 6A 基于

Q=21,000A0.82
Q=21,000A0.82

or
或者

For Metric Units:
公制单位：

Wetted Surface Area (square feet) 润湿表面积	Design Pressure (barg) 平方米 设计压力(barg)	Required Venting Capacity (Nm3/h) 必需排放能力 (Nm3/h)
<260	□ 1.034 barg	Table 5B and 5.3.3.1.3 表 5B 以及 5.3.3.1.3
□ 260	□ 1.034 barg	Equation 5B 方程 5B

$$Nm3/h=208.2FA0.82 \qquad (6B)$$

where
其中

Nm3/h = venting requirement, in normal cubic meters per hour of air,
Nm3/h =*Nm3/h* =排放要求,Nm3/H

F = environmental factor from Table 6B. Credit may be taken for only one environmental factor,
F =6B 中的环境因子.仅有一个环境因子可信,

A = wetted surface area, in square meters (see Table 5B, Footnote a).
A =润湿表面积,m2(见表 5B,脚注 a).

Note: Equation 6B is based on
注意:方程 6B 基于

Q=43,200A0.82
Q=43,200A0.82

The total heat absorbed, Q, is in BTU per hour for Equation 2A and in Watts for Equation 2B, Table 5 and the constants 1107 and 208.2 in Equations 5A and 5B, respectively, were derived from Equation 4 and Figure B-1 by using the latent heat of vaporization of hexane (144 BTU per pound 335,000 J/kg) at atmospheric pressure and the molecular weight of hexane (86.17) and assuming a vapor temperature of 60¡F (15.6¡C). This method will provide results within an acceptable degree of accuracy for many ßuids having similar properties (see Appendix B).

总的吸附热, Q, 在方程 2A 中是以 BTU/H 为单位而在方程 2B 和表 5 中则是以 W 为单位.表 5A 和表 5B 中的常数 1107 和 208.2，通过大气压下己烷的蒸发潜热(144BTU/pound,335,000J/kg) 在假定其蒸发温度为 60°F(15.6°C)条件下分别从方程 4 和图 B-1 中得到。

5.3.3.1.3 The total rate of venting determined from Table 5 may be multiplied by an appropriate environmental factor, F, selected from Table 6. Credit may be taken for only one environmental factor.
5.3.3.1.3 由表 5 得到的总的排放速率可能乘了一个从表 6 中选取的适当的环境因子。仅有一个环境因子可信.

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5.3.3.1.4 Full credit may be taken for the venting capacity provided for normal venting, since the normal thermal effect can be disregarded during a Þre. Also, it can be assumed that there will be no liquid movement into the tank.
5.3.3.1.4 尽管在火灾时下常规热效应可以被忽略，其在常规下的排放能力是可以全信的。同样，可以假定没有液体流动到罐中。

5.3.3.1.5 If normal venting devices are inadequate, additional emergency venting devices of the type described in Section 5.4.2 shall be provided so that the total venting capacity is at least equivalent to that required by Table 5 or Equation 4 or 5.
5.3.3.1.5 如果常规排放设备不适当，段 5.4.2 中所述的额外的紧急排放设备应该启用以便总的排放能力至少等于表 5 或者方程 4 或 5 中的需求.

5.3.3.1.6 The total venting capacity shall be based on thepressure indicated in Section 5.5.1.1.
5.3.3.1.6 总的排放能力应是在段 5.5.1.1 中指明的压力下得到。

5.3.3.2 Emergency Venting for Fire Exposure for Double-Wall Refrigerated Storage Tanks
5.3.3.2 双壁制冷贮藏罐的在辐射热下的紧急排放

The heat input from a Þre initially causes the vapors in the space between the walls of a double-wall refrigerated storage tank to expand, and the heat input also causes the vapors in the roof space of a double-wall tank with suspended-deck insulation to expand; however, it may be several hours before the increased heat input to the stored liquid causes a signiÞ-cantly increased vaporization rate. The venting requirements for handling the increased vaporization may be small compared to the requirements for handling the initial volumetric expansion of the vapors.
来自热源的供热先导致双壁制冷贮罐中夹层间的蒸汽膨胀，也导致有绝缘顶盖的罐中的顶部夹层中的蒸汽膨胀，然而，向贮藏的液体增加的供热可能需要数小时使其达到一个明显增加的蒸发速率。处理增加的蒸发量需要的排放量相对处理最初蒸汽发生体积膨胀需要的量要少。

Because emergency venting for a double-wall refrigerated storage tank is complex, no calculation method is presented here. A thorough analysis of the Þre relief for a double-wall refrigerated storage tank, including a review of the structural integrity of unwetted portions of the outer wall, should be conducted.
因为双壁制冷贮藏罐的紧急排放比较复杂,目前没有计算方法.一个对双壁制冷贮罐火灾救援的彻底分析，包括对外壁部分的未润湿的结构整体性检查，应是热可导的。

5.4 MEANS OF VENTING
5.4 排放方法

5.4.1 Normal Venting
5.4.1 常规排放

Normal venting shall be accomplished by a relief device (see API Standard 620).
常规排放应该要借助救援设备来完成。(见 API 标准 620).

5.4.1.1 Any relief device shall be designed so that it will protect the tank in the event of failure of any essential part.
5.4.1.1 任何救援设备应该是要设计为在任何关键部位失效时能够保护贮罐。

5.4.1.2 A tank that may be damaged by internal vacuum shall be provided with at least one vacuum relief device set and sized to open at a vacuum that is sufÞcient to protect the tank from damage.
5.4.1.2 贮罐可能受到来自内部真空的损伤，所以应该至少有一套真空救援设备并且大小应该能在真空下

打开以便充分的保护贮罐不受伤害。

Table 5A—Emergency Venting Required for Fire Exposure Versus Wetted Surface Area
表 5A-火灾暴露时润湿表面积与要求的紧急通气能力

A. English units 英制单位

Wetted Area[a] 润湿面积 (square feet)(平方英尺)	Venting Requirement 通气要求(SCFH)	Wetted Area[a] 润湿面积 (square feet)(平方英尺)	Venting Requirement 通气要求(SCFH)
20	21,100	350	288,000
30	31,600	400	312,000
40	42,100	500	354,000
50	52,700	600	392,000
60	63,200	700	428,000
70	73,700	800	462,000
80	84,200	900	493,000
90	94,800	1,000	524,000
100	105,000	1,200	557,000
120	126,000	1,400	587,000
140	147,000	1,600	614,000
160	168,000	1,800	639,000
180	190,000	2,000	662,000
200	211,000	2,400	704,000
250	239,000	2,800	742,000
300	265,000	>2,800[b]	—

Table 5B—Emergency Venting Required for Fire Exposure Versus Wetted Surface Area
表 5B-火灾暴露时润湿表面积与要求的紧急通气能力

B. Metric Units 公制单位

Wetted Area[a] 润湿面积 (square meter)(平方米)	Venting Requirement 通气要求(Nm3/h)	Wetted Area[a] 润湿面积 (square meter)(平方米)	Venting Requirement 通气要求(Nm3/h)
2	608	35	8,086
3	913	40	8,721
4	1,217	45	9,322
5	1,521	50	9,895
6	1,825	60	10,971
7	2,130	70	11,971
8	2,434	80	12,911
9	2,738	90	13,801
11	3,347	110	15,461
13	3,955	130	15,751
15	4,563	150	16,532
17	5,172	175	17,416
19	5,780	200	18,220
22	6,217	230	19,102
25	6,684	260	19,910
30	7,411	>260[b]	—

[a]The wetted area of a tank or storage vessel shall be calculated as follows:
a 储罐或储存容器的润湿面积应如下计算：

Sphere and Spheroids—The wetted area is equal to 55 percent of the total surface area or the surface area to a height of 30 feet (9.14 meters) above grade, whichever is greater.
球罐与扁球形罐-润湿面积等于储罐总表面积的 55%或到地上高度为 30 英尺(9.14 米)的那部分储罐表面积（取两者中数值较大的）。

Horizontal Tanks—The wetted area is equal to 75 percent of the total surface area or the surface area to

a height of 30 feet (9.14 meters) above grade, whichever is greater.
卧式储罐-润湿面积等于储罐总表面积的 75%或到地上高度为 30 英尺(9.14 米)的那部分储罐表面积（取两者中数值较大的）。

Vertical Tanks—The wetted area is equal to the total surface area of the vertical shell to a height of 30 feet (9.14 meters) above grade. For a vertical tank setting on the ground, the area of the ground plates is not to be included as wetted area. For a vertical tank supported above grade, a portion of the area of the bottom is to be included as additional wetted surface. The portion of the bottom area exposed to a fire depends on the diameter and elevation of the tank above grade. Engineering judgment is to be used in evaluating the portion of the area exposed to fire.
立式储罐-润湿面积等于到地上高度为 30 英尺(9.14 米)那部分立式壳体的总表面积。对于安装在地面上的立式储罐，底板面积不包括在润湿面积内；对于立式高架储罐，一部分底面积将作为附加润湿面积包括在内。暴露于火灾的那部分底面积取决于储罐直径和离地高度。在评估暴露于火灾的那部分底面积时，要进行工程计算与判断。

b For wetted surfaces larger than 2,800 square feet (260 square meters), see Section 5.3.3.1.3.
b 对于大于 2,800 平方英尺(260 平方米)的润湿表面，见 5.3.3.1.3 节。

Note:注释：
Table 5 and the constants 1107 and 208.2 in Equations 6A and 6B respectively were derived from Equation 5 and Figure B-1 by using the latent heat of vaporization (144 BTU per pound or 334900 J/kg) at atmospheric pressure and the molecular weight of hexane (86.17) and assuming a vapor temperature of 60°F (15.6°C). This method will provide results within an acceptable degree of accuracy for many fluids having similar properties (see Appendix B).
表 5 和公式 6A 与 6B 中的常数 1107 与 208.2 分别得自于公式 5 和图 B-1，方法是采用常压下己烷的汽化潜热为 144 BTU/lb(或 334900J/kg)、分子量为 86.17，并且假定其蒸气温度为 60°F(15.6°C)。对于具有相似性质的许多流体，此方法提供的结果精确度是可以接受的（参见附录 B）。

Table 6A—Environment Factors for Refrigerated Aboveground and Partially Belowground Tanks
表 6A –外界环境对地上及有部分埋于地下的低温贮罐的影响系数表

A. English Units英制单位

Tank design/Configuration 罐设计/布局	Insulation Conductance(BTU/hr ft^2 °F) 保冷导热系数（BTU/hr ft^2 °F ）	Insulation Thickness(in) 保冷层厚度（英寸）	*F* Factor *F 系数*
Bare metal tank 裸金属罐	-	0	1.0
Insulated tank a 保冷罐 a	4	1	0.3 [b]
	2.0	2	0.15 [b]
	1.0	4	0.075 [b]
	0.67	6	0.05 [b]
	0.5	8	0.0375 [b]
	0.4	10	0.03 [b]
	0.33	12	0.025 [b]
Concrete tank or fireproofing 混凝土罐或耐火罐	-	-	（see note c） 见注释c
Water-application facilities[d] 喷淋设施d	-	-	1.0
Depressuring and emptying facilities[e] 卸压和倒空设施e	-	-	1.0
Underground storage	-	-	0

地下部分			
Earth-covered storage above grade 地表面上覆土部分	-	-	0.03
Impoundment away from tank f 远离储罐的事故存液池	-	-	0.5

Note: aThe insulation shall resist dislodgment by fire-fighting equipment, shall be noncombustible, and shall not decompose at temperatures up to 1000°F (537.8°C). The user is responsible to determine if the insulation will resist dislodgment by the available fire-fighting equipment. If the insulation does not meet these criteria, no credit for insulation shall be taken. The conductance values are based on insulation with a thermal conductivity of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness). The user is responsible for determining the actual conductance value of the insulation used. The conservative value of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness) for the thermal conductivity is used.

注释：

a: 保冷层应能承载消防设施重量，应为非可燃物，并且应在1000°F(537.8°C)高温不发生分解。用户负责确定保冷层是否可以承载消防设施; 如果保冷层不符合标准, 没有合适的保冷材料可用时。可以按保冷层每小时、每平方英尺、每英寸厚度导热系数4BTU/hr·ft2(每平方米、每度、每厘米厚度保冷材料导热系数9w/m2·℃) 来考虑。用户负责确定所用保冷材料实际导热系数值。通常选用保冷材料导热系数保守值是每小时、每平方英尺、每英寸厚度导热系数4BTU/hr·ft2(每平方米、每度、每厘米厚度保冷材料导热系数9w/m2·℃)

bThese F factors are based on the thermal conductance values shown and a temperature differential of 1600°F (888.9°C) when using a heat input value of 21,000 BTU per hour per square foot (66,200 Watts per square meter) in accordance with the conditions assumed in API Recommended Practice 521. When these conditions do not exist, engineering judgment should be used to select a different F factor or to provide other means for protecting the tank from fire exposure.

b: 这些F系数基于在API推荐实例521中测出，实例是在条件假定为供入21000BTU/hr·ft2(66,200W/m2)热量，温度变化1600°F(888.9°C)下得出的导热系数值。当实际条件与这些条件不符时，用工程经验判断选择不同的F系数，或者提供其他措施来保护储罐暴露在明火中。

c: Use the F factor for an equivalent conductance value of insulation.

c:用与表中保冷导热系数相同的对应的F系数值

d:Under ideal conditions, water films covering the metal surfaces can absorb most incident radiation. The reliability of water application depends on many factors. Freezing weather, high winds, clogged systems, undependable water supply, and tank surface conditions can prevent uniform water coverage. Because of these uncertainties, no reduction in environmental factors is recommended; however, as stated previously, properly applied water can be very effective.

d：理想条件下，水膜覆盖金属表面可以吸收大部分易于发生的辐射热。喷淋设施的可靠性取决于很多因素。结冰、大风天气、障碍系统、不可靠的供水系统和储罐表面条件阻止形成水膜等。由于这些不确定性，不推荐减小环境系数；但是，正如前面所述，适当应用水是非常有效的。

eDepressuring devices may be used, but no credit shall be allowed in sizing the venting device for fire exposure.

e: 可以使用卸压装置，但是火灾情况下定通气装置大小是允许不确定的。

f:The following conditions must be met: A slope of not less than 1 percent away from the tank shall be provided for at least 50 feet (15 meters)toward the impounding area; the impounding area shall have a capacity that is not less than the capacity of the largest tank that can drain into it; the drainage system routes from other tanks to their impounding areas shall not seriously expose the tank; and the impounding area for the tank as well as the impounding areas for the other tanks (whether remote or with dikes around the other tanks) shall be located so that when the area is filled to capacity, its liquid level is no closer than 50 feet (15 meters) to the tank.

f:以下条件必须符合：从罐到事故存液池至少50英尺（15米）的斜坡，并且斜坡的坡度不小于1%；事故存液池容积应不小于最大可排出罐的罐容；从其他罐到事故存液池的排出通道不应使罐严重暴露；并且同样要为其它罐设置事故存液池（远距离或环绕其他罐区的隔堤），所以当充满液体时，液面离罐的距离不会接近于50英尺（15米）。

Table 6B—Environment Factors for Refrigerated Aboveground and Partially Belowground Tanks
表 6B –外界环境对地上及有部分埋于地下的低温贮罐的影响系数表

B. Metric Units公制单位

Tank design/Configuration 罐设计/布局	Insulation Conductance(Watts/m^2 °K) 保冷导热系数（Watts/m^2 °K）	Insulation Thickness(cm) 保冷层厚度（厚米）	*F* Factor *F 系数*
Bare metal tank 裸金属罐	-	0	1.0
Insulated tank a 保冷罐 a	22.7	2.5	0.3 [b]
	11.4	5	0.15 [b]
	5.7	10	0.075 [b]
	3.8	15	0.05 [b]
	2.8	20	0.0375 [b]
	2.3	25	0.03 [b]
	1.9	30	0.025 [b]
Concrete tank or fireproofing 混凝土罐或耐火罐	-	-	（see note c） 见注释c
Water-application facilitiesd 喷啉设施d	-	-	1.0
Depressuring and emptying facilitiese 卸压和倒空设施e	-	-	1.0
Underground storage 地下部分	-	-	0
Earth-covered storage above grade 地表面上覆土部分	-	-	0.03
Impoundment away from tank f 远离储罐的事故存液池	-	-	0.5

Note: aThe insulation shall resist dislodgment by fire-fighting equipment, shall be noncombustible, and shall not decompose at temperatures up to1000°F (537.8°C). The user is responsible to determine if the insulation will resist dislodgment by the available fire-fighting equipment. If the insulation does not meet these criteria, no credit for insulation shall be taken. The conductance values are based on insulation with a thermal conductivity of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness). The user is responsible for determining the actual conductance value of the insulation used. The conservative value of 4 BTU per hour per square foot per °F per inch of thickness (9 Watts per square meter per °C per centimeter of thickness) for the thermal conductivity is used.

注释：

a: 保冷层应能承载消防设施重量，应为非可燃物，并且应在1000°F(537.8°C)高温不发生分解。用户负责确定保冷层是否可以承载消防设施; 如果保冷层不符合标准，没有合适的保冷材料可用时。可以按保冷层每小时、每平方英尺、每英寸厚度导热系数4BTU/hr·ft2(每平方米、每度、每厘米厚度保冷材料导热系数9w/m2·℃) 来考虑。用户负责确定所用保冷材料实际导热系数值。通常选用保冷材料导热系数保守值是每小时、每平方英尺、每英寸厚度导热系数4BTU/hr·ft2(每平方米、每度、每厘米厚度保冷材料导热系数9w/m2·℃)

bThese F factors are based on the thermal conductance values shown and a temperature differential of 1600°F (888.9°C) when using a heat input value of 21,000 BTU per hour per square foot (66,200 Watts per square meter) in accordance with the conditions assumed in API Recommended Practice 521. When these conditions do not exist, engineering judgment should be used to select a different F factor or to provide other means for protecting the tank from fire exposure.
b: 这些F系数基于在API推荐实例521中测出，实例是在条件假定为供入21000BTU/hr·ft2(66,200W/m2)热量，温度变化1600°F(888.9°C)下得出的导热系数值。当实际条件与这些条件不符时，用工程经验判断选择不同的F系数，或者提供其他措施来保护储罐暴露在明火中。

c:Use the F factor for an equivalent conductance value of insulation.
c:用与表中保冷导热系数相同的对应的F系数值

d:Under ideal conditions, water films covering the metal surfaces can absorb most incident radiation. The reliability of water application depends on many factors. Freezing weather, high winds, clogged systems, undependable water supply, and tank surface conditions can prevent uniform water coverage. Because of these uncertainties, no reduction in environmental factors is recommended; however, as stated previously, properly applied water can be very effective.
d：理想条件下，水膜覆盖金属表面可以吸收大部分易于发生的辐射热。喷淋设施的可靠性取决于很多因素。结冰、大风天气、障碍系统、不可靠的供水系统和储罐表面条件阻止形成水膜等。由于这些不确定性，不推荐减小环境系数；但是，正如前面所述，适当应用水是非常有效的。

e: Depressuring devices may be used, but no credit shall be allowed in sizing the venting device for fire exposure.
e: 可以使用卸压装置，但是火灾情况下定通气装置大小是允许不确定的。

f: The following conditions must be met: A slope of not less than 1 percent away from the tank shall be provided for at least 50 feet (15 meters) toward the impounding area; the impounding area shall have a capacity that is not less than the capacity of the largest tank that can drain into it; the drainage system routes from other tanks to their impounding areas shall not seriously expose the tank; and the impounding area for the tank as well as the impounding areas for the other tanks (whether remote or with dikes around the other tanks) shall be located so that when the area is filled to capacity, its liquid level is no closer than 50 feet (15 meters) to the tank.
f: 以下条件必须符合：从罐到事故存液池至少50英尺（15米）的斜坡，并且斜坡的坡度不小于1%；事故存液池容积应不小于最大可排出罐的罐容；从其他罐到事故存液池的排出通道不应使罐严重暴露；并且同样要为其它罐设置事故存液池（远距离或环绕其他罐区的隔堤），所以当充满液体时，液面离罐的距离不会接近于50英尺（15米）。

5.4.1.3 A discussion of the types and operating characteristics of venting devices can be found in Appendix C.
5.4.1.3 附录 C 讨论了通气装置的类型和操作特性。

5.4.2 Emergency Venting
5.4.2 紧急通气

Emergency venting may be accomplished by the use of the following:
紧急通气可以通过以下方式实现：

a. Larger or additional relief devices.
a．更大的或附加的泄放装置

b. A gauge hatch that permits the cover to lift under abnormal internal pressure.
b．使用在内部压力异常的情况下允许开盖的量油口。

c. A manhole cover that lifts when exposed to abnormal internal pressure.
c．使用在内部压力异常的情况下可以打开的人孔盖。

5.5 SELECTION, INSTALLATION, AND MAINTENANCE OF VENTING DEVICES
5.5 通气装置的选择、安装和维护

5.5.1 Total Venting Requirements
5.5.1 总的通气要求

5.5.1.1 Pressure
5.5.1.1 压力

5.5.1.1.1 The pressure relief device or emergency venting device shall be suitable to relieve the flow capacity determined for but not limited by the largest single contingency or any reasonable and probable combination of contingencies.
5.5.1.1.1 泄压装置或紧急通气装置应能适应满足由但不限于最大单次意外事故或多次意外事故所有可能的合理组合所确定的泄放流量要求。

5.5.1.1.2 Consultation between the tank designer, the person specifying the venting devices, and the venting device manufacturer is strongly recommended to ensure that the venting devices are compatible with the tank design. The set or start-to-open pressure often must be lower than the design pressure of a tank to allow for adequate flow capacity of the devices. The operating pressure should be lower than the set pressure to allow for normal variations in pressure caused by changes in temperature and by other factors that affect pressure in the tank vapor space. The set pressure and relieving pressure must be consistent with the requirements of the standard according to which the tank was designed and fabricated. Some standards present specific requirements, but others may not.
5.5.1.1.2 强烈建议储罐设计者、指定通气装置的人员和通气装置制造商之间进行协商，以确保通气装置与储罐的设计相符。通气装置的设定压力和开启压力经常应小于储罐的设计压力以保证装置有足够的泄流能力。操作压力应低于设定压力以允许由温度变化或其他影响气相空间压力的因素导致的正常压力波动变化。设定压力和泄放压力必须与储罐设计和制造所采用标准的要求相一致。有些标准提出了具体的要求，而有些标准可能没有。

5.5.1.1.3 Requirements for pressure-relieving devices for tanks that are designed and fabricated in accordance with API Standard 620 are given in API Standard 620. The pressure setting of a pressure-relieving device shall not exceed the maximum pressure that can exist at the level where the device is located when the pressure at the top of the tank equals the nominal pressure rating for the tank and the liquid contained in the tank is at the maximum design level.
5.5.1.1.3 按照 API 标准 620 设计和制造的储罐，其泄压装置的要求参见 API 标准 620。当储罐顶的压力等于储罐的公称压力且储罐内液位达到最高设计液位时，泄压装置的压力设定值不应超过装置所处位置的最大压力。

Under normal conditions, pressure-relieving devices must have sufficient flow capacity to prevent the pressure from rising more than 10 percent above the maximum allowable working pressure. Under Fire emergency conditions, the devices shall be capable of preventing the pressure from rising more than 20 percent above the maximum allowable working pressure.
在正常条件下，泄压装置必须有足够的泄流能力，以防止储罐压力超出最大允许工作压力的10%。在发生火灾的紧急情况下，泄压装置应有能力防止储罐压力超出最大允许工作压力的20%。

5.5.1.2 Vacuum
5.5.1.1 真空

A vacuum relief device shall be installed to permit the entry of air, or another gas or vapor, to avoid excessive vacuum that may result. The vacuum relief device shall be suitable to relieve the flow capacity required for the largest single contingency or any reasonable and probable combination of contingencies. A gas-repressuring line with a suitable control and source of gas may be provided to avoid drawing air into the tank. The design of a gas-repressuring system to eliminate the requirement for vacuum relief valves is beyond the scope of this standard and should be considered only when the induction of air represents a hazard equal to or greater than failure of the tank.
应安装真空泄放装置以便让空气或另一种气体或蒸汽进入储罐，从而避免可能产生的过度真空。真空泄放装置应能适应满足由但不限于由最大单次意外事故或多次意外事故所有可能的合理组合所确定的泄

放流量要求。配有合适控制装置和气源的气体加压管线可以用来避免把空气吸入储罐。这种以取消真空泄压装置为目的的气体加压系统的设计超出了本标准讨论范围，并且只有当吸入空气导致的危险大于或等于储罐故障危害时才考虑使用。

In general, the set and relieving pressures for vacuum relief are established to prevent damage to a tank and must limit vacuum to a level no greater than that for which a tank has been designed. The vacuum-relieving devices of a tank shall be set to open at a pressure or vacuum that will ensure that the vacuum in the tank will not exceed the vacuum for which the tank has been designed when the inflow of air through the devices is at its maximum specified rate.

总的来讲，真空泄放阀的设定压力和泄放压力的制定是为了防止对储罐造成损害，并且须限制真空度不超过储罐的设计水平。在气体以最大规定流量通过装置进入储罐时，储罐真空泄放装置开启压力或真空度的设定应确保储罐真空度不超过其设计值水平。

5.5.2 Installation of Pressure and Vacuum Relief Devices

5.5.2 压力和真空泄放装置的安装

Pressure and vacuum relief devices shall be installed to:

压力和真空泄放装置的安装应：

a. Provide direct communication with the vapor space and not be sealed off by the liquid contents of the tank.

a. 与气相空间直接连通，并且不能被储罐内液体封淹。

b. Prevent plugging of the inlet by insulation during relieving conditions.

b. 防止在排放状况下，入口被保温材料堵塞。

c. Protect the tank from the closure of a block valve or valves installed between the tank and the pressure or vacuum relief device or between the pressure or vacuum relief device and the discharge outlet. This may be done by locking or sealing the block valves open without installing excess relief capacity or by providing excess pressure or vacuum relief capacity with multiple-way valves, interlocked valves, or sealed block valves arranged so that isolating one pressure or vacuum relief device will not reduce the remaining relief capacity below the required relief capacity.

c. 在切断阀、安装在储罐和压力或真空泄放装置之间的阀门、压力或真空泄放装置和排放口之间的阀门关闭时，能够保护储罐；这些可通过以下方法实现：在不安装额外的泄放能力情况下，把切断阀锁定或封闭在打开位置，或通过多路阀、联锁阀或密封切断阀提供额外的压力或真空泄放能力，这样切断一个压力或真空泄放装置后不会使余下的泄放能力降到要求的泄放能力之下。

d. Ensure that the inlet and outlet assemblies, including any block valves, will permit the relief device to provide the required flow capacity.

d.确保入口和出口组件，包括所有切断阀，都允许泄放装置能提供所要求的流量。

e. Keep cold vapor from producing a thermal gradient in the roof of the tank or reducing the temperature in the roof of the tank. For a tank with the suspended-deck-type roof insulation system, the inlet piping to the relief valve must penetrate the suspended deck to prevent cold vapor from entering the warm space between the outer roof and the suspended deck. The influence of this piping must be considered in the relief valve capacity calculations. Relief valves should be sized for the pressure available across the valve. Consideration should be given to the inlet pressure losses and the back pressure developed on the outlet flange.

e.避免冷蒸气在储罐顶部产生温度梯度或降低储罐顶部的温度。对于带有浮顶绝热系统的储罐，泄压阀的入口管道必须贯穿浮盘以防止冷蒸汽进入罐外顶和浮盘间的温暖空间。在泄压阀容量计算中应考虑这一管段的影响。泄压阀应根据现有存在的压力确定尺寸。应考虑入口压力损失和在出口法兰盘处形成的背压。

5.5.3 Discharge Piping

5.5.3 排放管线

5.5.3.1 Discharge piping from the relief devices or common discharge headers shall be installed to:

5.5.3.1 泄放装置的排放管线或公用排放汇管的安装应：

a. Lead to a safe location.
a．导向一个安全位置。

b. Be protected against mechanical damage.
b．保护不受机械损伤。

c. Exclude or remove atmospheric moisture and condensate from the relief devices and associated piping. This may be done by the use of loose-fitting rain caps or drains, but an accounting must be made of the pressure loss effects of these items. Drains, if provided, shall be installed to prevent possible flame impingement on the tanks, piping, equipment, and structures.
C．隔绝或去除从泄放装置和相关管线来的潮气和冷凝物。这可以通过使用宽松合适的防雨帽或排液管来做到这点，但是必须核算这些在压力损失方面的影响。如果使用排液管，安装时应能防止可能产生的火焰由此侵入储罐、管线、设备和构筑物。

d. Discharge in areas that (1) will prevent flame impingement on personnel, tanks, piping, equipment, and structures, and (2) will prevent vapor entry into enclosed spaces.
d.排放区域要求 1) 能防止火焰对人员、储罐、管线、设备和结构的冲击损害；2) 能防止蒸汽进入封闭空间。

e. Prevent air from recirculating into the valve body during relief conditions to prevent ice from forming when the relief temperature is below 32 F (0 ℃).
e.要防止在泄放时空气再循环进入阀体，以免在泄放温度低于0℃(32℉)时结冰。

f. Prevent vapor from the tank from freezing.
f.防止来自于储罐的蒸汽冻结。

5.5.3.2 When a tank is located inside a building, the tank venting devices shall discharge to the outside of the building.
5.5.3.2 在储罐位于建筑物内时，储罐的通气装置应排放到建筑物外。

5.5.3.3 Relief device discharge lines from one or more tanks may be connected to a common discharge header, provided the header complies with the other provisions of this paragraph. Liquid traps that can introduce sufficient back pressure to prevent relief devices from functioning properly shall be avoided. Other vents, drains, bleeders, and relief devices shall not be tied into the common discharge header if back pressures can be developed that prevent the relief devices on the tank from functioning properly. Back pressures developed during relief conditions must be taken into account when sizing the discharge header, sizing the relief devices, and compensating the set pressure of unbalanced relief devices (see API Recommended Practices 520 and 521).
5.5.3.3 如果排放汇管遵守本章的其他规定，一个或多个储罐的泄放装置排放管线可以被连接到一个排放汇管上。应避免使用会产生过高背压导致泄放装置不能正常发挥作用的集液器。如果可能会形成妨碍储罐泄放装置发挥正常作用的背压，其他通气口、排液管、分液管和泄放装置不应接入汇管。在确定排放汇管尺寸、泄放装置尺寸以及补偿非平衡泄放装置设定压力时，应考虑泄放期间所产生的背压(见 API Recommended Practices 520 和 521 页)。

5.5.3.4 Relief valves shall be arranged to discharge to open air unobstructed so that any impingement of escaping cold gas upon the container and any roof mounted items is prevented.
5.5.3.4 泄放阀的安装应能保证无阻碍的向大气排放，以防止逸出的冷气体对容器和罐顶安装部件的冲击。

5.5.3.5 A venting device discharge stack or vent shall be designed and installed to prevent water, ice, snow, or other foreign matter from accumulating and obstructing the flow. The discharge shall be directed upwards when relieving to the atmosphere. Independent support of the vertical stack should be considered. Provisions shall be made to reduce the thermal effects on the container and any roof mounted items caused by the ignition of vapor from the relief valve discharge stack..
5.5.3.5 通气装置的排气管道或通气管的设计和安装应能防止因水、冰、雪或其他外部物质堆积而阻碍放空流动。向大气排放时排出口应直接向上。应考虑为垂直排气管安装独立的支撑。应制定相关规定，以减

少由于安全阀排气管蒸汽被引燃时对容器和罐顶安装部件造成的热力影响。

5.5.4 Set Pressure Verification
5.5.4 设定压力检验

The set pressure of all pressure and vacuum relief devices should be verified by testing before the devices are placed in operation.

所有压力和真空泄放装置在投入运行前，应对这些装置的设定压力进行校验。

5.5.5 Materials of Construction
5.5.5 制造材料

Materials for a relief device and its associated discharge piping shall be selected for the stored-product service temperature and pressure at which the device and its piping are intended to operate. Also, the materials should be compatible with the product stored in the tank and with any products formed in the vicinity of the relief device (in case there is a discharge).

泄放装置及其相关排放管线的材质应根据它们运行时储存产品的工作温度和压力进行选择。这些材质也应与储罐储存的产品及泄放装置附近形成的任何产物相匹配(以防有排放发生的情况)。

5.5.6 Maintenance
5.5.6 维护

For recommended maintenance and inspection procedures, see API Bulletin 2521 and API

推荐使用的维护和检查程序参见API Bulletin 2521和API Recommended Practice 576。

5.6 TESTING AND MARKING OF VENTING DEVICES
5.6 通气装置的测试与标记

The procedures for the testing and marking of venting devices for refrigerated aboveground and belowground tanks are the same as the procedures for nonrefrigerated aboveground tanks (see Section 4.6).

制冷地上和地下储罐通气装置的测试和标记程序与非制冷地上储罐的程序相同(见4.6部分)。

APPENDIX A—BASIS OF THE NORMAL VENTING FOR TABLES 1 AND 2
附录 A 正常放空表 1 和 2 的根据

For liquids with a flash point below 100°F (37.8°C), this standard recommends a venting capacity of 12 SCFH of air for each barrel (2.02 Nm3/h per cubic meter) per hour of fill- ing rate. Of this quantity, one half, or 6 SCFH (1.01 Nm3/h per cubic meter) of air, represents the vapor displacement caused by liquid movement. The additional 6 SCFH (1.01 Nm3/h per cubic meter) of air was established on the basis of an evaporation rate of approximately 0.5 percent and to account for the conversion of dense vapors being vented to an air equivalent.

对于闪点低于 100 ℉ （ 37.8 ℃ ）的液体 ，这一标准的建议的排气能力按照每小时流入 1 桶汽油的速率为 12 标准立方英尺/小时（ 每立方米流体排放 2.02 标方/小时）。这个数量，其中一半，即 6 标准立方英尺/小时（每立方米流体排放 1.01 标方/小时）的排气，是由于液体流动造成的空气排放。在另外 6 标准立方英尺/小时（每立方米流体排放 1.01 标方/小时）的排气量是建立在一个按照油气蒸发率接近为百分之零点五并根据气相密度转换为当量空气流量的基础上的。

The evaporation rate of approximately 0.5 percent was selected on the basis of gasoline being pumped into an essentially empty tank. During this period, heat pickup is the greatest. Also, any vapor flashing as a result of hot line products (for example, the pipeline being exposed to the sun) is the most critical at this time, since there is no large heat sink such as exists in a full tank. In addition, vaporization is increased since there is essentially no tank pressure to suppress vaporization. For conversion of hydrocarbon vapor to air, a specific gravity of 1.5, compared with 1 for air, was arbitrarily selected.

蒸发率约为百分之零点五的选择是基于汽油被泵输送到一个原本空罐内的基础上。在此期间，热量的获得是最大的，另外，在这个时候由于任何的热作用（例如，管道被暴露在阳光）而导致气相挥发的结果是最危险的，因为在空罐内没有任何热冷却设备存在。此外，蒸发的增加是由于空罐内基本上没有压力抑制汽化。把油气转换成当量空气，相对空气比重 1 可以选择 1.5 的系数，是任意选择的。

In addition to the venting capacity for product movement indicated above, a thermal evaporation rate based on tank size (see Table 2) was established. This is additive to the venting for liquid movement.

除了上述液体流动产生的的放空量，基于罐的大小影响的热蒸发率的也已给出（见表 2 ），这个需要增加到由液体流动产生的放空量上。

It was established that in the southwestern United States, tanks could be cooled rapidly, as happens when a sudden rainstorm occurs on a hot, sunny day. For vacuum conditions,it was found that roof plates could be cooled as much as 60°F(33°C) and that shell plates could be cooled about 30°F(17°C). This can be converted to a heat loss from the tank vapor space of about 20 BTU per hour per square foot (63 Watts per square meter) of shell and roof surface. From this, vacuum (inbreathing) requirements were set. Since records

它是建立在美国西南部，存在罐可以迅速降温的情况，比如在炎热的晴天可能会突然有暴雨发生。这可能造成罐顶板可冷却高达 60 ℉ （ 33 ° C ）和该罐周围板可冷却约 30 ℉ （ 17 ℃ ），在此情况下会出现真空情况。这个可以转化为油罐气相中约每小时每平方英尺 20 BTU（ 63 瓦每平方米）的灌周和罐顶表面热损失。从这一点出发，真空（内吸气）要求设置。由于多快可以使罐内气相空间再变热（外排气）的记录不详，我们初步的指定内呼吸需求的的百分之六十作为排气的基础。

were not available on how fast tank vapor spaces can be heated (outbreathing), a figure of 60 percent of the inbreathing requirements was arbitrarily selected as the basis for thermal outbreathing.

注：BTU 为英国热能单位：是在美国和有时在英国使用的一种标准能量单位。它表示在液体水的密度最大时，将一磅纯液态水的温度提高 1 华氏度所需要的热能。

In establishing the basis above, it was recognized that the requirements for outbreathing are some what conservative; however, some conservatism was believed to be desirable to take into account both unusual climatic conditions and products that might generate more vapor than gasoline generates. Also, the cost involved for a larger venting device is very small, considering the overall cost of a tank. This conservatism also provides some margin of safety should pumping rates be increased slightly above design rates.

建立上述的基础上，人们认识到，对排气要求有些保守。不过，这些保守被认为是可取的，它既考虑

到不同寻常的气候条件也考虑了能比汽油产生更多气相的产品。此外，考虑到罐的整体成本，排放装置的加大所涉及的费用非常小。这个保守还提供在泵流量略高于设计流量时的一些安全余量。

APPENDIX B—BASIS OF EMERGENCY VENTING FOR TABLES 3 AND 5
附录 B—表 3 和 5 的紧急通风原则

The emergency venting requirements contained in the first edition of API Recommended Practice 2000, *Guide for Venting Atmospheric and Low-Pressure Storage Tanks* were based on the assumption that a tank subjected to fire exposure will absorb heat at an average rate of 6000 BTU per hour per square foot (18,900 Watts per square meter) of wetted surface. The minimum emergency relief capacity, given in approximate diameter of a free circular opening, was computed from the results of a detailed analysis of the distillation characteristics of a typical straight-run gasoline from Mid-continent crude oil, using a conventional orifice formula, an orifice coefficient of 0.7, and a vapor specific gravity of 2.5. An emergency venting capacity of 648,000 cubic feet (17,400 cubic meters) per hour was the maximum required for any tank, regardless of size. This maximum emergency venting capacity was based on the following: tanks with a capacity of more than 17,500 barrels (2,780 cubic meters), when heated, require such a long period of time to elapse before their contents reach a temperature at which rapid boiling starts that it is extremely unlikely that this point would ever be reached, and even if it should be, there would be ample time to take the necessary precautions to safeguard life and property.

第一版API RP2000（常压和低压储罐的通风指南）中的紧急通风要求，建立在假设一台承受火灾的储罐将平均吸收热量6000 BTU/h/ft 润湿面积(18900W/m2)的基础上。最小紧急泄放能力，用圆形开口的近似直径表示，是用常规的孔板公式（孔板系数取0.7、蒸气比重取2.5），通过对典型的产自中大陆原油的直馏汽油的蒸馏特性的详细分析结果计算得出的。无论多大尺寸，648,000 ft3/h（17,400m3/h）的紧急通风能力是任何储罐的最大通风要求。该最大通风能力建立在以下条件上：容积大于17,500桶(2,780m3)的储罐，当加热时，其物料达到迅速沸腾的起始温度（该温度极不可能达到）之前需要很长时间，而这个时间足够采取必要的措施保护生命和财产。

This basis for emergency venting was adopted by the National Fire Protection Association (NFPA)2 and was successfully used for many years. As far as can be determined, except for some containers of unusually small capacities, no case has been recorded in which a tank failed from overpressure because of insufficient emergency venting capacity when vented in accordance with this basis.

该紧急通风原则已经被美国国家消防协会(NFPA)注2采用，并成功实施了多年。除了少数罕有的小容积罐外，在确定前，尚无任何一台按本原则通风的储罐因紧急通风能力不足而导致超压失效的记录。

A few catastrophic tank ruptures did, however, occur in cases in which the emergency venting was not in accordance with this basis. These tank ruptures focused attention on emergency venting requirements. Many small-scale fire tests demonstrated that heat inputs of more than 6,000 BTU per hour per square foot (18,900 Watts per square meter) of surface could be obtained under ideal conditions; however, large-scale test data were lacking. In June 1961, during fire demonstrations in Tulsa, Oklahoma, a horizontal tank measuring 8 feet x 26 feet 10 inches (2.44 meters x 8.18 meters) was equipped with an emergency venting device sized to limit the internal pressure of the tank to approximately 3 inches of water column (7.5 mbarg). Measurements indicated that under exposure to fire, the pressure rose to approximately 1.6 pounds per square inch gauge (110 mbarg). Based on these tests, it was agreed that emergency venting requirements should be reexamined. As a result of this study, the current basis for heat input under exposure to fire was developed.2

少数灾难性的因通风不足导致的储罐破裂确实发生了，然而，这些案例的紧急通风并未基于本原则的基础上。这些储罐破裂原因集中在紧急通风要求上。很多小范围的消防试验证明，在理想状态下可以获得超过6,000 BTU/h/ft2 (18,900W/m2)的单位热量输入；然而，缺乏大范围的试验数据。1961年六月，俄克拉荷马州 (Oklahoma) 塔尔萨市 (Tulsa) 的消防示范中，一台8’ X 26’10” (2.44 m X 8.18m)的卧罐，装备了一个将罐内压力限制在3”水柱(7.5mbar)的紧急通风装置。测量显示暴露在火灾中时，压力升高到了约1.6 lbf/in2表压(110 mbarg)。基于这些测试，大家一致认为应重新检查紧急通风要求。作为这次研究的结论，研究出了目前的火灾情况下的热量输入原则注2。

注2：National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts 02269-9101.
美国国家消防协会，1 Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts 02269-9101.

Tables 3 and 5 are based on a composite curve that is composed of three straight lines when plotted on log graph paper. The curve may be depended in the following manner: The first straight line is drawn between 400,000 BTU per hour (117,240 Watts) at 20 square feet (1.86 square meters) of wetted surface area and 4,000,000 BTU per hour (1,172,400 Watts) at 200 square feet (18.6 square meters) of wetted surface area. The equation for this portion of the curve is:

表3和5是基于绘制在对数图纸上的3条直线组成的合成曲线。该曲线可以用下列方式绘制：第一条直线连接400,000 BTU/h (117,240 W) 对应润湿面积为20 ft2 (1.86m2)和4,000,000 BTU/h (1,172,400 W) 对应润湿面积200 ft2 (18.6m2)。该段曲线的公式为：

Q = 20,000A (English Units 英制单位) （B-1)

Q = 63,150A (Metric Units 公制单位)

The second straight line is drawn between 4,000,000 BTU per hour (1,172,400 Watts) at 200 square feet (18.6 square meters) of wetted surface area and 9,950,000 BTU per hour (2,916,000 Watts) at 1,000 square feet (93 square meters) of wetted surface area. The equation used for this portion of the curve is:

第二条直线连接4,000,000 BTU/h (1,172,400 W) 对应润湿面积200 ft2 (18.6m2)和9,950,000 BTU/h (2,916,000 W)对应润湿面积1000 ft2 (93m2)。该段曲线的公式为：

Q = 199,300A0.566 (English Units 英制单位) (B-2)

Q = 224,200A0.566 (Metric Units 公制单位)

The third straight line is drawn between 9,950,000 BTU per hour (2,916,000 Watts) at 1,000 square feet (93 square meters) of wetted surface area and 14,090,000 BTU per hour (4,129,700 Watts) at 2,800 square feet (260 square meters) of wetted surface area. The equation used for this portion of the curve is:

第三条直线连接9,950,000 BTU/h (2,916,000 W)对应润湿面积1,000 ft2 (93m2)和14,090,000 BTU/h (4,129,700 W) 对应润湿面积200 ft2 (18.6m2)。该段曲线的公式为：

Q = 963,400A0.338 (English Units 英制单位) (B-3)

Q = 630,400A0.338 (Metric Units 公制单位)

Figure B-1 shows the composite curve for English Units.

图B-1为英制单位的合成曲线。

For nonrefrigerated tanks designed for pressures of 1 pound per square inch gauge (69 mbarg) and below, with wetted surfaces larger than 2,800 square feet (260 square meters), it has been concluded that complete fire involvement is unlikely and loss of metal strength from overheating will cause failure in the vapor space before development of the maximum possible rate of vapor evolution. Therefore, additional venting capacity beyond the vapor equivalent of 14,090,000 BTU per hour (4,129,700 Watts) will not be effective.

对设计压力1 lbf/in2表压(69mbarg)及以下，润湿面积大于2,800 ft2 (260m2)的非冷藏罐，结论表明整个罐体完全失火是不太可能的，且过热引起的金属强度降低，在蒸气产生的速率达到最大可能速率之前，就将导致蒸气空间的罐体失效。因此，超出14,090,000 BTU/h (4,129,700 W)当量蒸气的额外的通风能力将没有作用。

For all refrigerated tanks, regardless of design pressure, and for all nonrefrigerated tanks and storage vessels designed for pressures over 1 pound per square inch gauge (69 mbarg), additional venting for exposed surfaces larger than 2,800 square feet (260 square meters) is believed to be desirable because, under these storage conditions, liquids often are stored at temperatures close to their boiling points. Therefore, the time required to bring these liquids to the boiling point may not be significant. For these situations, a heat input value should be determined on the basis of:

对所有冷藏罐，无论设计压力多少，及对所有设计压力大于1 lbf/in2表压(69mbarg)的非冷藏罐和储存容器，当火灾暴露面积大于2,800 ft2 (260m2)时，额外通风是值得的，因为，这些储存条件下，液体储存温度经常接近于沸腾温度。因此使这些液体达到沸腾点的时间可能很短。对这些情况，热输入量应基于下式确定：

Q = 21,000A0.82 (English Units 英制单位) (B-4)

Q = 43,200A0.82 (Metric Units 公制单位)

The total emergency venting requirements, in SCFH of air, are based on the heat input values described in the preceding paragraphs. These heat input values, in BTU per hour (Watts), are converted to SCFH (Nm3/h) of air on the assumption that the stored liquids will have the characteristics of hexane and the venting will occur at 60°F (15.6°C), using the following formula:

总的紧急通风要求，单位为标准立方英尺空气每小时，是基于上述段落中所述的热输入量。单位为英热单位每小时（瓦特）的热输入量，假设储存的液体与己烷的性质相同，且通风发生在60°F (15.6°C)，用以下公式转换为标准立方英尺空气每小时（Nm3/h）：

A. English Units 英制单位 (B-5)

where

其中

SCFH = venting requirement, in standard cubic feet of air per hour,
通风要求，标准立方英尺空气每小时

70.5 = factor for converting pounds of vapor to standard cubic feet of air，
转换因子，英磅蒸气转标准立方英尺空气

Q = total heat input, in BTU per hour (determined from Figure B-1 using the calculated wetted surface, A),
总输入热量，英热单位每小时（根据接触液体面积的计算值A，查图B-1）

L = latent heat of vaporization at relieving conditions, in BTU per pound,
泄放条件下的汽化潜热，英热单位每磅

M = molecular weight of the vapor being relieved.
泄放蒸气的摩尔重量

In the equation:
在下面的公式中：

$$SCFH = 1107A\ 0.82 \qquad \text{(B-6)}$$

the constant 1107 is derived from the previous equation, substituting 21,000 BTU per hour for *Q*, and the latent heat of vaporization, *L*, and the molecular weight *M*, for hexane (144 BTU per pound and 86.17, respectively).

常数1107从先前的公式中推导得出， Q代以21,000BTU/h，汽化潜热L和摩尔重量M，对己烷来说(分别为144英热单位／磅和86.17)

B. Metric Units
公制单位

Where

其中

Nm3 / h = venting requirement, in normal cubic meters of air per hour,
通风要求，标准立方米空气每小时

14982 = conversion factor,
转化因子

Q = total heat input, in Watts (determined from Figure B-1 using the calculated wetted surface, A),
总输入热量，瓦特（根据接触液体面积的计算值A，查图B-1）

L = latent heat of vaporization at relieving conditions, in J/kg,
泄放条件下的汽化潜热，焦耳每千克

M = molecular weight of the vapor being relieved.
泄放蒸气的摩尔重量

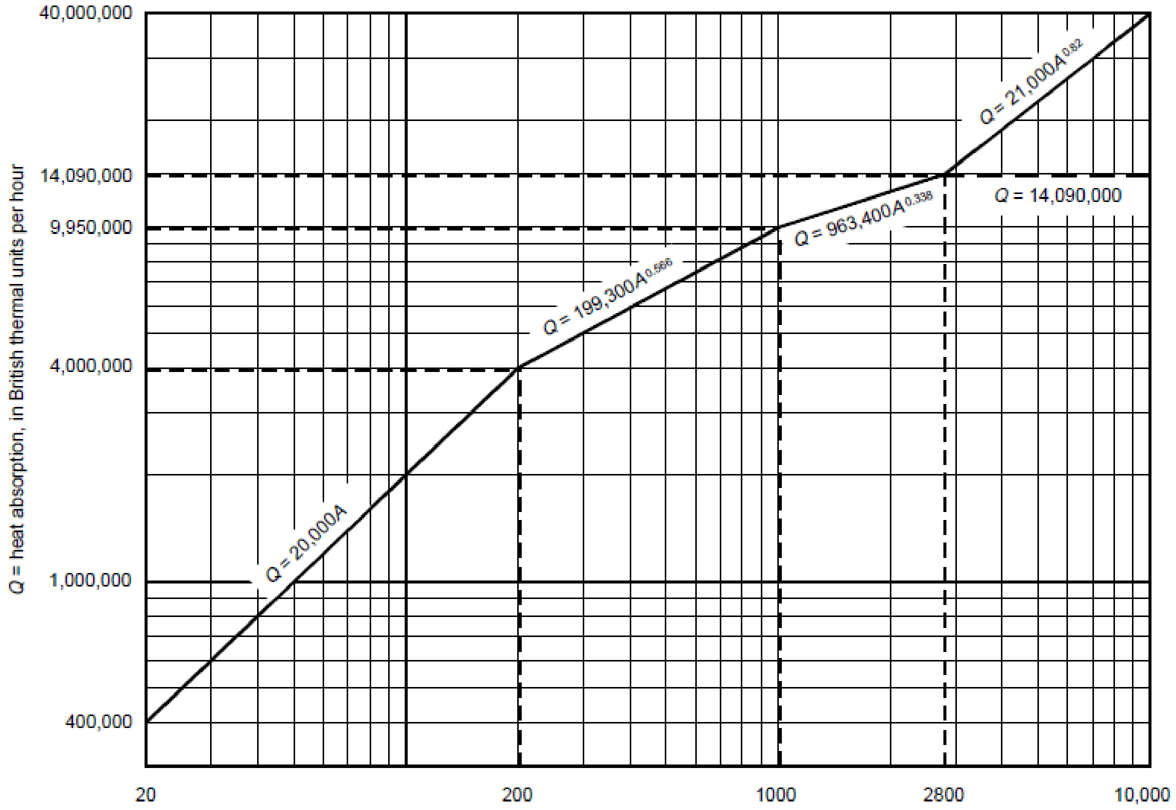
In the equation:
在下面的公式中：

$$Nm3\ /\ h\ =\ 208.2A0.82 \quad \text{(B-7)}$$

the constant 208.2 is derived from the previous equation, substituting 43,200 W for *Q*, and the latent heat of vaporization, *L*, and the molecular weight *M*, for hexane (334,900 J/kg and 86.17, respectively).
常数208.2从先前的公式中推导得出，Ｑ代以43,200瓦，汽化潜热L和摩尔重量M，对己烷来说(分别为334,900焦尔／千克和86.17)

No consideration has been given to possible expansion from heating the vapor above the boiling point of the liquid, the specific heat of the vapor, or the difference in density between the discharge temperature and 60°F (15.6°C) because some of these changes are compensating.
未考虑超过液体沸点时可能的蒸汽加热膨胀，蒸汽比热，或泄放温度与60°F (15.6°C)下的密度差异，因为其中的一些变化是补偿修正。

Because of some concerns expressed about the differences in various methods for determining fire case venting requirements, and a desire to standardize on one method, the subcommittee surveyed approximately 100 companies from 1993 to 1996. This survey indicated that there was no detectable difference in the level of safety provided by using the fire sizing methods found in this document, API RP 520, APIRP 521, NFPA documents, or other commonly used fire case venting calculation methods. The subcommittee abandoned efforts to standardize the industry on one method for determining fire case venting requirements in 1996.
因为对确定火灾情况下通风要求的各种不同方法的担心，以及期望能标准化为一种方法，附属委员会从1993到1996年调查了将近100加公司。调查表明，使用本文件、API RP520、API RP521、NFPA文件中的火灾评估方法或其他常用的火灾情况下的通风计算方法，从安全角度来讲没有明显的差异。1996年附属委员会放弃了将火灾情况下的通风要求标准化为一个方法的努力。



A = wetted surface area, in square feet
A=润湿面积，平方英尺

Note: Above 2,800 square feet of wetted surface area, the total heat absorption is considered to remain constant for nonrefrigerated tanks below 1 pound per square inch gauge. For nonrefrigerated tanks above 1 pound per square inch gauge and for all refrigerated tanks, the total heat absorption continues to increase with wetted surface area. This is the reason why the curve splits above 2,800 square feet.

注：超出 2,800 平方英尺润湿面积，压力低于 1 lbf/ft2 表压的非冷藏罐总吸热量为常数。大于 1 lbf/ft2 表压的非冷藏罐和所有冷藏罐，总吸热量随润湿面积的增加而增加。这是超出 2,800 平方英尺后曲线变化的原因。

Figure B-1—Curve for Determining Requirements for Emergency Venting During Fire Exposure

图 B-1 —火灾情况下的紧急泄放要求曲线

APPENDIX C—TYPES AND OPERATING CHARACTERISTICS OF VENTING DEVICES
附录 c-通气装置的类型和操作特点

C.1 Introduction
C.1 简介

Two basic types of pressure or vacuum vents, direct-acting vent valves and pilot-operated vent valves, are available to provide overpressure or vacuum protection for low-pressure storage tanks. Direct-acting vent valves may be weight loaded or spring loaded. Springs are generally used for set pressures above 1 pound per square inch gauge (69 mbarg) or vacuum below -1 pound per square inch gauge (-69 mbarg). These venting devices not only provide overpressure protection but also conserve product. Direct-acting vent valves are sometimes referred to as conservation vents.

对于低压储罐有两种基本形式的压力或真空通气用于提供过压或真空保护，即：直接作用式通气阀和先导式压力通气阀。直接作用式通气阀可以是重力式或弹簧式。弹簧式一般用于表压高于 1 磅每平方英寸（69 mbarg）或真空度低于-1 磅每平方英寸（-69 mbarg）的设定压力。这些通气装置不仅提供过压保护，也可以用来保存产品。直接作用式通气阀有时也称作安全通气。

Another type of venting device, an open vent, is available to provide overpressure or vacuum protection for storage tanks designed to operate at atmospheric pressure. An open vent is always open. It allows a tank designed to operate at atmospheric pressure to inbreathe and outbreathe at any pressure differential. An open vent is usually provided with some type of weather hood or shape that prevents rain or snow from entering the tank (see Figure C-1).

对于设计在常压下操作的储罐，可采用另外一种通气装置--开口通气管来提供超压或真空保护。开口通气管始终是打开的。它允许设计在常压下操作的储罐在任何压差下进行吸入和呼出。通常，开口通气管都配有某种防风雨罩或具有某种形状，以防雨雪进入罐内（见图 C-1）。

A summary of operating characteristics is provided in Table C-1.

操作特点汇总见表 C-1。

C.2 Direct-Acting Vent Valves
C.2 直接作用式通气阀

C.2.1 DESCRIPTION
C.2.1 说明

Direct-acting vent valves are available to provide pressure relief, vacuum relief, or a combination of pressure and vacuum relief. Combination vent valves may be of a side-by-side configuration (see Figure C-2). Side-by-side vent valves or pressure relief vent valves are available with flanged outlets for pressure discharge when pressure relief vapors must be piped away.

直接作用式通气阀用于提供压力泄放，真空泄放，或压力和真空泄放的结合。结合式通气阀可以是肩并肩的结构（见图 C-2）。当压力泄放气必须用管引导出去时，肩并肩通气阀或压力泄放通气阀带有用法兰连接的出口用于压力排放。

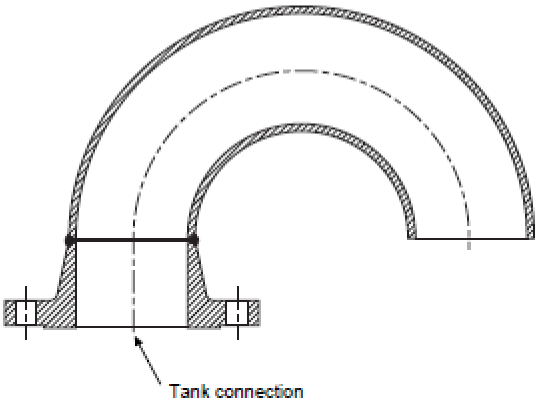


Figure C-1—Open Vent

Larger direct-acting vent valves are available to provide emergency relief and can provide access to a tank's interior for inspection or maintenance. They are typically available in sizes from 16 inches (400 mm) to 24 inches (600 mm) (see Figure C-3). Figure C-4 shows other types and configurations of direct-acting vent valves.

大型的直接作用式通气阀用于紧急泄放，并能在检查或维护时通过其进入罐内。典型尺寸为从 16 英寸（400 mm）到 24 英寸（600 mm）(见图 C-3)。图 C-4 展示了直接作用通气阀的其它形式和结构。

C.2.2 PRINCIPLE OF OPERATION
C.2.2 作用原理

The principle of operation of a direct-acting vent valve is based on the weight of the pallet or the spring force acting on the pallet to keep the device closed. When tank pressure or vacuum acting on the seat sealing area equals the opposing force acting on the pallet, the venting device is on the threshold of opening. Any further increase in pressure or vacuum causes the pallet to begin to lift off the seat.

直接作用式通气阀的作用原理是根据垫板的重量或弹簧作用在垫板上的力来保持装置封闭。当作用在阀座密封面上的罐压力或真空等于作用在垫板上的反作用力时，通气装置处于开启的临界状态。

Seventy percent to 100 percent overpressure is usually required to achieve full lift of a pallet (see Figure C-5). For an application in which full lift of the seat pallet is required for capacity reasons but cannot be obtained because of a pressure limit on the storage tank, a larger venting device or multiple venting devices must be used at reduced lift and capacity. Several large venting devices instead of many small venting devices are usually preferred to minimize the number of tank penetrations. As an alternative, a set pressure below the maximum allowable working pressure of the tank may be selected to allow full lift.

通常需要超压 70%到 100%可 使垫板完全升起。对于由于容量的原因要求阀座垫板完全升起，但是由于储罐的压力限制不能获得全部完全的应用，在降低的升起度或容量的情况下，必须使用大型通气装置或多个通气装置。通常用几个大型通气装置代替许多小型通气装置是较好的选择，这样可以最小化对罐的穿孔。另一种可选方案是，设定压力低于罐最大允 许工作压力，以允许完全升起。

C.2.3 SEAT TIGHTNESS
C.2.3 阀座气密

A soft, nonstick material is typically used on the sealing surface of the pallet. This material produces a better seal between the pallet and the nozzle and prevents the pallet from sticking to the nozzle.

通常柔软，非粘性的物质可用作垫板的密封面。这种物质在垫板和管口间产生良好的密封，并防止垫板粘在管口上。

A direct-acting vent valve is tightest when tank pressures are 75 percent or less of set pressure. When tank pressures are 90 percent or more of set pressure, seat leakage is common. The closer a tank gets to the set pressure, the more the seats leak. For the same set pressure, larger vent valves are tighter than smaller vent valves. This is because the circumferential unit load at the pallet seating surface is directly proportional to the diameter of the seating area.

当罐压力为设定压力的 75%或更低时，直接作用式通气阀有最好的气密性。当罐压力为设定压力的 90%或更高是，阀座的泄露很常见。越是接近罐的设定压力，泄露越严重。对于相同的设定压力，大型的通气阀比小型的通气阀气密好。这是因为阀座垫板表面的圆周单位负荷与阀座面的直径成正比。

Seat leakage can cause vent valve seats to stick closed if the vapors from the storage tank product polymerize when exposed to atmospheric air or the vapors autorefrigerate, condense, and freeze atmospheric moisture. Purging the seat area with an inert gas, such as nitrogen, or using a steam-jacketed venting device may be necessary to prevent sticking.

如果来从储罐产品的蒸汽接触空气发生聚合或蒸气自动制冷、冷凝和冷冻大气中的水分，阀座泄漏会导致通气阀阀座粘连。为了防止上述粘连，可能需要使用惰性气体（如氮气）来吹扫阀座或使用带有蒸汽夹套的通气装置。

Seat leakage can be caused by uneven bolt torque on flanged connections, particularly in large diameter devices Figure C-1—Open Vent such as weight-loaded emergency venting devices.

法兰连接的螺栓力矩不均匀会导致阀座泄露，尤其是直径较大的设备，如重力式紧急通气装置。

In areas with strict fugitive emissions regulations, open vents may not be acceptable and vent device selection must consider maximum leakage requirements during periods of normal tank operation.

在有严格逃逸排放规定的区域内，敞开式通气可能不可行，且在罐正常操作期间，通气装置的选择必须考虑最大泄露要求。

C.2.4 VENTING DEVICE SIZES AND SET PRESSURES
C.2.4 通气装置的尺寸和设定压力

Direct-acting vent valves are typically available in sizes from 2 inches (50 mm) to 12 inches (300 mm); however, vent valves in a stacked configuration (see Figure C-4) are available in sizes up to 24 inches (600 mm). The size of a vent valve is based on the venting device's tank connection.

直接作用式通气阀的典型尺寸为从 2 英寸（50 mm）到 12 英寸（300 mm）；叠加结构（见图 C-4）中的通气阀的尺寸可达 24 英寸（300 mm）。通气阀的尺寸取决于通气设备的罐连接。

Typical set pressure ranges for weight-loaded vent valves are up to 16 ounces per square inch pressure (69 mbarg) and up to 10 ounces per square inch vacuum (-43 mbarg). Springloaded vent valves must generally be used for pressure or vacuum settings that exceed these values because the supporting structure and space for the added weights is not available.

重力式通气阀的典型设定压力范围可达 16 盎司每平方英寸压力（69 mbarg）和 10 盎司每平方英寸真空（-43 mbarg）。由于没有提供支撑结构和空间增加的重量，一般情况下，弹簧式通气阀使用的压力或真空设定值必须超过这些值。

Verification of the set pressure of a venting device after it has been installed on a storage tank can be accomplished by increasing the tank pressure or vacuum. To change the set pressure, weights must be added or removed from the pallet, a new pallet must be used, or the spring must be adjusted (if a spring-loaded vent valve is being used).

通气装置安装到储罐之后，通过增加罐的压力和真空可以实现设定压力的确认。为改变设定压力，可在垫板上增加或减少重量，必须使用新垫板，或调整弹簧（如果使用弹簧式通气阀）。

C.3 Pilot-Operated Vent Valves
C.3 先导式通气阀门

C.3.1 DESCRIPTION
C.3.1 描述

Pilot-operated vent valves are available to provide pressure relief, vacuum relief, or a combination of pressure and vacuum relief. Some vent valves may be equipped with flanged outlets when pressure relief vapors must be piped away. Unlike side-by-side direct-acting vent valves, pilot-operated vent valves relieve pressure or vacuum through the same opening to atmosphere (see Figure C-6).

先导式通气阀可以用来实现泄压、真空泄放或泄压和真空泄放的组合。当泄压排出的蒸汽必须通过管道排走时，一些通气阀门可以使用配装法兰盘的出气口。与并行安装的直动式通气阀不同，先导式通气阀通过同一个与大气相通的出口来泄放压力或真空(见图 C-6)。

C.3.2 PRINCIPLE OF OPERATION
C.3.2 工作原理

A pilot-operated vent valve for pressure relief uses tank pressure, not weights or a spring, to keep the vent valve seat closed. The main seat is held closed by tank pressure acting on a large area diaphragm. This tank pressure covers an area greater than the seat sealing area, so the net pressure force is always in a direction to keep the seat closed. The volume above the diaphragm is called the dome. Should the diaphragm fail, the dome pressure will decrease, and the vent valve will open.

先导式通气阀泄压时利用储罐压力，而不是重力或弹簧外力，来保持通气阀阀座关闭。主阀座通过作用在大面积隔膜上的储罐压力保持关闭。罐压作用的面积大于阀座密封面的面积，因此净压作用方向总是能保持阀座的闭合。隔膜上方的空间叫做汽包。隔膜一旦失效，汽包压力将下降，通气阀随之打开。

The pilot is a small control valve that continuously senses tank pressure. When the tank pressure increases to set pressure, the pilot actuates to reduce the pressure in the dome volume, the force holding the seat closed is reduced, and the seat lifts to permit tank pressure to discharge through the vent valve. When the tank pressure decreases, the pilot closes, the dome volume repressurizes, and the main seat closes.

先导器是一个能够连续感知检测储罐压力的小型控制阀门。当储罐压力增加到设定压力，先导器动作减少汽包压力，保持阀座关闭的作用力随之减小，阀座打开将储罐压力通过通气阀泄放排出。当储罐压力减少后，先导器关闭，汽包重新加压，主阀座随之关闭。

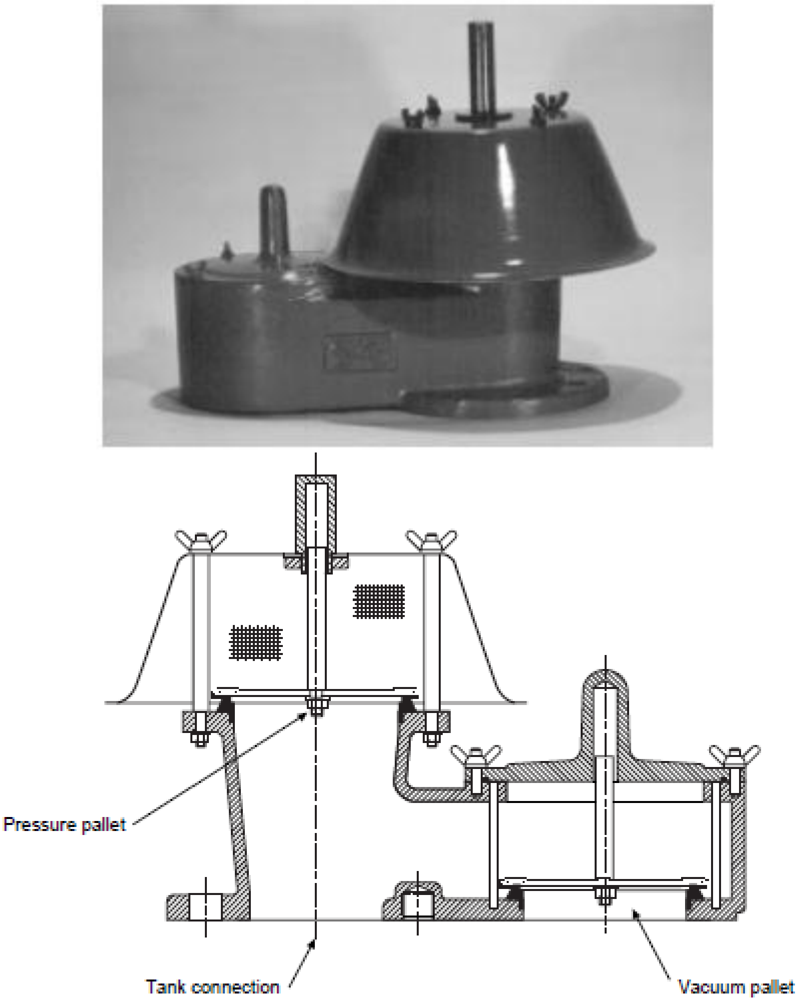


Figure C-2—Side-by-Side Pressure/Vacuum Vent

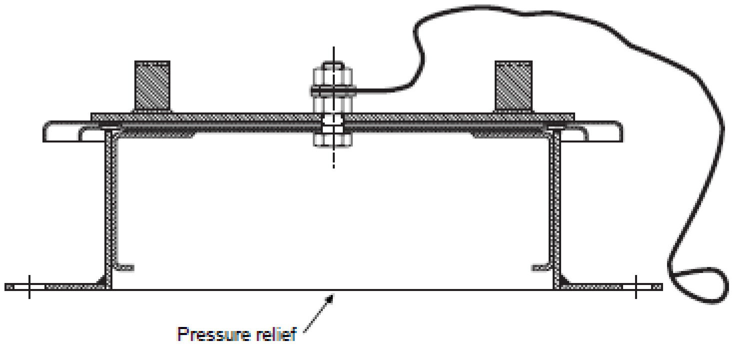


Figure C-3—Large Weight-Loaded Emergency Vent

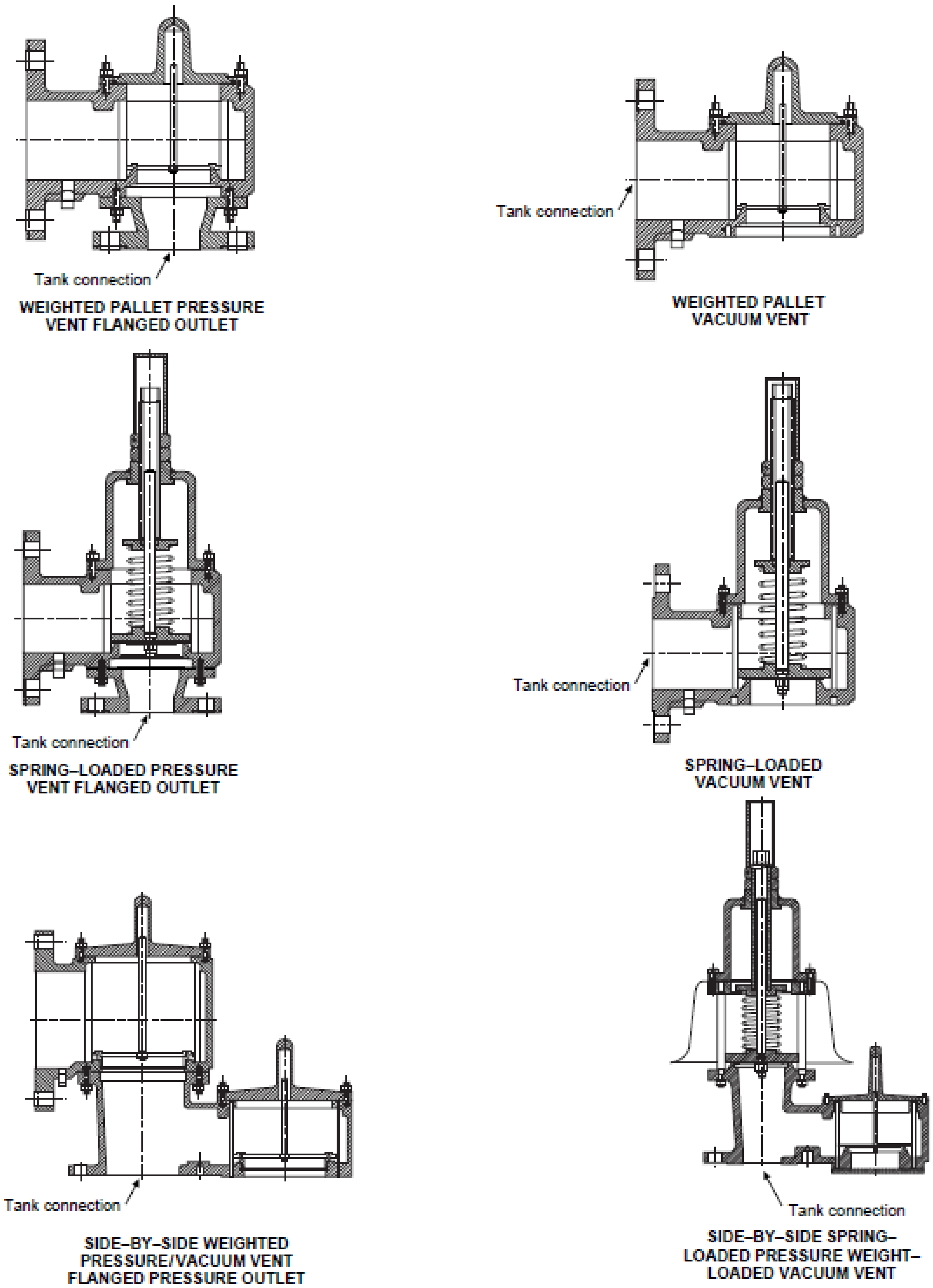


Figure C-4----Direct-Acting Vents

Blowdown is defined as the difference between opening and closing pressure. This pressure difference is expressed as pressure or as a percent of the set pressure. Typical blowdowns are 0 percent to 7 percent. A vent valve with 0 percent blowdown is known as a throttling vent valve. A throttling vent valve is similar to a direct-acting vent valve because it begins to open and close at almost the same pressure; however, unlike in a direct-acting vent valve, full lift of the seat in a throttling vent valve is obtained at or below 10 percent overpressure (see Figure C-5). Where tank operating pressures are very close to the maximum allowable tank pressure, this lift characteristic permits overpressure protection to be accomplished with smaller or fewer venting devices.

压力排放量定义为通风阀打开和关闭时的压力差。这个压力差用压力数值或占设定压力的百分比来表示。典型的压力排放量是 0%～7%。压力排放量为 0%的通气阀称为节流通气阀。节流通气阀与直动式的通气阀门相似，因为它们都是在几乎相同的压力下打开和关闭。不过，与直动式的通风阀门不同的是：节流通气阀的阀座可以在 10%或低于 10%的超压下完全打开(见图 C-5)。在储罐操作压力非常接近储罐最大允许压力的地方，这种打开特性允许使用较小或较少的通气装置来实现超压保护。

A pilot-operated vent valve for vacuum relief uses atmospheric pressure to keep the seat closed. The force holding the seat closed is equal to the seat sealing area times the pressure differential across the seat. This pressure differential is equal to atmospheric pressure plus the tank vacuum. When the tank vacuum equals the pilot set, the pilot opens to apply tank vacuum to the large dome volume above the diaphragm. Atmospheric pressure acting on the downstream side of the diaphragm forces the diaphragm and seat up. Little or no increase in tank vacuum beyond the vent valve setting is required to obtain full lift of the seat. When the tank vacuum decreases, the pilot closes and atmospheric pressure enters the dome to close the main seat.

用于真空泄放的先导式通气阀利用大气压力来保持阀座关闭。保持阀座关闭的作用力等于阀座密封部分面积乘以通过阀座两侧的压差。压差等于大气压力加上储罐真空度（表计）。当储罐真空等于先导器设定值时，先导器动作，将真空导入隔膜上方的气包。作用于隔膜下侧的大气压力使隔膜和阀座上升开启。相对通气阀设定真空值，几乎不用增加多少储罐真空度就可以实现阀座的全开。当储罐真空度降低时，先导器关闭，大气压力进入汽包并关闭主阀座。

Should the diaphragm fail, atmospheric air will enter the dome and prevent tank vacuum from creating a force differential to lift the seat. Double diaphragm vent valves are available to prevent such a failure (see Figure C-7): One diaphragm is for pressure actuation, and one is for vacuum actuation. Each diaphragm is isolated and protected from the flow stream and fully supported to minimize stress. The vacuum diaphragm moves only to provide vacuum relief to extend its service life.

一旦隔膜失效，大气空气将进入汽包，阻止通过储罐真空产生打开阀座的压力差。双隔膜通气阀能有效防止这种失效的发生(见图 C-7)：一个隔膜用于压力动作，另一个用于真空动作。每个隔膜都被隔离和保护不受流体的影响，并有充分支撑以达到应力最小化。真空隔膜仅在提供真空泄放时移动以延长其工作寿命。

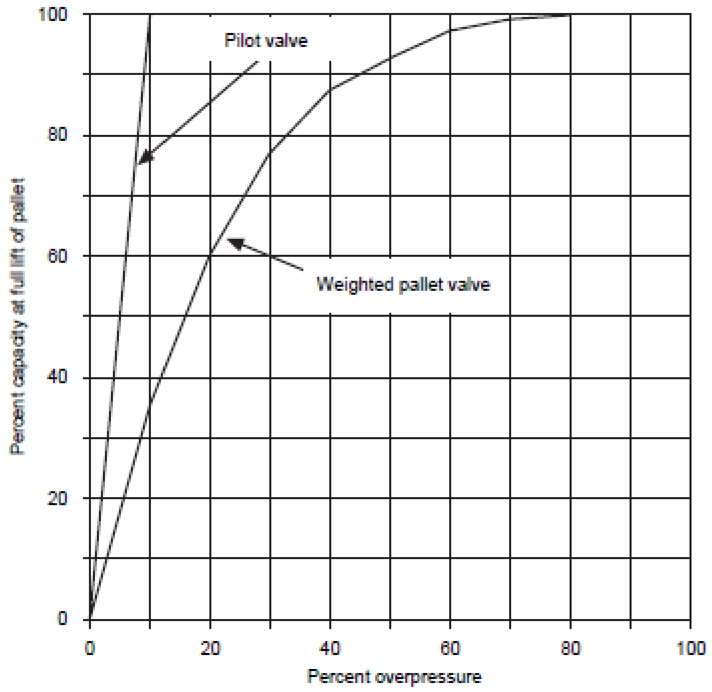


Figure C-5—Capacity/Overpressure Characteristic of Vent

C.3.3 SEAT TIGHTNESS
C.3.3 阀座紧密性

All low-pressure pilot vent valves are soft seated for premium tightness. Unlike in a direct-acting vent valve, the force holding the seat closed in a pilot vent valve increases with increasing pressure. This force is maximum just before the vent valve opens, so leakage will not occur when tank pressure increases or when tank pressure is kept near the set point of the venting device. The force available to open the seat at set pressure is also maximum, since the force holding the seat closed is removed when set pressure is reached. The opening force available is essentially equal to the seat area times the tank pressure.

所有低压先导式通气阀都采用软阀座以保证高度紧密性。不同于直动式通气阀，先导式通气阀保持阀座关闭的作用力随压力增加而增加。在通气阀打开之前，这一作用力达到最大，所以在储罐压力增加时或储罐压力保持在通气装置设定压力附近时，不会发生泄漏。因为达到设定压力时（达到最大值的）使阀关闭的作用力消除了，所以此时用来打开通气装置阀座的作用力也达到最大。这个打开阀座的作用力基本上等于阀座面积乘以储罐压力。

C.3.4 PILOT TYPES
C.3.4 先导器类型

Two types of pilot actions are available, modulating and snap action. For modulating action, the main vent valve opens gradually with increasing pressure and achieves rated relieving capacity at relieving pressure. Modulating valves reclose at set pressure. For snap action, the main valve opens rapidly at set pressure and achieves rated relieving capacity at relieving pressure. Blowdown is normally adjustable.

目前使用的先导器有两种：调制式和快动式。对于调制式先导器，主阀门将随压力增加而逐渐打开，在泄放压力时达到额定排放量。调制式阀在设定压力时重新关闭。对于快动式先导器，主阀门在达到设定压力时快速打开并且在泄放压力时达到额定排放量。压力排放量通常是可调节的。

C.3.5 VENTING DEVICE SIZES AND SETPRESSURES
C.3.5 通气装置尺寸和设定压力

Low-pressure pilot-operated vent valves are typically available in sizes from 2 inches (50 mm) to 12 inches (300 mm). The size of a vent valve is based on the venting device’s tank connection. Available set pressures range from 15 pounds per square inch gauge pressure (1.034 barg) to 14.7 pounds per square inch gauge vacuum (-1.013 barg). The minimum opening pressure is typically 2-inch water column pressure (5 mbarg) or 2-inch water column vacuum (-5 mbarg).

目前使用的典型低压先导式通气阀的尺寸在 2 英寸 (50mm)～12 英寸（300mm）之间。通气阀的尺寸是基于与通气装置与储罐的连接确定的。有效的设定压力范围是从 15 磅/in2(15psig) （1.034barg）～14.7 磅/in2(14.7psig-真空表压)(-1.013barg)。典型最小的打开压力是 2 英寸水柱（5mbarg）或 2 英寸水柱表计真空度（-5mbarg）。

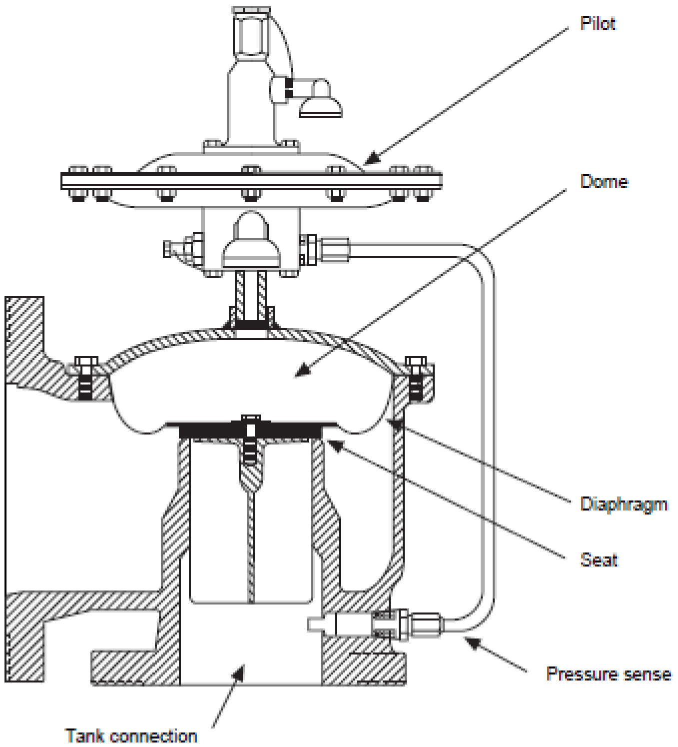


Figure C-6----Pilot-Operated Pressure Vent (Single Diaphragm)

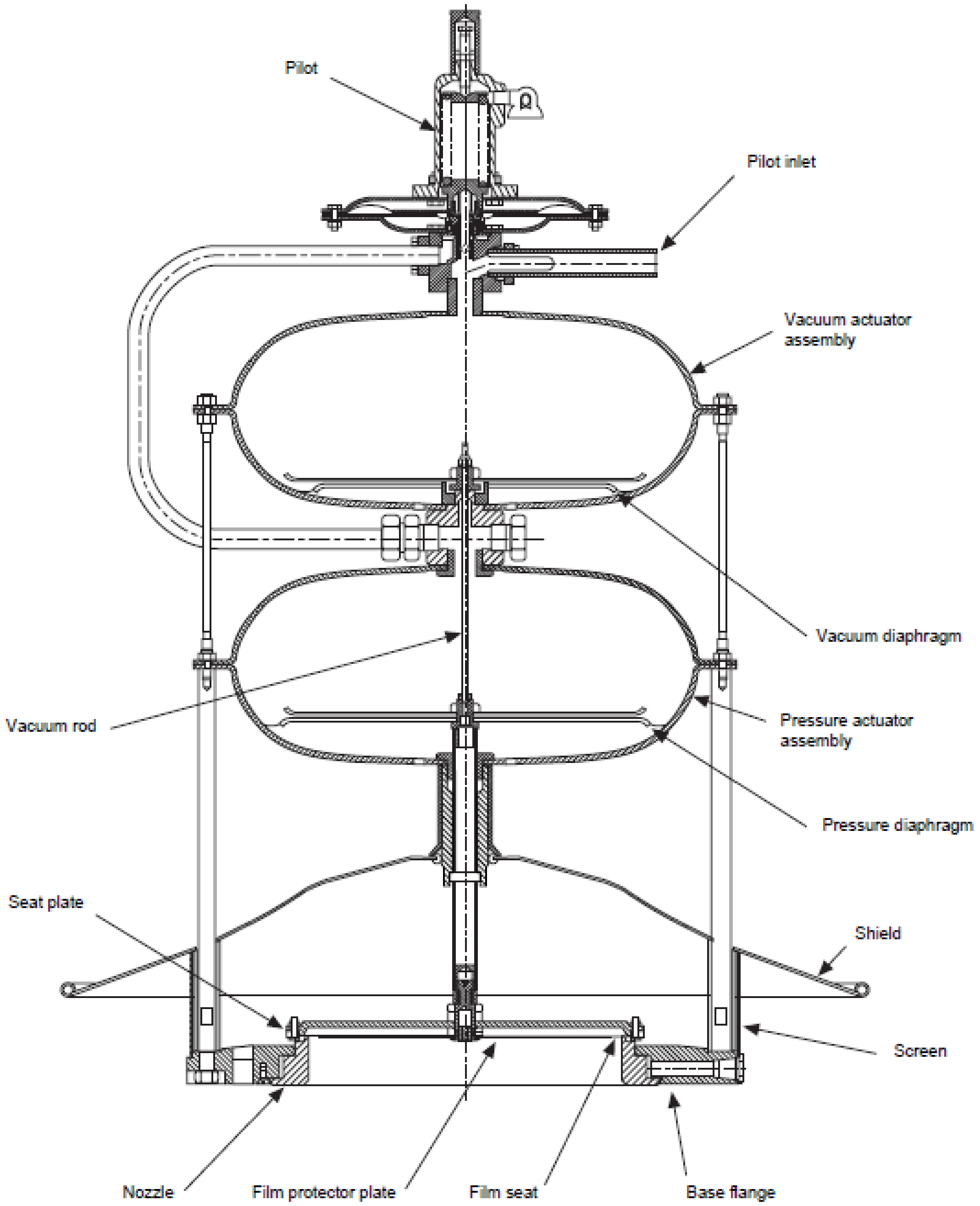


Figure C-7----Pilot –Operated Pressure/Vacuum (Double Diaphragm)

C.3.6 OPTIONAL FEATURES
C.3.6 可选功能

Several options are available with a pilot-operated vent valve. Forverifyingsetpressure, afield-testconnectioncan be supplied that permits checking the set pressure with the vent valve installed and pressurized.

先导式放空阀有一些功能。为确定设定压力，通过现场试验可以检定设定压力以便安装通气阀和加压。

A valve to operate the vent valve as a blowdown device can be supplied if depressurizing the storage tank is required. This valve can be operated manually at the vent valve or remotely from a control room.

可以通过调节通气阀，降低储罐压力，此时通气阀为放空装置，这一过程可以手动完成或在室内远程控制。

For installations where inlet piping pressure losses may cause the vent valve torapidcycle, the pilot can be equipped to sense tank pressure at a location upstream of the inlet pipe to prevent the vent valve from rapid cycling. This option, known as remote sense, will prevent the vent valve from rapid cycling; however, the relieving capacity will be reduced

由于阀门安装处入口管压损失造成通气阀快速循环，可以安装先导器来测出入口段的上游处罐压以防止通气阀快速循环。因为泄压能力的高低取决于通气阀入口处的压力，因此这一遥感方法可以防止通过气阀快速循环，但却降低了泄压能力。

Because capacity is dependent upon the pressure at the vent valveinlet. When in the tank vapors may be a problem, an external, fine element filter can be supplied for the pilot pres- sure sense line. When polymerization of tank vapors in the pilot may be a problem, an inert gas purge at the pilot pres- sure sense line can be supplied to prevent the tank vapors from entering the pilot.

对于罐内蒸气问题，可为先导器压力传感段外加细滤芯过滤器；对于罐内蒸气凝结先导器中的问题，可在压力传感段用惰性气体吹扫在先导器，防止蒸气进入先导器。

A pilot-operated vent valve can be equipped witha pilot lift lever and a position indicator. A lift lever permits manual operation of the pilot to make sure it is free to operate. Actua- tion of this lever will always open the main valve if the tank is pressurized. A position indicator is a differential pressure switch that can be used to signal a control room when the vent valve is open or closed.

先导式通气阀上可以安装先导器提升杆和示位器。提升杆可以手动控制先导器以保证通气阀是自由控制的。如果罐压增加，这个提升杆将开启主阀。示位器就是压差转换装置，它可以室内远程信号通气阀的开闭。

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