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ERRATA

This errata corrects an editorial error in the Fourth Edition of RP 521.

Page 64, Equation 30, shown below is incorrect:

$$U_c = 1.15 \frac{\sqrt{gD(\rho_1 - \rho_v)}}{\rho_v(C)}$$

The correct version of Equation 30 is as follows:

$$U_c = 1.15 \sqrt{\frac{gD(\rho_1 - \rho_v)}{\rho_v(C)}}$$

Guide for Pressure-Relieving and Depressuring Systems

Manufacturing, Distribution and Marketing Department

API RECOMMENDED PRACTICE 521
FOURTH EDITION, MARCH 1997

American Petroleum Institute

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FOREWORD

This recommended practice has been developed as a guide for plant engineers in the design, installation, and operation of pressure-relieving and depressuring systems. The text, based on the accumulated knowledge and experience of qualified engineers in petroleum-processing and related industries, recommends economically sound and safe practices for pressure relief.

Before this recommended practice was published, no source of collected information of this type was available for reference. The development of API Recommended Practice 520, *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries*, disclosed the existence of detailed information in the files of participating individuals; Recommended Practice 521 is a compilation of these pertinent data and is published as an adjunct to API Recommended Practice 520.

As modern processing units become more complex in design and operation, the levels of energy stored in these units point to the importance of reliable, carefully designed pressure-relieving systems. Suggested solutions to the immediate design, economic, and safety problems involved in pressure-relieving discharge systems are presented herein. Users of this recommended practice are, however, reminded that no publication of this type can be complete, nor can any written document be substituted for qualified engineering analysis.

This edition incorporates both editorial changes and major changes based on experience gained since the third edition was published. In line with the general practice for API publications, metric numbers, unit designations, and formulas have been included in the text.

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Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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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.

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.

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 proposed rule by the U.S. Environmental Protection Agency (EPA) proposing labeling requirements and phased banning of asbestos products, published at 51 *Federal Register* 3738–3759 (January 29, 1986; the most recent edition should be consulted).

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.

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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Guide for Pressure-Relieving and Depressuring Systems

SECTION 1—GENERAL

1.1 Scope

This recommended practice is applicable to pressure-relieving and vapor depressuring systems. The information provided is designed to aid in the selection of the system that is most appropriate for the risks and circumstances involved in various installations. This recommended practice is intended to supplement the practices set forth in API Recommended Practice 520, Part 1, for establishing a basis of design.

This recommended practice provides guidelines for examining the principal causes of overpressure; determining individual relieving rates; and selecting and designing disposal systems, including such component parts as vessels, flares, and vent stacks.

Piping information pertinent to pressure-relieving systems is presented in 5.4.1, but the actual piping should be designed in accordance with ASME B31.3 or other applicable codes.

Health risks may be associated with the operation of pressure-relieving equipment. The discussion of specific risks is outside the scope of this document.

1.2 Referenced Publications

The most recent editions of the following standards, codes, and specifications are cited in this recommended practice. Additional references are listed at the end of Sections 3, 4, and 5 and in the Bibliography, Section 6.

API

RP 520 *Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries*

Std 526 *Flanged Steel Safety-Relief Valves*

Std 527 *Seat Tightness of Pressure Relief Valves*

Std 2000 *Venting Atmospheric and Low-Pressure Storage Tanks: Nonrefrigerated and Refrigerated*

RP 2003 *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

Publ 2216 *Ignition Risk of Hydrocarbon Vapors by Hot Surfaces in Open Air*

Publ 2218 *Fireproofing Practices in Petroleum and Petrochemical Processing Plants (out of print)*

Std 2510 *Design and Construction of LP-Gas Installations at Marine and Pipeline Terminals, Natural Gas Processing Plants, Petrochemical Plants, and Tank Farms.*

AGA[1]

Purging Principles and Practice (Catalog Number XK0775)

ASME[2]

Boiler and Pressure Vessel Code, Section I, "Power Boilers," and Section VIII, "Pressure Vessels," Division 1

B31.3 *Chemical Plant and Petroleum Refinery Piping*

PTC 25 *Pressure Relief Devices*

NFPA[3]

30 *Flammable and Combustible Liquid Code*

68 *Guide for Venting Deflagrations*

69 *Explosion Protection Systems*

78 *Lightning Protection Code*

325M *Fire-Hazard Properties of Flammable Liquids, Gases, and Volatile Solids,* Volume I

1.3 Definition of Terms

Terms used in this recommended practice, as they relate to pressure-relieving systems, are defined in 1.3.1 through 1.3.37. Many of the terms and definitions are taken from API Recommended Practice 520, Part I, and ASME PTC 25.

1.3.1 accumulation: The pressure increase over the maximum allowable working pressure of a vessel during discharge through the pressure relief device, expressed in pressure units or as a percent. Maximum allowable accumulations are established by applicable codes for operating and fire contingencies.

1.3.2 atmospheric discharge: The release of vapors and gases from pressure-relieving and depressuring devices to the atmosphere.

1.3.3 back pressure: The pressure that exists at the outlet of a pressure relief device as a result of the pressure in the discharge system. Back pressure can be either constant or variable. Back pressure is the sum of the superimposed and built-up back pressures.

1.3.4 balanced pressure relief valve: A spring-loaded pressure relief valve that incorporates a means for minimizing the effect of back pressure on the performance characteristics

[1]American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209.

[2]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

[3]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269.

of the pressure relief valve (see Recommended Practice 520, Part I).

1.3.5 blowdown: The difference between the set pressure and the closing pressure of a pressure relief valve, expressed as a percentage of the set pressure or in pressure units.

1.3.6 built-up back pressure: The increase in pressure in the discharge header that develops as a result of flow after the pressure relief device or devices open.

1.3.7 burst pressure: The inlet static pressure at which a rupture disk device functions.

1.3.8 closed-bonnet pressure relief valve: A pressure relief valve whose spring is totally encased in a metal housing. This housing protects the spring from corrosive agents in the environment and is a means of collecting leakage around the stem or disk guide. The bonnet may or may not be sealed against pressure leakage from the bonnet to the surrounding atmosphere, depending on the type of cap or lifting-lever assembly employed or the specific handling of bonnet venting.

1.3.9 closed disposal system: A disposal system capable of containing pressures that are different from atmospheric pressure.

1.3.10 cold differential test pressure: The pressure at which the pressure relief valve is adjusted to open on the test stand. The cold differential test pressure includes corrections for the service conditions of back pressure or temperature or both.

1.3.11 conventional pressure relief valve: A spring-loaded pressure relief valve whose performance characteristics are directly affected by changes in the back pressure on the valve (see Recommended Practice 520, Part I).

1.3.12 design pressure of a vessel: At least the most severe condition of coincident temperature and gauge pressure expected during operation. It may be used in place of the maximum allowable working pressure in all cases where the maximum allowable working pressure has not been established. The design pressure is the pressure used in the design of a vessel to determine the minimum permissible thickness or other physical characteristics of the different parts of the vessel (see also maximum allowable working pressure).

1.3.13 flare: A means of safely disposing of waste gases through the use of combustion. With an elevated flare, the combustion is carried out at the top of a pipe or stack where the burner and igniter are located. A ground flare is similarly equipped except that combustion is carried out at or near ground level. A burn pit differs from a flare in that it is primarily designed to handle liquids.

1.3.14 huddling chamber: An annular pressure chamber in a pressure relief valve located beyond the seat for the purpose of generating a rapid opening.

1.3.15 lift: The actual travel of the disk away from the closed position when a valve is relieving.

1.3.16 maximum allowable accumulated pressure: The sum of the maximum allowable working pressure and the maximum allowable accumulation.

1.3.17 maximum allowable working pressure: The maximum gauge pressure permissible at the top of a completed vessel in its operating position for a designated temperature. The pressure is based on calculations for each element in a vessel using nominal thicknesses, exclusive of additional metal thicknesses allowed for corrosion and loadings other than pressure. The maximum allowable working pressure is the basis for the pressure setting of the pressure relief devices that protect the vessel.

1.3.18 open-bonnet pressure relief valve: A pressure relief valve whose spring is directly exposed to the atmosphere through the bonnet or yoke. Depending on the design, the spring may be protected from contact with vapors or gases discharged by the valve and will be cooled by the free passage of ambient air through and around the spring.

1.3.19 open disposal system: A disposal system that discharges directly from the relieving device to the atmosphere with no containment other than a short tail pipe.

1.3.20 operating pressure: The pressure to which the vessel is usually subjected in service. A pressure vessel is normally designed for a maximum allowable working pressure that will provide a suitable margin above the operating pressure in order to prevent any undesirable operation of the relieving device.

1.3.21 overpressure: The pressure increase over the set pressure of the relieving device, expressed in pressure units or as a percent. It is the same as accumulation when the relieving device is set at the maximum allowable working pressure of the vessel, assuming no inlet pipe loss to the relieving device.

Note: When the set pressure of the first, or primary, pressure relief valve to open is less than the vessel's maximum allowable working pressure, the overpressure may be greater than 10 percent of the valve's set pressure.

1.3.22 pilot-operated pressure relief valve: A pressure relief valve in which the main valve is combined with and controlled by an auxiliary pressure relief valve.

1.3.23 pressure relief valve: A generic term applied to relief valves, safety valves, and safety relief valves. A pressure relief valve is designed to automatically reclose and prevent the flow of fluid.