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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:

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

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Guide for Pressure-Relieving and Depressuring Systems

Manufacturing, Distribution and Marketing Department

API RECOMMENDED PRACTICE 521

FOURTH EDITION, MARCH 1997



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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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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 be used.

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CONTENTS

	Page
SECTION 1—GENERAL	1
1.1 Scope	1
1.2 Referenced Publications	1
1.3 Definition of Terms	1
SECTION 2—CAUSES OF OVERPRESSURE	3
2.1 General	3
2.2 Overpressure Criteria	4
2.3 Potentials for Overpressure	4
SECTION 3—DETERMINATION OF INDIVIDUAL RELIEVING RATES	7
3.1 Principal Sources of Overpressure	7
3.2 Sources of Overpressure	8
3.3 Effects of Pressure, Temperature, and Composition	8
3.4 Effect of Operator Response	8
3.5 Closed Outlets	8
3.6 Cooling or Reflux Failure	8
3.7 Absorbent Flow Failure	9
3.8 Accumulation of Noncondensables	9
3.9 Entrance of Volatile Material Into the System	10
3.10 Failure of Process Stream Automatic Controls	10
3.11 Abnormal Process Heat Input	12
3.12 Internal Explosion (Excluding Detonation)	12
3.13 Chemical Reaction	12
3.14 Hydraulic Expansion	13
3.15 External Fire	14
3.16 Opening Manual Valves	22
3.17 Electric Power Failure	22
3.18 Heat-Transfer Equipment Failure	23
3.19 Vapor Depressurization	24
3.20 Special Considerations for Individual Valves	27
3.21 References	31
SECTION 4—SELECTION OF DISPOSAL SYSTEMS	32
4.1 General	32
4.2 Fluid Properties That Influence Design	32
4.3 Atmospheric Discharge	32
4.4 Disposal by Flaring	39
4.5 Disposal to a Lower-Pressure System	50
4.6 Disposal of Liquids and Condensable Vapors	52
4.7 References	53
SECTION 5—DISPOSAL SYSTEMS	54
5.1 General	54
5.2 Definition of System Load	54
5.3 System Arrangement	55
5.4 Design of Disposal System Components	56
5.5 Flare Gas Recovery	74
5.6 References	78

	Page
SECTION 6—BIBLIOGRAPHY	78
6.1 Disposal Systems	78
6.2 Drums and Separators	78
6.3 Flares and Stacks	79
6.4 Flashing Flow in Pipes	80
6.5 Flashing Flow in Valves	80
6.6 Piping	80
6.7 Piping Guides and Anchors	81
6.8 Pressure Relief Valves	81
6.9 Rupture Disks	81
6.10 Surge and Pressure Transients	82
6.11 Systems	82
APPENDIX A—DETERMINATION OF FIRE RELIEF REQUIREMENTS	83
APPENDIX B—SPECIAL SYSTEM DESIGN CONSIDERATIONS	87
APPENDIX C—SAMPLE CALCULATIONS FOR SIZING A FLARE STACK	89
APPENDIX D—TYPICAL DETAILS AND SKETCHES	101

Figures

1—Average Rate of Heating Steel Plates Exposed to Open Gasoline Fire on One Side	15
2—Effect of Overheating Steel (ASTM A 515, Grade 70)	16
3—Equilibrium Phase Diagram for a Given Liquid	28
4—Pressure Levels	30
5—Maximum Downwind Vertical Distance From Jet Exit to Lean- Flammability Concentration Limit	34
6—Maximum Downwind Horizontal Distance From Jet Exit to Lean- Flammability Concentration Limit	35
7—Axial Distance to Lean and Rich Flammability Concentration Limits	35
8—Flame Length Versus Heat Release: U.S. Industrial Sizes and Releases (U.S. Customary Units)	42
9—Flame Length Versus Heat Release: U.S. Industrial Sizes and Releases (SI Units)	43
10—Approximate Flame Distribution Due to Lateral Wind on Jet Velocity From Flare Stack	43
11—Steam-Injected Smokeless Flare Tip	45
12—Typical Air-Assisted Flare System	47
13—Self-Supported Structure	49
14—Guyed-Supported Structure	49
15—Derrick-Supported Structure	49
16—Purge Reduction Seal—Molecular Type	51
17—Purge Reduction Seal—Velocity or Venturi Type	51
18—Isothermal Flow Chart	59
19—Isothermal Flow of Compressible Fluids Through Pipes at High Pressure Drops	60
20—Determination of Drag Coefficient	64
21—Flare Knockout Drum	65
22—Required Steam Rates for Elevated Flares	70

	Page
23—Noise Intensity at 100 Feet (30 Meters) From The Stack Tip	73
24—Typical Flare Gas Recovery System	75
25—Flare Gas Recovery Inlet Pressure Systems	77
A.1—Vapor Pressure and Heat of Vaporization of Pure Single-Component Paraffin Hydrocarbon Liquids	85
B.1—Typical Flow Scheme of a System Involving a Single Pressure Relief Device Serving Components in a Process System With Typical Pressure Profiles	88
C.1—Dimensional References for Sizing a Flare Stack	91
C.2.A—Flame Center for Flares and Ignited Vents: Horizontal Distance X_c (U.S. Customary Units)	96
C.2.B—Flame Center for Flares and Ignited Vents: Horizontal Distance X_c (SI Units)	97
C.3.A—Flame Center for Flares and Ignited Vents: Vertical Distance Y_c (U.S. Customary Units)	98
C.3.B—Flame Center for Flares and Ignited Vents: Vertical Distance Y_c (SI Units)	99
D.1—Flare Stack Seal Drum	102
D.2—Quench Drum	103
D.3—Typical Flare Installation	104

Tables

1—Possible Utility Failures and Equipment Affected	5
2—Bases for Relief Capacities Under Selected Conditions	7
3—Typical Values of Cubical Expansion Coefficient for Hydrocarbon Liquids and Water at 60°F.	13
4—Effects of Fire on the Wetted Surface of a Vessel	14
5—Environment Factor	17
6—Thermal Conductivity Values for Typical Thermal Insulations	21
7—Exposure Times Necessary to Reach the Pain Threshold	40
8—Recommended Design Total Radiation Levels Including Solar Radiation	41
9—Radiation From Gaseous Diffusion Flames	42
10—Required Steam Rates	45
11—Typical Values for Pipe Fittings	61
12—Typical Friction Factors for Clean Steel Pipe (Based on Equivalent Roughness of 0.00015 Feet)	62
13—Optimizing The Size of a Horizontal Knockout Drum (U.S. Customary Units)	67
14—Optimizing The Size of a Horizontal Knockout Drum (SI Units)	67
A-1—Comparison of Heat-Absorption Rates in Fire Tests	83

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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.*

AGA¹

Purging Principles and Practice (Catalog Number XK0775)

ASME²

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*

NFPA³

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

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

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

³National 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.