Denis DeMichael

Overpressure Protection
Overpressure Protection

- Recent Improvements
- Current Influences
- Looking Ahead
Capacity Certified Liquid Pressure Relief Valves

- Previously valve capacities were certified using only gas or steam
Capacity Certified Liquid Pressure Relief Valves

- Air or steam capacity certified valves used in liquid service
- Sized using 25% overpressure
  - Required valve to be set below MAWP
- Capacity correction factor ($K_p$)
  - Applied when 10% overpressure was used
- Performance issues

\[ A = \frac{Q}{38K_dK_wK_cK_vK_p}\sqrt{\frac{G}{1.25p - p_b}} \]
Capacity Certified Liquid Pressure Relief Valves

• Code rules were added for capacity certification using liquid (water)
ASME Marked Rupture Disks

• Previously two capacity rating methods were prescribed in BPV VIII
• Calculated capacities based on the pressure relief valve orifice equation
  • Used calculated net area after burst with 0.62 flow coefficient
• Capacity could be determined using relief valve $K_D$ capacity method “in general accordance” with the procedures
• These capacities could be significantly influenced by lengthy inlet and outlet lines
• No requirement for an ASME mark
ASME Marked Rupture Disks

• Code rules were added for capacity certified or flow resistance certified rupture disks
• Flow resistance method established a fitting loss factor for use in establishing the capacity of the complete relief system
• Required the disk and holder to be ASME marked
• Many disk manufacturers added ASME flows loop to accommodate the testing requirements
National Board “VR” Certificate

• Improved quality of repairs
  • Commercial and In-house
• Test facilities
  • Test vessel with adequate volume
  • Replaced Nitrogen cylinder and regulator
Current Influences

• Relief system design has become more complex
• Two phase flow
• OSHA 29 CFR 1910.119
Relief System Design Required Skills and Expertise

- Codes & Standards
- Relief devices
- Physical properties of fluid
- Fluid mechanics
- Two-phase flow
- Heat transfer

- Kinetics
- Equipment operation
- Strength of materials
- Metallurgy
- Environmental regulations
- Jurisdictional requirements
Relief System Design RAGAGEP

API STD 520 Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part 1—Sizing and Selection
API STD 520 Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries Part 2—Installation
API STD 521 Pressure-Relieving and Depressuring Systems
API STD 526 Flanged Steel Pressure-Relief Valves
API STD 527 Seat Tightness of Pressure Relief Valves
API STD 611 General Purpose team Turbines for Petroleum, Chemical, and Gas Industry Services
API STD 612 Petroleum Petrochemical and Natural Gas Industries—Steam Turbines—Special-Purpose Applications
API STD 614 Lubrication, Shaft-Sealing, and Control Oil Systems and Auxiliaries
Relief System Design RAGAGEP

API STD 617  Axial and Centrifugal Compressors and Expander-Compressors
API STD 618  Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services
API STD 619  Rotary-Type Positive Displacement Compressors for Petroleum, Petrochemical and Natural Gas Industries
API STD 620  Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API STD 650  Welded Steel Tanks for Oil Storage
API STD 672  Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Service
API STD 674  Positive-Displacement Pumps—Reciprocating
Relief System Design RAGAGEP

API STD  675  Positive Displacement Pumps—Controlled Volume for Petroleum, Chemical, and Gas Industry Services
API STD  676  Positive-Displacement Pumps—Rotary
API STD  685  Seal-less Centrifugal Pumps for Petroleum, Petrochemical, and Gas Industry Process Service
API STD  2000  Venting Atmospheric and Low-Pressure Storage Tanks
API RP  2028  Flame Arresters in Piping Systems
API RP  2210  Flame Arresters for Vents of Tanks Storing Petroleum Products
API STD  2350  Overfill Protection for Storage Tanks in Petroleum Facilities
API STD  2510  Design and Construction for Liquified Petroleum Gas Installations
ASHRAE  15  Safety Standard for Refrigeration Systems
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<td>ASME BPV-I</td>
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Relief System Design RAGAGEP

Pamphlet 1  Chlorine Basics
Pamphlet 5  Bulk Storage of Liquid Chlorine
Pamphlet 6  Piping Systems for Dry Chlorine
Pamphlet 9  Chlorine Vaporizing Systems
CAGI B 19.1  Safety Standard for Air Compressor Systems
CGA S-1.1  Pressure Relief Device Standards - Part 1 - Cylinders for Compressed Gases
CGA S-1.2  Pressure Relief Device Standards - Part 2 - Portable Containers for Compressed Gases
CGA S-1.3  Pressure Relief Device Standards - Part 3 - Stationary Storage Containers for Compressed Gases
CGA G-2.1  Requirements for the Storage and Handling of Anhydrous Ammonia
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Runaway Chemical Reaction

Vent Area Based on Gas or Vapor Flow

Vessel May Vent Most of Liquid Inventory
Design Institute for Emergency Relief Systems

- Began as a consortium of 29 companies formed in 1976 under the auspices of AIChE
- Spent $1.6 million on investigating two-phase flow
- Developed much of the theory, vent-sizing software, and test equipment
- Relief area for certain two-phase flow venting regimes can be 10 times that of vapor-only venting
DIERS

• Work continues today as a technical entity called DIERS

• Purpose
  • to reduce the frequency, severity and consequences of pressure producing accidents, and
  • to develop new techniques which will improve the design of emergency relief systems.

• Two-phase flow sizing method has been incorporated into many RAGAGEP’s.
  • Not limited to reactive systems

• Applies to processes with a listed chemical above a specified threshold quantity or more than 10,000 pounds of flammable gas/liquid

• Requires employers to document their relief systems comply with recognized and generally accepted good engineering practices (aka RAGAGEP)

• For existing systems designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the employer shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

- Heightened awareness around the use of RAGAGEPs
  - Including devices outside the scope of the law
- Some Standard Develop Organizations have seen increased participation
- New companies have been formed to assist with relief device design and documentation compliance
Section XIII – Rules for Overpressure Protection

- Proposed Section XIII
- Comprehensive Overpressure Protection Resource
- Rules to be invoked by the Construction Codes
Not in Scope

• Rules for application remain in construction Codes
  • Type of device
  • Number of devices
  • Maximum relief pressure
  • Required relieving capacity
  • Installation (Vessel Protection)
• Conformity Assessment (CA – 1)
Scope

• Content drawn from existing ASME Standards
  • BPV Sections I, III, IV, VIII, X and XII
  • PTC – 25

• Rules for Pressure Relief Devices
  • Materials
  • Construction
  • Testing
  • Settings
  • Capacity certification
  • Installation (Device Performance)

• Overpressure Protection by System Design
Scope

- Include mandatory requirements and non-mandatory guidance
- Other pressurized equipment
  - Rotating equipment
  - Low Pressure Vessels (< 15 psi)
  - Vacuum protection
- Reference to existing standards
  - In-service & Maintenance
Benefits

• Consolidation and Standardization
• Although Construction Code will remain primary focus guidance would not be limited to their scopes
  • Capacity certified and marked devices for < 15 psig
• Attract additional Subject Matter Experts to further enhance content
• Comprehensive resource
Storage Tank Vent Repairs

- Many “VR” shops are asked to repair storage tank vents
- Current available repair guidance is limited
- Work item to add tank vent guidance to the NBIC