Denis DeMichael

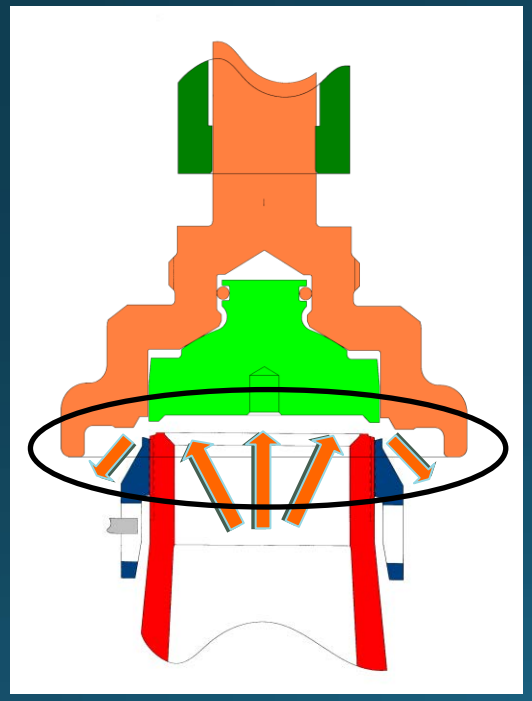
Overpressure Protection

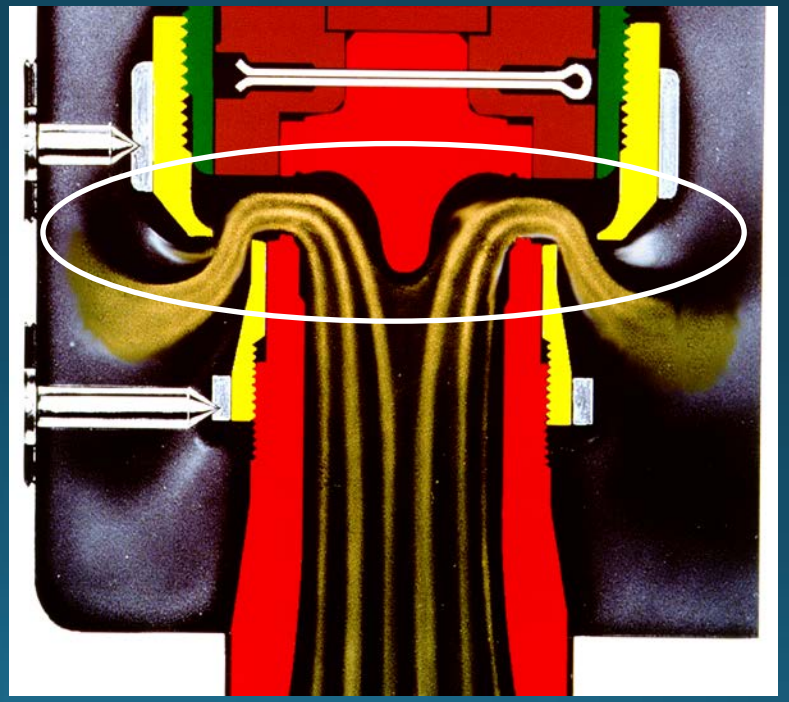
Overpressure Protection

- Recent Improvements
- Current Influences
- Looking Ahead

Capacity Certified Liquid Pressure Relief Valves

- Previously valve capacities were certified using only gas or steam





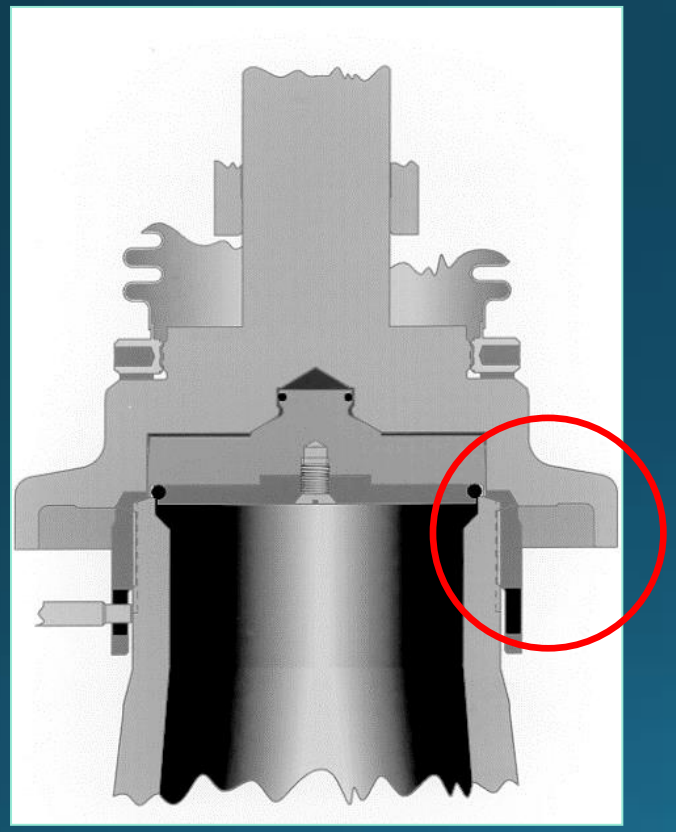
Capacity Certified Liquid Pressure Relief Valves

- 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

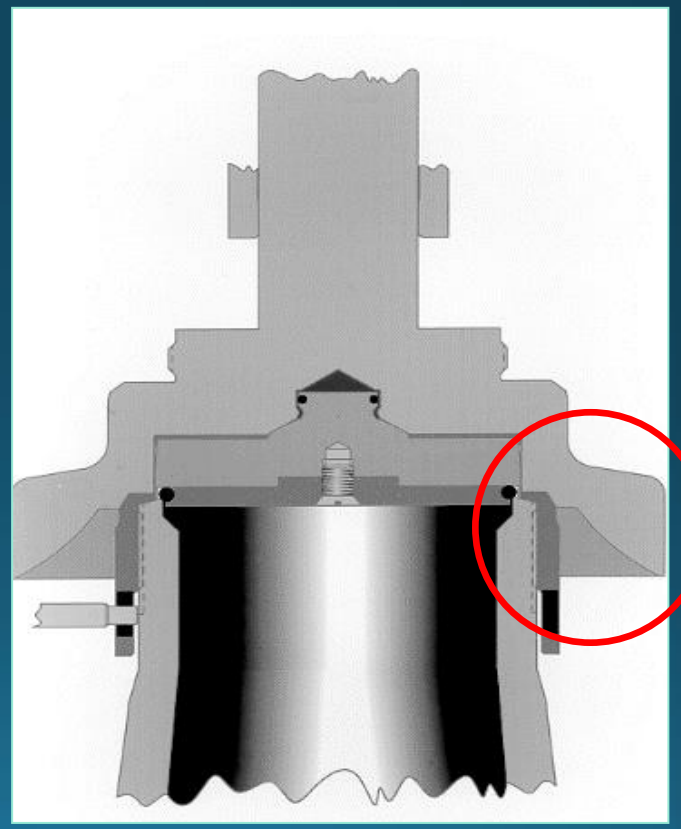
$$A = \frac{Q}{38 K_d K_w K_c K_v K_p} \sqrt{\frac{G}{1.25p - p_b}}$$

Capacity Certified Liquid Pressure Relief Valves

- Code rules were added for capacity certification using liquid (water)



Vapor Trim



Liquid Trim

ASME Marked Rupture Disks

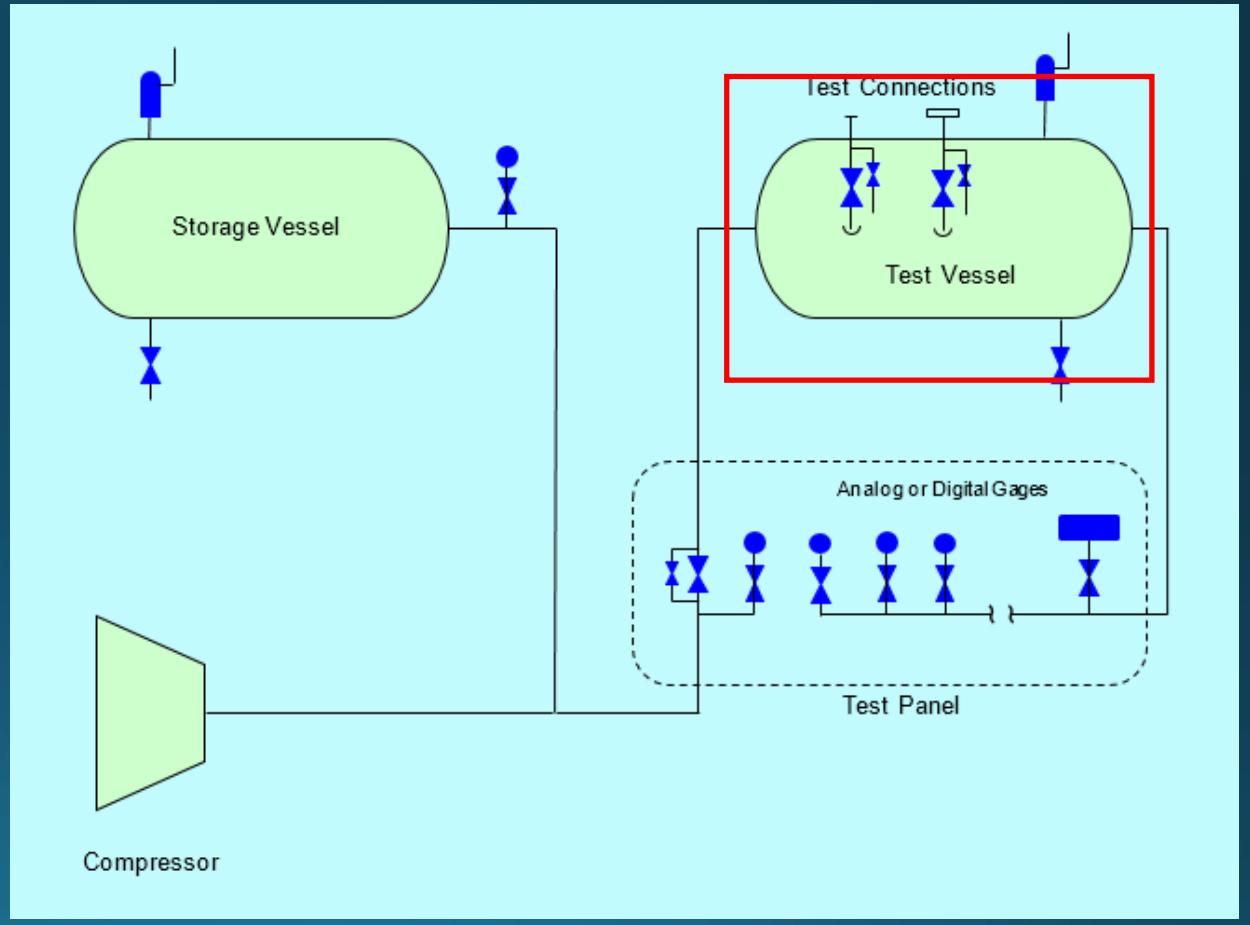
- Previously two capacity rating methods were prescribed in BPV VIII
- Calculated capacities based on the pressure relief valve orifice equation
  - Used calculated net area after burst with 0.62 flow coefficient
- Capacity could be determined using relief valve K_D capacity method "in general accordance" 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

Relief System Design RAGAGEP

ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME BPV-I	Boiler and Pressure Vessel Code Section I - Rules for Construction of Power Boilers
ASME BPV-IV	Boiler and Pressure Vessel Code Section IV - Rules for Construction of Heating Boilers
ASME BPV-VIII	Boiler and Pressure Vessel Code Section VIII, Divisions 1, 2, and 3 – Rules for Construction of Pressure Vessels
ASME BPV-X	Boiler and Pressure Vessel Code Section X - Fiber-Reinforced Plastic Pressure Vessels
ASME BPV-XII	Boiler and Pressure Vessel Code Section XII - Rules for Construction and Continued Service of Transport Tanks
ASME PTC 25	Pressure Relief Devices

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

Relief System Design RAGAGEP

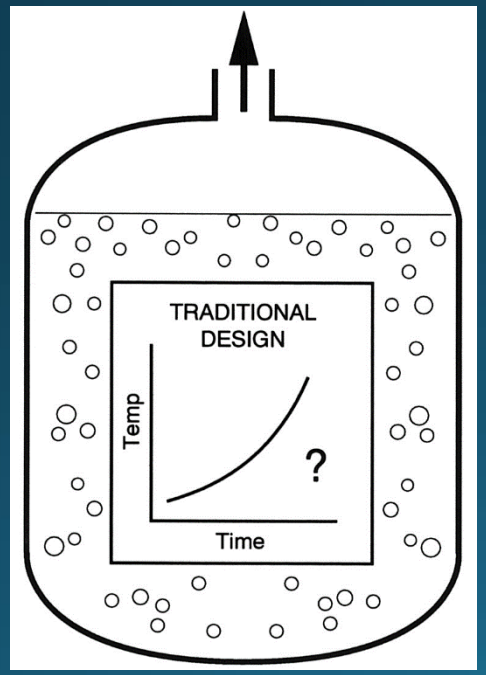
IIAR – 2	Equipment, Design and Installation of Closed-Circuit Ammonia Mechanical Refrigeration Systems
IIAR – 4	Installation of Closed-Circuit Ammonia Refrigeration System
Bulletin 109	Guidelines for IIAR Minimum Safety Criteria for a Safe Ammonia Refrigeration System
NB 18	National Board Pressure Relief Device Certifications
NB 23	National Board Inspection Code
NFPA 15	Standard for Water Spray Fixed Systems for Fire Protection
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 30	Flammable and Combustible Liquids Code
NFPA 30B	Code for the Manufacture and Storage of Aerosol Products

Relief System Design RAGAGEP

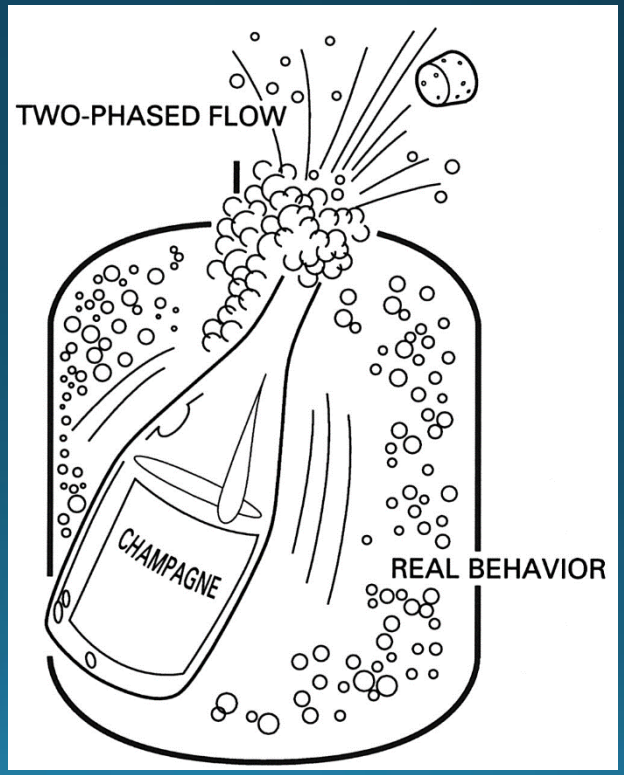
NFPA	31	Standard for the Installation of Oil-Burning Equipment
NFPA	35	Standard for the Manufacture of Organic Coatings
NFPA	36	Standard for Solvent Extraction Plants
NFPA	37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA	45	Standard on Fire Protection for Laboratories Using Chemicals
NFPA	55	Compressed Gases and Cryogenic Fluids Code
NFPA	58	Liquefied Petroleum Gas Code
NFPA	68	Standard on Explosion Protection by Deflagration Venting
UL	132	Standard for Safety Relief Valves for Anhydrous Ammonia and LP-Gas
UL	142	Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

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

29CFR 1910.119 - Process Safety Management of Highly Hazardous Chemicals

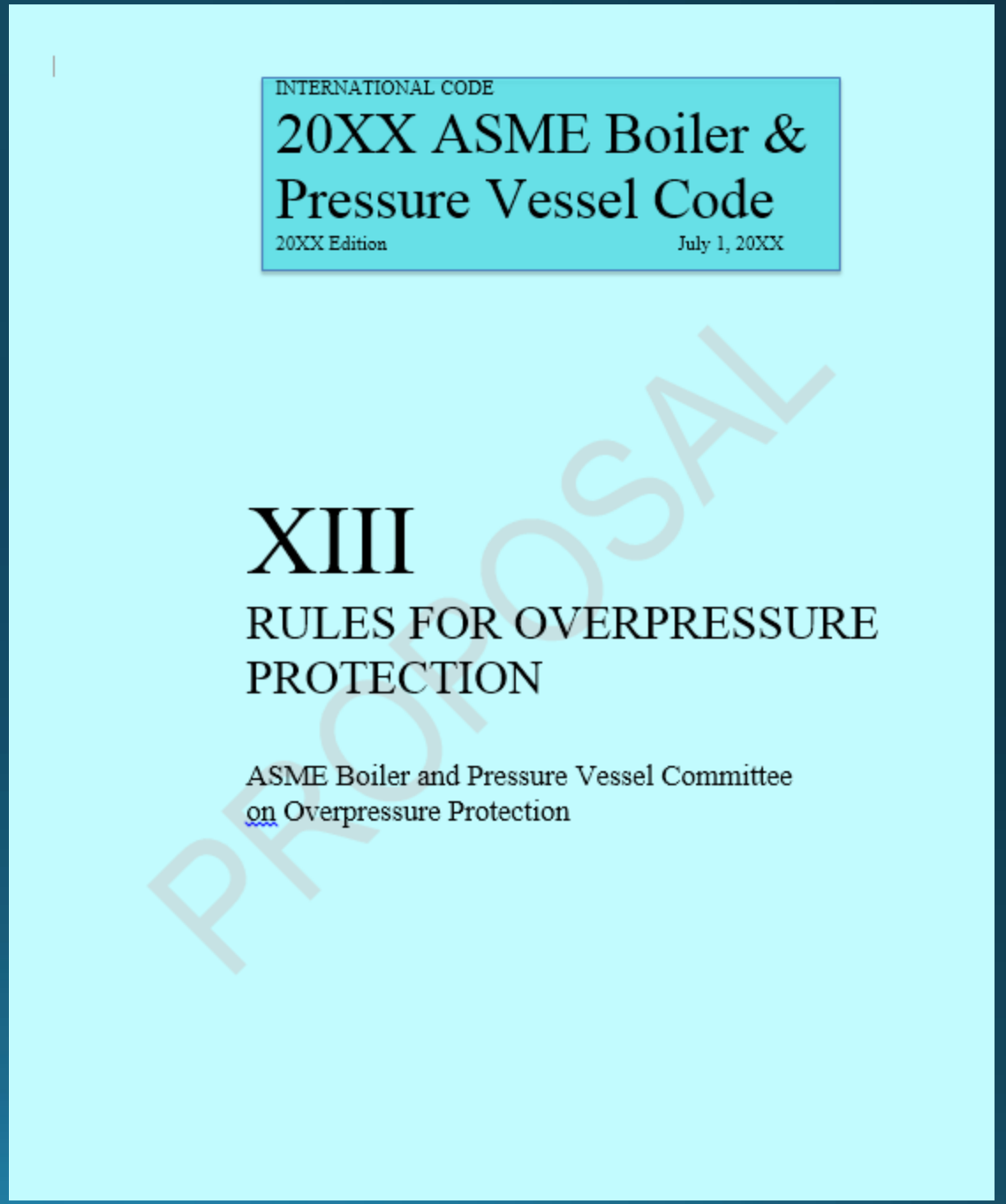
- Applies to processes with a listed chemical above a specified threshold quantity or more than 10,000 pounds of flammable gas/liquid
- Requires employers to document their relief systems comply with recognized and generally accepted good engineering practices (aka RAGAGEP)
- For existing systems designed 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.

29CFR 1910.119 - Process Safety Management of Highly Hazardous Chemicals

- 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

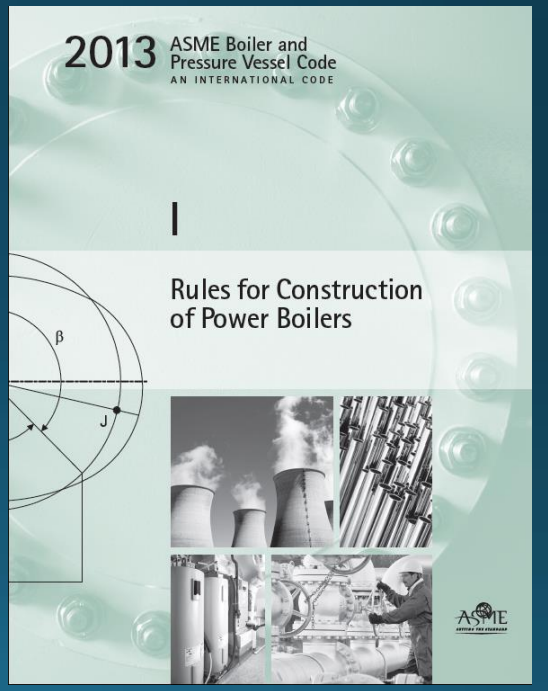
Section XIII – Rules for Overpressure Protection

- Proposed Section XIII
- Comprehensive Overpressure Protection Resource
- Rules to be invoked by the Construction Codes



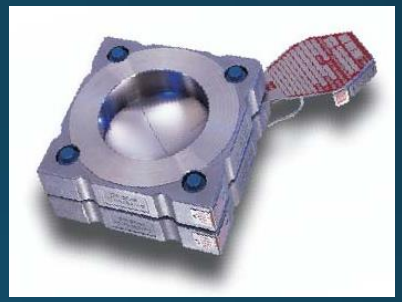
Not in Scope

- 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