



Risk-Based Inspection for Pressure Relief Devices



E²G Leadership in New API Technology:

- Targets the most critical PRD's
- Allows deferral of lower-risk PRD's
- Links PRDs to the damage state of protected equipment
- Considers other 'Layers of Protection'
- Optimizes intervals based on plant risk tolerance
- Cuts inspection & maintenance costs

E²G: Leaders in Developing Technologies that Manage Risk

Uniquely Qualified

E²G is uniquely qualified to implement the new API PRD RBI technology because we're recognized industry leaders in the four areas that were merged to create it: Risk-Based Inspection (RBI); Pressure Relieving Systems (PRS); damaged equipment Fitness-For-Service (FFS); and software engineering.

Industry Committee Leaders

E²G's Philip Henry, an industry recognized pressure relief system expert, led the development of the API PRD RBI methodology as Chairman of the API RBI Technical Working Group. Phil is also the API PRS Subcommittee chairman of TF520, responsible for standards associated with the sizing, selection, and installation of pressure relief devices. E²G is the project manager for the API RBI User Group Project. We contributed to the development of API 580, *Risk-Based Inspection*, and are currently rewriting API 581, *Base Resource Document Risk-Based Inspection*. E²G experts were also the principal authors of API RP 579, *Fitness-For-Service*.

Clients Benefit

Many commercial losses are the result of a failure to manage risk. Because E²G participates in developing industry standards, we know the maximum extent each can be used to provide a safe answer. And we continue to put significant effort into future development of these standards. E²G is the exclusive API subcontractor to develop and deliver training programs for RBI, FFS, and Pressure Relief System Design. We also offer the API-sponsored course on *Damage Mechanisms Affecting Fixed Equipment in the Refining Industry*.

Practical Advice

E²G's engineers have all worked for owner-users, so we understand the changing dynamics of a plant's operating environment and the pressures you face. We know that your concern is for safety, reliability, and optimizing your plant's operating condition for profitability -- and not needlessly inspecting, replacing or shutting it down. Unlike most consultants, we will help you make the practical decisions.



*The API RBI methodology can be used to evaluate a wide range of pressure relief devices including conventional, balanced and pilot-operated pressure relief devices, rupture disks and atmospheric storage protection devices.
(Photos courtesy of AG Crosby.)*

Implementing API PRD RBI at Your Plant

E²G can conduct a pilot study to demonstrate the new API PRD RBI technology, as well as provide site-wide implementation. Here's our process for implementation:

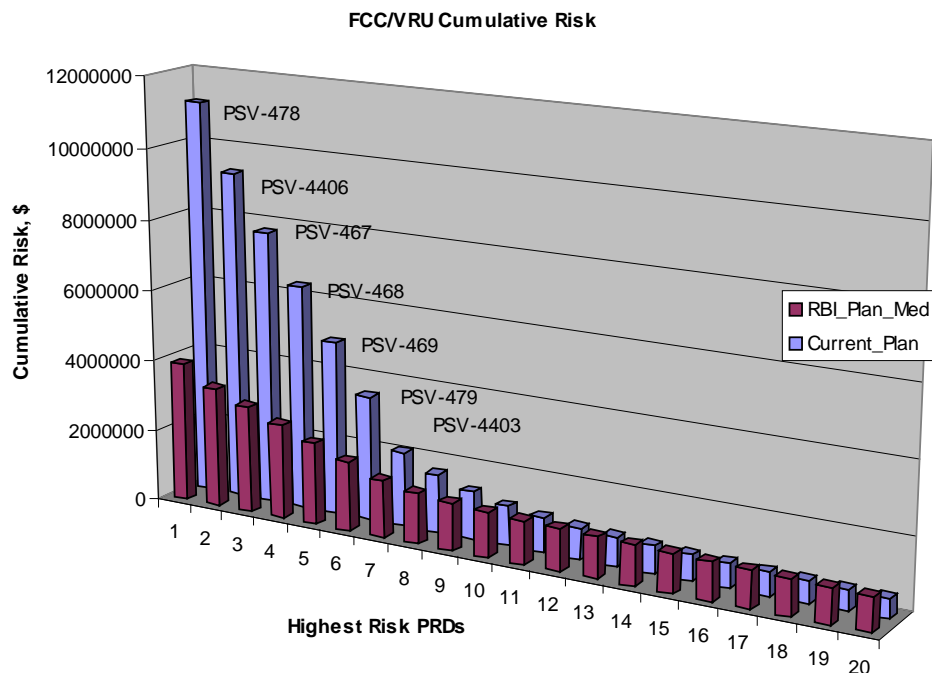
- Review the Process & Instrumentation Diagrams (P&ID)
- Review the pressure relief system design basis
- Gather and document past PRD testing and inspection histories
- Identify overpressure scenarios that could result in loss of containment
- Interview key process and operating personnel
- Determine the criticality of each PRD
- Evaluate the consequence of a PRD failing to open due to overpressure and leakage
- Calculate the optimum inspection interval based on the user's risk tolerance

The new API methodology is a highly quantitative approach to PRD RBI that provides in-depth documentation for your inspection plan. The calculations are not "black box" as the technology has been validated and approved by the industry committees. Additionally, this approach includes special features that:

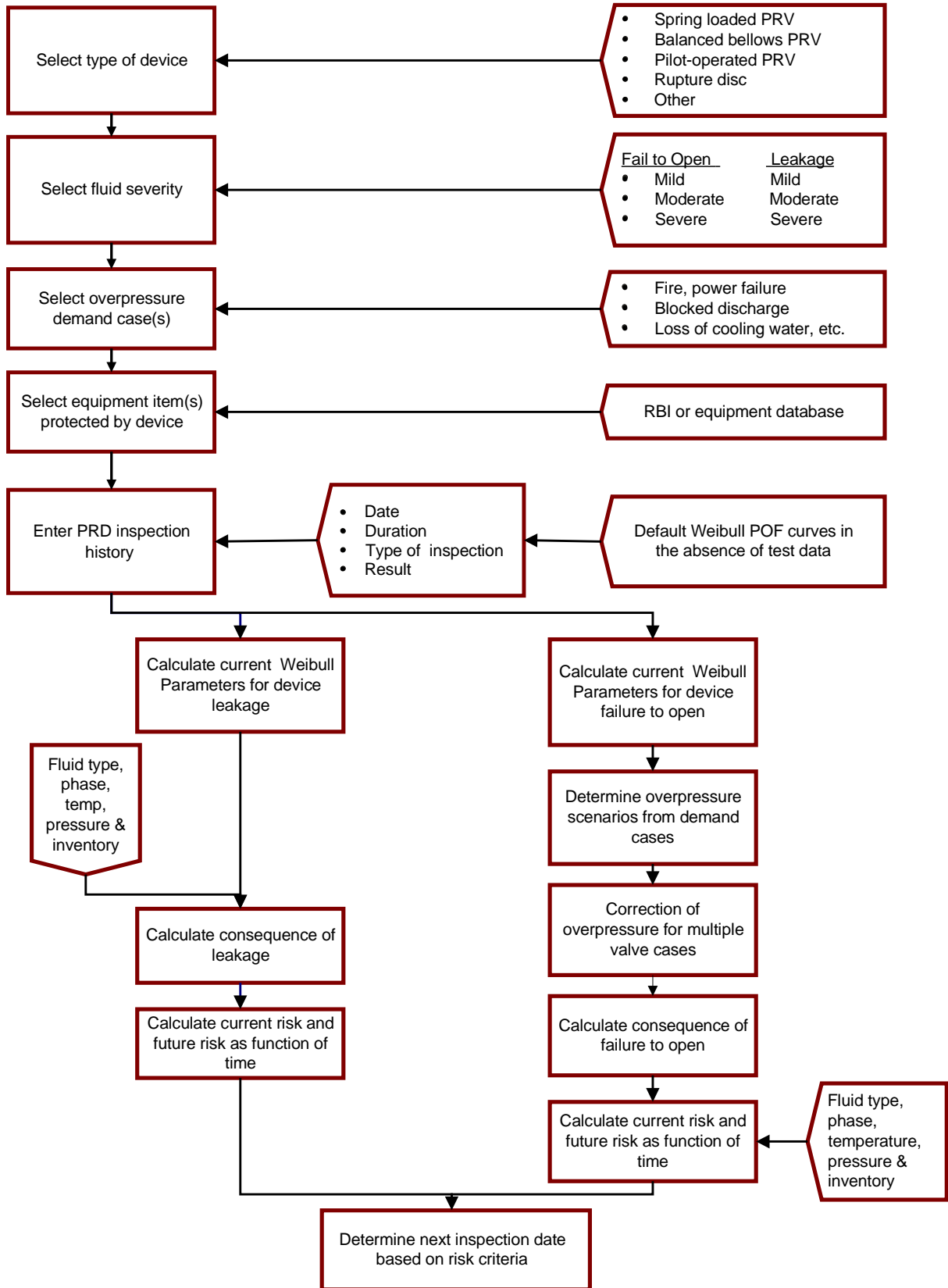
- Handle any pressure relief device, including conventional and pilot-operated relief devices, rupture disks and AST P/V devices.
- Provide default demand rates and overpressure potential as a function of the overpressure demand cases applicable for the PRD. Allows PRDs to be evaluated with consideration of other layers of protection.
- Allow users to provide personal reliability data in the form of Weibull parameters.
- Utilize a fluid property solver (NIST Supertrapp) that provides extensive fluid mixing capabilities from a list of over 225 pure components and chemicals.
- Use an internal consequence modeling package to evaluate the effects of fires, fireballs, BLEVEs, explosions and toxic releases on personnel and nearby equipment.
- Consider the effects of vibration, valve chatter and operating temperature on PRD reliability.
- Account for rupture disks installed in combination with pressure relief valves.

Impact on the Bottom Line

Many plants apply inspection intervals to PRDs in general agreement with API 510 and NBIC, without considering historical performance or potential risk. A recent site-wide implementation of PRD RBI resulted in significant maintenance cost savings and a payout under 1-1/2 years. Additionally, a significant reduction in overall plant risk was realized.



PRD RBI Flow Chart Logic Diagram



Introducing Technology That Helps You Manage Risk and Reduce Costs

Considered to be the ultimate 'Layer of Protection' for pressurized systems, properly functioning Pressure Relief Devices (PRDs) are essential to avoid unexpected overpressure events that can cause equipment damage and loss of containment - and result in costly plant shutdowns.

The regular inspection, testing and overhaul of pressure relief devices is needed to ensure proper PRD function upon demand. But when and how often do you need to inspect? Most inspection programs do an adequate job of managing the unreliability of PRDs, without giving much consideration to the potential consequences of PRD failure to open or leak. Many plants inspect PRDs on preset intervals as recommended by inspection codes, such as NB-23 and API 510. These Codes allow increases in inspection interval based on the historical performance of the PRD, but significant increases in intervals over the preset values can take many years.

The use of Risk-Based Inspection allows optimum intervals to be set immediately based on the probability and consequences associated with PRD failure.

To improve prediction accuracy and gain industry acceptance, an API RBI technical working group chaired by Phil Henry of The Equity Engineering Group, Inc. (E²G) has developed new technology that includes a highly quantitative approach for determining individual PRD inspection intervals, allowing owner-users to design maintenance programs based on measured risk. Created for owner-users by owner-users, this approach systematically prioritizes maintenance and inspection dollars by:

- Identifying longer inspection frequencies for lower risk PRDs
- Focusing inspection on the most critical applications, thereby reducing cost AND risk
- Setting optimized intervals based on plant risk tolerance

This API PRD RBI methodology developed by E²G has been incorporated into Rev. 8.0 of the API RBI software as well as E²G's VCESage™ software. Typically, the PRD module is linked directly to the protected equipment. However, PRD RBI can be performed without fixed equipment RBI. This new approach has the potential to significantly reduce maintenance costs without jeopardizing safety of the plant.

API's PRD RBI: Highly Quantitative & More Accurate

The API PRD RBI methodology evaluates the criticality of pressure relief devices, and sets inspection and testing frequencies accordingly. This approach, which is consistent with API 510 *Pressure Vessel Inspection Code*, employs extensive analysis in its calculations.

Extensive PRD Reliability/Failure Rate Database - Considers the fluid service, duration in service, and type of device, and provides default PRD failure rates backed by an extensive database of bench tests.

Criticality - Considers the overpressure scenarios (loss of cooling, fire, blocked discharge, etc.) applicable to each individual PRD.

- PRDs in critical services with highest demand rates should be inspected and tested more frequently than others.
- Some PRDs have a higher potential of overpressure upon failure to open on demand.

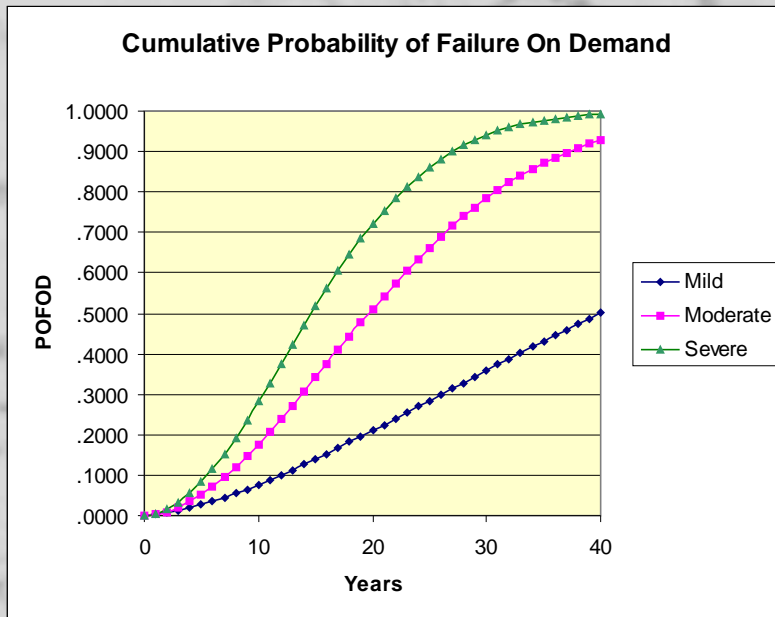
Integrated Consequence Analysis Package - Considers the fluid severity and hazard potential (flammable and toxic consequences) when evaluating loss of containment as a result of PRD failure to open. Also evaluates the consequence of PRD leakage.

Integrated System - Ties directly to the damage state of the equipment protected by the PRD. The criticality of the PRD increases as the condition of the protected equipment deteriorates over time.

Documented Inspection History - Updates the Default Probability of Failure using the historical PRD inspection data for each PRD.

- Utilizes a modified Bayesian updating approach to utilize the knowledge gained from PRD inspection records.
- Grades inspection effectiveness when adjusting PRDs reliability.

The Equity Engineering Group, Inc. is the recognized leader on aging infrastructure service and support for the oil refining and petrochemical industries. E²G experts help improve your plant's profitability by supplying state-of-the-art products and services that ensure equipment operational availability, control inspection costs, and avoid costly shutdowns.



How reliable are your relief valves? Most users don't know.

E²G has an extensive failure rate database for PRDs which provides the basis for the default probability of failure to open on demand and the probability of leakage curves used in the software. The user has the ability to override these default curves where user data is available.

In the chart above, the curves represent default data generated by using the E²G database for the failure to open on demand case. Additional default curves for the failure due to leakage case are also available.

Contacts:

Pressure Relief RBI
Philip Henry 216-283-6012

Valerie Magyari 216-658-4744

Risk-Based Inspection
Greg Alvarado 281-537-8848

Lynne Kaley 281-480-0556

Fitness-For-Service
David Osage 216-283-6010

Robert Brown 216-283-6015

Software Engineering
Mary Buchheim 216-283-6018



The Equity Engineering Group, Inc.
20600 Chagrin Blvd. • Suite 1200 • Shaker Heights, OH 44122
Phone: 216-283-9519 • Fax: 216-283-6022
www.equityeng.com