AMERICAN PETROLEUM INSTITUTE

API RP 581 – RISK BASED INSPECTION METHODOLOGY

BALLOT COVER PAGE

Ballot ID:

Title:	API 581 Qualitative vs Quantitative
Purpose:	To review and determine to proper use of “quantitative”, “semi-quantitative” and “qualitative” throughout the current document.
Impact:	The changes are minor (editorial) and should only clarify that the proper term is used, if even necessary.
Rationale:	During the recent ballot resolution activities for API 580 it was determined that API 581 erroneously refers to itself as a “quantitative” methodology. The action was taken to review the current use of the term in API 581 and ballot and required changes. **Qualitative**: 12 instances of this term (in all forms) were found in the document. All instances were deemed acceptable. Since no changes were required, **these instances were not detailed in this ballot**. **Quantitative**: 17 instances of this term (in all forms) were found in the document. All instances are detailed in the ballot below. Comments were provided for each based on their accepted use. It was determined that 9 instances needed editing and were redlined in this ballot below. 1 instance is currently being removed in Ballot 5414.
Technical Reference(s):	API 580, 3rd Edition

Primary Sponsor:	*Name:*	Robert Sladek
	Company:	Becht
	Phone:	281-686-4259
	E-mail:	rsladek@becht.com
Cosponsors:	*Name/Company:*	

Tracking Status					
Submitted to Task Group		**Submitted to SCI**		**Submitted to Master Editor**	
Date	***Resolution***	***Date***	***Resolution***	***Date***	***Added***

Proposed Changes and/or Wording *{attach additional documentation after this point}*

PART 1

1 Scope

1.1 Purpose

This recommended practice, API 581, *Risk-Based Inspection Methodology*, provides semi-quantitative analysis procedures to establish an inspection program using risk-based methods for pressurized fixed equipment including pressure vessel, piping, tankage, pressure-relief devices (PRDs), and heat exchanger tube bundles. API 580, *Risk-Based Inspection* provides guidance for developing risk-based inspection (RBI) programs on fixed equipment in refining, petrochemical, chemical process plants, and oil and gas production facilities. The intent is for API 580 to introduce the principles and present minimum general guidelines for RBI, while this recommended practice provides semi-quantitative calculation methods to determine an inspection plan.

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3.1.8

consequence

The outcome of an event or situation expressed qualitatively or quantitatively, being a loss, injury, disadvantage, or gain.

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PART 2

3.5.2 Overview

A management systems factor is used to adjust GFFs for differences in PSM systems. This factor is derived from the results of an evaluation of a facility or operating unit's management systems that affect plant risk. Different practices within units at a facility might create differences in the management systems factors between the units. However, within any one study, the management systems factor should be the same. The factor is applied equally to all components and, as a result, does not change the order of the risk-based ranking of the components. The management systems factor can, however, have a pronounced effect on the total level of risk calculated for each item and for the summed risk for the study. This becomes important when risk levels of entire units are compared or when risk values for similar components are compared between different units or plant sites.

The management systems evaluation covers all areas of a plant's PSM system that impact directly or indirectly on the mechanical integrity of process equipment. The management systems evaluation is based in large part on the requirements contained in API Recommended Practices and Inspection Codes. It also includes other proven techniques in effective safety management. A listing of the subjects covered in the management systems evaluation and the weight given to each subject is presented in Table 3.3.

It is not the intent of the management systems evaluation to measure overall compliance with all API recommendations or OSHA requirements; the emphasis is on mechanical integrity issues. Mechanical integrity is the largest single section, and most of the questions in the other subject areas are either losely related to mechanical integrity or they have a bearing on total unit risk. The management systems evaluation is provided in Annex 2.A. It consists of numerous questions, most of which have multiple parts. Each possible answer to each question is given a weight, depending upon the appropriateness of the answer and the importance of the topic. This system provides a ~~quantitative, reproducible~~ numerical score for the management systems evaluation. It also simplifies analysis of results, permitting the auditor to pinpoint areas of strength and weakness in the facility's PSM system. The number of questions and the

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19.3 Current Status of HTHA Investigations and Inspection

In 2010, an incident within the refining industry led to an investigation where HTHA was identified as the damage mechanism that led to the failure of a heat exchanger. The refining industry has been examining the findings published in the Chemical & Safety Board report, along with new information from the industry concerning HTHA damage.

At the time of API 581, Third Edition release, API Recommended Practice 941, Seventh Edition—*Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants*—is being revised. Technology for investigating HTHA susceptibility and inspection methods for detection and assessment of HTHA damage is being developed. The Third Edition of API 581 includes a conservative screening criterion that allows the owner–user to flag components potentially affected by HTHA (see Section 19.4) until a more quantitative risk assessment is developed based on a later edition of API 941. Additionally, the most current edition of API 941 should be consulted for guidance on investigation, inspection, and replacement.

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PART 2.A

Table 2.A.3—Process Hazard Analysis (Continued)

9	After the process hazards have been identified, are the likelihood and consequences of the failure scenarios assessed using either qualitative or quantitative techniques?

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PART 2.B

2.B.11.3.1.2 Base Corrosion Rate

The base corrosion rate, CR_B, is an estimated corrosion rate that is determined from the water scale tendency, chloride concentration, and a threshold for flow velocity [i.e. higher or lower than 2.44 m/s (8 ft/s)].

The concept of RSIs is used to predict whether water variables in the pH range of 6.5 to 9.5 will produce conditions that are scaling or corrosive to carbon steel. The expected tendencies are increased scaling conditions at higher temperatures, higher Ca hardness, and higher MO alkalinity and seeing corrosive conditions at lower temperatures, lower Ca hardness, or lower MO alkalinity. MO alkalinity refers to the methyl orange and the test used to measure the total alkalinity of water.

For given values of calcium hardness, MO alkalinity and total dissolved salt concentration, a value of pH, pH_s, exists at which the water is in equilibrium with solid $CaCO_3$. The deposit of $CaCO_3$ is thermodynamically possible when the pH of water is higher than pH_s, i.e. higher than the pH at saturation of calcium carbonate. The difference between the actual pH, pH_a, of a sample of water and the pH for $CaCO_3$ saturated water, pH_s, is called the Langelier Saturation Index (LSI) and is computed using Equation (2.B.9).

$$LSI = pH_a - pH_s \quad (2.B.9)$$

The LSI is used to predict the tendency for $CaCO_3$ to either dissolve or precipitate and provide corrosion resistance in fresh water, under varying conditions. While the concept of the Langelier index is correct and helpful, however, it should be emphasized that a positive value of the index can result from waters of totally different quality. As the pH increases, the Ca^{2+} concentration decreases drastically. The corrosion protection characteristics of the resulting $CaCO_3$ film differ accordingly. In other words, waters of different pH, Ca hardness, and MO alkalinity that give the same value of the index have different corrosivity.

The Langelier index alone cannot be used to do any quantitative assessment. However when used along with the RSI determined using Equation (2.B.10), a relatively good prediction of the scaling or corrosive tendencies of a water is obtained.

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Part 3

2 References

2.2 Informative

[14] CCPS, *Guidelines for Chemical Process Quantitative Risk Analysis*, Second Edition, Center for Chemical Process Safety of the American Institute of Chemical Engineers, New York, 2000.

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4.8.3.2 Effects of Mitigation Measures on Flammable Consequence Magnitudes

The adjustments to the magnitude of the consequence for flammable releases based on unit mitigation systems are provided in Table 4.10. These values are based on engineering judgment, using experience in evaluating mitigation measures in quantitative risk analyses. The consequence area reduction factor, $fact_{mit}$, to account for the presence of mitigation systems is provided in Table 4.10.

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Part 3.A

3.A.1 General

The consequence analysis is performed to aid in establishing a relative ranking of equipment items on the basis of risk. The consequence methodologies presented in Part 3 of this document are intended as simplified methods for establishing relative priorities for inspection programs. If more accurate consequence estimates are needed, the analyst should refer to more rigorous analysis techniques, such as those used in quantitative risk analysis.

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3.A.3.5.2 Assumptions and Limitations

The consequence procedure is a simplified approach to a relatively complex discipline. A large number of assumptions are implicit in the procedure in addition to the assumptions that would be part of a more indepth analysis. This section is intended to highlight a few of the more important assumptions related to the simplified approach but does not attempt a comprehensive discussion.

a) The consequence area does not reflect where the damage occurs. Jet and pool fires tend to have damage areas localized around the point of the release, but VCE and flash fires may result in damage far from the release point.

b) The use of a fixed set of conditions for meteorology and release orientations was chosen to represent a conservative basis for the consequence modeling. Meteorological and release orientations are site and situation specific. ~~Quantitative risk assessment~~ QRAcalculations allow for customization due to actual site condition since it significantly impacts the results.

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c) The probabilities associated with potential release event outcomes can be situation and site specific. Standardized event trees, including ignition probabilities, were chosen to reflect typical conditions expected for the refining and petrochemical industries. ~~Quantitative risk assessment~~ QRA calculations allow for customization of event probabilities since they significantly impact the results.

3.A.4 Level 2 Consequence Methodology

3.A.4.1 General

The use of event trees and semi-quantitative effects analysis forms the basis for the Level 2 consequence methodology provided in Part 3, Section 5 with the details for calculating event tree probabilities and the effects of pool fires, jet fires, flash fires, fireballs, VCEs, and BLEVEs are provided. Part 3 provides the impact of most of these events with the closed-form equations.

PART 5

1 Scope

1.1 Purpose

This recommended practice, API 581, *Risk-Based Inspection Methodology*, provides semi-quantitative analysis procedures to establish an inspection program using risk-based methods for pressurized fixed equipment including pressure vessel, piping, tankage, pressure-relief devices (PRDs), and heat exchanger tube bundles. API 580, *Risk-Based Inspection* provides guidance for developing risk-based inspection (RBI) programs on fixed equipment in refining, petrochemical, chemical process plants, and oil and gas production facilities. The intent is for API 580 to introduce the principles and present minimum general guidelines for RBI, while this recommended practice provides semi-quantitative calculation methods to determine an inspection plan.

6.2.5 Protected Equipment Failure Frequency as a Result of Overpressure

b) Selection of DF Class when PRD RBI Is Performed Without Fixed Equipment If fixed equipment risk analysis has not been performed, then the DFs for the protected equipment that normally would be calculated for fixed equipment will have to be specified. The DFs may be determined ~~quantitatively~~ using a DF class as shown in Table 6.11. This method should be considered to be less quantitative than when an RBI analysis is conducted to determine fixed equipment DFs.

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Commented [RS14]: Not Acceptable. Change to Semi-quantitative and add "analysis"

Commented [RS15]: Not Acceptable. Change to Semi-quantitative.

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