State of California
Department of Industrial Relations
Occupational Safety and Health Standards Board

Petition File No. 593

Board Staff Evaluation
Submitted by Maryrose Chan, Safety Engineer

December 29, 2021

State of California

Gavin Newsom, Governor

INTRODUCTION

On July 28, 2021, Brian R. Macejko, P.E., Phillip E. Prueter, P.E. and David A. Osage, ASME Fellow, P.E. for E^2G, The Equity Engineering Group, Inc., (Petitioners) submitted a petition concerning pressure vessels used in the petroleum refining, transportation and handling industry.

REQUESTED ACTION

The Petitioners are requesting to amend title 8, subchapter 15. Petroleum Safety Orders - Refining, Transportation and Handling, article 18. Unfired Pressure Vessels, Boilers, and Fired Pressure Vessels and Pressure Relief Valves, section 6857. Pressure Vessels and Boilers, by incorporating by reference the latest edition of American Petroleum Institute (API) 579, Fitness-for-Service (FFS) assessment standard.

BACKGROUND/HISTORY

On August 18, 2005, the Occupational Safety and Health Standards Board (Board) considered revisions to title 8, subchapter 14. Petroleum Safety Orders –Drilling and Production, sections 6505, 6533, 6551, and new section 6552 and subchapter 15. Petroleum Safety Orders - Refining, Transportation and Handling, sections 6755, 6845, 6857, and new section 6858. These sections became effective on July 26, 2006. The rulemaking was developed by the Cal/OSHA Pressure Vessel Unit under the direction of then Principal Engineer, Don Cook.

PETITIONERS' ASSERTIONS

The API Recommended Practice 579 (API RP579), First Edition, January 2000 that is currently incorporated by reference within section 6857 is no longer consistent with the latest edition of ASME Codes. Some examples are listed below:

- The ability to utilize allowable stress values from American Society of Mechanical Engineers (ASME) Section VIII, Division 2 (ASME VIII-2) for evaluation of equipment built to ASME Section VIII, Division 1 will no longer be permitted. Since the allowable stress criterion in ASME VIII-2 was reduced in 2007, the ASME/API Fitness-for-Service Joint committee (FFSJC) determined that the resultant factor of safety obtained after employing both the post-2007 ASME VIII-2 allowable stress criteria and API 579 FFS procedures would be inappropriate for pressure vessels designed and constructed to ASME VIII-1.

- The brittle fracture screening procedures for establishing minimum permissible temperature limits will be more restrictive for some components (e.g. ASME B16.5 flanges, pressure vessel nozzle reinforcement zones, etc.). The ASME/API FFSJC determined that the current procedures were inadequate in qualifying for protection from potential brittle fracture failures.
- The coefficient of variation (COV) criteria employed to justify use of point thickness readings in a general metal loss assessment will be replaced with a more conservative qualification on the minimum measured thickness. The ASME/API FFSJC determined that the COV was insufficient in classifying damage as general metal loss compared to local metal loss and there was opportunity for misapplication of the current assessment procedures.
- The thickness averaging procedure for evaluation of wall loss near a pressure vessel nozzle junction will be more stringent. The ASME/API FFSJC determined that the current published procedure could, under certain circumstances, permit more extensive wall loss near the nozzle junction as opposed to away from the nozzle junction and thus not in alignment with the intent of the FFS procedures.
- Numerous changes have been made to the procedures and critical input parameters associated with the evaluation of crack-like flaws. The ASME/API FFSJC identified errors in the current published procedures that in some instances may provide non-conservative results.

Additionally, the 2000 edition of API RP579 does not address the following damage mechanisms:

- Creep due to high temperature operation
- Hydrogen Induced Cracking (HIC) and Stress Oriented Hydrogen Induced Cracking (SOHIC) due to low temperature hydrogen damage
- Fatigue due to cyclic operation
- Dents, gouges, and dent-gouge combinations due to mechanical damage

CAL/OSHA's REPORT

Cal/OSHA's petition evaluation dated November 18, 2021, recommended that the petition be granted and the 2016 edition of API-579 be incorporated into title 8 section 6857 in place of the 2000 edition.

Cal/OSHA agrees the 2000 edition of API 579 does not address many of the common damage mechanism that affect equipment in the petroleum industry. Cal/OSHA's Pressure Vessel Unit has been involved in many FFS assessments involving damage mechanism not covered in the 2000 edition of API 579. In these instances, the requestor has been granted the ability to perform the FFS assessment per the more recent API 579 edition.

STAFF EVALUATION

API RP579, which was first published in January 2000, contains methods for assessing the structural integrity of pressurized equipment used in oil and gas, petrochemical, and chemical plants. API RP579 is intended to be used in conjunction with API 510, Pressure Vessel Inspection Code: Maintenance Inspection, Rerating, Repair and Alteration, API 570, Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems and API 653, Tank Inspection, Repair, Alteration, and Reconstruction.

According to the Foreword of API 579-1/ASME FFS-1 2016 Fitness-For-Service, a number of modifications and technical improvements are included, such as:

- Reorganized the standard to facilitate use and updates.
- Expanded equipment design code coverage.
- Added Annex for establishing an allowable Remaining Strength Factor.
- Simplified Level 1 criterion for the circumferential extent of a Local Thin Area through the modification of the Type A Component definition and subdivision of Type B Components into Class 1 or Class 2.
- Updated crack-like flaw interaction rules.
- Re-wrote weld residual stress solution Annex for use in the assessment of crack-like flaws.
- Updated guidance on material toughness predictions for use in the assessment of crack-like flaws.
- Updated evaluation procedures for the assessment of creep damage.
- Added Annex covering metallurgical investigation and evaluation of mechanical properties in a fire damage assessment.
- Developed new Part 14 covering the assessment of fatigue damage.

According to section 1.7.2 of API 579-1/ASME FFS-1 2016, the edition of the codes, standards, and recommended practices used in the FFS assessment shall be either the latest edition, the edition used for the design and fabrication of the component, or a combination thereof. The engineer responsible for the assessment shall determine the edition(s) to be used. Table 1.1 of API 579-1/ASME FFS-1 2016 contains the related reference codes, standards, and recommended practices.

Table 1.1 – Codes, Standards and Recommended Practices

Title	Identification
Pressure Vessel Inspection Code: Maintenance Inspection, Rerating, Repair and Alteration	API 510
Calculation of Heater-Tube Thickness in Petroleum Refineries	API Std 530

Title	Identification
Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems	API 570
Damage Mechanisms Affecting Fixed Equipment In The Refining Industry	API RP 571
Inspection of Pressure Vessels	API RP 572
Inspection of Fired Boilers and Heaters	API RP 573
Inspection Practices for Piping System Components	API RP 574
Recommended Practice for Inspection of Atmospheric and Low Pressure Storage Tanks	API RP 575
Inspection of Pressure Relieving Devices	API RP 576
Welding Processes, Inspection, and Metallurgy	API RP 577
Recommended Practice for Positive Materials Identification (PMI)	API RP 578
Recommended Practice for Risk-Based Inspection	API RP 580
Base Resource Document – Risk-Based Inspection	API RP 581
Design and Construction of Large, Welded, Low-Pressure Storage Tanks	API Std 620
Welded Steel Tanks for Oil Storage	API Std 650
Tank Inspection, Repair, Alteration, and Reconstruction	API Std 653
Steels for Hydrogen Service at Elevated Temperatures and Pressures	API RP 941
Avoiding Environmental Cracking in Amine Units	API RP 945
National Board Inspection Code	NB-23
Minimum Design Loads for Buildings and Other Structures	ASCE 7
Rules For Construction of Power Boilers	ASME B&PV Code Section I
Boiler and Pressure Vessel Code, Section II, Part A – Ferrous Material Specifications	ASME B&PV Code Section II, Part A
Boiler and Pressure Vessel Code, Section II, Part B – Nonferrous Material Specifications	ASME B&PV Code Section II, Part B
Boiler and Pressure Vessel Code, Section II, Part D –Properties	ASME B&PV Code Section II, Part D
Subsection NH – Class 1 Components in Elevated Temperature Service	ASME B&PV Code Section III, Division 1
Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels Division 1	ASME B&PV Code Section VIII, Division 1
Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels Division 2, Alternative Rules	ASME B&PV Code Section VIII, Division 2
Rules For In-service Inspection Of Nuclear Power Plant Components	ASME B&PV Code Section XI

Title	Identification
Alternative Method to Area Replacement Rules for Openings Under Internal Pressure, Section VIII, Division 1	ASME B&PV Code Case 2168
Alternative Rules for Determining Allowable Compressive Stresses For Cylinders, Cones, Spheres and Formed Heads Section VIII, Divisions 1 and 2	ASME B&PV Code Case 2286
Factory Made Wrought Steel Buttwelding Fittings	ASME B16.9
Manual for Determining the Remaining Strength of Corroded Pipelines	ASME B31G
Power Piping	ASME B31.1
Process Piping	ASME B31.3
Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids	ASME B31.4
Gas Transmission and Distribution Piping System	ASME B31.8
Hydrogen Piping and Pipelines	ASME B31.12
Welding Processes, Inspection, and Metallurgy	ASTM A20
Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications	ASTM A358
Standard Test Methods and Definitions for Mechanical Testing of Steel Products	ASTM A370
General Requirements for Specialized Carbon and Alloy Steel Pipe	ASTM A530
Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures	ASTM A671
Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures	ASTM A672
Carbon and Alloy Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures	ASTM A691
Test Methods of Tension Testing of Metallic Materials	ASTM E8
Standard Test Method for Measurement of Fatigue Crack Growth Rates	ASTM E647
Standard Practices for Cycle Counting in Fatigue Analysis	ASTM E1049
Standard Test Method for Measurement of Fracture Toughness	ASTM E1820
Test Method For The Determination of Reference Temperature, T_0 , For Ferritic Steels In The Transition Range	ASTM E1921
Standard Guide for Examination and Evaluation of Pitting Corrosion	ASTM G46
Specification for Unfired Fusion Welded Pressure Vessels	BS PD 5500

Title	Identification
Methods for the Assessment of the Influence of Crack Growth on the Significance of Defects in Components Operating at High Temperatures	BS PD 6539
Method for Determination of KIC, Critical CTOD and Critical J Values of Welds in Metallic Materials	BS 7448: Part 2
Code of Practice for Fatigue Design and Assessment of Steel Structures	BS 7608
Guide on Methods For Assessing the Acceptability of Flaws in Metallic Structures	BS 7910
Design of Steel Pressure Pipes	DIN 2413 Part 1
Design of Steel Bends Used in Pressure Pipelines	DIN 2413 Part 2
Summary of the Average Stress Rupture Properties of Wrought Steels for Boilers and Pressure Vessels	ISO/TR 7468-1981(E)
Detection, Repair, and Mitigation of Cracking in Refinery Equipment in Wet H2S Environments	NACE Std RP0296
Assessment Procedure For High Temperature Response Of Structures	EDF Nuclear Energy R-5
Assessment Of The Integrity of Structures Containing Defects	EDF Nuclear Energy R-6
A combined deterministic and probabilistic procedure for safety assessment of components with cracks – Handbook	SSM Research Report 2008:01
Method of Assessment for Flaws in Fusion Welded Joints with Respect to Brittle Fracture and Fatigue Crack Growth	WES 2805

As technology moves forward and new inspection methods become acceptable, the recommended practices change. Therefore, consensus standards incorporated by reference require updating. The manner in which the standards are updated must ensure that harmony is maintained with other sections of title 8. For example, section 6845. Piping, Fittings, and Valves incorporates by reference API 570, Piping Inspection Code, Second Edition, October 1998, Addendum 3, August 2003 and section 6857. Pressure Vessels and Boilers incorporates by reference API 510, Pressure Vessel Inspection Code, Eighth Edition, June 1997, Addendum 4, August 2003, which may also need to be updated.

Relevant Standards

Federal Standards

None.

California Standards

§6845. Piping, Fittings, and Valves.

(a) The design, fabrication, and assembly of piping systems installed prior to July 26, 2006, shall comply with General Industry Safety Orders and ASME B31.3- 1990, Chemical Plant and Petroleum Refinery Piping herein incorporated by reference. The design, fabrication, and assembly of piping systems installed on or after July 26, 2006, and the testing, inspection, and repair of all piping systems shall comply with Article 146 of the General Industry Safety Orders; API 570, Piping Inspection Code, Second Edition, October 1998, Addendum 3, August 2003; and ASME B31.3-2002, Process Piping; herein incorporated by reference.

(1) Excluded and optional piping systems specified in Section 1.2.2 of API 570-2003, are subject to inspection and testing by the employer in accordance with good engineering practices**.**

§6857. Pressure Vessels and Boilers.
(c) Maintenance, inspection, and repair procedures.
(1) Maintenance, inspection, and repair procedures of unfired pressure vessels shall comply with API 510, Pressure Vessel Inspection Code, Eighth Edition, June 1997, Addendum 4, August 2003; API 580, Risk-based Inspection, Recommended Practice, First Edition, May 2002; API 579, Fitness-for-Service, Recommended Practice, First Edition, January 2000; or the National Board Inspection Code/American National Standard ANSI/NB-23, 2004 Edition; which are hereby incorporated by reference.

(2) A written risk-based inspection program, as described in API 510-2003 and API 580-2002, may be used to increase the internal or on-stream inspection limits required by API 510-2003 Section 6.4 to a maximum of 15 years, or the external inspection interval described by API 510-2003, Section 6.3 to a maximum of 10 years, provided it is reviewed and accepted by the Division before the program is implemented, and every three years thereafter. Any revisions made to the accepted risk-based inspection program must also be submitted**,** reviewed, and accepted by the Division prior to implementation of these revisions.

STAFF RECOMMENDATION

Board staff recommends that the petition be GRANTED to the extent that an advisory committee be convened by the Cal/OSHA Pressure Vessel Unit. Cal/OSHA should review other sections of title 8 to ensure that the changes remain in harmony. The Petitioners should be extended an invitation to be part of the advisory committee.