



BODY OF KNOWLEDGE

API-570 AUTHORIZED PIPING INSPECTOR

CERTIFICATION EXAMINATION

2015 (Replaces July 2013)

API Authorized Piping Inspectors must have a broad knowledge base relating to maintenance, inspection, alteration and repair of in-service metallic piping systems. The API Authorized Piping Inspector Certification Examination is designed to determine if applicants have such knowledge.

Questions may be taken from anywhere within each document in this BOK, unless specifically excluded herein.

In the event that specific sections of a document are listed as excluded– all other sections within that document are included.

In some cases specific paragraphs or sections, such as the example shown below, are included as an aid to the candidate. This is not intended to exclude other paragraphs.

For example: In the “Corrosion Rate and Inspection Intervals” section of this BOK (Section A, Sub-section 1), it states:

The Inspector must be able to calculate:

- a) Corrosion Rates (API-570, Par. 7.1).

This means that the corrosion rate calculation will be found in paragraph 7.1. It does not mean that other paragraphs in that section are excluded.

The examination consists of two parts. The closed-book part tests the candidate on knowledge and tasks requiring everyday working knowledge of API Standard 570 and the applicable reference documents. The open-book portion of the examination requires the use of more detailed information that the inspector is expected to be able to find in the documents, but would not normally be committed to memory.

REFERENCE PUBLICATIONS:

A. API Publications:

API Standard 570 – Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems
API RP 571, Damage mechanisms Affecting Fixed equipment in the Refining Industry
API Recommended Practice 574 – Inspection Practices for Piping System Components
API RP 577, Welding Inspection and Metallurgy
API Recommended Practice 578 – Material Verification Program for New and Existing Alloy Piping Systems

B. ASME Publications:

American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code*:
Section V, Nondestructive Examination, and
Section IX, Welding and brazing Qualifications
B16.5, Pipe Flanges and Flanged Fittings
B31.3, Process Piping

Note: Refer to the Publications Effectivity Sheet in the application package for a list of specific editions, addenda, and supplements of the referenced publications that are effective for your examination date.

The following is the list of specific topics in which an API certified Piping Inspector should be knowledgeable.



CALCULATIONS FOR EVALUATING THICKNESS MEASUREMENTS, INSPECTION INTERVALS, AND PIPING INTEGRITY

- A. Code calculation questions will be oriented toward existing in-service piping, not new piping. API Authorized Piping Inspectors should be able to check and perform calculations relative to in-service deterioration, repairs, rerates, or alterations, such as those included in the following eight categories.**

Note: Candidates are expected to understand the SI units (metric system) and the US customary units (inches, feet, PSI, etc.) and to use both system formulas.

1. CORROSION RATES AND INSPECTION INTERVALS

The Inspector should be able to understand inspection data and determine the thickness measurement and visual external inspection intervals.

The Inspector must be able to calculate:

- b) Corrosion Rates (API-570, Par. 7.1)
- c) Remaining Service Life (API-570, Par., 7.1.1)
- d) Inspection Interval (API-570, Par., 6.3.3 & Table 2)

The formulas for performing the above calculations and rules for setting the inspection intervals may be "closed-book" during the exam.

2. WELD JOINT QUALITY FACTORS AND CASTING QUALITY FACTORS

The inspector should be able to determine the weld joint quality factor "Ej" of a longitudinal pipe weld joint. The inspector should be able to determine:

- a) Casting Quality factor, Ec from B31.3, 302.3.3 (b) and A-1A
- b) Weld Joint Quality factors from ASME B31.3, 302.3.4 and A-1B;
- c) Increased Joint Quality Factors by performing supplemental NDE from ASME B31.3 Table 302.3.4;

Determining weld joint quality factor may be part of an internal pressure problem since the joint factor Ej is used in the formulas for determining required thickness or internal design pressure.

3. INTERNAL PRESSURE / MINIMUM THICKNESS OF PIPE

The inspector should be able to determine:

- a) The minimum required thickness or pressure design thickness of a straight pipe section for a internal pressure only (ASME B31.3 Section 304.1.1 and 304.1.2);
- b) The minimum required thickness of a permanent blank for a given design pressure (ASME B31.3 Section 304.5.3);
- c) The "MAWP" of corroded pipe, compensating for expected corrosion loss at the next inspection (API 570, Par., 7.2)

The inspector should also be able to compensate for the corrosion allowance. (Add or subtract based on requirements from the exam problem).

4. PRESSURE TESTING



The inspector should be able to:

- a) Demonstrate knowledge concerning hydrostatic leak testing (ASME B31.3 Section 345.4)
- b) Demonstrate knowledge concerning pneumatic leak testing (ASME B31.3 Section 345.5)
- c) Calculate a hydrostatic or pneumatic leak test pressure (ASME B31.3 Sections 345.4, 345.5)

5. IMPACT TESTING

The inspector should be able to:

- a) Determine the minimum metal temperature of a material, which is exempt from impact testing (ASME B31.3, Section 323.2.2, Figure 323.2.2A & Table A-1).
- b) Determine the minimum required charpy V-notch impact values of a given material. (ASME B31.3, Section 323.3, Table 323.3.5)

6. PREHEATING AND HEAT TREATMENT REQUIREMENTS

The inspector should be able to determine which weld sizes require preheating and/or heat treatment. The inspector also should be able to:

- a) Determine what is the required or recommended preheat temperature (ASME B31.3, Section 330 & Table 330.1.1).
- b) Determine the governing thickness, holding time, holding temperature, and maximum Brinell hardness for heat treatment applications (ASME B31.3, Section 331 & Table 331.1.1).

7. THERMAL EXPANSION

The inspector should be able to determine the total thermal expansion of a material between temperatures (ASME B31.3, Appendix C, Table C-1).

8. MINIMUM WALL THICKNESS & WORKING PRESSURES FOR FLANGES

The inspector should be able to determine the minimum wall thickness and working pressure requirements for flanges. The inspector should also be able to:

- a) Determine the working pressure and minimum/maximum system hydrostatic test pressure for a flange of specified material and temperature (ASME B16.5, Par. 2. & Table 1A & Tables 2-1.1 through 2-3. 19 and Tables II-2.1.1 through II-2-3.19).
- b) Determine the minimum dimensions of a given flange (ASME B16.5 Tables 7 through 22 and Tables II-7 through 22).
- c) Determine maximum working pressure of a flange when given the design temperature, flange material and flange class.
- d) Determine maximum temperature of a flange when given the design pressure, flange material and flange class.
- e) Determine most cost effective flange when given the design pressure, design temperature, and flange material.

9. MINIMUM REQUIRED THICKNESS OF A PERMANENT BLANK (ASME B31.3, Par. 304.5.3)



B. The following are the ASME B31.3 code engineering requirements that are excluded from the examination and that the API Authorized Piping Inspectors will NOT be expected to know for the purposes of certification testing.

- 1 302 Design criteria – (All except for 302.3.3 Casting Quality Factor, *Ec*, and 302.3.4, Weld Joint Quality Factor, *Ej*)
- 2 304.1.3 Straight Pipe Under External Pressure
- 3 304.2 Curved and Mitered Segments of Pipe
- 4 304.3 Branch Connections
- 5 304.4 Closures
- 6 304.5 Pressure Design of Flanges & Blanks (All except 304.5.3, Blanks)
- 7 304.6 Reducers
- 8 304.7 Pressure Design of Other Components
- 9 315 Tubing Joints
- 10 316 Caulked Joints
- 11 317 Soldered and Brazed Joints
- 12 318 Special Joints
- 13 319.4 Flexibility Analysis
- 14 319.5 Reactions
- 15 319.6 Calculation of Movements
- 16 319.7 Means of Increasing Flexibility
- 17 322.3 Instrument Piping
- 18 Chap. VII Nonmetallic Piping and Piping Lined With Nonmetals
- 19 Chap. VIII Piping for Category M Fluid Service
- 20 Chap. IX High Pressure Piping
- 21 App.B Stress Tables and Allowable Pressure Tables for Nonmetals
- 22 App. D Flexibility and Stress Intensification Factors
- 23 App.E Reference Standards
- 24 App. G Safeguarding
- 25 App. H Sample Calculations for Branch Reinforcement
- 26 App. J Nomenclature
- 27 App. K Allowable Stresses for High Pressure Piping
- 28 App. X Metallic Bellows Expansion Joints
- 29 App. Z Preparation of Technical Inquiries



II. WELDING PROCEDURE AND QUALIFICATION EVALUATION

A. ASME BOILER AND PRESSURE VESSEL CODE, SECTION IX

The inspector should have the knowledge and skills required to review a Procedure Qualification Record and a Welding Procedure Specification and to be able to determine the following:

1. Determine if procedure and qualification records are in compliance with applicable ASME Boiler and Pressure Vessel Code and any additional requirements of API-570. The weld procedure review will include:
 - One Weld Procedure Specification (WPS); and
 - One Procedure Qualification Record (PQR).
2. Determine if all required essential and non-essential variables have been properly addressed. (Supplemental essential variables will not be a part of the WPS/PQR)
3. Determine that the number and type of mechanical tests that are listed on PQR are the proper tests, and whether the results are acceptable.

WELD PROCEDURE REVIEW MAY INCLUDE SMAW, GTAW, GMAW, OR SAW, WITH THE FOLLOWING LIMITATIONS:

1. No more than one process will be included on a single WPS or PQR and the WPS to be reviewed will be supported by a single PQR.
2. Filler metals will be limited to one-per-process for SMAW, GTAW, GMAW, or SAW
3. The PQR will be the supporting PQR for the WPS.
4. Base metals will be limited to P1, P3, P4, P5, and P8.
5. Dissimilar base metal joints, and dissimilar thicknesses of base metals will be excluded.
6. Special weld processes such as corrosion-resistant weld metal overlay, hard-facing overlay, and dissimilar metal welds with buttering of ferritic member will be excluded.
7. For P1, P3, P4, and P5, for the purpose of the examination the lower transition temperature will be 1330 F and the upper transformation temperature will be 1600 F.

B. ASME B31.3

The inspector should be familiar with and understand the general rules for welding in ASME B31.3, Chapter V such as:

1. Typical joints and definitions
2. Weld sizes
3. Restrictions on joints
4. Maximum allowable reinforcement
5. Inspection requirements
6. Preheating and Heat Treatment

C. API Standard 570

The inspector should be familiar with and understand any rules for welding in API-570. Any rules for welding given in API570 shall take precedence over those covering the same areas in ASME, B31.3.

Note: "Editorial" and non-technical requirements for the welding subject matter, the candidate is to be tested on, are excluded. This includes items such as the revision level of the WPS, company name, WPS number and date, and name of testing lab. However, the API Authorized Piping Inspector should know that the PQR must be signed and dated.

D. The inspector shall be familiar with all the requirements of and information in API RP 577.



III. NONDESTRUCTIVE EXAMINATION

A. ASME Section V, Nondestructive Examination

NOTE: The examination will cover only the main body of each referenced Article, except as noted.

1. Article 1, General Requirements:

The inspector should be familiar with and understand;

- a) The Scope of Section V,
- b) Rules for use of Section V as a referenced Code,
- c) Responsibilities of the Owner / User, and of subcontractors,
- d) Calibration
- e) Definitions of "inspection" and examination"
- f) Record keeping requirements,

2. Article 2, Radiographic Examination:

The inspector should be familiar with and understand;

- a) The Scope of Article 2 and general requirements,
- b) The rules for radiography as typically applied on butt welded seams such as, but not limited to:
 - o Required marking
 - o Type, selection, number, and placement of IQI's,
 - o Allowable density and density ranges
 - o Control of backscatter radiation
- c) Records

3. Article 6, Liquid Penetrant Examination (Including mandatory appendices II and III):

The inspector should be familiar with and understand the general rules for applying and using the liquid penetrant method, including but not limited to the following:

- a) The Scope of Article 6,
- b) General requirements such as but not limited to:
 - Procedures
 - Contaminants
 - Techniques
 - Examination
 - Interpretation
 - Documentation and record keeping

4. Article 7, Magnetic Particle Examination (Yoke and Prod techniques only):

The inspector should be familiar with and understand the general rules for applying and using the magnetic particle method including, but not limited to the following:

- a) The Scope of Article 7,
- b) General requirements such as but not limited to:
 - Procedures
 - Techniques (Yoke and Prod only)
 - Calibration



- Examination
- Interpretation
- c) Documentation and record keeping

5. Article 9, Visual Examination:

The inspector should be familiar with and understand the general rules for applying and using the visual examination method including, but not limited to the following:

- a) The scope of Article 9,
- b) General requirements such as but not limited to:
 - Procedures
 - Physical requirements
 - Procedure/technique
 - Evaluation
- c) Documentation and record keeping

6. Article 10, Leak Testing (Including Mandatory Appendix I Bubble Test –Direct Pressure Technique):

The inspector should be familiar with and understand the general rules for applying and using the leak testing method including, but not limited to the following:

- a) The scope of Article 10,
- b) General requirements such as but not limited to:
 - Procedures
 - Equipment
 - Calibration
 - Test
 - Evaluation
- c) Documentation and record keeping

7. Article 23, Ultrasonic Standards, **Section SE-797 only** – Standard practice for measuring thickness by manual ultrasonic pulse-echo contact method:

The inspector should be familiar with and understand;

- a) The Scope of Article 23, Section SE-797,
- b) The general rules for applying and using the Ultrasonic method
- c) The specific procedures for Ultrasonic thickness measurement as contained in paragraph 7.

B. ASME B31.3 and API-570: General nondestructive examination requirements:

ASME B31.3: The inspector should be familiar with and understand the general rules for NDE (Chapter VI).

C. API Standard 570: The inspector should be familiar with and understand the general rules for NDE in API-570.

IV: PRACTICAL KNOWLEDGE - GENERAL

The following topics may be covered:

- Organization and Certification Requirements.
- Types and Definitions of Maintenance Inspections.
- Welding on Piping
- Corrosion and Minimum Thickness Evaluation.
- Estimated Remaining Life.
- Inspection Interval Determination and Issues Affecting Intervals.
- Maintenance Inspection Safety Practices.
- Inspection Records and Reports.
- Repairs/Alterations/Reratings to Piping.
- Rerating Piping.
- Pressure Testing After Repairs, Alterations, or Rerating
- Pressure Temperature Ratings
- Markings
- Materials
- Dimensions
- Test
- Limiting Dimensions of Gaskets
- Methods for Establishing Pressure-Temperature Ratings
- Methods of performing positive material identification and related record keeping.

More information relative to each of the categories is contained in section "V. PRACTICAL KNOWLEDGE - SPECIFIC" where each reference publication applicable for study for the examination has been listed with relevant topics that may be covered on the examination.



V. PRACTICAL KNOWLEDGE - SPECIFIC

API-570, Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems – the entire document is subject to testing

API RP 571, Damage mechanisms Affecting Fixed equipment in the Refining Industry

ATTN: Examination questions will be based on the following portions of the document only:

- Par. 3 – Definitions
- 4.2.7 – Brittle Fracture
- 4.2.9 – Thermal Fatigue
- 4.2.14 – Erosion/Erosion Corrosion
- 4.2.16 – Mechanical Fatigue
- 4.2.17 – Vibration-Induced Fatigue
- 4.3.1 – Galvanic Corrosion
- 4.3.2 – Atmospheric Corrosion
- 4.3.3 – Corrosion Under Insulation (CUI)
- 4.3.5 – Boiler Water Condensate Corrosion
- 4.3.8 – Microbiological Induced Corrosion (MIC)
- 4.3.9 – Soil Corrosion
- 4.3.10 Caustic corrosion
- 4.4.2 – Sulfidation
- 4.5.1 – Chloride Stress Corrosion Cracking (Cl-SCC)
- 4.5.3 – Caustic Stress Corrosion Cracking (Caustic Embrittlement)
- 5.1.1.4 -Hydrochloric Acid (HCL) Corrosion
- 5.1.1.10 - Sour Water Corrosion (Acidic)
- 5.1.2.2 - Amine Stress Corrosion Cracking
- 5.1.3.1 – High Temperature Hydrogen Attack (HTTA)

API RP-574, Inspection of Piping, Tubing, Valves, and Fittings – the entire document is subject to testing

API RP 577, Welding Inspection and Metallurgy – the entire document is subject to testing

**API Recommended Practice 578 – Material Verification program for New and Existing Alloy piping Systems
the entire document is subject to testing**

ASME B16.5, Pipe Flanges and Flanged Fittings

- Scope
- Pressure Temperature Ratings
- Markings
- Materials
- Dimensions
- Test
- Limiting Dimensions of Gaskets
- Methods for Establishing Pressure-Temperature Ratings