

# NBBI NB-380-1 WORKBOOK

## Inservice Inspection

This document is a task-based training workbook designed to help jurisdictions and Authorized Inspection Agencies develop inspector candidates who do not meet the five-point education and experience requirements found in NB-263, RCI-1, *Rules for Commissioned Inspectors*. Completion of the workbook is intended to meet the alternative requirements found in NB-380, *National Board Inservice Inspector Training Program*.

Inspector Candidate: \_\_\_\_\_

Assigned Mentor: \_\_\_\_\_

Start Date: \_\_\_\_\_

Completion Date: \_\_\_\_\_

## Introduction:

This document is a task-based training workbook designed to help inspector candidates meet the requirements of NB-380, *National Board Inservice Inspector Training Program*. Consisting of seven modules, this workbook will guide inspector candidates as they acquire and demonstrate knowledge of the foundations of boiler and pressure vessel inspection. Topics and tasks covered within the workbook are based on NB-380 and NB-331-I, *National Board Body of Knowledge of Inservice Inspectors*.

The workbook contains three types of tasks. The first type is Knowledge Checks, where inspector candidates are to verbally demonstrate satisfactory knowledge and understanding of a specific topic to a commissioned inspector. These checks can be completed in any setting. The second is Practical Applications, where inspector candidates will demonstrate their understanding of inspection methods in the field under the supervision of a commissioned inspector. Examples of Practical Applications include verifying code plate information, verifying or supervising the testing of a low-water cutout device, or assessing the internal condition of a boiler. The final type of task is Module Assessments, where inspector candidates are tested to ensure they are retaining the subject matter for each module. These assessments are to be given by the Chief Inspector or Inservice Inspector Supervisor either verbally or in writing. Module Assessments shall be documented by the Inspection Agency.

Some jurisdictions are limited in the scope of equipment they can inspect, possibly making it difficult for inspector candidates in those areas to perform all the practical applications outlined within this workbook. While it is highly encouraged that Inspection Agencies work with other agencies or jurisdictions to allow inspector candidates to complete Practical Applications they otherwise would be unable to, allowances can be made by the Chief Inspector or Inservice Inspector Supervisor when necessary. In cases where an exception must be made, the Practical Application shall be supplemented by additional training on the relevant topic. The training will be documented and approved by the Chief Inspector or Inservice Inspector Supervisor. Exceptions are subject to prior acceptance of the National Board.

This workbook is designed only to meet the minimum requirements of NB-380. Inspection Agencies are responsible for providing additional instruction to inspector candidates. Instruction should include topics specific to their organization and the jurisdiction(s) in which they will be working. Documentation of additional training may be included with the workbook, though such training shall not take the place of workbook tasks except as allowed above.

An inspection log is provided alongside this workbook. The inspection log is to be used to document the inspector candidate's participation in 300 boiler and/or pressure vessel inspections, as required by NB-380. Alternative inspection logs may be used,

though the information contained in the provided inspection log should be considered the minimum standard for alternatives. Alternative inspection logs are subject to the acceptance of the National Board prior to implementation in accordance with Part 1 of NB-263, RCI-1, *Rules for Commissioned Inspectors*.

Successful completion of this workbook and inspection log are only one step in the commissioning process. Inspector candidates will also need to successfully complete the National Board Classroom Inservice Commission Course (IS) and the following National Board Online Training Courses: National Board Inspection Code, Part 1, Installation; National Board Inspection Code, Part 2, Inspection; and Rules for Commissioned Inspectors. Inspector candidates will also need to successfully pass the Inservice Inspector Commission Exam.

### **NB-380 Workbook Task Group Members**

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The responsibilities of the Task group are to develop and propose a workbook that an applicant/Inspection Agency may use to fulfill the requirements of the NB-380 Program. Source material for the workbook shall include, but not limited to, NB-380 requirements and the National Board Body of Knowledge for Inservice Inspectors (NB-331-I).

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# Module 1

## Boiler and Pressure Vessel Fundamentals

### Introduction:

This module introduces the Inspector Candidate to the fundamentals of the boiler and pressure vessel industry. Topics include physics, equipment design, corrosion and failure mechanisms, nondestructive examination, and more. This module will include additional foundational activities for the Inspector Candidate to work through with their assigned Mentor. After completing this module, Inspector Candidates should be able to demonstrate a working knowledge and understanding of the fundamentals needed to begin subsequent modules.

### Recommended Reference Material:

The following is a list of some materials that contain industry terms and fundamental concepts the Inspector Candidate will need to understand to complete this module:

- ASME Section VI, Recommended Rules for the Care and Operation of Heating Boilers
- ASME Section VII, Recommended Guidelines for the Care of Power Boilers
- ASME Section V, Nondestructive Examination
- U.S. Navy, NAVEDTRA 10535-H, Boiler Technician 3 & 2
- *National Board Inspection Code* (NBIC)
- NFPA 85, Boiler and Combustion Systems Hazards Code
- [Pan Global Website https://panglobal.org/](https://panglobal.org/)
- U.S. Navy, NAPERS 10788-B, Principles of Naval Engineering (PNE)
- Boiler & Pressure Vessel Manufacturers' Technical Publications
- ASTM C64-72(1977) Standard Specification for Refractories for Incinerators and Boilers
- [Insulation Outlook https://insulation.org/io/articles/a-different-perspective-refractory-materials-for-the-power-generation-industry-2/](https://insulation.org/io/articles/a-different-perspective-refractory-materials-for-the-power-generation-industry-2/)
- *Low Pressure Boilers*, Steingrass, Walker
- *High Pressure Boilers*, Steingrass, Walker
- ASTM D396-21, Standard Specification for Fuel Oils

### Activity 1:

The candidate must have an understanding of boiler industry terms found in some of the recommended reference materials listed above. The designated trainer should test the candidate on a preassigned group of terms regularly. To complete Activity 1, the trainer must select at random 50 vocabulary terms from the above publications and conduct a written (not multiple choice) test. A score of 90% or better is required.

Mentor Name	Mentor Signature	Date

### Activity 2:

Instruction of the Inspector Candidate following a textbook such as Steingrass’ “Low Pressure Boilers” and completion of any accompanying training material is required.

Mentor Name	Mentor Signature	Date

### Activity 3:

Instruction and review of the listed ASME, NBBI and NFPA documents as well as supplementary instruction related to insulation, refractory, fuels, is required. Specific boiler and pressure vessel literature for objects that will be found in the field must be covered by the designated trainer.

Mentor Name	Mentor Signature	Date

## Knowledge Checks: Boiler and Pressure Vessel Fundamentals

Boiler Basics and Principles	Initials	Date
Basic Terms		
Boiler		
Design		
Application		
Thermal energy		
Mechanical energy		
Thermodynamics		
Explain the first law of thermodynamics.		
Describe an example.		
Explain the second law of thermodynamics.		
Describe an example.		
Define heat.		
Define solids.		
Define liquids.		
Define sensible heat.		
Define latent heat.		
Define specific heat.		
Sketch the relationship between sensible vs latent heat for a lb. of water at atmospheric pressure.		
Describe the differences between Fahrenheit and Celsius.		
What is the formula to convert the terms above?		
Describe conduction.		
Describe radiation.		
Describe convection.		
Describe the properties of saturated steam.		

Thermodynamics (Continued)	Initials	Date
Describe how steam is generated.		
What does "change of state" mean?		
Sketch the steam cycle.		
<b>Boiler Design</b>		
List the most common boiler types.		
Explain how watertube boilers function and their primary use.		
Explain how firetube boilers function and their primary use.		
Explain how cast iron/cast aluminum are constructed and their primary use.		
Sketch each of the boiler types described above.		
Define these boiler classifications and list their expected location:		
Low pressure steam		
High pressure steam		
Hot water heating		
Hot water supply		
Water heaters		
High temperature hot water		
Identify symbols for equipment, piping, and valves.		
Describe a common cause for expansion and concerns related to it.		
Describe the combustion process.		
<b>Combustion</b>		
Describe the various fuels and fuel firing equipment:		
Pumps		
Heaters		
Burners, sprayer plates, diffusers		
Fuel oil		
Fuel storage/heaters		
List the components in a fuel oil system.		



Combustion (Continued)	Initials	Date
Describe the different fuel oil grades.		
Define:		
Flash point		
Fire point		
Pour point		
Volatility		
Heating value		
British thermal unit (BTU)		
What fuel oils require heating and under what circumstances?		
Combustion air		
Identify the parts of a burner.		
Identify the parts of a sprayer plate.		
Identify the parts of a return flow atomizer.		
Settings/casings/stacks/flues		
Barometric dampers		
Forced draft blowers		
Induced fans		
Sliding feet		
Identify the parts of a header type boiler.		
Describe how steam and water circulates in various boiler applications.		
Materials		
Plate, pipe, tubes, valves, nozzles		
Define “shock systems” and their hazards (feed and blowoff).		
Define slow opening in respect to valves.		
What are the maximum and minimum sizes for blowoffs?		
What are the requirements for drains?		

Refractory	Initials	Date
What are the purpose of firebrick, fire block, insulating block, expansion joints?		
Sketch a typical high pressure water tube boiler furnace.		
Describe the failure modes of refractories.		
Joints		
Describe the following:		
Welds		
Flanges		
Bolting		
Gaskets		
Threaded connections		
Boiler Components		
Describe the following:		
Steam drum		
Water drum		
Superheater		
Waterwall tubes		
Screen wall tubes		
Generating tubes		
Economizers		
Airbox		
LP/HP drains		
Soot blowers		
Water gage glass (tri-cocks)		
Steam smothering system		
Saddles/supports		
Manways and handholes		
Piping marking systems		

Boiler Components (Continued)	Initials	Date
Sketch a steam drum with internals - cyclone separator type (wrapper sheet/tube sheet).		
<b>Additional Terminology</b>		
Define the terms contained in the glossaries described below:		
ASME Section VI Article 2 (Appendix II)		
ASME Section VII Subsection 5 (Appendix III)		
Boiler System Component Definitions BT 3&2 4-1 - 4-2, 6-32 - 6-34; Appendix I		
ASME Section V Mandatory Appendix I Glossary of Terms for Nondestructive Examination		
<b>Boiler Operations</b>		
Describe the purpose of the following:		
Pressure and temperature gages		
Calibration		
Controls		
Light-off sequencing		
Shut down sequencing		
Appurtenances		
<b>Maintenance</b>		
Describe the following terms:		
Lay-ups - wet and dry, desiccants		
Boiler tube cleaners		
Water wash		
Plugging of tubes		
Describe the importance of documentation.		
Logs		
Describe the following terms:		
Deaerating feed tanks (DFT)		
Feed pump		
Condensate pump		

Maintenance (Continued)	Initials	Date
Describe the following terms:		
Condenser		
Blow piping		
Surface blow		
Bottom blow		
Personnel training		
Preventing explosions		
Water level/GG		
Furnace pressure		
Expansion - sliding feet/pipe hangers		
Chemical cleaning		
Pressure testing		
Start-up		
Online operation (casualties)		
Why are hydrostatic tests performed and why is water the preferred/required medium?		
Describe the hazards associated with hydrostatic and pneumatic tests and how the code mitigated some of them.		
<b>Corrosion and Failure</b>		
Describe the following:		
How boilers and boiler components fail		
Causes		
Case history		
Describe some boiler casualties and what immediate action should be taken or not taken.		
Describe water treatment program.		
Describe steam and water deposit-related problems.		
Describe why a boiler may overheat.		
Describe the causes of waterside corrosion.		

Corrosion and Failure (Continued)	Initials	Date
Describe corrosion fatigue cracking.		
Describe stress corrosion cracking.		
Describe creep.		
Describe fireside erosion.		
Describe fireside corrosion and damage.		
Describe destructive testing and when is it used.		
<b>Miscellaneous</b>		
Write a description for an inspection report based on a scenario determined by the trainer.		
Describe basic tools and measuring equipment.		
Describe a scenario that requires in-trade critical thinking.		
<b>Nondestructive Examination</b>		
Define:		
Nondestructive examination (NDE)		
Inspection		
Examination		
Technique		
Describe the following NDE methods and the imperfections/discontinuities each of the following NDE method can identify:		
RT – Radiography UT – Ultrasonics MT – Magnetic Particle PT – Liquid Penetrants VT – Visual LT – Leak Testing ET – Electromagnetic (Eddy Current) AE – Acoustic Emission		

Pressure Vessel Basics and Principles	Initials	Date
Codes		
Describe the following:		
ASME Section VII		
NBIC Part 1		
NBIC Part 2		
ASME Section V		
OSHA confined space entry		
Vessel Types		
Describe the following types of pressure vessels and describe the usage and hazards associated with each:		
Air tanks		
Air oil separators		
CO2 vessels		
Ammonia vessels		
Refrigeration vessels		
Autoclaves/sterilizers		
Dryer rolls (including corrugated, yankee, etc.)		
Deaerator tanks		
Rendering vessels		
Process vessels		
Pressure cookers/retorts		
Steam platens		
Shell and tube heat exchangers		
Plate and frame heat exchangers		
Economizers		
Expansion tanks		
Blowdown tanks		

Vessel Construction	Initials	Date
Demonstrate knowledge on the following types of vessel construction and materials, uses, and limitations:		
Welded Riveted Lined Cast iron Wire wound		
<b>Corrosion and Failure</b>		
Demonstrate knowledge on cause and effects of degradation of vessels and how to monitor.		
Demonstrate calculations of corrosion allowances, how they apply and how to calculate MAWP.		
Describe the effects of corrosion.		
Describe the considerations/concerns with UPV's usage with corrosive materials and corrosive environments.		
Describe the effects of thinning - internal and external.		
Describe the issues with vessels being used in applications not designed for.		
Describe minimum design metal temperatures and environments where this may be most problematic.		
<b>Nondestructive Examination (NDE)</b>		
Demonstrate knowledge on material testing (NDE) of UPV's and techniques applicable for various discontinuities.		
Describe when you would use UT straight beam thickness testing and why.		
Describe when you would use UT angle beam testing on vessels and why.		
Describe when you would use wet fluorescent magnetic particle exam and why.		
Describe when you would use liquid penetrant testing on a vessel and why.		
<b>Overpressure Protection</b>		
Demonstrate knowledge of proper overpressure protection for pressure vessels.		
Describe types of pressure relief devices for various pressure vessels.		
Demonstrate capacity calculations for different types of pressure vessels.		

Overpressure Protection (Continued)	Initials	Date
Demonstrate capacity calculations for different types of pressure vessels.		
Demonstrate knowledge of overprotection protection by system design and when it is acceptable.		

Boiler and Pressure Vessel Fundamentals Module Review:

Supervisor Name	Supervisor Signature	Date



# Module 2

## Code References Overview

### Introduction:

This module introduces the Inspector Candidate to the codes and standards throughout the boiler and pressure vessel industry. Each code has a specific, unique scope that impacts safety. National Board codes establish rules for inspectors and inspections. ASME codes govern the construction of boilers, pressure vessels and piping systems. The codes addressed in this module are only the foundation of what standards the Inspector Candidate will need to know. Inspector Candidates will need to familiarize themselves with additional standards (such as ASME Section II - Materials, ASME Section V - Nondestructive examination and/or ASME Section IX - Welding) for a fuller understanding of the reference material. After completing this module, Inspector Candidates should be able to demonstrate a working knowledge and understanding of the core codes and standards related in inservice inspection.

### Reference Material:

- RCI-1, NB-263, *Rules for Commissioned Inspectors*
- *National Board Inspection Code (NBIC)*, Parts 1 and 2
- ASME Section I, Power Boilers
- ASME B.31.1, Power Piping
- ASME Section IV, Heating Boilers
- ASME Section V, Nondestructive Examination
- ASME Section VIII, Division 1, Pressure Vessels
- ASME Section IX, Welding Brazing and Fusing Qualifications
- ASME CSD-1, Controls and Safety Devices for Boilers

**Knowledge Checks:**  
**Code References Overview**

**NBIC Forward**

*At this point the forward of NBIC should be read:*

The National Board of Boiler and Pressure Vessel Inspectors is an organization composed of chief inspectors for the states, cities, and territories of the United States and provinces and territories of Canada. It is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in post-construction activities of pressure-retaining items, thereby ensuring acceptance and interchangeability among jurisdictional authorities responsible for the administration and enforcement of various codes and standards.

NBIC Forward	Initials	Date
Discuss the forward to the NBIC.		

**NB-263: Rules for Commissioned Inspectors (RCI-1)**

*Rules for Commissioned Inspectors* will govern the requirements for issuance and renewal of commissions and endorsements, along with testing requirements. The rules also describe the duties and responsibilities.

*Participants should be asked to complete the free RCI-1 training in the NBBI Business Center and be asked by the instructor to read Part 7 in its entirety.*

Part 1 of RCI-1 should be reviewed with the Inspector Candidate, who will then go through the exercise of determining how many points they have in experience and education. Inspector Candidates will discuss the examination process. The duties for an inspector in Part 3 should be reviewed.

Discussion of Part 7 should address:

- Conflict of interest
- Good faith actions
- Public perception
- Independence, impartiality, and integrity

Inspectors must act in good faith, should be objective and immediately report safety hazards.

NB-263: <i>Rules for Commissioned Inspectors</i> (RCI-1)	Initials	Date
Demonstrate a thorough understanding of RCI-1.		

### *National Board Inspection Codes (NBIC), Part 1, 2, and 3*

The NBIC recognizes three important areas of post-construction activities where information, understanding, and following specific requirements will promote public and personal safety. These areas include:

- Installation
- Inspection
- Repairs and Alterations

The NBIC provides rules, information, and guidance for post-construction activities, but does not provide details for all conditions involving pressure-retaining items. Where complete details are not provided in this code, the code user is advised to seek guidance from the Jurisdiction and from other technical sources.

Part 1 provides requirements and guidance to ensure all types of pressure retaining items are installed and function properly. Installation includes meeting specific safety criteria for construction, materials, design, supports, safety devices, operation, testing, and maintenance. Part 1 Sections include:

- General Section
- Power Boilers
- Heat and Hot Water Boilers
- Pressure Vessels
- Piping
- Supplements for specific types of equipment

Part 2, one that will be used most by members and inservice inspectors, provides information and guidance needed to perform and document inspections for all types of pressure-retaining items. This part includes information on personnel safety, nondestructive examination, tests, failure mechanisms, types of pressure equipment, fitness for service, risk-based assessments, and performance-based standards. Part 2 includes:

- General Section for Inservice Inspection of Pressure-Retaining Items
- Detailed Requirements for Inservice Inspection of Pressure Retaining Items
- Corrosion and Failure Mechanisms
- Examinations, Test Methods and Evaluations
- Stamping Documentation and Forms
- Supplements

Part 3 provides information and guidance needed to perform and document repairs and alterations to boilers and pressure vessels. This part includes information on quality control systems, welding procedures and qualifications, repairs, alterations, examination, testing, documentation, and Stamping. Part 3 includes:

- General Section for Administrative Requirements
- Welding, Brazing, Fusing, and Heat Treatment
- Requirements for Repairs and Alterations
- Examination and Testing
- Certification/Documentation and Stamping
- Supplements

*The instructor should open Parts 1, 2, and 3 during the class showing participants the structure of the code books. Read the forward and the scope in each code.*

National Board Inspection Code Parts 1, 2, and 3	Initials	Date
Demonstrate a thorough understanding of NBIC Parts 1, 2, & 3.		

### ASME Section I: Rules for Construction of Power Boilers

This Code covers rules for construction of power boilers, electric boilers, miniature boilers, high-temperature water boilers, heat recovery steam generators, solar receiver steam generators, certain fired pressure vessels, and liquid phase thermal fluid heaters to be used in stationary service and includes those power boilers used in locomotive, portable, and traction service. Reference to a paragraph includes all the subparagraphs and subdivisions under that paragraph. The Code does not contain rules to cover all details of design and construction. Where complete details are not given, it is intended that the manufacturer, subject to the acceptance of the Authorized Inspector, shall provide details of design and construction which will be as safe as otherwise provided by the rules in the Code. The construction code will pull into the process other codes such as material properties (ASME Section II, PG-5.1), Non Destructive Examination (ASME Section V, PW-50.1) and Welding Processes (ASME Section IX, PW-28.1). The code is composed of the main parts:

- Part PG General Requirements for All Methods of Construction
- Part PW Requirements for Boilers Fabricated by Welding
- Part PR Requirements for Boilers Fabricated by Riveting
- Part PB Requirements for Boilers Fabricated by Brazing
- Part PL Requirements for Locomotive Boilers
- Part PA Alternative Rules for Boiler Construction
- Part PWT Requirements for Watertube Boilers
- Part PFT Requirements for Firetube Boilers
- Part PFH Optional Requirements for Feedwater Heater
- Part PMB Requirements for Miniature Boilers

- Part PEB Requirements for Electric Boilers
- Part PVG Requirements for Organic Fluid Vaporizers
- Part PFE Requirements for Feed water Economizers
- Part PTFH Requirements for Liquid Phase Thermal Fluid Heaters
- Part PHRSG Requirements for Heat Recovery Steam Generators
- Numerous Appendices

ASME Section I: Power Boilers	Initials	Date
Demonstrate a thorough understanding of ASME Section I.		

### ASME B31.1: Power Piping

The general philosophy underlying this Power Piping Code is to parallel those provisions of Section I, Power Boilers, of the ASME Boiler and Pressure Vessel Code, as they can be applied to power piping systems. The allowable stress values for power piping are generally consistent with those assigned for power boilers. This Code is more conservative than some other piping codes, reflecting the need for long service life and maximum reliability in power plant installations.

ASME B31.1: Power Piping	Initials	Date
Demonstrate a thorough understanding of ASME B31.1.		

### ASME Section IV: Heating Boilers

The rules of this Section of the Code cover minimum construction requirements for the design, fabrication, installation, and inspection of steam heating, hot water heating, and hot water supply boilers that are directly fired with oil, gas, electricity, coal, or other solid or liquid fuels, and for operation at or below the pressure and temperature limits set forth in this document. Similar rules for potable water heaters are also included.

ASME Section IV: Heating Boilers	Initials	Date
Demonstrate a thorough understanding of ASME Section IV.		

### ASME Section V: Nondestructive Examination

This Section of the Code contains requirements and methods for nondestructive examination (NDE), which are Code requirements to the extent they are specifically referenced and required by other Code Sections or referencing documents. These NDE methods are intended to detect surface and internal imperfections in materials, welds, fabricated parts, and components. They include radiographic examination,

ultrasonic examination, liquid penetrant examination, magnetic particle examination, eddy current examination, visual examination, leak testing, and acoustic emission examination.

ASME Section V: Nondestructive Examination	Initials	Date
Demonstrate a thorough understanding of ASME Section V.		

### ASME Section VIII Division 1 : Pressure Vessels

This Division contains mandatory requirements, specific prohibitions, and non-mandatory guidance for pressure vessel materials, design, fabrication, examination, inspection, testing, certification, and pressure relief. The Code does not address all aspects of these activities, and those aspects which are not specifically addressed should not be considered prohibited. Engineering judgment must be consistent with the philosophy of this Division, and such judgments must never be used to overrule mandatory requirements or specific prohibitions of this division.

ASME Section VIII Div. 1: Pressure Vessels	Initials	Date
Demonstrate a thorough understanding of ASME Section VIII.		

### ASME Section IX: Welding Brazing and Fusing Qualifications

Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, brazing operators, and fusing operators, and the procedures employed in welding, brazing, or plastic fusing in accordance with the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. As such, this is an active document subject to constant review, interpretation, and improvement to recognize new developments and research data. Section IX is a document referenced for the qualification of material joining processes by various construction codes such as Section I, III, IV, VIII, XII, etc. These particular construction codes apply to specific types of fabrication and may impose additional requirements or exemptions to Section IX qualifications. Qualification in accordance with Section IX is not a guarantee that procedures and performance qualifications will be acceptable to a particular construction code. Review of ASME Section IX should result in an understanding that this code works in conjunction with construction codes.

ASME Section IX: Welding, Brazing, and Fusing Qualifications	Initials	Date
Demonstrate a thorough understanding of ASME Section IX.		

### ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers

The rules of this Standard cover requirements for the assembly, installation, maintenance, and operation of controls and safety devices on automatically operated boilers directly fired with gas, oil, gas-oil, or electricity, subject to the service limitations, exclusions, and acceptance of other listings in CG-120, CG-130, and CG-140, respectively. Burners or burner assemblies installed on boilers or as replacement burners shall comply with the requirements of CF-110 and CF-410 for gas and oil firing, respectively. The use of a gaseous or oil fuel not listed in the definitions has not been evaluated, and special considerations may be required. The major perils in operating automatically fired boilers are loss of water (low water), furnace explosion, overpressure, and over temperature. Principal causes of accidents to automatically fired boilers are lack of proper controls and safety devices, lack of adequate maintenance, improperly trained operators, failure to test controls and safety devices, and complacency on the part of the operator due to long periods of trouble-free operation. It is believed that improved instrumentation, controls and safety devices, proper operating procedures, and a clearer understanding of installation requirements by the manufacturers, installers, and operators can greatly reduce the chances of personal injury, damage to property, and loss of equipment from accidents. The rules of this Standard cover requirements for the assembly, installation, maintenance, and operation of controls and safety devices on automatically operated boilers directly fired with gas, oil, gas-oil, or electricity, subject to the service limitations stated in the scope.

ASME CSD-1: Controls and Safety Devices	Initials	Date
Demonstrate a thorough understanding of ASME CSD-1.		

### How to Become an Inspector

*The instructor should ensure that each participant has reviewed each section of “How to Become a Commissioned Inspector” on the National Board Website. <https://www.nationalboard.org/Index.aspx?pageID=392&ID=28>*

How to Become an Inspector	Initials	Date
Review “How to Become a Commissioned Inspector”.		

### Code Reference Overview Module Review:

Supervisor Name	Supervisor Signature	Date

# Module 3

## Safety

### Introduction:

This module introduces the Inspector Candidate to safety equipment and practices. By completing this module, Inspector Candidates will demonstrate a working knowledge and the practical application of safety practices related to inservice inspection.

### Knowledge Checks:

#### Safety

Safety Basics	Initials	Date
Discuss or define the following:		
Where is personnel safety referenced in the NBIC?		
Who is responsible for your safety?		
What are the owner's/client's responsibilities?		
What precautions should be taken around pressure relief devices?		
Precautions when working in industrial areas		
What is PPE and what are some examples?		
What is "lock out tag out"? How is it used?		
Who is responsible for the lock out tag out system?		
Electrical safety - identify the possible dangers.		
Possible issues with standing water and electricity?		
What is required for confined space entry?		
What does the term "gas free" mean?		
At what percentage of oxygen by volume does hypoxia start?		
What items are used for fall protection? What PPE should be inspected before using?		
How high can someone go before requiring fall protection?		
Concerns with inadequate lighting in the work area?		



Concerns with low voltage electrical wiring?		
Safety concerns and considerations regarding carbon monoxide (CO)		
<b>Drug and Alcohol Awareness</b>	<b>Initials</b>	<b>Date</b>
Complete an alcohol awareness class, training, or seminar.		
<b>CPR and First Aid</b>		
Describe and discuss the following:		
The purpose of CPR and First Aid		
Heat stroke		
Heat exhaustion		
Hyperthermia		
Hypothermia		
Frost bite		
Describe the immediate actions and methods for treating the following conditions:		
Cuts/scrapes/bleeding		
Heat stroke		
Heat exhaustion		
Hyperthermia		
Hypothermia		
Frost bite		

### Practical Applications:

#### Safety

<b>Safety</b>	<b>Initials</b>	<b>Date</b>
At a field location, identify and review the following:		
Emergency evacuation plan		
Emergency exits		
First aid kits		
AED devices		
Eyewash station(s)		
MSDS		

Safety (Continued)	Initials	Date
Dawn and doff safety harness (or discuss if PPE not provided).		
Identify 10 safety concerns at a shop or field location.		
Complete 10 inspections wearing safety shoes, safety glasses, and a hard hat (and/or other PPE as required).		
Identify slip hazards.		
Perform signing into lock out tag out (simulate if necessary).		
Perform a confined space entry when permissible.		

**Safety Module Review:**

Supervisor Name	Supervisor Signature	Date

# Module 4

## Power Boilers and Power Piping

### Introduction:

This module introduces the Inspector Candidate to inspection techniques related to power boilers and power piping. By completing this module, Inspector Candidates will demonstrate a working knowledge and the practical application of inspection techniques and methods related to inservice inspection.

### Knowledge Checks:

#### Power Boilers

Jurisdictional Requirements	Initials	Date
Permitting		
Licensing		
Inspection frequency		
Exemptions		
Variances		
Violations		
<b>Installation Inspection</b>		
Boiler room condition		
Equipment clearances		
Combustion air intake		
Breaching/flue		
Fuel train (gas, oil) & certification		
Burner management systems		
Boiler blowdown tank size (capacity) and piping		
Feedwater piping		
Feedwater pumps' energy sources (solid & biomass fuels)		
Code stamping/nameplates and certification documents (boiler, BD Vessel, BEP)		

Installation Inspection (Continued)	Initials	Date
Safety valves (set pressure, capacity, size, mounting)		
SV discharge piping		
Jurisdictional identification, recording of pertinent information/inspection reports		
<b>Steam Power Boilers - Inservice External Inspection</b>		
Verification of boiler stamping, jurisdictional identification, and inspection history		
Water column blowdown, gage glass condition		
Low water fuel cut off device operation and reset		
High temperature limit		
High pressure limit		
Flame scanner/fire eye		
Safety valve operation/testing. Discharge piping		
Condition of valves and piping (drain, feedwater, blowdown, main steam)		
Pressure gage		
Condition of boiler external surfaces		
<b>Steam Power Boilers - Internal Inspection</b>		
Verification of boiler stamping, jurisdictional identification, and inspection history		
Water column & LWCO piping internal condition		
Low water fuel cut off device floats and chambers		
Condition of refractory		
Condition of tubes (fireside)		
Condition of tubes (waterside)		
Condition of tubesheets		
Condition of stays (tubesheet, crownsheet, waterlegs)		
Condition of steam drum		
Condition of mud drum		
Condition of furnace/generating bank		

Steam Power Boilers - Internal Inspection (Continued)	Initials	Date
Condition of handhole/manhole covers, sealing surfaces & gaskets		
Prior to entry		
Parts and appurtenances		
<b>Hot Water Power Boilers - Inservice External Inspection</b>		
Verification of boiler stamping, jurisdictional identification, and inspection history		
Condition of boiler casing		
Low water fuel cut off device operation and reset		
High temperature limit		
High pressure limit		
Flame scanner/fire eye		
Safety valve operation/testing. Discharge piping		
Pressure/temperature gage		
Condition of valves and piping (supply and return, drain)		
<b>Hot Water Power Boilers - Internal Inspection</b>		
Verification of boiler stamping, jurisdictional identification, and inspection history		
Low water fuel cut off device floats and chambers		
Condition of refractory		
Condition of tubes (fireside)		
Condition of tubes (waterside)		
Condition of tubesheets		
Condition of stays (tubesheet, crownsheet, waterlegs)		
Condition of furnace		
Condition of handhole/manhole covers, sealing surfaces & gaskets		
Prior to entry		
Parts and appurtenances		
<b>Boiler External Piping</b>		
Definition, jurisdictional/code limits (BP, BEP, Non-BEP)		

Boiler External Piping (Continued)	Initials	Date
ASME code stamping requirements		
Condition of isolation valves		
Condition drain/telltale valve		
Condition and effectiveness of supports and hangers		
Condition of flanged connections		

**Practical Applications:**  
Power Boilers and Power Piping

Inspection	Initials	Date
Perform an installation inspection of a power boiler.		
Perform an inservice inspection of a power boiler.		
Perform an internal inspection of a power boiler.		
Perform an installation inspection of a miniature boiler.		
Inspect a firetube power boiler.		
Inspect a watertube power boiler.		
Inspect a scotch marine power boiler.		
Verify adequate clearances on a newly installed power boiler.		
Verify adequate combustion air for a power boiler.		
Verify adequate feedwater supply.		
Verify functionality of a high-pressure limit switch (with manual reset).		
Verify functionality of a low-water cutout (float type).		
Verify functionality of a low-water cutout (probe type).		
Verify functionality of a low or high gas pressure switch.		
Verify functionality of a manually operated remote shutdown switch.		
Inspect the blowoff piping and valves of a power boiler.		
Use a borescope as part of an internal inspection.		
Calculate the minimum relief valve capacity for a power boiler.		

Inspection (Continued)	Initials	Date
Verify adequate overpressure protection for a power boiler.		
Documentation		
Document a new installation inspection for a power boiler.		
Document an inservice inspection for a power boiler.		
Document a violation for a power boiler.		
Review a manufacturer's data report for any power boiler.		
Review a CSD-1 report for any power boiler.		

Power Boilers and Power Piping Module Review:

Supervisor Name	Supervisor Signature	Date

# Module 5

## Low Pressure and Heating Boilers

### Introduction:

This module introduces the Inspector Candidate to code requirements and inspection techniques related to low pressure and heating boilers. By completing this module, Inspector Candidates will demonstrate a working knowledge and the practical application of inspection techniques and methods related to inservice inspection.

### Knowledge Checks:

#### Low Pressure and Heating Boilers

Jurisdictional Requirements	Initials	Date
Permitting		
Inspection frequency		
Contractor licensing		
Operator licensing		
Exemptions		
Construction standards		
Variances		
Violations		
<b>ASME Section IV</b>		
<b>Part HG, Articles 1 &amp; 2</b>		
Scope & service restrictions		
Material requirements		
<b>Part HG, Article 3</b>		
Design pressure		
Thickness calculations		
Openings in boilers, general		



Part HG, Articles 1 & 2 (Continued)	Initials	Date
Reinforcement for openings		
Flanged-in openings		
Inspection & access openings		
Stayed surfaces		
Ligaments		
Tube holes/attachments		
External piping connections		
Part HG, Articles 4 & 5		
Overpressure protection		
Proof tests		
Hydrostatic test		
Pneumatic test		
Inspection by AI		
Master data report		
Partial data report		
Marking of boilers		
Marking of parts		
Part HG, Article 6 (Steam)		
Steam gage		
Water gage glass		
Water column		
Water level control pipes		
Pressure control		
Low water fuel cutoff		
Water feeding devices		
Modular steam heating boiler		
Part HG, Article 6 (HWH & HWS)		
Pressure/altitude gage		

Part HG, Article 6 (HWH & HWS) (Continued)	Initials	Date
Thermometer/sensor		
Temperature control		
Low water fuel cutoff		
Modular HWH & HWS boilers		
Part HG, Article 6 (All)		
Controls inside jackets		
Electrical wiring		
Primary safety control		
Safety limit switches		
Burners		
Electric elements		
Part HG, Article 7		
PRV mounting		
Piping		
Feed/makeup water		
Storage tanks		
Thermal expansion		
Stop valves		
Bottom blow/drains		
Modular boilers		
Settings		
Method of support		
Part HC		
General		
Material requirements		
Design		
Tests		
Quality control/inspection		

Part HA	Initials	Date
General		
Material requirements		
Design		
Tests		
Quality control/inspection		
Part HLW, Article 1		
Scope & service restrictions		
Service limits		
Permissible markings		
Part HLW, Article 2		
Lining		
Primary pressure parts		
Misc. pressure part materials		
Flanges & pipe fittings		
Non-pressure part materials		
Part HLW, Article 5		
Proof test		
Testing of parts		
Witnessing tests		
Recording tests		
Certifying tests		
Hydrostatic test		
Part HLW, Article 6		
Inspection and certification		
Manufacturer's data reports		
Marking		

Part HLW, Article 7	Initials	Date
Temperature control		
Limit controls		
Heat generating apparatus		
Electrical wiring		
<b>Part HLW, Article 8</b>		
Pressure relief valves		
Water supply		
Thermal expansion		
Bottom drain valve		
Thermometer		
<b>Part HLW, Article 9</b>		
General		
Marking		
Manufacturer's data reports		
Pressure relief valves		
Supply/return headers		
Bottom drain valve		
Thermometers		
Scope & service restrictions		
Definitions		
General requirements		
Machine room requirements		
Source requirements		
Discharge requirements		
Operating systems		
Instruments/fittings/controls		
Pressure relief valves		
Testing and acceptance		

NBIC Part 1	Initials	Date
<b>Section 3</b>		
Scope		
Service restrictions		
Definitions		
General requirements		
Equipment room requirements		
Source requirements		
Discharge requirements		
Operating systems		
Instruments, fittings, and controls		
Pressure relief valves		
Testing and acceptance		
NBIC Part 2	Initials	Date
<b>Section 1</b>		
Scope		
Administration		
References to other codes		
Personnel safety		
Inservice inspection activities		
Pre-inspection activities		
Inspection planning		
Prep for internal inspection		
Post inspection activities		
Change of service		

Section 2.2, Boilers	Initials	Date
Service conditions		
Pre-inspection activities		
Condition of boiler room		
External inspection		
Internal inspection		
Evidence of leakage		
Corrosion considerations		
Waterside deposits		
Piping/parts/appurtenances		
Miscellaneous		
Gages		
PRDs		
Controls		
Records review		
Cast iron boilers		
Firetube boilers		
Watertube boilers		
Electric boilers		
Fired coil water heaters		
Fired storage water heaters		
Thermal fluid heaters		
Waste heat boilers		
Recovery boilers		
<b>Section 3, Corrosion and Failure</b>		
General corrosion		
Macroscopic corrosion		
Microscopic corrosion		
Control of corrosion		

Section 3, Corrosion and Failure (Continued)	Initials	Date
Process variables		
Protection		
Material selection		
Coatings		
Engineering design		
Failure mechanisms		
Fatigue		
Creep		
Temperature effects		
Hydrogen embrittlement		
Hi-temp hydrogen attack		
Hydrogen damage		
Bulges/blisters		
Overheating		
Cracks		
Section 4, Inspection		
Examinations, Test Methods, and Evaluations		
Scope		
Nondestructive exam (NDE)		
Visual		
Magnetic particle		
Liquid penetrant		
Ultrasonic		
Radiography		
Eddy current		
Metallographic		
Acoustic emission		
Pressure testing		

Section 4, Inspection (Continued)	Initials	Date
Liquid pressure testing		
Pneumatic pressure testing		
Damage Mechanism Assessment and Inspection Frequency		
Scope		
General requirements		
Responsibilities		
Remaining service life		
ID damage mechanisms		
Estimate Inspection Intervals and Evaluate the Following:		
Subject to erosion/corrosion		
Exposure to corrosion		
Corrosion not a factor		
Creep		
Brittle fracture		
Bulges/blisters/lamination		
Crack like indications		
Fire damage		
Cyclic fatigue		
Local thin areas		
Risk Based Assessment Programs		
Scope		
Definitions		
General		
Considerations		
Key elements		
RBI assessment		
Probability of failure		
Consequence of failure		



Section 4, Inspection (Continued)	Initials	Date
Risk evaluation		
Risk management		
Jurisdictional relationships		
Section 5, Documentation		
Scope		
Replace stamping/nameplate		
National Board Inspection Code Report Forms		
NB-136		
NB-4		
NB-5		
NB-6		
NB-7		
NB-403		

**Practical Applications:**  
Low Pressure and Heating Boilers

Inspection	Initials	Date
Perform an installation inspection of a low-pressure steam boiler.		
Perform an external inservice inspection of a low-pressure steam boiler.		
Perform an internal inservice inspection of any low-pressure steam boiler.		
Perform an installation inspection of a hot water heating boiler.		
Perform an installation inspection of a hot water supply boiler.		
Perform an external inservice inspection of any hot water boiler.		
Perform an internal inservice inspection of any hot water boiler.		
Inspect a watertube boiler.		

Inspection (Continued)	Initials	Date
Inspect a firetube boiler.		
Inspect a cast boiler (cast iron or aluminum).		
Inspect a vertical tube boiler.		
Inspect a condensing boiler.		
Verify functionality of a high-temperature limit (with manual reset).		
Verify functionality of a low or high gas pressure switch.		
Verify functionality of a low-water cutout (float type).		
Verify functionality of a low-water cutout (probe type).		
Verify functionality of a flame eye sensor.		
Verify functionality of a manually operated remote shutdown switch.		
Calculate the minimum relief valve capacity for a sectional boiler.		
Verify adequate overpressure protection.		
<b>Documentation</b>		
Document a new installation inspection for a heating boiler.		
Document an inservice inspection for a heating boiler.		
Document a new installation inspection for a steam boiler.		
Document an inservice inspection for a steam boiler.		
Review a manufacturer's data report for any boiler.		
Review a CSD-1 report.		

**Low Pressure and Heating Boilers Module Review:**

Supervisor Name	Supervisor Signature	Date

# Module 6

## Pressure Vessels

### Introduction:

This module introduces the Inspector Candidate to code requirements and inspection techniques related to pressure vessels. By completing this module, Inspector Candidates will demonstrate a working knowledge and the practical application of inspection techniques and methods related to inservice inspection.

### Knowledge Checks:

#### Pressure Vessels

Jurisdictional Requirements	Initials	Date
Permitting		
Inspection frequency		
Contractor licensing		
Operator licensing		
Exemptions		
Construction standards		
Variances		
Violations		
Code Requirements - Installation		
Clearances		
Piping connections and bolting		
Level and pressure indicating devices		
Overpressure protection		
Vessel Specific Requirements:		
Hot water and potable hot water storage tanks		
Yankee dryers		
Liquid carbon dioxide storage vessels		

Code Requirements - Installation (Continued)	Initials	Date
Graphite pressure equipment		
Pressure vessels for human occupancy		
Code Requirements - Inservice		
External Inspection:		
Inspection methods and devices		
Insulation and coverings		
Material condition		
Structure and attachments		
Gages		
Controls and safety devices		
Internal Inspection:		
Inspection methods and devices		
Vessel connections		
Vessel closures		
Potential corrosion and failure mechanisms		
Vessel Specific Requirements:		
Deaerators		
Compressed air vessels		
Expansion tanks		
Liquid ammonia vessels		
Pressure vessels with quick acting closures		
Transport tanks		
Anhydrous ammonia nurse tanks		
Pressure vessels for human occupancy		
Static vacuum insulated cryogenic vessels		
Wire wound vessels		
Graphite pressure equipment		
Fiber reinforced plastic pressure equipment		

Code Requirements - Inservice (Continued)	Initials	Date
Yankee dryers		
DOT transport tanks		
Pressure vessels in liquified petroleum gas service		
Stationary high-pressure composite pressure vessels		
Liquid carbon dioxide storage vessels		
Code Requirements - Documentation		
Nameplate markings		
Manufacturer's data report		
Nameplate replacement – NB-136		
Fitness for service assessment – NB-403		

**Practical Applications:**  
Pressure Vessels

Inspection	Initials	Date
Perform an installation inspection of any pressure vessel.		
Perform an inservice inspection of any pressure vessel.		
Perform an internal inspection of any pressure vessel.		
Inspect a compressed air vessel.		
Inspect a CO2 vessel.		
Inspect a deaerator.		
Inspect a heat exchanger.		
Inspect a hot water storage tank.		
Inspect a sterilizer or autoclave.		
Demonstrate or witness the application of a non-visual NDE method.		
Calculate the volume of a pressure vessel.		
Verify adequate overpressure protection for a pressure vessel.		

Documentation	Initials	Date
Document a new installation inspection for a pressure vessel.		
Document an inservice inspection for a pressure vessel.		
Document a violation for a pressure vessel.		
Review a manufacturer's data report for any pressure vessel.		
Demonstrate the use of the NB-136 form.		
Demonstrate the use of the NB-403 form.		

**Pressure Vessels Module Review:**

Supervisor Name	Supervisor Signature	Date

# Module 7

## Pressure Relief Devices

### Introduction:

This module introduces the Inspector Candidate to code requirements and inspection techniques related to pressure relief devices. By completing this module, Inspector Candidates will demonstrate a working knowledge and the practical application of inspection techniques and methods related to the inservice inspection of a wide variety of pressure relief devices.

### Knowledge Checks: Pressure Relief Devices

ASME Section XIII	Initials	Date
1.1 Scope		
Mandatory Appendix I, all definitions		
Part 13 Overpressure Protection by System Design		
NBIC Part 4		
Define and discuss the following terms:		
Capacity certification		
Changeover valve		
Pilot operated pressure relief valve		
Pressure relief device		
Pressure relief valve		
Relief valve		
Safe point of discharge		
Safety relief valve		
Safety valve		
Part 4, Section 2 - Installation		
Part 4, Section 3 - Inspection		

NBIC Part 4 (Continued)	Initials	Date
Part 4, Section 4 - Repair:		
4.1 Scope		
4.1 General Requirements		
4.7 Stamping Requirements for Pressure Relief Devices		
Part 4, Section 6 - Supplements:		
Supplement 1- Pressure relief valves on the low pressure side of steam pressure reducing valves.		
Supplement 2 - Pressure differential between pressure relief valve setting and boiler or pressure vessel operating pressure.		
Supplement 3 - Pressure relief and pilot valve storage & shelf life.		

**Practical Applications:**  
Pressure Relief Devices

Installation	Initials	Date
Verify adequate overpressure protection for a boiler.		
Verify adequate overpressure protection for a pressure vessel.		
Demonstrate ability to calculate discharge pipe size for manifolding of discharge pipes.		
Inspection		
Demonstrate ability to read and understand a <b>VR</b> nameplate.		
Demonstrate ability to review SV test report.		
Demonstrate the ability to calculate the reducing capacity required for a UPV PRD.		
Demonstrate the ability to calculate the reducing capacity required for the low pressure side of a steam pressure reducing station.		

**Additional Training:**



Online Training	Initials	Date
Successfully complete the NBBI online training course "Operation and Installation of Pressure Relief Devices".		

Pressure Vessels Module Review:

Supervisor Name	Supervisor Signature	Date

# Training Courses and Examination

## NBBI Online Training Courses:

<b>NBIC Part 1 Online Course</b>		
<i>Successfully complete the online training course for NBIC Part 1</i>		
Verified by:	Signature	Date
<b>NBIC Part 2 Online Course</b>		
<i>Successfully complete the online training course for NBIC Part 2</i>		
Verified by:	Signature	Date
<b>Rules for Commissioned Inspectors (RCI-1) Online Course</b>		
<i>Successfully complete the online training course for RCI-1</i>		
Verified by:	Signature	Date

## National Board Classroom Inservice Commission Course (IS):

<b>Inservice Commission Course (IS)</b>		
<i>Successfully complete the classroom commission course</i>		
Verified by:		Date

## National Board Inservice Inspector Commission Exam:

<b>Inservice Inspector Commission Exam</b>		
<i>Achieve a passing score on the Inservice Commission exam</i>		
Verified by:	Signature	Date

# List of Qualified Trainers

The following is a list of all commissioned Inservice Inspectors or Inservice Inspector Supervisors who contributed to the training of the Inspector Candidate. The initials used to indicate verified completion of a Knowledge Check or Practical Application must match one of the Inspector initials provided here.

Inspector Name	Commission Number	Initials	Signature

# Signature Page

## Inspector Candidate:

By signing this document, I affirm that I have completed the program requirements as outlined in NB-380 and detailed in this workbook. The dates and signatures in this workbook accurately reflect the training I have received and knowledge I have demonstrated.

Inspector Candidate's Acknowledgement		
	Signature	Date

## Chief Inspector or Inspector Supervisor:

By signing this document, I affirm that I have reviewed the workbook for accuracy and completeness. I affirm that the Inspector Candidate has completed the program requirements as outlined in NB-380 and detailed in this workbook. The dates and signatures in this workbook accurately reflect the training given under my supervision.

Supervisor's Acknowledgement		
	Signature	Date

# Comments and Notes

The following pages are reserved for comments, notes, or any other additional information to be shared with National Board staff.

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