

2023 National Board Digital Library “Single User” Instructional License Agreement

Carefully read the following terms and conditions before using the pdf file

COPYRIGHT & LICENSE

The *National Board Inspection Code* (NBIC) is a copyrighted publication of the National Board of Boiler and Pressure Vessel Inspectors. As such, this copyright extends to any/all published versions of the NBIC including printed copies or Web subscription.

You do not own this copy of the NBIC; the National Board has licensed this copy to you for the use described herein. This pdf file is licensed for use by a single user. “Use” means loaded in temporary memory or permanent storage on the computer. The National Board reserves all rights not expressly granted to you.

I understand that I am being provided a pdf file containing the 2023 NBIC in consideration of my representation and/or agreement that:

- I may photocopy the contents solely for my own use but I am prohibited from making such photocopy available to others for copying.
- I will not make the NBIC electronically available through downloading, file sharing or through any other means.
- Additionally, I will not loan the pdf file for the purpose of photocopy, electronic download, file sharing or for any other copying means.
- I understand that any unauthorized duplication of the NBIC through my actions, either deliberate or unintentional, directly or indirectly, may also subject me to a claim of copyright infringement.
- I further understand that any attempt to electronically alter information in the file rendered the device legally void and unusable for all future reference.

TERM

These terms and conditions are effective until terminated.

LIMITED WARRANTY

The files are provided ‘as is’ without warranty of any kind, either expressed or implied, including but not limited to implied warranties of merchantability and fitness for any particular purpose.

The National Board does not warrant that the functions contained in the files will meet your requirements or that the operation of the files will be uninterrupted or error free. You assume responsibility for selecting the software to achieve your intended results, and for the use and results obtained from the software.

LIMITATION OF REMEDIES

In no event will the National Board be liable to you for any damages, including any lost profits, lost savings, or any other incidental or consequential damages arising from the use or inability to use such program even if the National Board has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damage, so the above exclusion may not apply to you.

GENERAL

This Agreement will be governed by the laws of the state of Ohio.

Should you have any questions concerning this Agreement, you may contact the National Board by emailing info@nbbi.org.



2023
NBIC
NATIONAL BOARD INSPECTION CODE

ANSI/NB23

PART I
INSTALLATION

NATIONAL BOARD INSPECTION CODE
2023 EDITION
DATE OF ISSUE — JULY 1, 2023

This code was developed under procedures accredited as meeting the criteria for American National Standards. The Consensus Committee that approved the code was balanced to ensure that individuals from competent and concerned interests had an opportunity to participate. The proposed code was made available for public review and comment, which provided an opportunity for additional public input from industry, academia, regulatory and Jurisdictional agencies, and the public-at-large.

The National Board does not “approve,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

The National Board does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable Letters Patent, nor assume any such liability. Users of a code are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code.

The National Board accepts responsibility for only those interpretations issued in accordance with governing National Board procedures and policies that preclude the issuance of interpretations by individual committee members.



The above National Board symbols are registered with the US Patent Office.

“National Board” is the abbreviation for The National Board of Boiler and Pressure Vessel Inspectors.

No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

All charts, graphs, tables, and other criteria that have been reprinted from the *ASME Boiler and Pressure Vessel Code*, Sections I, IV, VIII, and X are used with the permission of the American Society of Mechanical Engineers. All Rights Reserved.

Library of Congress Catalog Card No. 52-44738
 Printed in the United States of America
 All Rights Reserved

www.NBBI.org

Copyright © 2023 by
 THE NATIONAL BOARD OF BOILER & PRESSURE VESSEL INSPECTORS
 All rights reserved
 Printed in U.S.A.

PART 1 — INSTALLATION

TABLE OF CONTENTS

Introduction		IX
Foreword		XIII
Personnel		XV
Section 1	General Guidelines	1
1.1	Scope	1
1.2	Purpose	1
1.3	Application of these Rules	1
1.4	Certification, Inspection, and Jurisdictional Requirements	1
1.4.1	Responsibility	1
1.4.2	Equipment Certification	2
1.4.3	Jurisdictional Review	2
1.4.4	Inspection	2
1.4.5	Boiler Installation Report	2
1.4.5.1	Boiler Installation Report Form	3
1.4.5.1.1	Guide for Completing National Board Boiler Installation Report	3
1.5	Change of Service	7
1.6	General Requirements	7
1.6.1	Supports, Foundations, and Settings	7
1.6.2	Structural Steel	7
1.6.3	Exit	7
1.6.4	Ladders and Runways	7
1.6.5	Fuel	8
1.6.6	Ventilation and Combustion Air	9
1.6.7	Lighting	10
1.6.8	Chimney or Stack	10
1.6.9	Carbon Monoxide (CO) Detector/Alarm	10
1.6.10	Testing and Final Acceptance	10
Section 2	Power Boilers	11
2.1	Scope	11
2.2	Definitions	11
2.3	General Requirements	11
2.3.1	Supports, Foundations, and Settings	11
2.3.2	Structural Steel	11
2.3.3	Clearances	11
2.4	Equipment Room Requirements	11
2.4.1	Exit	11
2.4.2	Ladders and Runways	12
2.4.3	Drains	12
2.4.4	Water (Cleaning)	12
2.5	Service Requirements	12
2.5.1	Feedwater	12
2.5.1.1	Volume	12
2.5.1.2	Connection	12
2.5.1.3	Pumps	13
2.5.1.4	Valves	13
2.5.2	Fuel	14
2.5.3	Electrical	14
2.5.3.1	Wiring	14
2.5.3.2	Remote Emergency Shutdown Switches	14
2.5.3.3	Controls and Heat-Generating Apparatus	14
2.5.4	Ventilation and Combustion Air	15
2.5.5	Lighting	15
2.5.6	Emergency Valves and Controls	15

2.6	Discharge Requirements	15
2.6.1	Chimney or Stack	15
2.6.2	Ash Removal	15
2.6.3	Drains	15
2.6.3.1	Connection	15
2.6.3.2	Pressure Rating	15
2.6.3.3	Parts	16
2.7	Operating Systems	16
2.7.1	Breeching and Dampers	16
2.7.2	Burners and Stokers	16
2.7.3	Steam Supply	16
2.7.4	Condensate and Return	17
2.7.5	Blowoff	17
2.8	Controls and Gages	18
2.8.1	Water	18
2.8.2	Pressure Gage	19
2.8.2.1	Connection	19
2.8.3	Temperature	20
2.8.4	Pressure Control	20
2.8.5	Automatic Low-Water Fuel Cutoff and/or Water Feeding Device for Steam and Vapor System Boilers	20
2.9	Pressure Relief Valves	21
2.9.1	Valve Requirements — General	21
2.9.1.1	Number	21
2.9.1.2	Location	22
2.9.1.3	Capacity	22
2.9.1.4	Set Pressure	23
2.9.2	Forced-Flow Steam Generator	24
2.9.3	Superheaters	24
2.9.4	Economizers	25
2.9.5	Pressure-Reducing Valves	25
2.9.6	Installation and Discharge Requirements	25
2.10	Testing and Acceptance	26
2.10.1	General	26
2.10.2	Pressure Test	27
2.10.3	Nondestructive Examination	27
2.10.4	System Testing	27
2.10.5	Final Acceptance	27
2.10.6	Boiler Installation Report	27
2.11	Tables and Figure	27
Section 3	Steam Heating Boilers, Hot-Water Heating Boilers, Hot-Water Supply Boilers, and Portable Water Heaters	28
3.1	Scope	28
3.2	Definitions	28
3.3	General Requirements	28
3.3.1	Supports	28
3.3.1.1	Methods of Support for Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers	28
3.3.2	Settings	30
3.3.3	Structural Steel	30
3.3.4	Clearances	30
3.4	Equipment Room Requirements	30
3.4.1	Exit	30
3.4.2	Ladders and Runways	30
3.5	Source Requirements	31
3.5.1	Water	31
3.5.2	Fuel	31
3.5.3	Electrical	31

3.5.3.1	Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers.....	31
3.5.3.2	Potable Water Heaters	31
3.5.3.3	Controls and Heat Generating Apparatus	32
3.5.4	Ventilation and Combustion Air	32
3.5.5	Lighting	32
3.5.6	Emergency Valves and Controls	32
3.6	Discharge Requirements.....	32
3.6.1	Chimney or Stack	32
3.6.2	Ash Removal	32
3.6.3	Drains	33
3.7	Operating Systems	33
3.7.1	Oil Heaters	33
3.7.2	Breeching and Dampers	33
3.7.3	Burners and Stokers	33
3.7.4	Feedwater, Makeup Water, and Water Supply	33
3.7.5	Stop Valves	34
3.7.5.1	Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers	34
3.7.5.2	Potable Water Heaters	38
3.7.6	Return Pipe Connections	39
3.7.7	Bottom Blowoff and Drain Valves	39
3.7.7.1	Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers	39
3.7.7.2	Potable Water Heaters	40
3.7.8	Modular Steam Heating and Hot-Water Heating Boilers	41
3.7.8.1	Individual Modules	41
3.7.8.2	Assembled Modular Boilers	41
3.7.9	Provisions for Thermal Expansion	41
3.7.9.1	Expansion Tanks and Piping for Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers	41
3.7.9.2	Expansion Tanks and Piping For Potable Water Heaters	44
3.8	Instruments, Fittings, and Controls	45
3.8.1	Steam Heating Boilers	45
3.8.1.1	Steam Gages	45
3.8.1.2	Water-Gage Glasses	45
3.8.1.3	Water Column and Water Level Control Pipes	46
3.8.1.4	Pressure Control	46
3.8.1.5	Automatic Low-Water Fuel Cutoff and/or Water Feeding Device	47
3.8.1.6	Modular Steam Heating Boilers	47
3.8.1.7	Instruments, Fittings, and Controls Mounted Inside Boiler Jackets	47
3.8.2	Hot-Water Heating or Hot-Water Supply Boilers	47
3.8.2.1	Pressure or Altitude Gages	47
3.8.2.2	Thermometers	48
3.8.2.3	Temperature Control	48
3.8.2.4	Low-Water Fuel Cutoff	48
3.8.2.5	Modular Hot-Water Heating Boilers	49
3.8.2.6	Instruments, Fittings, and Controls Mounted Inside Boiler Jackets.....	49
3.8.3	Potable Water Heaters	49
3.8.3.1	Temperature Controls	49
3.8.3.2	Thermometer	49
3.9	Pressure Relief Valves	49
3.9.1	Pressure Relief Valve Requirements — General	50
3.9.1.1	Installation of Pressure Relief Valves for Steam Heating, Hot-Water Heating, and Hot-Water Supply Boilers	50
3.9.1.1.1	Permissible Installation	50
3.9.1.1.2	Requirements for Common Connections for Two or More Valves	50
3.9.1.2	Threaded Connections	50
3.9.1.3	Prohibited Installations	50
3.9.1.4	Use of Shutoff Valves Prohibited	50
3.9.1.5	Pressure Relief Valve Discharge Piping	51
3.9.1.6	Temperature and Pressure Relief Valves	51

3.9.2	Pressure Relief Valve Requirements for Steam Heating Boilers	51
3.9.3	Pressure Relief Valve Requirements for Hot-Water Heating or Hot-Water Supply Boilers	52
3.9.4	Pressure Relief Valve Requirements for Potable Water Heaters	53
3.9.4.1	Installation	53
3.9.4.2	Permissible Installations	53
3.9.4.3	Requirements for Common Connection for Two or More Valves	54
3.9.4.4	Threaded Connections	54
3.9.4.5	Prohibited Installations	54
3.9.4.6	Use of Shutoff Valves Prohibited	54
3.9.4.7	Temperature and Pressure Relief Valve Discharge Piping	54
3.9.5	Pressure Relief Valves for Tanks and Heat Exchangers	55
3.9.5.1	Steam to Hot-Water Supply	55
3.9.5.2	High-Temperature Water to Water Heat Exchanger	55
3.9.5.3	High-Temperature Water to Steam Heat Exchanger	55
3.10	Testing and Acceptance	55
3.10.1	Pressure Test	55
3.10.2	Final Acceptance	55
3.10.3	Boiler Installation Report	55
3.11	Tables and Figures	56
Section 4	Pressure Vessels	57
4.1	Scope	57
4.2	Definitions	57
4.3	General Requirements	57
4.3.1	Supports	57
4.3.2	Clearances	57
4.3.3	Piping	57
4.3.4	Bolting	57
4.4	Instruments and Controls	57
4.4.1	Level Indicating Devices	57
4.4.2	Pressure Indicating Devices	58
4.5	Pressure Relief Devices	58
4.5.1	Device Requirements	58
4.5.2	Number of Devices	58
4.5.3	Location	58
4.5.4	Capacity	58
4.5.5	Set Pressure	59
4.5.6	Installation and Discharge Piping Requirements	59
4.6	Testing and Acceptance	60
4.7	Requirements for Hot Water Storage Tanks/Potable Hot Water Storage Tanks	60
4.7.1	Supports	61
4.7.2	Clearance and Accessibility	61
4.7.3	Temperature and Pressure Relief Devices	61
4.7.4	Thermometers	61
4.7.5	Shut Off Valves	61
4.7.6	Testing and Acceptance	61
Section 5	Piping	62
5.1	Scope	62
5.2	General Requirements	62
5.2.1	Additions to Existing Piping	62
5.2.2	Proximity to Other Equipment and Structures	62
5.2.3	Flanges and Other Non-Welded Joints	62
5.2.4	Valves	62
5.2.5	Materials	63
5.2.6	Hangers and Supports	63
5.2.7	Protection and Cleaning	63
5.2.8	Welding and Brazing	63
5.2.9	Bolting	63

5.3	Pressure Relief Devices	63
5.3.1	Device Requirements	63
5.3.2	Number of Devices	64
5.3.3	Location	64
5.3.4	Capacity	64
5.3.5	Set Pressure	64
5.3.6	Inlet and Discharge Piping Requirements	64
5.4	Examination, Inspection, and Testing	65
Section 6	Supplements	66
Supplement 1	Installation of Yankee Dryers	66
S1.1	Scope	66
S1.2	Installation Assessment	66
S1.3	Determination of Allowable Operating Parameters	68
S1.4	ASME Code Primary Membrane Stress Criteria	69
S1.5	Pressure Testing	70
S1.6	Nondestructive Examination	70
Supplement 2	Pressure Relief Valves on the Low-Pressure Side of Steam Pressure Reducing Valves	72
S2.1	Scope	72
S2.2	Pressure Relief Valve Capacity	72
S2.3	Calculation of Pressure Relief Valve Relieving Capacity	72
S2.4	Steam Flow When Flow Coefficients Are Not Known	80
S2.5	Two-Stage Pressure Reducing Valve Stations	80
Supplement 3	Installation of Liquid Carbon Dioxide Storage Vessels	82
S3.1	Scope	82
S3.2	General Requirements Storage Tank Location	82
S3.2.1	General Requirements (Enclosed and Unenclosed Areas)	82
S3.2.2	Unenclosed Area LCDSV Installations	83
S3.2.3	Enclosed Area LCDSV Installations	83
S3.3	Fillbox Location/Safety Relief/Vent Line Circuit Termination	83
S3.4	Gas Detection Systems	84
S3.5	Signage	84
S3.6	Valves, Piping, Tubing, and Fittings	84
S3.6.1	System Description	87
Supplement 4	Installation of Biomass (Wood/Solid Fuel) Fired Boilers	90
S4.1	Scope	90
S4.2	Purpose	90
S4.3	Determination of Allowable Operating Parameters	90
S4.4	General Requirements	91
S4.5	Fuel System Requirements and Controls	91
S4.6	Combustion Requirements	92
Supplement 5	Installation of Thermal Fluid Heaters	94
S5.1	Scope	94
S5.2	Definitions	94
S5.3	General Requirements	94
S5.3.1	Supports, Foundations, and Settings	94
S5.3.2	Structural Steel	94
S5.3.3	Settings	94
S5.3.4	Clearances	94
S5.4	Thermal Fluid Heater Room Requirements	95
S5.4.1	Exit	95
S5.4.2	Ladders and Runways	95
S5.5	System Requirements	95

S5.5.1	Thermal Liquids (Heat Transfer Fluids).....	95
S5.5.2	Expansion	95
S5.5.3	Connection	96
S5.5.4	Circulating Pump	96
S5.5.5	Piping and Valves	96
S5.5.6	Fuel	97
S5.5.7	Electrical	97
S5.5.8	Ventilation and Combustion Air	99
S5.5.9	Lighting	99
S5.5.10	Emergency Valves and Controls	99
S5.6	Discharge Requirements	99
S5.6.1	Chimney or Stack	99
S5.6.2	Drains	99
S5.6.3	Air Vent	99
S5.7	Overpressure Protection	99
S5.7.1	General Requirements	99
S5.7.2	Pressure Relief Valves	99
S5.7.3	Location	100
S5.7.4	Capacity	100
S5.7.5	Set Pressure	100
S5.7.6	Installation	100
S5.8	Testing and Acceptance	101
S5.8.1	General	101
S5.8.2	Pressure Test	102
S5.8.3	Nondestructive Examination	102
S5.8.4	System Testing	102
S5.8.5	Final Acceptance	102
S5.8.6	Installation Report	102
Supplement 6 Special Requirements for the Installation of Condensing Boilers		103
S6.1	Scope	103
S6.2	Determination of Allowable Operating Parameters	103
S6.3	General Requirements	103
S6.4	Flue Gas Venting System Piping Requirements	103
S6.5	Sealed Combustion System Requirements.....	103
S6.6	Condensate Drain System Requirements.....	104
Supplement 7 Installation of Graphite Pressure Equipment		105
S7.1	Scope	105
S7.2	Glossary of Terms	105
S7.3	General Requirements	105
S7.3.1	Receiving and Initial Inspection of Graphite Pressure Equipment	105
S7.3.2	Equipment Parameters/Clearances/Movement.....	106
S7.3.3	Supports/Foundations	106
S7.3.4	Piping Connections	106
S7.3.5	Instruments and Controls	107
S7.3.6	Post-Installation Activities.....	107
Supplement 8 Installation of Pressure Vessels for Human Occupancy (PVHOs)		108
S8.1	Scope	108
S8.2	General.....	108
S8.3	Documentation, Registration, and Regulatory Requirements	108
S8.4	PVHO System Configuration and Installation.....	109
S8.5	Responsibilities	111
S8.6	Other Codes, Standards, and References	112

Supplement 9	High-Temperature Water Boilers	113
S9.1	Scope	113
S9.2	Installation Requirements	113
Supplement 10	Overpressure Protection for Organic Fluid Vaporizers	114
S10.1	General Requirements.....	114
S10.2	Pressure Relief Devices.....	114
S10.3	Location.....	114
S10.4	Capacity.....	114
S10.5	Set Pressure.....	114
S10.6	Installation.....	114
Supplement 11	Installation of High-Pressure Composite Pressure Vessels	116
S11.1	Scope.....	116
S11.2	Supports.....	116
S11.3	Clearances.....	116
S11.4	Piping Loads.....	116
S11.5	Mechanical Connections.....	116
S11.6	Pressure Indicating Devices.....	117
S11.7	Pressure Relief Devices.....	117
S11.8	Assessment of Installation.....	118
S11.9	Ladders and Runways.....	119
Section 7	NBIC Policy for Metrication	120
7.1	General	120
7.2	Equivalent Rationale	120
7.3	Procedure for Conversion	120
7.4	Referencing Tables	121
Section 8	Preparation of Technical Inquiries to the <i>National Board</i> <i>Inspection Code Committee</i>	126
Section 9	Glossary of Terms	127
9.1	Definitions	127
Section 10	NBIC Approved Interpretation	135
10.1	Scope	135
Section 11	Index	147

INTRODUCTION

It is the purpose of the *National Board Inspection Code* (NBIC) to maintain the integrity of pressure-retaining items by providing rules for post-construction activities including installation, and by providing rules for post-installation activities including inspections, repairs, and alterations, thereby ensuring the safety of the pressure-retaining items' continued use.

The NBIC is intended to provide rules, information, and guidance to manufacturers, jurisdictions, Inspectors, owner-users, installers, contractors, and other individuals and organizations performing or involved in post-construction activities, thereby encouraging the uniform administration of rules pertaining to pressure retaining items.

SCOPE

The NBIC recognizes four 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
- Testing of Pressure Relief Devices

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 applicable jurisdiction or other technical sources.

The words “shall,” “should,” and “may” are used throughout the NBIC and have the following intent:

- Shall – action that is mandatory.
- Should – indicates a preferred but not mandatory means to accomplish the requirement unless specified by other sources, such as the Jurisdiction.
- May – permissive, not required or a means to accomplish the specified task.

ORGANIZATION

The NBIC is organized into four parts to coincide with specific post-construction activities involving pressure-retaining items. Each part provides general and specific rules, information, and guidance within each applicable post-construction activity. Individual NBIC parts or other published standards may contain additional information or requirements needed to meet the rules of the NBIC. Each part provides specific references to direct the user where to find this additional information. NBIC parts are identified as:

- Part 1, Installation – This part provides requirements and guidance to ensure the proper installation and functioning of all types of pressure-retaining items. Installation includes meeting specific safety criteria for construction, materials, design, supports, safety devices, operation, testing, and maintenance.
- Part 2, Inspection – This part provides information and guidance needed to perform and document inspections for all types of pressure-retaining items. This part includes information on personnel safety, non-destructive examination, tests, failure mechanisms, types of pressure equipment, fitness for service, risk-based assessments, and performance-based standards.
- Part 3, Repairs and Alterations – This part provides requirements and guidance to perform, verify, and document acceptable repairs or alterations to pressure-retaining items regardless of code of construction. Alternative methods for examination, testing, heat treatment, etc., are provided when the original code of construction requirements cannot be met. Specific acceptable and proven repair methods are also provided.
- Part 4, Pressure Relief Devices – This part provides information and guidance to ensure pressure relief devices are installed properly, that inspections of pressure relief devices are performed and documented properly, and that repairs to pressure relief devices are performed, verified, and documented properly.

Each part of the NBIC is divided into major sections as outlined in the Table of Contents.