

NFPA 85

Boiler and Combustion Systems Hazards Code

2007 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA DOCUMENTS

NOTICE AND DISCLAIMER OF LIABILITY CONCERNING THE USE OF NFPA DOCUMENTS

NFPA codes, standards, recommended practices, and guides, of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its codes and standards.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this document available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the NFPA list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

ADDITIONAL NOTICES AND DISCLAIMERS

Updating of NFPA Documents

Users of NFPA codes, standards, recommended practices, and guides should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of Tentative Interim Amendments. An official NFPA document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments and any Errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments or corrected through the issuance of Errata, consult appropriate NFPA publications such as the National Fire Codes® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed below.

Interpretations of NFPA Documents

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents

The NFPA does not take any position with respect to the validity of any patent rights asserted in connection with any items which are mentioned in or are the subject of NFPA codes, standards, recommended practices, and guides, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on these documents. Users of these documents 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.

NFPA adheres to applicable policies of the American National Standards Institute with respect to patents. For further information contact the NFPA at the address listed below.

Law and Regulations

Users of these documents should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

This document is copyrighted by the NFPA. It is made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making this document available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to this document.

Use of NFPA documents for regulatory purposes should be accomplished through adoption by reference. The term “adoption by reference” means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA documents, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA codes, standards, recommended practices, and guides and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA documents during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

For more information about NFPA, visit the NFPA website at www.nfpa.org.

Copyright © 2007 National Fire Protection Association. All Rights Reserved.

NFPA 85

Boiler and Combustion Systems Hazards Code

2007 Edition

This edition of NFPA 85, *Boiler and Combustion Systems Hazards Code*, was prepared by the Technical Committees on Fluidized Bed Boilers, Fundamentals of Combustion Systems Hazards, Heat Recovery Steam Generators and Other Combustion Turbine Exhaust Systems, Multiple Burner Boilers, Pulverized Fuel Systems, Single Burner Boilers, and Stoker Operations and released by the Technical Correlating Committee on Boiler Combustion System Hazards. It was issued by the Standards Council on December 1, 2006, with an effective date of December 20, 2006, and supersedes all previous editions.

This edition of NFPA 85 was approved as an American National Standard on December 20, 2006.

Origin and Development of NFPA 85

NFPA 85 has had a long history of documents that have been created and combined to form the present-day NFPA 85. (See Annex M, Origin and Development of NFPA 85, *Boiler and Combustion Systems Hazards Code*, which is a flowchart depicting the complex development over the years.) The first of these documents was NBFU 60, "Regulations of the National Board of Fire Underwriters for the Installation of Pulverized Fuel Systems as Recommended by the National Fire Protection Association" from 1924 that changed from an NBFU/NFPA document to an NFPA code in 1946.

The 2001 edition of NFPA 85 was a compilation of the following six standards:

NFPA 8501, *Standard for Single Burner Boiler Operation*

NFPA 8502, *Standard for the Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers*

NFPA 8503, *Standard for Pulverized Fuel Systems*

NFPA 8504, *Standard on Atmospheric Fluidized-Bed Boiler Operation*

NFPA 8505, *Standard for Stoker Operation*

NFPA 8506, *Standard on Heat Recovery Steam Generator Systems*

In the 2001 edition, significant new material was added for multiple burner boilers, including requirements for reburn systems. For heat recovery steam generators, the minimum purge flow requirements prior to starting the combustion turbine were reduced.

The 2004 edition was organized to provide administrative requirements in Chapters 1, 2, and 3 and common requirements in Chapter 4, Fundamentals of Boiler Combustion Systems. Subsequent chapters covered the specific requirements for each of the boiler and combustion systems covered by this document. The 2004 edition also provided new requirements that addressed selective catalytic reduction (SCR) systems for multiple burner boilers.

In the 2001 edition, Annex M was added to assist users to better understand the complex development of what is now known as NFPA 85.

The 2007 edition includes the following major changes, by chapter:

Chapter 4:

- (1) The specific requirements for furnace structural design have been removed from Chapter 4 and relocated as appropriate to the individual chapters.
- (2) Requirements for flue gas path auxiliary systems have been added along with supporting annex material.
- (3) The section previously titled "Programmable Logic Controllers" was merged into the design requirements for the logic system.
- (4) New flame proving requirements have been added.
- (5) Commissioning and installation requirements have been consolidated into a single section.

Chapter 5: The use of valve proving systems in fuel gas trains has been added.

Chapter 6:

- (1) The scope of Chapter 6 has been clarified as applying from the forced draft fan inlets to the stack inlet.
- (2) Requirements for flue gas path auxiliary systems specific to multiple burner boilers have been added.
- (3) Purge requirements have been rewritten and consolidated.
- (4) Furnace structural design requirements for multiple burner boilers have been added and now include the impact of booster fans. Implosion protection has been clarified as not being required on units that have no fan in the flue gas stream downstream of the boiler. In conjunction with these changes, a definition of *booster fan* has been added to Chapter 3.
- (5) Requirements for fuel gas and fuel oil safety shutoff valves were added.
- (6) Sections 6.6, 6.7, and 6.8 have been modified for consistency in numbering and content.

Chapter 7:

- (1) Requirements for lance and burner safety shutoff valves have been added.
- (2) Requirements for flue gas path auxiliary systems have been added.

Chapter 8:

- (1) The scope of Chapter 8 has been expanded from heat recovery steam generators to include other combustion turbine exhaust systems that present similar fire and explosion hazards, including those with no heat recovery. A definition of *combustion turbine exhaust systems* has been added to Chapter 3, and other changes were made throughout the code as required for consistency.
- (2) Additional combustion turbine interlocks have been added to ensure fuel gas in-leakage is not occurring during the combustion turbine purge and that excessive fuel is not being introduced during combustion turbine light-off.
- (3) Specific requirements for heat recovery steam generator (HRSG) implosion protection have been added.

Chapter 9: The fuels to which Chapter 9 applies have been revised.

Chapter 10: Transient design pressure requirements specific to stokers have been added.

Technical Correlating Committee on Boiler Combustion System Hazards (BCS-AAC)

Michael C. Polagye, *Chair*
FM Global, MA [I]

Bill Bass, Forney Corporation, TX [M]
James R. Bostick, ABB Automation, OH [M]
Dale E. Dressel, Solutia Incorporated, MO [U]
David S. Eason, Detroit Edison Company, MI [U]
Ronald E. Fringeli, Marsh USA Incorporated, OH [I]
Gordon G. Gaetke, The Dow Chemical Company, TX [U]
Masaaki Kinoshita, Mitsubishi Heavy Industries Limited, Japan [M]

Robert Malanga, Fire and Risk Engineering, NJ [SE]
Jerry J. Moskal, ALSTOM Power Incorporated, CT [M]
Nancy C. Polosky, Babcock & Wilcox Company, OH [M]
Peter J. Willse, GE Insurance Solutions, CT [I]
Henry K. Wong, Washington Group International, NJ [SE]

Alternates

Ronald J. Fleming, ABB Incorporated, OH [M]
(Alt. to J. R. Bostick)
Richard L. Haman, DTE Energy/Detroit Edison Company, MI [U]
(Alt. to D. S. Eason)
Takayoshi (Ted) Isoda, Mitsubishi Power Systems, Incorporated, CA [M]
(Alt. to M. Kinoshita)
Gerald E. McCullion, Honeywell, Incorporated, GA [M]
(Voting Alt. to Honeywell Rep.)

Michael R. Mulherin, The Dow Chemical Company, TX [U]
(Alt. to G. G. Gaetke)
John P. O'Rourke, ALSTOM Power Incorporated, CT [M]
(Alt. to J. J. Moskal)
Celso G. Schmidt, Forney Corporation, TX [M]
(Alt. to B. Bass)

Nonvoting

John C. deRuyter, The DuPont Company, Incorporated, DE [U]
Rep. TC on Stoker Operations
Michael B. Doherty, American Electric Power Service Corporation, OH [U]
Rep. TC on Pulverized Fuel Systems
John J. Eibl, The DuPont Company, Incorporated, TN [U]
Rep. TC on Single Burner Boilers
Dale P. Evelyn, Southern Company Services, Incorporated, AL [U]
Rep. TC on Fundamentals of Combustion Systems Hazards

Brian W. Moore, Hartford Steam Boiler Inspection & Insurance Company, CT [I]
Rep. TC on Fluidized Bed Boilers
John Van Name, Washington Group International, NY [SE]
Rep. TC on Heat Recovery Steam Generators
Harold R. Yates, HRY, Inc., MI [SE]
Rep. TC on Multiple Burner Boilers

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the reduction of combustion system hazards in single- and multiple-burner boilers with a heat input rate of 12,500,000 Btu/hr and above. This includes all fuels. This Committee also is responsible for documents on the reduction of hazards in pulverized fuel systems, fluidized-bed boilers, heat recovery steam generators and other combustion turbine exhaust systems, and stoker-fired boilers, at any heat input rate.

Technical Committee on Fluidized Bed Boilers (BCS-FBB) (Chapter 7, and Annexes H and L)

Brian W. Moore, *Chair*
Hartford Steam Boiler Inspection & Insurance Company, CT [I]

P. K. Chelian, Foster Wheeler Power Group, Incorporated, NJ [M]
Joseph N. Darguzas, EnviroPower, LLC, IL [IM]
Shelton Ehrlich, Palo Alto, CA [SE]
William Bradley George, Nova Scotia Power Incorporated, Canada [U]
David Habenicht, Global Risk Consultants Corporation, IL [SE]

Vic L. Jones, Merrick Industries Incorporated, FL [M]
David L. Kraft, Babcock & Wilcox Company, OH [M]
Donald L. Lueckenotte, Burns & McDonnell Engineering Company, MO [SE]
Paul H. Miller, Southern Company Services, Incorporated, AL [U]
Gary E. Norman, ALSTOM Power Incorporated, CT [M]

Alternates

Kevin M. Estes, Foster Wheeler Power Group,
Incorporated, FL [M]
(Alt. to P. K. Chelian)

John P. O'Rourke, ALSTOM Power Incorporated, CT [M]
(Alt. to G. E. Norman)

James M. Witt, Jr., Southern Company Services,
Incorporated, AL [U]
(Alt. to P. H. Miller)

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the operation and reduction of combustion system hazards and the prevention of boiler furnace explosions of fluidized-bed boilers. This includes all fuels at any heat input rate.

Technical Committee on Fundamentals of Combustion Systems Hazards (BCS-FUN) (Chapters 1-4 and Annexes I, J, and K)

Dale P. Evelyn, *Chair*

Southern Company Services, Incorporated, AL [U]

Kevin A. Alexeff, Stock Equipment Company, OH [M]
Courtney D. Alvey, Baltimore, MD [SE]
Carlton A. Bosfield, Grand Bahama Power Company,
FL [U]
David A. Cowdrick, Tampa Electric Company, FL [U]
Richard A. Gallagher, Zurich Services Corporation, DE [I]
Thomas B. George, Marsh USA Incorporated, MI [I]
Ted Jablowski, North American Manufacturing
Company, CT [M]
Randy J. Kleen, General Electric Company, TX [M]
Richard T. Long, Jr., Exponent, Incorporated, MD [SE]
Peter B. Matthews, Hartford Steam Boiler Inspection
& Insurance Company, CT [I]

Francisco A. Palacios, Babcock Power, Incorporated,
MA [M]
John R. Puskar, CEC Combustion Safety, Incorporated,
OH [SE]
Celso G. Schmidt, Forney Corporation, TX [M]
Franklin R. Switzer, Jr., S-safe, Incorporated, IN [SE]
Michael A. Walz, Burns & McDonnell Engineering
Company, MO [SE]
Harold R. Yates, HRY, Incorporated, MI [SE]
Allan J. Zadiraka, The Babcock & Wilcox Company,
OH [M]

Alternates

Bryan R. Baesel, CEC Combustion Safety, Incorporated,
OH [SE]
(Alt. to J. R. Puskar)

Barry J. Basile, Babcock Power, Incorporated, MA [M]
(Alt. to F. A. Palacios)

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents or portions of documents on fundamentals, maintenance, inspection, training, and safety for the reduction of combustion system hazards. Fundamentals shall specifically include definitions, furnace explosion/implosion prevention, manufacture, design and engineering, installation, coordination of design, construction and operation, basic operating objectives, equipment requirements, and commissioning.



Technical Committee on Heat Recovery Steam Generators and Other Combustion Turbine Exhaust Systems (BCS-HRS) (Chapter 8)

John Van Name, *Chair*
Washington Group International, NY [SE]

Harold Honath, *Secretary*
Coen Company Incorporated, CA [M]

Donald W. Bairley, ALSTOM Power Incorporated, CT [M]
Robert R. Balsbaugh, Burns & McDonnell Engineering Company, MO [SE]
Richard A. Brown, John Zink Company, LLC, OK [M]
John H. Conroy, Forney Corporation, TX [M]
Dale P. Evelyn, Southern Company Services, Incorporated, AL [U]
Gordon G. Gaetke, The Dow Chemical Company, TX [U]
George Y. Keller, Burns & Roe Enterprises, Incorporated, NJ [SE]

Steven A. Lefton, Aptech Engineering Services, CA [SE]
Brian W. Moore, Hartford Steam Boiler Inspection & Insurance Company, CT [I]
Martin C. Nygard, Nooter/Eriksen, MO [M]
Michael C. Polagye, FM Global, MA [I]
Jimmie J. Schexnayder, Entergy Corporation, LA [U]
Philip F. Souers, Siemens Power Corporation, FL [M]
Joseph M. Vavrek, Sargent & Lundy, LLC, IL [SE]
James P. Walawender, Black & Veatch Corporation, KS [SE]

Alternates

Alfred J. Beaty, Forney Corporation, TX [M]
(Alt. to J. H. Conroy)
Sanda Brumar, Burns & Roe Enterprises, NJ [SE]
(Alt. to G. Y. Keller)
Rodney T. Crockett, John Zink Company, LLC, OK [M]
(Alt. to R. A. Brown)
Rick Fiorenza, Coen Company Incorporated, CA [M]
(Alt. to H. Honath)
Robert P. Kaltenbach, Burns & McDonnell Engineering Company, MO [SE]
(Alt. to R. R. Balsbaugh)

Christopher J. Lech, ALSTOM Power Incorporated, CT [M]
(Alt. to D. W. Bairley)
Michael R. Mulherin, The Dow Chemical Company, TX [U]
(Alt. to G. G. Gaetke)
George N. Pyros, Siemens Power Generation, FL [M]
(Alt. to P. F. Souers)
Ronald Rispoli, Entergy Corporation, AR [U]
(Alt. to J. J. Schexnayder)

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents covering the operation of heat recovery steam generators and other combustion turbine exhaust systems, and the related reduction of combustion system hazards and prevention of explosions. This includes all fuels at any heat input rate.

Technical Committee on Multiple Burner Boilers (BCS-MBB) (Chapter 6 and Annexes B, C, and D)

Harold R. Yates, *Chair*
HRY, Incorporated, MI [SE]

Bernard Hrul, *Secretary*
Allen Bradley Company, MI [U]

Courtney D. Alvey, Baltimore, MD [SE]
Bill Bass, Forney Corporation, TX [M]
Frank J. Bennett, Mirant Mid-Atlantic, MD [U]
Dale E. Dressel, Solutia Incorporated, MO [U]
John J. Eibl, The DuPont Company, TN [U]
Dale P. Evelyn, Southern Company Services, Incorporated, AL [U]
Kenneth Joe Frazier, Salt River Project, AZ [U]
Gordon G. Gaetke, The Dow Chemical Company, TX [U]
Kris A. Gamble, Black & Veatch Corporation, KS [SE]
George Y. Keller, Burns & Roe Enterprises, Incorporated, NJ [SE]
Richard Kimball, HF Controls Corporation, TX [M]
Daniel J. Lee, ABB Incorporated, OH [M]
W. Scott Matz, Invensys Process Systems, TX [M]
Peter McKenna, Stone & Webster, Incorporated, MA [SE]
Lalit M. Mehta, Coen Company, Incorporated, CA [M]

Terry A. Nelson, Yokogawa Corporation of America, TX [M]
John P. O'Rourke, ALSTOM Power Incorporated, CT [M]
Francisco A. Palacios, Babcock Power, Incorporated, MA [M]
Michael C. Polagye, FM Global, MA [I]
Glenn A. Raney, Premier Consulting Services, TX [SE]
Thomas D. Russell, Honeywell, Incorporated, TX [M]
Jimmie J. Schexnayder, Entergy Corporation, LA [U]
Franklin R. Switzer, Jr., S-afe, Incorporated, IN [SE]
Joseph M. Vavrek, Sargent & Lundy, LLC, IL [SE]
Michael A. Walz, Burns & McDonnell Engineering Company, MO [SE]
Peter J. Willse, GE Insurance Solutions, CT [I]
Henry K. Wong, Washington Group International, NJ [SE]
Allan J. Zadiraka, The Babcock & Wilcox Company, OH [M]

Alternates

John E. Bollinger, The Babcock & Wilcox Company, OH [M]
(Alt. to A. J. Zadiraka)
John C. deRuyter, The DuPont Company, Incorporated, DE [U]
(Alt. to J. J. Eibl)
Ronald J. Fleming, ABB Incorporated, OH [M]
(Alt. to D. J. Lee)
Steven L. Hawkins, Black & Veatch Corporation, KS [SE]
(Alt. to K. A. Gamble)
Kenneth Hurlburt, Babcock Power, Incorporated, MA [M]
(Alt. to F. A. Palacios)
Robert P. Kaltenbach, Burns & McDonnell Engineering Company, MO [SE]
(Alt. to M. A. Walz)
Michael R. Mulherin, The Dow Chemical Company, TX [U]
(Alt. to G. G. Gaetke)

Gary E. Norman, ALSTOM Power Incorporated, CT [M]
(Alt. to J. P. O'Rourke)
Mark A. Ratcliffe, Invensys Process Systems, TX [M]
(Alt. to W. S. Matz)
Ronald Rispoli, Entergy Corporation, AR [U]
(Alt. to J. J. Schexnayder)
Wesley J. Schulze, Coen Company, Incorporated, CA [M]
(Alt. to L. M. Mehta)
George P. Seroke, DTE Energy/Detroit Edison Company, MI [U]
(Voting Alt. to DTE Energy Rep.)
James M. Witt, Jr., Southern Company Services, Incorporated, AL [U]
(Alt. to D. P. Evelyn)

Nonvoting

S. Dharmalingam, Bharat Heavy Electricals Limited, India [M]

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents covering the reduction of combustion system hazards and the prevention of boiler furnace explosions and implosions in multiple burner boilers with a heat input rate of 12,500,000 Btu/hr and above. This includes all fuels.

Technical Committee on Pulverized Fuel Systems (BCS-PFS) (Chapter 9)

Michael B. Doherty, *Chair*
American Electric Power Service Corporation, OH [U]

Courtney D. Alvey, Baltimore, MD [SE]
David A. Cowdrick, Tampa Electric Company, FL [U]
John C. deRuyter, The DuPont Company, Incorporated, DE [U]
Rory G. Eastman, ALSTOM Power Incorporated, CT [M]
Kenneth L. Gardner, Metso Industries, PA [M]
Roderick J. Hossfeld, Jenike & Johanson, Incorporated, MA [SE]

Walter E. Keiser, Georgia Power Company, GA [U]
Kiran R. Patel, Babcock Power, Incorporated, MA [M]
Jonathan R. Prantis, Foster Wheeler Energy Corporation, NJ [M]
Cleveland B. Skinker, Bechtel Power Corporation, MD [SE]
William A. (Andy) Smith, Global Risk Consultants Corporation, GA [SE]

Alternates

Alan J. Seibert, ALSTOM Power Incorporated, CT [M]
(Alt. to R. G. Eastman)

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the operation and design requirements of pulverized fuel systems and reduction of hazards associated with those systems. This includes all carbonaceous solid fuels at any heat input rate.



Technical Committee on Single Burner Boilers (BCS-SBB) (Chapter 5)

John J. Eibl, *Chair*
The DuPont Company, TN [U]

Courtney D. Alvey, Baltimore, MD [SE]
Carlton A. Bosfield, Grand Bahama Power Company,
FL [U]
John T. Connor, Burns & McDonnell Engineering
Company, MO [SE]
Dale E. Dressel, Solutia Incorporated, MO [U]
G. F. (Jerry) Gilman, SIS-Tech, OH [SE]
Ted Jablowski, North American Manufacturing
Company, CT [M]
Robert A. Koehler, Liberty Mutual Property, TX [I]
Rep. Property Casualty Insurers Association of America

Glenn A. Raney, Premier Consulting Services, TX [SE]
Gary J. Shrider, Babcock & Wilcox Company, OH [M]
Franklin R. Switzer, Jr., S-afe, Incorporated, IN [SE]
Jacques Van Heijningen, Siemens Building
Technologies, Inc., IL [M]
J. A. "Red" Wagner, Fireye, NJ [M]
Chris Wille, Coen Company, Incorporated, CA [M]
Peter J. Willse, GE Insurance Solutions, CT [I]

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the reduction of combustion system hazards and the prevention of boiler furnace explosions in single burner boilers with a heat input rate of 12,500,000 Btu/hr and above. This includes all fuels.

Technical Committee on Stoker Operations (BCS-STO) (Chapter 10 and Annexes F and G)

John C. deRuyter, *Chair*
The DuPont Company, Incorporated, DE [U]

J. Mike Cantrell, The McBurney Corporation, GA [IM]
Andrew K. Dant, Cogentrix Energy, Incorporated, NC [U]

John Hoh, National Board of Boiler & Pressure Vessel
Inspectors, OH [E]

Amy B. Spencer, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents covering the operation of stokers and related fuel burning equipment. This includes all fuels at any heat input rate.

Contents

Chapter 1 Administration	85- 10	6.7 Fuel Oil Systems	85- 61
1.1 Scope.	85- 10	6.8 Pulverized Coal Systems	85- 70
1.2 Purpose	85- 10	6.9 Selective Catalytic Reduction (SCR) Systems with Bypass Capability	85- 78
1.3 Application	85- 11		
1.4 Retroactivity	85- 11	Chapter 7 Atmospheric Fluidized-Bed Boilers	85- 78
1.5 Equivalency	85- 11	7.1 Application	85- 78
1.6 Enforcement	85- 11	7.2 Purpose	85- 78
		7.3 General	85- 78
Chapter 2 Referenced Publications	85- 11	7.4 Equipment Requirements	85- 79
2.1 General	85- 11	7.5 Furnace Pressure Excursion Prevention ...	85- 85
2.2 NFPA Publications	85- 11	7.6 Sequence of Operations	85- 87
2.3 Other Publications	85- 11	7.7 Sequence of Operations for Gas-Fired Warm-Up Burners	85- 92
2.4 References for Extracts in Mandatory Sections	85- 11	7.8 Sequence of Operations for Oil-Fired Warm-Up Burners	85- 97
		7.9 Interlock System	85-104
Chapter 3 Definitions	85- 12	7.10 Alarm System	85-110
3.1 General	85- 12		
3.2 NFPA Official Definitions	85- 12	Chapter 8 Heat Recovery Steam Generators and Other Combustion Turbine Exhaust Systems	85-111
3.3 General Definitions	85- 12	8.1 Application	85-111
		8.2 Purpose	85-112
Chapter 4 Fundamentals of Boiler Combustion Systems	85- 20	8.3 Project Coordination	85-112
4.1 Manufacture, Design, and Engineering	85- 20	8.4 Equipment	85-112
4.2 Installation and Commissioning	85- 20	8.5 HRSG Enclosure and Other Combustion Turbine Exhaust Systems.	85-115
4.3 Coordination of Design, Construction, and Operation	85- 21	8.6 Electrical	85-115
4.4 Maintenance, Inspection, Training, and Safety	85- 21	8.7 Controls, Monitoring, Alarms, and Interlocks	85-115
4.5 Basic Operating Requirements	85- 22	8.8 Purge, Start-up, Operation, and Shutdown of HRSG and Other Combustion Turbine Exhaust Systems.	85-118
4.6 Equipment Requirements	85- 22	8.9 Combustion Turbine Exhaust Bypass Systems	85-122
		8.10 Combustion Turbine and HRSG with Fresh Air Firing Capability	85-123
Chapter 5 Single Burner Boilers	85- 26	8.11 Combustion Turbine Exhaust System.	85-124
5.1 Application	85- 26		
5.2 Purpose	85- 26	Chapter 9 Pulverized Fuel Systems	85-124
5.3 Equipment Requirements	85- 26	9.1 Application	85-124
5.4 Starting of a Cold Boiler	85- 29	9.2 Purpose	85-124
5.5 Operating Systems	85- 30	9.3 General	85-125
5.6 Simultaneous Firing of Oil and Gas Fuels	85- 36	9.4 Design	85-125
5.7 Simultaneous Firing of Oil and Gas for Fuel Transfer Only	85- 38	9.5 Operation	85-137
5.8 Dual Oil Atomizers in a Single Burner	85- 40	9.6 Special Systems	85-139
Chapter 6 Multiple Burner Boilers	85- 41	Chapter 10 Stokers	85-144
6.1 Application	85- 41	10.1 Purpose	85-144
6.2 Purpose	85- 41	10.2 Fuel-Burning System	85-144
6.3 Mechanical Equipment Requirements	85- 41	10.3 Combustion Control System	85-145
6.4 Burner Management and Combustion Control Requirements	85- 41		
6.5 Furnace Implosion Protection	85- 50		
6.6 Fuel Gas Systems	85- 52		

10.4	Operation	85-145	Annex G	Stoker Descriptions	85-205
10.5	Furnace Inspection	85-147	Annex H	Guidelines for Determining the Minimum Permitted Temperature for Feeding a Fuel into a Fluidized Bed	85-209
10.6	On-Line Maintenance	85-147			
10.7	Access Doors or Observation Ports	85-147			
10.8	Ash Hopper Access Doors	85-147			
10.9	Ash Handling	85-147			
Annex A	Explanatory Material	85-147	Annex I	Sample Ordinance Adopting NFPA 85	85-210
Annex B	Multiple Burner Boiler Supervised Manual Systems	85-180	Annex J	Safety	85-211
Annex C	Multiple Burner Boiler Fundamental Principles of a Manual System	85-193	Annex K	Fuel Hazards	85-212
Annex D	Multiple Burner Boiler Low NO _x Operation — Special Considerations	85-202	Annex L	Personnel Hazards of Atmospheric Fluidized-Bed Boilers	85-215
Annex E	Industry Experience (Reserved)	85-203	Annex M	Origin and Development of NFPA 85	85-217
Annex F	Solid Fuel Firing in Stokers	85-203	Annex N	Informational References	85-218
			Index		85-220

NFPA 85

Boiler and Combustion Systems Hazards Code

2007 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Documents." They can also be obtained on request from NFPA or viewed at www.nfpa.org/disclaimers.

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex N. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex N.

Chapter 1 Administration

1.1* Scope. This code shall apply to single burner boilers, multiple burner boilers, stokers, and atmospheric fluidized-bed boilers with a fuel input rating of 3.7 MW_i (12.5 million Btu/hr) or greater, to pulverized fuel systems, to fired or unfired steam generators used to recover heat from combustion turbines [heat recovery steam generators (HRSGs)], and to other combustion turbine exhaust systems.

1.1.1 This code shall cover design, installation, operation, maintenance, and training.

1.1.2 This code shall cover strength of the structure, operation and maintenance procedures, combustion and draft control equipment, safety interlocks, alarms, trips, and other related controls that are essential to safe equipment operation.

1.1.3 Coordination of the design and operating procedures of the boiler furnace or HRSG system and any flue gas cleanup systems downstream of the postcombustion gas passes shall be required. Such coordination shall include requirements for ensuring a continuous flow path from the combustion air inlet through the stack.

1.1.4 Chapter 5, Single Burner Boilers, covers single burner boilers that fire the following fuels:

- (1) Fuel gas as defined in 3.3.74.
- (2)*Other gas having a calorific value and characteristics similar to natural gas
- (3) Fuel oil as defined in 3.3.73.3
- (4) Fuel gas and fuel oil that are fired simultaneously for fuel transfer
- (5) Fuel gas and fuel oil that are fired simultaneously and continuously

1.1.5 Chapter 6, Multiple Burner Boilers, covers multiple burner boilers firing one or more of the following:

- (1) Fuel gas, as defined in 3.3.74
- (2) Fuel oil, as defined in 3.3.73.3
- (3) Pulverized coal, as defined in 3.3.73.2.1
- (4) Simultaneous firing of more than one of the fuels stated in 1.1.5(1) through 1.1.5(3)

1.1.6 Chapter 7, Atmospheric Fluidized-Bed Boilers, covers atmospheric fluidized-bed boilers.

1.1.7* Chapter 8, Heat Recovery Steam Generators and Other Combustion Turbine Exhaust Systems, covers HRSG systems or other combustion turbine exhaust systems.

1.1.8 Chapter 9, Pulverized Fuel Systems, covers pulverized fuel systems, beginning with the raw fuel bunker, which is upstream of the pulverizer, and is the point at which primary air enters the pulverizing system, and terminating at the point where pressure can be relieved by fuel being burned or collected in a device that is built in accordance with this code. The pulverized fuel system shall include the primary air ducts, which are upstream of the pulverizer, to a point where pressure can be relieved.

1.1.9 Chapter 10, Stokers, covers boilers using a stoker to fire the following fuels:

- (1) Coal
- (2) Wood
- (3) Refuse-derived fuel (RDF)
- (4) Municipal solid waste (MSW)
- (5) Other solid fuels

1.1.9.1 Where solid fuel is fired simultaneously with other fuels (e.g., a solid fuel stoker fired in combination with fuel gas, fuel oil, or pulverized auxiliary fuel), additional controls and interlocks shall include those covered in Chapters 5, 6, and 9.

Exception No. 1: The purge requirements of Chapters 5 and 6 shall not be required when the stoker is firing and the boiler is on-line. In those cases, if no cooling air is being provided to the auxiliary burners, a purge of their associated air supply ducts shall be provided.

Exception No. 2: Where fuel oil or fuel gas is fired in a supervised manual system in accordance with Chapter 5, the excessive steam pressure interlock shall not be required.

1.2* Purpose. The purpose of this code shall be to contribute to operating safety and to prevent uncontrolled fires, explosions, and implosions in equipment described in Section 1.1.

1.2.1 This code shall establish minimum requirements for the design, installation, operation, training, and maintenance of pulverized fuel systems, boilers, HRSGs, combustion turbine exhaust systems, and their systems for fuel burning, air supply, and combustion products removal.

1.2.2 This code shall require the coordination of operating procedures, control systems, interlocks, and structural design.



1.2.3 This code shall not be used as a design handbook.

1.2.3.1 A designer capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs.

1.2.3.2 In such cases, the designer shall be responsible for demonstrating and documenting the validity of the proposed design.

1.3 Application.

1.3.1 This code shall apply to new installations and to major alterations or extensions that are contracted for subsequent to the effective date of this code.

1.3.2 Process heaters used in chemical and petroleum manufacture, wherein steam generation is incidental to the operation of a processing system, shall not be covered by this code.

1.4* Retroactivity. The provisions in this code reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this code, at the time the code was issued.

1.4.1 Unless otherwise specified, the provisions in this code shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the code. Where specified, the provisions in this code shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this code deemed appropriate.

1.4.3 The retroactive requirements of this code shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. (*See Annex I for sample wording for enabling legislation.*)

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2006 edition.

NFPA 54, *National Fuel Gas Code*, 2006 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 70, *National Electrical Code*®, 2005 edition.

2.3 Other Publications.

2.3.1 AISC Publications. American Institute of Steel Construction, One East Wacker Drive, Suite 700, Chicago, IL 60601.

AISCASD, *Specifications for Structural Steel Buildings — Allowable Stress Design and Plastic Design*, 1989, including supplement No. 1, 2001.

AISC LRFD, *Load and Resistance Factor Design for Structural Steel Buildings*, 1999.

2.3.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI K61.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*, 1999.

ANSI/FCI 70-2, *Control Valve Seat Leakage*, 2006.

2.3.3 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, 2002.

2.3.4 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME B31.1, *Power Piping*, 1998.

ASME B31.3, *Process Piping*, 1999.

2.3.5 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 388, *Standard Classification of Coals by Rank*, 1999.

ASTM D 396, *Standard Specification for Fuel Oils*, 1998.

ASTM D 409, *Standard Test Method for Grindability of Coal by the Hardgrove-Machine Method*, 1997.

ASTM D 1655, *Standard Specification for Aviation Turbine Fuels*, 1998.

ASTM D 2880, *Standard Specification for Gas Turbine Fuel Oils*, 1998.

2.3.6 Military Specifications. Department of Defense Single Stock Point, Document Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-T-5624, *Turbine Fuel, Aviation, Grade JP4, JP5, and JP5/JP8 ST*, 1995.

2.3.7 Other Publications.

Merriam-Webster's *Collegiate Dictionary*, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2007 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, 2007 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2002 edition.

NFPA 72®, *National Fire Alarm Code*®, 2007 edition.

NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2005 edition.

NFPA 853, *Standard for the Installation of Stationary Fuel Cell Power Systems*, 2007 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.2.8 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Agglomerating. A characteristic of coal that causes coking on the fuel bed during volatilization.

3.3.2 Agglomeration. Alkali compounds can attach to bed material particles. These compounds can have low melting points and cause the bed particles to stick to each other to form agglomerates.

3.3.3 Air.

3.3.3.1 Auxiliary Air. Air that is supplied from an auxiliary source to maintain a minimum fuel mixture velocity in burner piping.

3.3.3.2 Combustion Air. Air used to react with the fuel in the combustion process. For duct burners, this generally is combustion turbine exhaust.

3.3.3.3 Design Full Load Mass Airflow. The air flow required to achieve nameplate full load. For the purposes of Chapter 6, Multiple Burner Boilers, it is the flow required to achieve nameplate full load based on the original design fuel as defined by the boiler equipment manufacturer.

3.3.3.4* Excess Air. Air supplied for combustion in excess of theoretical air.

3.3.3.5 Overfire Air. Air supplied for combustion that is admitted into the furnace at a point above the burners or fuel bed.

3.3.3.6 Primary Air. Air supplied for combustion that is admitted into the furnace through a burner premixed with the fuel.

3.3.3.6.1 Primary Air (in a Bubbling Fluidized Bed). That portion of total air used to transport or inject fuel or sorbent and to recycle material to the bed.

3.3.3.6.2 Primary Air (in a Circulating Fluidized Bed). That portion of total air introduced at the base of the combustor through the air distributor.

3.3.3.6.3 Primary Air (for the purposes of equipment within the scope of Chapter 8, Heat Recovery Steam Generators and Other Combustion Turbine Exhaust Systems). The air that is contained in the combustion turbine exhaust.

3.3.3.6.4 Primary Air (in a Pulverized Fuel System). In a pulverized fuel system, can be either air or a flue gas/air mixture, and can simultaneously also be pulverizer air and/or transport air.

3.3.3.7 Pulverizer Air. Air or inert gas that is introduced into the pulverizer to dry the fuel, aid in pulverization and classification, and convey the pulverized fuel from the pulverizer.

3.3.3.8 Seal Air. Air or inert gas supplied to any device at sufficient pressure for the specific purpose of minimizing contamination.

3.3.3.9 Secondary Air. Air for combustion supplied to the burners or fuel bed in addition to the primary air.

3.3.3.9.1 Secondary Air (in a Bubbling Fluidized Bed). That portion of the air introduced through the air distributor.

3.3.3.9.2 Secondary Air (in a Circulating Fluidized Bed). That air that enters the combustor at levels above the air distributor.



3.3.3.9.3 Secondary Air (in a Single or Multiple Burner Boiler). That portion of the air entering through the air registers.

3.3.3.10 Tempering Air. Cool air added to the hot primary air or gas to modify its temperature.

3.3.3.11 Theoretical Air. The chemically correct quantity of air needed for complete combustion of a given quantity of a specific fuel.

3.3.3.12 Transport Air. Air or inert gas that is used to convey pulverized fuel.

3.3.3.12.1 Transport Air (in a Fluidized Bed). The air used to convey or inject solid fuel or sorbent or to recycle material.

3.3.3.13 Undergrate Air. Combustion air introduced below the grate.

3.3.4 Air Change. A quantity of air, provided through a fuel burner, equal to the volume of furnace and boiler gas passes.

3.3.5 Air-Rich. A ratio of air to fuel supplied to a combustion chamber that provides more than the minimum excess air needed for optimum combustion of the fuel.

3.3.6 Alarm. An audible or visible signal indicating an off-standard or abnormal condition.

3.3.7 Alteration. A change or modification that results in a deviation from the original design specifications or criteria.

3.3.8 Annunciator. A device indicating an off-standard or abnormal condition by both visual and audible signals.

3.3.9 Atmospheric Fluidized-Bed Combustion. A fuel-firing technique using a fluidized bed operating at near-atmospheric pressure on the fire side.

3.3.10 Atomizer. The device in a burner that breaks down liquid fuel into a finely divided state.

3.3.10.1 Mechanical Atomizer. The device in a burner that breaks down liquid fuel into a finely divided state without using an atomizing medium.

3.3.11 Atomizing Medium. A supplementary fluid, such as steam or air, that assists in breaking down liquid fuel into a finely divided state.

3.3.12 Augmented Air Firing. Supplementary firing with the addition of air at the duct burners to support and stabilize combustion or to reduce emissions.

3.3.13* Autoignition Temperature (AIT). The minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heated element.

3.3.14 Bed Compartment. Segments of a fluidized bed, which might be individually controlled with respect to combustion airflow and fuel feed.

3.3.15 Bed Drain. An opening provided in the enclosure of a fluidized bed for the removal of spent bed material and any tramp material.

3.3.16 Bed Material. Granular particles that compose a fluidized bed.

3.3.17 Bed Temperature. The average temperature of a fluidized bed.

3.3.18 Bin. An enclosure to store pulverized fuel.

3.3.19 Bin System (Storage System). A system in which the fuel is pulverized and stored in bins from which it is withdrawn through feeders, as needed, for burning.

3.3.20 Boiler. A closed vessel in which water is heated, steam is generated, steam is superheated, or any combination thereof by the application of heat from combustible fuels in a self-contained or attached furnace.

3.3.21 Boiler Enclosure. The physical boundary for all boiler pressure parts and for the combustion process.

3.3.22 Bottom Air Admission. A method of introducing air to a chain or traveling grate stoker under the stoker.

3.3.23 Bubbling Fluidized Bed (BFB). A fluidized bed in which the fluidizing velocity is less than the terminal velocity of individual bed particles and in which part of the fluidizing gas passes through the bed as bubbles.

3.3.24 Bunker. An enclosure to store raw fuel.

3.3.25 Burner. A device or group of devices for the introduction of fuel and air into a combustion chamber at the velocity, turbulence, and concentration required to maintain ignition and combustion of fuel.

3.3.25.1 Auxiliary Load-Carrying Burner. In a fluidized bed boiler, a burner whose primary purpose is load carrying, located over the bed and having its own air supply.

3.3.25.2* Duct Burner. A burner, mounted in a duct or discharging into a duct, used to heat the air, flue gas, or combustion turbine exhaust gas in the duct.

3.3.25.3 Over Bed Burner. In a fluidized bed boiler, a warm-up burner located above the bed and firing over or into the bed.

3.3.25.4 Warm-Up Burner (Warm-Up Gun). A burner, usually smaller than the main burner, that is ignited by another ignition source and is used to warm up the boiler. In cases where it is used as an igniter, its classification shall be verified by test.

3.3.25.4.1 Warm-Up Burner (in a Fluidized Bed Boiler). A burner having its own air supply used to warm up the bed to the ignition temperature of the main fuel. The warm-up burner also can be used for limited load carrying.

3.3.26* Burner Management System. The control system dedicated to combustion safety and operator assistance in the starting and stopping of fuel preparation and burning equipment and for preventing misoperation of and damage to fuel preparation and burning equipment.

3.3.26.1 Automatic Burner Management System — Nonrecycling. A burner management system by which a furnace is purged and a burner is started, ignited, and stopped automatically but does not recycle automatically.

3.3.26.2 Automatic Burner Management System — Recycling. A burner management system by which a furnace is purged and a burner is started, ignited, and stopped automatically and recycles on a preset pressure range.

3.3.26.3 Manual Burner Management System. A burner management system by which a furnace is purged and a burner is started, ignited, and stopped manually.

3.3.26.4 Manual, Supervised Burner Management System. A burner management system by which a furnace is purged and a burner is started, ignited, and stopped manually. Interlocks are included to ensure that the operation follows established, proper procedures.

3.3.27 Bypass Stack. A stack applied in addition to and separate from the normal HRSG exhaust stack that allows combustion turbine exhaust gas to flow independently to the atmosphere.

3.3.28 Calcination. The endothermic chemical reaction that takes place when converting calcium carbonate or calcium hydroxide to calcium oxide.

3.3.29 Calcium to Sulfur Molar Ratio (Ca/S). The ratio of the total moles of calcium in the sorbent fed to the boiler to the total moles of sulfur in the fuel fed to the boiler.

3.3.30 Char. The unburned combustibles in solid form combined with a portion of the fuel ash and sorbent.

3.3.31 Cinder Return. In a stoker-fired boiler, an apparatus for the return of collected cinders to the furnace, either directly or with the fuel.

3.3.32 Circulating Fluidized Bed (CFB). A fluidized bed in which the fluidizing velocities exceed the terminal velocity of individual bed particles.

3.3.33 Classifier. A device to control pulverized fuel particle size distribution.

3.3.34 Coal. See 3.3.73.2.

3.3.35 Coking Plate. A plate adjacent to a grate through which no air passes and on which coal is placed for distilling the coal volatiles before the coal is moved onto the grate.

3.3.36 Combustion Chamber. The portion of the boiler or HRSG enclosure into which the fuel is fed, ignited, and burned.

3.3.37 Combustion Turbine. A turbine in which the rotating element is actuated by the pressure of combustion gases on curved vanes.

3.3.38 Combustion Turbine Exhaust Systems. All ductwork from the combustion turbine exhaust to the stack, including any emission control systems contained within the exhaust flow path.

3.3.39 Combustion Turbine Runback. The controlled unloading of a combustion turbine to a level required by HRSG or other equipment control demands.

3.3.40 Commercial Operation. The date that the full plant capacity is formally added to the power grid.

3.3.41 Commissioning. The time period of plant testing and operation between initial operation and commercial operation.

3.3.42 Confined Space. Any work location or enclosure in which either of the following exists: (1) the dimensions are such that a person who is 1.8 m (6 ft) tall cannot stand up in the middle of the space or extend his or her arms in all directions without hitting the enclosure; (2) access to or from the enclosure is by manhole, hatch, port, or other relatively small opening that limits ingress and egress to one person at a time. Confined spaces include but are not limited to the following: pulverizers, ducts, heaters, windboxes, cyclones, coal dust collectors, furnaces, bunkers, bins and HRSGs.

3.3.43 Continuous Trend Display. A dedicated visual display of an operating trend(s) by any instrument such as a cathode

ray tube (CRT), chart recorder, or other device to quantify changes in the measured variable(s).

3.3.44 Control System.

3.3.44.1 Boiler Control System. The group of control systems that regulates the boiler process, including the combustion control system but not the burner management system.

3.3.44.2 Combustion Control System. The control system that regulates the furnace fuel and air inputs to maintain the air-fuel ratio within the limits that are required for continuous combustion and stable flame throughout the operating range of the boiler in accordance with demand.

3.3.44.2.1 Combustion Control System in a Fluidized Bed. In a fluidized bed, the control system that regulates the furnace fuel input, furnace air input, bed inventory, and other bed heat transfer mechanisms to maintain the bed temperature and the air-fuel ratio within the limits necessary for continuous combustion and stable bed operation throughout the operating range of the boiler in accordance with demand.

3.3.44.2.2 Combustion Control System in HRSG Systems. In HRSG systems, the control system that regulates the fuel input and air, where applicable, to maintain continuous combustion and stable flame.

3.3.44.3 HRSG Control System. The group of control systems that regulate the HRSG process, including the combustion control system but not the burner management system.

3.3.44.4 Start-Up Combustion Control System. A control system used to regulate and maintain proper air-fuel ratio during the start-up period where the customary indexes, such as pressure, temperature, load, or flow, that motivate the normal automatic combustion control system are not available or suitable.

3.3.45 Crusher. A device for reducing the size of solid fuels.

3.3.46 Damper. A valve or plate for controlling draft or the flow of gases, including air. [853, 2007]

3.3.46.1 Shutoff Damper. A close-fitting damper to prevent flow and minimize leakage of air or flue gas into any system component.

3.3.47 Design Full Load Mass Airflow. See 3.3.3.3.

3.3.48 Direct Fired System (Unit System). A system in which the fuel is pulverized and delivered in suspension directly to the burner(s).

3.3.49 Directional Blocking. An interlock that, upon detection of a significant error in furnace pressure or HRSG process variables, acts to inhibit the movement of all appropriate final control elements in the direction that would increase the error.

3.3.50 Distributor/Divider. A device that splits a single stream of pulverized coal and primary air into two or more streams.

3.3.51 Drag Seal. In a chain grate stoker, the hinged plate resting against the returning chain and used to seal the air compartments.

3.3.52 Drip Leg. A chamber of ample volume, with suitable cleanout and drain connections, over which fuel gas is passed so that liquids and solids are trapped.

3.3.53 Dump Plate. In a stoker-fired furnace, an ash-supporting plate from which ashes can be discharged from one side of the plate by rotation of the plate.



3.3.54 Dust Collector. An auxiliary separator that is used to separate the fuel dust from the air or inert gas prior to discharge of the latter from the system.

3.3.55 Elutriation. The selective removal of fine solids from a fluidized bed by entrainment in the upward flowing products of combustion.

3.3.56 Exhauster. See 3.3.60.2, Exhauster Fan.

3.3.57 Explosion Vent. A vent to relieve explosion pressures resulting from ignition of a mixture of decomposition gases and air. [40, 2007]

3.3.58 Explosive Mixture. A flammable or combustible mixture in a confined space.

3.3.59 False Start. A condition where the combustion turbine fails to complete its ignition sequence (failure to start) and can result in unburned fuels entering the HRSG enclosure or other combustion turbine exhaust systems.

3.3.60 Fan.

3.3.60.1 Booster Fan. A device used to assist in the supply of air to, or the removal of flue gas products from, the combustion chamber; or to supplement draft capability to achieve required flow through the combustion air or flue gas flow path.

3.3.60.2 Exhauster Fan. A fan located at the pulverizer outlet used to draw the primary air through the pulverizer and to deliver the primary air-fuel mixture to the burner(s) or other apparatus.

3.3.60.3 Forced Draft (FD) Fan. A device used to pressurize and supply ambient air to the combustion chamber to support combustion. In a fluidized bed boiler, FD fans generally include both primary air and secondary air fans.

3.3.60.4 Induced Draft (ID) Fan. A device used to remove the products of combustion from the boiler or HRSG by introducing a negative pressure differential.

3.3.60.5 Primary Air Fan. A fan used to supply coal transport air to the pulverizer or to the burner lines of a storage system.

3.3.60.6 Seal Air Fan. A fan used to supply sealing air.

3.3.61 Fan Override Action. A control that, upon detection of significant error in combustion chamber pressure, acts to reposition the induced draft fan control device(s) in a direction to reduce the error.

3.3.62 Fan Test Block Capability. The point on the fan head versus flow characteristic curve at which the fan is selected. This is the calculated operating point associated with the maximum continuous rating of the boiler or HRSG, plus the head and flow margins.

3.3.63 Feed-Forward Signal. A signal used to anticipate a change in the measured variable.

3.3.64 Flame. A body or stream of gaseous material involved in the combustion process and emitting radiant energy at specific wavelength bands determined by the combustion chemistry of the fuel. In most cases, some portion of the emitted radiant energy is visible to the human eye. [72, 2007]

3.3.65 Flame Detector. A device that senses the presence or absence of flame and provides a usable signal.

3.3.65.1 Self-Checking Flame Detector. A flame detector that automatically, and at regular intervals, tests the entire sensing and signal processing system of the flame detector.

3.3.66 Flame Envelope. The confines (not necessarily visible) of an independent process that converts fuel and air into products of combustion.

3.3.67 Fluidize. To maintain a bed of finely divided solid particles in a mobile suspension by blowing air or gas through the bed at such a velocity that the particles separate and behave much like a fluid.

3.3.68 Fluidized Bed. A bed of granular particles maintained in a mobile suspension by the velocity of an upward flow of air or gas.

3.3.69 Fly Carbon Reinjection. In a stoker-fired boiler, the process of removing the coarse carbon-bearing particles from the particulate matter carried over from the furnace and returning the carbonaceous material to the furnace to be combusted.

3.3.70 Freeboard. In a fluidized bed boiler, the space or volume above the upper surface of the bubbling bed and below the entrance to the convection pass.

3.3.71 Fresh Air Firing. The operation of an HRSG with air instead of combustion turbine exhaust.

3.3.72 Friability. The tendency of coal to crumble or break into small pieces.

3.3.73 Fuel.

3.3.73.1 Auxiliary Fuel. In a fluidized bed boiler, generally a gaseous or liquid fuel used to warm the bed material sufficiently to allow ignition of the main fuel upon injection into the heated bed material.

3.3.73.2 Coal. A solid fuel classified as lignite, subbituminous, bituminous, or anthracite as defined by ASTM D 388, *Standard Classification of Coals by Rank*.

3.3.73.2.1 Pulverized Coal. Coal that is reduced to a size such that at least 50 percent can pass through a 200-mesh (74 microns) sieve.

3.3.73.3 Fuel Oil (Oil Fuel). Liquid fuels defined as Grades 2, 4, 5, or 6 in ASTM D 396, *Standard Specification for Fuel Oils*, or as Grade 2GT in ASTM D 2880, *Standard Specification for Gas Turbine Fuel Oils*.

3.3.73.4 Hogged Fuel. Wood refuse that has been chipped or shredded by a machine known as a hog.

3.3.73.5 JP4. A light, volatile fuel with a boiling point between gasoline and light distillate. Its properties are defined in MIL-T-5624, *Turbine Fuel, Aviation, Grade JP4, JP5, and JP5/JP8 ST*, and are similar to ASTM D 1655, *Standard Specification for Aviation Turbine Fuels (Jet B)*, and ASTM D 2880, *Standard Specification for Gas Turbine Fuel Oils*.

3.3.73.6 Kerosene. A light, highly refined fuel that is slightly more volatile than No. 2 fuel oil. Its properties are defined in ASTM D 396, *Standard Specification for Fuel Oils*; ASTM D 1655, *Standard Specification for Aviation Turbine Fuels*, or ASTM D 2880, *Standard Specification for Gas Turbine Fuel Oils*.

3.3.73.7 LP-Gas. A material that is composed predominantly of any of the following hydrocarbons or mixtures of them: propane, propylene, n-butane, isobutane, and butylenes.

3.3.73.8 Main Fuel. In a fluidized bed boiler, gaseous, liquid, or solid fuel introduced into the bed after the bed temperature has reached a value sufficient to support its combustion and that is used during the normal operation of the boiler. Main fuels necessitate the use of the fluidized hot bed as their ignition source.

3.3.73.9 Municipal Solid Waste (MSW). Solid waste materials consisting of commonly occurring residential and light commercial waste. [850, 2005]

3.3.73.10 Natural Gas. A gaseous fuel occurring in nature and consisting mostly of a mixture of organic compounds, normally methane, ethane, propane, and butane. The calorific value of natural gases varies between about 26.1 MJ/m³ and 55.9 MJ/m³ (700 Btu per ft³ and 1500 Btu per ft³), the majority averaging 37.3 MJ/m³ (1000 Btu per ft³).

3.3.73.11 Pulverized Fuel. Solid fuel that is reduced to a size such that at least 50 percent will pass through a 200-mesh (74 microns) sieve.

3.3.73.12 Refuse-Derived Fuel (RDF). A solid fuel prepared from municipal solid waste. The waste material is usually refined by shredding, air classification, magnetic separation, or other means. The fuel can be packed, chopped, pelletized, pulverized, or subject to other mechanical treatment.

3.3.73.13 Supplementary Fuel. Fuel burned to supply additional heat to the steam generator or to support combustion.

3.3.74 Fuel Gas (Gas Fuel). Gaseous fuels defined as Natural Gas (see 3.3.73.10) or LP-Gas (see 3.3.73.7).

3.3.75 Fuel-Rich. Indicates a ratio of air to fuel supplied to a furnace that provides less than the minimum excess air needed for optimum combustion of the fuel.

3.3.76 Fuel Trip. The automatic shutoff of a specific fuel as the result of an interlock or operator action.

3.3.77 Furnace. The portion of the boiler enclosure within which the combustion process takes place and wherein heat transfer occurs predominantly by radiation.

3.3.78 Gate (for Raw Fuel) (Silo Gate; Bunker Gate). A shutoff gate between the raw-fuel bunker and the raw-fuel feeder.

3.3.79 Grate. The surface on which fuel is supported and burned and through which air is passed for combustion.

3.3.79.1 Bars or Keys Grate. Those parts of the fuel-supporting surface arranged to admit air for combustion.

3.3.79.2 Hand-Fired Grate. A grate on which fuel is placed manually, usually by means of a shovel.

3.3.80 Grindability. The characteristic of solid fuel that indicates its relative ease of pulverization, as defined by ASTM D 409, *Standard Test Method for Grindability of Coal by the Hardgrove-Machine Method*.

3.3.81 Header. A pipe or duct through which liquid or gas is conveyed and supplied to or received from multiple branches.

3.3.82 Heat Recovery Steam Generator (HRSG). A heat exchanger that uses a series of heat transfer sections (e.g., superheater, evaporator, and economizer) positioned in the exhaust gas flow of a combustion turbine to recover heat and supply a rated steam flow at a required temperature and pressure.

3.3.82.1 HRSG Enclosure. All ductwork from the combustion turbine exhaust through the steam generator to the stack, including any bypass duct connection.

3.3.82.2 HRSG Purge. See 3.3.117.1, Combustion Turbine Purge; 3.3.117.2, Duct Burner (HRSG) Purge; and 3.3.118, Purge Rate.

3.3.82.3 HRSG System. The unit assembly from the combustion turbine inlet to the flue gas outlet to the atmosphere.

3.3.83 Hogged Fuel. See 3.3.73.4.

3.3.84 Igniter. A permanently installed device that provides proven ignition energy to light off the main burner.

3.3.84.1 Class 1 Igniter. An igniter that is applied to ignite the fuel input through the burner and to support ignition under any burner light-off or operating conditions. Its location and capacity are such that it will provide sufficient ignition energy, generally in excess of 10 percent of full load burner input, at its associated burner to raise any credible combination of burner inputs of both fuel and air above the minimum ignition temperature.

3.3.84.2 Class 2 Igniter. An igniter that is applied to ignite the fuel input through the burner under prescribed light-off conditions. It is also used to support ignition under low load or certain adverse operating conditions. The range of capacity of such igniters is generally 4 percent to 10 percent of full load burner fuel input.

3.3.84.3 Class 3 Igniter. A small igniter applied particularly to fuel gas and fuel oil burners to ignite the fuel input to the burner under prescribed light-off conditions. The capacity of such igniters generally does not exceed 4 percent of the full load burner fuel input.

3.3.84.4 Class 3 Special Igniter. A special Class 3 high energy electrical igniter capable of directly igniting the main burner fuel.

3.3.85 Inert Gas. Any gas that is nonflammable, chemically inactive, noncontaminating for the use intended, and oxygen deficient to the extent required. [69, 2002]

3.3.86 Initial Operation. The first coordinated operation of the unit.

3.3.87 Interlock. A device, or an arrangement of devices, in which the operation of one part or one mechanism of the device or arrangement controls the operation of another part of another mechanism.

3.3.88 JP4. See 3.3.73.5.

3.3.89 Kerosene. See 3.3.73.6.

3.3.90 Lance. A device, without its own air supply, that provides fuel input directly into a fluidized bed.

3.3.91 Ledge Plate. A form of plate that is adjacent to, and overlaps, the edge of a stoker.

3.3.92 Light-Off Time Limit Timer. A device that is used on supervised manual burner management systems and limits the allowable time between completion of purge and light-off.

3.3.93 Lock Hopper. A feeding device that incorporates a double pressure seal, thus enabling solids to be fed into a system with a higher pressure than the pressure existing in the solid's storage area. Also, a letdown device that incorporates a double pressure seal, thus enabling solids to be withdrawn from a system with a higher pressure than that existing downstream of the lock hopper.



3.3.94 Logic System. The decision-making and translation elements of the burner management system. A logic system provides outputs in a particular sequence in response to external inputs and internal logic. Logic systems are comprised of the following: (1) hardwired systems — individual devices and interconnecting wiring — and (2) microprocessor-based systems — (a) computer hardware, power supplies, I/O devices, and the interconnections among them; and (b) operating system and logic software.

3.3.95 Low Fire. The minimum fire rate that results in stable combustion.

3.3.96 LP-Gas. See 3.3.73.7.

3.3.97 Main Fuel Temperature Permit. The minimum fluidized bed temperature at which the main fuel can be introduced with resulting stable combustion.

3.3.98* Master Fuel Trip. An event resulting in the rapid shut-off of all fuel, including igniters; for HRSGs, an event resulting in the rapid shutoff of all fuel to the duct burners, including igniters.

3.3.99 Master Fuel Trip Relay. An electromechanical relay(s) utilized to trip all required equipment simultaneously when a master fuel trip is initiated.

3.3.100 Minimum Fluidization Velocity. In a fluidized bed, the lowest velocity sufficient to cause incipient fluidization.

3.3.101 Monitor. To sense and indicate a condition without initiating automatic corrective action.

3.3.102 Natural Gas. See 3.3.73.10.

3.3.103 Oil. See 3.3.73.3, Fuel Oil (Oil Fuel).

3.3.104 Open Flow Path. A continuous path for movement of an airstream from the forced draft fan inlet to the stack; in an HRSG or other combustion turbine exhaust system, a continuous path for movement of an airstream through the HRSG system or other combustion turbine exhaust systems.

3.3.105 Open Register Light-Off Procedure. A procedure for purging and lighting off a boiler under specified, controlled conditions.

3.3.106 Operating Range. The range between the maximum fuel input and minimum fuel input within which the burner flame can be maintained in a continuous and stable manner.

3.3.107 Overfire Air Port. An opening in a furnace wall to enable the introduction of an overfire airstream.

3.3.108 Partial Loss of Flame. Loss of flame at any of the separate flame envelopes or burners while flame is maintained at any of the other flame envelopes or burners.

3.3.109 Positive Means. The physical methods of satisfying a requirement.

3.3.110 Postpurge. A purge performed after the burner(s) is shut down.

3.3.111 Pressure/Air Lock. A device for transferring pulverized fuel between zones of different pressure without permitting appreciable flow of air or gas in either direction.

3.3.112 Primary Air Fan (Pulverizer Air Fan). See 3.3.60.5, Primary Air Fan.

3.3.113 Prove. To establish by measurement or test the existence of a specified condition such as flame, level, flow, pressure, or position.

3.3.114 Pulverized Fuel. See 3.3.73.11.

3.3.115 Pulverized Fuel Pump. A device or system for transporting fuel mechanically or pneumatically by utilizing minimum airflow.

3.3.116 Pulverizer. A machine for reducing the particle size of a solid fuel so that it burns in suspension.

3.3.117 Purge. A flow of air or an inert medium at a rate that will effectively remove any gaseous or suspended combustibles and replace them with the purging medium.

3.3.117.1 Combustion Turbine Purge. A flow of air at purge rate through the combustion turbine and the appropriate portion of the HRSG enclosure or other combustion turbine exhaust systems for a number of volume changes sufficient to effectively remove any gaseous or suspended combustibles and replace them with the air.

3.3.117.2 Duct Burner (HRSG) Purge. A flow of combustion turbine exhaust gas or air at purge rate through the HRSG enclosure for a number of volume changes sufficient to effectively remove any gaseous or suspended combustibles and replace them with the purging medium.

3.3.118 Purge Rate. A constant flow of purging medium at velocity sufficient to achieve a purge.

3.3.119 Raw Fuel Feeder. A device for supplying a controlled amount of raw fuel.

3.3.120 Reburn. The process of admitting fuel downstream of the main burners to create a fuel-rich zone where chemical reactions reduce NO_x to molecular nitrogen.

3.3.121 Reburn Injector. A device that introduces fuel without combustion air into a furnace for the purpose of reducing NO_x emissions from the furnace.

3.3.122 Recirculation (Solids or Recycle). The reintroduction of solid material extracted from the products of combustion into a fluidized bed.

3.3.123 Recycle. A single burner boiler start-up that is initiated by steam pressure or water temperature following a normal shutdown.

3.3.124 Recycle Rate. In a fluidized bed, the rate at which a mass of material is reinjected into the bed. This value is often expressed as the ratio of the amount being reinjected to the total amount being elutriated from the fluidized bed.

3.3.125 Recycle Ratio. In a fluidized bed, the mass of material being reinjected into the bed divided by the mass of fuel being fed into the bed.

3.3.126 Refuse-Derived Fuel (RDF). See 3.3.73.12.

3.3.127 Register (Burner Air). A set of dampers for a burner, or air supply system to a particular burner, used to distribute the combustion air admitted to the combustion chamber. Frequently controls the direction and velocity of the airstream for efficient mixing with the incoming fuel.

3.3.128 Reinjection. In a fluidized bed boiler, the return or recycling of material removed or carried from the furnace back to the furnace. Also refers to fly ash collected and returned to the furnace or combustion chamber, sometimes expressed as a percent of the total collected.

3.3.129 Remote Operation. Control from a location removed from the combustion area.

3.3.130 Repair. A process that returns the combustion system or subsystem to its original design specifications or criteria.

3.3.131 Repeatability. The ability of a device to maintain a constant set point characteristic.

3.3.132 Restart. A manually initiated start-up.

3.3.133 Retort. A trough or channel in an underfeed stoker, extending within the furnace, through which fuel is forced upward into the fuel bed.

3.3.134 Safety Shutdown Trip Relay. See 3.3.99, Master Fuel Trip Relay.

3.3.135 Scavenging. The procedure by which liquid fuel left in a burner or igniter after a shutdown is cleared by admitting steam or air through the burner passages, typically through a dedicated scavenging medium valve.

3.3.136 Selective Catalytic Reduction (SCR). A method of reducing NO_x in flue gas.

3.3.137 Semifluidized. In a fluidized bed boiler, the state in which a uniform flow of air that is less than that necessary to fluidize the bed is admitted and is found to be sufficient to adequately remove gaseous combustibles.

3.3.138 Service Connection. A point at which fuel, an atomizing medium, or power is connected to the firing equipment or controlled devices.

3.3.139 Set Point. A predetermined value to which a device or system is adjusted and at which it performs its intended function.

3.3.140 Shutdown.

3.3.140.1 Emergency Shutdown (HRSG or other combustion turbine exhaust systems). An event resulting in the rapid shutoff of all fuel to the combustion turbine along with a master fuel trip.

3.3.140.2 Normal Shutdown. Stopping burner operation by shutting off all fuel and ignition energy to the combustion equipment.

3.3.140.3 Safety Shutdown (Single Burner Boiler). Stopping burner operation by shutting off all fuel and ignition energy to the furnace.

3.3.141 Side Air Admission. Admission of air to the underside of a grate from the sides of a chain or traveling grate stoker.

3.3.142 Soot Blower. A mechanical device for introducing steam, air, or water to clean heat-absorbing surfaces.

3.3.143 Sorbent. In a fluidized bed boiler, a constituent that reacts with and captures a pollutant or, more generally, a constituent that reacts with and captures another constituent.

3.3.144 Spent Bed Material. In a fluidized bed boiler, material removed from the bed generally comprised of reacted sorbent, calcined limestone, ash, and solid, unburned combustibles. For some applications, the spent bed material might also contain some inert material, such as sand.

3.3.145 Stable Bed. In a fluidized bed boiler, a bed of granular material that maintains sustained combustion at a desired temperature.

3.3.146 Stable Flame. A flame envelope that retains its continuity throughout the maximum rate of change within the operating range of the boiler, burner, or HRSG.

3.3.147 Steam Generator. A pressure vessel in which water is converted to steam or steam is superheated, or in which any combination thereof takes place.

3.3.148 Steam Generator Capacity. The manufacturer's stated steam output rate over a period of time for which the steam generator is designed to operate.

3.3.149 Steam Generator Enclosure. The physical boundary for all steam generator pressure parts and the combustion process.

3.3.150 Stoker.

3.3.150.1 Chain Grate Stoker. A stoker that has a moving endless chain as a grate surface, onto which coal is fed directly from a hopper.

3.3.150.2 Dump Grate Stoker. A stoker equipped with movable ashtrays, or grates, by means of which the ash is discharged at any desirable interval.

3.3.150.3 Forced Draft Stoker. A stoker in which the flow of air through the grate is caused by a pressure produced by mechanical means.

3.3.150.4 Front Discharge Stoker. A stoker so arranged that refuse is discharged from the grate surface at the same end as the coal feed.

3.3.150.5 Mechanical Stoker. A device consisting of a mechanically operated fuel feeding mechanism and a grate, used for the purpose of feeding solid fuel into a furnace, distributing it over a grate, admitting air to the fuel for the purpose of combustion, and providing a means for removal or discharge of refuse.

3.3.150.6 Multiple Retort Stoker. An underfeed stoker consisting of two or more retorts, parallel and adjacent to each other, but separated by a line of tuyeres, and arranged so that the refuse is discharged at the ends of the retorts.

3.3.150.7 Overfeed Stoker. A stoker in which fuel is fed onto grates above the point of air admission to the fuel bed. Overfeed stoker grates include the following: (1) *Front Feed, Inclined Grate* — Fuel is fed from the front onto a grate inclined downward toward the rear of the stoker; (2) *Chain or Traveling Grate* — A moving endless grate that conveys fuel into and through the furnace where it is burned, after which it discharges the refuse; (3) *Vibrating Grate* — An inclined vibrating grate in which fuel is conveyed into and through the furnace where it is burned, after which it discharges the refuse.

3.3.150.8 Rear Discharge Stoker. A stoker so arranged that ash is discharged from the grate surface at the end opposite the solid fuel.

3.3.150.9 Reciprocating Grate Stoker. A grate element that has reciprocating motion, usually for the purpose of fuel agitation or ash removal.

3.3.150.10 Side Dump Stoker. A stoker so arranged that refuse is discharged from a dump plate at the side of the stoker.

3.3.150.11 Single Retort Stoker. An underfeed stoker using one retort only in the assembly of a complete stoker.

3.3.150.12 Spreader Stoker. A stoker that distributes fuel into the furnace from a location above the fuel bed with a portion of the fuel burned in suspension and a portion on



the grates. Spreader stoker grates include the following: (1) *Stationary Grate* — A grate in which fuel is fed onto a fixed position grate; (2) *Dump Grate* — A grate in which fuel is fed onto a nonmoving grate that is arranged to allow intermittent discharge of refuse through tilting action of the grate bars; (3) *Continuous Discharge or Traveling Grate* — A grate that continuously discharges the refuse from the end after burning the fuel.

3.3.150.13 Traveling Grate Stoker. A stoker similar to a chain grate stoker with the exception that the grate is separate from but is supported on and driven by chains.

3.3.150.14 Underfeed Stoker. A stoker in which fuel is introduced through retorts at a level below the location of air admission to the fuel bed. Underfeed stokers are divided into three general classes.

3.3.150.14.1 Continuous Ash Discharge Underfeed Stoker. A stoker in which the refuse is discharged continuously from the normally stationary stoker ash tray to the ash pit, without the use of mechanical means other than the normal action of the coal feeding and agitating mechanism.

3.3.150.14.2 Rear Discharge Underfeed Stoker. A stoker having a grate composed of transversely spaced underfeed retorts that feed and distribute solid fuel to intermediate rows of tuyeres through which air is admitted for combustion. The ash is discharged from the stoker across the rear end.

3.3.150.14.3 Side Ash Discharge Underfeed Stoker. A stoker having one or more retorts that feed and distribute fuel onto side tuyeres or a grate through which air is admitted for combustion and over which the ash is discharged at the side parallel to the retorts.

3.3.150.15 Water Cooled Stoker. A stoker having tubes in or near the grate surface through which water is passed for cooling the grates.

3.3.151 Stoker Gate. An element of a stoker placed at the point of entrance of fuel into the furnace and by means of which the depth of fuel on the stoker grate is controlled. It is generally used in connection with chain or traveling grate stokers and has the form of a guillotine.

3.3.152 Sulfation. The exothermic chemical reaction that takes place when calcium oxide unites with oxygen and sulfur dioxide to form calcium sulfate.

3.3.153 Sulfur Capture. The molar fraction of sulfur in the fuel input that is “captured” by calcium oxide to form calcium sulfate.

3.3.154 Sulfur Reacted. In a fluidized bed, the fraction of the total sulfur in the fuel fed to the bed that is converted to sulfur dioxide or calcium sulfate.

3.3.155 Sulfur Retention. The molar ratio of the total sulfur in the fuel minus the sulfur leaving the unit as sulfur dioxide to the total sulfur in the fuel.

3.3.156 Supervise. To sense and indicate a condition requiring attention and to automatically initiate corrective action.

3.3.157 Supplementary Firing. The provision of duct burners in an HRSG to increase the temperature of the combustion turbine exhaust gases.

3.3.158 Switch.

3.3.158.1 Normal Shutdown, High Steam Pressure Switch. A pressure-actuated device that is arranged to effect a normal burner shutdown when the steam pressure exceeds a preset pressure.

3.3.158.2 Normal Shutdown, High Water Temperature Switch. A temperature-actuated device that is arranged to effect a normal burner shutdown when the water temperature exceeds a preset temperature.

3.3.158.3 Process Monitoring, High Oil Temperature Switch. A temperature-actuated device that initiates a signal when oil temperature rises above the limits that are required to maintain the viscosity range recommended by the burner manufacturer.

3.3.158.4 Process Monitoring, Low Oil Temperature Switch. A temperature-actuated device that initiates a signal when the oil temperature falls below the limits that are required to maintain the viscosity range recommended by the burner manufacturer.

3.3.158.5 Proof of Closure Switch. A device that provides feedback that a piece of equipment is in the closed position. For Chapter 5, Single Burner Boilers, when referring to safety shutoff valves, it is a non-field-adjustable switch installed by the valve manufacturer and that activates only after the valve is fully closed.

3.3.158.6 Safety Shutdown, Excessive Steam Pressure Switch. A pressure-actuated device that is arranged to effect a safety shutdown of the burner when the steam pressure exceeds a preset pressure.

3.3.158.7 Safety Shutdown, Excessive Water Temperature Switch. A temperature-actuated device that is arranged to effect a safety shutdown of the burner when the water temperature exceeds a preset temperature.

3.3.158.8 Safety Shutdown, High Gas Pressure Switch. A pressure-actuated device that is arranged to effect a safety shutdown or to prevent starting when the gas pressure exceeds the preset value.

3.3.158.9 Safety Shutdown, Low Gas Pressure Switch. A pressure-actuated device that is arranged to effect a safety shutdown or to prevent starting when the gas pressure falls below the preset value.

3.3.158.10 Safety Shutdown, Low Oil Pressure Switch. A pressure-actuated device that is arranged to effect a safety shutdown or to prevent starting when the oil pressure falls below the preset value.

3.3.158.11 Safety Shutdown, Low Water Cutout Auxiliary Switch. On single burner boilers, a device that is arranged to effect a safety shutdown of the burner when the water level in the boiler falls to a predetermined low level.

3.3.158.12 Safety Shutdown, Low Water Cutout Switch. A device that is arranged to effect a safety shutdown or master fuel trip when the water level in the boiler or HRSG falls to a predetermined low level.

3.3.159 Trial-for-Ignition Period (Igniter). The interval of time during light-off in which a safety control circuit permits the igniter fuel safety shutoff valve(s) to be opened before the flame detection system is required to supervise the igniter flame.

3.3.160 Trial-for-Ignition Period (Main Burner). The interval of time during light-off in which a safety control circuit permits the main burner fuel safety shutoff valve(s) to be opened before the flame detection system is required to supervise the main burner flame only.

3.3.161 Tuyeres. Forms of grates, located adjacent to a retort, feeders, or grate seals through which air is introduced.

3.3.162 Unattended Operation. A means of operation where the operator is not in view of operating instrumentation (local or remote), nor in a position to operate control systems.

3.3.163 Unit. The combined spaces of the furnace and the associated boiler passes, ducts, and fans that convey the gases of combustion to the stack; for HRSGs, the combined spaces of the combustion turbine, the HRSG, and the associated ducts that convey the air and combustion gases from the air intake to the stack; for other combustion turbine exhaust systems, the combined spaces of the combustion turbine, and the associated ducts that convey the air and combustion gases from the air intake to the stack.

3.3.164 Valve.

3.3.164.1 Barrier Valve. A valve, not necessarily dusttight, used to inhibit hot gases from traveling back into any system component open for inspection or maintenance.

3.3.164.2 Burner Shutoff Valve. In a pulverized fuel system, a valve that is installed in the fuel line between the pulverizer and the burner.

3.3.164.3 Charging Valve. In a gaseous or liquid fuel system, a small valve bypassing the main safety shutoff valve used for purging and charging the fuel headers and piping and for testing for leaks.

3.3.164.4 Check Valve. A valve that allows flow in one direction only. [13D, 2007]

3.3.164.5 Dusttight Valve. In a pulverized fuel system, a tight-seating valve installed in the fuel supply pipe to the burner to allow or stop flow.

3.3.164.6 Flow Control Valve. A valve capable of regulating quantity of through-put to a controlled range.

3.3.164.7 Safety Shutoff Valve (Safety Trip Valve). A fast-closing valve that automatically shuts off the gaseous or liquid fuel supply in response to a normal, emergency, or safety shutdown signal.

3.3.164.8 Supervisory Shutoff Valve. In a gaseous or liquid fuel system, a manually operated shutoff valve with a means to provide a "valve closed" position signal.

3.3.164.9 Vent Control Valve. A controllable valve for regulating the flow of vented air or gas from the system.

3.3.164.10 Vent Valve. A valve used to allow venting of air or gas from the system to the atmosphere.

3.3.165 Valve-Proving System. In a gaseous or liquid fuel system, a system that proves the leak tightness of all safety shutoff valves and prevents main burner or igniter light-off if the test is not satisfied.

3.3.166 Volatile Matter. The portion of mass, except water vapor, that is driven off in a gaseous form when solid fuels are heated.

3.3.167 Watch-Dog Timer. A timer external to a microprocessor-based control that is used to compare the microprocessor cycle timing against itself and that fails safely if the microprocessor timing stops or exceeds the watch-dog time interval.

Chapter 4 Fundamentals of Boiler Combustion Systems

4.1* Manufacture, Design, and Engineering.

4.1.1 The owner or the owner's representative shall, in cooperation with the manufacturer, ensure that the unit is not deficient in apparatus that is necessary for operation with respect to pressure parts, fuel-burning equipment, air and fuel metering, light-off, and maintenance of stable flame.

4.1.2 All fuel systems shall include provisions to prevent foreign substances from interfering with the fuel supply.

4.1.3* An evaluation shall be made to determine the optimum integration of manual and automatic safety features.

4.1.4 Although this code requires a minimum degree of automation, more complex plants, plants with increased automation, and plants designed for remote operation shall require additional provisions for the following:

- (1) Information regarding significant operating events that allow the operator to make a rapid evaluation of the operating situation
- (2) Continuous and usable displays of variables that allow the operator to avoid hazardous conditions
- (3) In-service maintenance and checking of system functions without impairment of the reliability of the overall control system
- (4) An environment conducive to timely and correct decisions and actions

4.1.5 The burner or fuel feed piping and equipment shall be designed and constructed to prevent the formation of hazardous concentrations of combustible gases that exist under normal operating conditions.

4.2 Installation and Commissioning.

4.2.1 The boiler, heat recovery steam generator (HRSG), combustion turbine exhaust system, or pulverized fuel system shall not be released for operation before the installation and checkout of the required safeguards and instrumentation system have been successfully completed.

4.2.2 The party responsible for the erection and installation of the equipment shall ensure that all pertinent apparatus is installed and connected in accordance with the system design.

4.2.3 The owner or owner's representative, the engineering consultant, the equipment manufacturer, and the operating company shall prohibit operation until the safeguards have been tested for correct operation as a system.

4.2.3.1 If temporary interlocks and instrumentation are necessary to meet these requirements, any such temporary system shall be reviewed by the purchaser, the engineering consultant, the equipment manufacturer, and the operating company, and agreement shall be reached on the system's ability to protect equipment and personnel in advance of start-up.

4.2.3.2 All temporary modifications shall be documented, and permanent resolutions shall be accomplished prior to commercial operation.



4.2.4 The safety interlock system and protective devices shall be tested jointly by the organization responsible for the system design and by those who operate and maintain such a system and devices.

4.2.5 After installation but before initial operation, coordinated tests of all systems shall be accomplished.

4.2.6 Documentation of the plant equipment, the system, and maintenance activities shall be updated to reflect changes in the status of equipment and operating procedures.

4.3 Coordination of Design, Construction, and Operation.

4.3.1* During the planning and engineering phases of plant construction, the design shall be coordinated with operating personnel.

4.3.2* The integration of the various components, including boiler or HRSG, burner, fuel and air supply equipment, controls, interlocks and safety devices, operator and maintenance functions, and communication and training, shall be the responsibility of the owner and the operating company.

4.4 Maintenance, Inspection, Training, and Safety.

4.4.1 Maintenance and Equipment Inspection. See also Annex J.

4.4.1.1* A program shall be provided for inspection and maintenance of equipment at intervals consistent with the type of equipment used, service requirements, and manufacturers' recommendations.

4.4.1.2 As a minimum, the maintenance program shall include the following:

- (1) In-service inspections to identify conditions that need corrective action
- (2) Well-defined planning for making repairs or modifications using qualified personnel and tools and instruments designed for the work
- (3) Equipment history and record of dates of service, conditions found, maintenance performed, and changes made
- (4) Written comprehensive maintenance procedures incorporating the manufacturer's instructions to define the tasks and skills required
- (5) Nondestructive examination requirements; tasks needing special tools; special environmental factors such as temperature limitations, dusts, contaminated or oxygen-deficient atmospheres, and limited access or confined space restrictions
- (6) Equipment condition assessment before and after maintenance
- (7) Supply of well-maintained spare parts to perform required maintenance
- (8) Housekeeping essential for safe operation and prevention of fires or explosions that includes the following:
 - (a) Provisions for cleaning of horizontal ledges or surfaces of buildings and equipment to prevent the accumulation of dust deposits greater than the minimum required to create an explosion hazard
 - (b) Water washing or vacuum cleaning methods to reduce the possibility of creating dust clouds
 - (c) Prohibition of the use of compressed air for cleaning

4.4.1.3* Operation, set points, and adjustments shall be verified by testing at specified intervals, and the results shall be documented.

4.4.1.4 Defects shall be reported and corrected, and the changes or repairs documented.

4.4.1.5 System configuration, including logic, set points, and sensing hardware, shall not be changed without detailed engineering review and documentation.

4.4.1.6 System operation shall be tested and verified for compliance with the design criteria whenever a controller is replaced, repaired, reprogrammed, or updated before returning it to service.

4.4.1.7 When a unit that fires liquid fuel is out of service and available for inspection, personnel shall check for any accumulation of unburned fuel in the boiler or HRSG enclosure, especially in the fin-tube area of an HRSG.

4.4.2 Training.

4.4.2.1 Operator Training.

4.4.2.1.1* The owner or the owner's representative shall be responsible for establishing a formal training program that is consistent with the type of equipment and hazards involved to prepare personnel to operate equipment.

4.4.2.1.2 Operating procedures shall be established that cover normal and emergency conditions.

4.4.2.1.2.1 Start-up, shutdown, and lockout procedures shall all be covered in detail.

4.4.2.1.2.2 Where different modes of operation are possible, procedures shall be prepared for each operating mode.

4.4.2.1.2.3 Procedures also shall be prepared for switching from one mode to another.

4.4.2.1.3 The owner or owner's representative shall verify that operators are trained and competent to operate the equipment under all conditions prior to their operation of such equipment.

4.4.2.1.4 The owner or owner's representative shall be responsible for retraining operators, including reviewing their competence, at intervals determined by the owner.

4.4.2.1.5 The training program and operating and maintenance manuals shall be kept current with changes in equipment and operating procedures and shall be available for reference and use at all times.

4.4.2.1.6 Operating procedures shall be directly applicable to the equipment involved and shall be consistent with safety requirements and the manufacturer's recommendations.

4.4.2.2 Maintenance Training.

4.4.2.2.1* The owner or owner's representative shall be responsible for establishing a formal and ongoing program that is consistent with the equipment and hazards involved, for training maintenance personnel to perform all required maintenance tasks.

4.4.2.2.2 Maintenance procedures and their associated training programs shall be established to cover routine and special techniques.

4.4.2.2.3 Environmental factors such as temperature, dusts, contaminated or oxygen-deficient atmospheres, internal pressures, and limited access or confined space requirements shall be included in the maintenance procedures.

4.4.2.2.4 Maintenance procedures shall be consistent with safety requirements and the manufacturer's recommendations and shall be kept current with changes in equipment and personnel.

4.5 Basic Operating Requirements.

4.5.1 Operating procedures with a minimum number of manual operations shall be established.

4.5.2 Standard operating procedures that result in well-defined and controlled operations shall be established.

4.5.3 Interlocks shall be provided to ensure correct operating sequences and to interrupt sequences when conditions are not correct for continuation.

4.5.4 No interlocks shall be bypassed during start-up or operation of the unit unless the bypass is tagged and is governed by operating procedures.

4.5.5 Purge and start-up procedures with necessary interlocks shall be established.

4.5.6 Written operating procedures and detailed checklists for operator guidance shall be provided for achieving all automatic and manual operating functions.

4.6 Equipment Requirements.

4.6.1* Structural Design. The furnace shall be capable of withstanding transient design pressures and normal operating pressures without permanent deformation due to yield or buckling of any support member. Transient pressures to be considered shall include but shall not necessarily be limited to misoperation of fans or dampers and a master fuel trip while operating at maximum design load. Refer to individual chapters for additional guidance.

4.6.2 Functional Requirements of Fuel-Burning System. See also Annex K.

4.6.2.1 Function. The fuel-burning system shall function to convert continuously any ignitable input into unreactive products of combustion at the same rate that the fuel(s) and air reactants enter the combustion chamber.

4.6.2.2 Compatibility. The fuel-burning system shall be sized to meet the operating requirements of the unit, compatible with other component systems, and capable of being controlled for the full operating range of the unit.

4.6.2.3 System Requirements.

4.6.2.3.1 The fuel-burning system shall provide means for start-up, operation, and shutdown of the combustion process, including openings and configurations in the component assemblies to allow observation, measurement, and control of the combustion process.

4.6.2.3.2 The fuel-burning system shall consist of the boiler or HRSG enclosure and the following subsystems, as applicable: air supplies, fuel supplies, main fuel burning, ignition, and combustion products removal and re-injection. Each shall be sized and interconnected to meet the requirements in 4.6.2.3.2.1 through 4.6.2.3.2.5.

4.6.2.3.2.1 The boiler enclosure or HRSG enclosure shall meet the requirements in 4.6.2.3.2.1(A) through 4.6.2.3.2.1(C).

(A) The enclosure shall be sized and arranged with respect to the main fuel-burning subsystem so that stable flame is maintained.

(B) The enclosure shall be free from “dead pockets” when prescribed purge procedures are followed.

(C) Observation ports shall be provided to allow visual inspection of the combustion chamber, igniter and burner flames (including the ignition zone), overfire air ports, re-burn injectors, and stoker grates.

4.6.2.3.2.2 The air supply subsystem shall meet the requirements in 4.6.2.3.2.2(A) through 4.6.2.3.2.2(D).

(A) The air supply equipment shall be sized and arranged to ensure a continuous airflow for all operating conditions on the unit.

(B)* The arrangement of air inlets, ductwork, and air preheaters shall be designed to minimize contamination of the air supply by flue gas, water, fuel(s), and other materials as a result of either intentional or accidental discharges.

(C) Drain and access openings shall be provided and shall be accessible.

(D) The air supply equipment shall be capable of continuing the required airflow during anticipated combustion chamber pressure pulsations.

4.6.2.3.2.3 Fuel supplies and main fuel-burning subsystems shall meet the applicable requirements in Chapters 5 through 10 for specific systems.

4.6.2.3.2.4* The ignition subsystem shall meet the requirements of 4.6.2.3.2.4(A) through 4.6.2.3.2.4(M).

(A) The ignition subsystem shall be sized and arranged to ignite the main burner input within the limitation of the igniter classification as follows:

- (1) It shall be verified through testing that the igniters furnished meet the requirements of the class specified in the design.
- (2) Igniters shall be designated as Class 1, Class 2, or Class 3 as defined in 3.3.84.1, 3.3.84.2, and 3.3.84.3 and as verified by test.

(B) Class 1 igniters shall be permitted to be used as Class 2 or Class 3 igniters. Class 2 igniters shall be permitted to be used as Class 3 igniters.

(C) Where Class 2 igniters are used, the burner shall be operated under controlled conditions to limit the potential for abnormal operation, as well as to limit the charge of fuel in the event that ignition does not occur during light-off.

(D) Class 2 igniters shall not be used to ignite the main fuel under uncontrolled or abnormal conditions.

(E) Where Class 3 igniters are used, the igniter shall be turned off as a part of the burner light-off procedure when the time trial for ignition of the main burner has expired, to ensure that the main flame is not dependent on ignition support from the igniter.

(F) Class 2 igniters shall not be used to extend the turndown range but shall be permitted to be used to support ignition under low-load or adverse operating conditions.

(G) Class 3 igniters shall not be used to support ignition or to extend the burner turndown range.

(H) Class 3 special igniters shall not be used unless supervision of the individual main burner flame is provided. Class 3 special igniters shall be permitted to be used without supervision of the individual main burner flame while the main burner is being scavenged.



(I)* Where Class 1 and Class 2 igniters are used, the tests described in 6.6.3.2.2, 6.7.3.2.2, and 6.8.3.2.2 shall also be performed with the ignition subsystem in service to verify that the igniters furnished meet the requirements of the class specified in the design.

(J) Tests shall be performed to determine transient limits in the ignition air and fuel supplies or in the main air and fuel supplies that do not extinguish the igniter flame or reduce the igniter's ability to perform its intended function or adversely affect other burners and igniters in operation.

(K) Igniters shall be permanently installed under the following conditions:

- (1) They shall be supervised to verify that the requirements of 4.6.2.3.2.4(A) and 4.6.2.3.2.4(B) are met.
- (2) This supervision shall include igniter capacity and individual igniter flame monitoring.
- (3) The capacity shall be measured by igniter header pressure as a minimum.
- (4) On single burner boilers, igniters shall not require supervision of igniter capacity.

(L) The ignition equipment shall be located in an environment free of excessive heat and accessible for maintenance.

(M) All igniter safety shutoff valves shall be located to minimize the volume of fuel that is downstream of the valve in the individual igniter fuel lines or that could flow by gravity into the combustion chamber after an emergency shutdown or a burner shutdown.

4.6.2.3.2.5 The combustion products removal subsystem shall meet the following requirements:

- (1) The flue gas ducts, fans, and stack shall be sized and arranged to remove the products of combustion at the same rate at which they are generated by the fuel-burning process during operation of the unit.
- (2) Drain and access openings shall be provided and shall be accessible.
- (3) The flue gas ducts shall be designed so that they do not contribute to combustion chamber pulsations.
- (4) Components common to more than one boiler or HRSG shall not limit the rate of removal of products of combustion generated during the operation of all boilers or HRSGs.
- (5) Boilers that share a common component between the furnace outlet and the stack shall have provisions to bypass the common component for unit purge.
- (6) Where the common component does not contain a possible ignition source, a bypass shall not be required.

4.6.2.3.3 Multiple Boilers.

4.6.2.3.3.1 Where multiple boilers are supplied from the same fuel supply source, there shall be a means of manual isolation for each boiler.

4.6.2.3.3.2 Dedicated safety shutoff valving, with related alarm, interlock, and control instrumentation, shall be provided for each boiler.

4.6.2.4 Gaseous Vent System Requirements.

4.6.2.4.1* The discharge from atmospheric vents shall be located so that there is no possibility of the discharged gas being drawn into a combustion air intake, ventilating system, or windows of the boiler or HRSG room or adjacent buildings and

shall be extended above the boiler or HRSG and adjacent structures so that gaseous discharge does not present a hazard.

4.6.2.4.2 Vent line sizes and vent valve port diameters shall not be less than the values shown in Table 4.6.2.4.2.

Table 4.6.2.4.2 Vent Sizes

Fuel Line Size		Minimum Vent Line Size	
NPS (in.)	DN (mm)	NPS (in.)	DN (mm)
≤1½	≤40	¾	20
2	50	1	25
2½ to 3	65 to 80	1¼	32
3½	90	1½	40
4 to 5	100 to 125	2	50
6	150	2½	65
7	175	3	80
8	200	3½	90
>8	>200	Vent internal cross-sectional area ≥15 % of the fuel line internal cross-sectional area	

4.6.2.4.3 The vent lines from individual burners shall be permitted to be manifolded together, and vent lines from individual igniters shall be permitted to be manifolded together.

4.6.2.4.3.1 Burner vents shall not be manifolded with igniter vents or lance vents in any combination.

4.6.2.4.3.2 Header vents shall be permitted to be manifolded with other header vents only where they are operated and tripped in parallel.

4.6.2.4.3.3 Vents of headers served from different pressure-reducing stations shall not be manifolded.

4.6.2.4.3.4 Vent systems of different boilers or HRSGs shall not be manifolded.

4.6.2.4.3.5 Vents of systems operating at different pressure levels shall not be manifolded.

4.6.2.4.3.6 Vents of systems using different fuel sources shall not be manifolded.

4.6.2.4.4 The cross-sectional area of the manifold line shall not be less than the greater of the following:

- (1) The cross-sectional area of the largest vent plus 50 percent of the sum of the cross-sectional areas of the additional vent lines
- (2) The sum of the cross-sectional areas of the two largest vent lines

4.6.2.5 Fuel Gas Piping Systems. Fuel gas piping material and system design shall be in accordance with NFPA 54, *National Fuel Gas Code* (for fuel gas piping inside industrial and institutional buildings), ASME B31.1, *Power Piping* (for fuel gas piping in power applications), or ASME B31.3, *Process Piping* (for fuel gas piping in process applications).

4.6.2.6 Fuel Oil Piping Systems. Fuel oil piping materials and system design shall be in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment* (for fuel oil piping inside industrial or institutional buildings), ASME B31.1, *Power Piping* (for fuel oil piping in power applications), or

ASME B31.3, *Process Piping* (for fuel oil piping in process applications).

4.6.3 Burner Management System Logic.

4.6.3.1 General Requirements.

4.6.3.1.1 The burner management system logic shall provide outputs in a particular sequence in response to external inputs and internal logic.

4.6.3.1.2 The logic system for burner management shall be designed specifically so that a single failure in that system does not prevent an appropriate shutdown.

4.6.3.2* Specific Requirements.

4.6.3.2.1 General. As a minimum, the requirements of 4.6.3.2.1 through 4.6.3.2.8 shall be included in the design to ensure that a logic system for burner management meets the intent of these requirements.

4.6.3.2.2* Alarms. Alarms shall be generated to indicate equipment malfunction, hazardous conditions, and misoperation.

4.6.3.2.3 Failure Effects. The logic system designer shall evaluate the failure modes of components, and as a minimum the following failures shall be evaluated and addressed:

- (1) Interruptions, excursions, dips, recoveries, transients, and partial losses of power
- (2) Memory corruption and losses
- (3) Information transfer corruption and losses
- (4) Inputs and outputs (fail-on, fail-off)
- (5) Signals that are unreadable or not being read
- (6) Failure to address errors
- (7) Processor faults
- (8) Relay coil failure
- (9) Relay contact failure (fail-on, fail-off)
- (10) Timer failure

4.6.3.2.4* Design. The design of the logic system for burner management shall include and accommodate the following requirements:

- (1) Diagnostics shall be included in the design to monitor processor logic function.
- (2) Logic system failure shall not preclude proper operator intervention.
- (3) Logic shall be protected from unauthorized changes.
- (4) Logic shall not be changed while the associated equipment is in operation.
- (5) System response time (throughput) shall be short to prevent negative effects on the application.
- (6) Protection from the effects of noise shall prevent false operation.
- (7) No single component failure within the logic system shall prevent a mandatory master fuel trip.
- (8) The operator shall be provided with a dedicated manual switch(es) that shall actuate the master fuel trip relay independently and directly.
- (9) At least one manual switch referenced in 4.6.3.2.4(8) shall be identified and located remotely where it can be reached in case of emergency.
- (10)*The logic system shall be monitored for failure.
- (11) Failure of the logic system shall require a fuel trip for all equipment supervised by the failed logic system.

4.6.3.2.5 Requirement for Independence.

4.6.3.2.5.1 The burner management system shall be provided with independent logic, independent logic solving hard-

ware, independent input/output systems, and independent power supplies and shall be a functionally and physically separate device from other logic systems.

4.6.3.2.5.2 For single burner boilers, boiler control systems shall be permitted to be combined with the burner management system under one of the following conditions:

- (1)*If the fuel/air ratio is controlled externally from the boiler control system
- (2) If the combined boiler control system and burner management system is specifically listed or labeled for the application

4.6.3.2.5.3 The burner management safety functions shall include, but shall not be limited to, purge interlocks and timing, mandatory safety shutdowns, trial timing for ignition, and flame monitoring.

4.6.3.2.5.4 The logic system shall be limited to one boiler or HRSG.

4.6.3.2.5.5 The same hardware type used for burner management systems shall be permitted to be used for other logic systems.

4.6.3.2.5.6 Data highway communications between the burner management system and other systems shall be permitted.

4.6.3.2.5.7 Signals that initiate mandatory master fuel trips shall be hard wired.

4.6.3.2.6 Momentary Closing of Fuel Valves.

4.6.3.2.6.1 Logic sequences or devices intended to cause a safety shutdown, once initiated, shall cause a burner or master fuel trip, as applicable, and shall require operator action prior to resuming operation of the affected burner(s).

4.6.3.2.6.2 No logic sequence or device shall be permitted that allows momentary closing and subsequent inadvertent re-opening of the main or ignition fuel valves.

4.6.3.2.7 Circuit Devices. No momentary contact or automatic resetting device, control, or switch that can cause chattering or cycling of the safety shutoff valves shall be installed in the wiring between the load side (terminal) of the primary or programming control and the main or ignition fuel valves.

4.6.3.2.8 Documentation. Documentation shall be provided to the owner and the operator, indicating that all safety devices and logic meet the requirements of the application.

4.6.4 Flame Monitoring and Tripping Systems. Additional requirements concerning flame detection associated with each type of steam generator covered by this code are given in the respective chapters.

4.6.4.1 Functional Requirements. The basic requirements of any flame monitoring and tripping system shall be as follows:

- (1) Combustion instability situations shall be brought to the attention of the operator for remedial action.
- (2) An emergency shutdown of the involved equipment shall be automatically initiated upon detection of serious combustion problems that will lead to the accumulation of unburned fuel.

4.6.4.2 Flame Detection.

4.6.4.2.1 Flame Detector Sighting.

4.6.4.2.1.1 Flame detector sighting shall be a factor in the initial design.



4.6.4.2.1.2 Field tests shall be required to establish optimum sighting angles of burners or nozzles and to check the effective angular range of flame detectors in relation to burners or nozzles.

4.6.4.2.2 Clean Air Supply. Clean air, where necessary, shall be supplied to minimize problems with dirty detector lenses.

4.6.4.2.3 Self-Checking of Flame Detectors. Where flame-sensing detectors can fail in the flame-proven mode, self-checking features shall be provided to ensure that the failure of any single component cannot result in a false indication of flame.

4.6.4.2.4* Reduced Emissions Control Effects.

4.6.4.2.4.1 Flame detector selection, sighting, and location shall be re-evaluated in accordance with 4.6.4.2 following implementation of methods or installation of equipment to reduce the emission of air pollutants.

4.6.4.2.4.2 When changes made to reduce the emission of air pollutants affect flame characteristics, main burners shall be tested for the limits of stable flame.

4.6.4.2.5 Flame Proving.

4.6.4.2.5.1 A flame detector shall not use any mechanical, electrical, or electronic means to force the flame detector into a "flame not detected" mode as part of the igniter and/or burner starting sequence.

4.6.4.2.5.2 A flame detector shall prove ignition of the associated fuel by proving "flame not detected" prior to introduction of that fuel to that igniter or burner and proving "flame detected" after introduction of that fuel to that igniter or burner.

4.6.4.2.5.3 An igniter flame detector shall not be required to prove "flame not detected" if the associated burner is proven in service and the associated igniter is out of service.

4.6.4.2.5.4 A burner flame detector shall not be required to prove "flame not detected" if an associated Class 1 igniter is proven in service.

4.6.4.2.5.5 The igniter flame detector(s) and/or the burner flame detector(s) shall not be required to prove "flame not detected" after the boiler load has been elevated to the point that it is no longer possible to achieve individual flame discrimination.

4.6.4.2.5.6 The boiler load specified in 4.6.4.2.5.5 shall be proven by test as the load level at which individual igniter and/or burner flame discrimination is no longer possible, but in no case shall be less than that for which tests show that complete combustion will occur.

4.6.4.3 System Objectives.

4.6.4.3.1 System objectives shall be developed that include those requirements that are specifically related to the combustion conditions typical for particular combustion chamber configurations, burner or firing systems, and fuel characteristics.

4.6.4.3.2 Such objectives shall be consistent with the individual manufacturer's design philosophy.

4.6.5* Combustion Control System.

4.6.5.1 Functional Requirements.

4.6.5.1.1 The combustion control system shall regulate the inputs into the combustion chamber to ensure continuous combustion and stable flame under all operating conditions.

4.6.5.1.2 Draft control, where applicable, shall be coordinated with the combustion control system.

4.6.5.1.3* On multiple burner boilers, equipment shall be provided and procedures shall be established to maintain the air-fuel ratio within design limits at each burner.

4.6.5.1.3.1 The equipment and procedures shall not be required to be a part of the combustion control system.

4.6.5.1.4 Boiler or HRSG control systems shall be permitted to be combined for more than one boiler or HRSG where separated from the burner management system.

4.6.5.2 System Requirements.

4.6.5.2.1* Except as noted in 4.6.5.2.2, under no circumstances shall the airflow demand be less than the purge rate.

4.6.5.2.2 For single burner boilers, airflow demand shall not be reduced below the low limit of the fuel-burning system as determined by the burner manufacturer and verified by operating test.

4.6.5.2.3 The fuel demand shall not increase the fuel input(s) above the available airflow.

4.6.5.2.4 Airflow demand shall not reduce airflow below that required by the actual fuel input(s).

4.6.5.2.5 The fuel demand shall not exceed the capability of the operating draft fans.

4.6.5.2.6 If the loss or shutdown of a draft fan causes the fuel demand to be greater than the capacity of the fans in service, the fuel(s) shall be rapidly reduced to a value that can be accommodated.

4.6.5.2.7 Measurements.

4.6.5.2.7.1 Measurements used in the combustion control system shall be accurate and reproducible to maintain stable firing conditions.

4.6.5.2.7.2 Pressure, temperature, density, and/or viscosity corrections shall be employed, as applicable, to meet the requirement of 4.6.5.2.7.1.

4.6.5.2.8 Where multiple fuels are fired, the fuel inputs shall be totalized on the basis of their relative heat values.

4.6.5.2.9 The total heat input to a given burner or combustion zone shall not exceed the maximum limits specified by the boiler or HRSG manufacturer.

4.6.5.2.10* Means shall be provided to enable the operator to adjust the air-fuel ratio for all boilers consistent with the fuel(s) being fired.

4.6.5.2.11 The equipment selection and the design of the combustion control system shall facilitate the on-line calibration, testing, and maintenance requirements described in 4.4.1.

4.6.5.2.12 The rate of increase of reburn fuel injection shall not exceed the response capability of the main combustion control system.

4.6.5.3 Additional Requirements.

4.6.5.3.1 Any logic commands from the burner management system shall take precedence over the combustion control system.

4.6.5.3.2 Where applicable, automatic control of airflow shall not be permitted unless the draft control is maintained in automatic control.

4.6.5.3.3* Automatic Control.

4.6.5.3.3.1 Automatic control of the fuel input(s) shall not be permitted unless the airflow is maintained in automatic control.

4.6.5.3.3.2 For HRSGs designed and operated in accordance with Chapter 8, automatic control of fuel inputs shall be permitted without automatic control of airflow.

4.6.5.3.4 The combustion control system shall neither automatically increase nor decrease a fuel input beyond the fuel-burning system's operating range as determined by the manufacturer and verified by operating test.

4.6.5.3.5 The combustion control system shall not reduce the fuel feed to a pulverizer below the minimum feed rate established by the pulverizer manufacturer for the manufacturer's specified design fuel.

4.6.5.3.5.1 For fuels with ignition characteristics different from those of the manufacturer's design fuel, the combustion control system shall not reduce the fuel feed rate below the value that ensures stable and self-sustaining combustion at the burners served by the pulverizer.

4.6.5.3.5.2 The minimum feed rate shall be determined by operational tests for fuels not conforming to the fuel specifications used by the manufacturer in the design of the pulverizer system.

4.6.6 Power Supplies. Precautions shall be taken to ensure the availability of a failure-free power supply (electric or pneumatic) to all control and safety devices.

4.6.7 Operating Information.

4.6.7.1 As a minimum, continuous trend display of steam flow, feed water flow rate, total fuel flow rate, and total airflow rate as a percentage of the maximum unit load, drum level, final steam temperature, main steam pressure, and furnace or combustion chamber draft shall be simultaneously available at the operating location.

4.6.7.1.1 For single burner package boilers, minimum continuous trend display shall include steam flow, airflow, drum level, steam pressure, and, where applicable, the furnace draft.

4.6.7.2 Alarms and indicators shall be grouped operationally and shall be visible to the operator to allow access to operational devices.

4.6.7.3 All emergency alarm indicators, push buttons, and selector switches shall be visible to the operator, labeled clearly, and protected to avoid inadvertent actuation.

4.6.7.4 All control functions shall be grouped for accessibility and in proximity to their associated alarm and indication devices.

4.6.7.5* Where video display units (VDUs) are used, data shall be displayed on monitor screens in a logical, operational grouping to minimize the number of keystroke operations needed to respond to system upsets.

4.6.7.6 Where VDUs are used, alarm functions shall be prioritized to appear on the monitor screen upon being sensed, regardless of any information already displayed.

4.6.8* Selective Catalytic Reduction.

4.6.8.1 Where selective catalytic reduction (SCR) systems are selected for NO_x emission control, they shall be integrated into the design of the boiler system, HRSG, or combustion turbine exhaust system to operate in the flue gas temperature range required.

4.6.8.2 Areas in which either anhydrous or aqueous ammonia is stored or piped shall be ventilated to preclude toxic or flammable concentration.

4.6.8.3 Areas in which anhydrous ammonia is stored or piped shall meet the requirements of ANSI K61.1, *Safety Requirements for the Storage and Handling of Anhydrous Ammonia*.

4.6.9* Flue Gas Path Auxiliary Systems — Fuel and Feedstock Piping. Positive means to prevent leakage of fuel or feedstock into an idle furnace or flue gas path shall be provided.

4.6.9.1 For gaseous fuels or feedstocks, provisions shall include a double block and vent valve arrangement on the fuel or feedstock supply, separate from any other double block and vent valve arrangements for other systems.

4.6.9.2 For gaseous fuels or feedstocks, a double block and vent valve arrangement shall be provided in the fuel or feedstock line associated with each flue gas path injection point.

4.6.9.3 For liquid or blown-in powder fuels or feedstocks, provisions shall include a double block valve arrangement on the fuel or feedstock supply, separate from any other double block valve arrangements for other systems.

Chapter 5 Single Burner Boilers

5.1 Application.

5.1.1 This chapter shall be used in conjunction with Chapters 1 through 4 and requires the coordination of operation procedures, control systems, interlocks, and structural design.

5.1.2 Where conflicts exist, the requirements of Chapter 5 shall apply.

5.1.3 All safety shutoff valves, safety interlock devices, valve-proving systems, and flame detection systems shall be listed or approved.

5.2 Purpose. The purpose of this chapter shall be to establish minimum requirements for the design, installation, operation, and maintenance of single burner boilers, their fuel-burning systems, and related systems to contribute to safe operation and, in particular, to the prevention of furnace explosions.

5.3 Equipment Requirements.

5.3.1 Fuel Supply — Oil.

5.3.1.1 Fuel shall be stored, prepared, and delivered to the oil service connection under anticipated operating conditions in accordance with the applicable portions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment*.

5.3.1.2 Operation of the burner shall not be attempted until a continuous fuel supply is assured.

5.3.1.3 Fuel shall be delivered continuously to the combustion chamber in a finely atomized form that can be ignited readily and consumed.



5.3.1.4 All equipment that is associated with pumping, heating, and straining the fuel from storage to the service connection shall be designed, sized, and interconnected so as to provide a suitable fuel supply over a full range of conditions.

5.3.1.5 Relief valves shall be installed after the pump to prevent overpressure in the system.

5.3.1.6 Fuel being burned shall be delivered to the burner at the temperature and pressure specified by the burner manufacturer.

5.3.1.7 Where the fuel must be heated, the interlocks and instruments shall reflect the correct values of the variable being measured, particularly in dead-end lines where heavy oil will tend to solidify.

5.3.1.8 Oil Supply.

5.3.1.8.1 The operation of a burner system that has the capability to burn heated and unheated oils shall include a procedure to ensure that the specified grade of oil, compatible with the selected mode of operation, is being supplied to the burner.

5.3.1.8.2 Precautions shall include the intended routing of recirculated oil.

5.3.1.9* Two safety shutoff valves in series, each with proof of closure switch, shall be provided in the oil line to the main burner.

5.3.1.10 Where pressure can develop in excess of the valve or piping rated pressure(s), the piping design shall include a means to prevent or relieve excess pressure between the valves.

5.3.1.11 Oil piping materials and system design shall be in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment* (for oil piping inside industrial or institutional buildings), ASME B31.1, *Power Piping* (for oil piping in power applications), or ASME B31.3, *Process Piping* (for oil piping in process applications).

5.3.2* Fuel Supply — Gas.

5.3.2.1 The gas supply at the gas service connection shall be controlled at the pressure for which the fuel-burning system had been designed.

5.3.2.2 Gas piping shall be sized to maintain the desired constant pressure for maximum burner flow.

5.3.2.3* Two safety shutoff valves in series, each with proof of closure switch, shall be provided in the fuel gas line to the main burner, and an automatic vent valve shall be provided between the two valves. When a listed automatic valve-proving system is used with two safety shutoff valves in series, each with a proof of closure switch, the automatic vent valve shall be permitted to be omitted.

5.3.2.3.1* Valve proving shall be performed either after every burner shutdown or prior to every burner light-off.

5.3.2.4 Foreign matter such as welding beads, chips, scale, dust, and debris shall be removed from the gas piping.

5.3.2.5 A drip leg shall be provided in the gas piping. (See A.5.3.2.3 and A.5.3.4.1.)

5.3.2.6 Gas piping material and system design shall be in accordance with NFPA 54, *National Fuel Gas Code* (for gas piping inside industrial and institutional buildings), ASME B31.1,

Power Piping (for gas piping in power applications), or ASME B31.3, *Process Piping* (for gas piping in process applications).

5.3.2.7 Valve Leakage Test.

5.3.2.7.1 Permanent means shall be provided for making valve leakage tests of the main burner gas safety shutoff valves.

5.3.2.7.2 Valve leakage tests of the main safety shutoff valves shall be conducted at least annually.

5.3.3 Alternate Fuel Firing.

5.3.3.1 Manual Fuel Selection. Where oil and gas are to be burned alternately, a manual fuel selector switch shall be provided to permit operation of the necessary interlocks, fuel safety shutoff valves, and controls for the fuel to be fired.

5.3.3.2 Automatic Fuel Selection.

5.3.3.2.1 Where oil and gas are to be burned alternately, an automatic change from one fuel to the other shall be accomplished only after a shutdown.

5.3.3.2.2 Provisions for manual changeover of the system shall be provided in accordance with 5.3.3.1 and Section 5.7.

5.3.3.2.3 For simultaneous firing of oil and gas fuels, Section 5.6 shall apply.

5.3.4 Fuel-Burning Equipment.

5.3.4.1* Ignition.

5.3.4.1.1 The main burner shall be equipped with a permanently installed igniter.

5.3.4.1.1.1 Class 1 Igniter.

(A) Where a Class 1 igniter is used, the main burner flame shall be proven by a flame detector.

(B) Either the main flame or the igniter flame shall be proven.

5.3.4.1.1.2 Class 2 Igniter.

(A) Where a Class 2 igniter is used, it shall not be used to ignite main fuel under uncontrolled or abnormal conditions.

(B) The burner shall be operated under controlled conditions to limit the potential for abnormal operation as well as to limit the charge of fuel to the furnace in the event that ignition does not occur during light-off.

(C) If the Class 2 igniter is not shut down once the main flame sequence is successfully completed, then the main burner flame shall be proven by a flame scanner independently of the igniter.

5.3.4.1.1.3 Class 3 Igniter.

(A)* Where a Class 3 igniter is used, the igniter shall be shut down as part of the burner light-off procedure when the time trial for ignition of the main burner has expired.

(B) The use of such igniters to support ignition or to extend the burner control range shall be prohibited.

(C) The main flame shall be proven by a flame scanner.

5.3.4.1.1.4 Class 3 Special Igniter. Where a Class 3 special igniter is used, the main burner flame shall be proven by a flame scanner.

5.3.4.1.2 The igniter flame or arc shall impinge on the main burner air-fuel mixture and shall supply sufficient ignition

energy to provide immediate ignition of all fuel discharge from the main burner under light-off conditions.

5.3.4.1.3* Igniter Safety Shutoff Valves. Two safety shutoff valves in series shall be provided in the fuel gas line to the igniter, and an automatic vent valve shall be provided between the two valves. When a listed automatic valve-proving system is used with two safety shutoff valves in series, the automatic vent valve shall be permitted to be omitted. (See Figure A.5.3.4.1.)

5.3.4.1.3.1* Valve-proving shall be performed either after every burner shutdown or prior to every burner light-off.

5.3.4.1.4 The igniter shall be designed for periodic removal, cleaning, and maintenance.

5.3.4.2 Main Burner.

5.3.4.2.1 The main burner shall direct the fuel and air into the furnace so as to provide a stable flame and efficient combustion over its entire operating range.

5.3.4.2.2 The limits of stable flame for the burner shall be determined by tests.

5.3.4.2.2.1 These tests shall be performed without the igniter in service and shall include the intended range and grade of fuel(s).

5.3.4.2.2.2* The tests shall verify that transients that are generated in the fuel and air systems do not adversely affect burner operation.

5.3.4.2.3 Each manual adjustment feature on the burner shall be provided with means for securing it in its intended position.

5.3.4.2.4 The atomizing equipment for oil burners shall be designed for periodic removal, cleaning, and maintenance.

5.3.4.2.5 Any procedure for clearing the atomizer and piping into the furnace prior to shutdown shall be accomplished while the fan is operating and the igniter is re-established or the main flame is proven continuously during this operation.

5.3.4.2.6 Clearing of the oil passages of the atomizer into the furnace immediately after a shutdown shall be prohibited.

5.3.4.3 Atomizing Medium for Oil Burners.

5.3.4.3.1 Where the fuel is to be atomized with the assistance of another medium, this atomizing medium shall be supplied free of contaminants that could cause an interruption of service.

5.3.4.3.2 The atomizing medium shall be provided at the pressure and temperature specified by the burner manufacturer.

5.3.4.3.3 Provisions shall be made to ensure that fuel cannot enter the atomizing medium line during or after operation.

5.3.4.4 Combustion Air Supply.

5.3.4.4.1 The combustion air supply equipment shall be capable of supplying combustion air for the optimum air-fuel ratio over the entire operating range of the burner.

5.3.4.4.2 Provisions shall be made for periodic cleaning of the combustion air supply equipment.

5.3.4.4.3 The requirements for the availability of combustion air shall be determined from NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, and NFPA 54, *National Fuel Gas Code*.

5.3.4.4.3.1 Louvers and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically or manually during equipment operation. The interlock shall be placed on the driven member.

5.3.4.4.3.2 Fans supplying air to the boiler room for combustion shall be interlocked with the burner so that airflow is proven during equipment operation.

5.3.4.5 Furnace. The furnace shall be designed to promote main burner stability while minimizing zones that cannot be purged.

5.3.4.6 Combustion Products Removal.

5.3.4.6.1* The outlet draft equipment shall be capable of removing combustion products without adversely affecting stable flame conditions.

5.3.4.6.2 Where two or more boilers are connected to a common stack, each connection shall be equipped with a damper system.

5.3.4.6.2.1 All boiler outlet dampers shall be equipped with accessible operating and locking devices.

5.3.4.6.2.2 This equipment shall be compatible with the combustion control system of the boiler.

5.3.4.6.2.3 Interlocks shall be provided to prevent firing against a closed damper.

5.3.4.6.2.4 Provisions shall be made to prevent rendering the interlock nonfunctional by one of the following means if the linkage becomes disconnected:

- (1) Placing the interlock on the driven member
- (2) Utilizing a furnace pressure switch
- (3) Other approved means

5.3.4.6.2.5 Dampers shall not be required on the outlet of boilers of a type in which maintenance operations are performed from outside the boiler.

5.3.5* Combustion Control System.

5.3.5.1 The combustion control system shall be installed in accordance with the requirements of 4.6.5.1.

5.3.5.2 The combustion control system shall maintain air-fuel mixtures at pre-established ratios throughout the operating range of the burner and during changes in the firing rate.

5.3.5.3* The system shall provide limits on fuel and air to prevent reducing furnace input below the point of stable burner operation.

5.3.5.4 The minimum and maximum points of stable burner operation shall be defined by the burner manufacturer and verified by operational tests.

5.3.6 Interlock System.

5.3.6.1 The system shall be equipped with a method of determining the operating state of each interlock without disassembling any of the interlock devices.

5.3.6.2 Each interlock shall be provided with a method of establishing the set point.

5.3.6.3 Interlock devices shall be designed for anticipated environmental conditions, such as temperature, humidity, vibration, and corrosive agents.



5.3.6.4 Bypass.

5.3.6.4.1 The interlocks on the low water cutouts shall be permitted to be bypassed for blowdown purposes only.

5.3.6.4.2 The bypass of 5.3.6.4.1 shall be of a type that is temporarily held during blowdown.

5.3.6.4.3 Interlocks shall not be bypassed manually at any time during normal operation.

5.3.6.4.3.1 Interlocks shall be permitted to be bypassed as allowed by 5.3.6.4, 5.4.3.2.1 (4), and 5.4.3.3.1 (4).

5.3.6.5* Each safety control ac circuit shall be two wires, one side grounded, and shall be protected with a suitable fuse or circuit breaker in the hot side only.

5.3.6.6 Safety Control dc Circuits.

5.3.6.6.1 Safety control dc circuits shall be arranged as called for in 5.3.6.5 where grounding is possible.

5.3.6.6.2 Where grounding is not possible and the circuit voltage exceeds 50 volts, the circuit shall have switching contacts in one side of the line and shall be provided with ground-fault circuit interrupters.

5.3.7 Flame Safety Shutdown System.

5.3.7.1 The response time from flame failure to de-energization of the safety shutoff valves shall not exceed 4 seconds.

5.3.7.2 The response time from de-energization of the safety shutoff valves to full closure shall not exceed 1 second.

5.3.7.3 Where flame-sensing detectors can fail in the flame-proven mode, self-checking features shall be provided unless the burner is operated for periods less than 24 hours and the burner management system includes a safe-start component checking feature.

5.3.7.4 A safe-start component checking feature shall include a circuit incorporated in the burner management system that prevents light-off if the flame-sensing relay is in the flame-present position due to component failure or due to the presence of actual or simulated flame.

5.3.8 Electrical Equipment.

5.3.8.1* All electrical equipment and wiring shall conform to NFPA 70, *National Electrical Code*.

5.3.8.2 Special fuels or applications could require components for hazardous location and shall be reviewed during the design of the system.

5.3.9* Gas and Oil Firing: Special Problems. Systems installed or designed to reduce NO_x emissions shall be evaluated to ensure that the performance of flame safety and combustion control systems are not impaired.

5.4 Starting of a Cold Boiler.

5.4.1 General.

5.4.1.1 Starting of a cold boiler shall be accomplished in conformance with the manufacturer's recommendations.

5.4.1.2 In no case shall a boiler that has been taken out of service for maintenance, repair, or extended shutdown be started from a cold condition without a trained operator present.

5.4.1.3 Start-Up Procedures.

5.4.1.3.1 Applicable start-up procedures for the provided boiler shall be followed.

5.4.1.3.2 The firing rate shall be limited in accordance with the boiler manufacturer's instructions.

5.4.2 Gas-Fired Boilers. The procedures of Section 5.5 shall be followed for starting a cold gas-fired boiler.

5.4.3 Oil-Fired Burners. When steam is not available for heating oil, as an atomizing medium, or for driving auxiliary equipment, one of the starting methods described in 5.4.3.1, 5.4.3.2, or 5.4.3.3 shall be used.

5.4.3.1 Auxiliary Air Atomizing of Oil. When auxiliary air atomizing of oil is used for a cold start-up, all the equipment, facilities, and procedures listed in 5.4.3.1.1, 5.4.3.1.2, and 5.4.3.1.3 shall be required.

5.4.3.1.1 Required Equipment. The following equipment shall be required:

- (1) Forced draft (FD) fan
- (2) Approved auxiliary oil heater for start-up fuel flow with a capacity not less than that required for minimum fire with stable flame (only for fuel oils that require heating)
- (3) Check valves in steam and air lines to the atomizer

5.4.3.1.2* Required Facility. An alternate atomizing air supply shall be required.

5.4.3.1.3 Starting Procedure. The following procedural steps shall be followed:

- (1) Circulate and heat oil, using auxiliary heater and recirculating system, to satisfy all interlocks, where included.
- (2) Follow the prefiring and light-off cycles as described in Section 5.5, using air as the atomizing medium.
- (3) Set combustion control at the light-off firing rate.
- (4) When steam pressure has reached the point required for heating and atomizing the oil, shut down in accordance with the normal shutdown procedure described in Section 5.5.
- (5) Close the atomizing air supply and open the atomizing steam supply, making certain that dry steam is available.
- (6) Change over from auxiliary oil heater to steam oil heater.
- (7) Continue the boiler start-up sequence.

5.4.3.2 Auxiliary Mechanical Atomizing of Heavy Oil. When auxiliary mechanical atomizing of heavy oil is used for a cold start-up, all the equipment, facilities, and procedures in 5.4.3.2.1 and 5.4.3.2.2 shall be required.

5.4.3.2.1 Required Equipment. The following equipment and facilities shall be required:

- (1) FD fan.
- (2) Approved auxiliary oil heater for start-up fuel flow with a capacity not less than that required for minimum fire with stable flame.
- (3) Mechanical atomizer.
- (4) Means to bypass atomizing medium interlocks. The bypassed interlocks shall be made evident to the operator by means of warning devices.

5.4.3.2.2 Starting Procedure. The following procedural steps shall be followed:

- (1) Circulate and heat oil using auxiliary heater and recirculating systems to satisfy oil interlocks, where included.
- (2) Bypass atomizing medium interlocks. [See 5.4.3.2.1(4).]

- (3) Insert mechanical atomizer.
- (4) Follow the prefiring and light-off cycles as described in Section 5.5.
- (5) Set combustion control at the light-off firing rate.
- (6) When steam pressure has reached the point required for heating and atomizing the oil, shut down in accordance with the normal shutdown procedure as described in Section 5.5.
- (7) Remove the mechanical atomizer.
- (8) Insert the steam atomizer.
- (9) Make the atomizing medium interlocks operable and place into service.
- (10) Change over from auxiliary oil heater to steam oil heater.
- (11) Continue the boiler start-up sequence.

5.4.3.3 Auxiliary Mechanical Atomizing of Light (Unheated) Oil. When auxiliary mechanical atomizing of light (unheated) oil is used for a cold start-up, all the equipment, facilities, and procedures in 5.4.3.3.1 through 5.4.3.3.3 shall be required.

5.4.3.3.1 Required Equipment. The following equipment shall be required:

- (1) FD fan.
- (2) Mechanical atomizer.
- (3) Check valves in the heavy and light oil lines.
- (4) Means to bypass atomizing medium interlocks. The bypassed interlocks shall be made evident to the operator by means of warning devices.

5.4.3.3.2 Required Facility. A light oil supply shall be required.

5.4.3.3.3 Starting Procedure. The following procedural steps shall be followed:

- (1) Shut off heavy oil to the system.
- (2) Insert the mechanical atomizer.
- (3) Bypass oil and atomizing medium interlocks. [See 5.4.3.3.1(4).]
- (4) Open the light oil supply into the system.
- (5) Follow prefiring and light-off cycles described in Section 5.5.
- (6) Set combustion control at the light-off rate.
- (7) When steam pressure has reached the point required for heating and atomizing the oil, shut down in accordance with the normal shutdown procedure as described in Section 5.5.
- (8) Shut off the light oil supply to the system.
- (9) Remove the mechanical atomizer.
- (10) Insert the steam atomizer.
- (11) Make the oil and atomizing medium interlocks operable by removing bypasses.
- (12) Open the heavy oil supply to the system.
- (13) Continue the boiler start-up sequence.

5.5 Operating Systems.

5.5.1* General. This section shall be used to define requirements for automatic recycling and automatic nonrecycling operating systems.

5.5.1.1 Manual systems shall not be installed for new installations or major alterations.

5.5.1.2 Different arrangements shall be permitted if they provide protection and meet the intent of this code. (See Figure A.5.3.1.9, Figure A.5.3.2.3, and Figure A.5.3.4.1 for typical arrangements.)

5.5.2 Automatic (Recycling) Systems for Watertube Boilers.

5.5.2.1 An automatic (i.e., recycling) unit shall not be started from a cold condition unless a trained operator is present.

5.5.2.2 This section shall be based on the premise that the unit is hot and that steam pressure and operating water level shall have been established.

5.5.2.3 The fuel to be fired shall have been manually selected.

5.5.2.4 The alternate fuel system shall be placed in a nonfiring condition, and the manual burner valve(s) shall be closed.

5.5.2.5 An igniter as specified in 5.3.4.1.1 shall be provided.

5.5.2.6 An automatic (i.e., recycling) unit shall recycle on high steam pressure, high water temperature, or low water level (not determined by the auxiliary low water cutout) and perform four major functions as follows:

- (1) Prefiring cycle
- (2) Light-off cycle
- (3) Modulation, where provided
- (4) Shutdown cycle

5.5.2.6.1 Prefiring Cycle. The prefiring cycle shall accomplish the following steps in the listed order, and the order of steps (5), (6), and (7) in the sequence shall be permitted to vary:

- (1) Prove the main fuel safety shutoff valves are closed.
- (2) Prove no flame is present at the burner.
- (3) Start the fan.
- (4) Satisfy the fan interlock.
- (5) Where an atomizing medium is used and if not already on, admit medium to main burner.
- (6) Where an atomizing medium is used, satisfy the atomizing medium interlocks.
- (7) Satisfy fuel interlocks.
- (8) Prove the purge airflow by satisfying one of the following items:
 - (a) Air pressure and "open damper" interlocks for all dampers in the flow path
 - (b) Airflow interlock
- (9) Purge airflow must reach no less than 70 percent of the airflow required at maximum continuous capacity of the unit.
- (10) The purge must be for at least eight air changes. Airflow during the period of opening the damper and returning it to light-off position is permitted to be included in computing the time for eight air changes.
- (11) Set controls to light-off position.
- (12) Prove the dampers and fuel control valve are in light-off position.
- (13) If a flue gas recirculation system is supplied, then it shall be purged per the manufacturer's instructions.

5.5.2.6.2 Light-Off Cycle — Class 3 Igniter. The light-off cycle for a burner with a Class 3 igniter shall accomplish the following in the listed order:

- (1)*Energize the ignition transformer and igniter fuel valves.
- (2) Prove igniter flame within 10 seconds of the energization of the igniter fuel valves; for a Class 3 special igniter, proof of igniter operation is not required.
 - (a) If proven, admit fuel to main burner. For an oil burner other than a return flow type, simultaneously shut off oil-recirculating flow.
 - (b) If not proven, establish safety shutdown.



- (3) After a maximum of 10 seconds for gas and Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils, shut off igniter.
- (4) Prove main flame (*see 5.3.4.1.1.3 and 5.3.4.1.1.4*) and proceed as follows:
 - (a) If proven, release to modulating control where provided.
 - (b) If not proven, establish safety shutdown.

5.5.2.6.3 Light-Off Cycle — Class 2 Igniter. The light-off cycle for a burner with a Class 2 igniter shall accomplish the following in the listed order:

- (1)*Energize the ignition transformer and igniter fuel valves.
- (2) Prove igniter flame within 10 seconds of the energization of the igniter fuel valves and proceed as follows:
 - (a) If proven, admit fuel to the main burner. For an oil burner other than a return flow type, simultaneously shut off the recirculating flow.
 - (b) If not proven, establish safety shutdown.
- (3) After a maximum of 10 seconds for gas and Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils, prove the main flame (*see 5.3.4.1.1.2*) and proceed as follows:
 - (a) If proven, release to combustion control for modulation, where provided.
 - (b) If not proven, establish safety shutdown.

5.5.2.6.4 Light-Off Cycle — Class 1 Igniter. The light-off cycle for a burner with a Class 1 igniter shall accomplish the following in the listed order:

- (1)*Energize the ignition transformer and igniter fuel valves.
- (2) Prove igniter flame within 10 seconds of the energization of the igniter fuel valves and proceed as follows:
 - (a) If proven, admit fuel to the main burner. For an oil burner other than a return flow type, simultaneously shut off recirculating flow.
 - (b) If not proven, establish safety shutdown.
- (3) After a maximum of 10 seconds for gas and Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils, prove the main flame (*see 5.3.4.1.1.1*) and proceed as follows:
 - (a) If proven, release to combustion control for modulation, where provided.
 - (b) If not proven, establish safety shutdown.

5.5.2.6.5 Modulation. Modulation, where provided, shall be accomplished by a combustion control system.

5.5.2.6.6 Normal Shutdown Cycle. The normal shutdown cycle shall accomplish the following in the listed order:

- (1) Shut off the fuel supply to the main burner.
- (2) For oil, proceed as follows:
 - (a) If a Class 1 igniter is used, use the manufacturer's instructions to purge the main burner oil gun prior to continuing the normal shutdown.
 - (b) Where used, open the recirculating valve.
 - (c) Shut off atomizing medium, if required by operating procedures.
- (3) Shut off the fuel supply to the igniter if in operation.
- (4) Perform a postpurge of the furnace and boiler gas passes; the duration of the postpurge must be no less than 15 seconds at an airflow rate not exceeding that at which the unit was shut down.
- (5) Shut down the fan, if required by operating procedures.

5.5.2.6.7 Normal Shutdown. For automatic (i.e., recycling) boilers, high steam pressure, high water temperature, or low

water level (not determined by the auxiliary low water cutout) shall accomplish a normal shutdown, and the burner shall be allowed to recycle when steam pressure, water temperature, or water level has returned to within the preset operating range.

5.5.2.6.8 Safety Shutdown Cycle. The safety shutdown cycle shall accomplish the following in the listed order and shall activate an alarm:

- (1) Shut off the fuel supply to the main burner.
- (2) Shut off the fuel supply and interrupt spark to the igniter if in operation.
- (3) For oil, proceed as follows:
 - (a) Where used, open the recirculating valve.
 - (b) Where used, shut off the atomizing medium, if required by operating procedures.
- (4) Where the inerting system is used, energize it simultaneously with 5.5.2.6.8(1).
- (5) Perform a postpurge of the furnace and boiler gas passes. The duration of the postpurge must be no less than 15 seconds at an airflow rate not exceeding that at which the unit was shut down.
- (6) After postpurge, shut down the fan, if desired.
- (7) Require manual reset.

5.5.2.6.9* Safety Shutdown. Any of the conditions in 5.5.2.6.9.1 or 5.5.2.6.9.2 shall accomplish a safety shutdown, and the burner shall not be allowed to recycle until a trained operator determines the cause of the shutdown and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting.

5.5.2.6.9.1 Oil conditions shall include the following:

- (1) Low fuel pressure
- (2) Low temperature of heated oils
- (3) Loss of combustion air supply
- (4) Loss of or failure to establish flame
- (5) Loss of control system actuating energy
- (6) Power failure
- (7) Low water level as determined by the auxiliary low water cutout
- (8) Loss of atomizing medium, where used, as interlocked by flow or two pressure switches (one located at the service connection and the other at the burner, either one of which shall initiate a safety shutdown on low pressure)
- (9) Excessive steam pressure or water temperature
- (10) High temperature of heated oil

5.5.2.6.9.2 Gas conditions shall include the following:

- (1) High gas pressure
- (2) Low gas pressure
- (3) Loss of combustion air supply
- (4) Loss of or failure to establish flame
- (5) Loss of control system actuating energy
- (6) Power failure
- (7) Low water level as determined by the auxiliary low water cutout
- (8) Excessive steam pressure or water temperature

5.5.3 Automatic (Nonrecycling) Systems for Watertube Boilers.

5.5.3.1 The provisions of 5.5.2.1, 5.5.2.3, 5.5.2.5, and 5.5.2.6 shall apply.

5.5.3.2 The provisions of 5.5.2.6.7 shall not apply.

5.5.3.3 When high steam pressure, high water temperature, or low water level establishes a normal shutdown, the burner shall not be allowed to recycle.

5.5.3.4 A trained operator shall initiate the restart.

5.5.4 Automatic (Recycling) Systems for Firetube Boilers.

5.5.4.1 This section shall be based on the premise that the equipment is in accordance with Section 5.3, that the boiler has been placed in service in accordance with Section 5.5, and that the operating water level has been established.

5.5.4.2 An automatic (i.e., recycling) unit shall recycle on high steam pressure, high water temperature, or low water level (not determined by the auxiliary low water cutout) and perform four major functions as follows:

- (1) Prefiring cycle
- (2) Light-off cycle
- (3) Modulation, where provided
- (4) Shutdown cycle

5.5.4.2.1 Prefiring Cycle. The prefiring cycle shall accomplish the following steps in the listed order, and the order of steps (5), (6), and (7) in the sequence shall be permitted to vary:

- (1) Prove the fuel safety shutoff valves are closed.
- (2) Prove no flame is present at burner.
- (3) Start the fan.
- (4) Satisfy the fan interlock.
- (5) Where an atomizing medium is used, and if not already on, admit the medium to the main burner.
- (6) Where an atomizing medium is used, satisfy the atomizing medium interlocks.
- (7) Satisfy the fuel interlocks.
- (8) Prove purge airflow by satisfying one of the following two items:
 - (a) Air pressure and "open damper" interlocks for all dampers in the flow path
 - (b) Airflow interlock
- (9) Purge airflow must reach no less than 70 percent of the airflow required at maximum continuous capacity of the unit.
- (10) The purge of the furnace and boiler gas passes must be for at least four air changes and under the following conditions:
 - (a) During the purge, the air damper must be driven to the full open position.
 - (b) Airflow during the time to open the damper and return it to light-off position is permitted to be included in computing the time for four air changes.
- (11) Prove the control system is in light-off position.
- (12) If a flue gas recirculation system is supplied, then it shall be purged per the manufacturer's instructions.

5.5.4.2.2 Light-Off Cycle. The light-off cycle shall accomplish the following in the listed order:

- (1)*Energize the ignition transformer and igniter fuel valves.
- (2) Prove the igniter flame within 10 seconds of the energization of the igniter fuel valves and proceed as follows (for a Class 3 special igniter, proof of igniter operation is not required):
 - (a) If proven, admit fuel to main burner.
 - (b) If not proven, establish safety shutdown.
- (3) After a maximum of 10 seconds for gas and Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils, shut off the igniter.
- (4) Prove the main flame and proceed as follows:

- (a) If proven, release to modulating control where provided.
- (b) If not proven, establish safety shutdown.

5.5.4.2.3 Modulation. Modulation, where provided, shall be accomplished by a combustion control system.

5.5.4.2.4 Normal Shutdown. High steam pressure, high water temperature, or low water (not determined by the auxiliary low water cutoff) shall accomplish a normal shutdown, and the burner shall be allowed to recycle when steam pressure, water temperature, or water level has returned to within the preset operating range.

5.5.4.2.5 Normal Shutdown Cycle. The normal shutdown cycle shall accomplish the following in the listed order:

- (1) Shut off the fuel supply to the main burner.
- (2) For oil, proceed as follows:
 - (a) Where used, open the recirculating valve.
 - (b) Where the manufacturer's instructions permit, purging the main burner oil gun in conjunction with the operation of its igniter is permitted.
 - (c) Where used, shut off the atomizing medium, if required by operating procedures.
- (3) Perform a postpurge of the furnace and boiler gas passes. The duration of the postpurge must be no less than 15 seconds at an airflow rate not exceeding that at which the unit was shut down.
- (4) After postpurge, shut down the fan, if required by operating procedures.

5.5.4.2.6 Safety Shutdown Cycle. The safety shutdown cycle shall accomplish the following in the listed order:

- (1) Shut off the fuel supply to the main burner.
- (2) Shut off the fuel supply and interrupt the spark to the igniter, if in operation.
- (3) For oil, proceed as follows:
 - (a) Where used, open the recirculating valve.
 - (b) Where used, shut off the atomizing medium, if required by operating procedures.
- (4) Where the inerting system is used, energize it simultaneously with 5.5.4.2.6(1).
- (5) Perform a postpurge of the furnace and boiler gas passes. The duration of the postpurge must be no less than 15 seconds at an airflow rate not exceeding that at which the unit was shut down.
- (6) After postpurge, shut down the fan, if required by operating procedures.
- (7) Require manual reset.

5.5.4.2.7* Safety Shutdown. Any of the conditions in 5.5.4.2.7.1 or 5.5.4.2.7.2 shall accomplish a safety shutdown, and the burner shall not be allowed to recycle until a trained operator determines the cause of the shutdown and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting.

5.5.4.2.7.1 Oil conditions shall include the following:

- (1) Low oil pressure
- (2) Low temperature of heated oils
- (3) Loss of combustion air supply
- (4) Loss of or failure to establish flame
- (5) Loss of control system actuating energy
- (6) Low water level as determined by the auxiliary low water cutout
- (7) Loss of atomizing medium where used
- (8) Excessive steam pressure or water temperature



- (9) Power failure
- (10) High temperature of heated oil

5.5.4.2.7.2 Gas conditions shall include the following:

- (1) High gas pressure
- (2) Low gas pressure
- (3) Loss of combustion air supply
- (4) Loss of or failure to establish flame
- (5) Loss of control system actuating energy
- (6) Low water level as determined by the auxiliary low water cutout
- (7) Excessive steam pressure or water temperature
- (8) Power failure

5.5.5 Automatic (Nonrecycling) Systems for Firetube Boilers.

5.5.5.1 The provisions of 5.5.4.1 and 5.5.4.2 shall apply, except that 5.5.4.2.4 shall not apply.

5.5.5.2 When high steam pressure, high water temperature, or low water level establishes a normal shutdown, the burner shall not be allowed to recycle.

5.5.5.3 A trained operator shall initiate the restart.

5.5.6 Supervised Manual Systems for Oil-Fired Watertube Boilers.

5.5.6.1 The steps listed in Table 5.5.6.1(a), Table 5.5.6.1(b), Table 5.5.6.1(c), and Table 5.5.6.1(d) shall be taken by a trained operator when starting a supervised manual unit, and the indicated interlocks shall be satisfied at each step.

5.5.6.1.1 Fuel pressure and temperature, atomizing medium, control system energy, power, and water level shall have been established.

5.5.6.1.2 When interlocks have been satisfied, this fact shall be indicated to the operator.

5.5.6.2 The fuel to be fired shall be selected.

5.5.6.2.1 The alternate fuel system shall be placed in a non-firing condition.

5.5.6.2.2 The supervisory or safety shutoff valve(s) shall be closed.

5.5.6.3 An igniter as specified in 5.3.4.1.1 shall be provided.

5.5.6.4* Any of the following conditions shall accomplish a safety shutdown, and the burner shall not be restarted until a trained operator goes out to the boiler, determines the cause of the shutdown, and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting:

- (1) Low pressure in the fuel supply
- (2) Loss of combustion air supply
- (3) Loss or failure to establish flame
- (4) Loss of control system actuating energy
- (5) Power failure
- (6) Low water level as determined by the auxiliary low water cutout
- (7) Loss of atomizing medium
- (8) Excessive steam pressure or water temperature

5.5.6.5 Either of the following conditions, where oil heating is provided, shall cause alarms to sound:

- (1) Low oil temperature
- (2) High oil temperature

5.5.7 Supervised Manual Systems for Gas-Fired Watertube Boilers.

5.5.7.1 The steps listed in Table 5.5.7.1(a), Table 5.5.7.1(b), Table 5.5.7.1(c), and Table 5.5.7.1(d) shall be taken by a trained operator when starting a supervised manual unit, and the indicated interlocks shall be satisfied at each step.

5.5.7.1.1 Control system energy, power, and water level shall have been established.

Table 5.5.6.1(a) Prefiring Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Check that fuel safety or supervisory shutoff valve is closed.	(1) Fuel safety or supervisory shutoff valve is closed.
(2) Start fan.	(2) Fan is on.
(3) Where used, open atomizing medium valve.	(3) Atomizing medium supply is available.
(4) Open damper(s) to purge position.	(4) (a) Air pressure and open damper(s) or (b) airflow. [See 5.5.2.6.1(9) and 5.5.2.6.1(10).]
(5) Start purge timer.	(5) Purge is complete.
(6) Place damper and fuel control valve in light-off position.	(6) Damper and fuel control valve are in light-off position. If light-off airflow is less than purge airflow rate, start light-off time limit timer.
(7) None.	(7) Spark, igniter, and main safety shutoff valves are ready for operation.

Table 5.5.6.1(b) Light-Off Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Energize ignition transformer and igniter safety shutoff valves.	(1) Prove igniter flame within 10 seconds of energization of igniter fuel valves. (For Class 3 special igniter, proof of igniter operation is not required.)
(2) Open fuel safety shutoff valve to main burner.	(2) None.
(3) Close recirculating valve, where used.	(3) None.
(4) Open manual fuel shutoff valve.	(4) Prove main flame within 10 seconds for Nos. 2 and 4 oils or 15 seconds for Nos. 5 and 6 oils. Close igniter safety shutoff valve(s).
(5) Bring unit to present operating pressure at rate specified by manufacturer, maintaining air-fuel ratios as established by tests.	(5) None.
(6) On reaching preset pressure range, change to automatic combustion control.	(6) None.

Table 5.5.6.1(c) Normal Shutdown Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Shut off fuel supply to main burner.	(1) Fuel safety shutoff valve(s) to main burner is closed.
(2) Open fuel recirculating valve, where used.	(2) None.
(3) Where used, shut off atomizing medium.	(3) None.
(4) Remove fuel atomizer.	(4) None.
(5) Perform postpurge of furnace and boiler gas passes. Duration of postpurge must be no less than 15 seconds at airflow rate not exceeding that at which unit was shut down.	(5) None.
(6) After postpurge, fan can be permitted to be shut down.	(6) None.

Table 5.5.6.1(d) Safety Shutdown Cycle (in listed order)

Operator Functions	Interlock Functions
(1) None.	(1) Shut off fuel supply to main burner; shut off fuel supply and interrupt spark to igniter, if in operation.
(2) Perform postpurge of furnace and boiler gas passes. Duration of postpurge must be no less than 15 seconds at airflow rate not exceeding that at which unit was shut down.	(2) None.
(3) After postpurge, fan can be permitted to be shut down.	(3) None.



Table 5.5.7.1(a) Prefiring Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Check that gas safety shutoff valves are closed.	(1) Gas safety shutoff valves are closed.
(2) Start fan.	(2) Fan motor is on.
(3) Open damper(s) to purge position.	(3) (a) Air pressure and open damper(s) or (b) airflow. [See 5.5.2.6.1(9) and 5.5.2.6.1(10).]
(4) Start purge timer.	(4) Purge is complete.
(5) Place damper and gas control valve in light-off position.	(5) Damper and fuel control valve are in light-off position. If light-off airflow is less than purge airflow rate, start light-off time limit timer.
(6) None.	(6) Spark and igniter and main safety shutoff valves are ready for operation.

Table 5.5.7.1(b) Light-Off Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Energize ignition transformer and igniter safety shutoff valve(s).	(1) Prove igniter flame within 10 seconds of the energization of igniter fuel valves. (For Class 3 special igniter, proof of igniter operation is not required.)
(2) Open gas safety shutoff valves to main burner.	(2) Prove main flame is within 10 seconds. Close igniter safety shutoff valve(s).
(3) Bring unit to preset operating pressure at rate specified by manufacturer, maintaining air-fuel ratios as established by tests.	(3) None.
(4) On reaching preset range, change to automatic combustion control.	(4) None.

Table 5.5.7.1(c) Normal Shutdown Cycle (in listed order)

Operator Functions	Interlock Functions
(1) Shut off gas supply to main burner and to igniter, if in operation, and interrupt spark.	(1) None.
(2) Perform postpurge of furnace and boiler gas passes. Duration of postpurge must be no less than 15 seconds at airflow rate not exceeding that at which unit was shut down.	(2) None.
(3) After postpurge, fan can be permitted to be shut down.	(3) None.

Table 5.5.7.1(d) Safety Shutdown Cycle (in listed order)

Operator Functions	Interlock Functions
(1) None.	(1) Shut off gas supply to main burner, shut off fuel supply, and interrupt spark to igniter, if in operation. Where used, simultaneously energize inerting system.
(2) Perform postpurge of furnace and boiler gas passes. Duration of postpurge must be no less than 15 seconds at an airflow rate not exceeding that at which unit was shut down.	(2) None.
(3) After postpurge, fan can be permitted to be shut down.	(3) None.

5.5.7.1.2 When interlocks have been satisfied, this fact shall be indicated to the operator.

5.5.7.2 The fuel to be fired shall be selected.

5.5.7.2.1 The alternate fuel system shall be placed in a non-firing condition.

5.5.7.2.2 The supervisory or safety shutoff valve(s) shall be closed.

5.5.7.3 An igniter as specified in 5.3.4.1.1 shall be provided.

5.5.7.4 Any of the following conditions shall accomplish a safety shutdown, and the burner shall not be restarted until a trained operator goes out to the boiler, determines the cause of the shutdown, and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting:

- (1) High gas pressure
- (2) Low gas pressure
- (3) Loss of combustion air supply
- (4) Loss of or failure to establish flame
- (5) Loss of control systems actuating energy
- (6) Power failure
- (7) Low water level as determined by the auxiliary low water cutout
- (8) Excessive steam pressure or water temperature

5.5.8 Soot Blowing. Where soot blowers are used, the following shall apply:

- (1) Soot blowing at nonoptimum air-fuel ratios has been known to lead to explosive formations of air-soot clouds within the boiler and shall be avoided.
- (2) Soot blowers shall be operated only while burners are firing at rates such that the burner flame cannot be extinguished.
- (3) Boilers that are equipped with automatic soot-blowing equipment shall have their controls interlocked to prevent operation when the burner is shut down or in the prefiring or light-off cycles.

5.6 Simultaneous Firing of Oil and Gas Fuels.

5.6.1* General. The equipment and procedures required in 5.6.1.1 through 5.6.1.3 shall be used to avoid a hazardous furnace condition when firing oil and gas simultaneously in a single burner boiler on a continuous basis.

5.6.1.1 Class 1 or Class 2 igniters shall be used during the light-off of the second fuel as required by the manufacturer or as established by test.

5.6.1.2 Each boiler shall be tested during initial start-up to determine whether any modifications to the procedures specified in Section 5.5 are required to establish ignition or to satisfy other design limitations during light-off, warm-up, or normal operation.

5.6.1.3 The initial prefiring cycle, light-off cycle, and normal shutdown cycles for the initial fuel to be fired and for single fuel operation shall be completed in accordance with Section 5.5.

5.6.2 Equipment Requirements. The following equipment shall be provided for continuous firing of both oil and gas:

- (1) A burner that is capable of burning either oil or gas fuel individually or both fuels simultaneously
- (2) A combustion control system that is capable of performing the following functions:
 - (a) Metering and totaling the inputs from both gas and oil fuels alone or in any combination
 - (b) Proportioning the total fuel input of each fuel individually or in any combination to total airflow in order to maintain the air-fuel ratio within design limits
 - (c) Limiting fuel demand to be less than measured airflow and limiting air demand to be greater than measured fuel flow
 - (d) For items 5.6.2(2)(a) through 5.6.2(2)(c), a control system that is designed to accommodate a fixed amount of secondary fuel without metering and totaling all fuels shall be permitted, provided the system maintains air-fuel ratios within design limits throughout the entire operating range of the burner
 - (e) Limiting total fuel input to the maximum capacity of the boiler
 - (f) Controlling and maintaining a minimum airflow rate that takes into account simultaneous fuel inputs
 - (g) Controlling and maintaining minimum input rates of each fuel
 - (h) Requiring a stable return to design air-fuel ratio after the trip or shutdown of either fuel
- (3) A safety interlock system with the following capabilities:
 - (a) Meets the requirements of 5.3.6 for each fuel being fired



- (b) Requires, on an interlock action specific to only one of the fuels being fired, that this particular fuel automatically shut down with operation continuing on the unaffected fuel in a stable manner; shutdown of both fuels permitted
- (c) Requires that both the first and second fuels be introduced with their flow control valves in light-off positions
- (d) Provides for the introduction of the second fuel without requiring a boiler purge
- (e) Requires a manual reset following any interlock shutdown
- (f) Prohibits the simultaneous light-off of both fuels
- (g) Requires flame detector(s) in accordance with 5.3.4 to supervise any of the following conditions:
 - i. Igniter flame as permitted by igniter class
 - ii. Gas firing
 - iii. Oil firing
 - iv. Combined gas and oil firing
- (h) Burner flame detectors are permitted to supervise multiple fuels.

5.6.3 Simultaneous Firing of Oil and Gas Fuels (Automated Second Fuel Start). This section shall define the requirements and procedures for an automated light-off and subsequent operation on a continuous basis of a second fuel.

5.6.3.1 Equipment Requirements. Equipment requirements shall be in accordance with 5.6.2 and 5.6.3.2.

5.6.3.2 A fuel transfer mode with the following functions shall be provided:

- (1) A gas-firing mode in which oil cannot be fired
- (2) An oil-firing mode in which gas cannot be fired
- (3) A gas-oil-firing mode that permits simultaneous firing of both fuels
- (4) The capability to signal the combustion control system to bias up the airflow, to position the control valve for the second fuel to light-off, and to open the safety shutoff valve(s) of the fuel being introduced
- (5) The capability to bias up the airflow by a preset value in response to a fuel transfer signal while the airflow remains in automatic mode

5.6.3.3 Subsequent Fuel Light-Off — Oil. When oil is introduced as the second fuel, the light-off cycle for the oil shall accomplish the following in the listed order:

- (1) Place fuel gas flow and airflow control loops in automatic mode.
- (2) Satisfy oil fuel system interlocks.
- (3) Install oil atomizer.
- (4) Open atomizing medium shutoff valve.
- (5) Select dual fuel firing.
- (6) Set oil control valve in light-off position.
- (7) Prove fuel oil control valve in light-off position.
- (8) With airflow in automatic mode, gradually bias up airflow by a preset amount corresponding to fuel input of fuel oil in light-off.
- (9) Establish ignition energy in accordance with manufacturer's instructions. Where an igniter is required, see 5.5.2.6.2, 5.5.2.6.3, or 5.5.2.6.4 for operating requirements.
- (10) Open oil safety shutoff valves and establish oil flow through the burner.
- (11) Gradually remove airflow bias.
- (12) Verify stable flame and that the air-fuel ratio is within design limits.

- (13) Place the combustion control system into the desired mode for controlling input rate of each fuel.
- (14) Shut down igniter as required.

5.6.3.4 Subsequent Fuel Light-Off — Gas. When gas is introduced as the second fuel, the light-off cycle for the gas shall accomplish the following in the listed order:

- (1) Place fuel oil flow and airflow control loops in automatic mode.
- (2) Satisfy gas fuel system interlocks.
- (3) Select dual fuel firing.
- (4) Set gas control valve in light-off position.
- (5) Prove fuel gas control valve in light-off position.
- (6) With airflow in automatic mode, gradually bias up airflow by a preset amount corresponding to fuel input of fuel gas in light-off.
- (7) Establish ignition energy in accordance with manufacturer's instructions. Where an igniter is required, see 5.5.2.6.2, 5.5.2.6.3, or 5.5.2.6.4 for operating requirements.
- (8) Close the vent valve (where used), open the gas safety shutoff valves, and establish gas flow to the burner.
- (9) Gradually remove airflow bias.
- (10) Verify stable flame and that the air-fuel ratio is within design limits.
- (11) Place the combustion control system into the desired mode for controlling input rate of each fuel.
- (12) Shut down igniter as required.

5.6.4 Simultaneous Firing of Oil and Gas Fuels (Manual Second Fuel Start). This section shall define the requirements and procedures required for the manual light-off and subsequent operation on a continuous basis of a second fuel.

5.6.4.1 Equipment Requirements. Equipment requirements shall be in accordance with 5.6.2 and 5.6.4.2.

5.6.4.2 The combustion control system shall have the capability to manually bias up the airflow while the airflow remains in automatic mode.

5.6.4.2.1 Either the oxygen trim or airflow control station shall be permitted to be used.

5.6.4.3 Subsequent Fuel Light-Off — Oil. When oil is introduced as the second fuel, the light-off cycle for the oil shall accomplish the following in the order listed:

- (1) Verify that fuel gas flow and airflow control loops are in automatic mode.
- (2) Satisfy oil fuel system interlocks.
- (3) Install oil atomizer.
- (4) Open atomizing medium shutoff valve.
- (5) Place oil control valve in light-off position.
- (6) With airflow in automatic mode, gradually bias up airflow by a preset amount corresponding to fuel input of fuel oil in light-off.
- (7) Establish ignition energy in accordance with manufacturer's instructions. Where an igniter is required, see 5.5.2.6.2, 5.5.2.6.3, or 5.5.2.6.4 for operating requirements.
- (8) Open oil safety shutoff valves and establish oil flow through the burner.
- (9) Gradually remove airflow bias.
- (10) Verify stable flame and that the air-fuel ratio is within design limits.
- (11) Place the combustion control system into the desired mode for controlling the input rate of each fuel.
- (12) Shut down igniter as required.

5.6.4.4 Subsequent Fuel Light-Off — Gas. When gas is introduced as the second fuel, the procedure shall be in the following order:

- (1) Verify that fuel oil flow and airflow control are in the automatic mode.
- (2) Satisfy gas fuel system interlocks.
- (3) Place the gas control valve in light-off position.
- (4) With airflow in automatic mode, gradually bias up airflow by a preset amount corresponding to fuel input of fuel oil in light-off.
- (5) Establish ignition energy in accordance with manufacturers' instructions. Where an igniter is required, see 5.5.2.6.2, 5.5.2.6.3, or 5.5.2.6.4 for operating requirements.
- (6) Close the vent valve (where used), open the gas safety shutoff valves, and establish gas flow to the burner.
- (7) Gradually remove airflow bias.
- (8) Verify stable flame and that the air-fuel ratio is within design limits.
- (9) Place the combustion control system into the desired mode for controlling input rate of each fuel.
- (10) Shut down igniter as required.

5.6.5 Shutdown Cycle.

5.6.5.1 Normal Oil Shutdown Cycle. The normal shutdown procedure for oil while continuing to fire gas shall be in the following order:

- (1) Reduce the oil flow to the light-off rate.
- (2) Shut off the oil supply to the burner and open the oil recirculating valve, where used.
- (3) Verify stable flame and adjust air-fuel ratio in preparation for purging the oil atomizer.
- (4) Purge oil passages of the oil atomizer.
- (5) Shut off the atomizing medium, if required.
- (6) Remove the oil atomizer from the burner, if required.
- (7) Verify stable flame and that the air-fuel ratio of the gas fire is within design limits.

5.6.5.2 Normal Gas Shutdown Cycle. The normal shutdown procedure for gas while continuing to fire oil shall be in the following order:

- (1) Reduce the gas flow to the light-off rate.
- (2) Shut off the gas supply to the burner.
- (3) Verify stable flame and that the air-fuel ratio of the oil fire is within design limits.

5.6.5.3* Oil Safety Shutdowns.

5.6.5.3.1 Any of the following operating conditions shall accomplish a safety shutdown of the oil supply to the burner (i.e., fuel trip):

- (1) Low fuel pressure
- (2) Low temperature of heated oils
- (3) Loss of atomizing medium, where used, as interlocked by flow or two pressure switches, one located at the service connection and the other at the burner, either one of which shall initiate a safety shutdown on low pressure
- (4) High temperature of heated oil

5.6.5.3.2 A complete boiler safety shutdown shall occur if oil is the only fuel being fired.

5.6.5.4 Gas Safety Shutdowns.

5.6.5.4.1 Either of the following conditions shall accomplish a safety shutdown of the gas supply to the burner (i.e., fuel trip):

- (1) High gas pressure
- (2) Low gas pressure

5.6.5.4.2 A complete boiler safety shutdown shall occur if gas is the only fuel being fired.

5.6.5.5 Boiler Safety Shutdowns. Any of the following conditions shall accomplish a complete safety shutdown of the boiler:

- (1) Loss of combustion air supply
- (2) Loss of or failure to establish flame
- (3) Loss of control system actuating energy
- (4) Power failure
- (5) Excessive steam pressure or water temperature
- (6) Low water level as determined by the auxiliary low water cutout
- (7) The occurrence of either an oil or a gas fuel trip when only that fuel is being fired

5.7 Simultaneous Firing of Oil and Gas for Fuel Transfer Only.

5.7.1* General. The equipment and procedures of 5.7.1.1 through 5.7.1.4 shall be used to avoid a hazardous furnace condition when operation of the boiler is transferred from fuel oil to fuel gas or from fuel gas to fuel oil without requiring a shutdown of the boiler.

5.7.1.1 Simultaneous Firing for Fuel Transfer on a Continuous Basis. When the combustion control system and burner management system are both designed for fuel transfer and simultaneous firing of oil and gas fuels on a continuous basis, the requirements of Section 5.6 shall apply.

5.7.1.2 Class 1 or Class 2 igniters shall be used during the fuel transfer as required by the manufacturer or established by test.

5.7.1.3 Each boiler shall be tested during initial start-up to determine whether any modifications to the procedures specified in Section 5.5 are required to establish ignition or to satisfy other design limitations during light-off, warm-up, or normal operation.

5.7.1.4 The initial prefiring cycle, light-off cycle, and normal shutdown cycles for the initial fuel to be fired and for single fuel operation shall be completed in accordance with Section 5.5.

5.7.2 Required Equipment. The following equipment shall be required:

- (1) A burner that is capable of firing the two fuels simultaneously during the transfer period
- (2) A combustion control system that is capable of performing the following functions:
 - (a) Proportioning fuel flow for each fuel individually
 - (b) Limiting total fuel input to the maximum capacity of the boiler
 - (c) Controlling a minimum airflow rate
 - (d) Controlling minimum input rates of each fuel
 - (e) Providing a stable return to design air-fuel ratio after the trip or shutdown of either fuel
- (3) A fuel transfer mode that includes the following:
 - (a) A gas-firing mode in which oil cannot be fired
 - (b) An oil-firing mode in which gas cannot be fired
 - (c) gas-oil-firing mode that permits simultaneous firing of both fuels, provided all interlocks for both fuels are satisfied, including light-off position for both fuel valves
 - (d) A control device, transfer timer, and an alarm for 5.7.2(3)(c), to limit continuous operation in this mode
- (4) A safety interlock system with the following capabilities:



- (a) Meets the requirements of 5.3.6 for each fuel being fired
- (b) Provides, on an interlock action peculiar to only one of the fuels being fired, that this particular fuel automatically shuts down with operation continuing on the unaffected fuel in a stable manner; shutdown of both fuels permitted
- (c) Provides that both the first and second fuels be introduced with their flow control valves in light-off positions
- (d) Provides an interlock action that will trip either fuel should its respective flow control valve leave a predetermined setting during fuel transfer
- (e) Provides for the introduction of the second fuel without requiring a boiler purge
- (f) Requires a manual reset following any interlock shutdown
- (g) Prohibits the simultaneous light-off of both fuels
- (h) Provides detector(s) to supervise any of the following conditions:
 - i. Igniter flame as permitted by igniter class
 - ii. Gas firing
 - iii. Oil firing
 - iv. Combined gas and oil firing
- (i) Burner flame detectors shall be permitted to supervise multiple fuels.

5.7.3 Simultaneous Firing of Oil and Gas for Fuel Transfer Only (Automated Transfer). This section shall define the requirements and procedures to be used for an automated transfer of operation from one fuel to a second fuel without requiring a shutdown of the burner.

5.7.3.1 Required Equipment. Equipment requirements shall be in accordance with 5.7.2 and 5.7.3.1.1 through 5.7.3.1.3.

5.7.3.1.1 The combustion control system shall have the capability to automatically increase the airflow by a preset value in response to a fuel transfer signal.

5.7.3.1.2 The airflow shall be held in a fixed position for the transfer period.

5.7.3.1.3 The fuel transfer mode shall have the capability to signal the combustion control system to increase airflow and open the safety shutoff valve(s) of the fuel being introduced.

5.7.3.2 Subsequent Fuel Light-Off — Oil. When oil is introduced as the second fuel, the transfer cycle from gas to oil shall be in the following order:

- (1) Satisfy oil fuel system interlocks.
- (2) Install an oil atomizer.
- (3) Open the atomizing medium shutoff valve.
- (4) Select dual fuel firing.
- (5) Set the gas-firing rate to light-off flow.
- (6) Set the oil control valve in the light-off position.
- (7) Prove fuel gas and fuel oil control valves are in light-off position.
- (8) Gradually increase airflow by a preset amount corresponding to fuel input of fuel oil in light-off.
- (9) Establish ignition energy in accordance with the manufacturer's instructions. Where an igniter is required, see 5.5.2.6.3 or 5.5.2.6.4 for operating requirements.
- (10) Open the oil safety shutoff valves and establish oil flow to the burner.
- (11) Verify stable flame and that the air-fuel ratio is within design limits.

- (12) Select the oil firing mode, which automatically trips the gas safety shutoff valves.
- (13) Gradually remove airflow increase.
- (14) Return the combustion control system and burner firing rate to automatic operation.
- (15) Shut down igniter as required.

5.7.3.3 Subsequent Fuel Light-Off — Gas. When gas is introduced as the second fuel, the transfer cycle from oil to gas shall be in the following order:

- (1) Establish the gas fuel system to satisfy interlocks.
- (2) Select the dual fuel firing mode.
- (3) Set the oil-firing rate to light-off flow.
- (4) Set the gas control valve to the light-off position.
- (5) Prove fuel gas and fuel oil control valves are in light-off position.
- (6) Increase airflow by a preset amount corresponding to fuel input of fuel gas in light-off.
- (7) Establish ignition energy in accordance with the manufacturer's instructions. Where an igniter is required, see 5.5.2.6.3 or 5.5.2.6.4 for operating requirements.
- (8) Close the vent valve (where used), open the gas safety shutoff valves, and establish gas flow to the burner.
- (9) Verify stable flame and that the air-fuel ratio is within design limits.
- (10) Select the gas-firing mode, which automatically trips the oil safety shutoff valves.
- (11) Gradually remove airflow increase.
- (12) Return the combustion control system and burner-firing rate to automatic operation.
- (13) Purge the oil gun into furnace, if required.
- (14) Close atomizing medium shutoff valve, if required.
- (15) Remove oil atomizer, if required.
- (16) Shut down igniter as required.

5.7.4 Simultaneous Firing of Oil and Gas for Fuel Transfer Only (Manual Transfer). This section shall define the requirements and procedures to be used for a manual transfer of operation from one fuel to a second fuel without requiring a shutdown of the burner.

5.7.4.1 Required Equipment. Equipment requirements shall be in accordance with 5.7.2 and 5.7.4.1.1 through 5.7.4.1.3.

5.7.4.1.1 The combustion control system shall have the capability to manually adjust the airflow.

5.7.4.1.2 Manual shutoff valves shall be provided at the burner, downstream of the safety shutoff valves for each fuel.

5.7.4.1.3 A pressure gauge shall be provided in each fuel line downstream of the manual shutoff valve.

5.7.4.2 Subsequent Fuel Light-Off — Oil. When oil is introduced as the second fuel, the procedure to transfer from gas to oil shall be as follows:

- (1) Where a Class 1 or Class 2 igniter is available, place it in service in accordance with the manufacturer's instructions as required.
- (2) Confirm that the manual oil valve at the burner is closed.
- (3) Satisfy oil fuel system interlocks.
- (4) Install an oil atomizer.
- (5) Open the atomizing medium shutoff valve.
- (6) Place the combustion control system in manual mode.
- (7) Reduce the gas-firing rate to light-off flow.
- (8) Place the oil control valve in the light-off position.

- (9) Place the fuel transfer into oil/gas mode, with the following results:
 - (a) When the oil safety interlocks are satisfied, the oil safety shutoff valves open.
 - (b) Fuel oil pressure now will be upstream of the manual oil valve at the burner.
- (10) Slowly close the manual gas shutoff valve while observing the gas pressure downstream of the valve until the gas pressure starts to drop. At this point, the gas flow rate is controlled by the manual valve instead of by the control valve.
- (11) Slowly close the manual gas valve while simultaneously opening the manual oil valve to light the oil flame from the gas flame, and proceed as follows:
 - (a) Continue to increase the oil-firing rate while cutting back on the gas-firing rate to maintain a constant heat input of the combined fuels to the burner, until the manual gas valve is closed and the manual oil valve is fully open.
 - (b) Excess air must be maintained at all times by continuously observing the burner flame or by observing the air-fuel ratio, oxygen indicator, or opacity indicator, if provided.
 - (c) During this period, airflow must be maintained at a constant rate with only the manual fuel valves operated.
- (12) Place the fuel transfer mode in the oil position.
- (13) Return the combustion control system and burner-firing rate to automatic operation.
- (14) Shut down igniter as required.

5.7.4.3 Subsequent Fuel Light-Off — Gas. When gas is introduced as the second fuel, the procedure to transfer from oil to gas shall be as follows:

- (1) Where a Class 1 or Class 2 igniter is available, place it in service in accordance with the manufacturer's instructions.
- (2) Confirm that the manual gas valve at the burner is closed.
- (3) Satisfy gas fuel system interlocks.
- (4) Place the combustion control system in manual mode.
- (5) Reduce the oil-firing rate to light-off flow.
- (6) Place the gas control valve in the light-off position.
- (7) Place fuel transfer in the gas/oil mode, with the following results:
 - (a) When the gas safety interlocks are satisfied, the gas safety shutoff valves open.
 - (b) Gas pressure now will be upstream of manual gas valve at the burner.
- (8) Slowly close the manual oil valve while observing the oil pressure downstream of the valve until the oil pressure starts to drop. At this point the oil flow is controlled by the manual valve instead of by the control valve.
- (9) Slowly close the manual oil valve while simultaneously opening the manual gas valve to light the gas flame from the oil flame, and proceed as follows:
 - (a) Continue to increase the gas-firing rate while cutting back on the oil-firing rate to maintain a constant heat input of the combined fuels to the burner until the manual oil valve is closed and the manual gas valve is fully open.
 - (b) Excess air must be maintained at all times by continuously observing the burner flame or by observing the air-fuel ratio, oxygen indicator, or opacity indicator, if provided.

- (c) During this period, airflow must be maintained at a constant rate with only the manual fuel valves operated.
- (10) Place the fuel transfer mode in the gas position. The oil safety shutoff valves close.
- (11) Return the combustion control system and burner-firing rate to automatic operation.
- (12) Purge the oil gun into the furnace, if required.
- (13) Shut off the atomizing medium, if required.
- (14) Remove the oil atomizer from burner, if required.
- (15) Shut down the igniter as required.

5.7.5 Safety Shutdowns. Safety shutdowns shall be initiated in accordance with 5.6.5.3 through 5.6.5.5.

5.8 Dual Oil Atomizers in a Single Burner.

5.8.1* General. Where a burner is equipped with main and auxiliary oil atomizers for the purpose of changing atomizers for maintenance without affecting the boiler load, the changeover of atomizers shall be carried out manually under stable firing conditions by a trained operator.

5.8.1.1 Class 1 or Class 2 igniters shall be used during the fuel transfer as required by the manufacturer or established by test.

5.8.1.2 Each boiler shall be tested during initial start-up to determine whether any modifications to the procedures specified in Section 5.5 are required to establish ignition or to satisfy other design limitations during light-off, warm-up, or normal operation.

5.8.1.3 The initial prefiring cycle, light-off cycle, and normal shutdown cycles for the initial fuel to be fired and for single fuel operation shall be completed in accordance with Section 5.5.

5.8.2 Required Equipment. The following equipment shall be required:

- (1) A burner that is capable of firing two oil atomizers simultaneously during the transfer period
- (2) A combustion control system that is capable of limiting the total fuel input to the maximum capacity of the boiler and that has the capability to manually adjust the airflow
- (3) A safety interlock system in accordance with 5.3.6 that also prohibits the simultaneous light-off of both atomizers
- (4) Manual oil shutoff valves at the burner, downstream of the safety shutoff valves for each atomizer
- (5) A pressure gauge in the fuel line downstream of each manual shutoff valve
- (6) Manual atomizing media shutoff valves for each atomizer except on mechanically atomized systems

5.8.3 Oil Atomizer Changeover Procedure. The procedures for a manual transfer of operation from one oil atomizer (main or auxiliary) to a second oil atomizer (auxiliary or main) without requiring a shutdown of the burner shall be as follows:

- (1) Where a Class 1 or Class 2 igniter is available, place it in service in accordance with the manufacturer's instructions.
- (2) Confirm that the manual oil valve at the burner for the atomizer to be started is closed.
- (3) Install the second oil atomizer.
- (4) Place the combustion control system in manual mode.
- (5) Slowly close the manual shutoff valve while observing the oil pressure downstream of the valve until the oil pressure starts to drop. At this point, the oil flow rate is controlled by the manual valve instead of by the control valve.



- (6) For nonmechanically atomized oil atomizers, slowly open the second atomizing medium shutoff valve until it is fully open.
- (7) Slowly close the manual oil valve for the atomizer in service while simultaneously opening the manual oil valve of the second atomizer to light the second atomizer from the first and proceed as follows:
 - (a) Continue to slowly increase the oil-firing rate on the second atomizer while cutting back on the firing rate of the first atomizer to maintain a constant heat input of the combined atomizers until the manual valve of the first atomizer is closed and the manual oil valve of the second atomizer is fully open.
 - (b) Excess air shall be maintained at all times by continuous observation of the burner flame or by observation of the air-fuel ratio, oxygen indicator, or opacity indicator, if provided.
 - (c) During this period, airflow must be maintained at a constant rate with only the manual fuel valves operated.
- (8) Close the atomizing media shutoff valve on the first atomizer, if present.
- (9) Return the combustion control system and burner-firing rate to automatic operation.
- (10) Shut down the igniter as required.

Chapter 6 Multiple Burner Boilers

6.1 Application.

6.1.1 This chapter shall be used in conjunction with Chapter 4 and requires the coordination of operation procedures, control systems, interlocks, and structural design. Where conflicts exist, the requirements of this chapter shall apply.

6.1.2 The sections of this code that are common to all fuels to be burned in a multiple burner boiler shall be used in conjunction with those sections that are applicable to a specific fuel being utilized.

6.1.3 Section 6.5 shall apply to minimizing the risk of negative furnace draft in excess of furnace structural capability.

6.1.4 Section 6.6 shall apply to burner management, combustion control systems, and operating procedures for multiple burner boilers utilizing fuel gas as defined in 3.3.74.

6.1.5 Section 6.7 shall apply to burner management, combustion control systems, and operating procedures for multiple burner boilers utilizing fuel oil as defined in 3.3.73.3.

6.1.6 Section 6.8 shall apply to burner management, combustion control systems, and operating procedures for multiple burner boilers utilizing pulverized coal fuel as defined in 3.3.73.2.1.

6.1.7 This chapter shall also apply to fired flue gas reheaters (duct burners) installed in the flue gas path downstream of a multiple burner boiler furnace.

6.2 Purpose.

6.2.1 The purpose of this chapter shall be to contribute to operating safety and to prevent furnace explosions and implosions in multiple burner boiler installations from the forced draft fan inlet(s) to the stack inlet.

6.2.2 This chapter establishes minimum requirements that shall be followed for the design, installation, operation, and maintenance of multiple burner boilers and their fuel-burning, air supply, and combustion products removal systems.

6.2.3* The user of this chapter shall recognize the complexity of firing fuel with regard to the type of equipment and the characteristics of the fuel.

6.2.4 This chapter shall not eliminate the need for competent engineering judgment.

6.3 Mechanical Equipment Requirements.

6.3.1 General requirements for mechanical equipment shall be in accordance with Section 4.6.

6.3.2 Forced draft (FD) and induced draft (ID) fans shall include all fans whose purpose is to supply air for combustion or remove products of combustion, including associated booster fans, and excluding fans in the pulverized fuel system.

6.3.3 Fuel Gas and Fuel Oil Safety Shutoff Valves.

6.3.3.1 A header safety shutoff valve and individual burner safety shutoff valves shall be provided.

6.3.3.2 Proof of closure shall be provided for all header and burner safety shutoff valves.

6.3.3.3 Multiple burners supplied from a common set of burner safety shutoff valves shall be treated as a single (individual) burner. Refer to 6.6.7.1.3 and 6.7.7.1.3 for two burner units.

6.3.3.4 Where fuel gas or fuel oil igniters are provided, a common igniter fuel header safety shutoff valve and individual igniter safety shutoff valves shall also be provided. The igniter header safety shutoff valve shall be dedicated to the igniter subsystem.

6.3.3.5 Multiple igniters supplied from a common set of igniter safety shutoff valves shall be treated as a single (individual) igniter.

6.3.3.6 Proof of closure in accordance with 6.4.2.3.4.5 shall be provided for all individual igniter safety shutoff valves.

6.3.3.7 Burner and igniter safety shutoff valves shall be located as close as practicable to the igniters or burners to minimize the volume of fuel downstream of the valve.

6.4 Burner Management and Combustion Control Requirements. Burner management and combustion control general requirements shall be in accordance with 4.6.3 through 4.6.7.

6.4.1* Unattended and Off-Site Operation. Unattended operation, no operator at the operating location(s), or operation of the plant from an off-site operating location shall require a higher level of automation, safety interlocks, and reliability, which are not addressed in this code.

6.4.1.1 In addition to operational and safety analysis, designs for off-site and unattended operations shall include risk analysis and hazard studies and shall be approved by the authority having jurisdiction.

6.4.1.2 Jurisdictional requirements regarding operator attendance shall be met.

6.4.2 Interlock System.

6.4.2.1 General.

6.4.2.1.1 The basic requirements of an interlock system for a unit shall accomplish the following:

- (1) Protect personnel from injury
- (2) Protect equipment from damage
- (3) Protect boiler operation by limiting actions to a prescribed operating sequence or by initiating trip devices when approaching an out-of-range or unstable operating condition

6.4.2.1.2 The interlock system shall comply with 4.6.3.

6.4.2.1.3* The mandatory automatic trips specified in 6.4.2.3 shall be provided.

6.4.2.1.4 Additional automatic trips shall be permitted. (*See 4.1.3 for trip function evaluation requirements.*)

6.4.2.1.5 Fuel-specific interlocks shall be provided for each design basis fuel.

6.4.2.1.6* Operating personnel shall be made aware of the limitations of the interlock system.

6.4.2.2 Functional Requirements.

6.4.2.2.1 The operation of any interlock that causes a trip shall be annunciated.

6.4.2.2.2 The interlock system shall be installed, adjusted, and tested to confirm design function and timing.

6.4.2.2.2.1 The actuation values and time of action of the initiation devices shall be tuned to the furnace and equipment on which they are installed.

6.4.2.2.2.2 After adjustment, each path and the complete system shall be tested to verify the adjustments.

6.4.2.2.3 Testing and maintenance shall be performed to keep the interlock system functioning as designed.

6.4.2.2.4 If a reburn system is employed, the reburn interlocks shall be integrated with the interlock system.

6.4.2.2.5 Interlocks associated exclusively with the reburn system shall trip only the reburn system and shall not generate a master fuel trip.

6.4.2.2.6 The starting procedure and operation shall be supervised to ensure that design operating parameters and sequences are used.

6.4.2.2.7 The minimum amount of equipment shall be tripped in the correct sequence when the safety of personnel or equipment is jeopardized.

6.4.2.2.8 The initiating cause of the trip shall be indicated, and no portion of the process shall be started until stable operating conditions within design parameters are established.

6.4.2.2.9 The necessary trip devices shall be coordinated into an integrated system.

6.4.2.2.10 Where automatic equipment is not installed or in service to accomplish the intended function, instrumentation or alternative means to enable the operator to complete the operating sequence shall be provided.

6.4.2.2.11 The design shall retain as much flexibility with respect to alternative modes of operation as is consistent with operating procedures and parameters.

6.4.2.2.12 The capability for preventive maintenance shall be provided.

6.4.2.2.13 The design shall not require any deliberate “defeating” of an interlock to start or operate equipment. Whenever a required interlock device is removed temporarily from service, it shall be noted in the log and annunciated. Other means shall be substituted to supervise this interlock function.

6.4.2.2.14 The mandatory master fuel trip-sensing elements and circuits shall be independent of all other control elements and circuits.

Exception No. 1: Individual burner flame detectors also shall be permitted to be used for initiating master fuel trip systems.

Exception No. 2: Airflow measurement and auctioneered furnace draft signals from the boiler control system shall be permitted to be used for a master fuel trip, provided all the following conditions are met:

- (1) *These interlocks are hardwired into the burner management system.*
- (2) *Tripping set points are protected from unauthorized changes.*
- (3) *Any single component failure of these sensing elements and circuits does not prevent a mandatory master fuel trip.*

6.4.2.2.15 Misoperation of the interlock system due to an interruption or restoration of the interlock energy supply shall be prevented.

6.4.2.3 Required Interlocks.

6.4.2.3.1* Interlock System. Figure 6.4.2.3.1 and Table 6.4.2.3.1(a) through Table 6.4.2.3.1(c) show the minimum required system of interlocks that shall be provided for basic furnace protection for a multiple burner boiler operated in accordance with this code.

6.4.2.3.2 Each source of operation of the master fuel trip relay shall actuate a cause-of-trip indication, which informs the operator of the initiating cause of the tripping impulse.

6.4.2.3.3 Main fuel oil-recirculating valves shall be permitted to be reset separately and opened following a trip of the master fuel trip relay only after all burner safety shutoff valves have been proven closed.

6.4.2.3.4 Purge Requirements. See Figure 6.4.2.3.4.

6.4.2.3.4.1 A boiler enclosure purge shall be performed as part of the open register, continuous purge light-off procedures specified in 6.6.5.1.5.7, 6.7.5.1.5.7, and 6.8.5.1.5.7.

6.4.2.3.4.2 A boiler enclosure purge shall be completed before resetting of the master fuel trip relay shall be permitted.



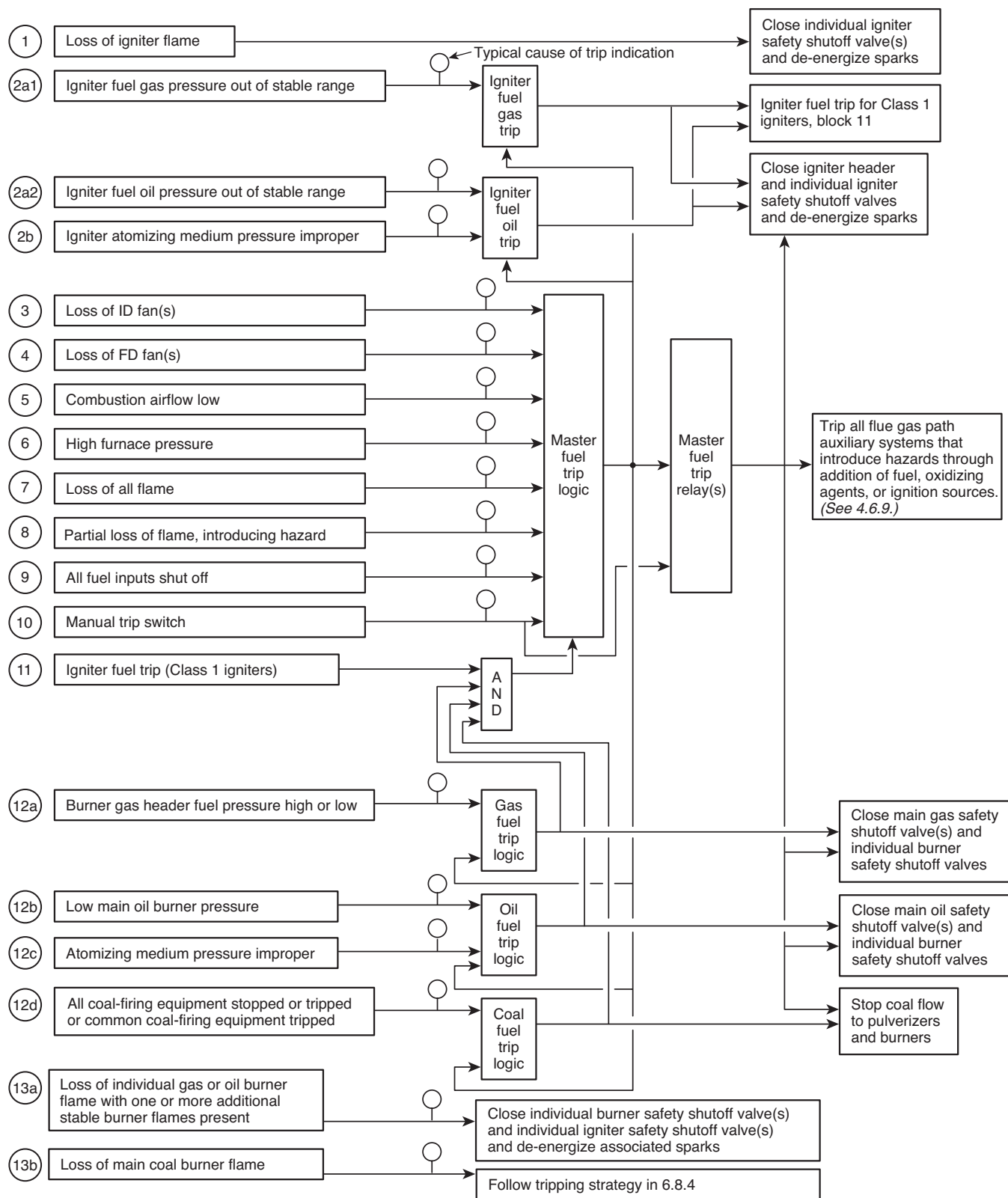


FIGURE 6.4.2.3.1 Interlock System for Multiple Burner Boiler.

Table 6.4.2.3.1(a) Interlock System for Multiple Burner Boiler

Block Number	Action
Block 1	Loss of an individual igniter flame shall cause the following actions: (1) Close the individual igniter safety shutoff valve(s) and de-energize the spark(s) (2) Open the vent valve (fuel gas ignition only) (3) Signal the main flame protection system that the igniter flame has been lost
Block 2a1	High or low igniter fuel gas header pressure shall be interlocked to initiate the tripping of the igniter header and individual igniter safety shutoff valves and de-energize sparks.
Block 2a2	Low igniter fuel oil header pressure shall be interlocked to initiate the tripping of the igniter header and individual igniter safety shutoff valves and de-energize sparks.
Block 2b	Where fuel oil is used for ignition fuel with air or steam atomization, atomizing air or steam pressure out of range shall trip the igniter and individual igniter safety shutoff valves and de-energize sparks. Where direct electric igniters are used, blocks 1 and 2 shall not apply. However, the master fuel trip system shall de-energize sparks and prevent re-energizing until all conditions for light-off have been re-established.
Blocks 3 through 12	These blocks represent conditions that initiate the tripping of all main and ignition fuel supplies through a master fuel trip relay contact(s). The master fuel trip relay(s) shall be of the type that stays tripped until the unit purge system interlock permits it to be reset, as shown in Figure 6.4.2.3.4. Whenever the master fuel trip relay(s) is operated, it shall trip all fuel header, burner, and igniter safety shutoff valves and de-energize all sparks and all ignition devices within the unit and flue gas path through master fuel trip relay contact(s). Master fuel trip relay contacts shall also trip the fuel oil system circulating and recirculating valves. If the design of the fuel oil supply system is such that backflow of fuel oil through the recirculating valve is inherently impossible or positively prevented, this valve shall be permitted to be manually operated and shall not be required to be interlocked to close automatically on a master fuel trip. The master fuel trip relay contacts shall also trip primary air fans or exhausters, coal feeders, and coal burner line shutoff valves, or take equivalent functional action to stop coal delivery to burners. The master fuel trip logic shall trip all fuel gas path auxiliary systems that introduce hazards through the addition of fuel, oxidizing agents, or ignition sources.
Block 3	The loss of all induced draft fans shall activate the master fuel trip relay.
Block 4	The loss of all forced draft fans shall activate the master fuel trip relay.
Block 5	Low combustion airflow below the permitted limits shall activate the master fuel trip relay.
Block 6	High furnace pressure, such as that resulting from a tube rupture or damper failure, shall activate the master fuel trip relay.
Block 7	Loss of all flame in the furnace shall activate the master fuel trip relay.
Block 8 (See A.6.4.2.3.1.)	A partial loss of flame that results in a hazardous condition shall activate the master fuel trip relay.
Block 9 (See A.6.4.2.3.1.)	When all fuel inputs to the furnace are shut off following a shutdown of the boiler for any reason, the master fuel trip relay shall be activated in accordance with Table 6.4.2.3.1(b) or Table 6.4.2.3.1(c).
Block 10	A manual switch that actuates the master fuel trip relay directly shall be provided for use by the operator in an emergency.
Block 11	The igniter fuel trip shall activate the master fuel trip relay in accordance with Table 6.4.2.3.1(b) or Table 6.4.2.3.1(c), if igniter fuel is the only fuel in service or if it is being used to stabilize a main fuel.
Block 12a	When the fuel gas burner header fuel pressure is above the maximum or below the minimum for a stable flame, that fuel shall be tripped. If fuel gas is the only fuel in service, the master fuel trip relay shall be actuated.
Block 12b	When the fuel oil burner header fuel pressure is below the minimum for a stable flame, that fuel shall be tripped. If fuel oil is the only fuel in service, the master fuel trip relay shall be actuated.

Table 6.4.2.3.1(a) Continued

Block Number	Action
Block 12c	This block represents operation of the fuel oil trip to prevent operation when atomizing air or steam pressure is out of range. If fuel oil is the only fuel in service, the master fuel trip relay shall be actuated.
Block 12d	This block represents the tripping/shutdown of coal-firing equipment that will cause a coal fuel trip. If coal is the only fuel in service, the master fuel trip relay shall be actuated.
Block 13a	Loss of flame at an individual fuel gas or fuel oil burner with one or more additional burners operating with stable flames that does not introduce a serious enough condition to warrant a master fuel trip as called for in block 8 shall close the individual burner safety shutoff valve(s) and associated igniter safety shutoff valve(s) and de-energize the associated igniter spark. For gang-operated burner valves, the requirements of 6.6.5.2.1.3(B)(19) and 6.7.5.2.1.3(B)(19) shall be met.
Block 13b	On loss of main coal burner flame, the tripping strategies of 6.8.4 shall be followed.

Table 6.4.2.3.1(b) Fuel Inputs Shutoff When Class 1 Igniters Are Used

Condition	Action Required
(1) First igniter(s) fails to light after successful unit purge. [See 6.6.5.2.1.3(B)(9), 6.7.5.2.3.2(J), and 6.8.5.2.1.3(B)(7).]	(1) Igniter valve(s) shall be closed immediately. Master fuel trip not required, but a 1-minute delay shall be required before retrieval of that or any other igniter.
(2) Any igniters proven on, all other fuel sources off, all igniter valves subsequently closed.	(2) Master fuel trip shall be actuated.
(3) Any igniter(s) proven on, any burner valve leaves closed limit, all burner valves subsequently closed, no other main fuel in service, igniter(s) remain proven.	(3) Associated main fuel gas trip valve and/or fuel oil trip valve shall be closed (fuel gas trip and/or fuel oil trip), proven igniters shall be permitted to remain in service.
(4) Any igniter(s) proven on, any pulverizer startup initiated, all pulverizers subsequently stopped, no other main fuel in service, igniter(s) remain proven.	(4) Proven igniters shall be permitted to remain in service.
(5) All igniter and burner valves closed and all feeders or pulverizers stopped.	(5) Master fuel trip shall be actuated.

Table 6.4.2.3.1(c) Fuel Inputs Shutoff When Class 2 or Class 3 Igniters Are Used

Condition	Action Required
(1) First igniter(s) fails to light after successful unit purge. [See 6.6.5.2.1.3(B)(9), 6.7.5.2.3.2(J), and 6.8.5.2.1.3(B)(7).]	(1) Igniter valve(s) shall be closed immediately. Master fuel trip not required, but a 1-minute delay shall be required before retrieval of that or any other igniter.
(2) Any igniters proven on, all other fuel sources off, all igniter valves subsequently closed.	(2) Master fuel trip shall be actuated.
(3) Any igniter(s) proven on, any burner valve leaves closed limit, all burner valves subsequently closed, no other main fuel in service, igniter(s) remain proven.	(3) Master fuel trip shall be actuated.
(4) Any igniter(s) proven on, any pulverizer startup initiated, all pulverizers subsequently stopped, no other main fuel in service, igniter(s) remain proven.	(4) (a) If first pulverizer fails to ignite as described in 6.8.5.2.1.3(B)(12), master fuel trip shall be actuated. (b) If last pulverizer in service is tripped, master fuel trip shall be actuated. (c) If last pulverizer in service is taken out of service in a normal shutdown sequence by an operator, proven igniters shall be permitted to remain in service.
(5) All igniter and burner valves closed and all feeders or pulverizers stopped.	(5) Master fuel trip shall be actuated.

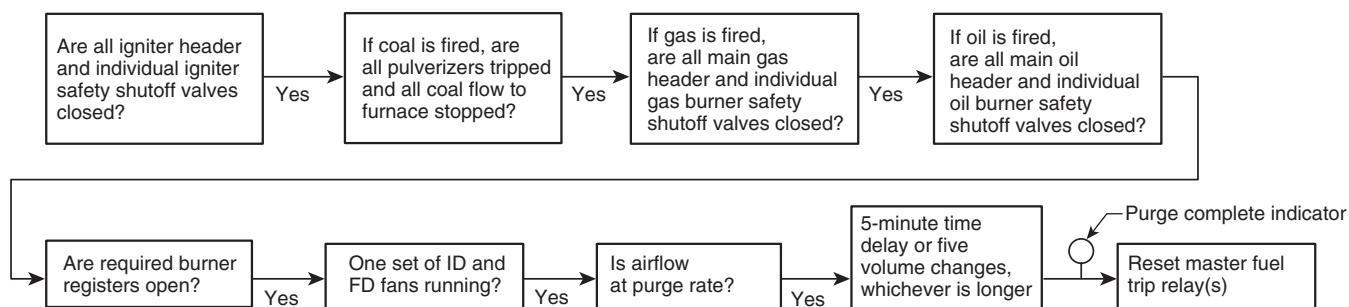


FIGURE 6.4.2.3.4 Unit Purge Interlocks.

6.4.2.3.4.3 A boiler enclosure purge shall be required after the occurrence of a master fuel trip or if any purge permissive, as defined in 6.4.2.3.4.5, is lost prior to introducing any fuel or ignition source to the boiler enclosure.

(A) On a normal shutdown, after all fuel has been removed from service, boiler enclosure purge conditions, including purge rate air flow, shall be established and a boiler enclosure purge completed.

(B)* On an emergency shutdown where FD and ID fans remain in service, boiler enclosure purge conditions shall be established and a boiler enclosure purge completed. Purge rate airflow shall be established in accordance with the following procedure:

- (1) All fans in the combustion air and flue gas streams that are in service at the time of the trip shall be left in service. This shall not include primary air fans or pulverizer exhausters used to convey coal into the furnace.
- (2) The airflow shall not be changed by deliberate manual or automatic control action except as permitted in (3) and (4).
- (3) If the airflow is greater than the purge rate, it shall be permitted to be decreased gradually to the purge rate for a boiler enclosure purge.
- (4) If the airflow is less than the purge rate at the time of the trip, it shall be continued at the existing rate for 5 minutes and then increased gradually to the purge rate airflow and held at that value for a boiler enclosure purge. If increasing airflow to purge rate requires starting fans, they shall be started in accordance with Section 6.5.
- (5) During a master fuel trip event, the overfire air system shall remain at the same setting as when the event occurred for such time as the main combustion airflow is held.
- (6) Following the hold period, the overfire air shall be permitted to be gradually adjusted to overfire air purge settings or cooling flows either manually or automatically.

(C) On an emergency shutdown where no fans remain in service, boiler enclosure purge conditions shall be established and a boiler enclosure purge completed. Purge rate airflow shall be established in accordance with the following procedure:

- (1) All dampers in the air and flue gas passages of the unit shall be opened slowly to the fully open position to create as much natural draft as possible to ventilate the unit.
- (2) Opening of fan dampers shall be timed or controlled to ensure that positive or negative furnace pressure transients beyond design limits do not occur during fan coastdown.
- (3) This condition shall be maintained for at least 15 minutes.
- (4) At the end of this period, the fan(s) shall be started in accordance with Section 6.5.

- (5) The airflow shall be increased gradually to the purge rate, and a boiler enclosure purge shall be completed.

(D) After completion of the boiler enclosure purge, the unit shall be permitted to either:

- (1) Shut down, closing the burner air registers and shutting down the forced draft fans and induced draft fans; however, maintaining airflow through the unit to prevent accumulation of combustible gases is a prudent procedural step due to the potential of fuel leak-by.
- (2) Relight in accordance with the applicable paragraphs of 6.6.5, 6.7.5, or 6.8.5, depending on the fuels being fired.

6.4.2.3.4.4 Purge Rate Air Flow.

(A)* The designer shall establish a minimum purge rate airflow. This purge rate airflow shall be in accordance with 6.4.2.3.4.4(B) and 6.4.2.3.4.4(D).

(B)* Purge rate airflow shall not be less than 25 percent of design full load mass airflow.

(C) Purge rate airflow shall not be greater than 40 percent of design full load mass airflow for coal-fired units.

(D) Purge rate airflow shall be maintained from the FD fan inlet through the stack.

(E) Purge rate airflow shall be maintained from purge completion through light off and initial loading as described in 6.6.5.1.5, 6.7.5.1.5, and 6.8.5.1.5.

6.4.2.3.4.5* Boiler Enclosure Purge Permissives. Boiler enclosure purge permissives shall, at a minimum, include the following:

- (1) All igniter header and individual igniter shutoff valves proven closed by valve position.

Exception: Where the igniter capacity is 1.5 MW_t (5 million Btu/hr) or less, proof of closure of individual igniter safety shutoff valves by means other than valve position shall be permitted.

- (2) If coal is fired on the unit, all pulverizers are stopped and all coal flow to the furnace stopped.
- (3) If fuel gas is fired on the unit, all main fuel gas header and individual fuel gas burner shutoff valves are proven closed by valve position.
- (4) If fuel oil is fired on the unit, all main fuel oil header and individual fuel oil burner shutoff valves are proven closed by valve position.
- (5) Any other sources of combustibles that could enter the boiler enclosure or flue gas path proven closed by valve position or other positive means.

Exception: Where the capacity of the combustible source is 1.5 MW_t (5 million Btu/hr) or less, proof of closure of shutoff valves by means other than valve position shall be permitted.

- (6) All required burner air registers are in purge position.
- (7) At least one FD fan and, if so equipped, one ID fan in service.
- (8) Flue gas recirculation fans shall be operated as recommended by the boiler manufacturer.
- (9) Total boiler airflow is at purge rate airflow.

6.4.2.3.4.6* Component Purge Permissives. Component purge permissives shall, at a minimum, include the following:

- (1) All sources of fuel and other combustibles into the component proven closed by valve position or other positive means
- (2) All sources of ignition energy proven off
- (3) Component purge flow rate at or above boiler enclosure purge rate airflow

6.4.2.3.4.7* Boiler Enclosure Purge.

(A)* Completion of the boiler enclosure purge shall require a minimum of 5 minutes and at least five volume changes of the boiler enclosure while all of the purge permissives are maintained.

(B) Accumulation of purge time and volume changes shall be permitted as soon as all of the purge permissives are satisfied.

(C) Loss of any of the purge permissives during a boiler enclosure purge shall cancel any purge time and volume changes that have accumulated.

(D) Completion of boiler enclosure purge shall be indicated.

(E) After the boiler enclosure purge is complete, the master fuel trip relay(s) shall be permitted to be reset.

6.4.2.3.4.8 Component Purge.

(A) Prior to being placed in operation, all flue gas path components from the boiler enclosure to the stack inlet (e.g., precipitators, fired reheaters) containing sources of ignition energy shall be purged for a minimum of 5 minutes and at least five volume changes of the component while all of the component purge permissives are maintained.

(B) Components shall be purged with air or, after the unit is in service, with flue gas or inert gas that will not support combustion.

(C)* Purging of these components shall be permitted to be performed concurrently with the boiler enclosure purge.

(D) Accumulation of purge time and volume changes shall be permitted as soon as all of the component purge permissives are satisfied.

(E) Loss of any of the purge permissives during a component purge shall cancel any purge time and volume changes that have accumulated.

(F) After the component purge is complete, the component shall be permitted to be reset.

6.4.2.3.5 Reserved.

6.4.2.3.6* Loss of ID Fan Interlocks.

6.4.2.3.6.1* An interlock to prove that each ID fan is running and capable of providing the required flow shall be provided.

Loss of such proofs shall initiate loss of induced draft fan interlocks.

6.4.2.3.6.2 Associated damper(s) shall be closed on loss of an individual induced draft fan, unless it is the last induced draft fan in service.

6.4.2.3.6.3 Where an interlock system is provided to start, stop, and trip ID fans and FD fans in pairs, the associated FD fan shall be tripped on loss of an individual ID fan, and the dampers associated with both fans shall be closed, provided they are not the last fans in service. If they are the last fans in service, the dampers associated with both fans shall remain open.

6.4.2.3.6.4 On loss of all ID fans, all FD fans shall be tripped. All ID fan dampers shall be opened after a time delay to minimize high draft during fan coastdown. Dampers shall remain open and fans shall be started in accordance with 6.5.3.2 through 6.5.3.3.4. Flue gas recirculation fan system dampers shall be closed.

6.4.2.3.6.5 The master fuel trip (not necessarily automatic) shall be activated when the furnace negative pressure exceeds the value recommended by the manufacturer. If fans are operating after the trip, they shall be continued in service. The airflow shall not be increased by deliberate manual or automatic control actions.

6.4.2.3.6.6 Before the main fuel firing and following a master fuel trip, all ID fans shall be tripped if furnace negative pressure exceeds the value recommended by the manufacturer. A short time delay shall be permitted to allow for the negative pressure transients due to loss of the main flame. The value of the negative pressure at which this trip is activated shall be greater than that specified in 6.4.2.3.6.5.

6.4.2.3.7* Loss of FD Fan Interlocks.

6.4.2.3.7.1* An interlock to prove that each FD fan is running and capable of providing the required flow shall be provided. Loss of such proofs shall initiate loss of FD fan interlocks.

6.4.2.3.7.2 Associated damper(s) shall be closed on loss of an individual FD fan, unless it is the last FD fan in service.

6.4.2.3.7.3 Where an interlock system is provided to start, stop, and trip ID fans and FD fans in pairs, the associated ID fan shall be tripped on loss of an individual FD fan, and the dampers associated with both fans shall be closed, provided they are not the last fans in service. If they are the last fans in service, the ID fan shall remain in controlled operation, and the dampers associated with the FD fan shall remain open.

6.4.2.3.7.4 On loss of all FD fans, all FD fan dampers shall be opened after a time delay to minimize high duct pressure during fan coastdown. Dampers shall remain open. Flue gas recirculation fan system dampers shall be closed.

6.4.2.3.7.5 The master fuel trip shall be activated when the furnace pressure exceeds the maximum pressure value recommended by the manufacturer. If fans are operating after the trip, they shall be continued in service. The airflow shall not be increased by deliberate manual or automatic control actions.

6.4.2.3.7.6 Before main fuel firing and following a 5-minute period after a master fuel trip (furnace postpurge), FD fans shall be tripped if the furnace pressure exceeds the maximum pressure value recommended by the manufacturer.

6.4.2.3.8 Multiple and Variable-Speed Fan Interlocks. On start of the second fan and subsequent fan(s), whether the FD