

# Pressure Vessels

## THE ASME CODE SIMPLIFIED

Eighth Edition

- ✔ An understanding of the history of standards for Code compliance
- ✔ The various ways different standards achieve compliance
- ✔ The difference and interaction between various standards

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Chapter

# 1

# Origin, Development, and Jurisdiction of the ASME Code

## History of the ASME Code

On March 20, 1905, a disastrous boiler explosion occurred in a shoe factory in Brockton, Massachusetts, killing 58 persons, injuring 117 others, and causing a quarter of a million dollars in property damage. For years prior to 1905, boiler explosions had been regarded as either an inevitable evil or "an act of God" (see Figs. 1.1 and 1.2). But this catastrophic accident had the effect of making the people of Massachusetts see the necessity and desirability of legislating rules and regulations for the construction of steam boilers in order to secure their maximum safety. After much debate and discussion, the state enacted the first legal code of rules for the construction of steam boilers in 1907. In 1908, the state of Ohio passed similar legislation, the Ohio Board of Boiler Rules adopting, with a few changes, the rules of the Massachusetts Board.

Therefore, other states and cities in which explosions had taken place began to realize that accidents could be prevented by the proper design, construction, and inspection of boilers and pressure vessels and began to formulate rules and regulations for this purpose. As regulations differed from state to state and often conflicted with one another, manufacturers began to find it difficult to construct vessels for use in one state that would be accepted in another. Because of this lack of uniformity, both manufacturers and users made an appeal in 1911 to the Council of the American Society of Mechanical Engineers to correct the situation. The Council answered the appeal by appointing a committee "to formulate standard specifications for the construction of steam boilers and other pressure vessels and for their care in service."

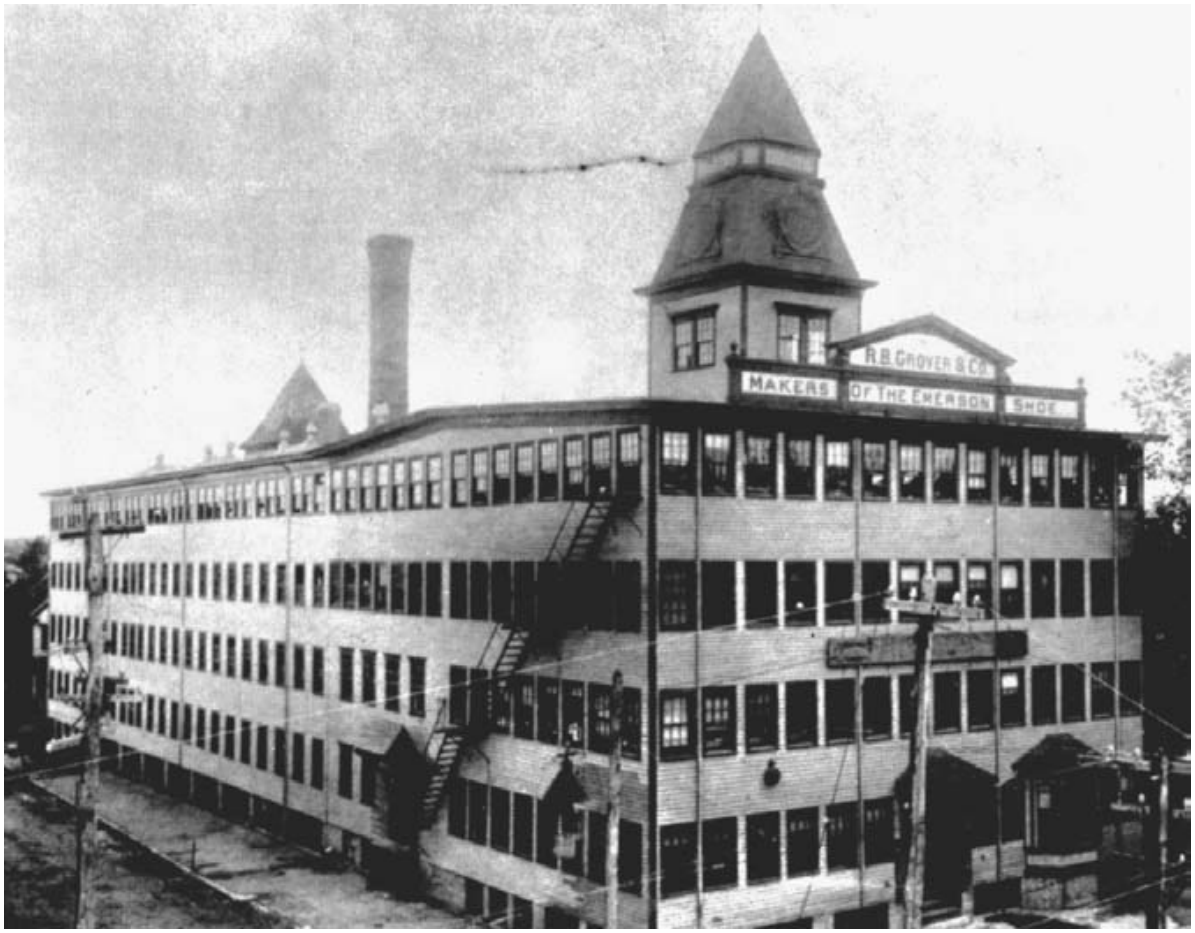


**Figure 1.1** The Brockton, Massachusetts, shoe factory. (*Courtesy of The Hartford Steam Boiler Inspection and Insurance Company.*)

The first committee consisted of seven members, all experts in their respective fields: one boiler insurance engineer, one material manufacturer, two boiler manufacturers, two professors of engineering, and one consulting engineer. The committee was assisted by an advisory committee of 18 engineers representing various phases of design, construction, installation, and operation of boilers.

Following a thorough study of the Massachusetts and Ohio rules and other useful data, the committee made its preliminary report in 1913 and sent 2000 copies of it to professors of mechanical engineering, engineering departments of boiler insurance companies, chief inspectors of boiler inspection departments of states and cities, manufacturers of steam boilers, editors of engineering journals, and others interested in the construction and operation of steam boilers, with a request for suggestions of changes or additions to the proposed regulations.

After three years of countless meetings and public hearings, a final draft of the first *ASME Rules for Construction of Stationary Boilers and For Allowable Working Pressures,* known as the 1914 edition, was adopted in the spring of 1915.



**Figure 1.2** Shoe factory after the boiler explosion of March 20, 1905, which led to the adoption of many state boiler codes and the *ASME Boiler and Pressure Vessel Code*. (*Courtesy of The Hartford Steam Boiler Inspection and Insurance Company.*)

## Additions to the Code

Since 1914, many changes have been made and new sections added to the Code as the need arose. The present sections are listed in the following order:

Section I. Power Boilers

Section II. Materials

- Part A: Ferrous Material Specifications
- Part B: Nonferrous Material Specifications
- Part C: Specifications for Welding, Rods, Electrodes, and Filler Metals
- Part D: Properties

Section III. Rules for Construction of Nuclear Components

- Subsection NCA: General Requirements for Divisions 1 and 2
- Division 1
  - Subsection NB: Class 1 Components
  - Subsection NC: Class 2 Components
  - Subsection ND: Class 3 Components
  - Subsection NE: Class MC Components
  - Subsection NF: Supports

Subsection NG: Core Support Structures

Subsection NH: Class 1 Components in Elevated Temperature Service

Appendices

Division 2. Code for Concrete Containments

Division 3. Containment Systems for Storage and Transport Packaging of Spent Nuclear Fuel and High Level Radioactive Materials and Waste

Section IV. Heating Boilers

Section V. Nondestructive Examination

Section VI. Recommended Rules for Care and Operation of Heating Boilers

Section VII. Recommended Guidelines for the Care of Power Boilers

Section VIII. Pressure Vessels

Division 1

Division 2. Alternative Rules

Division 3. Alternative Rules for Construction of High Pressure Vessels

Section IX. Welding and Brazing Qualifications

Section X. Fiber-Reinforced Plastic Pressure Vessels

Section XI. Rules for Inservice Inspection of Nuclear Power Plant Components

## ASME Boiler and Pressure Vessel Committee

The increase in the size of the Code reflects the progress of industry in this country. To keep up with this spontaneous growth, constant revisions have been required. The ASME Code has been kept up to date by the Boiler and Pressure Vessel Committee (currently consisting of more than 800 volunteer engineers and other technical professionals) which considers the needs of the users, manufacturers, and inspectors of boilers and pressure vessels. In the formulation of its rules for the establishment of design and operating pressures, the Committee considers materials, construction, methods of fabrication, inspection, certification, and safety devices. The ASME works closely with the American National Standards Institute (ANSI) to assure that the resulting documents meet the ANSI criteria for publication as American National Standards.

The members of the Committee do not represent particular organizations or companies but have recognized background and experience

by which they are placed in categories, which include manufacturers, users of the products for which the codes are written, insurance inspection, regulatory, and general. The Committee meets on a regular basis to consider requests for interpretations and revisions and additions to Code rules as dictated by advances in technology. Approved revisions and additions are published semiannually as addenda to the Code.

To illustrate, boilers were operating in 1914 at a maximum pressure of 275 psi and temperature of 600°F. Today, boilers are designed for pressures as high as 5000 psi and temperatures of 1100°F, and pressure vessels for pressures of 3000 psi and over and for temperatures ranging from –350°F to more than 1000°F.

Each new material, design, fabrication method, and protective device brought new problems to the Boiler Code Committee, requiring the expert technical advice of many subcommittees in order to expedite proper additions to and revisions of the Code. As a result of the splendid work done by these committees, the *ASME Boiler and Pressure Vessel Code* has been developed; it is a set of standards that assures every state of the safe design and construction of all boiler and pressure vessels used within its borders and is used around the world as a basis for enhancing public health, safety, and welfare. Many foreign manufacturers are accredited under the provisions of the *ASME Boiler and Pressure Vessel Code.*

## Procedure for Obtaining the Code Symbol and Certificate

Users of pressure vessels prefer to order ASME Code vessels because they know that such vessels will be designed, fabricated, and inspected to an approved quality control system in compliance with a safe standard. Pressure vessel manufacturers want the Code symbol and Certificate of Authorization so that they will be able to bid for Code work, thereby broadening their business opportunities. They also believe that authorization to build Code vessels will enhance the reputation of their shop.

If a company is interested in building Code vessels according to the ASME Section VIII, Division 1, Pressure Vessels Code, it should acquaint itself with Code Pars. U-2 and UG-92, which outline the manufacturer's responsibilities and define the requirements for an inspector. This third party in the manufacturer's plant, by virtue of being authorized by the state to do Code inspection, is the legal representation which permits the manufacturer to fabricate under state laws (the ASME Code).

Manufacturers who want to construct Code vessels covered by Section VIII, Division 1, obligate themselves with respect to quality

and documentation (see Code Appendix 10, Quality Control Systems). A survey will be required for the initial issuance of an ASME Certificate of Authorization and for each renewal. The evaluation is performed jointly by the Authorized Inspection Agency and the jurisdictional authority concerned which has adopted, and also administers, the applicable boiler and pressure vessel legislation. When the jurisdictional authority does not make the survey, or the jurisdiction is the inspection agency, the National Board of Boiler and Pressure Vessel Inspectors will be asked to participate in the survey.

After the survey has been jointly made to establish that a quality control system is actually in practice, the National Board representative, if involved, and the jurisdiction authority will discuss their findings with the manufacturer. If the manufacturer's system does not meet Code requirements, the company will be asked to make the necessary corrections. The survey team will then forward its report to the ASME with the recommendation that the manufacturer receive the Certificate of Authorization or, if failure to meet standards exists, that the certificate not be issued.

All Code shops must follow the above procedures in order to obtain the Code symbol. If your shop wants the Code Certificate of Authorization, you should write to the Secretary of the Boiler and Pressure Vessel Code Committee, ASME, 3 Park Avenue, New York, NY 10016-5990, stating your desire to build such vessels. To help the secretary and the Subcommittee on Code Symbol Stamps evaluate your shop, the application must describe the type and size of vessel the shop is capable of building and the type and size of your equipment, especially fabricating equipment. If possible, you should arrange with some Authorized Inspection Agency, such as your state, city, or insurance company, to undertake the inspection service after your shop has received ASME certification. You can then inform the ASME that specific inspection arrangements have already been made.

The secretary will send a statement of your request to the Subcommittee on Code Symbol Stamps. A request will also be made to the chief inspector of the particular state, city, or other inspection agency governing your company and/or the National Board of Boiler and Pressure Vessel Inspectors to make a survey that will determine whether or not your company has a quality control system that is capable of designing and fabricating pressure vessels by ASME Code rules.

The secretary receives a report of this survey and will then forward the report to the Subcommittee on Code Symbol Stamps. Should the subcommittee judge favorably, your company will be issued a Code symbol and Certificate of Authorization. A manufacturer with the ability, integrity, and quality control system to design and fabricate good pressure vessels will have no difficulty in obtaining Code authorization.

## The National Board of Boiler and Pressure Vessel Inspectors

The National Board of Boiler and Pressure Vessel Inspectors, an independent, nonprofit organization whose members are the jurisdictional officials responsible for enforcing and administrating the *ASME Boiler and Pressure Vessel Code,* was first organized in 1919. Since then, it has served for the uniform administration and enforcement of the rules of the *ASME Boiler and Pressure Vessel Code.* In drafting the first Code, the Boiler Code Committee realized that it had no authority to write rules to govern administration, and that compliance could be made mandatory only by the legislative bodies of states and cities.

Although some authorities thought that uniformity could be achieved by a code of uniform rules, they proved to be mistaken. Various states and cities adopted the ASME Code with the provision that boilers be inspected during construction by an inspector qualified under their own regulations; the boiler was then to be stamped with the individual local stamping to indicate its conformity with these regulations. This requirement created an unwieldy situation, for boilers constructed in strict accordance with the ASME Code still had to be stamped with the local stamping, thereby causing needless delay and expense in delivery of the vessel.

It was evident that some arrangement had to be made to overcome such difficulties. Therefore, boiler manufacturers met with the chief inspectors of the states and cities that had adopted the ASME Code and formed the National Board of Boiler and Pressure Vessel Inspectors for the purpose of presenting the ASME Code to governing bodies of all states and cities. Their aim was not only to promote safety and uniformity in the construction, installation, and inspection of boilers and pressure vessels but also to establish reciprocity between political subdivisions of the United States. Such ideals could best be carried out by a central organization under whose auspices chief inspectors, or other officials charged with the enforcement of inspection regulations, could meet and discuss their problems. The efforts of this first group of administrators succeeded in extending National Board membership to all Canadian provinces and most of the states and cities of the United States. It is now possible for an authorized shop to build a boiler or pressure vessel that will be accepted anywhere in the United States or Canada after it has been inspected by an Authorized Inspector holding a National Board Commission.

The ASME Code requires that Inspectors must meet certain minimum requirements of education and experience and must pass a written examination before they can be commissioned to perform Code inspections. One of the many functions of the National Board is the commissioning of Authorized Inspectors.

## Shop Reviews by the National Board

Before the issuance of an ASME Certificate of Authorization to build Code vessels, the manufacturer must have and demonstrate a quality control system. This system has to include a written description explaining in detail the quality-controlled manufacturing process.

Before the issuance of renewal of a Certificate of Authorization, the manufacturer's facilities and organization are subject to a joint review by the inspection agency and the legal jurisdiction concerned. For those areas where there is no jurisdiction, or where a jurisdiction does not review a manufacturer's facility, and/or the jurisdiction is the inspection agency, the function may be carried out by a representative of the National Board of Boiler and Pressure Vessel Inspectors. When the review of the manufacturer's facilities and organization has been made jointly by the inspection agency, and/or the legal jurisdiction, or a representative of the National Board of Boiler and Pressure Vessel Inspectors, a written report will be sent to the American Society of Mechanical Engineers. The National Board of Boiler and Pressure Vessel Inspectors also participates in all nuclear surveys.

The National Board also issues Certificates of Authorization for the use of the National Board R stamp, to be applied to ASME Code and National Board–stamped boilers and/or pressure vessels on which repairs are to be made (see the section Welded Repair or Alteration Procedure in this chapter).

Another important service the National Board performs is the certification of safety valves and safety relief valves. The *ASME Boiler and Pressure Vessel Code* contains specific requirements governing the design and capacity certification of safety valves installed on Code-stamped vessels. The certification tests are conducted at a testing laboratory approved by the ASME Boiler and Pressure Vessel Committee.

In addition to safety valve certification, the National Board has its own testing laboratory for its experimental work and for certifying ASME safety and relief valves. The facilities of the laboratory are also available to manufacturers and other organizations for research, development, or other test work.

## National Board Requirements

All Canadian provinces and most states require boilers and pressure vessels to be inspected during fabrication by an Inspector holding a National Board Commission and then to be stamped with a National Board standard number. Qualified and authorized boiler and pressure vessel manufacturers must be registered with the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229. In addition, two data sheets on each vessel must be filed

with the National Board, one copy of which is retained by the Board and the other sent to the administrative authority of the state, city, or province in which the vessel is to be used (see Code Par. UG-120).

The National Board of Boiler and Pressure Vessel Inspectors is constantly working to assure greater safety of life and property by promoting and securing uniform enforcement of boiler and pressure vessel laws and uniform approval of designs and structural details of these vessels, including the accessories that affect their safe operation; by furthering the establishment of a uniform Code; by espousing one standard of qualifications and examinations for inspectors who are to enforce the requirements of this Code; and by seeing that all relevant data of the Code are made available to members.

In prior years the Uniform Boiler and Pressure Vessel Laws Society issued a *Synopsis of Boiler and Pressure Vessel Laws*, *Rules*, *and Regulations*, the publishing of which has been assumed by the National Board. The book gives a summary of applicable laws of states, provinces, cities, and counties. It has proved valuable to users and manufacturers of boilers and pressure vessels. Figures 1.3 and 1.4 show political subdivisions of the United States and Canada.

## Code Case Interpretations

As the Code does not cover all details of design, construction, and materials, pressure vessel manufacturers sometimes have difficulty in interpreting it when trying to meet specific customer requirements. In such cases the Authorized Inspector should be consulted. If the Inspector is unable to give an acceptable answer or has any doubts or questions about the proper interpretation of the intent of the Code, the question can be referred to the Inspector Supervisor's office. If the Inspector and his or her supervisor are not able to provide a ruling, the manufacturer may then request the assistance of the Boiler and Pressure Vessel Committee, which meets regularly to consider inquiries of this nature. In referring questions to the Boiler and Pressure Vessel Committee, it is necessary to submit complete details, sketches of the construction involved, and references to the applicable paragraphs of the Code; it is also useful to include opinions expressed by others. (See Code Appendix 16 for guidance in preparing inquiries to the ASME.)

Inquiries should be submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 3 Park Avenue, New York, NY 10016-5990. (It should be noted that with the advent of the Internet, much of this work can be accomplished through the Web. The ASME can be found at www.asme.org.) The secretary will distribute copies of the inquiry to the committee members for study. At the next committee meeting, interpretations will be formulated.

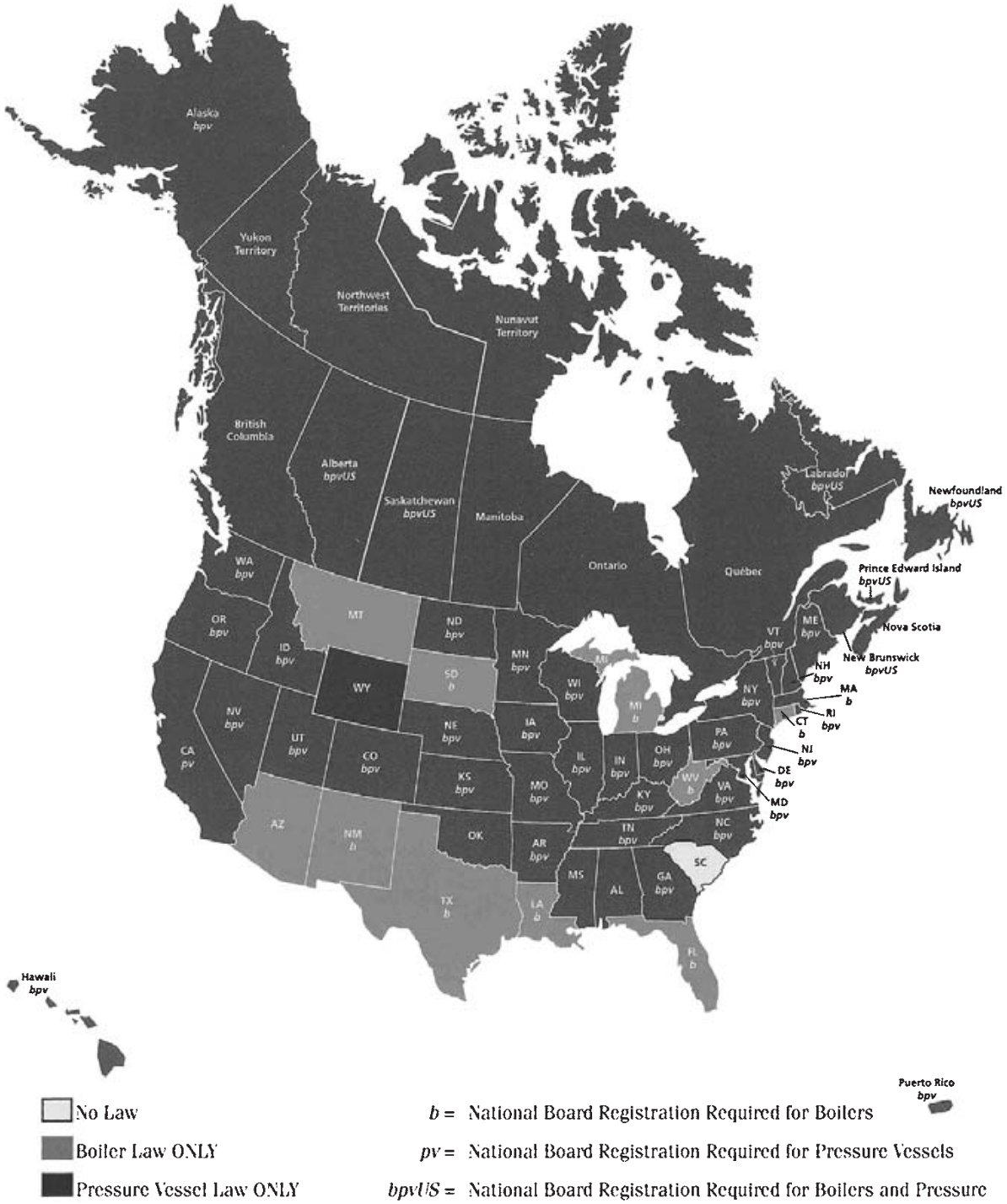


**Figure 1.3** Boiler and pressure vessel laws in the United States and Canada. (*Reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors, www.nationalboard.org, from* National Board Synopsis of Boiler and Pressure Vessel Laws, Rules and Regulations, © *2003.*)

These interpretations (issued twice each year) may then become addenda to the Code. If so, they will first be printed in the Addenda supplement of the Code for subsequent inclusion in the latest edition of the Code (printed every three years). Addendas are issued once each year.

The addenda incorporate as many case interpretations as possible in order to keep the open file of cases to a minimum. For their own good,

## BOILER AND PRESSURE VESSEL CODES

**KEY:**

I – Power Boilers
II – Materials
III(1) – Nuclear Facility Components
III(2) – Nuclear Facility (Code for Concrete Containments)
IV – Heating Boilers
V – Nondestructive Examination
VI – Care and Operating of Heating Boilers
VII – Care of Power Boilers
VIII(1) – Pressure Vessels
VIII(2) – Pressure Vessels (Alternate Rules)
VIII(3) – Pressure Vessels (Alternate Rules for High Pressure)
IX – Welding and Brazing Qualifications
X – Fiber-Reinforced Plastic Pressure Vessels
XI – Inservice Inspection, Nuclear

Y – Required by Law N – Not Required by Law

**UNITED STATES**

| Jurisdiction | I | II | III (1) | III (2) | IV | V | VI | VII | VIII (1) | VIII (2) | VIII (3) | IX | X | XI | Code Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Alaska | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| Arizona | Y | Y | N | N | Y | Y | N | N | N | N | N | Y | N | N | N |
| Arkansas | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| California | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| Colorado | Y | Y | N | N | Y | N | N | N | Y | Y | N | N | Y | N | N |
| Connecticut | Y | Y | Y | N | Y | Y | Y | Y | N | N | N | Y | N | N | Y |
| Delaware | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Florida | Y | Y | N | N | Y | Y | Y | Y | N | N | N | Y | N | N | N |
| Georgia | Y | N | Y | Y | Y | N | N | N | Y | Y | Y | N | Y | Y | Y |
| Hawaii | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Idaho | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Illinois | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| Indiana | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N | Y | N | N | N |
| Iowa | Y | Y | Y | Y | Y | Y | N | N | Y | Y | Y | Y | Y | N | N |
| Kansas | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| Kentucky | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N | Y | N | N | Y |
| Louisiana | Y | N | N | N | Y | N | Y | Y | N | N | N | Y | N | N | Y |
| Maine | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| Maryland | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Massachusetts | Y | Y | Y | N | Y | Y | N | N | Y | N | N | Y | Y | Y | N |
| Michigan | Y | Y | Y | N | Y | Y | N | N | Y | N | N | Y | N | Y | Y |
| Minnesota | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Mississippi | Y | N | N | N | Y | N | N | N | Y | N | N | N | N | N | N |
| Missouri | Y | Y | N | N | Y | Y | Y | Y | Y | Y | N | Y | Y | N | Y |
| Montana | Y | Y | N | N | Y | Y | Y | Y | N | N | N | Y | N | N | N |
| Nebraska | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| Nevada | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| New Hampshire | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| New Jersey | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| New Mexico | Y | N | N | N | Y | N | N | N | N | N | N | Y | N | N | N |
| New York | Y | Y | N | N | Y | Y | N | N | Y | N | N | N | N | N | Y |
| North Carolina | Y | Y | Y | Y | Y | Y | N | N | Y | Y | Y | Y | Y | Y | N |
| North Dakota | Y | Y | N | N | Y | Y | N | N | Y | Y | Y | Y | Y | N | N |
| Ohio | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Oklahoma | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | N | N | N |
| Oregon | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Pennsylvania | Y | Y | Y | Y | Y | N | N | N | Y | Y | Y | Y | N | Y | N |
| Rhode Island | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| South Carolina | Y | Y | N | N | N | Y | N | N | N | N | N | Y | N | N | N |
| South Dakota | Y | N | N | N | Y | Y | N | N | N | N | N | Y | N | N | N |
| Tennessee | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Texas | Y | N | Y | Y | Y | N | N | N | Y | Y | N | N | N | Y | Y |

**Figure 1.4** Tabulation of boiler and pressure vessel codes and stamping requirements in the United States and Canada. (*Reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors, www.nationalboard.org, from* National Board Synopsis of Boiler and Pressure Vessel Laws, Rules and Regulations, © *2003.*)

**UNITED STATES** *continued . . .*

| Jurisdiction | I | II | III (1) | III (2) | IV | V | VI | VII | VIII (1) | VIII (2) | VIII (3) | IX | X | XI | Code Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utah | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Vermont | Y | Y | N | N | Y | Y | N | N | Y | Y | N | Y | Y | N | N |
| Virginia | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Washington | Y | N | Y | Y | Y | N | N | N | Y | Y | Y | N | Y | N | N |
| West Virginia | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | N | N | Y |
| Wisconsin | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N | Y | Y | Y | Y |
| Wyoming | N | N | N | N | N | N | N | N | Y | Y | Y | N | N | N | N |

**CANADA**

| Jurisdiction | I | II | III (1) | III (2) | IV | V | VI | VII | VIII (1) | VIII (2) | VIII (3) | IX | X | XI | Code Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alberta | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| British Columbia | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Manitoba | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| New Brunswick | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| Newfoundland and Labrador | Y | Y | N | N | Y | Y | Y | Y | Y | Y | N | Y | Y | N | N |
| Northwest Territories | Y | Y | N | N | Y | Y | Y | Y | Y | Y | N | Y | N | N | N |
| Nova Scotia | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y |
| Nunavut Territory | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| Ontario | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Prince Edward Island | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | N | Y |
| Québec | N | N | N | N | N | N | N | N | N | N | N | Y | N | N | N |
| Saskatchewan | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N | Y | Y | Y | N |
| Yukon Territory | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | N | N |

**CITIES, COUNTIES AND TERRITORIES OF THE UNITED STATES**

| Jurisdiction | I | II | III (1) | III (2) | IV | V | VI | VII | VIII (1) | VIII (2) | VIII (3) | IX | X | XI | Code Cases |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque, New Mexico | Y | Y | N | N | Y | N | Y | Y | N | N | N | Y | N | N | Y |
| Buffalo, New York | Y | N | Y | Y | Y | N | N | N | Y | N | N | N | N | N | Y |
| Chicago, Illinois | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Denver, Colorado | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| Detroit, Michigan | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | N | N |
| Los Angeles, California | Y | Y | Y | Y | Y | Y | N | N | Y | Y | N | Y | N | N | Y |
| Miami-Dade County, Florida | Y | N | N | N | Y | N | N | N | Y | Y | N | N | N | N | Y |
| Milwaukee, Wisconsin | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| New Orleans, Louisiana | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N |
| Puerto Rico | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Seattle, Washington | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| Spokane, Washington | Y | Y | N | N | Y | Y | Y | Y | Y | Y | N | Y | Y | N | Y |
| St. Louis, Missouri | Y | Y | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | N |
| Washington, D.C. | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |

**Figure 1.4** (*Continued*)

**STAMPING REQUIREMENTS**

**UNITED STATES**

| Jurisdiction | National Board | ASME |
|---|---|---|
| Alabama | None | None |
| Alaska | R, VR | All, except HV, NV, UV, V |
| Arizona | R, VR | A, E, H, HLW, HV, M, PP, S, V |
| Arkansas | NR, R, VR | All |
| California | None | All |
| Colorado | NR, R, VR | All |
| Connecticut | R, VR | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, S, V |
| Delaware | NR, R, VR | All |
| Florida | R, VR | A, E, H, HLW, HV, M, PP, S, V |
| Georgia | NR, R, VR | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, RP, S, U, U2, U3, UM UV, V |
| Hawaii | R, VR | A, E, H, HLW, HV, M, PP, S, U, UM UV, V |
| Idaho | NR, R, VR | All |
| Illinois | R, VR | A, E, H, HLW, HV, M, N,* NA,* NPT,* NV,* PP, RP, S, U, U2, UM, UV, V |
| Indiana | NR, R | A, E, H, HLW, M, N, NA, NPT, PP, S, U, U2, UM UV, V |
| Iowa | R, VR | A, E, H, HLW, HV, M, N, NA, NPT, PP, S, U, U2, UV, V |
| Kansas | R, VR | A, E, H, HLW, HV, M, PP, S, U, UM, V |
| Kentucky | R, VR | A, E, H, HLW, HV, PP, S, U, UV, V |
| Louisiana | R, VR | A, E, H, HLW, HV, M, S |
| Maine | R, VR | A, E, H, HLW, HV, M, PP, RP, S, U, U2, U3, UM, UV, V |
| Maryland | R | All |
| Massachusetts | NR, R, VR | H, M, N, NA, NPT, NV, PP, S, U, UM |
| Michigan | None | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, S, V |
| Minnesota | NR, R, VR | All |
| Mississippi | VR | A, E, H, HLW, HV, M, S, U, UV, V |
| Missouri | R, VR | All |
| Montana | R, VR | A, E, H, HV, S |
| Nebraska | R, VR | A, E, H, HLW, HV, M, PP, S, U, U2, U3, V |
| Nevada | NR, R, VR | A, E, H, HLW, HV, M, NV, PP, S, U, U2, UM, UV, V |
| New Hampshire | NR, R, VR | A, H, N, NA, NPT, PP, S, U, UV |
| New Jersey | R | All |
| New Mexico | None | A, E, H, HLW, HV, PP, S, V |
| New York | R, VR | A, E, H, M, PP, S, U, V |
| North Carolina | R, VR | All |
| North Dakota | R, VR | A, E, H, HLW, HV, M, PP, RP, S, U, U2, U3, UD, UV, UV3, V |
| Ohio | NR, R, VR | All |
| Oklahoma | R, VR | A, E, H, HLW, HV, M, PP, S, U, U2, UM, UV, V |
| Oregon | R, VR | A, H, HLW, N, NPT, PP, S, U, U2, U3, UM, V |
| Pennsylvania | NR, R, VR | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, S, U, U2, U3, UM, UV, V |
| Rhode Island | NR, R, VR | All |
| South Carolina | None | None |
| South Dakota | NR, R, VR | A, E, H, HLW, HV, M, PP, S, V |
| Tennessee | NR, R, VR | All |
| Texas | R, VR | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, S, U, U2, UV, V |
| Utah | NR, R, VR | A, E, H, HLW, HV, M, N, NA, NPT, NV, PP, RP, S, U, U2, U3, UV, V |
| Vermont | R, VR | A, E, H, HLW, HV, M, PP, S, U, U2, UM, UV, V |
| Virginia | None | All |
| Washington | NR, R, VR | All |
| West Virginia | R, VR | A, E, PP, S |
| Wisconsin | NR, R, VR | All |
| Wyoming | None | U, U2, U3, UV |

* Comes under the jurisdiction of the Illinois Department of Nuclear Safety.

**Figure 1.4** (*Continued*)

all Code manufacturers should subscribe to the Code Cases offered by the American Society of Mechanical Engineers. They will then automatically receive all cases issued by the Boiler and Pressure Vessel Committee, some of which may prove very useful.

## Canadian Pressure Vessel Requirements

United States manufacturers of ASME Code vessels often receive orders for vessels to be installed in Canada. All provinces of Canada

**CANADA**

| Jurisdiction | National Board | ASME |
|---|---|---|
| Alberta | None | All when manufactured outside Canada |
| British Columbia | None | All |
| Manitoba | R, VR | S, U, H when manufactured outside Canada |
| New Brunswick | NR, R, VR | H, HLW, N, NV, PP, S, U |
| Newfoundland and Labrador | None | All |
| Northwest Territories | None | A, E, H, HLW, HV, M, S, U, U2, UM, UV, V |
| Nova Scotia | R, VR | A, M, PP, S, U, U2, UM, UV, V |
| Nunavut Territory | None | A, E, H, HLW, HV, M, S, U, U2, UM, UV, V |
| Ontario | None | All |
| Prince Edward Island | NR, VR | H, HLW, HV, M, N, NA, NPT, NV, S, U, U2, UV, V |
| Québec | None | All when manufactured outside Canada |
| Saskatchewan | None | E, H, HLW, HV, M, S, U, U2, UM, UV, V |
| Yukon Territory | None | All |

**CITIES, COUNTIES AND TERRITORIES OF THE UNITED STATES**

| Jurisdiction | National Board | ASME |
|---|---|---|
| Albuquerque, New Mexico | R, VR | A, E, H, HLW, HV, M, S, U, UM, UV, V |
| Buffalo, New York | R, VR | H, S, U |
| Chicago, Illinois | All | All |
| Denver, Colorado | NR, R, VR | All |
| Detroit, Michigan | None | All |
| Los Angeles, California | NR, R, VR | A, H, HLW, HV, M, PP, S, U, UM, UV, V |
| Miami-Dade County, Florida | None | None |
| Milwaukee, Wisconsin | R | H, S, U |
| New Orleans, Louisiana | NR, R, VR | All |
| Puerto Rico | NR, R, VR | All |
| Seattle, Washington | NR, R, VR | All |
| Spokane, Washington | R, VR | A, E, H, HLW, M, PP, S, U, U2, UV, V |
| St. Louis, Missouri | R | H, S, U, U2 |
| Washington, D. C. | VR | A, E, H, PP, U |

**Figure 1.4** (*Continued*)

have adopted the ASME Code and require vessels to be shop-inspected by an Inspector holding a National Board Commission and to be stamped with a provincial registration number in addition to the ASME symbol and National Board stamping.

But before construction begins, one important requirement has to be met in all provinces of Canada. Each manufacturer must submit blueprints and specification sheets in triplicate of all designs for approval and registration by the chief inspector of the province in which the vessel is to be used.

After the chief inspector receives the drawings, they are checked by an engineer to determine their compliance with the Code and also with provincial regulations. If the design does not meet the requirements, a report is sent to the manufacturer, explaining why it cannot be approved and requesting that the necessary changes be made and the corrected drawings returned. If the design complies in full, one copy of the drawing is returned to the manufacturer with the stamped

approval and a registration number that must be stamped on the vessel in addition to the ASME symbol and National Board stamping.

Once a design has been approved and registered, any number of vessels of that design can be built and used in the province where it is approved. If a vessel of the same design is to be sent to another Canadian province, the manufacturer's letter to the chief inspector of that pro-vince should state the registration number of the original approval. The second province will then use the same registration number with the addition of its own province number. For example, a design first registered in Ontario might have been given the number 764. This number would be followed by a decimal point and then the number 5, which signifies the Province of Ontario. The registration would thus be 764.5. If this same design were used in the Province of Manitoba, it would be given the registration number 764.54, with the figure 4 denoting Manitoba.

The Canadian provinces also require their own manufacturer's affidavit form, with the registration number and the shop inspector's signature on the data sheets. Finally, when a vessel is delivered to a purchaser in Canada, an affidavit of manufacture bearing the registration number and the signature of the authorized shop inspector must be sent to the chief inspector of the province for which it is intended.

## Department of Transportation Regulations

A new Chapter 11 in this book explains clearly the new federal regulations 49 CFR Parts ¶107, ¶178, and ¶180, formerly known as dockets HM-183 and HM-183A. This new regulation mandates and requires that all over-the-road specification cargo tank trucks be manufactured by a holder of an ASME Code symbol U stamp. Most of these cargo tank trucks will not bear the official ASME Code stamp; however, certain specification cargo tanks will be manufactured and continue to be stamped ASME if all the requirements of the Code are met. Additionally and most importantly, all specification cargo tanks will now be required to be repaired by the holder of a National Board R stamp.

These new regulations will require numerous companies to obtain the ASME U Code symbol stamp or the National Board R symbol stamp. Quality control programs will be required when no such programs have existed in the past. Training of personnel will now be involved in areas of nondestructive examination, testing, procedure qualification, and numerous other areas involving quality. This will cause additional expense to the facilities involved. New maintenance actions involving periodic tests and inspections are also mandated and must be carried out.

## Welded Repair or Alteration Procedure

Repairs or alterations of ASME Code vessels may be made in any shop that manufactures Code vessels or in the field by any welding contractor qualified to make repairs on such vessels. Recognizing the need for rules for repair and alterations to boilers and pressure vessels, the National Board of Boiler and Pressure Vessel Inspectors in their inspection code, Chapter III, gives rules that many states have incorporated into their own boiler and pressure vessel laws. Many companies have been using these rules as a standard for repairs to pressure vessels.

The National Board also has six Certificates of Authorization for use of the National Board R stamp. Any repair organization may obtain Certificates of Authorization for use of the National Board R stamp to be applied to ASME Code and National Board–stamped boilers and/or pressure vessels on which repairs have been made.

Before an R stamp is issued, the firm making repairs must submit to a review of its repair methods. It must also have an acceptable written quality control System covering repair design, materials to be used, welding procedure specifications, welders' qualifications, repair methods, and examination. The review will be made by a National Board member jurisdiction where the repair company is located. If there is no National Board member jurisdiction, or, at the request of such jurisdiction, the review will be made by a representative of the National Board.

Manufacturers and assemblers who hold ASME Certificates of Authorization and Code stamps, with the exception of H (cast iron), V, UV, and UM stamps, may obtain the National Board R stamp without review provided their quality control system covers repairs.

Whenever the R stamp is to be applied to National Board–stamped boilers and pressure vessels, all repairs are subject to acceptance by an Inspector who holds a valid National Board Commission and a valid Certificate of Competency issued by a state or jurisdiction of the United States or Province of Canada.

The Authorized Inspector will be guided by the *National Board Inspection Code** as well as by any existing local rules governing repair of vessels. When the work is to be done on location, repairs to a vessel require greater skill than was required when the vessel was first shop-constructed. Utmost consideration must be given to field repairs, which may necessitate cutting, shaping, and welding with portable equipment. The practicability of moving the vessel from the site to a properly equipped repair shop should be considered. Before repairs are made, the method of repair must be approved by an Authorized Inspector. The

*The Code is published by the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229.

Inspector will examine the vessel, identify the material to be welded, and compare it with the material to be used in repair. A check is then made to ensure that the welding contractor or shop has a qualified welding procedure for the material being welded and that the welder who does the work is properly qualified to weld that material. If the repair or alteration requires design calculations, the Inspector will review the calculations to assure that the original design requirements are met. For repair of Section VIII, Division 2 pressure vessels, the design calculations must be reviewed and certified by a Registered Professional Engineer experienced in pressure vessel design.

When the repairs or alterations and the necessary tests have been completed, one or more of the following reports are filled out (see Fig. 1.5): Form R-1, Report of Welded Repair; Form R-2, Report of Alteration; and Form R-3, Report of Parts Fabricated by Welding. (Form R-4, Report Supplementary Sheet, should be used for any information for which there is not enough room on one of the other three forms.) Some states and insurance companies have their own forms which must be signed by the contractor or manufacturer making the repair and by the Authorized Inspector.

When an alteration is made to a vessel, it shall comply with the section of the ASME Code to which the original vessel was constructed to conform. The required inspection shall be made by an Authorized Inspector holding a National Board Commission. No alteration shall be initiated without the approval of the Authorized Inspector.

When alterations are completed, Form R-2 shall be signed and certified, indicating that the alteration has met the applicable requirements. This R-2 report shall record the required data and shall clearly indicate what changes or alterations have been made to the original construction. On the R-2 report, under Remarks, the name of the original manufacturer, manufacturer's serial number, and the National Board number assigned to the vessel by the original manufacturer shall be stated. When the vessel has been altered, an original and one copy of the certified repair or alteration report shall be filed with the National Board of Boiler and Pressure Vessel Inspectors. A copy shall go to the jurisdictional authority, inspection agency, and the customer for either repairs or alterations when so requested by the applicable persons.

When the stamping plate is made for an altered vessel, it shall contain all the information required by the National Board Inspection Code (see Fig. 1.6). Note the difference in the stamping of the nameplate of an altered vessel from the stamping of the nameplate of a repaired vessel (see Fig. 1.7).

The words *Altered* or *Rerated* in letters $5/16$ in high shall be stamped on the plate in lieu of the Code symbol, National Board R symbol, and National Board number. The date shown on the nameplate shall be the

## FORM R-1 REPORT OF WELDED REPAIR

in accordance with provisions of the National Board Inspection Code

1. Work performed by (1) (name of repair organization) (2) (Form R No.)

(address) (53) (P.O. No. Job No. etc.)

2. Owner (3) (name)

(address)

3. Location of installation (4) (name)

(address)

4. Unit identification (5) (boiler, pressure vessel) Name of original manufacturer (6)

5. Identifying nos.: (7) (mfg serial no.) (8) (National Board No.) (8) (jurisdiction no.) (8) (other) (9) (year built)

6. NBIC Edition/Addenda: (10) (edition) (10) (addenda)

Original Code of Construction for Item: (11) (name/section/division) (11) (edition/addenda)

Construction Code Used for Repair Performed: (11) (name/section/division) (11) (edition/addenda)

7. Description of work: (12) (use supplemental sheet, Form R-4, if necessary)

Pressure Test, if applied (13) psi

8. Replacement Parts. Attached are Manufacturer's Partial Data Reports or Form R-3s properly completed for the following items of this report:

(14) (name of part, item number, data report type, mfr's. name and identifying stamp)

9. Remarks: (15)

### CERTIFICATE OF COMPLIANCE

I, (16), certify that to the best of my knowledge and belief the statements in this report are correct and that all material, construction, and workmanship on this Repair conforms to the National Board Inspection Code.

National Board "R" Certificate of Authorization No. (17) expires on (18), _____

Date (19), _____ (20) (name of repair organization) Signed (21) (authorized representative)

### CERTIFICATE OF INSPECTION

I, (22), holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of (23) and employed by (24) of (25) have inspected the work described in this report on (26), _____ and state that to the best of my knowledge and belief this work complies with the applicable requirements of the National Board Inspection Code.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date (19), _____ Signed (27) (inspector) Commissions (28) (National Board (incl endorsements), andjurisdiction, and no.)

**Figure 1.5** Form R-1, Report of Welded Repair; Form R-2, Report of Alteration; Form R-3, Report of Parts Fabricated by Welding; Form R-4, Report Supplementary Sheet; and Guide for Completing National Board Form R Reports. (*Reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors, www.nationalboard.org, from* 1998 National Board Inspection Code, *© 1998.*)

## FORM R-2 REPORT OF ALTERATION

in accordance with provisions of the National Board Inspection Code

1. Work performed by (1) (name of alteration organization) (2) (Form R No.)

(address) (53) (P.O. No. Job No. etc.)

2. Owner (3) (name)

(address)

3. Location of installation (4) (name)

(address)

4. Unit identification (5) (boiler, pressure vessel) Name of original manufacturer (6)

5. Identifying nos.: (7) (mfg serial no.) (8) (National Board No.) (8) (jurisdiction no.) (8) (other) (9) (year built)

6. NBIC Edition/Addenda: (10) (edition) (10) (addenda)

Original Code of Construction for Item: (11) (name/section/division) (11) (edition/addenda)

Construction Code Used for Alteration Performed: (11) (name/section/division) (11) (edition/addenda)

7. Description of work: (12) (use supplemental sheet, Form R-4, if necessary)

Pressure Test, if applied (13) psi

8. Replacement Parts. Attached are Manufacturer's Partial Data Reports or Form R-3s properly completed for the following items of this report:

(14)

(name of part, item number, data report type, mfr's. name and identifying stamp)

9. Remarks: (15)

**Figure 1.5** (*Continued*)

Form R-2 (back) (2) (Form R No.)

**DESIGN CERTIFICATION**

I, (16), certify that to the best of my knowledge and belief the statements in this report are correct and that the Design Change described in this report conforms to the National Board Inspection Code.
National Board "R" Certificate of Authorization No. (17) expires on (18), _____
Date (19), _____ (20) (name of design organization) Signed (21) (authorized representative)

**CERTIFICATE OF DESIGN CHANGE REVIEW**

I, (22), holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of (23) and employed by (24) of (25) have reviewed the design change as described in this report and state that to the best of my knowldge and belief such change complies with the applicable requirements of the National Board Inspection Code.
By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date (19), _____ Signed (27) (inspector) Commissions (28) (National Board (incl endorsements), and jurisdiction, and no.)

**CONSTRUCTION CERTIFICATION**

I, (16), certify that to the best of my knowledge and belief the statements in this report are correct and that all material, construction, and workmanship on this Alteration conforms to the National Board Inspection Code.
National Board "R" Certificate of Authorization No. (17) expires on (18), _____
Date (19), _____ (20) (name of alteration organization) Signed (21) (authorized representative)

**CERTIFICATE OF INSPECTION**

I, (22), holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of (23) and employed by (24) of (25) have inspected the work dedcribed in this report on (26), _____ and state that to the best of my knowledge and belief this work complies with the applicable requirements of the National Board Inspection Code.
By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date (19), _____ Signed (27) (inspector) Commissions (28) (National Board (incl endorsements), and jurisdiction, and no.)

**Figure 1.5** (*Continued*)

date of alteration. This nameplate shall be permanently attached to the vessel adjacent to the original manufacturer's nameplate or stamping, which shall remain on the vessel.

If the alteration requires removal of the original manufacturer's nameplate or stamping, it shall be retained and reattached to the altered vessel. Such relocation shall be noted on the R-1 report subject to the jurisdictional requirements.

## Managerial Factors in Handling Code Work

The producer of welded pressure vessels is faced today with many serious problems, not the least of which is managing to stay in business

## FORM R-3 REPORT OF PARTS FABRICATED BY WELDING

in accordance with provisions of the National Board Inspection Code

1. Manufactured by (1) (name of manufacturer) (2) (Form R No.)

(address) (53) (P.O. No. Job No. etc.)

2. Manufactured for (29) (name of purchaser)

(address)

3. Design Condition specified by (30) (name of organization) Code design by (31) (name of organization)

4. Design Code (32) (code type and section) (33) (code year) (34) (addenda date) (35) (formula on which MAWP is based)

5. Identification of Parts

| Name of Part | Qty. | Line No. | Manufacturer's Identifying No. | Manufacturer's Drawing No. | MAWP | Shop Hydro psi | Year Built |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| (36) | (37) | (38) | (39) | (40) | (41) | (13) | (9) |
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6. Description of Parts

| | (a) Connections other than tubes | | | Heads or Ends | | | (b) Tubes | | |
|---|---|---|---|---|---|---|---|---|---|
| Line No. | Size and Shape | Material Spec No. | Thickness In. | Shape | Thickness In. | Material Spec No. | Diameter In. | Thickness In. | Material Spec No. |
| | | | | | | | | | |
| (38) | (42) | (43) | (44) | (45) | (46) | (43) | (47) | (48) | (43) |
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7. Remarks (15)

**Figure 1.5** (*Continued*)

Form R-3 (back)

(2)
(Form R No.)

**CERTIFICATE OF SHOP COMPLIANCE**

I, (16), certify that to the best of my knowledge and belief the statements in this report are correct and that all material, fabrication, construction, and workmanship of the described parts conforms to the National Board Inspection Code and standards of construction cited.

National Board "R" Certificate of Authorization No. (17) expires on (18), _____

Date (19), _____ (20) Signed (21)

(name of R Certificate holder) (authorized representative)

**CERTIFICATE OF SHOP INSPECTION**

I, (22), holding a valid Commission issued by The National Board of Boiler and Pressure Vessel Inspectors and certificate of competency issued by the jurisdiction of (23) and employed by (24) of (25) have inspected the parts described in this report on (26), _____ and state that to the best of my knowledge and belief the parts comply with the applicable requirements of the National Board Inspection Code.

By signing this certificate, neither the undersigned nor my employer makes any warranty, expressed or implied, concerning the work described in this report. Furthermore, neither the undersigned nor my employer shall be liable in any manner for any personal injury, property damage or loss of any kind arising from or connected with this inspection.

Date (19), _____ Signed (27) Commissions (28)

(Inspector) (National Board (incl endorsements), and jurisdiction, and no.)

**Figure 1.5** (*Continued*)

and earn a fair profit.* Severe competition exists throughout the plate-fabricating industry, not only because of the growth in the number of fabricating shops but also because of the tremendous technological advances made in recent years. Many of the older, more heavily capitalized plants have been hit hard. Some of these have successfully turned to specialized fields; others produce specialty products that return a good profit when in demand. When demand slackens, these shops often turn to general fabrication, thereby increasing the competitive situation for the general plate fabricator.

For this type of fabricator, who essentially runs a job shop, the profit margin is restricted from the outset because jobs are usually awarded to the lowest bidder. Although there is nothing unusual in this method of competing, it does increase the need to think ahead clearly and to avoid unnecessary costs. For the job shop handling ASME Code vessels as well as non-Code work, the importance of careful planning is greatly increased because of the relatively high costs of Code material and also the variety in techniques and procedures demanded.

A second important factor in the award of a contract is delivery time, and here again planning assumes utmost importance. The buyer of a

*The material in this section, Managerial Factors in Handling Code Work, was contributed by C. H. Willer, former editor of *Welding Journal*.

## FORM R-4 REPORT SUPPLEMENTARY SHEET

in accordance with provisions of the National Board Inspection Code

1. Work performed by (1) (49) (name) (2) (49) (Form R reference)

(address) (53) (49) (P.O. No. Job No. etc.)

2. Owner (3 or 29) (49) (name)

(address)

3. Location of installation (4) (49) (name)

(address)

Reference Line No. Continued from Form R-____ (50)

(51) (52)

Date (19) , ____ Signed (21) (authorized representative) Name (20) (49) (authorized organization)

Date (19) , ____ Signed (27) (Inspector) Commissions (28) (49) (National Board (incl endorsements), and jurisdiction, and no.)

**Figure 1.5** (*Continued*)

## Guide for Completing National Board FORM R Reports

1. Name and address of the R Certificate organization which performed the work.
2. Form R Number assigned by the organization which performed the work. (A single, sequential log shall be maintained by the organization for R-1, R-2, and R-3 Forms registered with the National Board).
3. Name and address of the Owner of the pressure retaining item.
4. Name and address of plant or facility where the pressure retaining item is installed.
5. Description of the pressure retaining item, such as boiler or pressure vessel.
6. Name of original manufacturer of the pressure retaining item if a boiler or pressure vessel. If other than a boiler or pressure vessel, complete if known.
7. Serial number of the pressure retaining item as assigned by the original manufacturer.
8. Identification of the pressure retaining item by applicable registration number. If installed in Canada, indicate the Canadian design registration number (CRN), and list the drawing number under "other."
9. Identify the year in which fabrication/construction of the item was completed.
10. Indicate edition and addenda of the NBIC under which this work is being performed.
11. Indicate name, section, and division of original code of construction, including edition and addenda used for work being performed. (For repairs only, indicate "none" if not known.)
12. State exact scope of work, and attach additional data, sketch, Form R-4, etc. as necessary. If additional data is attached, so state.
13. Indicate test pressure applied.
14. To be completed for all welded pressure components added during the work. Indicate part, item number, manufacturer's name, stamped identification, and data report type.
15. Indicate any additional information pertaining to the work involved (eg. routine repairs.) For Form R-3 the part manufacturer is to indicate the extent he has performed any or all of the design function. If only a portion of the design, state which portion.
16. Type or print name of authorized representative of the "R" Certificate Holder.
17. Indicate National Board R Certificate or Authorization number.
18. Indicate month, day, and year that the R certificate expires.

**Figure 1.5** (*Continued*)

(19.) Enter date certified.

(20.) Name of R Certificate organization which performed the identified work.

(21.) Signature of authorized representative.

(22.) Type or print name of Inspector.

(23.) Indicate Inspector's jurisdiction.

(24.) Indicate Inspector's employer.

(25.) Indicate address of Inspector's employer (city and state or province).

(26.) Indicate month, day, and year of inspection by Inspector.

(27.) Signature of Inspector.

(28.) National Board commission number of Inspector, including endorsements, jurisdiction, and certificate of competency numbers.

(29.) Name and address of organization which purchased the parts for incorporation in the repair or alteration, if known. If built for stock, so state.

(30.) Name of organization responsible for specifying the code design conditions.

(31.) Name of organization responsible for performing the code design, if known.

(32.) Name, section, and division of the design code, if known.

(33.) Indicate code edition year used for fabrication.

(34.) Indicate code addenda date used for fabrication.

(35.) Indicate code paragraph reference for formula used to establish the MAWP, if known.

(36.) Identify name of part, such as "superheater header."

(37.) Indicate quantity of named parts.

(38.) Match line number references for identification of parts and description of parts.

(39.) Indicate manufacturer's serial number for the named part.

(40.) Indicate drawing number for the named part.

(41.) Indicate Maximum Allowable Working Pressure for the part, if known.

(42.) Use inside diameter for size; indicate shape as square, round, etc.

**Figure 1.5** (*Continued*)

(43.) Indicate the complete material specification number and grade.

(44.) Indicate nominal thickness of plate and minimum thickness after forming.

(45.) Indicate shape as flat, dished, ellipsoidal, or hemispherical.

(46.) Indicate minimum thickness after forming.

(47.) Indicate outside diameter.

(48.) Indicate minimum thickness of tubes.

(49.) Complete information identical to that shown on the Form R to which this sheet is supplementary.

(50.) Indicate the Form R type. Example: Form R-1, Form R-2, Form R-3

(51.) Indicate the reference line number from the Form R to which this sheet is supplementary.

(52.) Complete information for which there was insufficient space on the reference Form R.

(53.) If applicable, purchase order, job number, etc. assigned by the organization performing the work.

**Figure 1.5** (*Continued*)

Code vessel is not necessarily concerned if a producer incurs extra expense through carelessness but is very often acutely aware of delivery time. Good customer relations and even future business depend upon on-time deliveries. Obviously, cost and delivery time are related.

The job shop, then is faced with three fundamental problems in the production of Code work:

1. The ability to fabricate in accordance with the Code
2. The necessity for keeping costs at a minimum
3. The importance of making deliveries on time

The question naturally arises, "What concrete steps can be taken to assure the best fulfillment of these requirements?" A few general suggestions bear mention. First, there is no substitute for reading and understanding the ASME Code. Many protests are heard on this score, even from inspectors and engineers, but a knowledge of those sections of the Code that pertain to the type of work in which one is engaged is a necessity. But even this is not enough. Some vessel requirements are extremely simple; others are not. The vast industrial complex of today has created such a wide variety of pressure vessels that they constitute a perpetual challenge to the ingenuity of the fabricator. For the job shop, close cooperation and understanding are required from start to

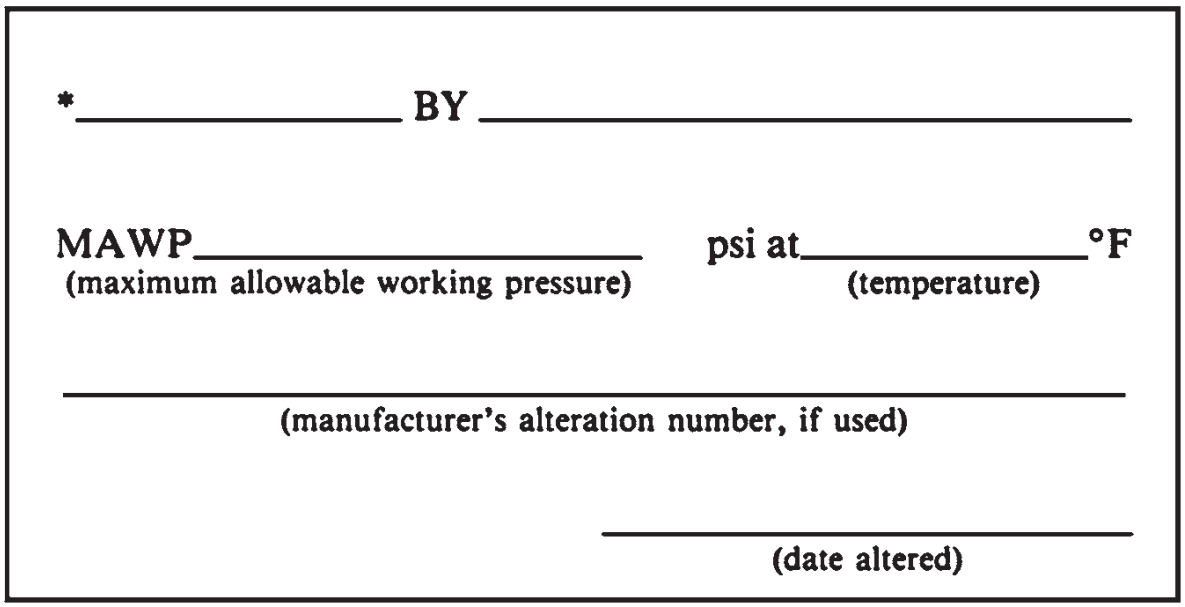


**Figure 1.6** Stamping or nameplate of an altered boiler or pressure vessel. (*Reprinted with permission from the* National Board Inspection Code*, 1992 ed., p. 49. Copyright 1992 National Board of Boiler and Pressure Vessel Inspectors.*)

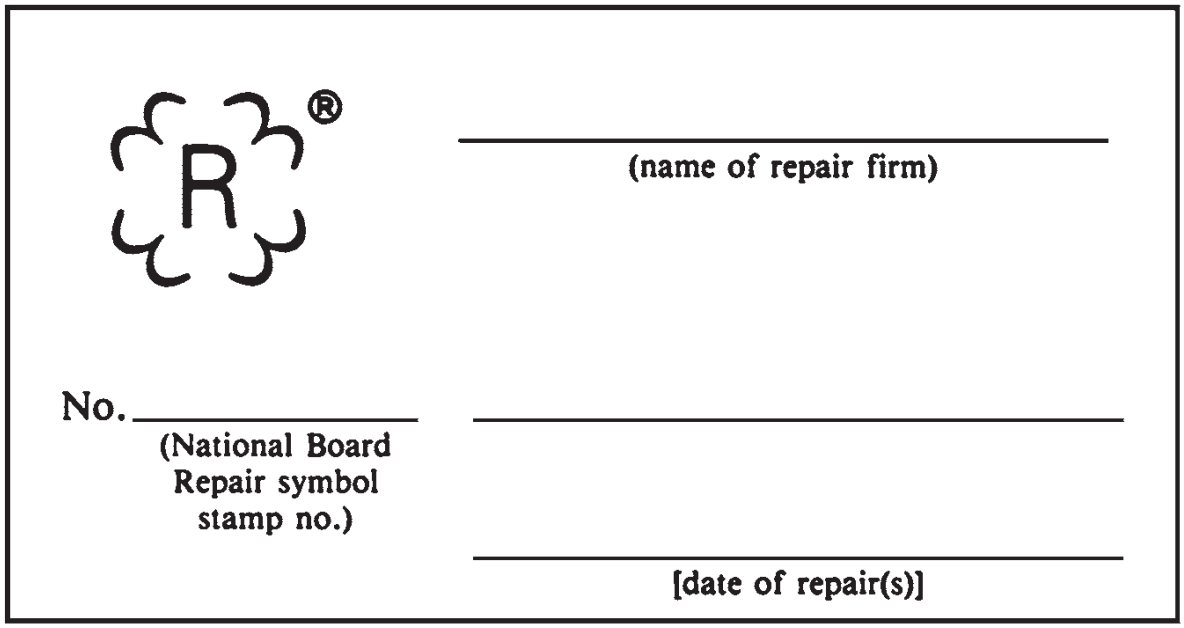


**Figure 1.7** Stamping or nameplate of a boiler or pressure vessel repaired by welding. (*Reprinted with permission from the* National Board Inspection Code*, 1992 ed., p. 49. Copyright 1992 National Board of Boiler and Pressure Vessel Inspectors.*)

finish. Sales, estimating, design, and purchasing must all be backed up by sound shop experience and a reasonable time schedule.

Particular methods for handling an order vary from one company to another. But within the limits set by customer specification and the rules of the Code, the job shop can seek a competitive advantage and avoid unnecessary costs and time losses by determining the following:

1. An overall production schedule
2. Acceptable alternatives in plate material and components
3. Acceptable alternatives in design geometry
4. Acceptable alternatives in fabricating methods
5. Acceptable sources of supply

Some freedom of choice is usually left to the fabricator, and finding the best means of satisfying the requirements at the least cost is the essence of this phase of the manufacturing process.

## Work-Flow Schedules

By the time an order for a Code job is accepted, it has been estimated, bid, and sold. For many reasons, a job-shop estimator does not completely and finally specify all details of material design and fabrication at the time of bidding. After an order is received, a work-flow schedule must be drawn up that allots time for shop fabrication, procurement of materials and components, design drafting, and takeoff. The shop fabrication schedule is based on an estimate of the total quantity of work-hours required, the necessary work-hour sequence (allowing for nonadditive, parallel operations), and finally the stipulated delivery date and the total shop load for the calendar period. This information determines the required delivery date for plate material, purchased components, and shop subassemblies. The lead time for these items sets the date for purchasing and thus for the completion of the design, drafting, and takeoff details initially required. An estimate of the time needed for the latter operations indicates the provisional starting date.

Although this simple computation can be made in many different ways, it is most important that it be made in a specific way, for it forms the basis on which all scheduling and expediting are founded. If the provisional starting date indicates on-time delivery, there is no problem. The sequence of determined dates becomes the production schedule, and expediting is managed accordingly. If the estimated delivery falls considerably ahead of time, the entire schedule can be appropriately delayed or more time can be allotted to any or all of the production steps. In this situation, the cost of maintaining the inventory must be balanced against the future availability of material in a

changing market. It must be remembered that although filler jobs are desirable, a reduction in work rate is not. If the estimated delivery falls after the required date, on the other hand, the operations must be reviewed to determine where and how time can be saved. Sometimes a simple solution is quickly found; more often, pressure has to be applied on all concerned, including the ASME Code Inspector; however, this pressure must be applied in a rational way.

It should be realized that the two hard necessities governing job-shop work—cost saving and time saving—are not always compatible. Earlier deliveries of purchased material usually cost more; heavier pressure on a work force usually results in overtime. Code restrictions on design, fabrication, and materials narrow the field of action. Nevertheless, certain routine procedures exist that will result in considerable savings.

## Mill Orders

From a cost and delivery angle, the design of a pressure vessel and the purchasing of the plate and heads are often related. Thus the steel mill system of extras, based on the weight of items ordered, varies inversely with the weight, a 10,000-lb item having no extra and lesser quantities taking gradually increased extras according to the published table. The maximum cost difference could amount to many dollars a ton. As an item consists of any number of plates of one width and one thickness of a given quality, it pays to design a vessel with equal-width plates (see Appendix A). Various mills also publish extras based on width, and these tables must be consulted. A buyer might be able to save considerably by arbitrarily increasing a plate width a fraction of an inch.

Tonnage mounts up fast in steel plate. The question is often asked, "Is it less expensive to design a given vessel for a higher test steel with less thickness even though the quality extra incurred by the decreased thickness may be higher?" It sometimes works out this way, by using, say, an SA-515 grade 70 steel instead of an SA-285 grade C steel. Fabrication cost differences must also be considered.

Sometimes the buyer rather than the designer will note that a plate useful for stock inventory can be added to a special item to bring the total weight into a lower class of extras, thus saving money. This is also true of heads. At some mills, discounts for quantity begin with four to six heads, and very sizable discounts are offered for larger quantities. It is also highly desirable to attempt to keep head diameters, radii, and thicknesses to the standards carried in mill stocks.

Mill conditions often affect the length of time required to fill an order. As mills have different rolling practices, schedules, minimum-quantity stipulations, base prices, size limits, and the like, all these details should