Wisconsin Administrative Code

Rules of

INDUSTRIAL COMMISSION

BOILER AND UNFIRED PRESSURE VESSEL CODE

Cite the rules in this Code as
(for example)
Wis. Adm. Code section Ind 41.001

INDUSTRIAL COMMISSION
State Office Building, Madison 2, Wisconsin
INDUSTRIAL COMMISSION
OF
WISCONSIN

E. G. Knutson
Chairman

John H. Ross
Commissioner

Helen E. Gilt, Secretary

Roger Ostrem
Director, Division of
Industrial Safety and Buildings

A. W. Rendall
Commissioner

Frank J. Bishop
Supervisor

Boiler Inspection

BOILER AND UNFIRED PRESSURE VESSEL CODE
Revised 1956

Issued by
INDUSTRIAL COMMISSION OF WISCONSIN
Madison, Wisconsin
1957
BOILER AND UNFired PRESSURE VESSEL CODE

INTRODUCTION

The frequency of boiler explosions, with the resulting loss of life and damage to property, compelled the Industrial Commission almost immediately after it was organized to attempt the formulation of a code of boiler rules. The first code was adopted by the Industrial Commission on December 14, 1914 and became effective January 16, 1915. This code was amended in many material respects on November 29, 1919 to correspond more closely with the standard code of boiler rules recommended by the American Society of Mechanical Engineers. Further amendments to this code were adopted on October 29, 1919. On October 5, 1927 the Industrial Commission adopted a resolution which repealed all the boiler orders contained in the code of "Boiler Rules" of 1920. The same resolution provided for the adoption of the orders contained in the revised "Boiler Code of January 1920." On March 1, 1944 the "Boiler Code of 1920" was revised and adopted by the Industrial Commission on March 4, 1944.

In November 1952 the Industrial Commission appointed an advisory committee to revise the boiler code of 1944 and to formulate a code which would cover both boilers and unfired pressure vessels, with the provision that the effect of boilers and unfired pressure vessel orders in force from July 1, 1940 to December 31, 1956, inclusive, shall not be impaired as to any boiler or unfired pressure vessel installed between these dates.

There have been important changes in the field of boiler and unfired pressure vessel design and fabrication since the adoption of the 1944 boiler code. The demand for greater economy of operation has resulted in higher steam pressures and in higher temperatures. To maintain the required standards for reasonable safety under these changed operating conditions, it has been necessary to introduce alloy steels in the design of high pressure boilers and unfired pressure vessels and it was necessary to resort to fusion welding of joints in order to secure the desired strength and tightness.

With a full knowledge of these changed conditions the Industrial Commission is confident that this newly revised code as of January 1, 1957 will adequately meet all minimum requirements for reasonable safety.

On September 4, 1956 the Industrial Commission voted to repeal old orders: 4101, 4111, 4216, 4267, 4269, 4300, 4301, 4302, 4304, 4305, 4306, 4307, 4308, 4309, 4310, 4311, 4312, 4313, 4314, 4315, 4316, 4317, 4318, 4319, 4320, 4321, 4322, 4323, 4324, 4325, 4326, 4327, 4328, 4329, 4330, 4331, 4332, 4333, 4334, 4335, 4336, 4337, 4338, 4339, 4340, 4341, 4342, 4343, 4344, 4345, 4346, 4347, 4348, 4349, 4350, 4351, 4352, 4353, 4354, 4355, 4356, 4357, 4358, 4359, 4360, 4361, 4362, 4363, 4364, 4365, 4366, 4367, 4368, 4369, 4370, 4371, 4372, 4373, 4374, 4375, 4376, 4377,
and to revise old orders as follows:

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<thead>
<tr>
<th>Old Orders</th>
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<tr>
<td>4189 Ind 41.01 4204 Ind 42.04 4223 Ind 42.23 4256 Ind 42.56</td>
<td>41.92 4294 42.06 4284 42.34 4234 42.62 4262</td>
<td>41.94 4292 42.08 4282 42.36 4236 42.64 4264</td>
<td>41.96 4290 42.10 4280 42.38 4238 42.66 4266</td>
<td>41.98 4288 42.12 4278 42.40 4240 42.68 4268</td>
<td>41.90 4286 42.14 4276 42.42 4242 42.70 4270</td>
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The old orders will be repealed and the new and revised orders will become effective on January 1, 1957.

IV

ADVISORY COMMITTEE

An advisory committee of boiler and unfired pressure rules appointed by the Industrial Commission without compensation, may hold hearings and gather such information as will assist in the formation of recommendations to the commission that will insure safety in the construction, installation and operation of steam boilers and unfired pressure vessels.

In the preparation of boiler and unfired pressure vessel rules, the Industrial Commission has had the assistance of the following members of the advisory committee:

C. W. Wheatley, Milwaukee, Wisconsin (Chairman.) Representing the Wisconsin Manufacturers’ Association.

Frank R. Boles, Milwaukee, Wisconsin (Vice Chairman,) Representing the Boiler and Pressure Vessel Insurance Companies.

G. J. Harfield, Milwaukee, Wisconsin. Representing the Wisconsin State Federation of Labor.

George M. Kustzewicz, Milwaukee, Wisconsin. Representing the City of Milwaukee.

R. H. Winders, Green Bay, Wisconsin. Representing the Wisconsin Cannery’s Association.

L. G. Frohner, Milwaukee, Wisconsin. Representing the Pressure Vessels Manufacturers.

Edward J. Berry, Milwaukee, Wisconsin. Representing the Boiler Manufacturers.

R. E. Connard, Manitowoc, Wisconsin. Representing the Wisconsin Utilities.


Charles B. Miller, Milwaukee, Wisconsin. Representing the Wisconsin Petroleum Industries.


Roland G. Steib, Green Bay, Wisconsin. Representing the Agricultural Anomia Institute.

Frank J. Bishop, Madison, Wisconsin (Secretary.) Representing the Industrial Commission of Wisconsin.

Jurisdiction of Industrial Commission

Boilers and unfired pressure vessels must comply with the laws of the state enacted for the safety of employees and frequenters in places of employment and public buildings and with orders of the industrial commission, adopted and published in conformity with sections 101.03 to 101.28, inclusive, of the statutes.

V
Penalty for Violation of Orders

Section 101.28 Penalty for violations. If any employer, employee, owner, or other person shall violate any provision of sections 101.01 to 101.25, inclusive, of the statute, or shall do any act prohibited in sections 101.01 to 101.29, inclusive, or shall fail or refuse to perform any duty lawfully enjoined within the time prescribed by the commission, or which no penalty has been specifically provided for, or shall fail, neglect or refuse to obey any lawful order given or made by the commission, or any judgment or decree made by any court in connection with the provisions of sections 101.01 to 101.29, inclusive, for each such violation, failure or refusal, such employer, employee, owner or other person shall forfeit and pay into the state treasury a sum not less than ten dollars nor more than one hundred dollars for each such offense. It shall be the duty of all officers of the state, the counties and municipalities, upon request of the industrial commission, to enforce in their respective departments, all lawful orders of the industrial commission, as far as the same may be applicable and consistent with the general duties of such officers.

Appeal

Section 101.31 Orders of commission declared lawful. All orders of the industrial commission in conformity with law shall be in force, and shall be prima facie lawful; and all such orders shall be valid and in force, and prima facie reasonable and lawful until they are found otherwise upon judicial review thereof pursuant to chapter 227 or until affirmed or revoked by the commission.

Administration

The boiler and unfired pressure vessels code is enforced by the industrial commission, in cooperation with municipal and other local officials who are required by law to enforce all orders of the commission which are germane to their respective duties (Wisconsin Statutes Section 101.28) and in cooperation with inspectors and insurance companies. This boiler and unfired pressure vessels code contains minimum standards and requirements which apply to places of employment and public buildings in cities and the state generally, and to local ordinances or code may be less stringent.

Chapter Ind 41

BOILER AND UNF IRED PRESSURE VESSEL CODE

Ind 41.01 Definitions as used in chapter 41 Ind 41.08 Certificate of competency for inspectors
Ind 41.02 Definitions as used in chapter 41 Ind 41.09 Multiple units on boilers and unfired pressure vessels
Ind 41.12 Periodic inspections Ind 41.10 Registration of boilers or unfired pressure vessels
Ind 41.16 Inspection by certain Ind 41.11 Boiler blow-down equipment
Inspection Ind 41.13 Construction
Ind 41.04 Exemptions Ind 41.14 New construction
Ind 41.07 Inspection certificates Ind 41.15 Exemptions to Ind 41.66

Ind 41.001 Definitions as used in chapters Ind 41 and 42.

(1) The term Advisory rooms shall mean a group of persons appointed to advise the Industrial Commission of Wisconsin which is designated by law to administer the regulations.

(2) The term A.S.M.E. boilers and unfired pressure vessels codes shall mean the Boiler and Unfired pressure Vessels Codes of the American Society of Mechanical Engineers.

(3) The term AUTHORIZED INSPECTOR OF QUALIFIED INSPECTOR shall mean.

(a) For shop inspectors, any individual who has been commissioned by the National Board of Boiler and Pressure Vessel Inspectors and holds a certificate of competency (issued by the Wisconsin Industrial Commission).

(b) For field inspectors, any individual who holds a certificate of competency issued by the Wisconsin Industrial Commission.

(4) The term BOILER and UNFIR ED PRESSURE VESSEL CODES is used to designate the accepted reference for construction, installation, operation, and inspection of boilers and unfired pressure vessels.

(5) The term CERTIFICATE OF COMPETENCY shall mean a certificate issued to a person who has passed an examination prescribed by the industrial commission.

(6) The term EXISTING INSTALLATIONS means as the application of these rules and regulations are concerned, shall mean and include all boilers and unfired pressure vessels constructed, installed, placed in operation or "Contracted for" before January 1, 1957.

(7) The term EXTERNAL EXAMINATION shall mean an examination made when a boiler or unfired pressure vessel is in operation.

(8) The term FIREWALLS means shall mean a process of welding metal in a molten, or molten and vaporous state, without the application of mechanical pressure or heat. Such welding may be accomplished by gas flame or by the electric arc.

(9) The term HOT WATER HEATING AND HOT WATER SUPPLY BOILERS shall mean a boiler completely filled with water which furnishes hot water to be used externally to itself, at pressures not exceeding 150 pounds per square inch gage and at temperatures not exceeding 250°.

Boiler and Unfired Pressure Vessel Code Register, December, 1964, No. 15
Pakenhall, if the boiler exceeds these limits, it shall be considered a Power Boiler.

(10) The term INTERNAL INSPECTION shall mean an inspection made when a boiler or unfired pressure vessel is shut down and handholes and manholes, or other inspection openings, are opened or removed for inspection of the interior.

(11) The term LOW PRESSURE STEAM BOILER shall mean a boiler on which the safety valves are set at pressures not exceeding 15 pounds per square inch gauge.

(12) The term MAJOR REPAIR used herein shall be considered as one upon which the strength of a boiler or unfired pressure vessel would depend.

(13) The term MINIATURE BOILER as used herein shall mean any boiler which generates steam or other vapor on which the safety valve is set at over 15 psig, which does not exceed any of the following limits: 16 inches inside diameter of the shell, 42 inches overall length of outside to outside of heads at center, 20 square feet of water heating surface, 100 pounds per square inch maximum allowable working pressure.

(14) The term NEW BOILERS or UNFired PRESSURE VESSELS INSTALLATION as far as the application of those rules and regulations are concerned, shall mean and include all boilers and unfired pressure vessels constructed, installed, placed in operation or "Contracted for" after January 1, 1957.

(15) The term NON-STANDARD BOILERS or UNFired PRESSURE VESSELS shall mean a boiler or unfired pressure vessel that does not bear the Wisconsin state stamp, the A.S.M.E. stamp, the National Board stamp, the A.P.I.-A.S.M.E. stamp, the Interstate Commerce Commission stamp as accepted in section 41.51 (5), or the stamp authorized by other recognized codes.

(16) The term OWNER or USER as used herein shall mean any person, firm or corporation, owning or operating any boiler or unfired pressure vessel within this state.

(17) The term PORTABLE BOILERS shall mean an internally fired boiler which is primarily intended for temporary location and the construction and usage is obviously portable.

(18) The term POWER BURNER shall mean a closed vessel in which steam or other vapor (to be used externally to itself) is generated by the direct application of heat and has a safety valve set at a pressure of more than 15 pounds per square inch gauge and which exceeds the dimensions for miniature boilers.

(19) The term PRESSURE VESSEL, when used collectively shall include power boilers, low pressure heating boilers, high pressure steam boilers, miniature boilers, hot water heating and supply boilers, and unfired pressure vessels.

(20) The term SECONDHAND BOILERS or UNFired PRESSURE VESSELS shall mean a boiler or unfired pressure vessel of which both the location and ownership have been changed after primary use.

(21) The term UNFired PRESSURE VESSEL shall mean a vessel in which pressure is obtained from an external source, or from an indirect application of heat. Vessels used for the storage and transportation of petroleum, gas or other flammable or explosive liquids, shall be considered unfired pressure vessels.

(22) The term WISCONSIN SPECIAL BOILERS and UNFired PRESSURE VESSELS shall mean a boiler or unfired pressure vessel which bears the stamp "Wisconsin Special or Wisconsin Standard."

History: Cr. Register, December, 1944, No. 15, eff. 1-1-45.

GENERAL REQUIREMENTS FOR THE INSTALLATION, OPERATION AND FIELD INSPECTION OF BOILERS AND UNFired PRESSURE VESSELS

Ind 41.01 Safety regulations. (1) No boiler or unfired pressure vessel shall be operated at a pressure in excess of the maximum allowable working pressure allowed by the inspection certificate (see section Ind 41.07) which pressure is to be ascertained by means of these orders.

(2) Boilers and unfired pressure vessels shall be equipped with such appliances as to insure safety of operation as hereinafter ordered.

(3) No unauthorized person shall remove or tamper with any safety appliances prescribed by the manufacturer, and no unpermitted person shall in any manner load the safety valve to a greater pressure than that allowed by the certificate of inspection.

(4) In all cases, boilers and unfired pressure vessels shall be so placed as to give ample room between any ceiling, wall or partition to connect and operate any valves or pipes or other fittings or connections used in such boilers and unfired pressure vessels.

(5) Whoever owns, uses, or causes to be used a boiler or unfired pressure vessel, except those covered in section Ind 41.03, unless the same is under the periodically guaranteed inspection of cities or insurance companies allowed by the industrial commission to conduct their own inspections, shall report to the industrial commission on January 1 of each year the location of such boilers and on January 1 of each even numbered year the location of such unfired pressure vessels.

(6) The owner or user of any boiler or any unfired pressure vessel shall immediately notify the industrial commission in case a defect is discovered affecting the safety of the boiler or the unfired pressure vessel. The owner or user of a boiler or an unfired pressure vessel shall notify the industrial commission when an accident occurs which serves to render a boiler or unfired pressure vessel imperative.

In case of a serious accident, such as an explosion, notice shall be given immediately to the industrial commission and neither the boiler nor unfired pressure vessel code.

Register, December, 1944, No. 15.
or the unfired pressure vessel or any of the parts thereof shall be removed or disturbed before an inspection has been made by the industrial commission.

History: Cr. Register, December, 1956, No. 12, eff. 1-1-47.

Ind 41.02 Inspection. (1) INSPECTION OF STEAM BOILERS. All steam boilers operated in the state of Wisconsin, except those included in section Ind 41.03, shall be subject to regular: internal and external inspection once each 12 months. Should operating conditions require longer periods than 12 months, an extension of time may be granted on application to the commission.

(2) INSPECTION OF UNFIRRED PRESSURE VESSELS. All unfired pressure vessels operated in the state of Wisconsin, except those included in section Ind 41.03 shall be subjected to internal or external inspections once each 24 months.

(3) PREPARATION. The owner or user of a boiler or an unfired pressure vessel subject to inspection shall prepare the vessel for inspection. To prepare a vessel for an internal inspection, all handholes, manhole plates and washout plugs shall be removed. The shell and heads shall be thoroughly cleaned and exposed as ordered. Each steam boiler shall be relieved of steam pressure, opened up, thoroughly drained of hot water and the combustion chamber and furnace cleaned out before any internal inspection or repairs are made.

History: Cr. Register, December, 1954, No. 12, eff. 1-1-47.

Ind 41.03 Non-periodic inspections. The following boilers and unfired pressure vessels will not be subject to periodic inspection, but in individual cases any such vessel will be subject to inspection by an authorized inspector on request of any person or upon initiative of the commission when there is reasonable cause to suspect that its construction, installation, maintenance or operation is not in keeping with the general purpose and intent of the applicable provisions of this code.

(1) Boilers or unfired pressure vessels which receive regular inspections by United States government inspectors.

(2) Steam boilers or unfired pressure vessels having an internal or external operating pressure not exceeding 15 psi with no limitations as to size. Hot water boilers having an internal operating pressure not exceeding 30 psi with no limitations as to size.

(3) Boilers of steam fire engines.

(4) Boilers used exclusively for agricultural purposes.

(5) Boilers or water heaters of less than 100 square feet of water heating surface.

(6) Unfired pressure vessels having an inside diameter not exceeding 6 inches with no limitation to pressure.

(7) Unfired pressure vessels having a volume of less than 6 cubic ft. and an operating pressure of less than 30 psi.

(8) Unfired pressure vessels with a volume of less than 14 cubic ft. with no limitation on pressure.

(9) Unfired pressure vessels which are used in accordance with the regulations of the interstate commerce commission.

Boiler and Unfired Pressure Vessel Code

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(10) Air receivers having a volume not to exceed 12 cubic feet and an operating pressure of less than 30 psi.

History: Cr. Register, December, 1964, No. 12, eff. 1-1-47.

Ind 41.04 Insurance inspections. All boilers and unfired pressure vessels subject to periodic inspections of insurance companies authorized to insure pressure vessels in this state, shall not be subject to regular inspections by the industrial commission on the following conditions:

(1) The insurance companies' regulations shall conform with the applicable orders in this code.

(2) The insurance companies' inspectors who inspect boilers and unfired pressure vessels operated in the state shall hold certificates of competency issued by the industrial commission.

(3) Reports of all inspections shall conform to the requirements of the industrial commission.

(4) A copy of all reports shall be forwarded to this industrial commission within 30 days after the inspection is made.

(5) Insurance companies shall report to the industrial commission the name of the owner or operator, and the location of every boiler and unfired pressure vessel on which insurance has been refused, cancelled or discontinued, giving the reasons thereof.

History: Cr. Register, December, 1964, No. 12, eff. 1-1-47.

Ind 41.05 Inspection by certain cities. Boilers and unfired pressure vessels within the regular corporate limits of cities of the first, second and third class which are regularly inspected by a qualified inspector of the city will not be subject to regular inspections by the industrial commission, provided such vessels are properly installed, equipped with fittings necessary to safety, and are not operated at pressures in excess of those determined pertinent to this code.

History: Cr. Register, December, 1964, No. 12, eff. 1-1-47.

Ind 41.06 Exemptions. Boilers and unfired pressure vessels owned or operated by companies or corporations may be exempt from inspections by the industrial commission provided a regular inspection service is maintained or provided by the owners or operators under the following conditions:

(1) The inspection service shall be subject to the approval of the industrial commission.

(2) The boiler or unfired pressure vessel shall be properly installed, and not operated at pressures in excess of that determined by the handbook.

(3) Reports of inspections of all boilers and unfired pressure vessels shall be made to the industrial commission on approved forms.

A copy of all reports shall be forwarded to the industrial commission within 30 days after the inspection is made.

History: Cr. Register, December, 1964, No. 12, eff. 1-1-47.

Ind 41.07 Inspection certificates. (1) An inspection certificate shall be issued by a city, corporation, or company employing the inspector, stating the maximum allowable working pressure after an inspection has been made. This certificate shall be kept on file at all times and made available when called for by a deputy of the industrial commission.

Boiler and Unfired Pressure Vessel Code

Register, December, 1964, No. 12
the industrial commission blue prints and specifications of the type for approval.

History: Cr. Register, December, 1964, No. 13, eff. 1–1–67.

Ind 41.11 Boiler blow-down equipment. (1) The blow-down from a boiler or boilers that enter a sewer system or blowdown which is considered a hazard to life or property shall pass through some form of blow-off equipment that will reduce pressure and temperature as required hereafter.

(2) The temperature of the water leaving the blow-off equipment shall not exceed 140° Fahrenheit.

(4) The pressure of the blow-off leaving any type of blow-off equipment shall not exceed 5 psi.

(5) The blow-off piping and fittings between the boiler and the blow-off tank shall comply with sections Ind 41.50 and Ind 41.51 of this code.

(6) All blow-off equipment shall be fitted with openings to facilitate cleaning and inspection.

History: Cr. Register, December, 1964, No. 13, eff. 1–1–67.

NEW CONSTRUCTION

Ind 41.58 Requirements. All boilers and unfired pressure vessels hereafter installed shall be constructed and installed in accordance with the following sections of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

History: Cr. Register, December, 1964, No. 13, eff. 1–1–67.

(1) Section I Power Boilers 1965 Edition* As amended to January 1, 1967

(2) Section II Material Specifications 1965 Edition* As amended to January 1, 1967

(3) Section IV Low Pressure Heating Boilers 1965 Edition* As amended to January 1, 1967

(4) Section V Miniature Boilers 1952 Edition* As amended to January 1, 1967

(5) Section VII Unfired Pressure Vessels 1956 Edition* As amended to January 1, 1967

(6) Section IX Welding Qualifications 1966 Edition* As amended to January 1, 1967

*Note: Copies of the above publications are available for inspection at the office of the Industrial Commission and the Secretary of State or the office of the Secretary of Business and Industry and the office of the Director of Business at the above addresses.

I. Boiler and Unfired Pressure Vessel Code  Register, December, 1964, No. 15

II. Boiler and Unfired Pressure Vessel Code  Register, December, 1964, No. 15

III. Boiler and Unfired Pressure Vessel Code  Register, December, 1964, No. 15
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It shall further be the policy of the industrial commission to revise and amend this part (Section 43.49 and Ind 43.51 New Construction) from time to time. Anyone using this code is cautioned to check with the industrial commission for the latest revisions.

History: Cr. Register, December, 1956, No. 15, eff. 1-4-57.

Ind 41.51 Exceptions to Ind 41.50. (1) Boilers and pressure vessels not meeting the standard of section Ind 41.50 may be approved by the industrial commission provided the following conditions are met:

(a) The design, material, and workmanship shall be such that they will be operated with an accepted factor of safety.

(b) Complete plans and specifications shall be submitted to, and approved by, the industrial commission before any construction is started.

(c) Vessels constructed under these conditions shall be inspected during construction by an authorized inspector and upon completion, shall be stamped "Wisconsin Special".

(2) The use of a vessel constructed under these conditions shall be limited to the operation and use set forth in the approved application unless additional approval is obtained from the industrial commission.

(3) It is the intent of this code that unfired pressure vessels which have been constructed, inspected, and stamped according to the Interstate Commerce Commission, Regulations Tariff No. 9 effective May 12, 1954 as amended to December 31, 1955, will be considered to meet the requirements of section Ind 41.51 (1) (a), (b), and (c) above, unless stated to the contrary. When such vessels are used in the state of Wisconsin, it shall be the responsibility of the owner of the vessel to have the construction records of the vessels available for inspection by the industrial commission.

History: Cr. Register, December, 1954, No. 12, eff. 1-1-55.

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Chapter Ind 42

BOILER AND UNFIR ED PRESSURE VESSEL CODE; EXISTING INSTALLATIONS

Ind 42.001 Application. The following orders shall apply to unfired pressure vessels or boilers installed prior to January 1, 1957 and secondhand unfired pressure vessels or boilers.

""s-vessel," for the installation, operation, and field inspection of vessels used for the transportation of liquid petroleum gases, liquefied ammonia, and the refrigerant ammonia vessels, see the state code which governs the construction, shop inspection, and field inspection at the time when the vessel was made. The code shall be promulgated by actions Ind 41.40 and Ind 41.51 and Ind 42.001 to 42.059 to Ind 42.099.

History: Cr. Register, December, 1956, No. 15, eff. 1-4-57.

Ind 42.001 Application. The following orders shall apply to unfired pressure vessels or boilers installed prior to January 1, 1957 and secondhand unfired pressure vessels or boilers.

""s-vessel," for the installation, operation, and field inspection of vessels used for the transportation of liquid petroleum gases, liquefied ammonia, and the refrigerant ammonia vessels, see the state code which governs the construction, shop inspection, and field inspection at the time when the vessel was made. The code shall be promulgated by actions Ind 41.40 and Ind 41.51 and Ind 42.001 to Ind 42.099 to Ind 42.099.

History: Cr. Register, December, 1956, No. 15, eff. 1-4-57.

Boiler and Unfired Pressure Vessel Code Register, December, 1956, No. 12.
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Ind 42.055 Maximum allowable working pressure. (1) The maximum allowable working pressure on a boiler or unfired pressure vessel is the safe pressure at which the boiler or unfired pressure vessel may be operated as determined by chapter 42 of this Wisconsin Administrative Code.

(2) No boiler or unfired pressure vessel shall be operated at a pressure in excess of the maximum allowable working pressure for such boiler or unfired pressure vessel.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.06 Code constructed vessels. Any pressure vessel that has been constructed and stamped in accordance with the rules and regulations of the A.S.M.E. Boiler and Pressure Vessel Code, or other recognized codes, or has the standard stamping of another state that has adopted the standard of construction of the A.S.M.E. Boiler and Pressure Vessel Code, shall be allowed to be operated at the maximum working pressure stamped on its shell providing the vessel is unaltered in good working order, and not deteriorated by age or corrosion. For unstamped vessels, the operating pressure shall be determined by using sections Ind 42.02 through Ind 42.06 inclusive.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.062 Pressure calculations for shells. The maximum allowable working pressure to be allowed on the shell of a boiler or unfired pressure vessel shall be determined from the following formula:

\[ P = \frac{\text{T.S.} \times 1.0 \times E}{E \times \text{P.S.}} \]

where \( P \) = maximum allowable working pressure, pounds per square inch;
\( \text{T.S.} \) = tensile strength of shell plate, pounds per square inch,
\( E \) = efficiency of longitudinal joint = method of determining which is given in section Ind 42.16;
\( \text{P.S.} \) = lowest factor of safety allowed by section Ind 42.09.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.063 Pressure calculations for flat heads and flat surfaces. The maximum allowable working pressure on flat surfaces of boilers and unfired pressure vessels shall be determined by the following formula:

\[ P = \frac{\text{T.S.} \times 1.0 \times E}{E \times \text{P.S.}} \]

where \( P \) = maximum allowable working pressure, pounds per square inch;
\( \text{T.S.} \) = tensile strength of plate, pounds per square inch,
\( E \) = efficiency of longitudinal joint = method of determining which is given in section Ind 42.16;
\( \text{P.S.} \) = lowest factor of safety allowed by section Ind 42.09.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

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Ind 42.06 Pressure calculations for dished heads. The maximum allowable working pressure on unstayed dished heads shall be determined by the following formula:

- Pressure on concave side (plus head):
  \[ P = \frac{2 \times \text{T.S.} \times E \times t}{8.33 \times \text{L}} \]
- Pressure on convex side (minus head):
  \[ P = \frac{2 \times \text{T.S.} \times E \times t}{8.33 \times \text{L}} \]

where \( t \) = thickness of plate, inches
\( \text{T.S.} \) = tensile strength pounds per square inch
\( \text{L} \) = radius to which the head is dished
\( E \) = efficiency of weakest joint used in forming the head

(Excessive of the Joint to the shell) for seamless heads

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.06 Dished head restrictions. Dished heads without skirts or flanges shall not be used for any pressure.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.064 Pressure calculation for toriques and circular flows. The maximum allowable working pressure on furnaces of vertical boiler and circular flows shall be determined as indicated in sections Ind 41.50 and Ind 41.51 of this code.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.07 Boiler plate thickness. (1) The minimum thickness of any boiler plate under pressure shall be 1/4 inch except that boiler plate in stayed surfaces shall be 5/16 inch thick minimum.

(2) Stainless steel for miniature boilers may be constructed of 5/16 inch boiler plate.

History: Cr. Regist., December, 1946, No. 12, eff. 1-1-47.

Ind 42.08 Secondhand boilers and unfired pressure vessels. (1) After January 1, 1957, except those covered by section Ind 42.01, all other secondhand boilers and unfired pressure vessels, by which is meant a pressure vessel on which both ownership and location are changed, shall have a factor of safety of at least 5.

(2) Each secondhand pressure vessel shall be inspected and a hydrostatic pressure test applied by an authorized inspector, before it is installed. The hydrostatic pressure test shall be one and one-half times the maximum allowable working pressure.

(3) A secondhand boiler of the lap seam type larger than 30 inches in diameter, shall be limited to a maximum allowable working pressure not exceeding 15 pounds.

(4) Boilers the longitudinal joint on which is exposed to the incense heat of the furnaces, shall not be installed for any pressure.

Note: The incense of inside wet strap will not be considered as strengthening or changing the original type of the boiler joint.

Boiler and Unfired Pressure Vessel Code: Register, December, 1946, No. 12.
(5) All secondhand pressure vessels when reinstalled must comply with all the orders in sections Ind 41.50 and Ind 41.51 pertaining to fittings, appliances, valves and connections and settings and supports.

(6) A portable boiler which is brought into this state for use, shall be inspected and shall be given a hydrostatic pressure test in accordance with subsection (2) of this section and the maximum allowable working pressure shall be determined by using the correct factor of safety according to section Ind 42.60.

History: Cr. Register, December, 1956, No. 12, eff. 1-1-57.

Ind 42.59 Factor of safety. Maximum allowable working pressure shall be determined by using a factor of safety of at least 5 except as provided in sections Ind 42.50 and Ind 42.58.

History: Cr. Register, December, 1956, No. 12, eff. 1-1-57.

Ind 42.60 Strength of materials. When the tensile strength of materials is not known, it shall be taken as 55,000 pounds per square inch for steel and 35,000 pounds per square inch for wrought iron, 30,000 pounds per square inch for copper and 15,000 pounds per square inch for cast iron. The resistance to crushing of mild steel shall be taken as 10,000 pounds per square inch of cross sectional area.

History: Cr. Register, December, 1956, No. 11, eff. 1-1-57.

Ind 42.61 Shearing strength of rivets. The maximum shearing strength of rivets per square inch of cross-sectional area shall be taken as follows:

<table>
<thead>
<tr>
<th>Ultimate Strength</th>
<th>Pounds per square inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron rivets in single shear</td>
<td>26,000</td>
</tr>
<tr>
<td>From rivets in double shear</td>
<td>75,000</td>
</tr>
<tr>
<td>Steel rivets in single shear</td>
<td>44,000</td>
</tr>
<tr>
<td>Steel rivets in double shear</td>
<td>80,000</td>
</tr>
</tbody>
</table>

History: Cr. Register, December, 1956, No. 12, eff. 1-1-57.

Ind 42.62 Rivet dimensions after driving. When the diameter of the rivet hole in the longitudinal joints of a boiler or unfired pressure vessel is not known, the diameter and cross-sectional area of rivets, after driving, shall be taken from the following tables:

### Table 1

<table>
<thead>
<tr>
<th>Diameter of Rivet after Driving</th>
<th>11/32&quot;</th>
<th>15/32&quot;</th>
<th>1/4&quot;</th>
<th>5/32&quot;</th>
<th>3/16&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross sectional area of rivet after driving</td>
<td>0.0712</td>
<td>0.0932</td>
<td>0.1018</td>
<td>0.1148</td>
<td>0.1378</td>
</tr>
</tbody>
</table>

Boiler and Unfired Pressure Vessel Code: Register, December, 1956, No. 12.

### Table 2

<table>
<thead>
<tr>
<th>Diameter of Plate</th>
<th>7/16&quot;</th>
<th>5/8&quot;</th>
<th>3/4&quot;</th>
<th>7/8&quot;</th>
<th>1&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of Rivet after Driving</td>
<td>11/32&quot;</td>
<td>15/32&quot;</td>
<td>1/4&quot;</td>
<td>5/32&quot;</td>
<td>3/16&quot;</td>
</tr>
<tr>
<td>Cross sectional area of rivet after driving</td>
<td>0.0712</td>
<td>0.0932</td>
<td>0.1018</td>
<td>0.1148</td>
<td>0.1378</td>
</tr>
</tbody>
</table>

Furred Weld

Register, December, 1956, No. 12, eff. 1-1-57.

Ind 42.64 Ligament between parallel tube holes. When a shell or drum is drilled for tube holes in a line parallel to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be taken as:

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shall be determined as shown in sections Ind 41.59 and Ind 41.51 of this code.

History: Cr. Register, December, 1964, No. 18, eff. 1-1-57.

Ind 43.15 Ligaments between diagonal tube holes. When a shell or drum is drilled for tube holes in a line diagonal with the axis of the shell or drum, the efficiency of the ligaments between the tube holes shall be determined as shown in section Ind 41.59 and Ind 41.51 of this code.

History: Cr. Register, December, 1956, No. 17, eff. 1-1-56.

Ind 43.16 Maximum pressure for cast iron boilers. (1) The maximum allowable working pressure on a steam boiler constructed wholly or principally of cast iron shall not exceed 15 pounds per square inch.

(2) The maximum allowable working pressure on boilers, the tubes of which are secured to cast iron headers, shall not exceed 150 pounds per square inch.

History: Cr. Register, December, 1954, No. 13, eff. 1-1-46.

Ind 43.17 Safety or relief valves required. Every boiler or unfired pressure vessel shall have one or more safety or relief valves set at or below the maximum allowable working pressure. On power boilers the remaining valves may be set at a higher pressure in accordance with section Ind 42.18.

History: Cr. Register, December, 1964, No. 18, eff. 1-1-57.

Ind 43.18 Safety valves for low pressure steam, miniature, and power boilers. (1) Every boiler shall be provided with safety valve capacity sufficient to discharge all the steam that can be generated without an increase over the maximum allowable working pressure or to which the valve is set, except a 5% increase while the valve is discharging for power and miniature boilers, and a 5 pound per square inch increase while the valve is discharging for low pressure steam boilers.

(2) The steam generating capacity of a boiler in pounds of steam per hour may be determined by one of the following:

(a) Manufacturer's maximum output rating.

(b) Pounds of steam per hour = Maximum Btu input per hour \times 0.75

(c) Actual evaporation test.

(d) On the basis of boiler heating surface or waterwall heating surface as given in the following table:

<table>
<thead>
<tr>
<th>Type of Boiler</th>
<th>Surface</th>
<th>Pounds of Steam</th>
<th>Watts of Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Boilers</td>
<td>Boiler heating surface</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Boiler heating surface</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Boiler heating surface</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Boiler heating surface</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Boiler heating surface</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Boiler heating surface</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

"Wet" indicates cast iron boiler.

Note: Compliance with section Ind 43.18-1) shall be required in every case.

(3) On power boilers one or more safety valves on the boiler proper shall be set at or below the maximum allowable working pressure. The remaining valves may be set within a range of 5% above the maximum allowable working pressure, but the range of setting of all of the valves on a boiler shall not exceed 10% of the highest pressure to which any valve is set.

(4) Safety valves which are constructed in accordance with the standards as specified in sections Ind 41.59 and Ind 41.51 of this code are acceptable. Safety valves constructed to other standards may be used if approved by the Industrial commission. Dead-weight or weighted-lever safety valves shall not be used.

(5) When 2 or more safety valves are used on a boiler, they may be mounted either separately or as twin valves made by placing individual valves on Y-branches, or duplets, triplets or multiples having two or more valves in the same body casing. The valves shall be made of equal sizes, if possible, and in any event if not of the same size, the smaller of the two valves shall have a relieving capacity of at least 50% of that of the larger valve.

(6) The safety valve or valves shall be connected to the boiler independent of any other steam connection, and attached as close as practicable to the boiler, without any unnecessary intervening piping or fittings. Every safety valve shall be connected so as to stand in an upright position, with spindle vertical, when possible.

(7) The opening or connection between the boiler and the safety valve or valves shall have at least the area of the inlet of the valve or valves. No valve of any description shall be placed between the required safety valve or valves and the boiler, nor on the discharge pipe between the safety valve and the atmosphere. When a discharge pipe is used, the cross-sectional area shall not be less than the full area of the valve outlet or of the total of the areas of the valve outlets discharging therethrough, and shall be as short and straight as possible and so arranged to avoid undue stresses on the valve or valves.

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(a) All safety-valve discharges shall be so located as to be carried clear from running boards, platforms, or otherwise carried to a safe location.

(b) Provision for gravity drain shall be made in the discharge pipe, at or near each safety valve, and where water of condensation may collect.

(c) The spring in a safety valve in service for pressures up to and including 250 pounds shall not be used for any pressure more than 15% above or 10% below that for which it was designed. For higher pressures, the spring shall not be used for any pressure more than 5% above or 5% below that for which it was designed.

(d) If the operating conditions of a valve are changed so as to require a new spring for a different pressure, the valve shall be adjusted by the manufacturer or his authorized representative who shall furnish and install a new name plate.

(e) Every superheater shall have one or more safety valves near the outlet. The discharge capacity of the safety valve or valves on an attached superheater may be included in determining the number and size of the safety valves for the boiler, provided there are no interposing valves between the superheater safety valve and the boiler, and provided the discharge capacity of the safety valve or valves on the boiler, as distinct from the superheater, is at least 75% of the aggregate valve capacity required. A non-blowing connection may be attached to the same outlet from the superheater that is used for the safety valve connection.

(f) Every boiler shall have outlet connections for the required safety valve or valves, independent of any other outside steam connection. The area of the boiler opening or openings shall be at least equal to the aggregate area of the inlet connections of all of the safety valves to be attached thereto. An internal collecting pipe, splash plate, or pan, total area for inlet of steam thereto is not less than twice the aggregate area of the inlet connections of the attached safety valves. The hole in such collecting pipe shall be at least 1/2 inch in diameter and the least dimension in any other form of opening for inlet of steam shall be 1/4 inch.

(g) If safety valves are attached to a separate steam drum or dome, the pressure between the boiler proper and the steam drum or dome shall be not less than required by section 42.18(1)-(10)-(a).

(h) When boilers allowed different pressures are connected to a common steam main and all safety valves are not set at the lowest pressure allowed, no safety valve shall be set to exceed by more than 50% the lowest pressure allowed.

(i) For conditions exceeding those specified in the above paragraphs, the case shall be referred to the industrial commission for decision.

History: Cr. Register, December, 1958, No. 12, eff. 1-1-59.

42.19 Water-relief valves for hot water boilers. (1) Each hot water boiler shall have one or more relief valves of the spring loaded type, without diaphragm, in the pressure side of the valve. These valves shall be set to relieve at a pressure of not below the maximum allowable working pressure of the boiler.

Boiler and Utensil Pressure Vessel Code: Register, December, 1958, No. 12.
(1) HORIZONTAL RETURN TUBULAR BOILERS—not less than 4 inches above the upper surface of the upper row of tubes except when the distance between the uppermost surface of the tubes and the top of steam space is 13 inches or less the distance may be reduced to 3 inches.

(2) LOCOMOTIVE TYPE BOILERS—3 inches above the highest part of the crown sheet.

(3) CIRCULAR TYPE TUBE BOILERS—not less than one-third the length of the tube above the lower tube sheets.

(4) WATER TUBE BOILERS—as specified by the manufacturer.

(5) SCOOP MAILING TYPE BOILERS—3 inches above the combustion chamber top.

Note: For dry back see section Ind 43.33.1 (1)

(6) CAST IRON BOILERS—as specified by the manufacturer.

(7) OTHER TYPES AND DESIGNS—for other types and new designs the location shall be fixed by the manufacturer subject to approval by the industrial commission.

History: Cr. Register, December, 1946, No. 12, eff. 1-1-47.

Ind 43.23 Gage cocks. (1) Every steam boiler, except those exempted below, shall have 2 gage cocks located within the range of the visible portion of the water glass.

(2) The following boilers shall not be required to have gage cocks:

(a) Boilers which do not have a definite water level.

(b) Boilers which have 2 water glases spaced not less than 2 feet apart on the same horizontal line.

(c) Boilers which have 2 remote water level indicators in addition to the required water glass.

(2) Miniature gage cocks.

(3) The following boilers shall be required to have only 2 gage cocks:

(a) Low pressure steam boilers.

(b) Locomotive type boilers not over 50 inches in diameter.

(c) Firebox or water leg boilers in which the water heating surface does not exceed 50 square feet.

History: Cr. Register, December, 1946, No. 12, eff. 1-1-47.

Ind 43.23 Water column piping. (1) No connections shall be placed on pipes connecting the water column to the boiler except connections for damper regulation, feed water regulator, steam gage or drain.

(2) The minimum size of the pipes connecting the water column to a boiler shall be 1 inch. Water-glass fittings or gage cocks may be connected directly to the boiler.

(3) The water connections to the water column of a boiler, when practicable, shall be provided with a cross at each right-angle turn to facilitate cleaning. The water column shall be fitted with a drain cock or drain valve with a suitable connection to the sump or other safe point of waste, and if the water connections thereto has a rising head or pocket which cannot be drained by means of the water column drain, an additional drain shall be placed in said connection in order that it may be blown off to clear any sediment from the pipe.

(4) The steam connection to the water column of a horizontal-return tubular boiler shall be taken from the top of the shell or the boiler and unfired pressure vessel code. Register, December, 1946, No. 12
(b) Each dry pipe or similar apparatus shall have two holes drilled into it. These holes shall be not less than 1/4 inch in diameter each and shall be kept open so that the condensation can escape.

(4) Each superheater shall be equipped with at least one drain so located as will most effectively provide for the proper operation of the apparatus.

History: Cr. Register, December, 1936, No. 12, eff. 1-9-37.

Ind 42.27 Steam mains. Provision shall be made for the expansion and contraction of steam mains connected to boilers, by providing substantial anchorages at suitable points, so that there shall be no unsafe strain transmitted to the boiler. Steam reservoirs shall be used on steam mains when heavy pulsations of the steam currents cause vibration of the boiler shell plates.

History: Cr. Register, December, 1936, No. 12, eff. 1-9-37.

Ind 42.28 Blow-off or drain. (1) Connected to the lowest space practicable of each pressure vessel, there shall be a bottom blow-off pipe fitted with a valve or cock. The valves shall be of straight-way or angle construction and cock shall have the plugs held in place with a gland or guard. Straight-way globe valves of the ordinary type or valves of such type that dam or pocket can exist for the collection of sediment, shall not be used in such connections.

(2) A surface blow-off shall not exceed 3/4 inch pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and so arranged that the removal of either will not disturb the other. A properly designed steel bucket or a flanged connection shall be used.

(3) (a) Each boiler shall have a bottom blow-off pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable. The maximum size of pipe and fittings shall be 2 inches and the minimum size of pipe shall be 1 inch for boilers with 100 square feet of water heating surface or less and low pressure steam boilers the minimum sizes of pipe and fittings may be 1 inch.

Straight-way globe valves of the ordinary type or valves of such type that dam or pocket can exist for the collection of sediment, shall not be used in such connections.

(b) The bottom blow-off pipe for low pressure steam, miniature, and hot water boilers referred to in connection which are the same size or larger than the boiler specified. In each case, the blow-off shall be so located that the connection may be completely drained.

(4) A bottom blow-off cock shall have the plug held in place by a gland or guard. The end of the plug shall be distinctly marked in line with the passage.

(5) (a) For power boilers, the bottom blow-off pipe or pipes shall be of wrought iron or steel pipe at least extra heavy.

(b) The fittings between a power boiler and the required bottom blow-off valve or valves shall be of steel, cast steel or malleable iron and shall be not less than extra heavy construction for pressures not exceeding 150 pounds per square inch.

(c) For pressures exceeding 150 pounds per square inch such fittings shall be of steel construction and not less than extra heavy.

Boiler and Explosion Pressure Vessel Code

Register, December, 1936, No. 12.
(4) A means shall be provided for feeding a boiler against the maximum allowable working pressure or the pressure at which the safety valve is set to blow.

(b) Where a source of feed is available at a sufficient pressure to feed the boiler against a pressure 6% higher than that at which the safety valve is set to blow, this may be considered one of the reasons.

(c) Every boiler and its piping system shall be provided with a water supply line from an outside source of water supply in order to replace the water leaving the system through leakage, process waste, or other reasons.

(d) A stop and check valve shall be provided in the water supply line with the stop valve closest to the boiler.

(e) On low pressure steam, miniature, and hot water boilers, the water supply line pressure shall be high enough to feed the boiler or the system against the maximum allowable working pressure of the boiler.

(f) A heater for oil or other liquid harmful to boiler operation shall not be installed directly in the steam or water space within a boiler. Where an external type heater for each service is used, positive means shall be provided to prevent the introduction into the boiler of oil or other liquid harmful to boiler operation.

History: Cr. Register, December, 1936, No. 15, eff. 1-1-37.

Ind 42.29 Combination regulators for boilers. (1) A temperature combination regulator, which will control the rate of combustion to prevent the temperature of the water or steam rising above 250° Fahrenheit at or near the outlet, or a thermostat device which will relieve the pressure on the boiler when the temperature exceeds 250° Fahrenheit, shall be used on all hot water boilers.

(2) When a temperature combination regulator is used on a steam boiler, it shall operate to prevent the steam pressure from rising above the maximum allowable working pressure for the boiler.

History: Cr. Register, December, 1936, No. 15, eff. 1-1-37.

Ind 42.29 Flanged connections. Openings in boilers having flanged connections shall have the flanges conform to the American standard for the corresponding flanges for bolts or studs. Steel outlet nozzles and flanges may be riveted or welded to the shell. Cast iron outlet nozzles or flanges will be permitted only on low pressure steam or hot water boilers and can be attached to the shell only by riveting.

History: Cr. Register, December, 1936, No. 15, eff. 1-1-37.

Ind 42.31 Washout and inspection openings. (1) All boilers or unfired pressure vessels shall be provided with suitable manhole or handhole openings, except special types where they are manifestly not needed or used.

(2) All horizontal fire tube boilers shall be required to have the following manholes or handhole openings: (a) A manhole in the front head below the tubes for: 1. Horizontal return tubular power boilers over 54 inches in diameter.

2. Horizontal return tubular low pressure steam or hot water boilers over 60 inches in diameter.
2. For smaller boilers a handhole may be used in place of the manhole.
   (b) A manhole in the upper part of the shell or head for: 1. Horizontal return tubular, fire box and locomotive power boiler over 48 inches.
   2. Scotch marine power boilers over 54 inches in diameter.
   3. Low pressure steam boilers over 60 inches in diameter.
   4. For smaller boilers a handhole may be used in place of the manhole.
   (c) Locomotive and fire box boilers shall also have the following handhole or washout openings: 1. One at each of the four corners of the lower portion of the water leg.
   2. One in the front head at or about the line of the crown sheet.
   3. One near the throat sheet of power boilers where possible.
   4. One in the rear head of power boilers below the tubes.
   (d) A vertical fire tube boiler, except boilers 24 inches or less in diameter, shall have not less than 4 handholes located as follows: Two in the shell at or about the line of the crown sheet or lower tube sheet; 2 in the shell at the lower part of the water leg.
   (e) Vertical fire tube boilers 24 inches or less in diameter shall have three one inch diameter washout plugs except that boilers not exceeding 12 inches internal diameter having less than 10 square feet of water heating surface need not have more than 2 such wash-out plugs, one of which may be used for the attachment of the bottom blow-off valve. The threads of the washout plugs shall be of non-ferrous material.
   (f) All unfired pressure vessels, in other than non-corrosive service, 18 inches in diameter or over shall be provided with one of the following washout or inspection opening combinations: 2 handholes in the shell or heads, a manhole, or 4 or more plugged threaded openings of 2 inches in diameter.
   (g) All unfired pressure vessels, in other than non-corrosive service, less than 18" and over 12" in diameter must be provided with at least 2 handholes, or 2 inspection holes properly located for inspection, the inspection holes to be not less than 1½" pipe size unless the pressure vessel has a removable head or cover plate. For vessels 12" and under inspection openings may be omitted.
   (h) Vessels not over 18" in inside diameter that are installed so that they must be disconnected from an assembly to permit inspection, need not be provided with openings for inspection, if there are at least two removable pipe connections not less than 1¼" pipe size.
   (i) Where handholes are provided, such handholes shall be not less than 2½ inches by 5½ inches in size.
   (j) Washout plugs, except for vertical fire tube boilers, shall be not less than 1½ inch pipe size and shall have threads of non-ferrous materials.
   (k) Every cast iron boiler shall be provided with washout openings to permit the removal of any sediment that may accumulate therein.
   Washout openings may be used for return pipe connection if the washout plug is placed in a tee so that the tee is directly opposite and as close as possible to the opening in the boiler.

History: Cr. Register, December, 1914, No. 12, eff. 1-15-27.

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...
### Table 6

**MAXIMUM FREE AIR SUPPLIED IN CUBIC FEET PER MINUTE FOR DIFFERENT SIZES OF SAFETY VALVES AT STATED PRESSURES**

<table>
<thead>
<tr>
<th>Diameter of Valve (inches)</th>
<th>Gage pressure, pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td>2(\frac{1}{16})</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>2(\frac{1}{4})</td>
<td>32</td>
</tr>
<tr>
<td>2(\frac{1}{8})</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>3(\frac{1}{16})</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>4(\frac{1}{8})</td>
<td>54</td>
</tr>
</tbody>
</table>

### Table 7

**ORIFICE RELIEVING CAPACITIES, LB. PER HR. PER SQ. IN., FOR DETERMINING THE PROPER SIZING OF RELIEF VALVES USED ON LOW PRESSURE SIDE OF REDUCING VALVES**

<table>
<thead>
<tr>
<th>Outlet Pressure, psi</th>
<th>Pressure-reducing valve inlet pressure, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>100</td>
</tr>
<tr>
<td>150</td>
<td>125</td>
</tr>
<tr>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>5000</td>
<td>5000</td>
</tr>
</tbody>
</table>

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The larger of the relief valve capacities calculated by the above two formulas shall be used for selecting the relief valve for the vessel.

Example:

Suppose a high pressure boiler operating at 125 psi distributes steam to a series of 40 psi A.S.M.E. constructed retorts through a 1\(\frac{1}{4}\) inch size pumphouse reducing valve provided with a globe-valved 1 inch by-pass. Determine the proper A.S.M.E. relief valve protection for the retorts. Utilizing data in Tables 7 and 8 and the first of the two formulas above:

\[ W = \frac{1}{3} \times 7200 \times 2.64 = 4896 \text{ Lbs. Steam per hour} \]

Checking the by-pass steam flow according to the second formula given:

\[ W = \frac{1}{4} \times 7200 \times 0.86 = 2100 \text{ Lbs. Steam per hour} \]

The potential steam flow through the pressure reducing valve is 4896 Lbs. per hour rated capacity or 4896/1000 or 4.896,000 Btu per hour.

History: Cr. Register, December, 1914, No 12, eff. 1-1-27.

Table 8

<table>
<thead>
<tr>
<th>Nominal pipe size, inches</th>
<th>Approx. internal area, square inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(\frac{1}{2})</td>
<td>0.42</td>
</tr>
<tr>
<td>1</td>
<td>0.52</td>
</tr>
<tr>
<td>2</td>
<td>0.98</td>
</tr>
<tr>
<td>3</td>
<td>1.60</td>
</tr>
<tr>
<td>4</td>
<td>2.64</td>
</tr>
<tr>
<td>5</td>
<td>4.00</td>
</tr>
<tr>
<td>6</td>
<td>5.73</td>
</tr>
<tr>
<td>7</td>
<td>7.53</td>
</tr>
<tr>
<td>8</td>
<td>9.64</td>
</tr>
<tr>
<td>10</td>
<td>12.32</td>
</tr>
<tr>
<td>12</td>
<td>14.80</td>
</tr>
</tbody>
</table>

Notes: In applying these rules the size of the pipe shall be based upon standard weight size and the full size of the pressure-reducing valve.

REPAIRS, ADDITIONS OR ALTEARATIONS

Ind 42.56 Rules and reports. (1) Repairs, additions or alterations to any boiler or pressure vessel or their fillings, settings or appurtenances shall be made according to the rules for existing installations or repairs of this code. In the absence of specific rules the rules for new construction shall apply. Permission shall be obtained from the industrial commission for cases not specifically covered in any section of this code.

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pressure. This involves calculations of the patch joints based on the shape and location of the patch. The rules herein provide a basis for determining the efficiency of the patch joints to be readily determined. It is required that when riveted patches are considered necessary or desirable, they shall be applied under the following rules:

1. The first thing that shall be taken into consideration when proceeding with the design of a patch is whether or not all of the end stress is to be carried by the patch in other words, whether the heads are supported or unsupported. In drums of water tube boilers, the full end wise stress has to be carried by the shell plates and the patch area, whereas in shells of horizontal tubular boilers some of the end wise stress is carried by the through rods, tubs or flues, and consequently there is less stress on the shell and patch area. It is evident then that a patch in one case need not have the same width for a given length as in the other case. In other words, different constants may be used in determining the width. Tables 10 and 11 take into account these 2 different conditions.

2. The angle of a patch when laid out in the flat does not change when formed to the curvature of the boiler, therefore, the diameter of the boiler does not need to be taken into consideration in the design when the proportions of fees (S) are met.

3. (a) A patch shall be laid out in the flat and then carefully formed to accurately follow the contour of the boiler where it is to be applied.

(b) Patches shall be of the same thickness as the original thickness of the plate they replace.

4. (a) Beams exposed to the products of combustion shall be single riveted lap construction.

(b) Beams not exposed to the products of combustion shall be double riveted or constructed similar to the original seams of the boiler.

5. (a) Patches exceeding 24 inches in length shall have the proper width as determined by the rules herein.

(b) Patches 24" or less in length shall be triangular, crescent, diamond or oval in form and the width shall be at least twice the length.

(c) If it is found that a patch would extend extremely high it may be shortened in width to the extent that no more than 4 rivets will be in a longitudinal line, as shown in Figure 5.

(d) Likewise, to avoid the necessity of cutting in sharp corners, a patch may be shortened in width to the extent that no more than 4 rivets will be in a longitudinal line, as shown in Figure 5.

(e) If it is found that a patch would have to be 60 inches or more in length considerations shall be given to the use of a sheet having a width equivalent to 1/2 of the circumference of the boiler and the longitudinal seam shall be of a design similar to the design of the original seam of the boiler.

(f) In designing patches, it is not necessary to deal with angles in the form of degrees, but merely with the dimensions of the triangles forming a patch. The relation between the length and width provides certain fixed constants that have been tabulated and designated as Tables 10 and 11. The constant is the figure by which the length shall be multiplied to determine the width.

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(c) If a patch is diamond in shape, it is considered equivalent to 2 triangular patches and half the total length is used in determining the width.

(5) As the angle of a patch as laid out when flat does not change when folded to the curvature of the boiler, the diameter of the boiler does not have to be taken into consideration in the design.

(b) In laying out new patches over 24 inches long, it is recommended that they be triangular or diamond in shape, as may be required for the particular job, with definite straight line sides, but with the corners properly rounded out to permit proper welding, as illustrated in Figures 2, 3, 4, and 5.

(b) Where the length designated as "L" and the width designated as "W" is measured is also shown in Figures 2, 3, 4, and 5.

(9) Rivets, patch bolts or staybolts may be used in "riveted" seams surfaces that are stayed or braced, provided at least one rivet or patch bolt is used between adjacent staybolts. The riveting shall be completed first.

(b) Rivet holes may be counterbored in patches on shells that have braced heads, if desired, without materially affecting the calculated strength of the patch. The angle of the diameter with center line of the rivet hole shall not exceed 45 degrees and the depth shall not exceed half the thickness of the plate.

(b) Where patches have already been applied the problem is to determine the effective diagonal efficiency. If the seams are all rounded, that is to say, the patch is convex or oval in shape, the length "L" shall be taken between the center of the extreme two rivets on the longitudinal center line and the width "W" between the center of the extreme two rivets on the girthwise center line, as illustrated in Figures 6 and 7.

**Fig. 6**
CRESSENT PATCH
At Girth Seam

**Fig. 7**
OVAL PATCH

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Ind 42.55 Material for riveted patches. (1) Patch material shall be either flux box or flange steel. Structural steel shall not be used. The repair shop shall produce a copy of the manufacturer's mill test report of the material to be used.

(2) The material shall contain the steelmaker's brand. If only part of a plate is required and this part does not contain the brand, the brand shall be transferred to the patch plate in the presence of an authorized boiler inspector or representative of the plate manufacturer, before the plate is cut. Rivets, patch bolts, or staybolts shall be of material of standard quality.

History: Cr. Register, December, 1954, No. 12, eff. 1-1-55.

Ind 42.54 Workmanship on riveted patches. (1) All patch plates shall be placed inside a boiler shell or drum where exposed to the products of combustion and where deposits would be pocketed. Where a patch plate includes the part to which the blow-off is attached, the patch shall be placed on the outside.

(2) All defective material exposed to the products of combustion shall be removed and properly trimmed to provide for next workmanship in attaching the patch. Defects not exposed to the products of combustion need not be removed unless necessary to insure a workmanlike job.

(3) A distincted sheet which is to be patched shall first be set back straight as much as possible before proceedeing with the cutting out of the plate so that the patch may be kept as small as possible.

(4) The edge of a patch shall be beveled by planing, chopping, or gas cutting before applying it to the boiler. Rivets shall be driven by gun, if at all possible.

(5) All rivet holes shall be drilled full size or the holes may be punched not to exceed 1/2 inch less than full size for plates over 5/16 inch, and 1/4 inch less for plates 5/16 inch or less in thickness, and then reamed to full size with patch in place. Rivet holes are usually 1/16 inch greater in diameter than the normal diameter of the rivet last a 1/32 inch difference is preferable when the rivets are of uniform size.

(6) If soil welding is used, it shall be laid in a single bead with a throat thickness not less than 8/16 inch, nor more than 5/16 inch. The patch shall be tight before seal welding under a hydrostatic test equal to the operating pressure.

(7) Where 3 plates have to be lapped at the corners of a patch, the middle plate shall be carefully caressed to a feather edge the entire width of the lap, as shown in Figure 5.

History: Cr. Register, December, 1954, No. 12, eff. 1-1-55.

Ind 42.55 Calculations for riveted patches. (1) First the length L of the patch shall be determined. The dimension L, of course, governed by the area of the defect. Next, the normal efficiency, c, of the single-riveted seam that is to be used in the patch shall be determined from Table 5. This is governed by the thickness of plate and diameter of rivet holes.

(2) After determining the length that a patch shall be, the next step is to determine what the width girthwise shall be. This is found by multiplying the length by the constant, c, as shown in Table 10 or 11, depending upon the type of boiler to be repaired. These tables

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give a constant C for a given efficiency, $e$, if patch and efficiency, $E$, of longitudinal seam.

(6) To determine the longitudinal efficiency of an existing patch, $L$ and $W$ shall be measured, also the pitch, $p$ and diameter of rivet, $d$. $W$ divided by $L$ will give the constant $C$. Table 9 will give $e$. Then under $e$ in Table 10 or 11, depending upon the type of boiler to be repaired, find the constant $C$. Then whatever $E$ at the left is found is the longitudinal or allowed efficiency of the patch seam (See section Ind 42.56).

<table>
<thead>
<tr>
<th>Plate Thickness, $t$</th>
<th>Repair Hole Diameter, $d$</th>
<th>Pitch of Repair, $p$</th>
<th>Efficiency of Repair, $e$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16</td>
<td>1/16</td>
<td>1/16</td>
<td>0.00</td>
</tr>
<tr>
<td>1/32</td>
<td>1/32</td>
<td>1/32</td>
<td>0.00</td>
</tr>
<tr>
<td>3/64</td>
<td>1/16</td>
<td>1/16</td>
<td>0.00</td>
</tr>
<tr>
<td>1/32</td>
<td>1/16</td>
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<td>3/64</td>
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<tr>
<td>1/16</td>
<td>1/16</td>
<td>1/16</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Tensile strength assumed at 50,000 psi and shearing strength at 46,000 psi.

Ind 42.56 Examples of calculations for riveted patches. (1) Design or patch for horizontal-tubular boiler. (a) A patch is to be placed in the fire sheet of a horizontal-tubular boiler having shell plate 7/16 inch thick, a longitudinal seam efficiency of 74%, and a length of patch of 36 inches. Find the width $W$ of patch to be applied so that there will not be any reduction in pressure, using a single-riveted seam of normal design.

(b) Referring to Table 9, it is found that a 7/16 inch plate with 15/16 inch diameter rivet holes, pitch 3/8 inch, gives a seam efficiency of 56%.

(c) Referring to Table 10, 7/16 and 0.66 give a constant C=1.75;
then width $W = L \times C = 56 \times 1.75 = 98$ inches.

(2) Permissible allowance on an existing patch for horizontal-tubular boiler. (a) A cast iron patch has already been installed on a horizontal-tubular boiler. It is found to be 36 inches long and 48 inches wide. The seam is noted to be single-riveted with 13/16 inch riveted holes pitched 3/16 to 1/4 inch. The boiler shell plate is 9/16 inch thick. The longitudinal seam is of the double-riveted butt-strap type having an efficiency of 82%. The safety valves is set for 130 pounds pressure. What maximum pressure should be allowed on the boiler?

(b) Referring to Table 9, it shows that the normal efficiency of the patch seam is 57%.

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(c) If the efficiency is not found in the table, refer to any other available table or determine it in the customary manner described in sections Ind 44.09 and Ind 45.01 of this code.

(d) Divide the width of the patch $W = 48$ inches by the length $L = 30$ inches to find the constant $C = \frac{48}{30} = 1.60$.

(e) Follow down column $a = 0.67$ of Table 10 until 1.60 is found. It will be noted that this is somewhere between 1.45 and 1.62 representing $E$ somewhere between 0.72 and 0.78. The difference between 1.56 and 1.62 is 0.06, and the difference between 1.56 and 1.60 is 0.04. By interpolation, $E$ should be 0.74 plus 4/6 of 0.04 which is 0.739.

(f) The pressure approved water directly as the steam efficiency. Accordingly $F = 0.739/100 \times 185 = 110$ pounds per square inch.

(g) If this allowance interferes with the operation of the plant, the patch will have to be replaced by a new one with proper dimensions giving a diagonal efficiency of 95%.

(h) Design of Patch for Water-Tight Seals. (a) Sections of the plate having a total length of 36 inches (measured at the pitch line) are to be removed on each side of a girth seam. The patch is to be diamond or oval shape. The shell plate is 7 1/2 inches thick and the longitudinal seam is double-ribbed bolt strap construction, having an efficiency of 92.5%. What should be the width of the patch for maintaining the same pressure allowance?

(i) Referring to Table 9, it shows that a single-ribbed lap seam with 7 1/2 inch plate, 15/16 inch diameter rivet holes, and 1 5/8 inch pitch has a normal efficiency of 60%.

(j) Referring to Table 11, it shows that $E = 0.82$ and $a = 0.56$, the constant $C = 1.16$.

(k) Then width $W = C \times L = 2$

$W = 1.16 \times 30 \times 2 = 54.58$ pounds, or 57 inches.

History: Ct. Registrar, December, 1936, No. 12, eff. 1-6-37.

Ind 42.04 Welded. Manufactures, owners or contractors undertaking repairs under these rules shall have available for the inspector a written welding procedure specification that shall be followed in making the necessary repair and also a record of procedure qualification tests. Welding procedure specifications shall have been prepared and qualified in accordance with the requirements of sections Ind 41.59 and Ind 43.61 of this code under Welding Qualifications, section Ind 41.56-(e). Repairs by fusion welding on low pressure steam and hot water boilers shall be exempt from the provisions of sections Ind 42.04 through Ind 42.07, except that a qualified welder shall be required for such repairs and the repairs shall conform to sections Ind 43.01, Ind 43.62, Ind 43.63, Ind 43.64, and Ind 43.65.

History: Ct. Registrar, December, 1936, No. 13, eff. 1-6-37.

Ind 43.00 Welding. (1) Welder Qualification. Manufactures, owners or contractors shall have available for the inspector records of welder qualification tests showing that each welder shall be employed on the work has satisfactorily passed tests as prescribed in sections Ind 43.09 and Ind 43.61 of this code under Welding Qualifications for the type of filler metal to be used and for each position in which he will be called upon to operate in making the repair.

(2) Welding Tests. Manufacturer's, owner's or contractor's responsibility, inspector's duty. Preparation of welding procedure.
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specifications and the conducting of tests of procedures and welders shall be the responsibility of the manufacturer, owner or consignee. Before repairs are started, it shall be the duty of the inspector to satisfy himself by examination of the written welding procedure and records of operations that the welder and procedures have been properly qualified as required in section Ind 41.50 (4). Witnessing of the tests by the inspector shall not be mandatory but he shall have the right to witness such tests when he deems it necessary. The inspector shall also have the right to call for and witness the making of test plates by any welder, at any time, and to observe the physical testing of such plates.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.61 Rules for welding. The repairs that may be made under these rules are limited to sheets of flanges or fire box quality having known weldable quality and further limited to carbon steels having a carbon content of not more than 0.25% and low alloy steels having a carbon content of not more than 0.35%. Structural steel shall not be used. The welding of high alloy material and non-ferrous material shall be done in accordance with the requirements of section Ind 41.50 and Ind 41.51 of this code for boilers and unfired pressure vessels.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.62 Prohibited repairs. A welder shall not make repairs in a plate thickness in excess of that permitted under sections Ind 41.50 and Ind 41.55 of this code for Welding Qualifications. A welder shall not make repairs on a material that is not covered within his qualification tests.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.63 Procedure. Groove welds shall completely penetrate the thickness of the material being welded. If possible, welding shall be applied from both sides of the plate or a backing strip or ring may be used to insure complete penetration. Manually applied welds shall have a convex surface on both sides if applied on both sides of the plate being joined, or on one side if welding is applied from one side only. Valleys and undercutting at edges of welded joints shall not be permitted. The reinforcement may be chipped, ground, or machined off flush with the base metal, if so desired, after the welding has been completed.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.64 Defective weld. In making a repair to a weld that has failed in service, the defective weld shall be removed by chipping, grinding or gouging until sound metal is exposed on all sides. The resulting groove shall be filled as required by the applicable welding procedure.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.65 Stress relieving operations. (1) In repairing carbon or low alloy steels, when required by rules and considered necessary by the authorized inspector, thermal stress relieving shall be applied to the completed work. The heat may be applied by any means that will raise the temperature of the material being heated gradually.

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and uniformly to approximately 1,200 degrees Fahrenheit. (In the absence of more accurate means of determining temperature, a dull red glow in daylight will suffice.) This temperature shall be maintained for a period of one hour per inch of thickness of material. For circumferential joints, the area heated shall comprise a band extending completely around the cylinder and having a width on each side of the outer line of the weld not less than 3 times the greatest width of the finished weld. For nozzle, the heated area shall comprise a circumferential band extending around the entire vessel, including the nozzle or welded attachment and shall extend at least 6 inches from the plate thickness beyond the welding which connects the nozzle or other attachment to the vessel. Under certain conditions other methods of thermal stress relieving acceptable to the authorized inspector may be used. Under certain conditions preheating may be necessary.

(2) Upon completion of the stress relieving operation, the plate shall be allowed to cool at a rate not greater than 500 degrees Fahrenheit per hour; divided by the maximum thickness of the weld joint in inches, but in no case more than 500 degrees Fahrenheit per hour. This rate of cooling shall be maintained until a temperature of approximately 600 degrees Fahrenheit is reached, after which normal cooling by exposure in a still atmosphere may be permitted.

(3) Thermal stress relieving of austenitic steels is a controversial subject. It shall not be attempted except in accordance with the recommendations of the manufacturer of the material or the requirements of sections Ind 41.50 and Ind 41.51 of this code.

(4) In lieu of thermal stress relieving of carbon steels, preheat or other methods acceptable to the authorized inspector may be employed.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Ind 42.66 Cracks, permissible welded repairs. (1) Cracks in unstayed shells, drums or headers of boilers or pressure vessels may be repaired by welding, providing the crack does not extend between rivet holes in a longitudinal seam or parallel to a rivet seam within 8 inches, measured from nearest edge of crack. The total length of any one such crack shall not exceed 8 inches. Cracks of greater length may be welded, provided the complete repair is radiographed and stress relieved in accordance with section Ind 42.65. See Figures 8 and 8 (a) for Acceptable Methods.

(2) Cracks of any length in unstayed furnace may be welded, provided the welds are thermally stress relieved in accordance with section Ind 42.65. Welds applied from both sides of the plate shall be used where possible. Welds applied from one side only shall be subject to the approval of the authorized inspector. Field repair of cracks at locations or areas of flange of furnaces opening are prohibited unless specifically approved by the industrial commission. See Figures 9 for Acceptable Methods.

(3) Cracks of any length in stayed areas may be repaired by fusion welding except that multiple or star cracks radiating from rivet or staybolt holes shall not be welded. See Figure 18 for Acceptable Methods.

History: Cr. Register, December, 1943, No 12, eff. 1-1-57.

Note: Repealer and Uniform Pressure Vessel Code. Register, December, 1945, No 8.
Ind. 42.69 Corroded surfaces and seal welding. (1) Corroded areas in stayed surfaces may be built up by fusion welding, provided the remaining plate has an average thickness of not less than 50% of the original thickness, and further provided the areas so affected are not sufficiently extensive to impair the safety of the object. See Figure 11 for Acceptable Methods.

(2) Corroded areas around manhole or handhole openings in either stayed or unstayed plates may be built up by fusion welding, provided the average least thickness does not exceed 50% of the original plate thickness and also provided the area to be so repaired does not extend more than 3 inches from the edge of the hole.

(3) Corroded areas in unstayed shells, drums or headers may be built up by fusion welding provided that in the judgment of the authorized inspector, the strength of the structure has not been impaired. See Figure 12 for Acceptable Methods.

(4) Edges of butt straps or of plate laps and nozzles or connections attached by riveting may be restored to original dimensions by welding. Seam welding shall not be used except with the special approval of the authorized inspector, and in no case where cracks are present in riveted areas. See Figure 13 for Acceptable Methods.

(5) The ends of tubes in fire tube and water-tube boilers may be seal welded provided they have not been reduced more than 10% in thickness, and requirements in Ind. 43.30 and Ind. 43.52 of this code are satisfied. See Figure 14 for Acceptable Methods.

History: Cr. Register, December, 1944, No. 12, eff. 1-1-45.

Ind. 42.71 Re-rolling and piercing tubes. Re-rolling or piercing of tubes or pipes in either fire tube or water tube boilers is permitted provided the thickness of the tube or pipe has not been reduced by more than 10% from that required by sections Ind. 42.50 and Ind. 41.61 of this code for the pressure to be carried. In all cases the requirements of sections Ind. 41.50 and Ind. 41.61 of this code shall be met.

History: Cr. Register, December, 1944, No. 12, eff. 1-1-45.

Ind. 42.75 Patching, material. The material used for patches shall be of the same general quality and have at least the minimum physical properties of the plate to be patched. The thickness of any patch shall be at least equal to, but not more than, 1/4 inch greater than the plate being patched.

History: Cr. Register, December, 1944, No. 12, eff. 1-1-45.

Ind. 42.76 Flux or butt welded patches. (1) Flux or butt welded patches in unstayed shells, drums or headers shall be radiographed and stress relieved to conform to the requirements of sections Ind. 41.50 and Ind. 41.61 of this code for new construction. Subject to the approval of an authorized inspector, testing or other methods of stress relieving may be substituted for thermal stress relieving. Subject to compliance with this requirement, no limit is placed on dimensions or location of such patches or on the thickness of the material. When the longest dimension of a patch does not exceed 16 times the plate thickness or a maximum of 8 inches, radiographing and stress relieving is not required. See Figure 15 for Acceptable Methods.
CRACKS IN UNSTAYED SHELLS, DRUMS AND HEADERS

Fig. 8

CIRCUMFERENTIAL CRACKS AT GIRTH SEAMS

Cautions: Before attempting repairs care shall be taken to remove the cause of cracks of this type. Welding shall not be used if "cupping" embrittlement is indicated. Multiple or star cracks shall not be welded. In repairing fire cracks, the area to be repaired shall be opened up, and for repairing fire cracks at girth seam, the seam shall be used.

Example of Multiple or Star Cracking

CRACKS BETWEEN TUBE HOLES

In repairing cracks of this type, welding shall be applied from both sides of the tube if possible. The tube in which the cracks extend and the tubes on each side of them shall be crossed and the cracks filled, ground or grinded to provide the necessary weld. Where the tubes are open the holes shall be cushioned before new tubes are installed.

CRACKS IN HEADERS

In repairing cracks of this type, welding may be applied from one side. A backing strip shall be used if possible to insure complete penetration at bottom of welding groove.
**Fig. 9**
**CRACKS IN UNSTAYED FURNACES**

**Caution:** Successful performance of this repair requires a positive weld free from slag, porosity, voids, cracks or other defects.

Cracks shall be chipped, ground, or gashed to provide controlled welding groove. Provided only in areas of normal chipping or flake burning and welding against both sides of the plate. Thermal stress relieving is recommended.

**Fig. 10**
**CRACKS IN STAYED PLATES**

**Caution:** Before attempting repairs to cracks of this type the inner surface of the plate shall be carefully examined for possible excessive stress.

Stays to which cracks may extend shall be removed and the cracks then chipped, ground or gashed to provide the required welding groove.

After welding, threaded staybolt holes shall be retapped and new staybolts properly driven and headless.

Multiple or star cracks radiating from staybolts or rivet holes shall not be repaired by welding.
REINFORCING OF CORRODED AREAS IN STAYED PLATES

If corroded areas include rivets or staybolt holes, these shall be removed and discarded.

Threaded staybolt holes shall be retapped and new holes bored adjacent to old holes. New staybolts or rivets are driven.

Note: Welding shall not cover rivets or staybolt heads.

Corroded areas of tube sheets may be built up by welding where tubes act as stays.

All tubing in such corroded areas shall be removed before welding is applied. After welding the tube holes shall be tested before new tubes are installed.
**Fig 13**

**SEAL WELDING OF CAULLING EDGES**

**Caution:** Seal welding shall not be applied if cracks are present in the weld area.

Indications of persistent or recurring leakage may be a sign of cracking. The seal welding shall be applied in a manner consistent with these cracking indications, including removal of rust, if necessary, to ensure the integrity of the area.

Seal welding shall be applied in one light layer if practicable, but not more than two layers shall be used.

**Throat approx. 1/2”**

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**Fig 14**

**SEAL WELDING OF TUBE ENDS**

Seal welding shall be applied to one side of the tube to ensure a tight seal. Use of welding shall be made to ensure the integrity of the weld.

In water-tube boilers, tubes may be seal welded on inside or outside of tube sheet.

Plugging may be used if desired, but shall not exceed a 1/8” dimension.

In fire-tube boilers, requirements of section 41.12 and 41.13 of the code shall be complied with.
**Fig 15**

**FLUSH OR BUTT WELDED PATCHES IN UNSTAYED AREAS**

- Not less than 8 in. or more than 8 in.
- Not less than 8 in.

Acceptable Detail of Weld

Before any effort is made to patch a flanged or deformed area, the original shape or curvature shall be restored as far as possible. Patch shall be rolled or pressed to proper shape or curvature. Edges shall align without distress.

Flush or butt welded patches may be of any shape, an adequate radius shall forever be provided at corners if patch is replaceable. Sharp corners shall be avoided.

Note: Patch shall be of material equal to the original construction in thickness and quality.

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**Fig 16**

**FLUSH OR BUTT WELDED PATCHES IN STAYED AREAS**

- Patches shall be of material equal to the original in quality and thickness.
- Before applying patches of this type, defective metal shall be cut away completely.
- Patch edges shall not be left to rest between staybolt rows or riveted seams.
- In applying patches of this type, sharp corners shall be avoided. Ample radius shall be provided at corners.
Fig. 17
LAP-FILLET WELDED PATCHES

Patch shall be of equal thickness and the welds in quality and thickness. If any repair includes a new sheet plate, the patch shall be adopted and the patch shall be welded at edges. New sheet used shall be installed in patch area. The inner surface of the patch shall be covered by welding.

Lap Fillet Welded Patch in Unlazed Area

1. Flash Butt Welded Head
With this repair, the old head is not close to the point of tangency of the flange and the new head is flashed welded to the tube shell. The old head, being a welded tee, is to be cut off at the flange, and the flash butt welded to the tube shell. The new head is the same as the old head, being a welded tee. The new head, being a welded tee, is to be cut off at the flange, and the flash butt welded to the tube shell.

2. Lapped and Fillet Welded Head
With this repair, the new head is lapped under the flange of the old head, previously started as shown in sketch. New head, then fillet welded at edges.

3. Segmental or Pie-Shaped Butt Welded Patch

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Fig. 18
ACCEPTABLE REPAIRS FOR CORRODED OR WORN HEADS OF VERTICAL TUBE OR SIMILAR TYPE BOILERS

1
2
3

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Fig. 10
ACCEPTED REPAIRS FOR INSPECTION OPENINGS

A badly corroded manhole flange may be repaired by cutting out damaged section and inserting a ring type frame as shown. Dimensions shall comply with requirements of Sections 41.94 and 41.11 of this code.

Ring type frame may be fabricated and steeled relieved in shop then welded in place. Rules for flash patches shall be complied with.

Plate lap should not be less than 1/2".
When corrosion has reduced thickness of plate around manhole opening by more than 1/2", a reinforcing ring shall be used as shown placed on the flange.

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Fig. 21
ACCEPTED "WINDOW" PATCH FOR WATER TUBE
BOILER TUBES

This type of patch may be used if neces-
sary to seal a hole cut in a water wall
tube to provide access for welding the
back side of a sheet joint, or to replace a
small short bead.

When in doubt concerning the explo-
sion of certain Ind. 41.40 and Ind. 41.41
of this code, patches shall be cut from tubes
of same size and thickness as the one
being repaired.

When practicable, a removable copper
backup bevel should be provided to pro-
vide bonding, and conductivity, through the tube
wall. This will help prevent the formation of air
flask and result in a better weld at the joint.

This figure shows an acceptable patch for
water tube boilers.
Power Boilers Ind 42.18
Superheater Ind 42.18
Type Not Permitted Ind 42.18
Second Hand Boilers Ind 41.09 Ind 42.08
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Shearing of Rivets Ind 42.11
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Maximum Pounds of Steam Per Hour per Square Foot of Surface Table 4
Maximum Number of Pipe Threads for Connections Table 6
Maximum Air Supplied in Cubic Feet per Minute Table 6
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