

# **Wisconsin Administrative Code**

## **Rules of**

### **DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS**

#### **BOILER AND PRESSURE VESSEL CODE**

Cite the rules in this Code as

(for example)

**Wis. Adm. Code section lrd 41.001**

**DEPARTMENT OF INDUSTRY, LABOR AND  
HUMAN RELATIONS**

**GEF 1, 201 E. Washington Ave.  
Madison, Wisconsin 53702**

## Chapter Ind 41

## BOILER AND PRESSURE VESSEL CODE

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## PART I

## SCOPE

Ind 41.01 Scope. (1) The provisions of this code apply to boilers and pressure vessels in use at places of employment and in public buildings.

(2) "Water" means and includes every place, whether indoors or

outside, which is used for the purpose of generating steam or pressure. "Boiler" means any vessel in which steam or pressure is generated or maintained, and which is used for the purpose of generating steam or pressure. "Pressure vessel" means any vessel in which pressure is maintained, and which is used for the purpose of containing a liquid or gas under pressure. "Inspection" means an examination of a boiler or pressure vessel to determine its fitness for service. "Inspected" means examined and found to be in compliance with the provisions of this code. "Inspection report" means a report made by an inspector in accordance with the provisions of this code. "Inspection fee" means a fee charged for the inspection of a boiler or pressure vessel. "Inspection fee schedule" means a schedule of inspection fees established by the department. "Inspection fee schedule" means a schedule of inspection fees established by the department. "Inspection fee schedule" means a schedule of inspection fees established by the department.

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(9) HOT WATER HEATING BOILER AND HOT WATER SUPPLY BOILER. A boiler completely filled with water that furnishes hot water to be used externally to itself at pressures not exceeding 160 psig or at temperatures not exceeding 250° F. (A boiler exceeding either of these limits shall be classified as a power boiler.)

(10) INSPECTOR, AUTHORIZED OR QUALIFIED.

(a) *Field inspector.* A boiler or pressure vessel inspector who holds a valid certificate of competency issued by the department.

(b) *Shop inspector.* A boiler or pressure vessel inspector who is holding the necessary commissions and employed by a city or a state which has adopted the ASME boiler and pressure vessel code, or who is employed by an insurance company and who, when performing shop inspections in Wisconsin, holds a certificate of competency issued by the department.

(11) INTERNAL INSPECTION. One made when the boiler or pressure vessel is shut down and handholes and manholes or other inspection openings are opened or removed for inspection of the interior as required by the inspector.

(12) NON-STANDARD BOILER OR NON-STANDARD PRESSURE VESSEL. One not bearing a valid Wisconsin stamping, nor the ASME stamping, nor the National Board stamping, nor the U.S. Department of Transportation stamping, nor the stamping of the API-ASME, nor any stamping authorized by other applicable codes.

(13) OWNER OR USER. Any person, firm, or corporation owning or operating a boiler or pressure vessel.

(14) PRESSURE VESSEL. A vessel that obtains its pressure from an external source or from an indirect application of heat.

(15) REPAIR, MAJOR REPAIR, AND ALTERATION.

(a) *Repair.* Work necessary to return a boiler or pressure vessel to a safe satisfactory condition.

(b) *Major repair.* A repair upon which the strength of a boiler or pressure vessel will depend.

(c) *Alteration.* A change in a boiler or pressure vessel that substantially alters the original design requiring consideration of the effect of the change on the original design. It is not intended that the addition of nozzles smaller than an unreinforced opening size be considered an alteration.

(16) SECONDHAND VESSEL. A boiler or pressure vessel when both location and ownership have been changed subsequent to the original installation.

*Note:* For further explanation of definitions, see the current edition of the ASME Code—Section VIII—Scope.

*History:* Cf. Register, April 1961, No. 64, eff. 5-1-61; am. (2) (b), (7), (10), Register, January 1966, No. 121, eff. 2-1-66; am. (3) (5), (8) (a) and (b), (9), (10), (11), (12), (13), (14), (15), and (16), Register, October, 1970, No. 178, eff. 11-1-70; r. and corr., Register, May, 1974, No. 231, eff. 6-1-74.

PART III

GENERAL RULES

Ind 41.03 Safety regulations. (1) No boiler or pressure vessel shall be operated at a pressure in excess of the maximum operating pressure stated on its current certificate of operation.

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# INSTALLATION REGISTRATION

SB-257 (11/71)

State of Wisconsin  
Department of Industry, Labor & Human Relations  
**INDUSTRIAL SAFETY AND BUILDINGS DIVISION**

Complete appropriate portion

Installing Contractor shall prepare this form in triplicate and distribute as follows:

**White**—Attach Registration Fee of \$5.00, making check payable to Wisconsin Department of Industry, Labor & Human Relations. Send to Industrial Safety & Buildings Division, Box 2209, Madison, Wisconsin 53701.

**Yellow**—Send to Owner who shall POST IT IN A CONSPICUOUS PLACE.

**Pink**—Retain for file

| BOILER   |  | PRESSURE VESSEL  |        |
|--|--|--|--------|
| Mfgd By  |  | Diameter   |        |
| <input type="checkbox"/> Power <input type="checkbox"/> Heating <input type="checkbox"/> Miniature |  |  |        |
| <input type="checkbox"/> New <input type="checkbox"/> Used   |  | Mfr's Data Report  | Length |
|  |  | <input type="checkbox"/> Yes <input type="checkbox"/> No   |        |
| Heating Surface  |  | Waterwalls   |        |
|  |  | <input type="checkbox"/> New <input type="checkbox"/> Used |        |

|                               |                        |                |                                  |       |                 |
|-------------------------------|------------------------|----------------|----------------------------------|-------|-----------------|
| Name of User or Owner         |                        |                | Location of Installation         |       |                 |
| Street Address                |                        |                | Wis. Registration No.            |       | Natl. Board No. |
| City                          | State                  | Zip            | ASME Mfg Serial No.              |       | Other No.       |
| Safety Valves—Settings        |                        | Capacity       | P S I G                          |       |                 |
| 1.                            | _____                  | _____          | Maximum Allowable Pressure _____ |       |                 |
| 2.                            | _____                  | _____          | Hydrostatic Test Pressure _____  |       |                 |
| 3.                            | _____                  | _____          | Date Tested _____                |       |                 |
| Authorized Inspector          |                        | Wis. Comm. No. | Employer                         |       | Date Inspected  |
| Name of Installing Contractor |                        | Street Address | City                             | State | Zip Code        |
| Date Installation Completed   | Signature of Installer |                | Title                            |       | Date Registered |

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(5) ANNUMENTS AND REVOCATIONS. (a) A certificate becomes invalid when the holder terminates his employment with the employer of record at the time of issue. A renewal may be obtained under the provisions of this section provided applicant meets eligibility requirements.

(b) A certificate may be annulled or revoked when incompetency or negligence is determined after investigation.

(6) RECIPROCAL COMMISSIONS. (a) A reciprocal certificate of competency may be granted by the department to a boiler or pressure vessel inspector under the following conditions:

1. The inspector shall be employed by a boiler insurance company licensed to do business in Wisconsin. The boiler insurance company shall make the application for a reciprocal commission to the department.

2. The inspector shall hold a commission issued by the National Board of Boiler and Pressure Vessel Inspectors or a certificate of competency from a city or state which has adopted the A.S.M.E. Boiler and Pressure Vessel Code and which holds a written examination similar to that required by Wisconsin.

3. The inspector shall appear before an examining board appointed by the department to review his qualifications as an inspector. **HISTORY:** Cr. Register, April, 1961, No. 64, eff. 5-1-61; R. and Recr. Register, February, 1971, No. 182, eff. 3-1-71; am. (1), (3) (c), (4) (a), (6) (a) 1. and 3., Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 41.10 Adoption of standards.** (1) Pursuant to section 227.025, Wis. Stats, the attorney general and the revisor of statutes have consented to the incorporation by reference of the following standards. Copies of the standards in reference are on file in the offices of the department, the secretary of state and the revisor of statutes, or they may be procured for personal use from the following publishers:

(a) The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

|                |   | As Amended<br>by Summer<br>& Winter<br>Addenda | As Amended<br>by Summer<br>& Winter<br>Addenda |
|----------------|---|--|--|
| 1. Section I   | Power Boilers, 1971 Edition                               | 1971   | 1972   |
| 2. Section II  | Material Specifications, 1971 Edition, Parts A, B and C   | 1971   | 1972<br>(Parts A & B only)                     |
| 3. Section III | Nuclear Power Plant Components, 1971 Edition              | 1971   | 1972   |
| 4. Section IV  | Heating Boilers, 1971 Edition                             | 1971   | 1972   |
| 5. Section V   | Nondestructive Examination, 1971 Edition<br>(winter only) | 1971   | 1972   |

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- (d) A drain connection at least 2-inch standard pipe size,
- (e) Connections designed so that freezing will not close the inlet, the outlet, or the vent,
- (f) Vent piping, full size, piped to the outside atmosphere and discharged to a safe location.

Note: Blow-off equipment designed in accordance with the boiler blow-off equipment code issued by the National Board of Boiler and Pressure Vessel Inspectors, 1968 edition, will meet the requirements of this section. Other methods of designing blow-off equipment may be used if approved by the department.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and recor. (6), Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 41.12 Vessels supplied through pressure reducing valves. (1)**  
The following formula shall be used for determining the sizes of safety and relief valves on pressure vessels such as pressure cookers, indirect hot water heaters, equipment in heating systems, etc., which are supplied through pressure reducing valves from boilers carrying a higher steam pressure. Where a pressure reducing valve is supplied by a boiler, the capacity of the safety valve or valves on the low pressure side of the system need not exceed the capacity of the boiler.

$$RVC = \frac{1}{2} \times OC \times VSPA$$

Where RVC = relief valve capacity, lbs. of steam per hour.

OC = orifice capacity, lbs. of steam per hour per sq. in. (See Table 1.)

VSPA = valve size pipe area, sq. in. (See Table 2.)

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TABLE 2.—INTERNAL PIPE AREA

| Nominal pipe size, inches | STANDARD                         |                                   |                                      |
|---------------------------|----------------------------------|-----------------------------------|--------------------------------------|
|                           | Actual internal diameter, inches | Approx. internal diameter, inches | Approx. internal area, square inches |
| 2 3/8                     | 0.6775                           | 0.49                              | 0.19                                 |
| 2 1/2                     | 0.840                            | 0.62                              | 0.30                                 |
| 2 1/4                     | 1.050                            | 0.82                              | 0.53                                 |
| 1 3/4                     | 1.315                            | 1.05                              | 0.86                                 |
| 1 1/2                     | 1.660                            | 1.38                              | 1.50                                 |
| 1 1/4                     | 1.900                            | 1.61                              | 2.04                                 |
| 1 1/2                     | 2.375                            | 2.07                              | 3.36                                 |
| 3/4                       | 2.875                            | 2.47                              | 4.73                                 |
| 3/4                       | 4.0                              | 3.07                              | 7.39                                 |
| 4                         | 4.5                              | 3.55                              | 9.89                                 |
| 5                         | 5.563                            | 4.03                              | 12.73                                |
| 6                         | 6.625                            | 5.05                              | 19.99                                |
| 8                         | 8.625                            | 6.07                              | 28.89                                |
| 10                        | 10.750                           | 8.07                              | 51.15                                |
| 12                        | 12.750                           | 10.19                             | 81.55                                |
|                           |                                  | 12.09                             | 114.80                               |

*Notes:* In applying these rules, the area of the pipe is always based upon standard weight pipe and the inlet size of the pressure-reducing valve.

(a) The following formula shall be used to determine the steam flow rate through the bypass when pressure reducing valves are arranged with a valved bypass which also acts as a potential steam source hazard in case the bypass is left open.

$$RVC = \frac{1}{4} \times OC \times BPA.$$

Where RVC = relief valve capacity, lbs. of steam per hour.

OC = orifice capacity, lbs. of steam per hour per square inch. (See Table 1.)

BPA = bypass pipe area, sq. inch. (See Table 2.)

(b) The larger of the relief valve capacities calculated by the formulas in subsections Ind 41.12 (1) and (1) (a) shall be used for selecting the relief valve for the vessel.

*Note: Example.* Suppose a high pressure boiler operating at 125 psi distributes steam to a series of 40 psi ASME constructed retorts through a 1 1/2 inch size pressure reducing valve provided with a glove-valved 1 inch bypass. Determine the proper ASME relief valve protection for the retorts. Utilizing data in tables and the first of the 2 formulas above:  $W = \frac{1}{4} \times 7200 \times 2.04 = 4896$  lbs. steam per hour.

Checking the bypass steam flow according to the second formula gives:  $W = \frac{1}{4} \times 7200 \times 0.86 = 3100$  lbs. steam per hour.

The potential steam flow through the pressure reducing valve is 4896 lbs. per hour rated capacity or

4896 X 1000 or 4,896,000 BTU per hour.

*History:* Cf. Register, April, 1961, No. 64, et. 6-1-61; am. Register, January, 1966, No. 121, et. 2-1-66; r. and rec. (1) and Table 1, Register, February, 1971, No. 153, et. 3-1-71, r. (1) second, "Note" following Table 2 including referenced formulas that follow this note and cr. (1) (a) and (b), Register, May, 1971, No. 185, et. 6-1-71.

**Ind 41.13 Maintenance.** (1) All boilers shall be installed and maintained in such a manner as to prevent excessive corrosion and deterioration.

(2) The inspector shall note conditions during internal inspection, external inspection, or hydrostatic pressure test and shall order such changes or repairs as will place the boiler in a safe working condition.

*Note:* Sections VI and VII, ASME Boiler and Pressure Vessel Code, "Recommended Rules for Care and Operating of Heating Boilers" and "Recommended Rules for Care of Power Boilers" are excellent guides for boiler owners and operators.

*History:* Cr. Register, February, 1971, No. 182, et. 3-1-71.

(a) To enter without delay and at reasonable times any factory, plant, establishment, construction site, or other area, workplace or environment where work is performed by an employee of an employer; and

(b) To inspect and investigate during regular working hours and at other reasonable times, and within reasonable limits and in a reasonable manner, any such place of employment and all pertinent conditions, structures, machines, apparatus, devices, equipment, and materials therein, and to question privately any such employer, owner, operator, agent or employee.

(2) CONTACTING REPRESENTATIVE. The inspector before making his inspection shall contact a representative of the employer and a representative authorized by his employees who shall be given an opportunity to accompany the inspector during the physical inspection of any workplace under subsection (1) for the purpose of aiding such inspection.

(a) Where there is no authorized employee representative, the inspector shall consult with a reasonable number of employees concerning matters of health and safety in the workplace.

Note: The department policy is not to give advance notice, but in the scheduling and in the act of inspecting it may not always be possible to avoid advance notice or to obtain accompaniment as, for example, inside boilers or in precarious locations of elevator installations, but otherwise these rules will be diligently observed.

(3) INSPECTION OF BOILERS. Except as regulated in sections Ind 41.20 (5) and Ind 41.21, boilers shall be subjected to either a regular internal or external inspection at least once every 12 months by a qualified inspector.

(a) When *internal inspection* is not possible. Where an internal inspection is not possible because of the construction of the boiler, an external inspection will be acceptable.

(4) INSPECTION OF PRESSURE VESSELS. Except as regulated in section Ind 41.21, pressure vessels shall be subjected to a regular internal or external inspection at least once every 24 months by a qualified inspector.

(5) INSPECTION OF LOW PRESSURE STEAM OR VAPOR HEATING BOILERS, AND HOT WATER HEATING BOILERS. Except as regulated in section Ind 41.21, low pressure steam or vapor heating boilers and hot water heating boilers shall be subjected to a regular external or internal inspection at least once every 24 months by a qualified inspector.

Note: Extension of period between inspections. If operating conditions require, longer periods between inspections of boilers may be approved by the department upon a written request for an extension.

Note: For inspection fees, see Wis. Adm. Code chapter Ind 69, Fee Schedule.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am. (2), (3), (4), Register, October, 1970, No. 173, eff. 11-1-70; renum. (1), (2), (3), (4), to be (3), (4), (5) and (6) and cr. (1) and (2), Register, April, 1973, No. 208, eff. 5-1-73; r. and recr. (3), (4), (5) and r. (6), Register, May, 1974, No. 221, eff. 6-1-74.

Ind 41.21 Vessels exempt from periodic inspections. (1) The following boilers and pressure vessels will not be subject to periodic inspection, but in individual cases any such vessel will be subject to inspection by or on order of the department upon complaint of any person or upon initiative of the department when there is reasonable cause



(d) The insurance company shall report to the department within 30 days when insurance coverage is started or discontinued on a boiler or pressure vessel. The reason for discontinuing the coverage shall be given on the report.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and recr. Register, February, 1971, No. 182, eff. 3-1-71; am. (1) (a), (b) and (d), Register, May, 1974, No. 231, eff. 6-1-74.

**Ind 41.24 Inspections by cities.** (1) Periodic inspections of boilers and pressure vessels by cities of the first class may be accepted by the department under the following conditions:

(a) The boiler and pressure vessel inspectors employed by the city shall hold certificates of competency issued by the department.

(b) The city shall keep a record of such periodic inspections and shall submit a copy to the department.

(c) The inspection procedures used by the city shall conform to the regulations of this code.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and recr. Register, February, 1971, No. 182, eff. 3-1-71; am. (1) (a) and (b), Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 41.25 Companies or corporations allowed to make inspections.**

(1) Periodic inspections by companies or corporations of boilers or pressure vessels which they own or operate may be accepted by the department under the following conditions:

(a) The boiler and pressure vessel inspectors employed by the company or corporation shall hold certificates of competency issued by the department.

(b) The company or corporation shall report inspections of boilers and pressure vessels to the department as required in section Ind 41.26.

(c) The inspection procedures used by the company or corporation shall conform to the regulations of this code.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and recr. Register, February, 1971, No. 182, eff. 3-1-71; am. (1) (a) and (b), Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 41.26 Reporting of inspections.** (1) Reports of periodic internal or external inspections of boilers and pressure vessels shall be sent to the department within 15 days from the date of inspection.

(2) External inspections shall be reported only when either of the following conditions is found:

(a) An internal inspection is not possible because of the construction of the vessel. In such cases the first inspection shall be reported to the department in the same manner as an internal inspection. The report shall be marked "external" and the reason for making an external inspection instead of an internal shall be given.

(b) When violations of this code or unsafe conditions involving the safety of the vessel are found. This report shall be made on ASME Form P-6 and shall explain the violation or unsafe condition with references to code section numbers. A copy of the recommendations to the owner or user of the vessel shall accompany the report to the department.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61; am. (1) Register, February, 1971, No. 182, eff. 3-1-71; am., Register, May, 1974, No. 221, eff. 6-1-74.

(3) It shall be unlawful for any person, firm, partnership or corporation to use, operate, or offer for sale for operation within the state any condemned boiler or pressure vessel.

History: Cr. Register, October, 1970, No. 178, eff. 11-1-70; am. (1) and (2), Register, May, 1974, No. 221, eff. 6-1-74.

#### PART V

### NEW INSTALLATIONS ORIGINAL CONSTRUCTION

Ind 41.50 ASME code vessels. Except as regulated in Wis. Adm. Code sections Ind 41.51, Ind 41.52 and Ind 41.53, boilers and pressure vessels installed after the effective date of this section shall be constructed and installed in accordance with the sections of the ASME Boiler and Pressure Vessel Code adopted under section Ind 41.10 (1) (a).

Note: The department will recognize the applicable "case interpretations" of ASME Boiler and Pressure Vessel Code as being acceptable. History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and rec. Register, December, 1962, No. 84, eff. 1-1-63; am. Register, August, 1964, No. 104, eff. 9-1-64; am. Register, January, 1966, No. 121, eff. 2-1-66; am. Register, March, 1966, No. 123, eff. 4-1-66; r. and rec. Register, November, 1970, No. 179, eff. 12-1-70; am. (1) Intro. par. Register, March, 1971, No. 189, eff. 4-1-71; r. and rec. Register, May, 1974, No. 221, eff. 6-1-74.

Ind 41.51 Wisconsin special vessels. (1) Where it is not possible or practical to construct a boiler or pressure vessel in strict compliance with section Ind 41.50, the department may grant a modification to the owner or user to permit the installation of the vessel as a Wisconsin special within the state of Wisconsin under the following conditions:

(a) When the method of designing or constructing the vessel is not covered by the ASME codes listed in section Ind 41.10, the department may approve the installation of the vessel if adequate proof of comparable safety of the design or construction is shown.

1. Complete plans, calculations, and specifications in duplicate shall be submitted to and approved by the department before the vessel is installed.

2. The vessel shall be stamped "Wisconsin Special".

3. All other applicable requirements of the ASME codes listed in section Ind 41.10 shall be met.

(b) When the vessel is to be built by an owner for his own use, the department may waive the stamping required by the ASME codes listed in section Ind 41.10.

1. Complete plans, calculations, and specifications in duplicate shall be submitted to and approved by the department before the vessel is installed.

2. The vessel shall be stamped "Wisconsin Special".

3. All other applicable requirements of the ASME codes listed in section Ind 41.10 shall be met.

(c) When a small number of vessels is to be built by a manufacturer, the department may waive the stamping required by the ASME codes listed in section Ind 41.10.

1. Complete plans, calculations, and specifications in duplicate shall be submitted to and approved by the department before the vessel is installed.

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Ind 41.55 Pressure gauges for air receivers. (1) Air receivers shall be equipped with an indicating pressure gauge so located as to be readily visible.

(2) The dial of the pressure gauge shall be graduated to approximately double the pressure at which the safety valve is set, but not less than one and one-half times that pressure.

History: Cr. Register, May, 1974, No. 221, eff. 6-1-74.

PART VI

EXISTING INSTALLATIONS

Ind 41.60 Application. (1) The provisions of sections Ind 41.60 through Ind 41.99 shall apply to boilers installed prior to January 1, 1957.

(2) Pressure vessels installed prior to January 1, 1957 shall meet the requirements of section Ind 41.99, pressure relief devices for pressure vessels.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am., (2), Register, May, 1974, No. 221, eff. 6-1-74.

Ind 41.61 Maximum allowable working pressures. (1) The maximum allowable working pressure on a boiler is the safe pressure at which the boiler may be operated as determined by the provisions of sections Ind. 41.60 through Ind 41.99, inclusive, of this code.

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

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 41.62 Code constructed vessels. Any boiler 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 and may 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 boilers, the operating pressure shall be determined by using sections Ind 41.63 through Ind 41.76, inclusive.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 41.63 Pressure calculations for shells. The maximum allowable working pressure to be allowed on the shell of a boiler shall be determined from the following formula:

$$P = \frac{T.S. \times t \times E}{R \times F.S.}$$

where P = maximum allowable working pressure, pounds per square inch,

T.S. = tensile strength of shell plate, pounds per square inch,

t = minimum thickness of shell plates, inches,

E = efficiency of longitudinal joint — method of determining which is given in section Ind 41.73,

R = inside radius of the outside course of the shell,

F.S. = lowest factor of safety allowed by section Ind 41.70.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

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Ind 41.69 Other methods of installing safety devices and other appliances. Where the ASME codes listed in Ind 41.10 permit other methods of installing safety devices and other appliances on boilers, these methods may be used on existing boilers.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am. Register, May, 1974, No. 221, eff. 6-1-74.

Ind 41.70 Factor of safety. Maximum allowable working pressure shall be determined by using a factor of safety of at least 5 except as provided in section Ind 41.62.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 41.71 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 45,000 pounds per square inch for wrought iron, 30,000 pounds per square inch for copper and 18,000 pounds per square inch for cast iron. The resistance to crushing of mild steel shall be taken as 95,000 pounds per square inch of cross sectional area.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 41.72 Shearing strength of rivets. (1) MAXIMUM PER SQUARE INCH. The maximum shearing strength of rivets per square inch of cross-sectional area shall be taken as follows:

|                                    |
|------------------------------------|
| Ultimate strength                  |
| Pounds per                         |
| square inch                        |
| Iron rivets in single shear -----  |
| 38,000                             |
| Iron rivets in double shear -----  |
| 76,000                             |
| Steel rivets in single shear ----- |
| 44,000                             |
| Steel rivets in double shear ----- |
| 88,000                             |

(2) RIVET DIMENSIONS AFTER DRIVING. When the diameter of the rivet holes in the longitudinal joints of a boiler is not known, the diameter and cross-sectional area of rivets, after driving, shall be taken from Table 3.

TABLE 3

| Thickness of Plate                          | $\frac{1}{4}$ "<br>0.25"  | $\frac{3}{8}$ "<br>0.2812"                          | $\frac{1}{2}$ "<br>0.3125"  | $\frac{5}{8}$ "<br>0.34375" | $\frac{3}{4}$ "<br>0.375                          | $\frac{7}{8}$ "<br>0.39375" | $\frac{1 1}{8}$ "<br>0.41875" | $\frac{1 1}{4}$ "<br>0.4418 | $\frac{1 3}{8}$ "<br>0.46438 | $\frac{1 1}{2}$ "<br>0.48688 | $\frac{1 5}{8}$ "<br>0.50938 | $\frac{1 3}{4}$ "<br>0.53185 | $\frac{1 7}{8}$ "<br>0.55432 |
|---|---|---|-----------------------------|-----------------------------|---|-----------------------------|-------------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| Diameter of Rivet after Driving             | $\frac{5}{16}$ "  | $\frac{3}{8}$ "                                     | $\frac{1}{2}$ "             | $\frac{3}{4}$ "             | $\frac{1}{2}$ " and $\frac{1 1}{8}$ "<br>2" pitch | $\frac{3}{4}$ "             | $\frac{1}{2}$ "               | $\frac{1 1}{4}$ "           | $\frac{1 1}{2}$ "            | $\frac{1 1}{2}$ "            | $\frac{1 1}{2}$ "            | $\frac{1 1}{2}$ "            | $\frac{1 1}{2}$ "            |
| Cross sectional area of rivet after driving | 0.3712<br>sq. in.   | 0.3712<br>sq. in.                                   | 0.4418<br>sq. in.           | 0.4418<br>sq. in.           | 0.4418<br>sq. in.                                 | 0.4418<br>sq. in.           | 0.5185<br>sq. in.             | 0.5185<br>sq. in.           | 0.5185<br>sq. in.            | 0.5185<br>sq. in.            | 0.5185<br>sq. in.            | 0.5185<br>sq. in.            | 0.5185<br>sq. in.            |
| Thickness of Plate                          | $\frac{1}{8}$ "<br>0.4375"  | $\frac{7}{16}$ "<br>0.4375"                         | $\frac{1}{4}$ "<br>0.46875" | $\frac{3}{8}$ "<br>0.46875" | $\frac{1}{2}$ "<br>0.5"                           | $\frac{5}{8}$ "<br>0.5625"  | $\frac{3}{4}$ "<br>0.625"     | $\frac{3}{4}$ "<br>0.625"   | $\frac{3}{4}$ "<br>0.625"    | $\frac{3}{4}$ "<br>0.625"    | $\frac{3}{4}$ "<br>0.625"    | $\frac{3}{4}$ "<br>0.625"    | $\frac{3}{4}$ "<br>0.625"    |
| Diameter of Rivet after Driving             | $\frac{1}{8}$ "<br>up to and including $\frac{2 1}{4}$ "<br>pitch | $\frac{3}{16}$ "<br>over $\frac{2 1}{4}$ "<br>pitch | $\frac{1}{4}$ "             | $\frac{1}{4}$ "             | $\frac{1}{2}$ "                                   | $\frac{1}{2}$ "             | $\frac{1 1}{4}$ "             | $\frac{1 1}{4}$ "           | $\frac{1 1}{4}$ "            | $\frac{1 1}{4}$ "            | $\frac{1 1}{4}$ "            | $\frac{1 1}{4}$ "            | $\frac{1 1}{4}$ "            |
| Cross sectional area of rivet after driving | 0.6018<br>sq. in.   | 0.6908<br>sq. in.                                   | 0.6908<br>sq. in.           | 0.6908<br>sq. in.           | 0.6908<br>sq. in.                                 | 0.8866<br>sq. in.           | 0.8866<br>sq. in.             | 0.8866<br>sq. in.           | 0.8866<br>sq. in.            | 0.8866<br>sq. in.            | 0.8866<br>sq. in.            | 0.8866<br>sq. in.            | 0.8866<br>sq. in.            |

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

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(2) The maximum allowable working pressure on boilers, the tubes of which are secured to cast iron headers, shall not exceed 160 pounds per square inch.

History: Cr. Register, April, 1961, No. 64, eF. 5-1-61.

Ind 41.77 Safety or relief valves required on boilers. Every boiler 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 41.78.

History: Cr. Register, April, 1961, No. 64, eF. 5-1-61.

Ind 41.78 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 6% 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 =  $\frac{\text{Maximum Btu input per hour} \times 0.75}{1000}$

(c) Actual evaporation test.

(d) On the basis of boiler heating surface or waterwall heating surface as given in Table 5.

TABLE 5  
MINIMUM POUNDS OF STEAM PER HOUR PER SQUARE  
FOOT OF SURFACE

| Type of Boilers                                  | Surface   | Firetube Boilers | Water-tube Boilers |
|--|---|------------------|--------------------|
| Power Boilers-----                               | Boiler heating surface                              | 5                | 5                  |
|  | Hand-fired  | 7                | 8                  |
|  | Stoker-fired  | 8                | 10                 |
|  | Oil, gas, or pulverized fuel fired                  |                  |                    |
|  | Waterwall heating surface                           | 8                | 8                  |
|  | Hand-fired  | 10               | 12                 |
|  | Stoker-fired  | 14               | 16                 |
|  | Oil, gas, or pulverized fuel fired                  |                  |                    |
| Low Pressure Steam and<br>Miniature Boilers----- | Boiler heating surface<br>any method of firing----- | 5                | 5*                 |

\*Shall include cast iron boilers.

Note. Compliance with section Ind 41.78 (1) will 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 3% above the maximum allowable working pressure, but the range of setting of all of

(10) (a) 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 areas of inlet connections of all of the safety valves to be attached thereto. An internal collecting pipe, splash plate or pan may be used, provided the total area for inlet of steam thereto is not less than twice the aggregate areas of the inlet connections of the attached safety valves. The holes in such collection pipes shall be at least  $\frac{3}{4}$ " in diameter and the least dimension in any other form of opening for inlet of steam shall be  $\frac{3}{4}$ ".

(b) If safety valves are attached to a separate steam drum or dome, the opening between the boiler proper and the steam drum or dome shall be not less than required by section Ind 41.78 (10) (a).

(c) 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.

(d) For conditions exceeding those specified in the above paragraph, the case shall be referred to the department for decision.

History: Or Register, April, 1961, No. 64, eff. 5-1-61; am. (4) and (10) (d), Register, May, 1974, No. 221, eff. 6-1-74.

Ind 41.79 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 disk guides on the pressure side of the valve. The valves shall be set to relieve at a pressure at or below the maximum allowable working pressure of the boiler.

(2) Relief valves which are constructed in accordance with sections Ind 41.50 and Ind 41.51 of this code are acceptable. Relief valves constructed to other standards may be used if approved by the department.

(3) Water-relief valves shall be attached directly or as close as possible to the boiler without any unnecessary intervening pipe or fitting. A water-relief valve shall not be connected to an internal pipe in the boiler. Water-relief valve shall be connected so as to stand upright with the spindle vertical when possible.

(4) No shut-off of any description shall be placed between the water-relief valve and the boiler, nor on discharge pipes between such valve and the atmosphere.

(5) When a discharge pipe is used its area shall be not less than the area of the valve or aggregate area based on the nominal diameters of the valves with which it connects. The discharge pipe shall be pitched away from the valve to prevent water from lodging in the upper part of the valve or in the pipe. The water-relief valve shall be so located and piped that there will be no danger of scalding attendants.

(6) The required water-relief valve capacity for any hot water boiler shall be equal to the maximum Btu output at the boiler nozzle or shall be equal to the boiler heating surface multiplied by 5000.

(7) The water-relief valve capacity for each hot water boiler shall be such that the valve or valves will relieve all the pressure that can be generated by the boiler without allowing the pressure to rise more than 3 pounds above the maximum allowable working pressure of the boiler.

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

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 41.83 Water column piping.** (1) No connections shall be placed on pipes connecting the water column to the boiler except connections for damper regulator, feed water regulator, steam gage or drains.

(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 direct 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 ashpit or other safe point of waste, and if the water connection thereto has a rising bend or pocket which cannot be drained by means of the water column drain, an additional drain shall be placed in this 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 upper part of the head; the water connection shall be taken from the front head at a point not less than 6 inches below the center line of the shell. For the firebox types of boilers, the water connection to the water column shall be taken at a point not less than 6 inches below the lowest water line or as near thereto as possible, and in no case less than 18 inches above the mud ring.

(5) When shut-offs are used on the connections to a water column, they shall be either outside-screw-and-yoke type valves or stop cocks with levers permanently fastened thereto and marked in line with their passage. Where stop cocks are used they shall be of a type with the plug held in place by a guard or gland.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 41.84 Pressure gages.** (1) (a) Every boiler shall be provided with a pressure gage connected to the upper part of the boiler and so arranged that the gage cannot be shut off from the boiler except that a shut-off valve or cock shall be placed close to the gage or a second shut-off valve or cock close to the boiler to permit removal for testing while the boiler is in operation.

(b) For steam boilers, the gage may also be connected to the water column or water column steam connection. For steam boilers, a siphon or equivalent device of sufficient capacity to keep the gage tube filled with water shall be provided.

(2) The dial of the pressure gage shall be graduated to at least one and one-half times the pressure at which the safety or relief valve is set except as follows:

(a) On low pressure steam boilers the gage shall be graduated to at least 30 pounds per square inch.

(b) On hot water boilers the pressure or altitude gage shall be graduated to at least one and one-half times the maximum allowable working pressure.

(3) (a) For low pressure steam boilers, the travel of the pointer

the minimum size shall be 1 inch except that for boilers with 100 square feet of water heating surface or less and low pressure steam boilers the minimum size of pipe and fittings may be  $\frac{3}{4}$  inch. Straight-way globe valves of the ordinary type or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used on such connections.

(b) The bottom blow-off pipe for low pressure steam, miniature, and hot water boilers may be connected to return connections which are the same size or larger than the size herein specified. In such 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 guard or gland. 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 and shall be 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 fitting shall be of steel construction and not less than extra heavy.

(d) Cast iron pipe and fittings shall not be used in the bottom blow-off pipe between the boiler and the bottom blow-off valve or valves.

(6) (a) On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 pounds per square inch, each bottom blow-off pipe shall have 2 slow-opening valves, or one slow-opening valve and a cock, and such valves, or valve and cock, shall be at least extra heavy construction. On a boiler having multiple blow-off pipes a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required. Two independent valves, or a valve and a cock may be combined in one body provided the combined fitting is the equivalent of 2 independent valves, or a valve and a cock, so that the failure of one to operate could not affect the operation of the other.

(b) Every traction and portable boiler shall have a bottom blow-off valve; when the maximum allowable working pressure exceeds 125 pounds per square inch, the blow-off valve shall be at least extra heavy.

(c) For pressures exceeding 200 pounds per square inch the valves or cocks shall be of steel construction.

(d) The blow-off valve or valves shall be the full size of the blow-off pipe.

(7) A bottom blow-off pipe when exposed to direct furnace heat shall be protected by fire brick or other heat resisting material so arranged that the pipe may be inspected.

(8) An opening in the boiler setting for a blow-off pipe shall be arranged to provide for free expansion and contraction.

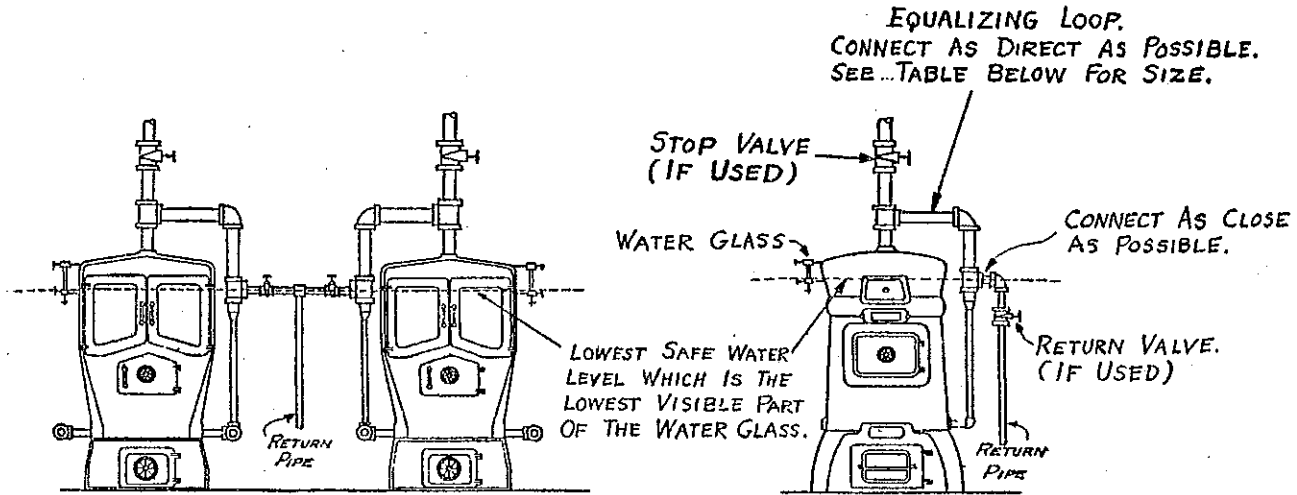
(9) See section Ind 41.11 for required boiler blow-down equipment.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.



Fig. 1

RETURN PIPE LOOP CONNECTION



| GRATE AREA, OR<br>Sq. Ft. | OR<br>SAFETY VALVE<br>CAP, LBS./HR | EQUALIZING LOOP<br>SIZE, INCHES |
|---------------------------|------------------------------------|---------------------------------|
| 4 OR LESS                 | 250 OR LESS                        | 1 1/2                           |
| OVER 4 TO 15              | 251 TO 2000 Inc.                   | 2 1/2                           |
| OVER 15                   | OVER 2000                          | 4                               |

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(5) 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.

(6) 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 plug is directly opposite and as close as possible to the opening in the boiler.

History: Cr. Register, April, 1961, No. 64, et. 5-1-61.

**Ind 41.92 Manholes.** Where manholes are provided, such manholes shall be not less than 11 inches by 15 inches, or 10 inches by 16 inches in size. A circular manhole opening shall be not less than 15 inches in diameter.

History: Cr. Register, April, 1961, No. 64, et. 5-1-61.

**Ind 41.93 Maintenance.** (1) All boilers shall be installed and maintained in such a manner as to prevent excessive corrosion or deterioration.

(2) The inspector shall note conditions during the internal inspection, external inspection or hydrostatic pressure test and order such changes or repairs as will place the boiler in a safe working condition.

History: Cr. Register, April, 1961, No. 64, et. 5-1-61.

**Ind 41.94 Threaded openings.** (1) All pipe threads shall conform to the American Pipe Thread standard and all connections one inch pipe size or over shall have not less than the number of threads given in Table 6. For smaller pipe connections there shall be at least 4 threads in the opening.

(2) If the thickness of the shell of the boiler is not sufficient to give such number of threads a construction shall be employed which will provide at least the required number of threads.

TABLE 6  
MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS TO BOILERS

| Size of pipe connections, inches   | 1 & 1¼ | 1½ & 2 | 2¼ to 4 incl | 4½ to 6 incl | 7 & 8 | 9 & 10 | 12     |
|--|--------|--------|--------------|--------------|-------|--------|--------|
| Number of threads per inch   | 11½    | 11½    | 8            | 8            | 8     | 8      | 8      |
| Minimum number of threads required for opening                                 | 4      | 5      | 7            | 8            | 10    | 12     | 18     |
| Minimum thickness of material required to give above number of threads, inches | 0.348  | 0.485  | 0.875        | 1            | 1.25  | 1.5    | 1.6265 |

History: Cr. Register, April, 1961, No. 64, et. 5-1-61.

**Ind 41.95 Boiler setting and installation.** (1) A horizontal return tubular boiler over 72 inches in diameter shall be supported from steel hangers by the outside suspension type of setting, independent of the boiler side walls. The hangers shall be so designed that the load is properly distributed between the rivets attaching them to the shell

standards of sections Ind 41.50 and Ind 41.51 of this code are acceptable. Safety valves constructed to other standards may be used if approved by the department.

(4) Rupture disks may be used in lieu of safety valves on vessels containing substances that may render a safety valve inoperative, or where a loss of valuable material by leakage should be avoided, or contamination of the atmosphere by leakage of noxious gases must be avoided. Such rupture disks shall be tested, marked, and installed in accordance with the ASME codes listed in section Ind 41.10.

(5) When hot water supply is heated indirectly by steam in a coil or pipe a water relief valve of at least one inch in diameter, set to relieve at or below the maximum allowable working pressure of the tank shall be used.

(6) Each safety or relief valve shall have a full size direct connection to the pressure vessel. When an escape pipe is used it shall be full sized and fitted with an open drain, to prevent water lodging in the upper part of the safety or relief valve or escape pipe. When a pressure vessel is fitted with 2 safety or relief valves on one connection, this connection to the pressure vessel shall have a cross-sectional area equal to or greater than the combined area of the 2 safety or relief valves. No valve of any description shall be placed between the safety or relief valve and the pressure vessel, nor on the escape pipe between the safety or relief valve and the atmosphere.

(7) When an elbow is placed on a safety or relief valve escape pipe it shall be located close to the safety or relief valve outlet, or the escape pipe shall be securely anchored and supported.

(8) When the capacity of the safety valve on an existing tank for containing gases is not known, the relieving capacity of such safety valve shall be determined from Table 7. Such safety valves shall not exceed 4 inches in diameter.

TABLE 7  
MAXIMUM FREE AIR SUPPLIED IN CUBIC FEET PER MINUTE FOR DIFFERENT SIZES OF SAFETY VALVES AT STATED PRESSURES

| Diameter of Valve (inches) | Gage pressure, pounds |     |     |      |      |      |      |      |      |      |
|----------------------------|-----------------------|-----|-----|------|------|------|------|------|------|------|
|                            | 50                    | 100 | 150 | 200  | 250  | 300  | 350  | 400  |      |      |
| 1/4                        | 26                    | 32  | 42  | 51   | 59   | 67   | 74   | 81   | 88   | 95   |
| 3/8                        | 37                    | 59  | 78  | 96   | 112  | 127  | 141  | 155  | 169  | 183  |
| 1/2                        | 58                    | 94  | 124 | 152  | 178  | 202  | 224  | 248  | 270  | 293  |
| 3/4                        | 82                    | 135 | 180 | 221  | 259  | 293  | 325  | 355  | 385  | 414  |
| 1                          | 114                   | 186 | 248 | 302  | 354  | 400  | 444  | 484  | 521  | 557  |
| 1 1/4                      | 189                   | 305 | 419 | 501  | 592  | 668  | 741  | 814  | 887  | 959  |
| 1 1/2                      | 222                   | 457 | 613 | 750  | 880  | 998  | 1114 | 1230 | 1346 | 1462 |
| 2                          | 393                   | 638 | 856 | 1050 | 1230 | 1398 | 1557 | 1716 | 1875 | 2034 |
| 2 1/2                      |                       |     |     |      |      |      |      |      |      |      |
| 3                          |                       |     |     |      |      |      |      |      |      |      |
| Gage pressure, pounds      |                       |     |     |      |      |      |      |      |      |      |
| Diameter of Valve (inches) | 500                   | 600 | 800 | 1000 | 1200 | 1500 | 2000 | 2400 |      |      |
| 1/4                        | 61                    | 70  | 84  | 97   | 109  | 128  | 147  | 167  |      |      |
| 3/8                        | 129                   | 147 | 177 | 205  | 230  | 270  | 304  | 330  |      |      |
| 1/2                        | 224                   | 282 | 346 | 386  | 423  | 483  | 518  | 548  |      |      |
| 3/4                        | 286                   | 324 | 390 | 450  | 500  | 586  | 644  | 692  |      |      |
| 1                          | 374                   | 424 | 509 | 584  | 654  | 762  | 844  | 914  |      |      |
| 1 1/4                      | 472                   |     | 634 |      |      |      |      |      |      |      |
| 1 1/2                      |                       |     |     |      |      |      |      |      |      |      |
| 2                          |                       |     |     |      |      |      |      |      |      |      |
| 2 1/2                      |                       |     |     |      |      |      |      |      |      |      |
| 3                          |                       |     |     |      |      |      |      |      |      |      |

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am. (3) and (4), Register, May, 1974, No. 221, eff. 6-1-74.

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Chapter Ind 42

REPAIRS, MAJOR REPAIRS, ALTERATIONS

|           |  |           |  |
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PART VII

REPAIRS, MAJOR REPAIRS, ALTERATIONS

Ind 42.01 Rules and reports. (1) Repairs, major repairs, or alterations to any boiler or pressure vessel or their fittings, settings, or appurtenances shall be completed in accordance with the requirements of sections Ind 42.01 through 42.22. Other methods may be acceptable provided they are approved by the department. In the absence of specific rules, the rules for new construction shall apply. No repair, major repair, or alteration by welding shall be made without the approval of an authorized inspector who shall, if he considers it necessary, inspect the object before granting an approval.

(2) Manufacturers, owners, or contractors who make major repairs\* in accordance with these rules shall furnish the department with a report of every such major repair within 30 days after completion. \* See section Ind 41.02 (15).

Ind 42.02 Hydrostatic test or nondestructive testing. If, in the opinion of the authorized inspector, a hydrostatic test is necessary, such a test shall be applied at a pressure of at least the operating pressure, but not to exceed 150% of the maximum allowable working pressure. In lieu of a hydrostatic test, if approved by the authorized inspector, radiographic testing, ultrasonic testing, or other applicable nondestructive testing of the repair may be utilized. Such tests shall be applied after the repair has been completed.

History: Cr. Register, April, 1961, No. 64, eR. 5-1-61; r. and recr., Register, May, 1974, No. 221, eR. 6-1-74.

Ind 42.03 Design of riveted patches. It is the purpose of sections Ind 42.03 through Ind 42.07 covering the application of riveted patches, to restore to the weakened portion of the shell or head enough of its initial strength to permit the boiler to operate at its original working pressure. This involves calculations of the patch joints based on the shape and location of the patch. The rules herein given enable 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 seams, whereas in shells of horizontal tubular boilers some of the end wise stress is carried by the through rods, tube or flues, and consequently there is less stress on the shell and patch seams. It is evident then that a patch in the 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 9 and 10 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 provisions of item (3) are met.

(3) (a) A patch shall be laid out in the flat and then carefully formed to accurately fit 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) Seams exposed to the products of combustion shall be single riveted lap construction.

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

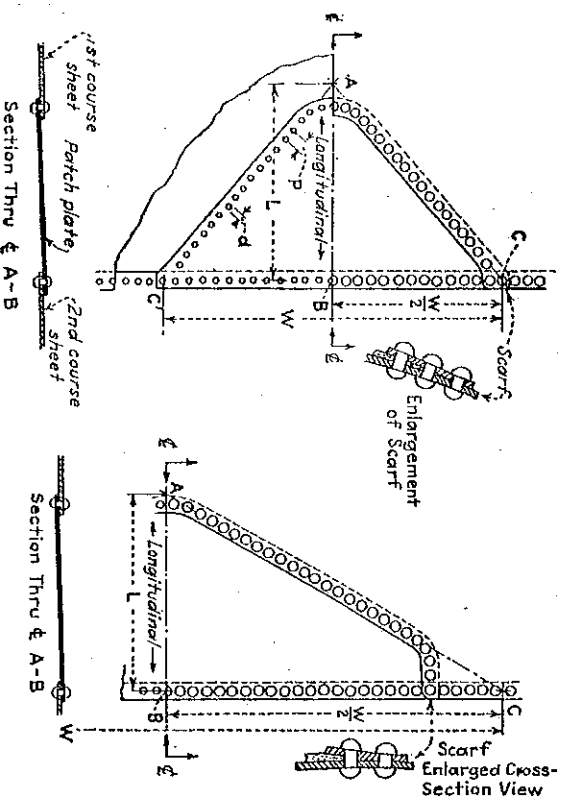
(5) (a) Patches exceeding 24 inches in length shall have the proper width as determined by the rules herewith.

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

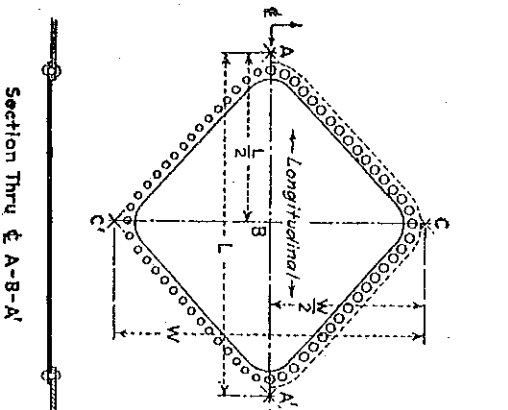
(6) (a) If it is found that a patch would extend extremely high it

**Fig. 2**  
**TRIANGULAR PATCH**  
 At girth seam on bottom of boiler (inside) as viewed from outside of boiler

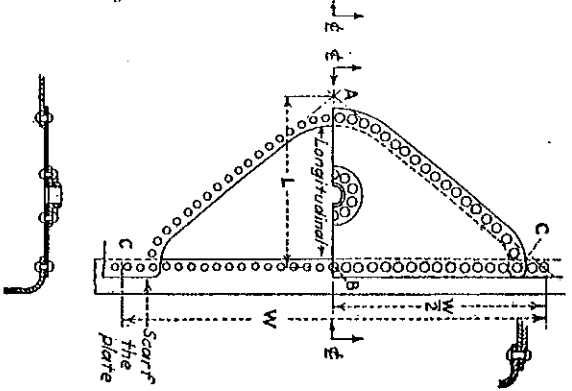
**Fig. 3**  
 Showing how patch may be shortened girthwise provided no more than 4 rivets are in a line parallel with the longitudinal seam.



**Fig. 4**  
**DIAMOND SHAPE PATCH**  
 At centre of sheet (inside)



**Fig. 5**  
**TRIANGULAR PATCH**  
 At head seam and blow-off on bottom of boiler (outside)



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(6) If seal welding is used, it shall be laid in a single bead with a throat thickness not less than  $\frac{1}{8}$  inch, nor more than  $\frac{1}{4}$  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 plates shall be carefully scarfed to a feather edge the entire width of the lap, as shown in Figure 2.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 42.06 Calculations for riveted patches. (1) First the length L of the patch shall be determined. The dimension is, of course, governed by the area of the defect. Next, the normal efficiency, e, of the single-riveted seam that is to be used in the patch shall be determined from Table 8. 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<sub>1</sub> as shown in Table 9 or 10, depending upon the type of boiler to be repaired. These tables give a constant C for a given efficiency, e, of patch and efficiency, E, of longitudinal seam.

(3) 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 8 will give e. Then under e in Table 9 or 10, 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 42.07).

TABLE 8  
EFFICIENCIES OF SINGLE-RIVETED SEAMS

| Plate Thickness, t | Rivet Hole Diameter, d | Pitch of Rivets, p | Efficiency of Seam, e |
|--------------------|------------------------|--------------------|-----------------------|
| 1/4                | 1/4                    | 1 1/2              | 63.3                  |
| 3/8                | 3/8                    | 1 1/2              | 60.0                  |
| 1/2                | 1/2                    | 1 1/2              | 58.0                  |
| 5/8                | 5/8                    | 1 1/2              | 57.0                  |
| 3/4                | 3/4                    | 1 1/2              | 57.5                  |
| 7/8                | 7/8                    | 2 1/4              | 56.0                  |
| 1                  | 1                      | 2 1/4              | 55.5                  |
| 1 1/8              | 1 1/8                  | 2 3/8              | 55.7                  |
| 1 1/4              | 1 1/4                  | 2 3/8              | 53.0                  |
| 1 3/8              | 1 3/8                  | 2 3/8              | 52.5                  |
| 1 1/2              | 1 1/2                  | 2 3/8              | 50.5                  |
| 1 5/8              | 1 5/8                  | 2 3/8              | 51.4                  |
| 1 3/4              | 1 3/4                  | 2 3/8              | 51.4                  |
| 1 7/8              | 1 7/8                  | 2 3/8              | 51.4                  |
| 2                  | 2                      | 2 3/8              | 51.4                  |

Tensile strength assumed at 55,000 psi and shearing strength at 44,000 psi.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 42.07 Examples of calculations for riveted patches. (1) DESIGN OF PATCH FOR HORIZONTAL-TUBULAR BOILER. (a) A patch is to be placed in the fire sheet of a horizontal-return tubular boiler having shell plate  $\frac{1}{2}$  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.

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**TABLE 10**  
**TABLE OF CONSTANTS FOR USE IN COMPUTING PATCH SEAMS WHEN HEADS ARE UNSUPPORTED**

|     | "e" efficiency of patch seams |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|-----|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|     | .50                           | .51   | .52   | .53   | .54   | .55   | .56   | .57   | .58   | .59   | .60   | .61   | .62   | .63   | .64   | .65   |
| .65 | 2.20                          | 2.06  | 1.93  | 1.80  | 1.69  | 1.56  | 1.45  | 1.35  | 1.24  | 1.14  | ----- | ----- | ----- | ----- | ----- | ----- |
| .66 | 2.30                          | 2.16  | 2.03  | 1.90  | 1.78  | 1.66  | 1.55  | 1.45  | 1.34  | 1.22  | 1.12  | ----- | ----- | ----- | ----- | ----- |
| .67 | 2.40                          | 2.26  | 2.13  | 2.00  | 1.88  | 1.75  | 1.64  | 1.52  | 1.43  | 1.32  | 1.21  | ----- | ----- | ----- | ----- | ----- |
| .68 | 2.50                          | 2.36  | 2.23  | 2.10  | 1.98  | 1.86  | 1.73  | 1.63  | 1.52  | 1.42  | 1.31  | 1.19  | ----- | ----- | ----- | ----- |
| .69 | 2.62                          | 2.46  | 2.33  | 2.20  | 2.07  | 1.95  | 1.84  | 1.71  | 1.61  | 1.50  | 1.40  | 1.30  | 1.17  | ----- | ----- | ----- |
| .70 | 2.75                          | 2.57  | 2.43  | 2.30  | 2.16  | 2.04  | 1.93  | 1.80  | 1.69  | 1.59  | 1.49  | 1.37  | 1.28  | 1.16  | ----- | ----- |
| .71 | 2.87                          | 2.70  | 2.53  | 2.40  | 2.26  | 2.14  | 2.02  | 1.90  | 1.79  | 1.67  | 1.57  | 1.47  | 1.37  | 1.26  | 1.15  | ----- |
| .72 | 3.00                          | 2.81  | 2.65  | 2.48  | 2.36  | 2.23  | 2.11  | 1.99  | 1.88  | 1.78  | 1.66  | 1.56  | 1.45  | 1.36  | 1.26  | 1.14  |
| .73 | 3.14                          | 2.93  | 2.76  | 2.60  | 2.46  | 2.33  | 2.20  | 2.09  | 1.97  | 1.87  | 1.75  | 1.64  | 1.54  | 1.44  | 1.35  | 1.24  |
| .74 | 3.28                          | 3.07  | 2.87  | 2.71  | 2.56  | 2.42  | 2.30  | 2.19  | 2.06  | 1.93  | 1.83  | 1.73  | 1.62  | 1.52  | 1.43  | 1.34  |
| .75 | 3.38                          | 3.19  | 3.00  | 2.83  | 2.66  | 2.52  | 2.40  | 2.27  | 2.15  | 2.05  | 1.92  | 1.81  | 1.71  | 1.61  | 1.51  | 1.42  |
| .76 | 3.52                          | 3.32  | 3.14  | 2.96  | 2.78  | 2.62  | 2.49  | 2.36  | 2.24  | 2.12  | 2.01  | 1.90  | 1.79  | 1.69  | 1.60  | 1.50  |
| .77 | -----                         | 3.46  | 3.28  | 3.07  | 2.90  | 2.74  | 2.58  | 2.45  | 2.32  | 2.22  | 2.10  | 1.98  | 1.88  | 1.77  | 1.67  | 1.58  |
| .78 | -----                         | ----- | 3.40  | 3.19  | 3.03  | 2.85  | 2.69  | 2.55  | 2.42  | 2.30  | 2.19  | 2.07  | 1.96  | 1.86  | 1.75  | 1.66  |
| .79 | -----                         | ----- | ----- | 3.32  | 3.16  | 2.97  | 2.80  | 2.65  | 2.51  | 2.39  | 2.27  | 2.16  | 2.05  | 1.94  | 1.84  | 1.74  |
| .80 | -----                         | ----- | ----- | 3.46  | 3.28  | 3.10  | 2.92  | 2.75  | 2.61  | 2.48  | 2.36  | 2.24  | 2.14  | 2.03  | 1.92  | 1.83  |
| .81 | -----                         | ----- | ----- | ----- | 3.40  | 3.20  | 3.03  | 2.87  | 2.71  | 2.57  | 2.45  | 2.33  | 2.21  | 2.11  | 2.00  | 1.90  |
| .82 | -----                         | ----- | ----- | ----- | ----- | 3.34  | 3.16  | 2.97  | 2.82  | 2.67  | 2.53  | 2.42  | 2.30  | 2.19  | 2.09  | 1.98  |
| .83 | -----                         | ----- | ----- | ----- | ----- | 3.46  | 3.29  | 3.10  | 2.93  | 2.78  | 2.63  | 2.50  | 2.39  | 2.27  | 2.17  | 2.06  |
| .84 | -----                         | ----- | ----- | ----- | ----- | ----- | 3.39  | 3.22  | 3.05  | 2.87  | 2.75  | 2.59  | 2.47  | 2.37  | 2.25  | 2.15  |
| .85 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | 3.32  | 3.17  | 2.99  | 2.89  | 2.69  | 2.55  | 2.44  | 2.34  | 2.23  |
| .86 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | 3.45  | 3.29  | 3.13  | 2.96  | 2.78  | 2.65  | 2.54  | 2.42  | 2.32  |
| .87 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.40  | 3.24  | 3.07  | 2.90  | 2.76  | 2.62  | 2.50  | 2.40  |
| .88 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.32  | 3.17  | 3.00  | 2.86  | 2.71  | 2.59  | 2.47  |
| .89 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.46  | 3.29  | 3.14  | 2.97  | 2.81  | 2.68  | 2.56  |
| .90 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.40  | 3.24  | 3.07  | 2.93  | 2.78  | 2.65  |
| .91 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.35  | 3.19  | 3.03  | 2.87  | 2.75  |
| .92 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.45  | 3.29  | 3.14  | 2.97  | 2.83  |
| .93 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.39  | 3.24  | 3.09  | 2.93  |
| .94 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.32  | 3.19  | 3.03  |
| .95 | -----                         | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 3.43  | 3.28  | 3.1   |

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Constant "C" Triangle or crescent shape patches  $C = W + L$      $W = C \times L$      $L = W + C$   
 Diamond or oval shape patches  $C = 2W + L$      $W = C \times L \div 2$      $L = 2W + C$



prepared and qualified in accordance with the requirements of ASME Section IX, Welding Qualifications (Ind 41.10) and section Ind 41.51 of this code.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; r. and recor., Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 42.09 Welders.** (1) **WELDER QUALIFICATION.** Manufacturers, owners or contractors shall have available for the Inspector records of welder qualification tests showing that each welder to be employed on the work has satisfactorily passed tests as prescribed in sections Ind 41.50 and Ind 41.51 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 specifications and the conducting of tests of procedures and welders shall be the responsibility of the manufacturer, owner or contractor. 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 qualification tests that procedures and welders have been properly qualified as required in section Ind 41.50. 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, April, 1961, No. 64, eff. 5-1-61; am. (2), Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 42.10 Rules for welding.** The repairs that may be made under these rules are limited to steels of flange or fire box quality having known weldable quality and further limited to carbon steels having a carbon content of not more than 0.35%. Structural steel shall not be used. The welding of high alloy material and nonferrous material shall be done in accordance with the requirements of ASME Section IX, Welding Qualifications (Ind 41.10) and section Ind 41.51 of this code.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am., Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 42.11 Prohibited repairs.** A welder shall not make repairs in a plate thickness in excess of that permitted under sections Ind 41.50 and Ind 41.51 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, April, 1961, No. 64, eff. 5-1-61.

**Ind 42.12 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 plates 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

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rivet seam within 8 inches, measured from nearest calking edge. The total length of any one such crack shall not exceed 8 inches. Cracks of a greater length may be welded, provided the complete repair is radiographed and stress relieved in accordance with section Ind 42.14. See Figures 8 and 8(a) for acceptable methods.

(2) Cracks of any length in unstayed furnaces may be welded, provided the welds are thermally stress relieved in accordance with section Ind 42.14. 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 knuckle or turn of flange of furnace opening are prohibited unless specifically approved by the department. See Figure 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 10 for acceptable methods.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61; am. (2), Register, May, 1974, No. 221, eff. 6-1-74.

Ind 42.16 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 that 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 loss of 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. Seal 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 of sections Ind 41.50 and Ind 41.51 of this code are satisfied. See Figure 14 for acceptable methods.

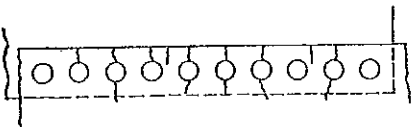
History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

Ind 42.17 Re-ending and piecing tubes. Re-ending or piecing 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 41.50 and Ind 41.51 of this code for the pressure to be carried. In all cases the requirements of sections Ind 41.50 and Ind 41.51 of this code shall be met.

History: Cr. Register, April, 1961, No. 64, eff. 5-1-61.

CRACKS IN UNSTAYED SHELLS, DRUMS AND HEADERS

Fig. 8



Fire Cracks at Girth Seams

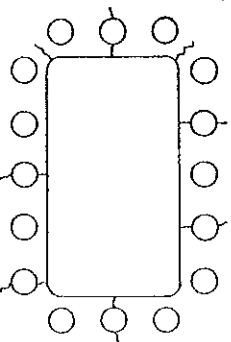
Prior to repairing fire cracks by welding, the rivets to which such cracks may extend and the rivets on each side of them shall be removed.

Tack bolts shall be placed in alternate holes to hold the plate laps firmly.

Cracks shall then be chipped, ground or gouged to produce required welding groove.

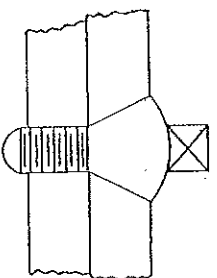
CRACKS WHICH EXTEND PAST THE INNER EDGE OF THE PLATE LAP SHALL BE WELDED FROM BOTH SIDES.

Rivet holes shall be reamed before new rivets are driven.



Fire Cracks at Door Openings

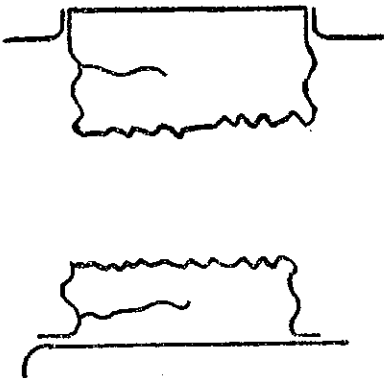
Repairs shall be made as for fire cracks at girth seams. Patch bolts may be used where it is not possible to rerive rivets.



Patch Bolt

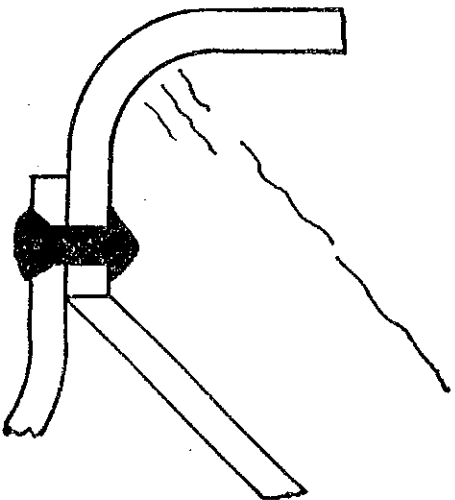
CRACKS IN UNSTAYED FURNACES

Fig. 9



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

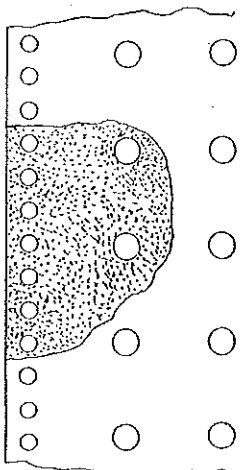
Cracks shall be chipped, ground or sanded to provide rounded leading groove; root or weld shall be cleaned by chipping or flame gouging and welding applied from both sides of the date. Internal stress relieving is recommended.



**Field repair of cracks at knuckle or turn of flange of furnace opening is difficult. It is recommended that this repair be made in a well equipped shop.**

REINFORCING OF CORRODED AREAS IN STAYED PLATES

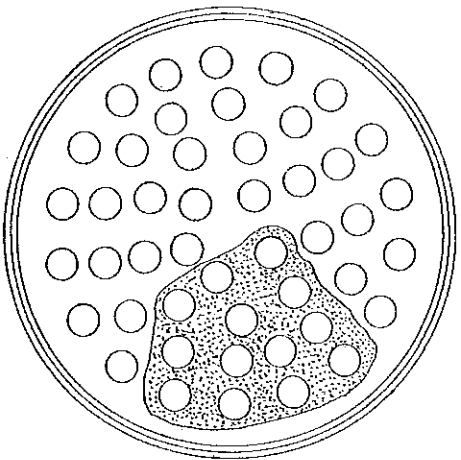
Fig. 11



If corroded area includes rivets or staybolts, these shall be removed before welding is applied.

Threaded staybolt holes shall be retapped and rivet holes reamed before new staybolts are installed or rivets are driven.

Note: Welding shall not cover rivets or staybolt heads.

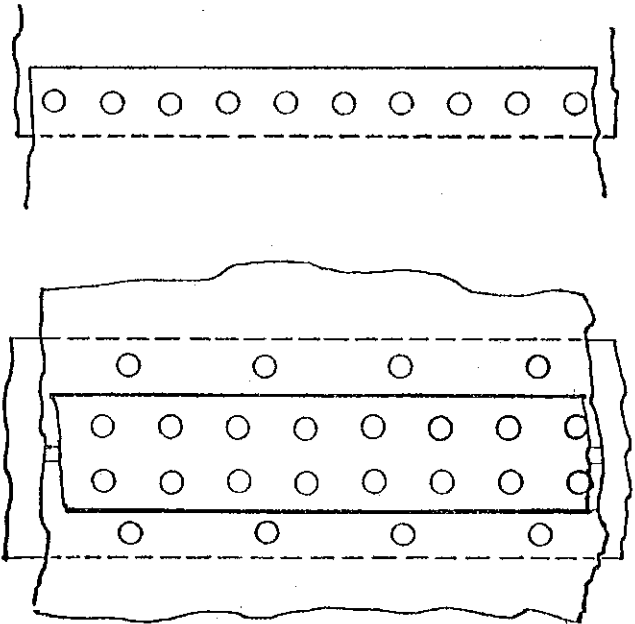


Corroded areas of tube sheets may be built up by welding where tubes act as stays.

All tubes in such corroded areas shall be removed before welding is applied.

After welding, the tube holes shall be reamed before new tubes are installed.

Fig 13  
SEAL WELDING OF CAULKING EDGES



**Caution.**—Seal welding shall not be applied if cracks are present in riveted areas.  
Indications of persistent or recurring leakage may be a sign of cracking. No welding shall be applied until a careful examination including removal of rivets if necessary has been made of such areas.  
Seal welding shall be applied in one light layer if practicable but not more than two layers shall be used.

Throat approx.  $\frac{1}{4}$ "

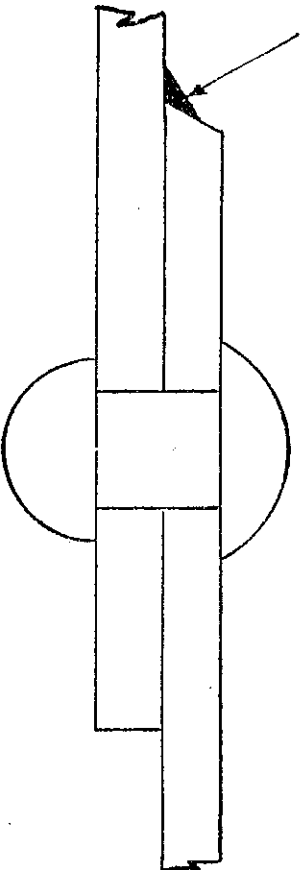
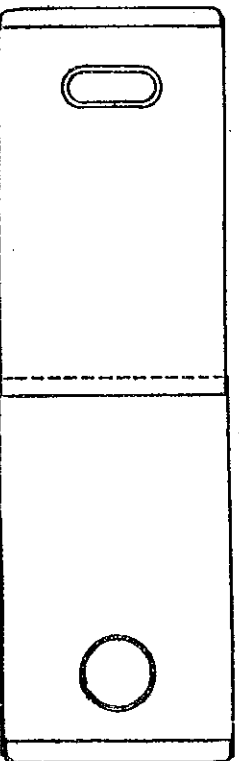
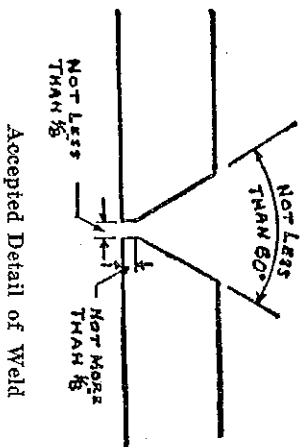


Fig 15  
 FLUSH OR BUTT WELDED PATCHES IN UNSTAYED AREAS



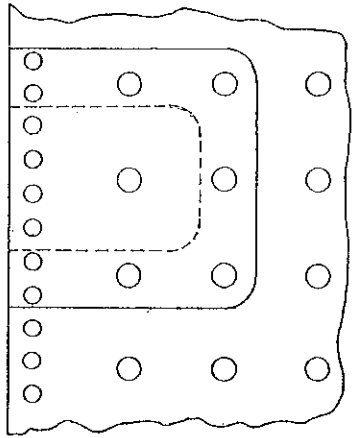
Before any effort is made to patch a bagged or deformed area the original shape or curvature shall be restored as far as possible. Patch shall be rolled or pressed to proper shape or curvature. Edges shall align without overlap.

Push or butt welded patches may be of any shape, an adequate radius shall however be provided at corners if patch is rectangular. Sharp corners shall be avoided.

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

LAP-FILLET WELDED PATCHES

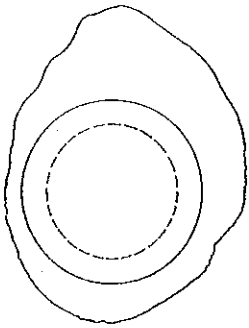
Fig. 17



Patches shall be of material equal to the original in quality and thickness.

If area to be patched includes a riveted seam rivets shall be removed before patch is applied and new rivets driven before patch is welded at edges.

New staybolts shall be installed in patched area, the heads of staybolts shall not be covered by welding.



Lap Fillet Welded Patch in Unstayed Area

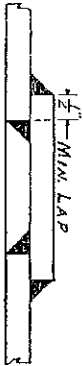
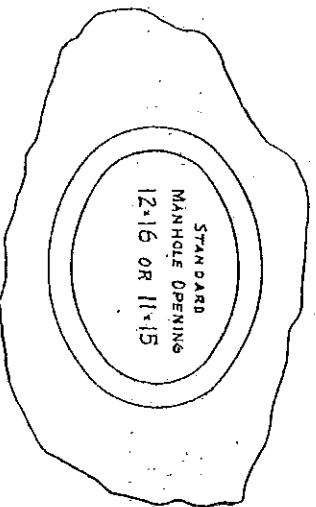




Fig. 19  
ACCEPTED REPAIRS FOR INSPECTION OPENINGS



A badly corroded manhole flange may be repaired by cutting out flanged section and inserting a ring type frame as shown. Dimensions shall comply with requirements of sections Ind 41.50 and Ind 41.51 of this code.



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

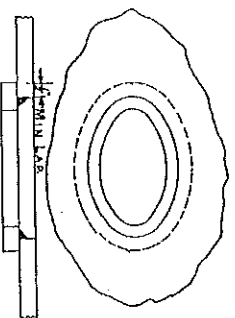
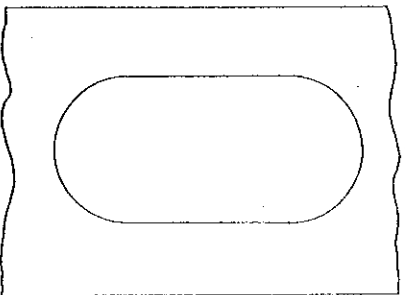


Plate lap should not be less than  $\frac{1}{2}$ ".  
When corrosion has reduced thickness of plate around handhole opening by more than 50% (average) a reinforcing ring shall be used as shown placed on the inside.

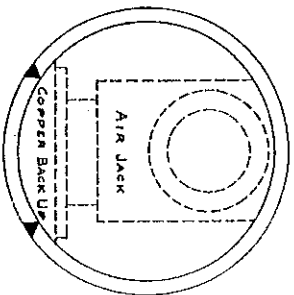
ACCEPTED "WINDOW" PATCH FOR WATER TUBE  
BOILER TUBES

Fig. 21



This type of patch may be used if necessary to seal a hole cut in a water wall tube to provide access for welding the back side of a circum. joint or to replace a small sharp bag.

Window patches shall comply with provisions of sections Ind 41.50 and Ind 41.51 of this code. Patch shall be cut from tube of same size and thickness as the one being repaired.



When practicable, a removable copper backup recessed as shown to provide complete weld penetration through the tube wall and held in place by a removable air jack shall be used during the welding operation.

**Ind 42.32 Installation.** All secondhand pressure vessels exclusive of vessels used for the storage and transportation of liquefied petroleum gases, anhydrous ammonia, and all refrigerant containing vessels when reinstalled shall comply with the ASME codes listed in section Ind 41.10 in regard to fittings, appliances, valves, connections, settings and supports. (The excluded vessels are subject to the provisions of other applicable administrative codes.)

**History:** Cr. Register, April, 1961, No. 64, eff. 5-1-61; am., Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 42.33 Portable boilers.** A portable boiler, when brought into this state for use, shall be given the inspection and test specified in section Ind 42.31 and the allowable working pressure shall be calculated using sections Ind 41.60 through Ind 41.99 unless it meets either of the following requirements:

(1) The boiler was constructed and stamped according to section Ind 42.26 code constructed vessels.

(2) The boiler is insured by a boiler insurance company.

**History:** Cr. Register, April, 1961, No. 64, eff. 5-1-61

PART IX  
INSPECTION AND REPAIR OF PRESSURE VESSELS  
IN PETROLEUM REFINERIES

**Ind 42.35 Application.** Sections Ind 42.35 through Ind 42.63 shall apply to the inspection, repair, evaluation for continued use, and the methods for computing the maximum allowable working pressure of pressure vessels in petroleum refineries.

**History:** Cr. Register, April, 1961, No. 64, eff. 5-1-61; am., Register, May, 1974, No. 221, eff. 6-1-74.

**Ind 42.36 Inspection; general.** (1) Vessels that are inspected in accordance with the procedures described herein will be acceptable, however, other procedures approved by the department may be used.

(2) New vessels shall be permitted to operate within the conditions for which they were constructed as determined in section Ind 42.40 or, in cases where the provisions of section Ind 42.39 (1) (c) apply, for an initial period during which corrosion rates are determined as specified in section Ind 42.39 (1) (c).

(3) If the vessel is to be kept in service the allowable conditions of service and the length of time before the next inspection shall be based on the condition of the vessel, as determined by the inspection.

(4) If the allowable working pressure and temperature are changed, the period of operation until the next inspection shall be established for this new service.

(5) If both the ownership and location of any vessel are changed, the vessel shall be inspected before it is re-used and the allowable conditions of service and the next period of inspection shall be established for the new service.

**History:** Cr. Register, April, 1961, No. 64, eff. 5-1-61; am., Register, May, 1974, No. 221, eff. 6-1-74.

Register, May, 1974, No. 221  
Boiler and Pressure Vessel Code

able, the probable corrosion rate as estimated from the inspector's knowledge and experience on vessels in similar service.

(c) If the probable corrosion rate cannot be determined by either of the above mentioned methods, thickness determinations shall be made after approximately 1,000 hours of service, or one normal run if longer than this; subsequent sets of thickness measurements shall be taken after additional similar intervals until the corrosion rate is established. If the probable corrosion rate is determined by this method, the corrosion data indicated by the first inspection may be used as a first approximation of the corrosion rate, but shall be excluded from all subsequent computations of the corrosion rate, since attack on the initial surfaces may not be indicative of subsequent attack on corroded surfaces.

History: Cr. Register, April, 1961, No. 64, cR. 5-1-61.

**Ind 42.40 Maximum period between inspections.** (1) When the contents of a vessel are known to be, or expected to be, corrosive, the maximum period between internal inspections shall not exceed  $\frac{1}{2}$  of the estimated remaining safe operating life of the vessel, or 5 years, whichever is less; except in cases where an adequate inspection history extending over a period of at least 5 years has established that the corrosion rate is reasonably uniform and predictable, the interval between the current inspection and the next subsequent one may be established as the projected full remaining safe operating life of the vessel, provided this projected period does not exceed one year.

(2) In cases where part or all of the vessel wall has a protective lining, the frequency of inspections for the portions of the vessel so protected shall be determined from a consideration of records of previous experience with the protection afforded by the lining during similar operations (and the corrosion allowance for the protected metal if there is any likelihood that the lining will fail), but the maximum period between internal inspections shall not exceed 5 years.

(3) When a vessel has 2 or more zones of considerable extent and the net discarding thicknesses, corrosion allowances, or corrosion rates for each differ so much that the foregoing provisions give significant differences in maximum periods between inspections for the respective zones (e.g., the upper and lower portions of some fractionating towers), the periods between inspections may be established individually for each zone on the basis of the conditions applicable thereto, instead of being established for the entire vessel on the basis of the zone which requires the more frequent internal inspection.

(4) The "net discarding thickness" for a vessel or zone, as referred to above, shall be understood to mean the large of the following:

(a) The net wall thickness, exclusive of any corrosion allowance, required for the safety valve setting and operating temperature for the service in which the vessel is being used, or

(b) The minimum practical thickness permitted by the provisions of section Ind 41.50.

(5) When the contents of a vessel are known to be non-corrosive, the vessel need not be inspected internally as long as it remains in the same service and provided all the following conditions are met:

(a) The non-corrosive character of the contents (including the effect

surfaces, before corrosion starts, at suitable intervals to a depth equal to the metal thickness allowed for corrosion, and to plug these holes with protective material that can be readily removed to determine from time to time the loss in metal thickness as measured from the bottom of these holes.

(c) When the depth of corrosion cannot be readily determined otherwise, holes may be drilled through the portions of the wall where corrosion appears to be a maximum, and the thickness determined by taking thickness-gage measurements through these holes. If suitably located existing openings are available, such measurements may be taken through these openings.

(d) Any other suitable method (such as ultrasonic or gamma-ray instruments) that will not affect the safety of the vessel may be used provided it will assure minimum thickness determinations accurate within the following tolerances:

| <u>Wall Thickness, t</u><br>½ in. and less | <u>Permissible Tolerance</u><br>0.10t  |
|--|--|
| Over ½ in.                                 | ½ in., or 0.05t, whichever is greater. |

(2) For a corroded area of considerable size in which the circumferential stresses govern, the least thicknesses along the most critical element of such area may be averaged over a length not exceeding:

(a) The lesser of ½ the vessel diameter, or 20 in., in the case of vessels with inside diameters of 60 in. or less; or

(b) The lesser of ½ the vessel diameter, or 40 in., in the case of vessels with inside diameters greater than 60 inches—except that if the area contains an opening, the distance within which thicknesses are averaged on either side of such opening shall not extend beyond the limits of reinforcement as referred to in section Ind 41.50. If, because of wind loads or other factors, the longitudinal stresses would be of importance, the least thicknesses in a similarly determined length of arc in the most critical plans perpendicular to the axis of the vessel also shall be averaged for computation of the longitudinal stresses. The thicknesses used for determining corrosion rates at the respective locations shall be the average thicknesses determined as aforesaid; and for the purposes of section Ind 42.48 "the actual thickness as determined by inspection" shall be understood to mean the most critical value of average thickness so determined.

(3) Widely scattered pits may be ignored provided their depth is not more than ½ the net thickness of the vessel wall (exclusive of corrosion allowance), the total area of the pits does not exceed 7 sq. in. within any 8-in. diameter circle, and the sum of their dimensions along any straight line within this circle does not exceed 2 inches.

History: CR Register April, 1961, No. 64, eR. 5-1-61.

**Ind 42.42 Correction of corrosion rate.** If, upon measuring the wall thickness at any inspection, it is found that an inaccurate rate of corrosion has been assumed, the rate to be used for the next period shall be increased or may be decreased to conform with the actual rate found.

History: CR Register April, 1961, No. 64, eR. 5-1-61.

spherical (dished) heads, if no record exists as to the crown radius and knuckle radius of the heads, these dimensions should be ascertained and recorded even though no evidence of distortion is observed.

(b) *Joints.* Examine inner and outer surfaces of welded joints carefully for possible cracks and for other defects such as may have been uncovered by the progress of corrosion. Magnetic-particle inspection is suggested as a useful means for doing this either throughout the lengths of the welds or as a supplement to visual inspection on selected lengths which may appear to need more than a visual inspection. Examine riveted joints inside and outside of the vessel for the condition of rivet heads, butt straps, and plates, and for the condition of the calked edges.

(c) *Manways, nozzles, and other openings.* Examine the surfaces of all manways, nozzles, and other openings carefully for distortion, cracks, and other defects giving particular attention to all welding or riveting used for attaching such parts and their reinforcements. If drawings are not available which show details of opening reinforcements and their attachments, take such measurements on these components as may be needed for computing the adequacy thereof. If any question exists as to the condition of any threaded connections, the threaded parts should be disassembled to permit a careful check of the number of threads that remain effective and in good condition. Examine accessible flange faces for distortion and for the condition of gasket seating surfaces.

(5) The inspection items given above are not presumed to be complete for every vessel, but include those features common to most vessels and in general those of greatest importance. Inspectors must supplement this list with any additional items necessary for the particular vessel or vessels involved.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 42.44 Check of dimensions.** The vessels shall be examined for visible indication of distortion; if any such distortion is suspected or observed, the over-all dimensions of the vessels shall be checked to determine the extent and seriousness of the distortion.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 42.45 Pressure relief devices.** The safety valves and other protective devices, such as rupture disks and vacuum valves, where used, should be checked to see that they are in proper condition. This inspection, in the case of valves, will normally include a check on their operation at the set pressure, a check that the proper spring is installed for the service, and an examination to determine that inlets, outlets, and discharge piping are free of corrosion products or other stoppage.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 42.46 Temperature measuring devices.** Temperature measuring devices used for determining metal temperatures shall be checked for accuracy and general condition.

*History:* Cr. Register, April, 1961, No. 64, eff. 5-1-61.

**Ind 42.47 Allowable operation based on inspection data.** Defects or damage discovered during the inspection shall be repaired in accordance with section Ind 42.50 through section Ind 42.63, or shall consti-

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sidered and approved by the inspector. Other methods may be used if submitted to and approved by the department. All such work shall be of the highest quality of workmanship, and shall be executed in a manner and by practices complying with the applicable provisions of section Ind 41.50, and with code approved materials and under proper supervision. Complete records of all such work shall be made and filed.

History: Cr. Register, April, 1961, No. 64, eR 5-1-61; am., Register, May, 1974, No. 221, eR 6-1-74.

**Ind 42.51 Defects in welded joints and plates.** Repairs to cracks found in welded joints and to minor defects found in plates may be made, after preparing a U or V-shaped groove the full depth and length of the crack, by filling this groove with weld metal deposited in accordance with the requirements of section Ind 42.57, or by riveting a reinforcing plate which meets the requirements of section Ind 41.50 for a hole equal in diameter to the full length of the crack after chipping out or drilling the ends.

History: Cr. Register, April, 1961, No. 64, eR 5-1-61.

**Ind 42.52 Corrosion pits.** Isolated corrosion pits may be filled with weld metal deposited in accordance with the requirements of section Ind 42.57. Such pits shall be cleaned to sound metal before welding.

History: Cr. Register, April, 1961, No. 64, eR 5-1-61.

**Ind 42.53 Thickness gage holes.** (1) In corroded vessels subject to rapid stress fluctuations, the holes drilled through the vessel wall for measuring thickness in accordance with section Ind 42.41 shall be closed by welding which complies with section Ind 42.57 and provides complete penetration and fusion for the full depth of the hole.

(2) For vessels in other service, these holes may be treated as unreinforced openings and may be closed by any method permitted under the rules of the A.S.M.E. code.

History: Cr. Register, April, 1961, No. 64, eR 5-1-61.

**Ind 42.54 Corroded or distorted flange faces.** (1) Corroded flange faces may be cleaned thoroughly and built up with weld metal deposited in accordance with the requirements of section Ind 42.57 and re-machined in place, if possible, to a thickness not less than that of the original flange or that required by calculations in accordance with the rules in section Ind 41.50. Corroded flanges may also be re-machined in place, without building up with weld metal, provided the metal removed in the process does not reduce the thickness of the flange below that calculated as above.

(2) Warped flanges which cannot be re-machined, or flanges which have become distorted because of excessive tightening of bolts, shall be replaced with new flanges which have at least the dimensions conforming to section Ind 41.50, welded on in accordance with the requirements of section Ind 42.57.

History: Cr. Register, April, 1961, No. 64, eR 5-1-61.

**Ind 42.55 Cracks at tapped openings.** (1) It is not recommended to repair a crack at a tapped opening by chipping, welding, and re-tapping.

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Ind 42.60 Applying patches to vessels by riveting. The application of a riveted patch shall be made in conformity with the rules given in section Ind 41.50 for reinforcing plates attached by riveting.

History: Cr. Register, April, 1961, No. 64, eT. 5-1-61.

Ind 42.61 New connections. (1) New connections may be installed on vessels provided the design, location, and method of attachment meet the construction requirements of section Ind 41.50.

(2) Welding shall conform to the requirements of section Ind 42.57 and riveting to the requirements of section Ind 42.59.

History: Cr. Register, April, 1961, No. 64, eT. 5-1-61; am. (1), Register, May, 1974, No. 221, eT. 6-1-74.

Ind 42.62 Calking riveted vessels. Riveted joints may be made tight either by mechanical calking or by metallic arc seal welding in accordance with Ind 41.50 after carefully cleaning the seam and cleaning around the rivet heads.

History: Cr. Register, April, 1961, No. 64, eT. 5-1-61.

Ind 42.63 Pressure test after repairs. A vessel, which has had repairs or alterations, shall be given a pressure test in accordance with section Ind 42.49 (2), provided the inspector deems it necessary.

History: Cr. Register, April, 1961, No. 64, eT. 5-1-61.



