

DEPARTMENT FOR PROMOTION OF INDUSTRY AND INTERNAL TRADE

(Central Boilers Board)

NOTIFICATION

New Delhi, the 7th August, 2026

F. No. P-30014/3/2021-Boiler.—Whereas, the draft regulations as required under section 40 of the Boilers Act, 2025(12 of 2025) were published *vide* notification of the Government of India in the Ministry of Commerce and Industry (Department for Promotion of Industry and Internal Trade) *vide* number G.S.R. 31(E), dated 14th January, 2026, inviting objections or suggestions from all persons likely to be affected thereby, before the expiry of the period of thirty days from the date on which the said Gazette notification was made available to the public;

AND WHEREAS, the said notification was made available to the public on the 27th January, 2026;

AND WHEREAS, no objections or suggestions were received from the public on the said draft regulations;

NOW, THEREFORE, in exercise of the powers conferred by section 40 of the Boilers Act, 2025, and in supersession of the Indian Boiler Regulations, 1950, except as respects things done or omitted to be done before such supersession, the Central Boilers Board hereby makes the following regulations, namely: —

PRELIMINARY

1. Short title, application and commencement. — (1) These regulations may be called the Indian Boiler Regulations, 2026.

(2) These regulations shall apply to all boilers including those working on the principles of natural circulations, forced circulation and forced flow with no fixed steam and water line.

(3) They shall come into force on the date of their publication in the Official Gazette.

2. Definitions. — (1) In these regulations, unless the context otherwise requires, -

(a) “Act” means the Boilers Act, 2025 (12 of 2025);

(b) “Appraisal Committee” means a Committee constituted by the Central Boilers Board to evaluate the performance of a firm or a company applying for recognition as Inspecting Authority;

(c) “Central Boilers Board Examination Standing Committee” means a Committee constituted by the Central Boilers Board to conduct examination for recognition of competent persons;

(d) “design pressure of boiler”, -

(i) in relation to a natural or assisted circulation boiler means the maximum allowable working pressure in the steam drum of the boiler;

(ii) in relation to an once through forced-circulation boiler means the maximum allowable working pressure at the final superheater steam outlet;

(e) “design temperature”, -

(i) for unheated components means the fluid temperature inside the component, under operation;

- (ii) for heated components, means the fluid temperature inside the component under sustained conditions increased by specified code allowances;
- (f) “Evaluation Committee” means a committee constituted by the Central Government to evaluate the performance of firm or a company applying for recognition as competent authority, well-known material testing laboratory, well-known steel maker, well-known foundry or forge, well-known tube or pipe maker and well-known remnant life assessment organisation;
- (g) “firm” means a firm and includes a company;
- (h) “Form” means the forms appended to these regulations;
- (i) “maximum allowable working pressure” means the design pressure of any part, adjusted to take into account the pressure drop and hydraulic head;
- (j) “pipe” means the cylindrical hollow parts, other than tube, drum or header with a design intent to carry a flow of steam or water or water-steam mixture during normal operation, including those that carry intermittent flow, such as drain pipes;

Explanation.— For the purpose of this clause , the expression ‘pipe’ implies that there is no design intent to effect heat transfer through the wall of the pressure part;

- (k) “tube” means a tubular pressure part that is either exposed over much of its length to hot gases for purposes of heat transfer or is directly butt welded to such a tubular pressure part including a tube stub on a drum or header.

- (2) The words and expressions used herein and not defined but defined in the Act or the rules made thereunder shall have the meanings respectively assigned to them in that Act or the rules.

CHAPTER-1

3. General requirements, application of standard conditions and exception thereto.—

- (1) No boiler shall be registered under sub-section (5) of section 12 of the Act and no certificate shall be issued under sub-section (6) of that section, unless the standard conditions in respect of material, design and construction, specified in these regulations are satisfied in respect of such a boiler.
- (2) Notwithstanding anything contained in sub-regulation (1), the Chief Inspector may, subject to the provisions of regulation 29, register a boiler and issue a certificate authorising the use thereof, under any of the following circumstances, namely:-
- (a) when the material used in the construction of a boiler, steam-pipe, economiser or superheater is not in conformity with these regulations but used in other countries as being suitable for use in the construction of boilers and steam-pipes, provided that such material is not specifically prohibited by these regulations and that the methods of manufacture, fabrication and heat treatment conform to the specified Codes or Standards;
- (b) when the constructional features of a boiler, steam-pipe, economiser or superheater are not in conformity with these regulations but are not considered by the Board to be inferior in strength to those prescribed in these regulations and form part of the usual manufacturing practice of boilers and steam-pipes in other countries;

- (c) when a boiler, steam-pipe, economiser or superheater has been built in conformity with these regulations but no certificate as required under the regulations is forthcoming;
- (3) No structural part of a boiler which is subject to pressure, shall be made of Bessemer process steel or of Cast or Malleable Cast Iron.
- (4) Where no specific provision is made in these regulations for design or manufacture of any pressure part, the Inspecting Authority may permit the design, manufacture, stage inspections and certification of such pressure parts including the valves; mountings and fittings conforming to the Codes or Standards like British Standards (BS), European Standards (EN), American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Tubular Exchanger Manufacturers Association (TEMA), Technical Requirements Document (TRD), *GOSudarstvennyy Standrat*(GOST) and Japanese Industrial Standards (JIS), which are known to be commonly used in industrially advanced countries and the decision of Inspecting Authorities shall be binding on all Registering Authorities.
- (5) The tubes of boilers and heat exchangers made of titanium and other exotic metals may be approved as per international codes, including American Society of Mechanical Engineers (ASME), British Standards (BS), European Standards (EN), *Deutsches Institut fur Normung*(DIN), Tubular Exchanger Manufacturers Association (TEMA) with the minimum thickness specified in those codes of manufacture.
- 4. Inspection of boiler to comply with foreign code.**— Notwithstanding anything contained in these regulations, the inspecting authority may inspect any boiler meant for export during the various stages of its construction to comply with the requirements of any foreign code and may grant a certificate in Part-A of Form-I.
- 5. Exemption of boiler or boiler components.**— Any boiler or boiler component may be exempted under sub-section (4) of section 38 of the Act in the whole or any part of the State from the operation of all or any of the provisions of the Act, subject to the following conditions, namely:-
- (1) design and construction of boiler or boiler component is in accordance with international code or standard including British Standards (BS), European Standards (EN), American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Tubular Exchanger Manufacturers Association (TEMA), Technical Requirements Document (TRD), GOST and Japanese Industrial Standards (JIS);
 - (2) materials used in the construction are not specifically prohibited under these regulations;
 - (3) design, construction and materials of boiler or boiler components are satisfied by the State Governments by necessary tests and examination like Remnant Life Assessment, which shall be carried out by the owner.
- 6. Fee not prescribed in regulations.** — For any activity, which in the opinion of a State Government involves time and labour and for which no fee has been specified in these regulations, may be determined by the State Government.
- 7. Standard requirements.** — (1) The construction of boilers shall comply with the following requirements, namely:-
- (a) all plates and bars used in the construction of boilers shall be tested and found to conform with the regulations hereinafter contained.
 - (b) (i) all boilers during construction shall be under the supervision of a competent person and shall be inspected at all stages of construction as specified in Appendix-A.

(ii) tubes and steam-pipes shall also be inspected at the makers' works at the stages as specified in Appendix-A, and the tests conducted by the makers shall also be witnessed by the Competent Person;

(iii) the welders engaged in welding of boilers, boiler components, economisers, feed pipes, steam-pipes and super-heaters shall possess certificate in Form-II;

(iv) boilers shall be manufactured by a boiler manufacturer of appropriate class;

(v) any firm seeking recognition shall apply to an Inspecting Authority operating in the State in which the recognition is sought in questionnaire 'Form-III' alongwith the following fee:

Sl. No.	Class of manufacturer	Fee for recognition (Rs.)	Fee for renewal of recognition (Rs.)
(1)	(2)	(3)	(4)
(i)	Special Class	20,000/-	10,000/-
(ii)	Class I	15,000/-	7,500/-
(iii)	Class II	10,000/-	5,000/-
(iv)	Class III	7,500/-	3,750/-
(v)	Class IV	5,000/-	2,500/-
(vi)	Boiler Component	5,000/-	2,500/-

(2) A firm seeking recognition as a manufacturer shall meet the following requirements depending upon the class of boilers, namely:-

(a) special class boiler manufacturer for manufacture of boilers of any type and capacity.— A special class boiler manufacturer shall have minimum covered area of 7500 square meters for manufacturing facilities and shall have following design, fabrication and testing facilities:-

(i) machinery, tools and equipment:

(A) mandatory: Submerged Arc Welding(SAW) machine for seam welding, TIG welding machine, panel bending machine, welding and grinding equipment, radial drilling machine, chamfering machine, tube bending machine, tube swaging machine, burners for pre-heating and post heating, heat treatment facilities, hydraulic test pump (upto 500 Kgs./cm² or above), band saw cutting machine, air compressor, measuring tools.

(B) optional: Plate bending or rolling machine of appropriate thickness, tube expander, dished end making machine.

(ii) quality assurance and testing facilities:

Magnetic Particle Inspection(MPI), Liquid Penetrant Inspection(LPI), Positive Material Identification (PMI) facilities, Universal Testing Machine (UTM), Radiographic Testing (RT), Ultrasonic Testing (UT).

(iii) manpower:

(A) graduate engineers in relevant discipline with minimum five years experience in the field of boilers, engineers with experience in erection, commissioning and supervision, Non Destructive Testing(NDT) personnel with Level-III NDT Certificates from Indian Society for Non-destructive Testing(I.S.N.T.) or American Society for Non-destructive Testing(A.S.N.T.) and IBR certified welders of appropriate class.

(B) manufacturer shall provide in-house facilities for training of engineers, technicians and welders and shall have in house research and development facilities or tie up for research and development.

Note:1. Manufacturers need not have manufacturing facilities for manufacture of dished ends, pumps and fittings if they outsource manufacturing of these items.

2. Based on the functional requirement manufacturing of any boiler part or component may be outsourced to an approved manufacturer.

3. Rolling and Edge preparation process may be outsourced and manufactures need not have manufacturing facilities for the same.

4. Design office may be located within any of their manufacturing facilities or outside the manufacturing facilities .

(b) Class-I boiler manufacturer for manufacture of boilers of working pressure upto 180 Kgs./cm².— A class-I boiler manufacturer shall have minimum covered area of 5000 square meters for manufacturing facilities and shall have following design, fabrication and testing facilities:

(i) machinery, tools and equipment:

(A) mandatory: Submerged Arc Welding(SAW) machine for seam welding, Tungsten Inert Gas(TIG) welding machine, panel bending machine, welding and grinding equipments, radial drilling machine, chamfering machine, tube bending machine, tube swaging machine, burners for pre-heating and post heating, heat treatment facilities, hydraulic test pump upto 300 Kgs./cm² or above, band saw cutting machine, air compressor, measuring tools.

(B) optional: Plate bending or rolling machine of appropriate thickness, tube expander, dished end making machine.

(ii) quality assurance and testing facilities:

Mandatory: Magnetic Particle Inspection(MPI), Liquid Penetrant Inspection(LPI), Positive Material Identification (PMI) facilities, Universal Testing Machine (UTM), Radiographic Testing (RT), Ultrasonic Testing (UT).

(iii) manpower:

(A) graduate engineers in relevant discipline with a minimum of four years experience in the field of boilers, engineers with erection, commissioning and supervision experience, NDT personnel with Level-II NDT Certificates from Indian Society for Non-destructive Testing(I.S.N.T.) or American Society for Non-destructive Testing(A.S.N.T.) and IBR certified welders of appropriate class.

(B) manufacturer shall provide in-house facilities for training of engineers, technicians and welders.

Note: 1. Manufacturers need not have manufacturing facilities for manufacture of Dished Ends, pumps and fittings which may be outsourced.

2. Based on the functional requirement manufacturing of any boiler part or component may be outsourced to an approved manufacturer.

3. Rolling and edge preparation process may be outsourced and manufactures need not have manufacturing facilities for the same.
 4. Design office may be located within any of their manufacturing facilities or outside the manufacturing facilities .
- (c) Class-II boiler manufacturer for manufacture of boilers of working pressure upto 120 Kgs./cm².— A class-II boiler manufacturer shall have minimum covered area of 3000 square meters for manufacturing facilities and shall have following design, fabrication and testing facilities:
- (i) machinery, tools and equipment:
 - (A) mandatory: Submerged Arc Welding(SAW) machine for seam welding, Tungsten Inert Gas (TIG) welding machine, welding and grinding equipments, radial drilling machine, chamfering machine, tube bending machine, burners for pre-heating and post heating, heat treatment facilities, hydraulic test pump upto 200 Kgs./cm² or above, band saw cutting machine, air compressor, measuring tools.
 - (B) optional: Plate bending or rolling machine of appropriate thickness, panel bending machine, tube expander, dished end making machine, tube swaging machine.
 - (ii) quality assurance and testing facilities:
 - (A) mandatory: Magnetic Particle Inspection (MPI), Liquid Penetrant Inspection(LPI)
 - (B) optional: Universal Testing Machine (UTM), Radiographic Testing (RT), Ultrasonic Testing (UT)
 - (iii) manpower:

graduate or diploma engineers in relevant discipline with a minimum of three years experience in the field of boilers for graduate engineers and five years for diploma Engineer', NDT personnel with Level-II NDT Certificates from Indian Society for Non-destructive Testing(I.S.N.T.) or American Society for Non-destructive Testing(A.S.N.T.) and IBR certified welders of appropriate class.
- Note:** 1. Manufacturers need not have manufacturing facilities for manufacture of Dished Ends, pumps and fittings which may be outsourced.
2. Based on the functional requirement manufacturing of any boiler part or component may be outsourced to an approved manufacturer.
 3. Rolling and edge preparation process may be outsourced and manufactures need not have manufacturing facilities for the same.
 4. Design office may be located within any of their manufacturing facilities or outside the manufacturing facilities .
- (d) Class-III boiler manufacturer for manufacture of boilers of working pressure upto 50 Kgs./cm².— A Class-III boiler manufacturer shall have minimum covered area of 1500 square meters for manufacturing facilities and shall have following design, fabrication and testing facilities:
- (i) machinery, tools and equipment:
 - (A) mandatory: Plate bending or rolling machine of appropriate thickness, Tungsten Inert Gas (TIG) welding machine, welding and grinding equipments, radial drilling machine, chamfering machine, tube bending machine, burners for pre-heating and post heating, heat treatment facilities, hydraulic test pump upto 100 Kgs./cm² or above, band saw cutting machine, air compressor, measuring tools.
 - (B) optional: Submerged Arc Welding(SAW) machine for seam welding, panel bending machine, tube expander, dished end making machine, tube swaging machine.

(ii) quality assurance and testing facilities:

(A) mandatory: Magnetic Particle Inspection (MPI), Liquid Penetrant Inspection (LPI)

(B) optional: Universal Testing Machine (UTM), Radiographic Testing (RT), Ultrasonic Testing (UT)

(iii) manpower:

graduate or diploma engineers in relevant discipline with a minimum of two years experience in the field of boilers for graduate engineers and four years for diploma engineers, NDT personnel with Level-II NDT Certificates from Indian Society for Non-destructive Testing (I.S.N.T.) or American Society for Non-destructive Testing (A.S.N.T.) and IBR certified welders of appropriate class.

Note: 1. Manufacturers need not have manufacturing facilities for manufacture of Dished Ends, pumps and fittings which may be outsourced.

2. Based on the functional requirement manufacturing of any boiler part or component may be outsourced to an approved manufacturer.

3. Rolling and edge preparation process may be outsourced and manufacturers need not have manufacturing facilities for the same.

4. Design office may be located within any of their manufacturing facilities or outside the manufacturing facilities.

(e) Class-IV boiler manufacturer for manufacture of boilers of working pressure upto 17.5 Kgs./cm².—A class-IV boiler manufacturer shall have adequate covered area for manufacturing facilities and shall have following design, fabrication and testing facilities:

(i) machinery, tools and equipment:

mandatory: Plate bending or rolling machine of appropriate thickness, radial drilling machine, welding and grinding equipments, hydraulic test pump upto 50 Kgs./cm² or above, tube expander, lathe machine, power hacksaw, drill machine, measuring tools .

(ii) manpower:

graduate or diploma engineers in relevant discipline with a minimum of one year experience in the field of boilers for graduate engineers and three years for diploma engineers and IBR certified welders of appropriate class.

Note: 1. Manufacturers need not have manufacturing facilities for manufacture of Dished Ends, pumps and fittings which may be outsourced.

2. Based on the functional requirement manufacturing of any boiler part or component may be outsourced to an approved manufacturer.

3. Heat Treatment, Non-Destructive Testing (NDT) and mechanical testings may be outsourced.

4. Design office may be located within any of their manufacturing facilities or outside the manufacturing facilities.

(f) Boiler component manufacturer: A boiler component manufacturer shall have adequate covered area for manufacturing facilities and have adequate design and fabrication facilities for the boiler components which they intend to manufacture. In case boiler component is to be manufactured as per the design of boiler manufacturer, design facilities may not be required.

Note: 1. A higher class boiler manufacturer shall be eligible to manufacture lower class boilers.

2. A boiler manufacturer shall also be eligible to manufacture boiler components as boiler component manufacturer.

- (3) The Inspecting Authority shall scrutinise and evaluate the application along with the replies to the questionnaire and after satisfying itself that the requirements under sub-regulation (2) are fulfilled, shall recognise the firm as a manufacturer in the category applied for.
- (4) The recognition of the firm as a manufacturer shall be for a period of three years and the firm may apply for renewal of their recognition at least ninety days before the expiry of said period.

8. Certificates, drawings and specifications. — An application for registration of a boiler under sub-section (1) of section 12 and clause (c) of sub-section (1) of section 19 of the Act, the following certificates and drawings or specifications shall be furnished to the Chief Inspector, the certificates and drawings or specifications may also be submitted through electronic means along with digital signatures, namely:-

- (a) (i) A certificate in Form-I(Part-B) or Form-I(Part-C), as the case may be, from an Inspecting Authority, certifying that the material was tested and the boiler was built under their supervision in respect of the inspection of the boiler during construction and the hydraulic test applied on completion.
- (ii) In case of a boiler which is to be assembled only at site, requirement of the hydraulic test on a completely assembled boiler by the Inspecting Authority shall not apply provided that the individual parts of such boiler have been hydraulically tested and certified by the Inspecting Authority separately as required under these regulations.
- (iii) In case of waste heat boilers, a certificate in Form-I(Part-B) or Form-I(Part-C) as applicable may be issued by the Inspecting Authority of the State, where the boiler is installed, after completion of construction at site on the strength of the certificates supplied to him in prescribed forms by the owners for the individual components which are required to be furnished for registration of a boiler under this regulation, shall be submitted to the Inspecting Authority of the State, where the boiler is installed, before the commencement of construction of such boiler at the site.
- (iv) The Inspecting Authority may grant a certificate in Form-I(Part-D) in lieu of Form-I(Part-B) or Form-I(Part-C), for boilers for which variations from the standard conditions in respect of material, design and construction features permitted by the Board or the Inspecting Authority.
- (v) The Inspecting Authority shall issue certificate in Form-I(Part-E) after completion of boiler erection and satisfactory hydrostatic test at the assembly site.
- (b) A certificate in Form-IV(Part-A) of manufacture and test signed by the maker of the boiler or its representative, containing a description of the boiler, its principal dimensions, particulars of the kind of material used in its construction, the thickness of all plates, particulars of any departure from ordinary practice in making the shell, such as, solid rolling or welding, the hydraulic test to which the boiler was subjected, the intended working pressure, the area of heating surface, the maximum continuous evaporative capacity, the year and place of manufacture, and the works number of the boiler.

Note: The Inspecting Authority may approve a modified form of certificate omitting items which do not pertain to a particular boiler.

- (c) (i) In case of shop assembled boilers, drawings to an appropriate scale showing the principal dimensions, sections, maker's number, position of Inspecting Authority's stamp, bill of material, welding details and design parameters.

(ii) In case of site assembled boilers, drawings showing general and pressure parts arrangement, drawings of coils, panels, headers and drums with details of principal dimensions, bill of materials and design parameters. Manufacturer may use appropriate scale for drawings and in case of identical or similar multiple sub-assemblies, drawings for only one sub-assembly may be submitted.

- (d) (i) A certificate in Form-V(Part-A) from the steel maker and a certificate from the maker of the plates or bars, of the nature referred to in regulations 45 and 46 respectively and the certificate from the maker of the plates, or bars, shall show the charge numbers, the plate or bar numbers and the number and dimensions of the various plates tested, their chemical analysis, their ultimate tensile strength in kilograms per square millimetre of section, the percentage of elongation and the length on which measured, the number, kind and result of bend or other tests made and the date of tests .

(ii) In case any question arises in respect of the fitness of the boilers for the working pressure approved by the Inspecting Authority within a period of three years from the date of their registration, the owner shall if requested by the Chief Inspector obtain and furnish the original documents specified in the said clauses:

Provided that in respect of the steel made and tested by Well-known steel makers recognised by the Central Boilers Board in the manner laid down in regulations 17 to 23, a certificate of Well-known steel maker in Form-V(Part-A) shall be accepted in lieu of a certificate from an Inspection Authority.

(iii) In case where the original certificate from well-known steel makers in Form-V(Part-A) is not produceable, owing to such certificate containing details of plates used for other purposes also, an extract from the original certificate duly signed by the makers of the boiler and countersigned by the Inspecting Authority shall be accepted in lieu of the certificate in Form-V(Part-A), provided all information required in Form-V(Part-A) are furnished in the extract.

(iv) The extract of all test certificates of materials used in boiler and boiler components in Form-V(Part-B) along with Form-IV(Part-A).

(v) In the case of fusion welded drums, diagram of weld repairs and temperature charts of heat-treatment shall also be furnished.

(vi) Alloy steel materials used in creep range in furnace or super-heater zone—

(A) two numbers of 1000 hour stress rupture tests shall be carried out at 50°C above the maximum service temperature for each grade of alloy steel and Nickel alloys; when used in furnace or in super heater zone;

(B) the stress to cause rupture in 1000 hours at the above temperatures may be taken from the master curve corresponding to - 20 percent line at this stress, a minimum rupture life of 1000 hours is expected and both the samples shall pass 1000 hour tests at the above stress and temperature;

(C) the short-term stress rupture tests for 1000 hours as mentioned above are carried out by National Metallurgical Laboratory or well known steel makers or any other Material Testing Laboratory recognised by the Central Boilers Board for creep testing and collecting elevated temperature data of alloy steel produced indigenously or from a nationally recognised or accredited testing laboratory for creep testing in that country of manufacture for alloy steel produced outside India, for the purpose of checking whether the steel is up to the specification

and also to ensure that the steel is capable of meeting the long-term rupture stress values or maximum allowable stress values given in American Society of Mechanical Engineers (ASME) or British Standards (BS) or European Standards (EN) Code, as the case may be, and a certificate is given to this effect; alternately the testing can also be done in any other laboratory if the tests are witnessed by a Competent Person working with a recognised Inspecting Authority;

(D) these samples may be selected at random by the Competent Person and may be in the form of semi-finished products, say, forged bars of about 25 mm², which shall undergo heat treatment as prescribed by the relevant specifications.

- (vii) For such boilers having a capacity of 20 tons per hour and above which are required to be assembled at site, the mountings may be supplied separately and all boilers of capacity less than 20 tons per hour shall carry all the mountings or fittings certificates in respective forms with details mentioned in Form-IV(Part-A), issued at the time of manufacture of boilers.

9. Maker's stamp.— The boiler shall have a stamp in a conspicuous place such as-

MAKER'S NAME -----

Work's Number-----Year of Make ----- Tested to -----

kg/cm²(g) on ----- Design pressure ----- kg/cm²(g)

Competent Person's or
Inspecting Authority's Official Stamp

- 10. Certificates for pipes.**— A certificate of manufacture and test in Form-IV(Part-B) signed by the maker and the Inspecting Authority shall be furnished and well-known pipe makers may also furnish digitally signed on-line certificate of manufacture and test in Form-IV(Part-B) through electronic mode along with digital signature.
- 11. Certificates for tubes.**— A certificate of manufacture and test in Form-IV(Part-C), signed by the maker and the Inspecting Authority shall be furnished and well-known tube makers may also furnish certificate of manufacture and test in Form-IV(Part-C) through electronic mode along with digital signature.

Note: In case of pipes or tubes made by well-known Pipe or Tube Makers recognised by the Central Boilers Board in the manner as laid down in regulations 17 to 23 in India or other countries, material testing including mechanical tests may be carried out by them and the particulars regarding testing of material including mechanical tests as certified by them and the particulars appropriate column or paragraphs in the certificate in Form-IV(Part-B), or Form-IV(Part-C), and in case, certificate from the “well-known Pipe or Tube Makers” as aforesaid is produced, such certificate may be accepted in lieu of the certificate from the Inspecting Authority insofar as it relates to testing of material including mechanical tests specified in this form.

- 12. Certificates for mounting and fittings.**— A certificate of manufacture and test in Form-IV(Part-D), signed by the maker and the Inspecting Authority in respect of boiler mountings and steam-pipe fittings during manufacture, shall be furnished.

Note: A Photocopy of certificate in Form-IV(Part-D) shall be accepted provided it is endorsed by the manufacturer or the Inspecting Authority who has signed the original certificate.

13. Certificate for Castings.— A certificate of manufacture and test in Form-IV(Part-E), signed by the maker and the Inspecting Authority shall be furnished. However, in the case of castings manufactured by well known foundries recognised by the Central Boilers Board, signature of Inspecting Authority shall not be required.

14. Certificate for Forgings.— A certificate of manufacture and test in Form-IV(Part-F), signed by the maker and the Inspecting Authority shall be furnished. However, in the case of forgings manufactured by well known forges recognised by the Central Boilers Board, signature of Inspecting Authority shall not be required.

15. Certificate of inspection during manufacture of Headers, Desuperheaters or Attemperators, Blowdown Tanks, Feedwater Tanks, Accumulators and Dearators.—A certificate of manufacture and test in Form-IV(Part-G), signed by the maker and the Inspecting Authority, shall be furnished.

16. Certificate of inspection during manufacture of dished ends or end covers.— A certificate of manufacture and test in Form-IV(Part-H), signed by the maker and the Inspecting Authority shall be furnished.

17. Application for recognition.—(1) An application for recognition as Competent Authority, Inspecting Authority, Well-known Material Testing Laboratory, Well-known Steel Maker, Well-known Foundry or Forge, Well-known Tube or Pipe Maker and Well-known Remnant Life Assessment Organisation, in one of the areas of activity in which they are engaged, shall be made by a firm to the Secretary, Central Boilers Board, along with specified fee.

(2) An application under sub-regulation (1) shall be made in duly filled in Forms VI (Part-A) to VI (Part-G) applicable to the area of activity and may also be submitted through electronic means .

(3) Any firm applying for recognition as Competent Authority and Inspecting Authority under sub-regulation (1) shall have a minimum experience of two years in the area of activity for which recognition is applied for and for recognition as Well-known Material Testing Laboratory or Well-known Steel Maker or Well-Known Foundry or Forge, Well-Known Tube or Pipe Maker or Well-Known Remnant Life Assessment Organisation, experience of two years shall be required under these regulations.

(4) In case of firms in foreign countries seeking recognition as Competent Authority or Well-Known Steel Maker, Well Known Pipe or Tube Maker, Well Known Foundry or Forge, a fee of ten thousand US dollars shall be deposited along with the completed form to meet the expenses of the visit of the Evaluation Committee specified under regulation 23:

Provided that where the firm has more than one manufacturing unit in the same country, an additional fee at the rate of two thousand US dollars per additional unit shall be deposited.

(5) In case of firms in foreign countries seeking recognition as Inspecting Authority, a fee of one thousand US dollars shall be deposited along with the completed forms.

(6) In case of firms in India seeking recognition under sub-regulation (1), a fee of rupees fifteen thousand shall be deposited along with the completed form and for renewal of recognition, a fee of rupees ten thousand shall be deposited along with the completed form.

(7) The Evaluation Committee shall carry out the evaluation of the manufacturing works of the firms within ninety days of receipt of the fees in case of manufacturing works in foreign countries and within sixty days in case of manufacturing works in India.

(8) The Appraisal Committee or Evaluation Committee, as the case may be, shall also evaluate the performance of the firm applying for recognition as Competent Authority or Inspecting Authority within sixty days of receipt of fee.

(9) The certificate of recognition shall be valid for a period of five years from the date of visit of the plant by the Evaluation Committee or meeting of the Appraisal Committee, as the case may be and in case of renewal of the recognition, if an application is received for renewal along with the required fee, firm's certificate of recognition may be renewed after following the procedure specified under these regulations and the certificate shall be issued for a further period of five years.

18. Scrutiny of applications by Evaluation Committee or Appraisal Committee.—(1) The Secretary, Central Boilers Board shall forward all the applications except that for recognition as Inspecting Authority received under sub-regulation (1) of regulation 17, along with replies to the questionnaire form under sub-regulation (2) of that regulation, to the Evaluation Committee.

(2) For recognition as Inspecting Authority all the applications along with replies to the questionnaire shall be forwarded to the Appraisal Committee.

(3) The Evaluation Committee or the Appraisal Committee, as the case may be, shall examine all the applications and replies to the Questionnaire specified under sub-regulation (1) and :

(a) where the application is for recognition as Inspecting Authority, the Appraisal Committee, may,—

(i) call any of the applicants if it considers necessary, to appear before it to give clarification for additional information that may be required by the said Committee;

(ii) visit any of the applicant firms on a specific request in writing from such firm or if decided so by the Appraisal Committee to evaluate the performance of the said firm and for this purpose the Appraisal Committee may depute three members to visit the applicant firm;

(b) where the applications are for recognition as Competent Authority or Well-Known Material Testing Laboratory, Well-Known Remnant Life Assessment Organisation, Well-Known Steel Maker, Well-Known Foundry or Forge or Well-Known Tube or Pipe Maker, the Evaluation Committee shall inspect the laboratories of such Material Testing Laboratory and Remnant Life Assessment Organisation or the factories of such steel makers, foundry or forge and tube or pipe makers, where the testing and manufacturing activities are being carried out in order to evaluate the performance quality of the tests conducted and products manufactured.

(4) The Evaluation Committee or the Appraisal Committee, as the case may be, after satisfying itself that the requirements specified in regulations 23 and 24 are fulfilled, shall submit a report to the Secretary, Central Boiler Board recommending either to grant or refuse recognition.

19. Recognition of a firm as Competent Authority, Inspecting Authorities, Well Known firms —On examining the report of the Evaluation Committee or the Appraisal Committee, as the case may be, the Secretary, Central Boilers Board may issue a certificate of recognition to the applicant in the applicable Form:

Provided that if he decides to refuse the recognition, he shall inform the applicant with the reasons to be recorded in writing.

20. Validity of certificate of recognition:- A certificate of recognition issued under regulation 19, shall be valid for a period of five years.

21. Renewal of certificate of recognition.— (1) A firm may apply for renewal of the certificate of recognition at least three months before its expiry to the Secretary, Central Boilers Board who after following the procedure specified in these regulations may renew the certificate of recognition or refuse renewal, and in case of renewal, it shall be valid for a further period of five years.

(2) The period of validity shall be deemed to have been extended till such time the decision on the renewal is not taken after receipt of the application under sub-regulation (1).

22. Appeal.— (1) Any firm aggrieved with the decision given by the Secretary, Central Boilers Board may prefer an appeal to the Chairperson, Central Boilers Board.

(2) All applications received by the Chairperson, Central Boilers Board, under sub-regulation (1), shall be decided in consultation with the Central Boilers Board.

23. Evaluation Committee.— (1)(a) For the purpose of these regulations, the Central Boilers Board constitutes the Evaluation Committee consisting of the following persons, namely:-

- (i) Technical Adviser (Boilers) -- Chairperson
- (ii) Chief Inspector (Boilers) of the State where the unit is located -- Member
- (iii) One representative from Board representing Central Government or Bureau of Indian Standards or Boiler and Boiler component manufacturers or National Laboratories or Engineering Consultancy agencies or user of boilers and other interests - Member.
- (b) Secretary, Central Boilers Board shall nominate the members;

(2) Functions of Evaluation Committee.—(a) The Evaluation Committee shall evaluate the performance of a firm applying for recognition in accordance with the provisions of these regulations, in particular in the following areas, namely:-

- (i) Quality System;
- (ii) Organisation;
- (iii) Review of quality system;
- (iv) Documentation--
 - (A) Inspection and test procedures;
 - (B) Records;
 - (C) Technical data;
- (v) Inspection equipment;
- (vi) Inspection of purchased material or services—
 - (A) Purchasing;
 - (B) Purchasing data;

- (C) Receiving inspection;
- (D) Verification of purchased material;
- (vii) In-process inspection;
- (viii) Workmanship;
- (ix) Inspection and test of completed items;
- (x) Sampling procedure;
- (xi) Control of non-conforming material;
- (xii) Indication of inspection status;
- (xiii) Protection and preservation of product quality—
 - (A) material handling;
 - (B) storage;
 - (C) delivery;
- (xiv) Training.

(b) For recognition as Competent Authority, the Evaluation Committee shall evaluate the performance of a firm applying for such recognition in accordance with the provisions of these regulations, in particular in the following areas, namely:-

- (i) The firm shall be a registered entity and not a sole proprietorship.
- (ii) For operation in India, the firm shall be registered in India also;
- (iii) The authorised signatory responsible to issue a certificate to qualified welders on behalf of the Competent Authority shall be an employee of the Competent Authority and shall be an engineer with five years experience in the field of welding having a degree in mechanical or production or metallurgical or welding engineering and certificate of Level-II in radiography techniques;
- (iv) The firm or company shall have a workshop with the following facilities, namely: -
 - (A) electric welding sets for conducting welding of the specimens;
 - (B) pre-heating facilities;
 - (C) platforms for welding;
 - (D) the following in-house testing machines:-
 - (I) Universal testing machine;
 - (II) Non-Destructive Testing (NDT) – dye penetration tests;
 - (III) Machines for preparation of specimens;
 - (IV) Hardness tester (optional);
 - (E) Radiography, (micro and macro examination of samples) may be outsourced to approved agencies.
 - (F) For operation in India, workshop with above facilities shall be required to be available in India also;
- (v) The firm shall be familiar with the requirements for examination of welders under these regulations;

- (vi) An inspecting Authority may also work as a Competent Authority for in-house certification of welders and for this purpose it may avail the facility of an outside agency having above facilities for testing of weld specimens for in-house certification of welders, provided it has in-employment an authorised signatory as mentioned in sub-clause (iii) above.
- (c) For recognition as Remnant Life Assessment Organisation (RLAO), the Evaluation Committee shall evaluate the performance of a firm applying for recognition as RLAO in accordance with the provisions of these regulations, in particular in the following areas, namely:-
- i. For undertaking Remnant Life Assessment (RLA) of boilers operating above 120 kgs./cm² pressure—
 - (A) Knowledge on boiler design, manufacturing and field knowledge on operation and maintenance of boilers, materials, codes and standards;
 - (B) Expertise in failure analysis, stress analysis to evaluate pressure-part component life;
 - (C) Expertise on metallurgy, NDT and other RLA assessment techniques;
 - (D) Internal Oxide Thickness (IOT) measurement and analytical capabilities;
 - (E) Firm or company shall have,—
 - (I) National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited laboratory with experts in the field and necessary equipment or instruments for testing of sample tubes, deposits;
 - (II) Laboratory with experts for analysis of Water Wall (WW) deposits and solvent selection with a capability to issue guidelines for chemical cleaning of boilers; (it may also be outsourced);
 - (III) NDT laboratory with qualified personnel;
 - (IV) Skilled and experienced manpower for site work to carry out RLA tests as per regulations 313 to 315;
 - (V) All measuring and testing instruments required for RLA study of boilers as stipulated in regulation 313 to 315; and
 - (VI) A minimum experience of five of RLA studies under Inspecting Authorities.
 - ii. For undertaking RLA of boilers operating upto 120 kg/cm² pressure—
 - (A) Knowledge on boiler design, manufacturing and field knowledge on operation and maintenance of boilers, materials, codes and standards;
 - (B) Knowledge in failure analysis, stress analysis to evaluate pressure part component life;
 - (C) Knowledge on metallurgy, NDT and other RLA assessment techniques;
 - (D) IOT measurement and analytical capabilities;
 - (E) Firm shall have—
 - (I) National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited laboratory with experts in the field and necessary equipment or instruments for testing of sample tubes, deposits (It may also be outsourced);

- (II) Laboratory with experts for analysis of Water Wall (WW) deposits and solvent selection with a capability to issue guidelines for chemical cleaning of boilers (It may also be outsourced);
- (III) NDT laboratory with qualified personnel;
- (IV) Skilled and experienced manpower for site work to carry out RLA tests as per regulation 313 to 315;
- (V) All measuring and testing instruments required for RLA study of boilers as stipulated in regulation 313 to 315; and
- (VI) A minimum experience of five RLA studies under Inspecting Authorities.

24. Appraisal Committee.—(1)(a) Composition of Appraisal Committee.— For the purpose of these regulations, the Central Boilers Board constitutes the Appraisal Committee consisting of the following persons, namely:-

- (i) Technical adviser (Boilers) – Chairperson;
 - (ii) Five Chief Inspectors or Directors of Boilers from States [including Chief Inspectors or Directors of Boilers of the States in which registered offices of applicant firm are located] – Members;
 - (iii) Five Members from Board representing Central Government or Bureau of Indian Standards or Boiler and boiler component manufacturers or National Laboratories or Engineering Consultancy agencies or users of boilers and other interests; - Members
- (b) Secretary, Central Boilers Board shall nominate the members;

(2) Functions of Appraisal Committee.— The Appraisal Committee shall evaluate the performance of a firm applying for recognition as an Inspecting Authority under these regulations, in the following areas, namely:-

- (i) the firm shall be a registered entity and for its operation in India, the entity shall be registered in India;

Explanation. - For the purposes of this regulation, it is hereby declared that the sole proprietorship firm is not eligible to apply for recognition as Inspecting Authority.

- (ii) the firm shall, —
 - (a) not be involved in any commercial activity other than the inspection, certification and related activities under the Indian and International Codes and Standards;
 - (b) have an in-house design and drawing inspection office and for operation in India the in-house design and drawing inspection office shall be situated in India ;
 - (c) have various codes in its office and the knowledge of various international codes along with the Act and these regulations;
 - (d) have employed the Competent Persons possessing Central Boilers Board authorisation cards for operation in India issued under regulation 25(5)(c)(i);
 - (e) have a documented quality programme established and maintained to fulfil the inspection requirements under these regulations;

- (f) have complete details of each and every Competent Person employed in its organisation for inspection and certification of boilers;
- (g) have a training programme for Competent Persons.

25. Procedure for recognition of Competent Person.—

(1)(a) This regulation provides requirements for the uniform qualification, examination, issuance and renewal of Central Boiler Boards authorisation to competent persons under the Act for inspection and certification of boilers and boiler components during manufacture, erection, operation and maintenance throughout India.

(2) Minimum qualifications and experience required are as under.—

- (a) shall be a graduate in Mechanical Engineering or Production or Power Plant or Metallurgical Engineering from a recognised institute;
- (b) minimum five years' experience singly or cumulatively in the following fields related to boilers:-
 - (i) Design;
 - (ii) Manufacture;
 - (iii) Commissioning;
 - (iv) Operation and maintenance;
 - (v) Inspection and certification during manufacture or operation and maintenance;
 - (vi) High Pressure Welding-Inspection;
- (c) Level-II NDT Certificates from Indian Society for Non-Destructive Testing (ISNT) or American Society for Non-Destructive Testing (ASNT) or any other professional body recognised by ISNT or ASNT in Non-Destructive methods of testing in radiography and ultrasonic testing.
- (3) Central Boilers Board Examination Standing Committee Composition: -(a)For the purpose of these regulations, the Central Boilers Board constitutes the 'Central Boilers Board Examination Standing Committee' consisting of the following persons-
 - (i) Technical adviser (Boilers) -- Chairperson
 - (ii) Two Chief Inspectors or Directors of Boilers from States -- Members
 - (iii) Two Members from Board representing Central Government or Bureau of Indian Standards or Boiler and boiler component manufacturers or National Laboratories or Engineering Consultancy agencies or user of boilers and other interests - Members
- (b) Secretary, Central Boilers Board shall nominate the members;

(4) The Process for Central Boilers Board Examination shall be as under—

- (a) an examination shall be conducted by the Central Boilers Board Examination Standing Committee or an agency or Regional Examination Standing Committees authorised by it, as per the following examination methods, namely: -
 - (i) written examination consisting of design, manufacture, operation and maintenance of the boiler, Non Destructive Testing Techniques, inspection and certification of boilers during manufacture and use as per these regulations (70% weightage);

- (ii) candidate shall be required to secure at least 45% marks in each written examination papers and at least 60% marks in aggregate to qualify for viva-voce;
 - (iii) viva-voce on the above (30% weightage);
 - (iv) the candidate shall secure at least 60% marks in aggregate (written exam with 70% weightage and viva-voce with 30% weightage) in order to pass the examination;
 - (v) the Central Boilers Board shall issue a passing grade certificate to the candidate after passing the examination;
- (b) application for appearing in the Central Boiler Board Examination shall be made in the format as provided by the Central Boilers Board Examination Standing Committee at such place and time as decided by the Central Boilers Board Examination Standing Committee or an agency or Regional Examination Standing Committees authorised by it.
- (5) The process for Central Boilers Board authorisation shall be as under: —
- (a) the Competent Person shall perform the work without conflict of interest;
 - (b) an applicant for a Central Boiler Board Authorisation shall meet the following requirements, namely:-
 - (i) the applicant shall be in regular employment of, and exclusively engaged by a Central Boilers Board recognised Inspecting Authority:
Provided that for inspection and certification of boilers during use under section 13 of the Act, the applicant can work independently also without taking employment with the Central Boilers Board recognised Inspecting Authority ;
 - (ii) the applicant shall meet the minimum qualification and experience requirements as referred in sub-regulation (2) of this regulation;
 - (iii) the applicant shall have taken and passed the Central Boilers Board examination as referred to in sub-regulation (4) of this regulation;
 - (iv) the applicant shall apply for an authorisation not later than three years after passing the Central Boilers Board Examination and a person whose authorisation has not been issued within the three year period shall be required to take the Central Boiler Board Examination and receive a passing grade; and
 - (v) the maximum age for the Competent Person shall be sixty-five years provided the person is medically fit;
 - (c) (i) when the applicant meets the requirements as referred to in clause (b) and at the request of the applicant's employer; a Central Boilers Board authorisation card and a certificate shall be issued:
Provided that the request for authorisation card, only for undertaking inspection and certification of boilers during use, under section 13 of the Act, may also be made by the applicant;
 - (ii) the application for an authorisation shall be on forms available with the Central Boilers Board; and
 - (iii) a Competent Person may possess only one valid authorisation card;
- (d) (i) the validity of an authorisation certificate shall be three years from the date of issue or in co-terminus with the validity period of recognition of employing Inspecting Authority (wherever applicable), whichever is earlier;
- (ii) for undertaking inspection and certification of boilers during manufacture and erection, the Competent Person must be in regular employment of the Central Boilers Board recognised Inspecting Authority failing which the authorisation lapses;

- (iii) Where the Competent Person leaves the employment, Central Boilers Board Authorisation Card shall be surrendered by the Inspecting Authority to the Secretary, Central Boilers Board within a period of seven days from the date of such leaving;
- (iv) the request for renewal shall be made by the Competent Person's employer and the request shall certify that the Competent Person maintained inspection proficiency by performing or supervising inspection activity and that the individual has met the continuing updation requirement as laid down in sub-clause (vi):
Provided that request for renewal of authorisation, only for undertaking inspection and certification of boilers during use under section 13 of the Boilers Act, 2025, can also be made by the Competent Person, giving details of inspections undertaken in the last three years, and confirming that he has met the continuing updation requirement as given in clause (vi) of this sub-regulation;
- (v) on change of employment, a request for authorisation card shall be made by the Competent Person's current employer on forms obtained from the Central Boilers Board;
- (vi) each Central Boilers Board authorised Competent Person, at least once every three years, shall either attend a Central Boilers Board seminar or receive other instruction related to inspections and the instruction may be in any format, e.g., classroom, home study, or web-based; the topics may include any subject of relevance to the inspection process, such as new methods, products, materials, technology or changes to construction or repair codes;
- (vii) a person whose authorisation has not been renewed for five years or less may, on proper application, shall have the authorisation reinstated;
- (viii) the employer or Competent Person, if working independently, as the case may be, shall provide verification of continuing updation as mentioned in sub-clause (vi); and
- (ix) a person whose authorisation has not been renewed for more than five years shall be required to qualify the examination conducted by Central Boilers Board;

(e)

- (i) a Central Boilers Board authorisation may be revoked by the Secretary, Central Boilers Board on the ground of falsification of any statement contained in any application;
- (ii) when an evaluation reveals that a Competent Person authorised by Central Boilers Board is found negligent in his duty or made false statements on forms used for documentation of his duties, a Central Boilers Board Committee formed for the purpose may examine the evaluation and recommend to the Secretary, Central Boilers Board, a suitable action against such Competent Person and the Secretary, Central Boilers Board shall take the decision;
- (iii) if any person is aggrieved by a decision of the Secretary, Central Boilers Board, he may prefer an appeal against such decision to the Central Boilers Board within thirty days from the date of communication of the decision;
- (iv) the decision of the Central Boilers Board shall be binding; and
- (v) any person aggrieved by, -
 - (A) an order made or purporting to be made by a Competent Person in the exercise of any power conferred by or under the Act; or

- (B) a refusal of a Competent Person to make any order or to issue any certificate which he is required or enabled by or under the Act to make or issue ,
may, within thirty days from the date on which such order or refusal is communicated to him, prefer an appeal against such order or refusal, to the Chief Inspector of Boilers of the State in which the boiler is located;
- (C) fees for each authorisation issued, renewed or reinstated fixed by the Central Boiler Board examination standing committee shall be paid including through electronic mode.
- (6) The Central Boilers Board authorisation number for the purpose of its usage shall be recorded on all forms used by him and on the items inspected and stamped as a proof of inspection and the authorisation number shall also be entered into the Competent Person's diary and other relevant records.
- (7)(a) A diary shall be maintained by the Competent Person for,-
- (i) inspection of construction activities; and
 - (ii) in-service inspection including repairs and alterations for each location or site as per the format laid down by the Central Boilers Board;
- (b) the diary shall be bound and numbered and the purpose of the diary shall be to provide a record of the Competent Person's activity and to support the continuity of inspections;
- (c) the Competent Person's diary shall be the property of the employer Inspecting Authority, wherever applicable, and shall be available at the location or site of the inspection; and
- (d) the diary shall be maintained for a minimum period of five years from the date of last entry and it may also be maintained in digitised form with provision for online entries:-
- (8) Duties and responsibilities of a Competent Person shall include the following, namely:-
- (a) on receipt of an application for renewal of certificate for use of a boiler, the Competent Person shall, within fifteen days from the date of such receipt inspect the boiler on a date communicated to the owner in advance;
 - (b) a copy of memorandum of inspection book shall be obtained from the concerned boiler inspectorate through the Inspecting Authority or directly, if working independently, for in-service boilers which shall be returned within a period of seven days from the date of completion of final inspection for making necessary entries therein;
 - (c) the Competent Person shall also discharge the following duties at various stages, namely:-
 - (i) Inspection during manufacture and commissioning:-
 - (A) work to the satisfaction of the Inspecting Authority for inspection during manufacture, erection and commissioning of boilers as per the provisions of these regulations;
 - (B) Inspect during manufacture and erection as per the procedure given in Appendix-A;
 - (ii) In – service inspection:-
 - (A) verify whether the stamping or nameplate is legible and represents the item described on the inspection documentation;

- (B) perform external and internal inspection and witness any required pressure tests;
- (C) report the inspection results, including any nonconforming conditions to the owner of the boilers;
- (iii) Repairs and alterations:-
 - (A) verify that the boiler owner has informed the chief inspector in writing and the activity is permitted under the scope of the certificate or the structural alteration, addition or renewal is made under his supervision;
 - (B) verify that the boiler repairer has a valid certificate as specified under these regulations;
 - (C) monitor the quality control system and verify the system is being implemented as required by regulations;
 - (D) verify that all materials comply with these regulations;
 - (E) verify that all welding procedure specifications, procedure qualification records, and welder and welding operation records conform to these regulations;
 - (F) verify that heat treatments as required under these regulations have been performed and properly documented;
 - (G) verify that non-destructive examinations and tests as required under these regulations have been performed and properly documented;
 - (H) witness pressure tests as required under these regulations;
 - (I) verify that information in the forms is correct and that the details have been properly punched;
 - (J) verify the correctness of the stamping;
- (9) Competent Person or Inspecting Authority may charge a fee for the inspection subject to the condition that the fee shall not be less than the fee specified by the concerned State.
- (10) Inspection shall be carried out as provided under these regulations and the relevant certificate shall be issued as follows, namely:-
 - (a) For in-service Boilers inspection: -
 - (i) one copy shall be given to the owner of the boiler on the day of inspection;
 - (ii) one copy shall be given to the Chief Inspector along with the Memorandum of Inspection Book (Form-XI);
 - (iii) one copy shall remain in Book.
 - (iv) In case inspection is not carried out as provided under these regulations, the Chief Inspector of Boilers shall report the matter to the Secretary, Central Boilers Board for appropriate action against the Competent Person which may include cancellation of his authorisation.

(b) For inspection during manufacture: -

- (i) one copy shall be given to the manufacturer;
- (ii) one copy shall remain with the Inspecting Authority.

(c) For inspection during erection:-

- (i) one copy shall be given to the owner of the boiler;
- (ii) one copy shall be given to the Chief Inspector;
- (iii) one copy shall remain with the Inspecting Authority.

26. Modification of formulae. —

- (1) For determining the maximum allowable working pressure to be allowed on various parts of boilers, the material to which the formulae apply shall, in the absence of specific provision to the contrary, be still complying with the requirements of Chapter-2.
- (2) Where no test certificates for plates are produced, the material may be treated as iron, if the Inspecting Authority is satisfied that the material is of suitable boiler quality. If in such cases the Inspecting Authority is clearly satisfied that the material is of good quality, a higher strength than that allowed for iron may be permitted but the strength of the plates shall not, save for special reasons, be assumed to be more than 37kg/mm². In such cases the values of tensile and shear strength shall not be more than 37kg/mm² and 30kg/mm² for steel, and 30kg/mm² and 25kg/mm² for iron. For iron across the grain the tensile strength may be 25kg/mm².
- (3) For flat plates of copper, the working pressure as found from the formulae, reduced by fifty percent, shall be the permitted working pressure.
- (4) When the quality of material and the make of steel pipe have not been supported by certificates from the manufacturers in Form-IV(Part-B), the pipes shall be tested in a test house and the maximum permissible working stress shall be such as the Inspecting Authority may determine after reasons to be recorded in writing.

27. Procuring of materials. — (1) Where procuring materials directly from mills is not feasible due to small quantity, the following method shall be adopted, namely:-

- (a) materials fully identifiable, supported by a materials test report by material manufacturer but not covered by a form under these regulations,—
 - (i) when a material is received with complete identification marks applied by the mill and supported by a materials test report, the manufacturer of boiler, boiler component, and spares shall demonstrate to the satisfaction of the Inspecting Authority that all requirements of the material specification specified under these regulations have been met;
 - (ii) the materials test report issued by materials manufacturer shall be presented to the Inspecting Authority for verification;
 - (iii) any additional tests as determined by the Inspecting Authority shall be conducted in a test house and results documented;
 - (iv) Form-IV(Part-B) shall be prepared with specification, size, quantity, reported test results and jointly signed by manufacturer of boiler, boiler component or spares and the Inspecting Authority;

(b) materials fully identifiable with mill markings for a production lot but not supported by materials test reports and forms under these regulations,—

- (i) the manufacturer of boiler, boiler components or spares shall present such materials to the Inspecting Authority for as marked by the mill. Shipping document or purchase order or as the case may be, drawing are also to be presented to establish required specification of materials;
- (ii) testing of materials shall be conducted as per materials specification and additional requirements of these regulations, if any;
- (iii) number of samples for tests shall be determined by the Inspecting Authority but not less than 10% of the quantity under consideration;
- (iv) test results are to be recorded in Form-IV(Part-B), signed by manufacturer and the Inspecting Authority;
- (v) plates or sheets qualified in the manner as provided above shall not be permitted for use in boiler shell or drum construction;

28. Standard specifications for materials.— The standard specifications for steel wrought iron and copper plates and bars, and the cast steel shall be such as provided in Chapter -2 of these regulations.

29. Registration of second-hand boilers not in accordance with the standard conditions.— In case a second hand boiler is not conforming to the requirements of these regulations for its registration, then the same shall not be registered except in the following cases, namely:—

- (1) *Water Tube Boilers:* Where the documents required under their code of manufacture for their registration are furnished and its workmanship is not in any way doubtful, the second-hand Water Tube Boiler may be registered by reducing the working pressure of the parts of the boiler as calculated from the regulations by ten percent:

Provided that a higher working pressure, being not more than the working pressure allowed by the code of manufacture, may be allowed on the recommendation of the Board made by it on the basis of life assessment tests carried out on the boiler.

- (2) *Shell Type Boilers:* Where the documents required under their code of manufacture, for their registration are furnished, the second-hand Shell Type Boiler may be registered by reducing the working pressure of the parts of the boiler as calculated under these regulations as per the table given below:

Table 1/1

Age of boiler (from the date of first use) in years	25	35	45	50	60	70	80	90	100
Reduction in working pressure (percent)	5	10	15	20	30	40	50	60	70

CHAPTER-2 MATERIALS OF CONSTRUCTION

PART-I

30. Plates, Pipes, Tubes, Castings, Forgings and Fittings of Carbon, Alloy, Stainless Steel and Nickel Alloys Grades.—(1) The regulation cover boiler plates, tubes, pipes, castings, forgings and fittings of carbon, alloy, stainless steel and nickel alloy grades and shall conform in all respects with the requirements herein specified.

- (2) The material conforming to other national or international standards which are known to be commonly used as being suitable for use as boiler plates, tubes, pipes, castings, forgings and fittings can also be used with the designations of the national or international standards, provided such materials are not specifically prohibited by these regulations.
- (3) While making boiler plates, tubes, pipes, castings, forgings and fittings to other national or international standards the allowable stresses, chemical and mechanical properties of the respective standards shall be followed while designing.
- (4) The different grades of material used in boiler plates, tubes, pipes, castings, forgings and fittings and their design metal temperatures shall be as per Table 2/1.
- (5) M number grouping in the Table 2/1 indicates alphanumeric designations that are assigned to base metals for the purpose of grouping different grades of materials for welding and post weld heat treatment (PWHT).

TABLE2 /1: Material Grouping

Serial No.	M Number / Group	Nominal composition	Plates ('t' thickness in mm)	Pipes	Tubes	Castings	Forgings & Fittings	Max Permissible Temp (°C)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	M1/Gr 1 (Carbon Steel)	C	SA 515 Gr60 (t≤ 25)		SA 179, BS 3059			427
2.		C-Si	SA 515 Gr60 (t=26-50) SA 515 Gr60 (t=51-100) SA515 Gr60 (t> 100)	SA 106 Gr A , SA 106 Gr B	SA 210 Gr A1	SA 352 LCB	SA 266 Gr1	427
3.		C-Mn-Si					SA 350 LF1	427
4.	M1/Gr 2 (Carbon Steel)	C					SA 105	427
5.		C-Si	SA 515 Gr70 (t≤ 25) SA 515 Gr70 (t=26-50) SA 515 Gr70 (t> 50)			SA 216 WCB	SA 266 Gr2, SA 266 Gr3	427
6.		C-Mn-Si	SA 516 Gr60, Gr70 (t≤ 12.5) SA 516 Gr60, Gr70 (t=12.6–50) SA 516 Gr60, Gr70 (t=51-100) SA 516 Gr60, Gr70 (t>100) SA 299 GrA (t≤ 25), SA 299 GrA (t>25)	SA 106 Gr C	SA 210 Gr C	SA 216 WCC, 352 LCC	SA 350 LF2	427
7.	M3/Gr 1 (L A S)	C-0.5 Mo		SA 335 Gr P1	SA 209 Gr T1			538
8.		0.5 Cr-0.5 Mo		SA 335 Gr P2	SA 213 Gr T2			538
9.	M3/Gr 2	C-0.5 Mo					SA 182 F1	538
10.		0.5 Cr-0.5 Mo					SA 182 F2	538
11.	M4/Gr 1 (L A S)	1.25Cr-0.5Mo-Si	SA 387 Gr11 Cl 2	SA 335 Gr P11	SA 213 Gr T11	SA 217 WC6	SA 182 F11 Cl 1,2,3 SA 234 WP11 Cl 1 SA 336 F11 Cl 1,2,3	649
12.		1Cr-0.5Mo	SA 387 Gr12 Cl 2	SA 335 Gr P12	SA 213 Gr T12		SA 182 F12 Cl 1,2 SA 234 WP12 Cl 1 SA 336 F12	649
13.	M5A/Gr 1 (L A S)	2.25Cr-1Mo	SA 387 Gr22 Cl 2	SA 335 Gr P22	SA 213 Gr T22	SA 217 WC9	SA 182 F22 Cl 1,3 SA 234 WP22 Cl 1	649
14.	M5B/Gr 1 (A S)	5Cr-0.5Mo		SA 335 Gr P5	SA 213 Gr T5		SA 182 F5 SA 234 WP5 Cl1 SA 336 F5	649

15.		9Cr-1Mo		SA 335 Gr P9	SA 213 Gr T9		SA 182 F9 SA 234 WP9 Cl1 SA 336 F9	649
16.	M15E Gr 1 (A S)	9Cr-1Mo-V	SA 387 Gr91 Cl 2	SA 335 Gr P91	SA 213 Gr T91	SA 217 C12A	SA 182 F91 SA 234 WP91 SA 336 F91	649
17.	M8/Gr 1 (S S)	18Cr-8Ni	SA 240 304		SA 213 TP 304, SA 213 TP 304H	SA 351 CF8	SA 182 F304 SA 182 F304H	816
18.		18Cr-8Ni	SA 240 304L		SA 213 TP 304L		SA 182 F304L	427
19.		16Cr-12Ni-2Mo	SA 240 316		SA 213 TP 316 SA 213 TP 316H	SA 351 CF8M	SA 182 F316 SA 182 F316H	816
20.		16Cr-12Ni-2Mo	SA 240 316L		SA 213 TP 316L		SA 182 F316L	454
21.		18Cr-10Ni-Ti			SA 213 TP 321 SA 213 TP 321H		SA 182 F321 SA 182 F321H	816
22.		18Cr-10Ni-Cb			SA 213 TP 347 SA 213 TP 347H	SA 351 CF8C	SA 182 F347H	816
23.	M8/Gr2 (SS)	25Cr-20Ni			SA 213 TP 310S			816
24.	MX12				12X1Mφ			649
25.	MX20			X20CrMoV121	X20CrMoV121			649
26.	M43	52Ni-22Cr- 13Co-9Mo	SB 168 N06617	SB 167 N06617	SB 167 N06617		SB 564 N06617- Forgings SB 166 N06617 – Rod, Bars & Wire	

Notes:

1. For stay bars, material as per SA 675 or equivalent can also be used.
2. For ERW tubes, material as per BS/EN 10217 or equivalent can also be used.
3. For Cold-drawn resistance welded tubes, BS/EN 10305 or equivalent can also be used.
4. Materials under development may be used with approval from the Technical Advisor (Boiler).
5. In addition to the above, materials conforming to IS or to any of the International codes BS, EN, ASME, DIN and JIS can also be used.
6. In case of any variations between the requirements (Chemical, Mechanical and Dimensional tolerances) specified in IBR and the actual material specifications, the requirements of the latter shall govern.

PART-II

31. Materials of construction for plates. — (1) Steel for Carbon, alloy, stainless steel and nickel alloy plates shall be made by the open hearth, electric furnace or basic oxygen process or any other process which gives steel having equivalent specified properties.

- (2) General deoxidation practice shall be appropriate to the type of steel used, particularly where the deoxidation practice influences the level of the elevated temperature properties of steel.
- (3) Semi-killed steel may be used for plates in carbon(C) and carbon manganese(C-Mn) steel with an upper limit of the tensile strength not exceeding 56 kg /mm² and with thickness not exceeding 50 millimeter (mm).
- (4) The steel may be strand cast or cast in stationary molds.
- (5) If heats of the same nominal chemical composition are consecutively strand cast at one time, the heat number assigned to the cast product (slab) may remain unchanged until all the steel in the slab is from different heats.
- (6) When two consecutively strand cast heats have different nominal chemical composition ranges, the manufacturer shall remove the transition material by any procedure that positively separates the grades.
- (7) The ratio of reduction of thickness from a strand-cast slab to plate shall be at least 3:1, except that reduction ratios as low as 2:1 are permitted if all the following limitations are complied with, namely:-
 - (a) The specified plate thickness is seventy-five millimeter(mm) or more.
 - (b) One or more of the following low hydrogen practices are used, namely:-
 - (i) vacuum degassing during steelmaking;
 - (ii) controlled soaking of the slabs or plates;
 - (iii) controlled slow cooling of the slabs or plates.
 - (c) The sulphur content is 0.004 percent or less, based upon heat analysis.
 - (d) One or more of the following practices are used, namely:-
 - (i) electromagnetic stirring during strand casting;
 - (ii) soft reduction during strand casting;
 - (iii) heavy pass reductions or other special practices during plate rolling;
 - (iv) combined forging and rolling during plate rolling.
 - (e) The plates are ultrasonically examined based on continuous scanning over hundred percent of the plate surface.
 - (f) The plates are through-thickness tension tested.
 - (g) Unless otherwise specified in the purchase order, plates shall be produced from plate-as-rolled.
- (8) Plates of fusion welded boiler drums, vessels, separators, headers and other pressure parts shall conform to the chemical composition given in Table 2/2 in this chapter.
- (9) The steel shall not contain more than 0.05 per cent of sulphur or phosphorus.
- (10) When the material is required for flame cutting or welding or both, the carbon content shall not exceed 0.30% and due precautions shall be taken when the carbon content exceeds 0.26 percent.
- (11) When steels are intended for service temperatures over 371°C, the silicon content shall be not less than 0.10 percent or alternatively, the material shall be required to pass the proof test for creep quality of carbon steel plates of boiler quality.
- (12) (a) In case of Carbon Steel,—

- (i) Plates having thickness of twelve millimeter (mm) or less than that, not intended for hot forming, can be supplied in unnormalised or as rolled condition subject to the condition that the code of manufacture provides for the same.
- (ii) For plates having thickness more than twelve millimeter (mm), not intended for hot forming, shall be supplied in the normalised conditions:
- (iii) If normalising is to be performed by the fabricator, the plates shall be either normalised or heated uniformly for hot forming. However, the temperature to which the plates are heated for hot forming does not significantly exceed the normalising temperature:

Provided that such normalising may be exempted by the Competent Person if it is demonstrated by the manufacturer that equivalent properties can be produced by the rolling subsequent cooling.

- (iv) The boiler manufacturer may, if he so wishes order a check analysis.

Table 2/2: Chemical composition (%)

Serial No.	Grade of materials	Carbon (C)	Manganese (Mn)	Phosphorus (P)	Sulphur (S)	Silicon (Si)	Chromium (Cr)	Nickel (Ni)	Molybdenum (Mo)	Vanadium (V)	Nitrogen (N)	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	SA 299 GrA (t≤25)	0.26	0.9-1.4	0.035	0.035	0.15-0.4	-	-	-	-	-	-
2.	SA 299 GrA (t>25)	0.28	0.9-1.5	0.035	0.035	0.15-0.4	-	-	-	-	-	-
3.	SA 515 Gr60 (t≤25)	0.24	0.9	0.025	0.025	0.15-0.4	-	-	-	-	-	-
4.	SA 515 Gr60 (t=26-50)	0.27	0.9	0.025	0.025	0.15-0.4	-	-	-	-	-	-
5.	SA 515 Gr60 (t=51-100)	0.29	0.9	0.025	0.025	0.15-0.4	-	-	-	-	-	-
6.	SA 515 Gr60 (t>100)	0.31	0.9	0.025	0.025	0.15-0.4	-	-	-	-	-	-
7.	SA 515 Gr70 (t≤25)	0.31	1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
8.	SA 515 Gr70 (t=26-50)	0.33	1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
9.	SA 515 Gr70 (t>50)	0.35	1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
10.	SA 516 Gr60 (t≤12.5)	0.21	0.6-0.9	0.025	0.025	0.15-0.4	-	-	-	-	-	-
11.	SA 516 Gr60 (t=12.6-50)	0.23	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
12.	SA 516 Gr60 (t=51-100)	0.25	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
13.	SA 516 Gr60 (t>100)	0.27	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
14.	SA 516 Gr70 (t≤12.5)	0.27	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
15.	SA 516 Gr70 (t=12.6-50)	0.28	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
16.	SA 516 Gr70 (t=51-100)	0.3	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
17.	SA 516 Gr70 (t>100)	0.31	0.85-1.2	0.025	0.025	0.15-0.4	-	-	-	-	-	-
18.	SA 387 Gr11 Cl 2	0.05-0.17	0.4-0.65	0.025	0.025	0.5-0.8	1.0-1.5	-	0.45-0.65	-	-	-
19.	SA 387 Gr12 Cl 2	0.05-0.17	0.4-0.65	0.025	0.025	0.15-0.4	0.8-1.15	-	0.45-0.65	-	-	-
20.	SA 387 Gr22 Cl 2	0.05-0.15	0.3-0.6	0.025	0.025	0.5	2.0-2.5	-	0.9-1.10	-	-	-
21.	SA 387 Gr91 Cl 2	0.08-0.12	0.3-0.6	0.02	0.01	0.2-0.5	8.0-9.5	0.4	0.85-1.05	0.18-0.25	0.03-0.07	Nb: 0.06-0.1; Al: 0.02; Ti: 0.01; Zr: 0.01
22.	SA 240 304	0.07	2	0.045	0.03	0.75	17.5-19.5	8.0-10.5	-	-	0.1	-
23.	SA 240 304L	0.03	2	0.045	0.03	0.75	17.5-19.5	8.0-12	-	-	0.1	-
24.	SA 240 316	0.08	2	0.045	0.03	0.75	16.0-18.0	10.0-14.0	2.0-3.0	-	0.1	-
25.	SA 240 316L	0.03	2	0.045	0.03	0.75	16.0-18.0	10.0-14.0	2.0-3.0	-	0.1	-
26.	SB 168 N06617	0.05-0.15	1.0	-	0.01	1.0	20.0-24.0	44.5 min	8.0-10.0	-	-	Co:10.0-15.0; Fe:3.0; Al: 0.8-1.5; Cu:0.5; Ti:0.6; B:0.006

(Note: Maximum when single values specified)

(b) In case of Alloy Steel,—

- (i) Except for Grade 91 plates, all plates shall be thermally treated either by annealing, normalising and tempering, or, when permitted by the purchaser, accelerated cooling from the austenitising temperature by air blasting or liquid quenching, followed by tempering.
- (ii) Grade 91 plates shall be thermally treated, either by normalising-and-tempering or by accelerated cooling from the austenitising temperature by air blasting or liquid quenching, followed by tempering.
- (iii) Grade 91 plates shall be austenitised at 1040°C to 1080°C and shall be tempered at 730°C to 800°C.

(c) In case of Stainless Steel,— The material shall be solution annealed to meet the mechanical property requirements of the applicable material grades.

(d) In case of Nickel Alloys,— Grade N06617 shall be solution annealed at 1150°C to 1230°C and quenched in water or rapidly cooled by other means.

32. Removal of defects, etc.— (1) Minor surface defects of the plates may be removed by mechanical means to achieve a smooth level surface provided that the minimum specified thickness is maintained.

(2) Surface defects may be repaired by welding, only with approval of the Inspecting Authority provided that the plate is stress relieved after welding where necessary.

33. Rolling margin for carbon steel. —No plate or rolled section shall be under the specified thickness at any part, nor more than five per cent over the calculated weight, except that in the case of thin plates and wide plates the weight tolerances shall be as per Table 2/3 mentioned below:

Table 2/3: Schedule of percentage of rolling weight tolerances for boiler plates

Width in millimetre(mm)

Serial No.	Thickness in mm	Under 1219	1219 to 1524	1524 to 1828	1828 to 2134	2134 to 2438	2438 to 2743	2743 to 3048	3048 to 3352	3352 and over
		%	%	%	%	%	%	%	%	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	6 to under 8	5	5	5	7	9	12	-	-	-
2.	8 to under 10	5	5	5	6	7.5	10	11	12	-
3.	10 to under 11	5	5	5	6	6	8	9	11	15
4.	11 to under 13	5	5	5	5	6	7.5	8	9	12
5.	13 to under 16	5	5	5	5	6	6	7.5	9	10
6.	16 to under 19	5	5	5	5	5	5	7	8	9
7.	19 to under 25	5	5	5	5	5	5	6	7	8
8.	25 to under 51	5	5	5	5	5	5	5	9	7

Note: All the above margins will be taken over net theoretical weight.

34. Testing and inspection.—The tests and inspections shall be made at the place of manufacture prior to despatch; but in the event of any of the material proving unsatisfactory in the course of being worked into boilers, such material shall be rejected, despite any previous certificate of satisfactory testing, and such further tests of the material from the same charge shall be made as the Competent Person may consider desirable.

35. Selection of test pieces.—All test pieces of material shall be selected by the Competent Person and tested in his presence, and thereafter he shall satisfy himself that the conditions herein described are fulfilled.

36. Tensile test pieces.—(1)The tensile test pieces shall be as per the relevant material specifications.

(2) For plate thickness exceeding 60 millimeter (mm), test pieces shall be taken from the exterior third of the plate cross-section and wherever practicable, the rolled surface shall be retained on two opposite sides of the test piece.

37. Tensile test.—(1)The test specimen shall comply with the following requirements, namely:-

Table 2/4

Serial No.	Grade	Mechanical Properties (minimum, when single value specified)		
		TS MPa (kg/mm ²)	YS MPa (kg/mm ²)	% Elongation on GL = 50 mm min.
(1)	(2)	(3)	(4)	(5)
1.	SA 299 GrA (t≤25)	515-655 (52.5-66.8)	290 (29.6)	19
2.	SA 299 GrA (t>25)	515-655 (52.5-66.8)	275 (28)	19
3.	SA 515 Gr60 (t≤25)	415-550 (42.3-56.1)	220 (22.4)	25
4.	SA 515 Gr60 (t=26-50)	415-550 (42.3-56.1)	220 (22.4)	25
5.	SA 515 Gr60 (t=51-100)	415-550 (42.3-56.1)	220 (22.4)	25
6.	SA 515 Gr60 (t>100)	415-550 (42.3-56.1)	220 (22.4)	25
7.	SA 515 Gr70 (t≤25)	485-620 (49.5-63.2)	260 (26.5)	21
8.	SA 515 Gr70 (t=26-50)	485-620 (49.5-63.2)	260 (26.5)	21
9.	SA 515 Gr70 (t>50)	485-620 (49.5-63.2)	260 (26.5)	21
10.	SA 516 Gr60 (t≤12.5)	415-550 (42.3-56.1)	220 (22.4)	25
11.	SA 516 Gr60 (t=12.6-50)	415-550 (42.3-56.1)	220 (22.4)	25
12.	SA 516 Gr60 (t=51-100)	415-550 (42.3-56.1)	220 (22.4)	25
13.	SA 516 Gr60 (t>100)	415-550 (42.3-56.1)	220 (22.4)	25
14.	SA 516 Gr70 (t≤12.5)	485-620 (49.5-63.2)	260 (26.5)	21
15.	SA 516 Gr70 (t=12.6-50)	485-620 (49.5-63.2)	260 (26.5)	21
16.	SA 516 Gr70 (t=51-100)	485-620 (49.5-63.2)	260 (26.5)	21
17.	SA 516 Gr70 (t>100)	485-620 (49.5-63.2)	260 (26.5)	21
18.	SA 387 Gr11 Cl 2	515-690 (52.5-70.3)	310 (31.6)	22
19.	SA 387 Gr12 Cl 2	450-585 (45.9-59.6)	275 (28)	22
20.	SA 387 Gr22 Cl 2	515-690 (52.5-70.3)	310 (31.6)	18
21.	SA 387 Gr91 Cl 2	585-760 (59.6-77.5)	415 (42.3)	18
22.	SA 240 304	515 (52.5)	205 (21)	40
23.	SA 240 304L	485 (49.5)	170 (17.3)	40
24.	SA 240 316	515 (52.5)	205 (21)	40
25.	SA 240 316L	485 (49.5)	170 (17.3)	40
26.	SB 168 N06617	655 (66.8)	240 (24.5)	35

- (2) In case of Carbon Steel,— (i) The upper yield point at room temperature shall not be less than 50% of the specified minimum tensile strength at room temperature.
- (ii) The maximum permissible stress shall be taken as provided in governing boiler codes of the country of the material to which it belongs and in case of non-availability of the same, for the purpose of evaluating the maximum permissible stress, the minimum values of the stress at proof limit 0.2% at elevated temperature (E_t) may be calculated by multiplying the minimum specified tensile strength at room temperature (R_{20}) by the value of the ratio (E_t/R_{20}) given in Table 2/5 below:

Table 2/5

Minimum values for the ratio of the stress at proof limit 0.2% at elevated temperature (E_t) to the minimum specified tensile strength at room temperature (R_{20}) of carbon Steel Boiler plates

Temperature °C	*250	*275	300	325	350	375	400	425
E_t/R_{20}	0.40	0.38	0.36	0.34	0.33	0.32	0.31	0.30

*For temperature lower than 300°C any test required for acceptance purposes, in the absence of records of previous test at these temperatures shall be at 300°C, in which case the proof stress shall be not less than value obtained by calculation from the specified minimum tensile strength at room temperature and the above proof-ratio of 0.36 for 300°C.

38. Number of tensile tests.— For the purpose of test of shell plates, butt straps and plates, gusset plates, end plates, furnace plates and flanging plates, one tensile test piece shall be cut from each plate as rolled.

39. Bend tests in case of cold bends.—(1) Test pieces shall be sheared lengthwise or crosswise from plates or bars, and shall not be less than 38 millimeter(mm) wide, but for small bars the whole section may be used.

- (2) (a) In all cold bend tests, on samples 13 millimeter (mm) in thickness and above, the rough edge or bur caused by shearing may be removed by filing or grinding and samples 25 millimeter(mm) in thickness and above may have the edges machined, but the test pieces shall receive no other preparation.
- (b) The test pieces shall not be annealed unless the material from which they are cut is similarly annealed and in such case the test piece shall be similarly treated with the material before testing.
- (3) For bend test of plates of all grades of steel, the test piece shall withstand, without fracture, being bent cold through 180° around a mandrel, the radius of which shall have a relationship to the plate thickness as given below:—

Serial No.	Tensile strength	Mandrel Radius
(1)	(2)	(3)
1.	36 - 49 kg/mm ²	1 T*
2.	41 - 57 kg/mm ²	1 T
3.	45 - 64 kg/mm ²	1.5 T

*Where, T = Plate thickness

- (4) For small sectional material the bend tests may be made from the flattened bar.
- (5) Bend tests may be made either by pressure or by blows.

40. Number of bend tests.— A bend test shall be taken from each plate as rolled. The bend tests from shell plates, butt straps and other plates which have not to be flanged or worked in the fire or which when in use are not to be exposed to flame, shall be cold bend tested.

41. Additional tests before rejection.—(1)(a) If the test pieces first selected by the Competent Person fail to fulfil the test requirements under these regulations, two further tests of the same heat may be made, but if either of these fail, the plates or bars from which test pieces were cut shall be rejected.

(b) In all such cases further tests shall be made before any material from the same charge can be accepted.

(2) If the unsatisfactory result of a test is due to technical conditions of the testing method or to a closely limited defect of a test piece, then, the failure can be left out of consideration in the decision on the fulfilment of the requirement and another test piece may be substituted.

(3) If the unsatisfactory result of test is due to an unfavourable heat treatment, the plate and the test strip may be heat treated again and thereafter, the entire test shall be repeated.

42. Branding.—(1) Every plate, section and bar shall be clearly and distinctly marked by the maker at two places with identification mark number by which they can be traced to the charge from which the material was made.

(2) Every plate shall also be stamped by the steel maker as provided in IS: 2002 and with the following information, namely:-

- (a) Name of manufacturer;
- (b) Specification;
- (c) Heat Number;
- (d) Plate Number, and
- (e) Stamp.

43. Defacing of rejected material.— In the event of the material failing to withstand the prescribed tests, the identification mark of the Competent Person which has been stamped on the material, shall be defaced by punch marks extending beyond the identification mark, in the form of a cross, thus denoting that the material has failed.

44. Facilities for inspection.— The maker shall adopt a system of making the ingots, billets, slabs, plates, bars, etc. so as to enable the finished material to be traced to the original charge, and the Inspector or Competent Person, as the case may be, shall be given every facility by maker for tracing all plates and bars to their respective charges, and for witnessing the required tests and when Inspector or Competent Person, as the case may be is satisfied with the material and with the results of the tests, the Inspector or Competent Person, as the case may be, shall be provided two copies of test reports of the material for his signature.

45. Steel not produced where rolled.—(1) Where steel is not produced in the works at which it is rolled, a certificate in Form V(Part-A) or Form IV(Part-C), as the case may be, shall be supplied to the Competent Person deputed to witness the testing of the material, stating the Open Hearth or Electric Process or any of the Oxygen Processes by which it was made, the name of the Steel-Maker who supplied it and the numbers of the charges for reference to the books of the Steel-Maker.

(2) The number of the charge shall be marked on each plate or bar for the purpose of identification.

46. Maker's certificate.— Before the mill sheets are signed, the maker shall furnish to the Competent Person with a certificate in Form V(Part-A) or Form IV(Part-C), as the case may be, guaranteeing that the material has been made by an Open Hearth or an Electric Process, acid or basic, and that it withstands satisfactorily test described above in the presence of the Competent Person.

PART-III

47. Seamless Tubes of Carbon, Alloy, Stainless Steel and Nickel Alloys for Boiler, Superheater, Reheater and Heat Exchanger.— (1) These regulations shall apply on hot finished and cold drawn seamless boiler, super heater, re-heater and heat exchanger tubes of carbon, alloy, stainless steel and nickel alloy grades and shall conform the requirements herein specified in Part III in addition to the requirements specified in regulation 30.

(2) For design metal temperatures Table 2/1 of regulation 30 shall be considered.

(3) (a) The tubes shall be seamless and manufactured from fully killed steel produced by an open hearth or electric process or any of the oxygen process.

(b) The steel shall conform to the following limits of chemical composition, namely:-

Table 2/6: Chemical Composition (%)

Serial No.	Grade	Chemical composition %									
		Carbon (C)	Manganese (Mn)	Silicon (Si)	Sulphur (S)	Phosphorus (P)	Chromium (Cr)	Molybdenum (Mo)	Vanadium (V)	Nickel (Ni)	Other Elements
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	SA 179	0.06-0.18	0.27-0.63	0.25 max	0.035 max	0.035 max					
2	SA 210 Gr A1	0.27 max*	0.93 max	0.10 min	0.035 max	0.035 max					
3	SA 210 Gr C	0.35 max*	0.29-1.06	0.10 min	0.035 max	0.035 max					
4	SA 209 Gr T1	0.10 0.20	0.30 0.80	0.10 0.50	0.025 max	0.025 max	-----	0.44 0.65	---	---	----
5	SA 213 Gr T2	0.10 0.20	0.30 0.61	0.10 0.30	0.025 max	0.025 max	0.50 0.81	0.44 0.65	----	---	----
6	SA 213 Gr T5	0.15 max	0.30 0.60	0.50 max	0.025 max	0.025 max	4.00 6.00	0.45 0.65	----	----	----
7	SA 213 Gr T9	0.15 max	0.30 0.60	0.25 1.00	0.025 max	0.025 max	8.00 10.0	0.90 1.10	----	----	----
8	SA 213 Gr T11	0.05 0.15	0.30 0.60	0.50 1.00	0.025 max	0.025 max	1.00 1.50	0.44 0.65	----	----	----
9	SA 213 Gr T12	0.05 0.15	0.30 0.61	0.50 max	0.025 max	0.025 max	0.80 1.25	0.44 0.65	----	---	----
10	SA 213 Gr T22	0.05 0.15	0.30 0.60	0.50 max	0.025 max	0.025 max	1.90 2.60	0.87 1.13	----	----	----
11	SA 213 Gr T91	0.07 0.14	0.30 0.60	0.20 0.50	0.010 max	0.020 max	8.00 9.50	0.85 1.05	0.18 0.25	0.40 max	Cb 0.06 - 0.10 N 0.030-0.070 Al 0.02 max Ti 0.01 max Zr 0.01 max
12	SA 213 TP304	0.08 max	2.00 max	1.00 max	0.030 max	0.045 max	18.0 20.0	----	---	8.00 11.0	----
13	SA 213 TP304H	0.04 0.10	2.00 max	1.00 max	0.030 max	0.045 max	18.0 20.0	----	---	8.00 11.0	----
14	SA 213 TP304L	0.035 max	2.00 max	1.00 max	0.030 max	0.045 max	18.0 20.0	----	---	8.00 12.0	----
15	SA 213 TP310S	0.08 max	2.00 max	1.00 max	0.030 max	0.045 max	24.0 26.0	----	---	19.0 22.0	----

16	SA 213 TP316	0.08 max	2.00 max	1.00 max	0.030 max	0.045 max	16.0 18.0	2.00 3.00	---	10.0 14.0	-----
17	SA 213 TP316H	0.040 0.10	2.00 max	1.00 max	0.030 max	0.045 max	16.0 18.0	2.00 3.00	---	11.0 14.0	-----
18	SA 213 TP316L	0.035 max	2.00 max	1.00 max	0.030 max	0.045 max	16.0 18.0	2.00 3.00	---	10.0 15.0	-----
19	SA 213 TP321	0.08 max	2.00 max	1.00 max	0.030 max	0.045 max	17.0 20.0	----	---	9.00 13.0	Ti = 5xC min 0.60 max
20	SA 213 TP321H	0.04 0.10	2.00 max	1.00 max	0.030 max	0.045 max	17.0 20.0	----	---	9.00 13.0	Ti = 4xC min 0.60 max
21	SA 213 TP347	0.08 max	2.00 max	1.00 max	0.030 max	0.045 max	17.0 20.0	----	---	9.00 13.0	Cb = 10xC min, 1.00 max
22	SA 213 TP347H	0.04 0.10	2.00 max	1.00 max	0.030 max	0.045 max	17.0 19.0	----	---	9.00 13.00	Cb = 8xC min, 1.00 max
23	SB 167 N06617	0.05 0.15	1.0 max	1.0 max	0.015 max	-	20.024 .0	8.0 10.0	-	44.5 min	Co:10.0- 15.0; Fe:3.0 max; Al: 0.8-1.5; Cu:0.5 max; Ti:0.6 max; B:0.006 max

* For grade SA 210 Gr A1 and SA 210 Gr C for each reduction of 0.01% below the specified carbon maximum, an increase of 0.06% Manganese above the specified maximum will be permitted up to a maximum of 1.35%.

(c) The grain size of cold worked grade TP 321H shall be No.7 or coarser.

(4) (a) Hot finished tubes of Carbon Steel grades need not be heat treated. Cold drawn tubes of Carbon Steel grades shall be given a sub-critical annealing, a full anneal, or a normalising heat treatment after the final cold finishing process.

(b) All tubes of grades provided in Table 2/6, except Carbon steel grades, T91, 12X1Mφ, X20CrMoV121 and N06617 grades shall be reheated and furnished in full annealed, isothermal annealed or normalised and tempered condition. If furnished in the normalised and tempered condition, the minimum tempering temperature for Grades T1 and T11 shall be 650°C and the minimum tempering temperature for Grades T5, T9 and T22 shall be 675°C.

(c) Tubing of Grades T1, T2 and T12 either hot finished or cold drawn, may be given a final heat treatment at 650°C to 730°C, instead of heat treatments specified in clause (b) above, at the option of the manufacturer.

(d) Grade T91 shall be normalised at 1040°C minimum and tempered at 730°C minimum as a final heat treatment.

(e) Grade 12x1Mo shall be normalised at 950°C - 980°C and tempered at 720°C - 750°C for a period of 1 to 3 hours.

(f) Grade X20CrMoV121 shall be normalised at 1020°C - 1070°C and tempered at 730°C - 780°C for a period of 1 hour minimum.

(g) All stainless steel tubes shall be furnished in the heat treated condition and the heat treatment procedure, except for the H grades steel which shall consist of heating the material to a minimum temperature of 1040°C and quenching in water or rapidly cooling by other means.

- (h) All H grades steel shall be furnished in the solution treated condition. If cold working is involved in processing, the minimum solution treating temperatures for grades TP321H and TP347H shall be 1100°C and for grades TP304H and TP316H shall be 1040°C and if the P grade is hot rolled, the minimum solution treatment for grades TP 321 H and TP 347 H shall be 1050°C and for grades TP 304H and TP 316H shall be 1040°C.
- (i) Grade N06617 shall be solution annealed at 1150°C to 1230°C and quenched in water or rapidly cooled by other means.
- (5) (a) The tubes shall be well finished, cleaned and free from harmful defects and they shall be reasonably straight, smooth, cylindrical and subject to the following tolerances, namely:-
- They shall have smooth ends free of burrs;
 - They shall have a workmanlike finish;
 - Surface imperfections like any discontinuity or irregularity found in the tube may be removed by grinding, provided that smooth a curved surface is maintained, and the wall thickness is not decreased to less than that permitted;
 - The outside diameter at the point of grinding may be reduced by the amount so removed.
- (b) Permissible variations in outside diameter shall be as follows:-

Table 2/7: Carbon Steel, alloy and stainless steels except 12X1M ϕ , X20CrMoV121 and N06617

Serial No.	Outside Diameter (mm)	Permissible variation Over (mm)	Permissible variation Under (mm)
(1)	(2)	(3)	(4)
1	Hot finished seamless tubes		
2	101.6 and under	0.4	0.8
3	Over 101.6 to 190.5 incl.	0.4	1.2
4	Over 190.5 to 228.6 incl.	0.4	1.6
5	Cold finished seamless tubes		
6	Under 25.4	0.1	0.1
7	25.4 to 38.1 incl.	0.15	0.15
8	Over 38.1 to 50.8 excl.	0.2	0.2
9	50.8 to 63.5 excl	0.25	0.25
10	63.5 to 76.2 excl.	0.3	0.3
11	76.2 to 101.6 incl.	0.38	0.38
12	Over 101.6 to 190.5 incl.	0.38	0.64
13	Over 190.5 to 228.6 incl.	0.38	1.14

Table 2/8: For grade 12X1M ϕ

Serial No.	Outside diameter (mm)	Permissible Variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1	Hot finished and cold finished tubes		
2	Under 30.0	0.30	0.30
3	30 to 50	0.40	0.40
4	Over 50.0	0.80%	0.80%

Table 2/9: For grade X20CrMoV121

Serial No.	Outside diameter (mm)	Permissible Variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Hot finished Seamless tubes		
2.	100 and under	0.75% (0.5 mm min)	0.75% (0.5 mm min)
3.	Cold finished seamless tubes		
4.	120 and under	0.60% (0.25 mm min)	0.60%(0.25 mm min)
5.	Over 120	0.75%	0.75%

Table 2/10: For grade N06617

Serial No.	Outside diameter (mm)	Permissible Variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Seamless Cold-worked tubes		
2.	Over 10 and less than 16	0.13	0.13
3.	16 - 38	0.19	0.19
4.	Over 38 - 76	0.25	0.25
5.	Over 76 to 114	0.38	0.38
6.	Over 114 to 152	0.51	0.51
7.	Over 152 to 168	0.64	0.64
8.	Over 168 to 219	0.79	0.79
9.	Hot finished Tubes		
10.	19 to 38	0.4	0.8
11.	Over 38.1 to 102	0.8	0.8
12.	Over 102 to 235	1.6	0.8

(c) Permissible variation in Wall Thickness in percentage shall be as follows:-.

Table 2/11: Carbon Steel, alloy and stainless steels except 12X1M ϕ , X20CrMoV121 and N06617

Serial No.	Outside diameter (mm)	% variation in wall thickness							
		2.4 mm and under		Over 2.4 mm to 3.8 mm Incl.		Over 3.8 mm to 4.6 mm incl.		Over 4.6 mm	
		Over	Under	Over	Under	Over	Under	Over	Under
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Seamless Hot Finished tubes								
2.	101.6 & under	40	0	35	0	33	0	28	0
3.	Over 101.6	NA	NA	35	0	33	0	28	0
4.	Seamless Cold Finished tubes								
5.		Over				Under			
6.	38.1 and under	20				0			
7.	Over 38.1	22				0			

Table 2/12: For Grade 12X1M ϕ

Serial No.	Outside Diameter (mm)	Permissible variation %	
		Over	Under
(1)	(2)	(3)	(4)
1.	Hot Finished Seamless Tubes		
2.	108 and under	15	10
3.	Over 108	20	5
4.	Cold Finished Seamless Tubes		
5.	All sizes	10	10

Table 2/13: For Grade X20CrMoV121

Outside diameter (mm)	Permissible variation %	
	Over	Under
(1)	(2)	(3)
100 and under	12.5	10

Table 2/14: For Grade N06617

Serial No.	Outside diameter (mm)	Permissible Variation (%)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Seamless Cold-worked tubes		
2.	Over 10 and less than 16	15.0	15.0

3.	16 - 38	10.0	10.0
4.	Over 38 - 76	10.0	10.0
5.	Over 76 to 114	10.0	10.0
6.	Over 114 to 152	12.5	12.5
7.	Over 152 to 168	12.5	12.5
8.	Over 168 to 219	12.5	12.5
9.	Hot finished Tubes		
10.	19 to 38	12.5	12.5
11.	Over 38.1 to 102	12.5	12.5
12.	Over 102 to 235	12.5	12.5

(d) Permissible variations in length shall be as follows:-

Table 2/15: Carbon Steel, alloy and stainless steels except 12X1M ϕ , X20CrMoV121 and N06617

Serial No.	Method of manufacture	Outside diameter (mm)	Cut length (mm)	
			Over	Under
(1)	(2)	(3)	(4)	(5)
1.	Seamless hot finished	All sizes	5	0
2.	Seamless cold finished	Under 50.8	3	0
		50.8 and over	5	0

Note: The above permissible variations in lengths apply to cut lengths up to and including 7.3 m. For lengths over 7.3 m, an additional over tolerance of 3 mm for each 3 m or fraction thereof, shall be permissible, up to a maximum of 12 mm. Length tolerances on the positive side other than specified may be mutually agreed.

Table 2/16: For grade 12X1M ϕ

Serial No.	Outside diameter (mm)	Length of tubes (m)	Permissible variation (mm)	
			Over	Under
(1)	(2)	(3)	(4)	(5)
1.	Under 108	Under 9	15	0
2.		9 to 12	35	0
3.	108 and over	All lengths	50	0

Table 2/17: For grade X20CrMoV121

Serial No.	Length of tube (m)	Permissible variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	6 and under	10	0
2.	Over 6 to 12 incl.	15	0

Table 2/18: For grade N06617

Serial No.	Outside Diameter of tube (mm)	Permissible variation in Length (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Under 50.8	3.2	0
2.	50.8 and over	4.8	0

48. Selection of Tubes for Test.—(1) (a) (i) Test specimens required for the flattening, expanding or flaring test specified herein below shall be taken from the ends of finished tubes prior to upsetting swaging, expanding or any other forming operations or being cut to length.

(ii) They shall be smooth on the ends and free from burrs and flaws.

(b) (i) If desirable and practicable tensile test may be carried out on full section of the tubes up to the capacity of the testing machine.

(ii) For large size tubes, the tensile test specimen shall consist of strip cut longitudinally from the tube and which is not straightened within the gauge length and further heat treated.

(c) If any test specimen shows flaws or defective machining it shall be discarded and another specimen be taken into consideration.

(d) All specimens shall be tested at room temperature.

(2) (a) The test specified herein below shall be made on minimum two tubes for first hundred tubes and one per hundred or part thereof for tubes over 100 numbers from each lot.

(b) Lot applies to all tube of same size and wall thickness of same heat and heat treatment.

(3) (a) The test specimen shall comply with the requirements as specified in table 2/19.

(b) The hardness test may be carried out on the wall cross section or on a flat on the outside surface of the tube sample.

Table 2/19: Mechanical Property Requirements

Serial No.	Grade	Yield strength MPa (kg/mm ²) Min	Tensile Strength MPa (kg/mm ²) Min	% Elongation on GL= 50 mm min *	Hardness	
					HRB max	HB max
(1)	(2)	(3)	(4)	(5)	(6)	
1.	SA 179	180 (18.3)	325 (33.1)	35	72	130
2.	SA 210 Gr A1	255 (26.1)	415 (42.2)	30	79	143
3.	SA 210 Gr C	275 (28.2)	485 (49.3)	30	89	179
4.	SA 209 Gr T1	205 (21.1)	380 (38.7)	30	80	146
5.	SA 213 Gr T2	205 (21.1)	415 (42.2)	30	85	163
6.	SA 213 Gr T5	205 (21.1)	415 (42.2)	30	85	163
7.	SA 213 Gr T9	205 (21.1)	415 (42.2)	30	89	179

8.	SA 213 Gr T11	205 (21.1)	415 (42.2)	30	85	163
9.	SA 213 Gr T12	220 (22.5)	415 (42.2)	30	85	163
10.	SA 213 Gr T22	205 (21.1)	415 (42.2)	30	85	163
11.	SA 213 Gr T91	415 (42.2)	585 (59.6)	20	25 HRC	250
12.	12X1Mφ	274 (28.0)	441 (45.0) 637 (65.0)	21	85	163
13.	X20CrMoV121	490 (50.0)	690 (70.4) 840 (85.7)	17	25 HRC	250
14.	SA 213 TP 304	205 (21.1)	515 (52.5)	35	90	192
15.	SA 213 TP304H	205 (21.1)	515 (52.5)	35	90	192
16.	SA 213 TP304L	170 (17.3)	485 (49.5)	35	90	192
17.	SA 213 TP310S	205 (21.1)	515 (52.5)	35	90	192
18.	SA 213 TP316	205 (21.1)	515 (52.5)	35	90	192
19.	SA 213 TP316H	205 (21.1)	515 (52.5)	35	90	192
20.	SA 213 TP316L	170 (17.3)	485 (49.5)	35	90	192
21.	SA 213 TP321	205 (21.1)	515 (52.5)	35	90	192
22.	SA 213 TP321H	205 (21.1)	515 (52.5)	35	90	192
23.	SA 213 TP347	205 (21.1)	515 (52.5)	35	90	192
24.	SA 213 TP347H	205 (21.1)	515 (52.5)	35	90	192
25.	SB 167 N06617	240 (24.5)	655 (66.8)	35	-	-

*The tensile test specimen shall be as per the relevant material specifications.

Note: For longitudinal strip tests of Carbon steel a deduction in percentage elongation 1.5% shall be made for each 0.8 mm decrease in wall thickness under 8 mm from the minimum elongation value requirement.

- (4) A section of the tube not less than 63 mm in length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack or flaw:

$$H = (1 + e) t / e + t/D$$

Where, t = specified thickness of tube (mm)

D = specified outside diameter of the tube (mm)

e = a constant, as given below

e = 0.07 for Carbon steel with maximum specified carbon above 0.18%

e = 0.09 for Carbon steel with maximum specified carbon 0.18% or less.

e = 0.08 for alloy steel

e = 0.09 for Austenitic steel

Note: No flattening test required for grade N06617.

- (5) A section of the tube approximately 100 mm in length shall stand being flared with a tool having a 60° included angle until the tube at the mouth of the flare has been expanded to the percentages given below, without cracking:

Table 2/20

Serial No.	Ratio of inside diameter to outside diameter	Minimum expansion of inside diameter %
(1)	(2)	(3)
1.	0.9	21
2.	0.8	22
3.	0.7	25
4.	0.6	30
5.	0.5	39
6.	0.4	51
7.	0.3	68

Note: No expanding or flaring test required for grade N06617.

- (6) (a)(i) If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other tubes of the same batch.
(ii) If any of these tests fails, the batch of the tubes represented may be given a further heat treatment and entire set of test shall be repeated.
- (b) If the repeat tests are satisfactory the tubes shall be accepted. If any failure in the tests should occur, the entire batch of the tubes shall be rejected.
- (7) (a) Each tube shall be tested by the manufacturer and shall withstand a hydraulic pressure of one and half times of the design pressure subject to a minimum of 1 kg/mm², but not greater than pressure calculated by the following formula:

$$P = 2 S t / D$$

Where, P = test pressure

D = specified outside diameter of the tube

t = specified wall thickness of the tube

S = stress which shall be taken as 40% of the minimum tensile strength at room temperature for carbon and alloy steel and 80% of the minimum yield strength at room temperature for austenitic stainless steel.

- (b) Despite anything contained in the clause(a), the hydraulic test at the maker's works may be dispensed with, provided that the tubes are subject to non-destructive testing by an appropriate method like Ultrasonic or Eddy Current or Stray Flux testing.

PART-IV

49. Seamless Carbon, Alloy Steel and Nickel Alloy Pipes.— (1) This regulation shall apply on hot finished and cold drawn seamless carbon, alloy steel and Nickel alloy pipes for high temperature service and the pipes shall conform in all respects with the requirements under this regulation in addition to the requirements specified in regulation 30.

- (2) For design metal temperatures Table 2/1 of regulation 30 shall be considered.
- (3) (a) The pipes shall be seamless and manufactured from fully killed steel produced by an open hearth or electric process or any of the oxygen processes.
- (b) The steel shall conform to the following limits of chemical composition, namely:—

Table 2/21: Chemical Composition (%)

Serial No.	Grade	Chemical composition %										
		Carbon (C)	Manganese (Mn)	Silicon (Si)	Sulphur (S)	Phosphorus (P)	Chromium (Cr)	Molybdenum (Mo)	Vanadium (V)	Nickel (Ni)	Copper (Cu)	Other Elements
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	SA 106 Gr A	0.25* Max	0.27 0.93	0.10M in	0.035 Max	0.035 Max	0.40* * Max	0.15* *Max	0.08* * Max	0.40* * Max	0.40* * Max	
2.	SA 106 Gr B	0.30* Min	0.29 1.06	0.10M in	0.035 Max	0.035 Max	0.40* * Max	0.15* * Max	0.08* * Max	0.40* *Max	0.40* * Max	
3.	SA 106 Gr C	0.35* Max	0.29 1.06	0.10M in	0.035 Max	0.035 Max	0.40* *Max	0.15* *Max	0.08* *max	0.40* *Max	0.40* * Max	
4.	SA 335 Gr P1	0.10 0.20	0.30 0.80	0.10 0.50	0.025 max	0.025 max	----- 0.50	0.44 0.65	-----	-----		-----
5.	SA 335 Gr P2	0.10 0.20	0.30 0.61	0.10 0.30	0.025 max	0.025 max	0.50 0.81	0.44 0.65	-----	-----		-----
6.	SA 335 Gr P5	0.15 max	0.30 0.60	0.50 max	0.025 max	0.025 max	4.00 6.00	0.45 0.65	-----	-----		-----
7.	SA 335 Gr P9	0.15 max	0.30 0.60	0.25 1.00	0.025 max	0.025 max	8.00 10.0	0.90 1.10	-----	-----		-----
8.	SA 335 Gr P11	0.05 0.15	0.30 0.60	0.50 1.00	0.025 max	0.025 max	1.00 1.50	0.44 0.65	-----	-----		-----
9.	SA 335 Gr P12	0.05 0.15	0.30 0.61	0.50 max	0.025 max	0.025 max	0.80 1.25	0.44 0.65	-----	-----		-----
10.	SA 335 Gr P22	0.05 0.15	0.30 0.60	0.50 max	0.025 max	0.025 max	1.90 2.60	0.87 1.13	-----	-----		-----
11.	SA 335 Gr P91	0.08 0.12	0.30 0.60	0.20 0.50	0.010 max	0.020 max	8.00 9.50	0.85 1.05	0.18 0.25	0.40 max.		Cb=0.06 - 0.10 N=0.030 - 0.70 Al=0.02 max. Ti=0.01 max. Zr=0.01 max.
12.	X20Cr MoV121	0.17 0.23	1.00 max	0.50 max	0.03 max	0.030 max	10.0 12.5	0.80 1.20	0.25 0.35	0.30 0.80		-----
13.	SB 167 N06617	0.05 0.15	1.0 max	1.0 max	0.015 max	-	20.02 4.0	8.0 10.0	-	44.5 min	0.5 max	Co:10.0-15.0; Fe:3.0 max; Al: 0.8-1.5; Ti:0.6 max; B:0.006 max

* For each reduction of 0.01% below the specified carbon maximum, an increase of 0.06% manganese above the specified maximum will be permitted up to a maximum of 1.35%.

** Cr + Cu + Mo + Ni + V < 1.0 %

(4) (a)(i) Carbon Steel hot finished pipes need not be heat treated.

(ii) Cold drawn pipes shall be given a sub-critical anneal, a full anneal, or a normalising heat treatment after the final cold finishing process.

(b) (i) Pipes of grades P1, P2, P5, P9, P11, P12, and P22 except P91, X20CrMoV121 and N06617 shall be reheated and furnished in full annealed, isothermal annealed or normalised and tempered condition.

- (ii) If furnished in the normalised and tempered condition, the minimum tempering temperature for grade P1, P2, P11 and P12 shall be 650°C and the minimum tempering temperature for grades P5, P9 and P22 shall be 675°C.
- (c) Pipes of grades P1, P2 and P12 either hot finished or cold drawn may be given a final heat treatment at 650°C to 705°C, instead of heat treatment specified in clause (b) above at the option of the manufacturer.
- (d) Grades P91 shall be normalised at 1040°C minimum and tempered at 730°C minimum as a final heat treatment.
- (e) Grades X20CrMoV121 shall be normalised at 1020°C - 1070°C and tempered at 730°C - 780°C for a period of one hour minimum.
- (f) Grade N06617 shall be solution annealed at 1150°C to 1230°C and quenched in water or rapidly cooled by other means.
- (5) (a) (i) The pipes shall be finished, cleaned free from harmful defects.
(ii) They shall be reasonably straight, smooth, cylindrical and subject to the tolerance specified in this sub-regulation. Pipes manufacturer shall explore a sufficient number of visual inspections to provide reasonable assurance that they have been properly evaluated.
- (b) Permissible variations in outside diameter shall be as follows:-

Table 2/22: Carbon Steel Hot finished and cold finished seamless pipes

Serial No.	Outside diameter (mm)	Permissible variations (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	10.3 to 48.3 incl.,	0.40	0.40
2.	Over 48.3 to 114.3 incl.,	0.80	0.80
3.	Over 114.3 to 219.1 incl.,	1.60	0.80
4.	Over 219.1 to 457.0 incl.,	2.40	0.80
5.	Over 457.0 to 660.0 incl.,	3.20	0.80
6.	Over 660.0 to 864.0 incl.,	4.00	0.80
7.	Over 864.0 to 1219.0 incl.,	4.80	0.80

Table 2/23: For all grades of alloy steel except X20CrMoV121 and N06617

Serial No.	Hot finished and Cold finished seamless pipes		
	Outside diameter (mm)	Permissible variations (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	10.3 to 48.3 incl.	0.40	0.40
2.	Over 48.3 to 114.3 incl.	0.80	0.80
3.	Over 114.3 to 219.1 incl.	1.60	0.80
4.	Over 219.1 to 300 incl.	2.40	0.80
5.	Over 300.	1%	1%

Table 2/24: For Grade X20CrMoV121

Serial No.	Outside diameter (mm)	Permissible variations (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	100 and under	0.75%	0.75%
2.	Over 100 to 320 incl.	0.90%	0.90%
3.	Over 320	1.00%	1.00%

Table 2/25: For Grade N06617

Serial No.	Outside diameter (mm)	Permissible Variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Seamless Cold-worked pipes		
2.	Over 10 and less than 16	0.13	0.13
3.	16 - 38	0.19	0.19
4.	Over 38 - 76	0.25	0.25
5.	Over 76 to 114	0.38	0.38
6.	Over 114 to 152	0.51	0.51
7.	Over 152 to 168	0.64	0.64
8.	Over 168 to 219	0.79	0.79
9.	Hot finished pipes		
10.	64 to 114	0.79	0.79
11.	Over 114 to 165	1.2	1.2
12.	Over 165 to 235	1.6	1.6

(c) Permissible variation in wall thickness shall be as follows:-

Table 2/26: For grade X20CrMoV121

Serial No.	Outside diameter (mm)	Permissible variation %	
		Over	Under
(1)	(2)	(3)	(4)
1.	100 and under	12.5	10
2.	Over 100 to 320 incl.	12.5	12.5
3.	Over 320	15.0	12.5

Table 2/27: For grade N06617

Serial No.	Outside diameter (mm)	Permissible Variation (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Seamless Cold-worked pipes		
2.	Over 10 and less than 16	15.0	15.0
3.	16 - 38	10.0	10.0
4.	Over 38 - 76	10.0	10.0
5.	Over 76 to 114	10.0	10.0
6.	Over 114 to 152	12.5	12.5
7.	Over 152 to 168	12.5	12.5
8.	Over 168 to 219	12.5	12.5
9.	Hot finished pipes		
10.	64 to 114	16.0	12.5
11.	Over 114 to 165	16.0	12.5
12.	Over 165 to 235	16.0	12.5

Note: For all grades, except X20CrMoV121 and N06617, the minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.

- (d) Seamless Hot finished and Cold finished pipes can be ordered in specified length or in random length. If ordered in specified length, the tolerances shall be as follows:

Table 2/28

Serial No.	Grade	Length (m)	Permissible variation in (mm)	
			Over	Under
(1)	(2)	(3)	(4)	(5)
1.	All grades except X20CrMoV121 and N06617	All length	6	0
2.	For grade X20CrMoV121	6 and under	10	0
3.		Over 6 to 12 incl.	15	0

Table 2/29: For grade N06617

Serial No.	Outside Diameter of pipe (mm)	Permissible variation in Length (mm)	
		Over	Under
(1)	(2)	(3)	(4)
1.	Under 50.8	3.2	0
2.	50.8 and over	4.8	0

- (6) (a) Test specimen required for flattening and expanding or flaring test specified in sub-regulations herein below shall be taken from ends of finished pipes prior to upsetting, swaging, expanding or any other forming operations or being cut to length and they shall be smooth on ends and free from burrs and flaws.
- (b) If desirable and practicable, tensile test may be carried out on full section of the pipe up to the capacity of the testing machine and for large size pipes, the tensile test specimen shall consist of strip cut longitudinally from the pipe and which is not straightened within the gauge length and further heat treated.
- (c) If any test specimen shows flaws or defective machining it may be discarded and another specimen substituted.
- (d) All specimens shall be tested at room temperature.
- (7) The tests specified in sub-regulations below shall be made on minimum 2 pipes for first 100 pipes and 1 per 100 or part thereof for pipes over 100 numbers from each lot. Lot applies to all pipes of same nominal size and wall thickness of same heat and heat treatment.
- (8) (a) The tensile test may be carried out on the test pieces cut out from the pipe in the longitudinal direction which shall not be further heat treated nor straightened within the gauge length. As an alternative, pipes may be tested on full cross section.
- (b) Test pieces cut from the ends of the selected pipes shall comply with the requirements specified in this sub-regulation.

Table 2/30

Serial No.	Grade	Yield Strength MPa (kg/mm ²) min	Tensile Strength MPa (kg/mm ²) min	%Elongation on G.L.= 50 mm min * for full tube testing
(1)	(2)	(3)	(4)	(5)
1.	SA 106 Gr A	205 (21.1)	330 (33.1)	35
2.	SA 106 Gr B	240 (24.7)	415 (42.2)	30
3.	SA 106 Gr C	275 (28.2)	485 (49.3)	30

*The tensile test specimen shall be as per the relevant material specifications.

Note: For longitudinal strip test, the minimum required elongation shall be determined by the following equation:

$$e = 1940 (A^{0.2}/U^{0.9})$$

Where e = minimum elongation in 50.8 mm, % rounded to the nearest 0.5%.

A = cross sectional area of the tensile test specimen in mm² based on specified outside diameter or nominal specimen width and specified wall thickness rounded to the nearest 6.45 mm². If the area thus calculated is more than 484 mm² then use area as 484 mm². If the calculated area is less than 484 mm² then use the actual area thus obtained.

U = specified tensile strength in MPa.

Table 2/31: Mechanical Property Requirements for Alloy Steels

Serial No.	Grade	Yield Strength MPa (kg/mm ²) min	Tensile Strength MPa (kg/mm ²) min	% elongation on GL= 50 mm min *
(1)	(2)	(3)	(4)	(5)
1.	SA 335 Gr P1	205 (21.1)	380 (38.7)	30
2.	SA 335 Gr P2	205 (21.1)	380 (38.7)	30
3.	SA 335 Gr P5	205 (21.1)	415 (42.2)	30
4.	SA 335 Gr P9	205 (21.1)	415 (42.2)	30
5.	SA 335 Gr P11	205 (21.1)	415 (42.2)	30
6.	SA 335 Gr P12	220 (22.5)	415 (42.2)	30
7.	SA 335 Gr P22	205 (21.1)	415 (42.2)	30
8.	SA 335 Gr P91	415 (42.2)	585 (59.8)	20
9.	X20CrMoV121	490 (50.0)	690 (70.4) 840 (85.6)	17
10.	SB 167 N06617	240 (24.5)	655 (66.8)	35

*The tensile test specimen shall be as per the relevant material specifications.

- (9) For pipes of outside diameter 60.3 millimetre(mm) and under, a bend test shall be conducted. A sufficient length of pipe shall stand being bent cold through 90° around a cylindrical mandrel, the diameter of which is 12 times the nominal diameter of the pipe, without developing cracks.

Provided that bend test shall be required for grade N06617.

- (10)(a) For pipes of outside diameter over 60.3 mm, a flattening test shall be conducted and a section of the pipe not less than 63 mm in length shall be flattened cold between two parallel flat surfaces to a distance between the plates (H) as calculated by the formula given below, without showing any sign of a crack or flaw:

$$H = \frac{(1 + e) t}{e + t/D}$$

where, t = specified thickness of pipe (mm)

D = specified outside diameter of the pipe (mm)

e = a constant, as given below

e = 0.07 for Carbon steel with maximum specified carbon above 0.18%

e = 0.09 for Carbon steel with maximum specified carbon 0.18% or less.

e = 0.08 for alloy steel

(b) For pipe whose diameter equals or exceeds 254 mm, a bend test may be conducted instead of the flattening test. The bend test specimens shall be bent at room temperature through 180° without cracking on the outside of the bent portion. The inside diameter of the bend shall be 25 mm. Substitution of the bend test for the flattening test shall be subject to the approval of the purchaser.

(c) For pipe whose diameter exceeds 635 millimetre (mm) and whose diameter to wall thickness ratio is 7.0 or less, the bend test described in sub-regulation (9) shall be conducted instead of the flattening test.

Provided that flattening test shall be required for grade N06617.

(11) (a) If any one or more tests specified in these regulations fail, two further tests of the same kind may be made on two other pipes of the same batch and if any of these tests fails, the batch of the pipes represented may be given a further heat treatment and entire set of tests shall be repeated.

(b) If the repeat tests are satisfactory the pipes shall be accepted and in case of any failure in the tests, the entire batch of the pipes shall be rejected.

(12) (a) Each pipe shall be tested by the manufacturer and shall withstand a hydraulic pressure to one and half time the design pressure, but not greater than pressure calculated by the formula given below and in the absence of working pressure indicated in the Test Certificate then the test pressure indicated in the Test Certificate divided by 1.5 shall be the maximum working pressure:

$$P = 2St/D$$

Where, P = test pressure

D = specified outside diameter of the pipe

t = specified wall thickness of the pipe

S = stress which shall be taken as 40% of the minimum tensile strength at room temperature.

(b) Despite anything contained in the clause (a) above, the hydraulic test at the maker's works may be dispensed with, provided that the pipes are subject to non-destructive testing by an appropriate method like Ultrasonic or Eddy Current or Stray flux testing.

PART-V

50. Castings of carbon, alloy and stainless steel.-(1) This regulation shall cover carbon, alloy and stainless steel castings used in the construction of boilers and steam pipes, including their fittings.

(2) (a) All castings shall be supplied in the heat-treated condition as following:-

(i) carbon steel castings: annealing, or normalising, or normalising and tempering.

(ii) alloy steel castings: annealing, or normalising and tempering, or hardening or quenching and tempering.

(iii) stainless steel castings: solution annealing.

(b) Heat treatment shall be carried out either at the discretion of the manufacturer or the Competent Person and shall be carried out at suitable temperatures to give the mechanical properties specified in regulation 54.

- (3) All castings shall be properly fettled and dressed and all surfaces shall be satisfactorily cleaned for inspection purposes.
- (4) The castings can be supplied as cast, rough machined or after final machining. The Non-Destructive Testing may be performed in as cast or in machined condition as per the non-destructive examination(NDE) requirements of relevant material specifications.

51. Process of manufacture.—(1) The steel used for castings shall be made by an Open Hearth or Electric Furnace or any other process which gives steel having equivalent properties.

- (2) The steel shall comply with the chemical composition specified in the Table 2/32.

Table 2/32: Chemical composition (%)

Serial No.	Grade	Carbon(C)	Manganese (Mn)	Phosphorus (P)	Sulphur(S)	Silicon(Si)	Chromium (Cr)	Nickel(Ni)	Molybdenum(Mo)	Vanadium (V)	Nitrogen (N)	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	SA 352 LCB	0.30	1.00	0.04	0.045	0.60	0.50	0.50	0.20	0.03	-	Cu-0.30
2.	SA 216 WCB	0.30	1.20	0.04	0.045	0.60	0.50	0.50	0.20	0.03	-	Cu-0.30
3.	SA 216 WCC	0.25	1.20	0.04	0.045	0.60	0.50	0.50	0.20	0.03	-	Cu-0.30
4.	SA 352 LCC	0.25	1.20	0.04	0.045	0.60	0.50	0.50	0.50	0.03		Cu-0.30
5.	SA 217 WC6	0.05–0.20	0.50–0.80	0.04	0.045	0.60	1.00–1.50	0.50	0.45–0.65	-	-	Cu-0.50 W-0.10
6.	SA 217 WC9	0.05–0.18	0.40–0.70	0.04	0.045	0.60	2.00–2.75	0.50	0.90–1.20	-	-	Cu-0.50 W-0.10
7.	SA 217 C12A	0.08–0.12	0.30–0.60	0.030	0.010	0.20–0.50	8.0–9.5	0.40	0.85–1.05	0.18–0.25	0.030–0.070	Nb- 0.060–0.10 Al- 0.02 Ti- 0.01 Zr- 0.01
8.	SA 351 CF8	0.08	1.50	0.040	0.040	2.00	18.0-21.0	8.0-11.0	0.50	-	-	-
9.	SA 351 CF8M	0.08	1.50	0.040	0.040	1.50	18.0–21.0	9.0–12.0	2.0–3.0	-	-	-
10.	SA 351 CF8C	0.08	1.50	0.040	0.040	2.00	18.0–21.0	9.0-12.0	0.50	-	-	-

- Note:**
1. Maximum when single values specified
 2. A carbon content not exceeding 0.3% may be subjected to the agreement between the boiler maker and the inspecting Authority.

52. Freedom from and rectification of defects.—The steel castings shall have clean surfaces and shall be free from defects and the specified permissible variations in size or thickness shall not be exceeded. Defects may be repaired by welding only, with the approval of the Inspecting Authority provided that the castings are stress-relieved after welding if necessary.

53. Number of tests and provision of test samples.—Tensile and bend test pieces shall be prepared from test samples representative of each melt or heat-treatment batch as following:-

- (i) (a) The test samples shall be cast attached to or separate from the castings as agreed between the manufacturer and the Competent Person.
(b) The agreement for attached test samples shall include the precise location and method of attachment. If the Competent Person fails to make such an agreement with the manufacturer, the decision as to the manner of providing test samples shall rest with the manufacturer.
(c) The discretion of the manufacturer shall not, however, apply to the testing of castings made from more than one melt as indicated in sub-regulation (4) below.
- (ii) (a) If the test samples are attached to the castings, at least one tensile test, and when required one bend test, shall be made from each melt.
(b) Such test samples shall not be detached from the castings until heat-treatment of the castings has been completed and they have been stamped by the Competent Person.
(c) Test samples shall be stamped by the Competent Person after that heat-treatment process.
- (iii) (a) If the test samples are cast separately, they shall be provided to the extent of 2 per cent of the number of castings from each melt, but in no case there shall be less than 2 samples per melt, except by agreement between the manufacturer and the Competent Person.
(b) The test samples shall be cast in moulds of the same material as is used for the castings and shall be made at the same time as the castings, and run from the same ladle.
(c) The samples shall be stamped by the Competent Person so as to identify the castings to which they relate.
- (iv) (a) When a casting is made from more than one melt, at least four tensile tests, and where required four bends tests, shall be made from test samples situated as far apart as possible on the casting.
(b) Some of the test samples shall be taken from as near the top and others near from the bottom of the casting as is practicable.
- (v) Test samples shall be heat-treated with the castings they represent.

54. Tensile test.— (1) The upper yield point at room temperature shall be not less than fifty percent of the specified minimum tensile strength at room temperature.

- (2) The minimum value of stress at proof limit of 0.2% at elevated temperature (E_t) of the material may be calculated by multiplying the minimum specified tensile strength at room temperature (R_{20}) by the value of ratio E_t/R_{20} given in Table 2/5 under regulation 37.
- (3) If, however, the tensile tests are carried out on specimen conforming to any other standards, the material will be accepted provided the tensile strength and elongation computed on the basis of the dimensions of the test pieces under the regulation shall conform to the above requirements.
- (4) The test specimen shall comply with the requirements given below:

Table 2/33

Serial No.	Grade	Mechanical Properties (minimum, when single value specified)		
		TS MPa (kg/mm ²)	YS MPa (kg/mm ²)	% Elongation on GL = 50 mm min*.
(1)	(2)	(3)	(4)	(5)
1.	SA 352 LCB	450-620 (45.8-63.2)	240 (24.5)	24
2.	SA 216 WCB	485 to 655 (49.5-66.8)	250 (25.5)	22
3.	SA 216 WCC	485 to 655 (49.5-66.8)	275 (28)	22
4.	SA 352 LCC	485-655 (49.5-66.8)	275 (28)	22
5.	SA 217 WC6	485-655 (49.5-66.8)	275 (28)	20
6.	SA 217 WC9	485-655 (49.5- 66.8)	275 (28)	20
7.	SA 217 C12A	585-760 (59.6-77.5)	415 (42.3)	18
8.	SA 351 CF8	485 (49.5)	205 (21)	35
9.	SA 351 CF8M	485 (49.5)	205 (21)	30
10.	SA 351 CF8C	485 (49.5)	205 (21)	30

*The tensile test specimen shall be as per the relevant material specifications.

55. Bend tests.—(1) Cold bend tests shall be made upon test pieces having rectangular section of 25 mm wide by 19 mm thick.

(2) The test pieces shall be machined and the edges rounded to a radius of 1.6 mm and shall be bent over the thinner section.

(3) Bend tests may be made by pressure or by blows, and the test pieces shall without fracture withstand being bent round a former having a radius of 25 mm through an angle not less than that given in the Table 2/34.

Table 2/34

Serial No.	Grade of Casting	Angle of Bend minimum
(1)	(2)	(3)
1.	M1 Group 1 & 2 M3 Group 1 & 2, M4 Group1	120°
2.	M5A Group1, M5B Group1, M15E Group1	90°
3.	M8 Group 1 & 2 and M43	No test

(4) Alternatively, the specimen preparation for bend test, test method and acceptance criteria may conform to the relevant material specifications.

56. Additional Tests.—(1)(a) In case any of the original test pieces fail to pass the mechanical tests, two further samples which represent the same castings shall be selected and tested in the same manner.

(b) The manufacturer shall have the right, if he so desires to re-heat-treat the castings before the two further samples are selected.

(c) In case the two further test satisfy the requirements of this standard, castings represented by them shall be accepted and in case either of the re-tests fail, the castings represented shall be liable to rejection.

(2) The Competent Person may call for hardness testing of the heat-treated castings.

(3) (a)(i) The Competent Person may call for radiographic examination or other non-destructive testing of the castings and castings found to be unsound may be treated in accordance with regulation 52.

(ii) If the welding repairs are sanctioned by the Competent Person, they shall be carried out in accordance with regulation 57.

(b) High class Castings for which a factor greater than 80% is taken in computation of permissible working stress shall be subject to the following inspection requirements, namely:

(i) (a) Each casting shall be examined by radiographic or ultrasonic methods at all critical locations and found free from harmful defects.

(b) All the castings shall be fully machined to such an extent that all critical sections are exposed for full thickness.

(ii) All castings shall be examined at all critical locations using magnetic-particle or penetrant-fluid procedure, or by grinding or machining and etching.

(iii) (a) Castings found to be defective shall be rejected by the Inspecting Authority or repaired to its satisfaction.

(b) If repairs by welding are carried out, the castings shall be subsequently stress-relieved or heat treated.

(c) Castings found to be unsound may be treated in accordance with regulation 57.

(d) Repaired areas of castings shall be re-examined by the Competent Person in accordance with sub-clause (i) of this sub-regulation and shall be shown to be free from harmful defects.

(iv) Castings to which a quality factor of 0.90 is assigned shall be clearly and permanently marked with 'G' suitable symbol after being examined as above and found satisfactory.

(4) The provisions of clause (a) of sub-regulation 3 shall apply to the castings other than high class castings for which a factor greater than 80% is used in the computation of permissible working stress for shells of Boiler and integral super-heater Drums and Headers under regulation 170.

57. Procedure for welding.—(1) In order to maintain a high standard of workmanship in the practice of arc-welding repair to steel castings, a written down procedure taking care of the following requirements shall be followed.

(2) (a) The surfaces of the steel, it is intended to weld shall be cleaned and freed from all foreign matter, otherwise it may result in poor penetration and unsound weld metal.

(b) The preparation for the welding of cracks shall be of the U or V types. When the latter is used, the included angle shall be not less than 70. Where cracks extend through the section of the casting, the choice between single and double preparation, U or V will be governed by:

(i) the thickness of the casting;

(ii) the location of the defect. In double preparation, U or V the root of the U or V should be sufficiently open to ensure complete penetration.

(3) The selection of electrodes shall be compatible with the relevant material groups. The electrode manufacturer's recommendations for the use of the electrode shall be strictly followed.

(4) Variations in composition, mass design and the extent of welding required make it impossible to lay down specific rules to establish conditions under which pre-heating should be applied. When after consideration of each casting in the light of the above variables it is deemed necessary to pre-heat, such pre-heating should be carried out at a temperature of 150°C-300°C.

(5) (a) When the welding is carried out after the casting has received its normal heat treatment, a further heat treatment may be considered necessary. This treatment need be applied only in cases where welding has been such as to induce either internal stresses which would be detrimental to the casting, or locally hardened areas

which would cause difficulty in machining. Where this further heat treatment is applied, the casting, where possible, should not be allowed to go cold after welding, but should be charged into a warm furnace and reheated to a suitable tempering temperature which in general should be not less than 550°C.

- (b) When considering the advisability of applying this further treatment, its effect on the physical properties of the castings shall be borne in mind. If the treatment, or the welding itself is such that the physical properties will be adversely affected, the full heat treatment required to produce satisfactory qualities shall be substituted.

PART-VI

58. Forgings of carbon, alloy, stainless steel and nickel alloys.—(1) The steel used for the forgings shall be made by an Open Hearth or Electric or basic Oxygen process or by any other process which gives steel having equivalent properties.

(2) (a) The steel shall not contain more than 0.05 per cent of sulphur or of phosphorus.

(b) The steel shall comply with the chemical composition specified in the Table 2/35.

Table 2/35: Chemical composition (%)

Serial No.	Grade	Carbon (C)	Manganese (Mn)	Phosphorus (P)	Sulphur(S)	Silicon(Si)	Chromium (Cr)	Nickel(Ni)	Molybdenum (Mo)	Vanadium(V)	Nitrogen (N)	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	SA 266 Gr1	0.30	0.40–1.05	0.025	0.025	0.15–0.35	-	-	-	-	-	-
2.	SA 266 Gr2	0.30	0.40–1.05	0.025	0.025	0.15–0.35	-	-	-	-	-	-
3.	SA 266 Gr3	0.35	0.80–1.35	0.025	0.025	0.15–0.35	-	-	-	-	-	-
4.	SA 350 LF1-Note 4	0.30	0.60–1.35	0.035	0.040	0.15–0.30	0.30	0.40	0.12	0.08	-	Nb-0.02 Cu-0.04
5.	SA 350 LF2-Note 4	0.30	0.60–1.35	0.035	0.040	0.15–0.30	0.30	0.40	0.12	0.08	-	Nb-0.02 Cu-0.04
6.	SA 105 - Note 4	0.35	0.60–1.05	0.035	0.040	0.10–0.35	0.30	0.40	0.12	0.08	-	Cu-0.4
7.	SA 182 F1	0.28	0.60–0.90	0.045	0.045	0.15–0.35	-	-	0.44–0.65	-	-	-
8.	SA 182 F2	0.05–0.21	0.30–0.80	0.040	0.040	0.10–0.60	0.50–0.81	-	0.44–0.65	-	-	-
9.	SA 182 F11 Cl 1	0.05–0.15	0.30–0.60	0.030	0.030	0.50–1.00	1.00–1.50	-	0.44–0.65	-	-	-
10.	SA 182 F11 Cl 2	0.10–0.20	0.30–0.80	0.040	0.040	0.50–1.00	1.00–1.50	-	0.44–0.65	-	-	-
11.	SA 182 F11 Cl 3	0.10–0.20	0.30–0.80	0.040	0.040	0.50–1.00	1.00–1.50	-	0.44–0.65	-	-	-
12.	SA 182 F12 Cl 1	0.05–0.15	0.30–0.60	0.045	0.045	0.50	0.80–1.25	-	0.44–0.65	-	-	-
13.	SA 182 F12 Cl 2	0.10–0.20	0.30–0.80	0.040	0.040	0.10–0.60	0.80–1.25	-	0.44–0.65	-	-	-
14.	SA 182 F22 Cl 1,3	0.05–0.15	0.30–0.60	0.040	0.040	0.50	2.00–2.50	-	0.87–1.13	-	-	-
15.	SA 182 F5	0.15	0.30–0.60	0.030	0.030	0.50	4.0–6.0	0.50	0.44–0.65	-	-	-
16.	SA 182 F9	0.15	0.30–0.60	0.030	0.030	0.50–1.00	8.0–10.0	-	0.90–1.10	-	-	-
17.	SA 182 F91	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.0–9.5	0.40	0.85–1.05	0.18–0.25	0.03–0.07	Nb-0.06–0.10; Al 0.02 Ti 0.01; Zr 0.01
18.	SA 182 F304	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	-	-	0.10	-
19.	SA 182 F304H	0.04–0.10	2.00	0.045	0.030	1.00	18.0–20.0	8.0–11.0	-	-	-	-
20.	SA 182 F304L	0.030	2.00	0.045	0.030	1.00	18.0–20.0	8.0–13.0	-	-	0.10	-
21.	SA 182 F316	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.0–3.0	-	0.10	-
22.	SA 182 F316H	0.04–0.10	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0	2.0–3.0	-	-	-
23.	SA 182 F316L	0.030	2.00	0.045	0.030	1.00	16.0–18.0	10.0–15.0	2.0–3.0	-	0.10	-
24.	SA 182 F321	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	-	-	-	J
25.	SA 182 F321H	0.04–0.10	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0	-	-	-	K

26.	SA 182 F347H	0.04–0.10	2.00	0.045	0.030	1.00	17.0–20.0	9.0–13.0	-	-	-	<i>M</i>
27.	SA 234 WPB-Note 2	0.30	0.29–1.06	0.050	0.058	0.10 min	0.40	0.40	0.15	0.08	-	-
28.	SA 234 WPC	0.35	0.29–1.06	0.050	0.058	0.10 min	0.40	0.40	0.15	0.08	-	-
29.	SA 234 WP11 Cl 1	0.05–0.15	0.30–0.60	0.030	0.030	0.50–1.00	1.00–1.50	-	0.44–0.65	-	-	-
30.	SA 234 WP12 Cl 1	0.05–0.20	0.30–0.80	0.045	0.045	0.60	0.80–1.25	-	0.44–0.65	-	-	-
31.	SA 234 WP22 Cl 1	0.05–0.15	0.30–0.60	0.040	0.040	0.50	1.90–2.60	-	0.87–1.13	-	-	-
32.	SA 234 WP5 Cl1	0.15	0.30–0.60	0.040	0.030	0.50	4.0–6.0	-	0.44–0.65	-	-	-
33.	SA 234 WP9 Cl1	0.15	0.30–0.60	0.030	0.030	1.00	8.0–10.0	-	0.90–1.10	-	-	-
34.	SA 234 WP91	0.08–0.12	0.30–0.60	0.020	0.010	0.20–0.50	8.0–9.5	-	0.85–1.05	-	-	-
35.	SA 336 F11 Cl 1	0.05–0.15	0.30–0.60	0.025	0.025	0.50–1.00	1.00–1.50	-	0.44–0.65	-	-	-
36.	SA 336 F11 Cl 2,3	0.10–0.20	0.30–0.80	0.025	0.025	0.50–1.00	1.00–1.50	-	0.45–0.65	-	-	-
37.	SA 336 F12	0.10–0.20	0.30–0.80	0.025	0.025	0.10–0.60	0.80–1.10	-	0.45–0.65	-	-	-
38.	SA 336 F5	0.15	0.30–0.60	0.025	0.025	0.50	4.0–6.0	0.50	0.45–0.65	-	-	-
39.	SA 336 F9	0.15	0.30–0.60	0.025	0.025	0.50–1.00	8.0–10.0	-	0.90–1.10	-	-	-
40.	SA 336 F91	0.08–0.12	0.30–0.60	0.025	0.025	0.20–0.50	8.0–9.5	0.40	0.85–1.05	0.18–0.25	0.03–0.07	Nb-0.06–0.10; Al-0.02 Ti-0.01; Zr-0.01
41.	SB 564 N06617 SB 166 N06617	0.05–0.15	1.0	-	0.015	1.0	20.0–24.0	44.5 min	8.0–10.0	-	-	Co:10.0–15.0; Fe:3.0; Al: 0.8–1.5; Cu:0.5; Ti:0.6; B:0.006

- Note:**
1. Maximum when single values specified
 2. For SA 234 WPB, Fittings made from bar or plate may have 0.35 max carbon.
 3. For SA 234 WPB & SA 234 WPC Fittings:
 - (i) The sum of copper, nickel, chromium, molybdenum and vanadium shall not exceed 1.00%.
 - (ii) Fittings made from forgings may have 0.35 max carbon and 0.35 max silicon with no minimum
 - (iii) For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted, up to a maximum of 1.65 %.
 4. For SA 350 LF1, LF2 & SA 105 Forgings
 - (i) The sum of chromium and molybdenum shall not exceed 0.32%.
 - (ii) The sum of copper, nickel, chromium, molybdenum and vanadium shall not exceed 1.00%.
 5. *J* Grade F 321 shall have a titanium content of not less than five times the carbon content and not more than 0.70 %.
K Grade F 321H shall have a titanium content of not less than four times the carbon content and not more than 0.70 %.
M Grades F 347H shall have a columbium content of not less than eight times the carbon content and not more than 1.10 %.

- (3) Heat treatment shall be as per relevant material specifications.
- (4) Where not machined, the forgings, shall have workman like surfaces as normally obtained by rolling, forging or drawing.

Provided that the minimum required thickness is maintained, minor surface defects may be admitted and other defects removed by mechanical means so as to achieve a smooth surface. Surface defects may also be repaired, by welding only, with the approval of the Inspecting Authority provided that the parts are stress-relieved after welding where necessary.

59. Selection of test pieces.— (1) For testing, either the parts themselves shall be used or additional material or sufficient size for test pieces shall be available. In the case of headers for examples, surplus lengths for test rings may be used. In the case of flanges swaged in dies, the punching left may be used as test pieces, in which case the identity of the material of the punching with that of the flange shall be evidenced in an adequate manner. The test may be performed also on the semi-finished material for example a bar or a billet, provided it is given approximately the same reduction and heat-treatment as the finished forging. For headers with closed ends, the test rings shall be cut off before dishing or reducing and shall be subjected to the same heat treatment as the headers themselves. In the case of headers, which are closed by special covers, the test ring shall be cut off after heat treatment. Similar procedure shall be followed for test pieces of other forgings.

- (2) For testing, piece of one and the same cast of the same heat treatment batch as well as of similar dimensions may be gathered into one group and at least one test piece shall be made from each group.
- (3) Tangential test piece shall be used for headers where practicable. For header with outside diameter less than 200 mm, longitudinal test pieces may be allowed.

60. Tensile strength.—(1) The tensile strength of the material shall conform with mechanical properties as per Table 2/36 of this sub-regulation.

Table 2/36

Serial No.	Grade	Mechanical Properties (minimum, when single value specified)		
		TS MPa (kg/mm ²)	YS MPa (kg/mm ²)	% Elongation on GL = 50 mm min*.
(1)	(2)	(3)	(4)	(5)
1.	SA 266 Gr1	415-585 (42.3-59.6)	205 (21)	23
2.	SA 266 Gr2	485-655 (49.5-66.8)	250 (25.5)	20
3.	SA 266 Gr3	515-690 (52.5-70.4)	260 (26.5)	19
4.	SA 350 LF1	415-585 (42.3-59.6)	205 (21)	25
5.	SA 350 LF2	485-655 (49.5-66.8)	250 (25.5)	22
6.	SA 105	485 (49.5)	250 (25.5)	30
7.	SA 182 F1	485 (49.5)	275 (28)	20
8.	SA 182 F2	485 (49.5)	275 (28)	20
9.	SA 182 F11 Cl 1	415 (42.3)	205 (21)	20
10.	SA 182 F11 Cl 2	485 (49.5)	275 (28)	20
11.	SA 182 F11 Cl 3	515 (52.5)	310 (31.6)	20
12.	SA 182 F12 Cl 1	415 (42.3)	220 (22.4)	20
13.	SA 182 F12 Cl 2	485 (49.5)	275 (28)	20
14.	SA 182 F22 Cl 1	415 (42.3)	205 (21)	20
15.	SA 182 F22 Cl 3	515 (52.5)	310 (31.6)	20

16.	SA 182 F5	485 (49.5)	275 (28)	20
17.	SA 182 F9	585 (59.6)	380 (38.7)	20
18.	SA 182 F91	620 (63.2)	415 (42.3)	20
19.	SA 182 F304	515 (52.5)	205 (21)	30
20.	SA 182 F304H	515 (52.5)	205 (21)	30
21.	SA 182 F304L	485 (49.5)	170 (17.3)	30
22.	SA 182 F316	515 (52.5)	205 (21)	30
23.	SA 182 F316H	515 (52.5)	205 (21)	30
24.	SA 182 F316L	485 (49.5)	170 (17.3)	30
25.	SA 182 F321	515 (52.5)	205 (21)	30
26.	SA 234 WPB	415 (42.3)	240 (24.5)	22
27.	SA 234 WPC	485 (49.5)	275 (28)	22
28.	SA 182 F321H	515 (52.5)	205 (21)	30
29.	SA 182 F347H	515 (52.5)	205 (21)	30
30.	SA 234 WP11 Cl 1	415-585 (42.3-59.6)	205 (21)	22
31.	SA 234 WP12 Cl 1	415-585 (42.3-59.6)	220 (22.4)	22
32.	SA 234 WP22 Cl 1	415-585 (42.3-59.6)	205 (21)	22
33.	SA 234 WP5 Cl1	415-585 (42.3-59.6)	205 (21)	22
34.	SA 234 WP9 Cl1	415-585 (42.3-59.6)	205 (21)	22
35.	SA 234 WP91	585-760 (59.6-77.5)	415 (42.3)	20
36.	SA 336 F11 Cl 1	415-585 (42.3-59.6)	205 (21)	20
37.	SA 336 F11 Cl 2	485-660 (49.5-67.3)	275 (28)	20
38.	SA 336 F11 Cl 3	515-690 (52.5-70.4)	310 (31.6)	18
39.	SA 336 F12	485-660 (49.5-67.3)	275 (28)	20
40.	SA 336 F5	415-585 (42.3-59.6)	250 (25.5)	20
41.	SA 336 F9	585-760 (60.7-77.5)	380 (38.7)	20
42.	SA 336 F91	620-760 (63.2-77.5)	415 (42.3)	20
43.	SB 564 N06617 SB 166 N06617	655 (66.8)	241 (24.6)	35

*The tensile test specimen shall be as per the relevant material specifications.

- (2) The upper yield point at room temperature shall be not less than 50% of the specified minimum tensile strength.
- (3) The minimum values of the stress at proof limit 0.2% at elevated temperature (E_t) may be calculated by multiplying the minimum specified tensile strength of the material at room temperature (R_{20}) by the value of the ratio E_t/R_{20} given in the Table 2/5 under regulation 37.

61. Bend tests.— (1) Bend test pieces shall be of rectangular cross-section machined to a finished size of 25 mm wide by 19 mm thick. The edges shall be rounded to a radius of 1.6 mm. The test pieces shall be bent over the thinner section.

- (2) Test pieces shall be bent when cold through an angle of 180° without fracture, the internal radius of the bend being not greater than that specified in Table 2/37 for the 25 mm wide by 19 mm thick test piece.

Table 2/37

Serial No.	Grade of forging	Internal radius of bend (mm)
(1)	(2)	(3)
1.	M1 Group 1 & 2 M3 Group 1 & 2, M4 Group1	6.35
2.	M5A Group1, M5B Group1, M15E Group1 & M8 Group 1 & 2	1.5 x thickness of test specimen
3.	M43	No test

Alternatively, the specimen preparation for bend test, test method and acceptance criteria may conform to the relevant material specifications.

62. Additional tests before rejection.— (1) In case either a tensile or a bend test fails, two further tests of the type which failed may be made on test pieces out from the same forging. If the results obtained from these retests are satisfactory, the forging shall be accepted, provided that in other respects they fulfil the conditions laid down above for steel forgings. If these retests do not give satisfactory results, the forgings represented may be re-heat-treated together with the remainder of the test blocks and presented for further testing.

- (2) In all cases where final retests do not give satisfactory results, the forgings represented by the test pieces which fail shall be rejected.

PART-VII

63. GENERAL GREY IRON CASTINGS (GRADE A).— (1) The castings shall be cast from metal melted or refined in any metallurgical plant other than an iron ore smelting furnace, for the use of which furnace permission in writing must be received from the Inspecting Authority.

- (2) The Composition of the iron as cast shall be left to the discretion of the manufacturer but the maximum percentage of phosphorus or sulphur or both may be specified by the Inspecting Authority, if it so desires.
- (3) The castings shall be accurately moulded in accordance with the pattern or working drawings supplied by the Inspecting Authority with the addition of such letters, figures or marks as may be specified and the drawings shall include the tolerances specified in the regulation.
- (4) (a) The castings shall be sound, clean out of twist and free from blow holes distortion and all surface and other defects.
(b) They shall be well dressed or fettled and shall be machinable by normal methods.

64. Provision of test bars.—(1) Prior to testing, the Inspecting Authority shall state whether it requires tensile or transverse tests, or both, and it may also specify cast on bars where the design of the casting and method of running permit.

(2)(a) When the test bars are cast separately they shall be poured at the same time and from the same ladle, or metal as the casting or castings they represent.

(b) The number of test specified in regulation 69 shall be applicable to all castings of each melt.

(3) When the bars are cast-on, the mould for the casting and the mould for the test piece shall be joined together in such a manner that the liquid metal fills both moulds at the same operation.

(4) All test bars shall be cast in green sand or dry sand or in loam moulds according to whether the casting or castings they represent are moulded in green sand, or in loam or dry sand, respectively.

(5) The test bars shall not be subjected to any heat treatment after leaving the moulds.

65. Dimension of test bars.— (1) (a) The Transverse test bars of the diameter specified by the Inspecting Authority according to the main cross-sectional thickness of the casting represented, shall conform to the following dimensions, namely:-

Table 2/38

Serial No.	Diameter test Bar	Limits on Diameter	Overall length	Main cross-sectional thickness of casting represented
(1)	(2)	(3)	(4)	(5)
1.	mm	mm.	mm.	mm.
2.	15	+ 1	254	Not Exceeding 10
3.	22	+ 1.7	381	Over 10 and not exceeding 19
4.	30	+ 2	533	Over 19 and not exceeding 28
5.	40	+ 2.5	533	Over 28 and not exceeding 41
6.	53	+ 2.5	685	Over 41

(b) Bars cast to a size in excess of the limits given above may be machined to a diameter within the specified limits.

(c) Bars cast within these limits of diameter may also be machined before the transverse test is made, providing that the finished diameter falls within these limits.

- (2) The tensile test bars of the diameter specified by the Inspecting Authority, according to the main cross-sectional thickness of the casting represented shall conform to the dimensions shown in the Table 2/39. Bars may be tested with either plain or screwed ends.

TABLE 2/39

<i>Serial No.</i>	<i>Diameter as Cast</i>	<i>Gauge diameter</i>	<i>Area</i>	<i>Min. parallel length</i>	<i>Min. radius</i>	<i>Min. Length of plain ends</i>	<i>Screwed ends</i>		<i>Approximate minimum overall</i>		<i>Main cross- sectional thickness of casting represented</i>
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		(9)		(10)
1.	<i>B</i>	<i>D</i>	<i>A</i>	<i>P</i>	<i>R</i>	<i>C</i>	<i>E</i>	<i>F</i>	<i>LP</i>	<i>LS</i>	
2.	mm.	mm.	Sq.m m.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
3.	15	10	80	25	38	38	13 S.P. 14 S.F. 14 S.W	14	114	3	Not exceeding 10
4.	22	14	161	50	89	38	19 S.F. 22 S.W.	19	179	37	Over 10 and not exceeding 19
5.	30	20	322	50	89	50	38 S.F. 38 S.W	38	210	149	Over 19 and not exceeding 38
6.	41	29	645	50	89	63	38 S.F. 38 S.W.	38	229	184 184	Over 38 and not exceeding 41
7.	53	41	1290	50	89	89	50 S.F	51	286	210	Over 41

The test bars shall be cast as parallel bars of the diameters given in column B and then machined to the dimensions C and P in the Table 2/39.

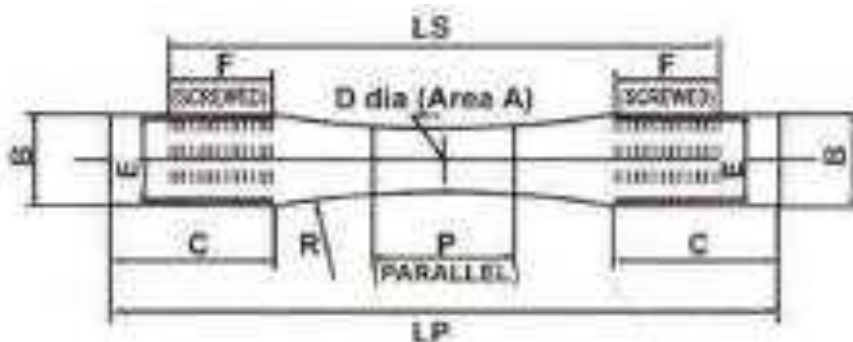


Fig. 2/1

- (3) For castings of over 51 mm in thickness, a test bar of diameter larger than 53 mm may be used by agreement between the manufacturer and the Inspecting Authority. For diagram and table see Fig.2/1 and Table 2/39 under sub-regulation (2) of this regulation.

66. Mechanical test.—(1)The casting shall comply with the transverse and tensile tests specified in regulations 67 and 68.

(2) All test pieces shall be selected by the Competent Person and tested to his satisfaction.

67. Transverse test.—(1)A transverse test bar cast in accordance with sub-regulation (1) of regulation 65 when placed on supports set at the distance shown in column 2 of Table 2/40 must sustain a load applied at the centre of not less than that shown in column 3 and must show before rupture a deflection not less than that shown in column 4.

(2) The supports and the point of application of the load shall be rounded to a radius of not less than 3 mm.

Table 2/40

Serial No.	Diameter of test bar	Distance between support	Minimum breaking load Grade A	Minimum deflection Grade A
(1)	(2)	(3)	(4)	(5)
1.	mm.	mm.	kg	mm.
2.	15	228	240	1.8
3.	22	305	538	2.5
4.	30	457	885	3.8
5.	40	457	1941	3
6.	53	610	3020	3.8

(3) If the diameter of a transverse test bar as cast varies within the limits specified in sub-regulation (1) of regulation 65, the equivalent breaking load for the test bar of standard diameter shall be calculated in accordance with the factors given in Appendix-B .

68. Tensile test.— A tensile test bar machined to the dimensions shown in sub-regulation (2) of regulation 65 and tested with either plain or screwed ends must show a breaking strength of not less than that shown in the Table 2/41:

Table 2/41

Serial No.	Diameter of test bar	Minimum ultimate tensile stress – Grade A
(1)	(2)	(3)
1.	mm.	Kg/mm ²
2.	15	17.5
3.	22	16.8
4.	30	15.5
5.	40	14.8
6.	53	14

Note: Self-aligning grips to ensure axial loading are recommended.

69. Number of transverse and tensile tests.—(1) The number of tests required for each batch of castings shall be in accordance with the Table 2/42, and various classes of castings divided into four representative groups.

(2) One test shall refer to one transverse and one tensile test, whether taken from one or two test bars as cast.

Table 2/42

Serial No.	Group	Weight of Castings	Test requirements
(1)	(2)	(3)	(4)
1.	1	Upto 13 kg	One test for each 1524 kgs of castings or part thereof.
2.	2	Over 13 kg. And upto 50 kg.	One test for each 1814 kgs of castings or part thereof
3.	3	Over 50 kg And upto 907 kg	One test each 3629 kgs of castings or part thereof.
4.	4	Over 907 kg and important castings where mutually agreed upon.	One test for each 3629 kgs of castings or part thereof or for each casting weighing 3629 kgs or more.

In the above group 1, 2 and 3, all castings represented by one test shall be poured from the same ladle or same heat as the bar or bars provided for the test.

70. Additional tests.— The additional tests shall be carried out in accordance with the Table 2/43 before a casting or batch of castings, if rejected:

Table 2/43

Serial No.	Test piece	Event	Conditions
(1)	(2)	(3)	(4)
1.	1 st	If this fails	The second test piece shall be tested.
2.	2 nd	If this passes	The batch or separate casting represented shall be accepted.
3.		If this fails	The batch or separate casting represented may be rejected.
4.	Provided that in the case of failure of both test pieces if either show obvious defects a third test piece may be taken from a broken casting or a piece may be cut from a unable casting for further testing as follows:		
5.	3 rd	If this passes	The batch or separate casting represented shall be accepted.
6.		If this fails	The batch or separate casting Represented may be rejected.

PART-VIII

71. COVERED ELECTRODES FOR SHIELDED METAL ARC WELDING.—(1) (a)(i) This regulation shall apply to covered electrodes of sizes 2.0 mm and larger in diameter for shielded metal arc welding of carbon steel, low alloy steels, stainless steels and non-ferrous materials;

(ii) Electrodes of less than 2.0 mm in diameter shall not be used in boilers.

(b) The covered electrode shall comply with the requirements specified in these regulations.

(c) The characteristics and behaviour under ordinary working conditions shall be such that satisfactory weld deposits can be made by a welder of average skill and experience and that the following characteristics are obtained, namely:-

- (i) relative ease in the control of the slag and weld metal during welding;
- (ii) good degree of stability of the arc;

- (iii) no undue degree of spatter;
 - (iv) desired rate of deposition and depth of penetration.
 - (v) easy removability of the slag;
 - (vi) no undue tendency to under-cut;
 - (vii) desired contour of the weld deposits: and
 - (viii) low internal porosity of the weld metal.
- (2) The covered electrodes shall be classified into following categories and in accordance with applicable Specifications for Filler Alloys (SFA) of American Society of Mechanical Engineers (ASME) Part IIC specifications or AWS (American Welding Society) specifications or equivalent:
- (a) Carbon steel electrodes
 - (b) Low alloy steel electrodes
 - (c) Stainless steel electrodes
 - (d) Nickel and nickel-alloy welding electrodes
- (3) Covered electrodes may be made by any method that shall yield a product conforming to the requirements of these regulations and relevant Specifications for Filler Alloys (SFA) or American Welding Society (AWS) specification.
- (4) (a) The nominal size of the covered electrodes shall refer to the diameter of the core wire and the length shall not exceed 450 mm with provision for end gripping.
 (b) The tolerance on the specified diameter of the core wire of the electrodes shall be ± 0.05 mm.
 (c) The tolerance on the length of the electrodes shall be ± 10 mm or as specified in relevant Specifications for Filler Alloys (SFA) or American Welding Society (AWS) specifications.
- (5) (a) The core wire and covering shall be free from defects that would interfere with the uniform deposition of electrode.
 (b) The flux covering shall be sufficiently robust to withstand the normal conditions of transport, storage, handling and use, without damage and shall be uniform in thickness all over so that it fuses evenly.
 (c) The covering shall be concentric with core and the permissible variation on maximum core plus one covering shall not exceed the minimum core plus one covering as under:
- (i) For diameter up to 2.5 mm 7 % of mean dimension,
 - (ii) For diameter 3.2 to 4.0 mm 5 % of mean dimension, and
 - (iii) For diameter 5 mm and larger 4 % of mean dimension.
- (6) At least one imprint of electrode classification shall be imprinted at the covering within 65 mm of grip end. The imprinting shall be legible both before and after welding.
- (7) (a) Covered electrodes shall be suitably packed to guard against damage during transportation. When stored, the electrodes shall be kept in their original bundles or packing in a dry store room and under such conditions, the electrodes shall be capable of giving results similar to those which they would have given on the date of their dispatch from the manufacturer for a period of two years or as recommended by the electrode manufacturer whichever is less. Usage of electrodes beyond this period may be permitted after conducting check tests as per specification, provided it is not restricted by the electrode manufacturer.
- (b) Each package shall be marked with the following information.
- (i) Name of the Manufacturer.
 - (ii) Trade name / Brand name of the electrodes.
 - (iii) Size and quantity of electrodes.

- (iv) Batch Number and date of manufacture.
 - (v) Recommended current range.
 - (vi) AWS Classification.
- (8) (a) The electrodes shall be subjected to initial tests and periodic check tests to ensure that the requirements of these regulations are fulfilled.
- (b) Electrodes intended for use with more than one type of current or polarity shall be tested using each type of current and polarity shall be tested using each type of current and polarity.
 - (c) Where any test specimen fails to satisfy the requirements of any particular test, two further test specimens shall be prepared using the electrodes from the same batch and submitted to the same test.
 - (d) The batch of electrodes shall be accepted as having passed the test provided that the tests of both the additional specimens are satisfactory.
- (9) Test certificate provided by the manufacturer of covered electrode shall fulfil the requirements of the specification. The manufacturers, when called upon, shall produce the results of the most recent periodic check test carried out within the preceding 12 months, for electrodes supplied.

PART-IX

72. RODS AND ELECTRODES FOR GAS SHIELDED ARC WELDING.—(1)(a) This regulation apply to electrodes and rods of sizes 0.8 mm and larger in diameter for gas shielded arc welding of carbon steels, low alloy steels, stainless steels and non-ferrous materials used in these regulations.

- (b) The rods and electrodes shall comply with this regulation and the applicable requirements of AWS or SFA specifications.
- (c) Their characteristics and behaviour under ordinary working conditions shall be such that satisfactory weld deposits can be made by a welder of average skill and experience with following characteristics.
- (d) The rods and electrodes shall be suitable for manual, semi-automatic and machine welding.
- (i) relative ease in the control of the molten pool during welding;
 - (ii) desired degree of stability of the arc;
 - (iii) no undue degree of spatter;
 - (iv) desired rate of deposition and depth of penetration.
 - (v) no undue tendency to under-cut;
 - (vi) desired contour of the weld deposits; and
 - (vii) low internal porosity of the weld metal.

- (2) The electrodes and rods shall be classified into following four categories, namely:-
- (a) Carbon steel Electrodes and rods;
 - (b) Low-alloy steel electrodes and rods;
 - (c) Stainless steel electrodes and rods; and
 - (d) Nickel and nickel-alloy welding electrodes and rods
- (3) Electrodes and rods shall be made by any method to yield a product conforming to the requirements of these regulations and relevant Specifications for Filler Alloys (SFA) or American Welding Society (AWS) specification.
- (4) The size and tolerance of the electrodes and rods for straight length and coils form shall meet the appropriate Specifications for Filler Alloys (SFA) or American Welding Society (AWS) specification.
- (5) (a) The rods and electrodes shall have smooth finish and reasonably free from slivers, depressions, scratches, scale, seams, laps and foreign matter so that these do not affect the properties of the weld metal.

- (b) The core ingredients shall be uniformly distributed throughout the length of the electrode ensuring consistent weld metal properties.
- (6) (a) Coils, spools and drums, containing electrodes shall have tag or label suitably and securely affixed with suitable information.
(b) Rods shall have at least one imprint for positive identification of Specifications for Filler Alloys (SFA) or American Welding Society (AWS) specification.
- (7) (a) Electrodes and rods shall be suitably packed to guard against damage during transportation.
(b) Product information shall be legibly marked on each package.
- (8) Each package shall be marked with the following information, namely:-
(a) Name of the Manufacturer;
(b) Trade name / Brand name of the electrodes;
(c) Size and quantity of electrodes;
(d) Lot, Control or heat number; and
(e) American Welding Society (AWS) Classification
- (9) (a) The electrodes and rods shall be subjected to initial tests and periodic check tests to ensure that the requirements of these regulations are fulfilled.
(b) Electrodes and rods intended for use with more than one type of gas shall be tested using each type of gases.
(c) Where any test specimen fails to satisfy the requirements of any particular test, two further test specimens shall be prepared using the electrodes from the same batch and submitted to the same test.
(d) The batch of electrodes shall be accepted as having passed the test provided that the tests of both the additional specimens are satisfactory.
- (10) (a) Test certificate provided by the manufacturer of electrodes and rods shall fulfil the requirements of the specification.
(b) The manufacturers, when called upon, shall produce the results of the latest Periodic check test carried out within the preceding twelve months, for electrodes and rods supplied.

PART-X

73.ELECTRODES FOR FLUX CORED ARC WELDING.—(1)(a) This regulation apply to electrodes for flux cored arc welding either with or without shielding gas.

(b) The electrodes shall be suitable for flux cored arc welding of carbon steels, low alloy steels, stainless steels and nonferrous materials used in these regulations.

(c) The electrodes shall comply with the applicable requirements of AWS or SFA specification.

(d) Their characteristics and behaviour under ordinary working conditions shall be such that satisfactory weld deposits can be made by a welder of average skill and experience and that the following characteristics are also obtained.

(e) The electrodes shall be suitable for manual, semi-automatic and machine welding as per following parameters,-

- (i) relative ease in the control of the molten pool during welding;
- (ii) desired degree of stability of the arc
- (iii) no undue degree of spatter;
- (iv) desired rate of deposition and depth of penetration.
- (v) no undue tendency to under-cut;
- (vi) desired contour of the weld deposits
- (vii) low internal porosity of the weld metal and
- (viii) desired degree of slag removal

- (2) The electrodes shall be classified into following four categories, namely:-
- (a) Carbon steel Electrodes;
 - (b) Low-alloy steel electrodes;
 - (c) Stainless steel electrodes ; and
 - (d) Nickel and nickel-alloy welding electrodes
- (3) Electrodes shall be made by any method to yield a product conforming to the requirements of these regulations and relevant AWS or SFA specification.
- (4) The size and tolerance of the electrodes and rods for straight length and coils form shall meet the appropriate AWS or SFA specification.
- (5) **Finish and uniformity.**— The electrodes shall have smooth finish and reasonably free from slivers, depressions, scratches, scale, seams, laps and foreign matter so that these do not affect the properties of the weld metal. The core ingredients shall be uniformly distributed throughout the length of the electrode ensuring the weld metal properties.
- (6) Coils, spools and drums containing electrodes shall have tag or label suitably and securely affixed with suitable information.
- (7) (a) Electrodes shall be suitably packed to guard against damage during transportation and product information shall be legibly marked on each package.
- (b) Each package shall be marked with the following information, namely:-
- (i) Name of the Manufacturer;
 - (ii) Trade name /Brand name of the electrodes;
 - (iii) Size and quantity of electrodes;
 - (iv) Lot, Control or heat number; and
 - (v) American Welding Society (AWS) Classification
- (8) (a) The electrodes shall be subjected to initial tests and periodic check tests to ensure that the requirements of these regulations are fulfilled.
- (b) Where any test specimen fails to satisfy the requirements of any particular test, two further test specimens shall be prepared using the electrodes from the same batch and submitted to the same test.
- (c) The batch of electrodes shall be accepted as having passed the test provided that the tests of both the additional specimens are satisfactory.
- (9) (a) Test certificate provided by the manufacturer of electrodes shall fulfil the requirements of the specification.
- (b) The manufacturers, when called upon, shall produce the results of the most recent periodic check test carried out within the preceding twelve months, for the electrodes supplied.

PART-XI

- 74. ELECTRODES AND FLUXES FOR SUBMERGED ARC WELDING.**— (1) (a) This regulation apply to electrodes and fluxes for submerged arc welding process.
- (b) The electrodes and flux combination shall be suitable for submerged arc welding of carbon steels, low alloy steels and nickel alloys in these regulations.
- (c) The electrodes and flux combination shall comply with the applicable requirements of AWS or SFA specification.
- (d) The wire flux combination shall be suitable for multi run and single run technique, using DC or AC current and producing weld with desired physical and metallurgical properties.

(e) The electrode flux combination shall be suitable for either semi-automatic or machine welding process.
(f) The characteristics and behaviour of the flux electrode combination under ordinary working conditions shall be such that satisfactory weld deposits can be made by a welder of average skill and experience with following characteristics, namely:-

- (i) desired rate of deposition and depth of penetration;
- (ii) no undue tendency to under-cut;
- (iii) desired contour of the weld deposits;
- (iv) low internal porosity of the weld metal; and
- (v) desired degree of slag removal

(2) The electrodes shall be classified into following three categories, namely:-

- (a) Carbon steel electrodes with suitable flux;
- (b) Low-alloy steel electrodes with suitable flux; and
- (c) Nickel alloy electrodes with suitable flux

(3) (a) Electrodes shall be made by any method to yield a product conforming to the requirements of these regulations and relevant AWS or SFA specification.

(b) The method of manufacture of flux shall be fused, agglomerated and mixed and Crushed slag or re-crushed flux shall not be used for manufacture of flux.

(4) (a) The size and tolerance of the electrodes shall meet the appropriate AWS or SFA specification.

(b) Flux shall be granular for smooth feeding and ensure proper shielding. The particle size distribution shall be uniform and consistent.

(5) (a) The electrodes shall have smooth finish and free from slivers, depressions, scratches, scale, seams, laps and foreign matter.

(b) These shall not affect the properties of the weld metal.

(c) The core ingredients shall be uniformly distributed throughout the length of the electrode ensuring the weld metal properties.

(6) (a) Coils, spools and drums containing electrodes shall have tag or label suitably and securely affixed with suitable information.

(b) Bags containing flux shall have suitable identification.

(7) (a) Electrodes and fluxes shall be suitably packed to guard against damage during transportation and product information shall be legibly marked on each package.

(b) Each package shall be marked with the following information, namely:-

- (i) Name of the Manufacturer ;
- (ii) Trade name / Brand name of the electrodes or flux;
- (iii) Size and quantity of electrodes or flux;
- (iv) Lot, batch or heat number; and
- (v) American Welding Society (AWS) Classification

(8) (a) The electrodes and flux shall be subjected to initial tests and periodic check tests to ensure that the requirements under these regulations are fulfilled.

(b) Where any test specimen fails to satisfy the requirements of any particular test, two more test specimens shall be taken and subjected to the same test.

(c) The batch of electrodes and flux shall be accepted as having passed the test provided that the tests of both the additional specimens are satisfactory.

- (9) (a) Test certificate provided by the manufacturer of electrodes and flux shall fulfil the requirements of the specification.
- (b) The manufacturers, when called upon, shall produce the results of the latest periodic check test carried out within the preceding twelve months, for the electrodes or flux supplied.

75.(1) Initial tests of each brand of electrodes shall be carried out in accordance with these regulations and relevant AWS or SFA specification.

- (2) (a) All weld metal tensile test specimens shall be prepared and tested in accordance with the method described in Appendix-C.
- (b) The ultimate tensile stress, yield stress and elongation of each test specimen shall meet the relevant AWS or SFA specification.
- (3) One fillet weld hot cracking test shall be carried out as specified in Appendix-C.
- (4) (a) The electrodes shall be deemed to be satisfactory provided no hot cracking occurs under the conditions of test.
- (b) Crater cracks may be neglected provided they do not run into the full section of the weld.
- (5) One transverse tensile test shall be carried out for each welding position for which the electrode is recommended by the manufacturer except two tests shall be required for the flat position. The ultimate tensile stress shall meet the relevant AWS or SFA specification. The method of preparation of the test pieces is specified in Appendix-C.
- (6) Two bend tests one with the face and the other with the root in tension shall be carried out for each welding position for which the electrode is recommended by the manufacturer, except that two in each shall be carried out for those intended for flat position only. The method of preparation and carrying out the test shall be in accordance with Appendix-C. The electrode shall be deemed to be satisfactory provided that on completion of the test, no crack or defect at the outer surface is greater than 3 mm measured across the specimen or 1.6 mm measured along its length. Premature failures at corners of the test specimen shall not be considered a cause for rejection. For nickel alloy electrodes three transverse side bend test shall be carried out as per the applicable AWS or SFA specification.
- (7) Five impact test specimens are required for carbon steel and low alloy steel electrodes only. The size of the electrode shall be as per the relevant AWS or SFA specification. Charpy V notch testing shall be carried out as per the applicable AWS or SFA specification.
- (8) Each classification of electrode shall be tested for the chemical analysis of undiluted weld metal as per the relevant AWS or SFA specification.
- (9) (a) All weld test plate shall be radiographed to evaluate the usability of the electrode and the soundness of the weld deposits prior to taking up for other tests.
- (b) For the purpose of radiography, the backing plate shall be removed and both the surfaces of the weld metal shall be machined or ground smooth and flush without reducing the thickness of the weld metal.
- (c) Test procedure and acceptance norms shall be in accordance with the relevant AWS or SFA specification.
- (d) A length of 25 mm from both the ends of the test plate shall be discarded and need not be considered in evaluation of the radiograph.

76. Periodic check test.— The following periodic check tests shall be carried out on each brand of electrodes, namely:-

- (i) Periodic check tests consist of a selection of the tests mentioned under regulation 75 and they shall be repeated at intervals of not more than 12 months to provide evidence that the electrodes currently produced continue to possess the properties recorded in the initial tests.
- (ii) All-weld tensile test with any two sizes of electrodes within the limits mentioned in sub-regulation (2) of regulation 75.
- (iii) One Tee joint fillet weld hot cracking test as mentioned in sub-regulation (3) of regulation 75.

CHAPTER-3

CONSTRUCTION AND WORKMANSHIP

PART-I

77. Preparation of plates.— (1) The edges of all plates and butt straps shall be machined or flame cut by machine and the caulking edges shall be bevelled to an angle not sharper than 20° to the plane of the plate and between 70° and 80° wherever practicable. Gusset Plates may be sheared except on those edges, which are to be welded.

(2) Plates which are to be flame-cut by machine without heat treatment or subsequent grinding or machining shall not have a carbon content higher than 0.25 per cent.

(3) Where the carbon content exceeds 0.25 percent, heat treatment, grinding or machining shall be carried out.

(4) The edges of all plates shall have a smooth finish.

(5) Before commencing welding of the joint (apart from tack welding), it shall be ascertained that the chamfered edges are in alignment and that the defects in alignment between the surfaces of the plates do not exceed as given in the table 3/1:

Table 3/1: ALIGNMENT TOLERANCE OF SECTIONS TO BE BUTT-WELDED

Serial No.	Section Thickness(t), in mm	Direction of joints in cylindrical shells	
		Longitudinal	Circumferential
1	Up to 13 mm incl.	$\frac{1}{4} t$	$\frac{1}{4} t$
2	Over 13 mm up to 19 mm	3 mm	$\frac{1}{4} t$
3	Over 19 mm and up to 38	3 mm	5 mm
4	Over 38 mm and up to 51 mm	3 mm	3 mm
5	Over 51 mm	Lessor of $t/16$ or 9 mm	Lessor of $t/8$ or 19 mm

(6) If plate edges of unequal thickness are abutted and the difference between the surfaces exceeds the limit mentioned as above on either side, the thicker plate shall be thinned to a smooth taper for a distance not less than 4 times the offset including, if so desired, the width of the weld. In longitudinal joints, the middle line of the plates shall be in alignment within 10 per cent of the thickness of the thicker plate with a maximum of 3 mm.

78. Normalising or stress relieving of steel plates.— (1) All plates which have been dished or flanged shall be stress relieved as components when cold worked and normalized when hot worked fully or partially.

(2) Stress relieving of components may be combined with final stress relieving when stress relieving is envisaged later.

79. Minimum thickness of plates.— No boiler plate shall be less than 6 mm in thickness.

PART-II

80. Cylindrical shells.— (1) Each ring shall be formed from not more than two plates and rolled to cylindrical form to the extreme ends of the plate. The bending shall be done entirely by machine. Local heating or hammering shall not be used for correction of profile.

(2) The longitudinal seam or seams may be placed in any suitable position but the seams in successive rings shall not fall in line and shall be staggered by minimum 150 mm.

(3) In the case of brick set boilers the seam or seams shall be kept as far as practicable clear of the brickwork.

81. Position of longitudinal seams.— Each ring of plate forming the shell, barrel or drum shell, where practicable, be in one piece and have its longitudinal seam well out of line with those of the adjoining rings. In Lancashire, Cornish, and other types of boilers, where parts of the shell are exposed to flame, the longitudinal seams shall, where practicable, be in the steam space, arranged alternately on each side of the crown and clear of the brick work.

82. Circumferential and end seams.— Joint efficiency of circumferential seams shall be determined as detailed in sub-regulation (1) of regulation 169. In the event of tube holes forming a ligament at the location of circumferential seams, the joint efficiency shall be calculated as per regulation 171.

83. Angle rings.— Angle rings for the attachment of end plates to shell plates and/or flue sections shall be rolled or machined so that they fit closely to the flat and cylindrical surfaces to be connected, and shall be machined or machine gas cut on the caulking edges.

84. Thickness of shell angle rings.— Where shell plates and end plate are connected by means of an external angle ring, the angle rings shall not be less in thickness than as follows:

Table 3/2

(1)	For shell plates up to and including 16 mm in thickness	10 per cent in excess of the thickness of the thickness of the shell plate.
(2)	For shell plate exceeding 16 mm thickness and up to and including 25 mm in thickness.	90 per cent of the thickness and not less than 17 mm.
(3)	For shell plates over 25 mm in thickness.	Made from angle bar having a section thickness of 25 mm.

85. Welded shell plates.— The requirements of welded shells shall be covered by the provisions made in regulations in Chapter -4 or Chapter -12, as the case may be.

PART-III

86. Flat end plates.— (1) Wherever practicable, the flat or dished end plates of boilers shall be in one piece made from one rolled plate. Where diameter of boiler is so large as to make this impracticable, the flat end plates may be made from two pieces by fusion butt-welding. (See figures 12/1 and 12/2). In the latter case, the line of welding shall be parallel to the horizontal axis of the boiler and shall be subjected to full radiographic examination.

(2) Flanging of plates shall be done by machine. Cold forming of flanged end plate shall be followed by heat treatment. Such flanging shall be done hot, preferably in one operation, but where this is impracticable creep machine flanging may be used provided that the plate is worked at a suitable temperature and heated for an adequate distance beyond that portion of the plate under immediate treatment.

- (3) Hot forming of welded plates shall be permitted provided that the welded joint is subjected to 100 percent radiographic or Ultrasonic examination after hot forming.
- (4) Welded plates up to and including 20 mm thickness can be cold formed provided it complies with following conditions.
 - (a) Before cold forming, the weld reinforcement shall be ground smooth, and the manufacturer shall take precautions, where necessary, in order to avoid crack formation in the weld metal or the heat affected zone.
 - (b) If the inside radius of curvature after forming is less than 10 times the thickness, stress relieving shall be carried out.
 - (c) After cold forming, the welded joints shall be visually examined and subjected to 100 percent radiographic or Ultrasonic examination throughout their length. Joints of any thickness which have been cold formed to a radius less than 10 times the thickness.
 - (d) Knuckles shall be inspected for cracks by magnetic particle or penetrant methods.
 - (e) After completion of the flanging operation flanges shall be of true peripheral contour (either circular or straight as necessary to ensure accurate alignment with the connecting parts), and of good surface, free from bulges, grooves or other local irregularities; flat portions of the plate shall be free from set or distortion.
- (5) In the construction of unfired boilers when the dished ends do not form a part of the heating surface cold spun dished ends conforming to IS: 2825 may be used.
- (6) Care shall be taken to see that the flanges are circular and of good surface, free from local irregularities, and that they are parallel and square with the flat part of the plate.
- (7) Flat portions of end plates, on completion of all flanging and machining operations, shall be flat and free from set or distortion.

87. Strengthening of flat end plate at manhole.— (1) In all cases, the front end plate gusset stays below the furnaces shall be placed as closely as possible to the mudhole frame.

- (2) Where flat end plates are flanged for connection to the shell, the inside radius of flanging shall be not less than 1.75 times the plate thickness, with a minimum of 38 mm.

88. End Plates in steam spaces.— When the end plates of boilers situated in the steam space are liable to contact with hot gases, the end plates shall be efficiently shielded from such contact.

89. Hemispherical crowns.— (1) The segments for hemispherical shell crown plates shall be pressed in one heat to correct curvature and shall be butt-welded together in accordance with Figures 12/3, 12/4, 12/5 or 12/6. The cylindrical portion of the crown shall be tangential to the hemispherical portion.

- (2) Where hemispherical furnace crowns are pressed from one plate, they shall be pressed to form by machine in progressive stages without thinning and shall be annealed on completion.

90. Dished end and crown plates.— (1) The dished end plates of boilers shall be preferably in one piece made from one-rolled plate. If this is impracticable, owing to the large diameter, the dished end plate may be made from two plates, fusion butt welded together and in such cases the requirements of stress relieving and

radiographic examination as provided for in regulation 86 shall apply and the line of weld shall be parallel to the horizontal axis of the boiler.

- (2) The inside radius to which a plate is dished shall not be greater than the external diameter of the shell to which it is attached, except in the case of Lancashire and Cornish boilers when the radius shall not exceed $1\frac{1}{2}$ times the diameter of the shell.
- (3) The inside radius of curvature of the flanges to the shell or firebox shall not be less than four times the thickness of the crown or end plate and in no case less than 63 mm.
- (4) The inside radius of curvature to uptakes shall be not less than twice the thickness of the crown plate and in no case less than 25 mm.
- (5) Bunged mouth-pieces may be welded on to end plates in place of the orthodox flanging for the attachment of furnace tubes. Such welding shall comply with provisions of regulation 97.
- (6) Manhole frames may be similarly welded on the front end plates, and will be subject to provisions of regulation 97.

91. Tube plates.— Smoke box tube plates shall be flanged for attachment to the barrel or shell and shall be flat and connected thereto by welding.

92. Parts of flat tube plates within the tube nests.—(1) Where the total area of all tube nests in directly fired multi-tubular boilers exceeds 0.65 square meters, stay tubes shall be fitted.

- (2) Where the total number of tubes in horizontal multi-tubular waste heat boilers and direct fired loco type boilers is arranged in one nest, the area of which exceed 1.95 sq. m stay tubes shall be fitted.
- (3) In all cases where the total number of tubes is arranged in more than one nest, stay tubes shall be fitted.
- (4) The parts of tube plates which lie outside the nests of tubes shall be stayed or supported wherever the size of the area of plate subject to steam pressure necessitates staying or support, either by marginal stay tubes or other means.

93. Flanging of end plates.— All flanges shall be a good fit to the shell and flues. Flogging and/or hammering in the fitting of these parts is prohibited. The caulking edges of all flanged plates shall be machined or machine gas cut.

PART-IV

94. Furnaces.—(1) No furnace or firebox top, whether plain or corrugated, shall exceed 22 mm in thickness, and all circular sectioned furnaces when new, shall be as near the truly circular form as the type of joint will permit.

- (2) The use of Z angle rings for furnace foundation seams shall be prohibited.
- (3) Furnace crowns, uptakes and other plates not in tension may be joined by fusion welding provided the conditions laid down in regulation 95 to 101 are complied with. The end connections of such plates to the shell or shell crown shall also comply with such conditions. This construction shall not apply to furnaces of Lancashire and Cornish type boilers consisting wholly or plain sections.

95. Furnaces of horizontal boilers.— (1) The sections of the internal flues shall each be in one plate and shall be bent while cold to circular form and shall be welded longitudinally.

- (2) The maximum permissible variation in diameter at any cross-section shall not exceed the thickness of the plate.

- (3) The weld shall be placed at the lower part of the flues, and shall break joint in successive sections by at least 305 mm.
- (4) Each flange for the circular seams shall be formed at one heat by suitable machinery.
- (5) The sections shall be allowed to cool gradually to avoid internal stresses.
- (6) The caulking edges of all flue flanges shall be machined or machine gas cut.
- (7) The circular seams shall be arranged so that they do not fall in line with those of the adjacent flue or with the circumferential seams of the shell and are at least 152 mm apart.
- (8) When flues are flanged for attachment to both end plates the total length of each completed flue shall not exceed the length of the shell measured from the inner surface of the back end plate to the inner surface of the front end plate, both adjacent to the shell.
- (9) Where the flues are flanged for attachment to the end plates, the end sections shall be 1.5 mm thicker than the remaining sections, except in cases where the calculated thickness is over 21 mm, when the end section shall be 22 mm in thickness.
- (10) The flanged portion of furnace rings shall have radius of curvature of not less than 25 mm on water side.
- (11) Sections of corrugated flues may be fusion butt welded circumferentially and afterwards stress relieved by heat treatment.
- (12) As an alternative to Adamson flanges, furnaces which are partly fitted with corrugated sections shall be strengthened by means of suitable stiffening rings adequately welded to the furnaces. In no case shall a flat stiffener be less than 63 mm x 13 mm.

96. Furnaces of vertical boilers.— (1) The furnaces of vertical boilers may be constructed in one or more lengthwise sections, each section being rolled from one plate to a full circle. In such cases, the component sections may be jointed circumferentially by electrically butt welding and shall be stress relieved in accordance with regulation 123.

- (2) In the case of vertical boilers where tube plates form part of the firebox, the tube plate portion may be constructed in two vertical sections and the vertical seams when welded shall be stress relieved. The maximum permissible variation in diameter, at any cross-section shall not exceed 6 mm for fireboxes up to 900 mm in diameter, or 10 mm for fireboxes over 900 mm in diameter, or half the thickness of the plate whichever is greater.
- (3) Circular furnaces shall preferably be tapered, a taper of 38 mm in diameter per 300 mm of height being recommended. The minimum water space at the bottom between the furnaces and the shell shall not be less than 50 mm for boilers up to 760 mm in diameter and shall be not less than 63 mm for boilers over 760 mm diameter.
- (4) The method of welding shall be in accordance with regulation 151. Flats formed in the firebox for the insertion of water tubes shall have ample radius at the junction of the flat and the curved surfaces and shall be free from sharp corners or tool marks. The plate shall not be unduly thinned.
- (5) Ogee flanging where integral with the firebox or in a separate ring shall preferably be formed in one heat by suitable machinery and shall be allowed to cool gradually to avoid internal stresses. Rings of fire holes

mouthpieces or foundation rings shall be made of mild steel. Z sections shall not be used for foundation rings.

- (6) Furnaces of vertical type boilers may be attached to the shell at the fire hole by a circular ring of substantial section fusion welded to shell and firebox. The opening in the shell for fire hole shall be substantially compensated by a ring welded on the outside of the shell plate.
- (7) At the fire hole the firebox plate and the shell plate may be flanged and fusion welded together.

97. Fusion butt welded longitudinal seams.— Where the longitudinal seam is fusion butt welded, the precautions shall be observed as follows:

- (i) Plates 20 mm and above in thickness shall be bevelled from both sides of each abutting edge but the bevel need not necessarily be the same on each side (see Figs. 3/1 and 3/2). Plates less than 20 mm in thickness may be bevelled from one side only of each abutting edge (see Figs. 3/3 and 3/4). The included angle of the bevel shall be not less than 60° and the bevelling may be any one of the forms shown in Figs. 3/1 to 3/4.

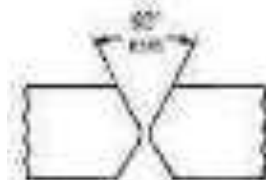


Fig. 3/1

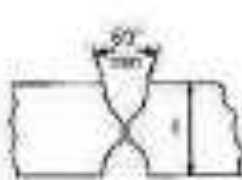


Fig. 3/2



Fig. 3/3



Fig. 3/4

- (ii) In order to obtain full penetration of the weld metal, a gap shall be maintained between the plates when they are being welded. Joints shall be welded from both sides, and the slag shall be removed after making each run. Before the second side of the joint is welded any slag or defect at the bottom of the first run shall be removed by grinding, chipping or machining. There shall be no appreciable undercutting of the plate.
- (iii) For the purposes of relieving internal stresses, the plates adjacent to a fusion weld shall be efficiently annealed after welding.

98. Furnace crown.— (1) The furnace crown shall be made from one plate and the seam connecting it to the furnace shall not fall in line with any circumferential seam of the boiler shell.

- (2) The furnace crown may be welded to the vertical portion of the firebox. The joint shall be fusion butt welded by the electric arc process, provided the conditions for fusion welding under regulation 97 are observed. Where the joint is to be welded, the edges of the furnace crown and the firebox body shall be bevelled in accordance with Fig. 3/3 or Fig. 3/4. The depth of the flange of the furnace crown plate from the commencement of the curvature of the flanging radius shall be not less than four times the plate thickness with a minimum of 38 mm. On completion of welding the firebox shall be effectively stress relieved by heat treatment (also refer regulation 100).

99. Cross tubes.— (1) Cross tubes shall be made from seamless steel pipes or from plate or strip rolled and electric resistance or fusion butt welded into pipes by electric arc process. The fusion welding shall conform to the requirements of Chapter-12. Tolerances on these pipes shall conform to the requirements of regulation 251. Where welded pipes are used, the longitudinal welds shall be so situated that they are not exposed to the direct impact of flame.

- (2) Cross tubes shall not exceed 305 mm internal diameter. The minimum thickness shall be 8 mm.
- (3) Where welded construction is employed, the tubes shall be of sufficient length to enter the furnace plate and the flush with the water side all round or project not less than 6 mm and not more than 16 mm into the water space at any part of the circumference. Where the tubes are fusion welded in position, the

firebox plates shall be suitably chamfered and the joints shall be welded externally and internally (see Fig. 3/5).

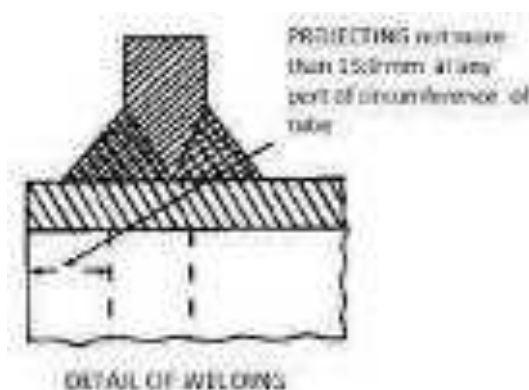


Fig. 3/5: Fusion Welding of Cross Tubes of Vertical Cross Tube Boilers

100. Uptakes.— (1) The uptakes shall be formed from seamless steel pipes or from plate or strip rolled and electric resistance welded or fusion butt welded into pipes by electric arc process. The tolerances on these pipes shall comply with the requirements of regulation 251.

- (2) The uptake shall be fusion butt welded by the electric arc process to the upward flange of the opening in the firebox crown plate provided the conditions for fusion welding given in regulation 97 are observed. The edges of the upward flange and the adjacent end of the uptake shall be bevelled in accordance Fig. 3/3 or Fig.3/4. The depth of the crown plate opening from the commencement of the curvature of the flanging radius shall be not less than twice the plate thickness with a minimum of 25 mm. On completion of welding the uptake and crown plate shall be effectively stress relieved by heat treatment.
- (3) Where the firebox crown plate is also fusion welded to the body of the firebox, the firebox complete with uptake shall be effectively stress relieved by heat treatment on completion of the welding.
- (4) Welded uptakes shall be so arranged that the weld is directly facing the longitudinal centre line of the manhole.

101. Loco type fireboxes.— (1) The seams shall be welded subject to the depth of the flange being such that the welded seams fall between the 1st and 2nd rows of screwed stays or between the flange and the adjacent row screwed stay.

- (2) The firehole mouthpiece may be similarly welded when the firebox and shell are flanged for the purpose.
- (3) The welding shall comply with regulation 97.

PART-V

102. Bar stays.— Bar stays shall not be welded at any part. They shall preferably have plus threads and the ends of the stays being upset or the middle portion being reduced for this purpose. Stay bars which have been worked in the fire shall be subsequently annealed.

103. Longitudinal stays.— (1) Longitudinal and similar solid screwed stays shall be efficiently secured with nuts at each end and not merely riveted over. Where they are over 3657 mm in length, they shall be supported at intervals of 1829 mm along its length.

- (2) Where the stay is screwed through both plates, the stay and holes shall have a continuous thread and fitted with nuts and washers on the outside. Where the stay passes through clearing holes and internal

nut and washer shall also be fitted. Where the stay is not normal to the surface of the plate the washer shall be shaped so as to form a true surface for the nuts or a knuckle joint may be fitted.

- (3) In vertical boilers the stays shall either be screwed into both crown plates or screwed into the furnace crown plate and passed through clearing holes in the shell crown plate.

104. Nuts and Washers for Stays.— (1) The washers shall be at least $2\frac{1}{2}$ times the diameter of the threaded portion of the stay and not less than 6 mm in thickness.

- (2) The thickness of the external nuts shall be at least equal to the diameter of the threaded portion of the stay. Where bar stays pass through clearing holes in end plates, internal nuts of a thickness not less than two-thirds of the diameter of the threaded portion of the stay shall be fitted.

105. Jointed stays.— Where jointed longitudinal stay are fitted, they shall, where practicable, be fitted with pins having an effective sectional area 25 percent in excess of that of the stay. If the pins are slack in the holes, the total slackness shall not be more than 1.6 mm. The pins shall be as close as possible to the shoulder of the eye forging. The shoulder of the forging shall be at least 13 mm wide all round, i.e. the diameter at the shoulder shall be not less than the diameter of the hole plus 25 mm.

106. Diagonal bar or rod stays.— The sectional area of diagonal rod or bar stay shall bear the same proportion to that of a direct stay as the length of the diagonal stay bears to the length of the perpendicular line from the end of the diagonal stay to the surface supported. The ends of diagonal stays, shall not be bent, but shall be attached to the plate with bevelled washers and nuts or with riveted tee, blocks or angles and shackle pins (refer regulation 105 for eyes and pins).

PART-VI

107. Screwed stays.— (1) Screwed stays and the holes for these shall be screwed with a continuous thread.

- (2) The screwed threads of the stay shall be clean and free from checks or imperfections, of full depth, correct whitworth form and a good fit in the holes. The middle portion shall preferably be turned down to the bottom of the thread.
- (3) The stays shall be screwed with fine threads of not less than 11 threads per 25 mm.
- (4) The diameter of the stay over the threads shall not be less than 19 mm or twice the thickness of the firebox plate whichever is the greater.
- (5) The pitch of the stays at the furnace of vertical boilers shall not exceed 14 times the thickness of the furnace plate.
- (6) Where the stays are not fitted with nuts, the ends shall be riveted over to form substantial heads. Alternatively stays may be screwed through the shell and firebox plates and the projecting ends shall be substantially fillet welded in an approved manner. The projection of the end of the stay from the surface of the plate shall be not less than one quarter of the diameter of the stay but in no case less than 6 mm. The full end of the stay shall be visible on completion of the welding.
- (7) Crown stays of Loco type boilers shall either be fitted with nuts or riveted over on the fire side.

108. Axial drilling.— All screwed stays less than 355 mm long should preferably be drilled with a tell-tale hole 5 mm diameter to a depth of 13 mm beyond the inner face of the plate. Stays which are obscure on one side shall preferably be made from hollow stay bar.

109. Stay nuts.— (1) Nuts of screw stays in combustion chambers and firebox shall not be less than 19 mm thick for stays up to 38 mm diameter over threads, 22 mm thick for 41 mm and 44 mm stays, 25 mm thick for 47 mm and 51 mm stays, and 28 mm thick for stays over 51 mm in diameter.

(2) The nuts shall be made of solid mild steel or of iron which shall be without weld, if exposed to flame.

110. Spacing of end stays—allowance for curves, etc.— For the tops of fireboxes and combustion chambers, the distance between the rows of stays nearest to the tube plate or fire hole plate or back plate, as the case may be, and the commencement of curvature of these plates at their flanges shall not be greater than the horizontal pitch of the stays.

PART-VII

111. Girder stays for firebox and combustion chamber crowns.— (1) Each girder when of the normal type, fitted with stay bolts and nuts, shall be of the double plate interconnected type of sufficient strength to support its proportion of the load on the crown to support plate independently of the crown plate, and the bolts or weld attachments shall have sufficient cross-sectional area to carry the applied load.

(2) The clear waterway between the crown plate and the underside of the girder bars shall be as large as practicable but in no case less than 38 mm as in Fig.3/8.

(3) The ends of the girders shall not rest on the landing of the flat crown plate but shall be carefully fitted to bed directly on the bends of the corners of the vertical end or side plates.

(4) The toes of the girder plates shall be solid with the girder plates and not separate pieces attached thereto.

(5) Girders shall be properly attached to the crown plate by bolts or screws.

(6) Where an all welded firebox is fitted, the girder stays may be welded to the firebox prior to stress relieving. The girder stays shall be recessed for waterways as in sub-regulation (2) (Fig. 3/6 and Fig. 3/7). Such girders shall be securely welded by an approved method to the firebox crown. The method of welding and the proportions of attachment shall be to the satisfaction of the Inspecting Authority.

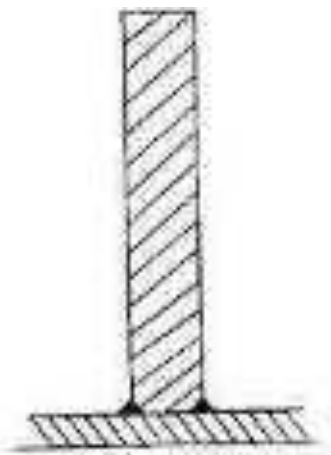


Fig. 3/6

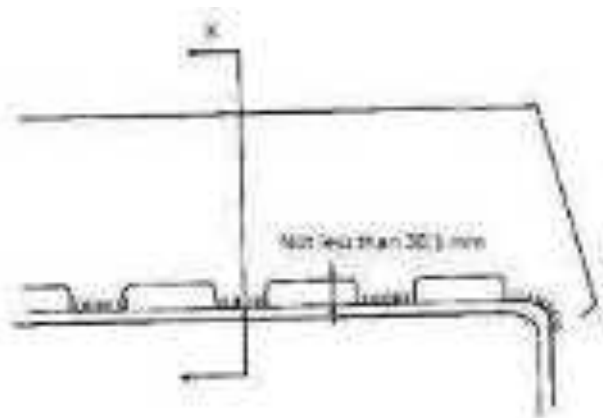


Fig. 3/7

PART-VIII

112. Gusset stays.—(1) Gusset plates shall be flat and perpendicular to the end plates. The gusset angles shall be fitted to bed closely to the shell end plate and gusset plates. Cranking or setting of the plates is prohibited.

(2) Gusset stays, where fitted, shall comprise flat plates secured by double angles to the shell and end plate respectively, and shall be designed in accordance with the following.

113. Breathing space.—(1) Gusset stays shall be so arranged as to allow sufficient breathing space around furnace connections and the tube nests.

(2) For Lancashire boilers, the proportions shown in the table below are recommended for portion of the end plates above the furnaces and flues.

Table 3/3

Sl. No.	Thickness of End Plate	L (Fig.3/8)	L (Fig. 3/9)
(1)	(2)	(3)	(4)
	mm	mm	mm
1	13	228	254
2	14	254	254
3	16	279	309
4	17	309	330
5	19	309	330
6	21	309	330
7	Above 21	317	343

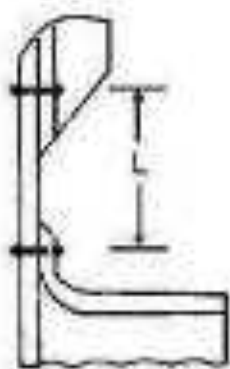


Fig. 3/8



Fig. 3/9

(3) Fig. 3/8 shows the breathing space recommended for the following conditions: Flat end, furnace or flues flanged for attachment to end plate, furnaces and flues formed with Adamson flanged seams.

(4) Fig. 3/9 shows similar conditions to Fig. 3/8 except that the end plate is flanged outwards for the furnace or flue ring connection, the breathing spaces allowed being 25 mm more than those for the same thickness of plate in Fig. 3/8

(5) Where a corrugated section not less than 1830 mm long is included in each internal flue or a Lancashire boiler, the dimensions given in the table above may be reduced by approximately 38 mm throughout.

- (6) It is recommended that the breathing space below the furnaces and flues shall be approximately one half of the dimensions given in the table above. Whereas it is desired to use any other arrangement which gives a greater or less degree of flexibility, the amount of breathing space shall be specially considered and modified as the necessity of the case requires.
- (7) For Gusset stays above tube nests, as fitted in waste heat boilers without internal furnaces, a breathing space of 203 mm from the center line of the top tubes to the center of the toe rivets of the gusset angles is recommended (see Fig. 3/9).

114. Gusset angles.— The gusset angles connecting the stays to the shell and end plates shall be at least $7/8^{\text{th}}$ of the thickness of the shell plate, but shall be not less than 13 mm thickness.

115. Load on gusset stay.— Each gusset stay supporting the end plate of a boiler shall be designed to carry the whole load due to pressure on the area supported by it.

PART-IX

116. Boiler tubes subject to external pressure.— Both plain and stay smoke tubes may be made either of wrought iron or steel and may be electric-resistance-welded or seamless.

117. Fitting of plain tubes.—(1) Plain tubes shall be expanded at both ends. The expanding shall be parallel throughout the full thickness of the tube plate. Plain tubes may also be bell-mouthed, beaded, or welded at the gas inlet end.

- (2) Where stay tubes are not fitted, the ends of the tubes shall be beaded over at the fire box end and beaded or bell-mouthed at the other end. If bell-mouthed, the tubes shall protrude not less than 13 mm beyond the tube plate.

PART-X

118. Screw threads of stay tubes.—(1) Stay tubes shall be screwed at both ends with continuous threads, and the holes in the tube plates shall be tapped with continuous threads. The pitch of the threads shall not be finer than 11 threads per 25 mm. The stay tubes shall be expanded by roller expanders and not made right by caulking only.

- (2) Stay tubes may be attached by welding in which case they shall not be adjacent within the same tube nest except in local areas, where not more than two adjacent stay tubes may be attached by welding. The form of attachment shall be such that there is a mechanical hold in addition to the welding, as shown in Fig.3/10. On completion of welding the stay tubes shall be lightly re-expanded.

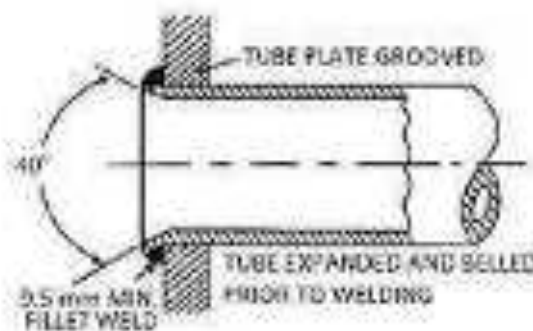


Fig. 3/10: Typical Example of Welded Stay Tube

119. Stay tubes.—(1) Stay tubes are tubes having a weld depth equal to the nominal tube thickness plus 3 mm. These stay tubes are not required within tube nests except when the tube nests comprise tubes which are expanded only.

- (2) If tube nests comprise plain tubes that are expanded and beaded, expanded and belled or expanded and welded, welded stay tubes shall be used in boundary rows in sufficient numbers to carry the flat plate loadings outside the tube area.
- (3) For plain tubes or stay tubes exposed to flame or gas temperatures exceeding 600°C, the ends of welded tubes shall be dressed flush with the welds. If not so exposed, the ends of welded tubes shall extend a maximum of 10 mm beyond the weld or, in the case of expanded tubes the tubes shall project beyond the tube plate up to a maximum of 15 mm.
- (4) Each stay tube shall be designed to carry its due proportion of the load on the plates which it supports.
- (5) The thickness of stay tubes welded into tube plates shall be such that the axial stress on the thinnest part of the tube does not exceed 7.14 kg/mm².
- (6) The thickness of stay tube at any part shall not be less than the values shown in the Table below. Minus tolerances shall be taken into account when ordering tubes.

TABLE 3/4

Serial No.	Nominal outside diameter in mm		Minimum Thickness in mm
(1)	(2)		(3)
1.	Not exceeding 38		2.28
2.	Exceeding 38	but not exceeding 51	2.81
3.	Exceeding 51	but not exceeding 70	3.12
4.	Exceeding 70	but not exceeding 76.2	3.38
5.	Exceeding 76.2	but not exceeding 88.9	3.96
6.	Exceeding 88.9	but not exceeding 101.6	4.26
7.	Exceeding 101.6	but not exceeding 127	4.55

120. Thickened ends of stay tubes.— If stay tubes are required to have their thickness increased at the screwed ends so that the thickness at the bottom of the threads is approximately the same as in the body of the tube the thickening shall be attained by upsetting and not by welding process, and the tubes shall be annealed after the upsetting.

121. Load on stay tubes and stay bars.— Stay tubes shall be designed to carry the whole load due to pressure on the area to be supported. In each case the area to be calculated is as follows:

- (i) For a stay tube within the tube nest the net area to be supported shall be product of the horizontal and vertical pitches in mm of the stay tube less the area of the tube holes embraced. Where the pitch of the stay tube is irregular the area shall be taken as the square of the mean pitch of the stay tubes (i.e. the square of $\frac{1}{4}$ of the sum four sides of any quadrilateral bounded by four adjacent stay tubes) less the area of the tube holes embraced.
- (ii) For a stay in the boundary row the net area to be supported shall be the area enclosed by lines passing midway between it and the adjacent points of support less the area of any tubes embraced. The adjacent points of support may be other stay tubes or the commencement of curvature of flanging of center line of the circle or rivets securing the end plate to the shell angle.

- (iii) In the case of bar stay where there are no stay tubes in the tube nest the area to be supported shall extend to the tangential boundary of the tube nest.

PART-XI

122.Boiler and super heater tubes subject to internal pressure steel tubes.—(1) All tubes which are subject to internal pressure of water or steam shall be cold drawn or hot finished seamless or electric resistance welded in accordance with Chapter-2. Except as provided for in sub-regulation (2) below, they shall be without joint.

- (2) Tubes having an external diameter not exceeding 127 mm may be jointed and such joints may be flash welded, machine forge welded arc or gas welded. Tubes above 127 mm diameter may also be welded provided they are located outside the furnace. Such welds must conform to the requirements of Chapter-7.
- (3) Flash butt welding shall be undertaken as per the qualified procedure. The external fin caused by flash butt welding shall be removed subject to a maximum height of 5 percent of the tube outside diameter. The required flow area shall be ensured by conducting ball test using nearest ball diameter of 75% of the nominal Internal Diameter of the tube size.
- (4) All fusion welded butt joints shall be post weld heat treated as per the requirements specified in regulation 123.
- (5) When gas welding is implied the technique followed shall be approved by a Competent Person.
- (6) For design metal temperatures and material requirements refer to Table 2/1 of regulation 30.
- (7) The technique employed in all field welding of tubes shall be subject to the approval of Inspecting Authority or Chief Inspector as the case may be.
- (8) All butt weld of tubes shall be tested as required hereunder:
- (i) For tubes greater than 178 mm bore, all welds shall be non-destructively tested by radiographic or other approved methods.
 - (ii) For tubes greater than 102 mm bore and up to and including 178 mm bore, ten (10) per cent of the welds by each welder, selected at random with a minimum of 2 welds per welder, shall be subjected to non-destructive examination by radiographic or other approved method.
 - (iii) For tubes 102 mm bore and under, sample welds simulating the production welds shall be provided for mechanical testing either at a rate of 2 per cent or after each 150 welding hours with a minimum of one sample weld per welder.
 - (iv) Alternatively, 5 per cent of the welds made by each welder selected at random, with a minimum of one weld per welder, shall be subjected to non-destructive examination by radiographic or other approved method. This rate may be reduced to 2 per cent by arrangement with the Inspecting Authority after initial satisfactory results have been produced.
 - (v) In the event of any non-destructive test not meeting the requirements, defects in the welds represented by that test shall be rectified and the Inspecting Authority may call for an increase in the number of non-destructive tests until such time as a satisfactory standard is achieved.
- (9) Butt welded joints as indicated in sub-regulation (8) shall be subjected to non-destructive examination by radiographic, radioscopy or other approved methods such as ultrasonic testing including phased array ultrasonic testing, magnetic particle inspection or liquid dye penetrant inspection. When radioscopy

examination is to be performed in lieu of radiography on welded components, the following requirements shall be met, namely:-

- (a) A written procedure shall be submitted for approval to the Inspecting Authority which shall contain the following:
 - (i) material and the thickness range;
 - (ii) equipment qualifications;
 - (iii) test object scan plan;
 - (iv) radiosopic parameters;
 - (v) image processing parameters;
 - (vi) image display parameters;
 - (vii) image archiving requirements;
 - (viii) accept-reject criteria (Code reference);
 - (ix) performance evaluation;
 - (x) Operator identification.
- (b) The system shall be aided with an image processor to enhance the quality of the radiosopic images and system performance quality shall exhibit-
 - (i) A thin section contrast sensitivity of 3 percent;
 - (ii) A thick section contrast sensitivity of 2 percent;
 - (iii) A spatial resolution of 3 line pairs per mm;
 - (iv) Image Quality Sensitivity (IQI) sensitivity - 2 percent of the joint thickness when wire IQI's are to be used, the wire diameter axis shall be oriented along the axis of the least sensitivity of the system.
- (c) Radioscopes are to be properly marked to co-relate with particular part of joint represented.
- (d) The radiosopic examination data shall be recorded and stored on a suitable storage media like videotape, magnetic disk or optical disk at the maker's plant for a sufficient period after the date of radiosopic examination as specified by the Inspecting Authority, efficient radiosopic examination record recall shall be made available at any time over the record retention period and shall be traceable to the test objects.
- (e) When repair has been performed as a result of radiosopic examination, the repaired areas shall be re-examined using the same radiosopic technique to evaluate the effectiveness of the repair.
- (f) To aid in proper interpretation of the radiosopic examination data, the details of the technique used shall accompany the data. The minimum information shall include the approved procedure requirements and system performance test data.

123. Requirements of Post Weld Heat Treatment(PWHT).— The requirements of Post Weld Heat Treatment(PBWH) shall be as provided in Table 3/5

Table 3/5

Serial No.	Material group (as per Table 2/1)	PWHT	PWHT not required under the following conditions:
(1)	(2)	(3)	(4)
1	M1 Group 1, M1 Group 2	595°C min	(i) For All Product Forms: (a) nominal weld thickness $(t) \leq 20$ mm; and (b) If preheated to 95°C min when nominal weld thickness $(t) \leq 20$ mm and nominal base metal thickness ≤ 25 mm; and (c) $C \leq 0.25\%$; (ii) Only for tubes and pipes, if $0.25\% < C \leq 0.3\%$ and nominal thickness ≤ 9 mm; In case of welded stays, diameter of stay is not used to determine preheat requirements.
2	M3 Group 1	595°C min	(a) For all product forms nominal wall thickness $(t) \leq 16$ mm except for tubes and pipes $t \leq 13$ mm & $OD \leq 127$ mm; and (b) $C \leq 0.25\%$
3	M4 Group 1	650°C min	(a) For all product forms nominal base metal thickness $t \leq 16$ except for tubes and pipes $t \leq 13$ mm & $OD \leq 127$ mm; and (b) $C \leq 0.15\%$; and (c) Preheat 120°C min
4	M5A Group 1 & M5B Group 1	675°C min	(a) For all product forms nominal base metal thickness $t \leq 16$ except for tubes $t \leq 13$ mm & $OD \leq 127$ mm and for pipes $t \leq 13$ mm & $OD \leq 127$ mm; and (b) $Cr \leq 3\%$; and (c) $C \leq 0.15\%$; and (d) Preheat 150°C min
5	M15 E Group 1	730°C to 785°C	NIL
6	M8	PWHT : Nil	NIL
7	MX20	PH: 250-300°C for GTAW and 400-450	NIL

		for SMAW Post Heat:80-100°C for 90 minutes minimum PWHT: 740°C - 760°C	
8	MX12 (t up to 52 mm)	PH:220°C PWHT: 725°C +/- 15°C	NIL
9	M43	950°C min	(a) For design temperature less than 540°C or (b) for circumferential butt welds in pressure parts with a nominal base metal thickness of 13 mm or less at the weld

Notes-1:

- (a) All the heat treatment ranges shall be aligned with the Qualified Welding Procedure.
- (b) When pressure parts of two different M-Number groups are joined by welding, the post weld heat treatment shall be as specified in Table 3/5 for the material requiring the higher post weld heat treatment temperature, except M-No. 8 group.
- (c) Fillet welds, partial penetration welds, and full penetration welds through the tube or pipe thickness, attaching M-No. 4 or M-No. 5A tubes and pipe to headers of lower M-Number material, may be post weld heat treated at the temperature specified in Table 3/5 for the lower M-Number material provided the tubes or pipe comply with all the following conditions:
 - (i) a maximum specified chromium content of 3 percent
 - (ii) a maximum size of NPS 4 (DN 100)
 - (iii) a maximum thickness of 13 mm.
 - (iv) a maximum specified carbon content of not more than 0.15 percent
- (d) When non-pressure parts are welded to pressure parts, the post weld heat treatment temperature of the pressure parts shall control. Pressure part welds and attachment welds using ferritic filler metals that have a specified chromium content of more than 3% shall receive a post weld heat treatment. The post weld heat treatment time and temperature used shall be not less than that shown in Table 3/5 for a base metal of equivalent analysis.
- (e) The nominal thickness to be considered for determining Post Weld Heat Treatment and soaking time shall be defined as:
 - (i) For full penetration butt welds, the nominal thickness is the thinner of the parts being joined.
 - (ii) For full penetration corner welds, the nominal thickness is the depth of the weld.
 - (iii) For partial penetration groove and material repair welds, the nominal thickness is the depth of the weld. The total depth of partial or full penetration groove welds made from both sides shall be taken as the sum of the depth of both sides at a given location.

- (iv) For fillet welds, the nominal thickness is the weld throat. When a fillet weld is used in conjunction with a groove weld, the nominal thickness is either the depth of the groove weld or the fillet throat dimension, whichever is greater.
- (v) Except as stipulated in clause (vi) below, the nominal thickness is the depth of the groove, if present, through the shell or nozzle or reinforcing pad, or the throat of any fillet weld, whichever is greater.
- (vi) When multiple openings form a ligament where the spacing between centres is less than twice the average diameter, the nominal thickness of a combination groove and fillet weld shall be the sum of the groove depth and fillet weld throat.
- (vii) The thickness of the pressure part at the point of attachment where a non-pressure part is welded to a pressure part, in case of butt welds;
- (viii) The thickness of the fillet weld at the point of attachment where a non –pressure part is welded to a pressure part, in case of fillet welds.
- (f) When it is impractical to carry out PWHT at the temperature specified in Table III/5 for M1 and M3 materials, it is permissible to carry out PWHT at lower temperatures for longer periods of time in accordance with table 3/6 given below.

Table 3/6: Alternate PWHT requirements for Carbon and Low alloy steels

Serial No.	Decrease in temperature below minimum specified temperature, °C	Minimum holding time at decreased temperature, hour [Note(1)]	Notes
(1)	(2)	(3)	(4)
1	28	2	-
2	56	4	-
3	83	10	(2)
4	111	20	(2)

Notes:

(1) Minimum holding time per 25 mm for thickness up to and including 50 mm. Add 15 min per 25 mm of thickness for thickness greater than 50 mm.

(2) These lower Post Weld Heat Treatment temperatures permitted only for M-No 1, Group 1 and 2 materials.

- (g) Soaking during heating / SR (or PWHT) shall be as per below guidelines:

Table 3/7: Soaking

Serial No.	HT Cycle	Soaking Time	Remarks
(1)	(2)	(3)	(4)
1	Hot Working/ Normalizing	For M5B, M-15E Gr1 (P91): 30 minutes per 25 mm of “t” or 30 minutes min whichever is greater & for all others 30 minutes per 25 mm of “t” or 15 minutes min whichever is greater.	‘t’ is the product thickness for Stress relieving.
2	SR/PWHT – Carbon Steels	1 hour per 25 mm of “t” for “t” up to 50 mm with an additional 15 minutes for every 25 mm above 50 mm (15 minutes minimum).	‘t’ is nominal thickness as per Note (b) of Table 3/5 for PWHT.
3	SR/PWHT – Alloy Steels	1 hour per 25 mm of “t” with below mentioned minimum soaking times: (M3 & M4) – 30 minutes minimum. (M5A) – 60 minutes minimum except for M5A pipes of OD ≤ 127mm and t ≤ 13mm, which require only 30 minutes) (M5B & M-15 E Gr 1) – 60 minutes minimum	
4	MX20	2 hrs minimum for thickness below 60 mm and 3 hrs minimum for thickness above 60 mm	
5	MX12 (t up to 52 mm)	1 hour per 25 mm of ‘t’ - 30 minutes minimum.	
6	SR/PWHT – Nickel Alloys	1 hour per 25 mm of ‘t’ - 60 minutes minimum.	

- (h) The temperature of the furnace at the time of placing the component for SR/PWHT shall not be higher than 425°C. The component shall be kept at SR/PWHT temperature to the minimum soaking time. After SR/PWHT the component shall be left to cool to in the furnace to a temperature not exceeding 425°C. After withdrawal from the furnace the part shall be allowed to cool in a still atmosphere.
- (i) The rate of heating above 425°C and rate of cooling up to 425°C shall be as below. The rate of heating and rate of cooling should not exceed 335°C per hour divided by the thickness in inches, but in no case should it be more than 335°C per hour.

Notes 2:

- (i) In case socket welded joints or other type of joints for carbon steel pipes, valves and fittings, PWHT is not required if the throat thickness of fillet weld does not exceed 20 mm or carbon content does not exceed 0.25%.

- (ii) For carbon steel Headers and Mud boxes of water tube boilers, material having a maximum Carbon content of 0.25%, the Post Weld Heat Treatment requirement for tubes welded to Header is not mandatory when all the following conditions are fulfilled, namely:-
- The outer diameter (OD) of tubes is not more than 51 MM;
 - The outer diameter of the Header is not more than 219.1 MM;
 - The Header thickness is not more than 13 MM;
 - A minimum pre-heat of 100°C is applied.
- (iii) For Carbon steel, if the thickness of the small component of boiler exceeds 20 mm and the weld recess also exceeds 20 mm local stress relieving to the satisfaction of the Inspecting Authority shall be permitted.
- (iv) Post-weld heat treatment in weld joints of carbon steel and low alloy steel may be exempted when heat treatment is not practical where inside is lined with special Stainless Steel which cannot be heated beyond 400°C (due to the associated problem of reduction of corrosion properties of such lining during heating to the temperature), when all the following conditions are satisfied –
- Built-up overlay welding (buttering is performed on both the welding edge bevels of the parts of the closing joint to be welded together. The buttering can be of:
 - With Carbon Steel Electrode with low carbon (C) = 0.1 Percent max. (Ex: E7018-1) in case of Carbon Steel parts.
 - With Stainless Steel Electrode E-309 or with Inconel electrode in case of low alloy steel parts.
 - With low alloy steel electrodes, having carbon (C) = 0.12 percent maximum or with Inconel electrode in case of high strength low alloy steel parts having UTS greater than 56 kg/mm² such as WB36, SA 533 Type B Cl 2;
 - Buttering thickness shall be 15 mm minimum on the side where chip back is required to be done before re-welding and 8 mm minimum on the other side. Refer Figure given below:

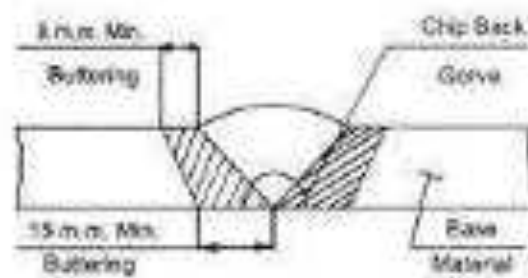


Fig. 3/11

- Suitable pre-heat and other pass heating is applied during buttering;
- Individual parts are post-weld heat treated after buttering prior to welding the special stainless steel corrosion resistant liner plate or prior to applying final weld overlay of special corrosion resistant stainless steel lining;
- The final layer on the internal line side shall be compatible with liner material and final weld (carbon steel welding in carbon steel base metal, low alloy steel Inconel welding in case of high strength low alloy steel base metal and E309 Inconel welding in case of other low alloy steel

base metals) on the base metal side shall be compatible with base metal in respect of mechanical properties. The welding procedure shall be established taking care of adequate toughness and ductility and the procedure approved by Inspecting Authority or Chief Inspector, as the case may be;

(f) Charpy – V Notch impact test is carried out at 20°C for:

- (i) Base metal and heat affected zone,
- (ii) Weld metal in case of Carbon Steel welding;

(g) Non-destructive testing as below (recommended):

- (i) Magnetic particle test of weld bevels prior to buttering.
- (ii) Dye-Penetrant test of buttering layer.
- (iii) Dye-Penetrant test of rest of weld.
- (iv) Dye-Penetrant test of final weld on internal liner side.
- (v) Ultrasonic test of final weld after hydro test of the equipment with the closing seam.

124. Attachment of Steel Tubes.— (1) Steel tubes shall be connected to the tube plates by one of the following methods:-

- (i) Expanding.
 - (ii) Strength welding.
 - (iii) Mechanical bolted ball joint.
- (2) Drift or roller expanded tubes shall project through the neck or bearing part in the holes by at least a quarter of 25 mm and shall be secured from drawing out by being bell mouthed to the extent of 0.8 mm for each 25 mm in diameter plus 1.6 mm.
- (3) Tubes may be seal welded into fittings or headers for both boilers and super heaters after they have been expanded and flared provided the material in the fittings or headers does not contain carbon in excess of 0.35 per cent.
- (4) In the case of drifted or roller expanded tubes, the tube holes in the tube plates of drums, pockets, or headers shall be formed in such a way that the tubes can be effectively tightened in them. Where the tube ends are not normal to the tube plate, there shall be a neck or belt of parallel seating of at least 13 mm depth measured in a plane normal to the axis of the tube at the holes.
- (5) Where tubes are strength welded direct to the tube plates, the technique followed shall be approved by the Inspecting Authority and all welds shall be suitably heat treated. In the case of plates below 22 mm thickness, the requirement of stress relieving by heat treatment after welding of the tubes may be waived provided the weld satisfies the requirements of the maximum hardness and also the requirements concerning the impact values of the weld metal. The welding procedure adopted and the weld sequence selected shall also be subject to the approval of the Inspecting Authority. This provision is applicable to only shop welding of tubes at the Manufacturers Works.
- (6) Tubes spacers, supporting clips and lugs may be welded to the tubes. Flash welding of studs for supporting refractories, etc, is also permissible.
- (7) The tubes shall be so arranged that they are accessible for cleaning internally and externally.

PART-XII

125. Headers, mud boxes, etc. of water tube boilers.—(1) (a) Headers and mud boxes, etc. of water tube Boiler may be of seamless or welded steel or of cast steel complying with the requirements of the provisions contained in regulations 49 to 57. Where welded, the welding shall be stress relieved, radio graphed or ultrasonically examined and in all respects shall be to the satisfaction of the Inspecting Authority as per Table 3/5 of regulation 123.

- (b) Open ends of seamless steel tube headers may be closed by forging or the ends may be secured by bolting, screwing or welding in an approved manner. Bolting shall not be used where the bolts are exposed to or are swept by gases of combustion.
 - (c) The method of attachment of the ends shall be subject to the approval of the Inspecting Authority.
- (2) Each piece prior to being fitted in place shall be subjected to hydraulic tests to one-and-a-half times the design pressure of the boiler into which it is to be fitted.
- (3) (a) The sighting hold doors and header caps shall be substantial and be capable of being removed or replaced from time to time without loss of efficiency of safety. They may be held in position either by means of bolts or by seal welding.
- (b) The bolts by which they are held in place shall be fitted to them in such a way as to satisfy the above conditions.
- (c) The doors shall be so designed that they will not blow out in the event of breakage of the bolt.
- (d) Circular holes also may be provided in addition to elliptical holes, if provision is made to prevent the door bolts from turning, while securing the joint.
- (4) All flanges shall have a fillet with a radius of curvature at least equal to the thickness of the necks to which they are attached.

PART-XIII

126. Stand pipes and pads etc.—Stand pipes and seating for carrying mountings shall be made of wrought, cast or fabricated steel. These shall take the form of short stand pipes, pressed steel plate saddles, forged pads or pads cut from round rolled bar as may be most convenient and secured to the boiler by welding. Where short stand pipes are used they shall be of solid forged, fabricated or cast steel. They shall be carefully bedded to the shell before attachment. The jointing faces to which mountings are to be bolted shall be machined. Pads shall have sufficient thickness to allow the drilling of stud holes for mountings without the inner surface being pierced and the length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud.

127. Design of stand pipes.— The design of the branches and stand-pipe shall be regulated in the following manner:

- (i) in order to withstand the maximum allowable working pressure, the minimum thickness of branch and stand-pipe shall be determined in accordance with the provisions specified in sub-regulation (1) of regulation 244;
- (ii) Compensation requirements for openings in the main pressure parts shall be determined in accordance with the provisions of regulation 179;

- (iii) The additional thickness shall be considered to withstand superimposed loading due to connecting pipe-work or fittings.
- (iv) The minimum thickness of the branch or standpipe shall be the greatest of the values required above and shall not be less than $0.015 d_o$ plus 3.2 mm where, d_o is the outside diameter of the branch (in mm);

Provided that the provisions of the regulations shall not apply to such tube stub which have been designated as tubes.

128. Pressed plate saddles.— Where pressed plate saddles are employed they shall be formed to bed closely to the boiler and machined on the face jointing the mounting and on the edges. The studs for attachment of mountings, if screwed through the saddle, shall each be fitted with a nut on the inside having a thickness equal to the diameter of the stud. Where the stud holes do not penetrate through the saddle, the length of the screwed portion of the stud in the plate shall not be less than the diameter of the stud.

129. Seatings for mountings.— (1) For pressures not exceeding $8.7 \text{ kg/cm}^2(\text{g})$, mountings with the screwed ends not exceeding 1 inch S.P.T. (Straight Pipe Threads) may be used; the screwed portion of any such mounting being not less than 5 mm.

- (2) The mountings may be screwed:
 - a. Directly into the boiler shell plate, nuts being fitted on the water side, or
 - b. Into steel distance pieces the length of thread engaged being in no case less than the bore of the mounting plus 6 mm.
- (3) The distance pieces shall be made from solid mild steel. They shall be screwed into the plate and fitted with nuts on the water side. The walls of the distance pieces shall be not less than 6 mm thick at the bottom of the thread.

130. Attachment of mountings.— (1) Mountings may be attached directly to any shell or end plate where the plate is of sufficient thickness to allow a suitable surface to be obtained for the attachment of the boiler mountings.

- (2) The minimum thickness at the hole in the shell or end plate shall be not less than the thickness required for the maximum allowable working pressure considering the plate as being unpierced.
- (3) Where the boiler mountings are secured by studs, the studs shall have a full thread holding in the plate for at least one diameter. If the stud holes penetrate the whole thickness of the plate. The stud shall be screwed right through the plate and be fitted with a nut inside having a thickness equal to the diameter of the stud. Where bolts are used for securing mountings they shall be screwed right through the plate with their heads inside the shell or end plate.

131. Insufficient thickness of end plates.— (1) In cases where the thickness of the end plate is insufficient for this purpose the mountings shall be joined to suitable steel seatings as provided in regulation 126.

- (2) The following constructions as to stand pipes attached to shells and end plates shall be permissible:
 - (i) Where the internal diameter of the stand pipe does not exceed 25 mm, the standpipe may be screwed into the plate and fitted with a nut on the waterside.
 - (ii) Where the internal diameter of the standpipe exceeds 25 mm but does not exceed 51 mm, it may be screwed in and seal-welded.
 - (iii) Where the diameter of the standpipe exceeds 51 mm, it may be welded to the end plate.

(3) The foregoing provisions as to the stand pipe shall be regulated by the following conditions:

- (i) When stand pipes are screwed, the screwing shall be of Standard Pipe Thread,
- (ii) Where stand pipes, saddles or other forms of seatings are fabricated by fusion welding they shall be stress relieved by heat treatment before attachment to the boiler,
- (iii) Where the bore of the stand pipe or seating and the hole in the plate do not exceed 127 mm plus twice the thickness of the plate, the seating may be welded to the plate without subsequent heat treatment of the weld so made. Where the hole in the plate exceeds 127 mm plus twice the thickness of the plate, the plate to which seating is attached shall be stress relieved by heat treatment.

132. Attachment of water and pressure gauges.— Water gauge and pressure gauge siphons may be attached direct to the front end plates without the intervention of a pad or stand pipe, provided they are flanged and secured by studs. If the studs are screwed through the plate, nuts shall be fitted on the inside of the plate.

133. Mountings on flat places.— Where the flanged mountings are attached direct to a flat plate, such mountings shall be provided with a substantial spigot, the full thickness of the boiler plate.

134. Bolts and nuts.— Bolts and nuts shall be machined where they come in contact with the flanges, and all holes in saddles and pads shall be drilled.

Note: In all cases where the boiler is lagged the joint of the mountings shall be clear of the lagging surface or the lagging kept clear of flange so that the joint can be inspected and, when necessary, remade.

PART-XIV

135. Manholes, mudholes etc.— (1) Sufficient sight and cleaning holes shall be provided to permit efficient inspection and cleaning. Such holes shall normally be elliptical in form and not less than 89 mm x 63 mm.

- (2) At least one manhole or sight hole shall be provided in the upper part of the cylindrical shell or in the shell crown, or end plate and this shall not be less than as given in the TABLE 3/8:

TABLE 3/8

Serial No.		Size in mm
1	Boilers not exceeding 760 mm	230 x 180
2	Boilers over 760 mm diameter and not exceeding 915 mm	305 x 230
3	Boilers over 915 mm diameter and not exceeding 1060 mm	355 x 255
4	Boilers over 1060 mm diameter and not exceeding 1220 mm	380 x 280
5	Boilers over 1220 mm	410 x 305

- (3) Where the size of construction of the boiler does not permit entry for cleaning and inspection, sufficient cleaning holes shall be provided in the shell for these purposes.
- (4) Where cross tubes are fitted in Vertical boilers one cleaning hole shall be provided opposite at least one end of each tube. At the bottom of the narrow water spaces at least three cleaning holes shall be provided. The cleaning holes shall be so arranged that the circumferential distance between them does not exceed 91 cm unless the foundation ring is sufficiently accessible to permit cleaning and inspection from the inside of the boiler.

Note: Wherever practicable the frames should be secured to the inside of the shell so that the shorter axis is parallel to the longitudinal centre line of the boiler.

- (5) Cleaning holes or mud holes in Loco Tope boilers shall be provided at each bottom corner of the outer firebox casing, above the firehole ring and on each side of saddle plate in line with bottom of barrel.
- (6) In the case of small boilers or where the foregoing provisions are impracticable the cleaning holes or mud holes shall be as near as possible in the corner of the outer firebox casing and the holes as large as circumstances permit.

136. Compensating rings and frames for openings in shells.— (1) Compensating rings and frames for openings in shells shall be of same material as that of shell. The compensation provided shall preferably be flanged frames, which shall be fitted in all cases where the shell plate exceeds 14 mm thick. Flanged frames shall be weld-less and shall be flanged or pressed to provide a flat jointing surface for the cover.

- (2) All compensating rings and frames shall be formed to bed closely to the surfaces to be connected. Any weld therein shall be on the transverse centre line.

- (3) The flat jointing surfaces of all flanged or pressed frames and all doors or covers shall be machined.

137. Internal doors.— Internal doors shall be of wrought steel in accordance with Chapter-2 and constructed in accordance with the following:-

- (1) Doors shall be formed to fit closely to the internal joint surface and should be fitted with studs, nuts and crossbars;
- (2) Doors for circular opening larger than 250 mm or elliptical/rectangular openings larger than 250 mm x 175 mm shall have two studs but for openings of 250 mm x 170 mm or less only one stud may be fitted. Doors for openings not larger than 123 mm x 90 mm may have the stud forged integrally with door;
- (3) Doors studs shall be of welding quality steel having a minimum specified tensile strength of not less than 36.7 kg/mm² and those for manholes shall be not less than 30 mm and they shall be fixed in any of the following way:-
 - (a) screwed through the plate and fillet welded on inside;
 - (b) fillet welded each side of the plate with a leg length of not less than 10 mm;
 - (c) attached to the door by an intermediate plate or lugs so that the strength of the attachment is not less than the strength of the studs and the studs are prevented from turning; or
 - (d) provided with an integrated collar and be riveted or screwed onto the door plate and be prevented from turning in which case the strength of the attachment shall not be less than the strength of the studs;
- (4) Door spigot when the door is in the central position shall have a clearance of approximately 105 mm all around and at no point shall the clearance exceed 3 mm. The spigot depth shall be sufficient to trap the gasket;
- (5) The nuts shall be of appropriate material compatible with that of the bolts and be placed on the seating surface;
- (6) The cross-bars shall be of substantial proportions and of mild or wrought steel.

Note: Eye bolts of suitable legs on the door plate or headed bolts engaging with slotted sections on the door plate may be used instead of studs.

- (7) The minimum calculated thickness of the door of the flat plate construction (i.e. unstiffened and made from one plate shall be not less than that determined by the following formula: -

$$t = \sqrt{\frac{0.35 Pxd^2 + W}{f}} \quad \text{for a circular door}$$

$$t = \sqrt{\frac{0.35 P (2-a/b) \times a^2 + W}{f}} \quad \text{for an elliptical door}$$

Where,

- t = is the minimum calculated thickness of the flat door (in mm)
P = is the design pressure of boiler in N/mm²
d = is the diameter of the opening to which the door is fitted, if round (in mm)
a = is the minor axis of the opening to which the door is fitted if elliptical (in mm)
b = is the major axis of the opening to which the door is fitted, if elliptical (in mm)
W = is the full load capacity of one stud (effective stud area X design stress value at design temperature) in N
f = is the maximum permissible stress values as available in the governing codes of the country of the material to which it belongs in N/mm²
Note: A design stress value of 50 N/mm² may be used for carbon steel bolts for design temperature not exceeding 300°C.

138. Raised manhole frames, cover plates and joint bolts.— (1) (a) Raised circular manhole frames not exceeding 406 mm in diameter shall be at least 19 mm thick in all parts. The circular cover plates and joint flanges for such frames shall be not less than:

- 25 mm thick for pressures not exceeding 8.4 kg/cm² (g)
28 mm thick for pressures over 8.4 kg/cm² but not exceeding 14 kg/cm² (g).
32 mm thick for pressures over 14 kg/cm² but not exceeding 17.5 kg/cm² (g).

- (b) For pressures 14 kg/cm² (g) and over, raised circular manhole frames shall not be fitted. The cover plates shall be secured by at least sixteen steel bolts not less than 25 mm diameter, such that the stress in the bolts due to steam pressure shall not exceed:-

- 350 kg/cm² for 25 mm bolts.
421 kg/cm² for 28 mm bolts.
456 kg/cm² for 32 mm bolts

- (c) For the purpose of calculation, the pressure shall be assumed to act on the whole area within the pitch circle of the bolts and the bolt area at the bottom of the screw thread shall be taken.

- (2) External raised circular mouthpieces shall be:

- (a) formed in one piece without welds,
(b) formed from a suitable rolled section and forge welded, or
(c) Fabricated by fusion welding provided they are stress relieved by heat treatment after welding and before attaching to the boiler.
(d) Welds shall be positioned so that they are located on the transverse center line of the boiler. The jointing flanges of mouthpieces and covers shall be machined on the face and edge and on the bearing surface for the bolts.

- (e) Bolts and nuts shall be machined where in contact with the flanges and the joints should be formed inside and outside the bolts to preclude the possibility of flange distortion. Cover plates shall be dished outwards to a depth of approximately one-eighth of the internal diameter of the frames.
- (f) All frames and mouthpieces shall be close to the surfaces to which they are to be connected. All caulking edges shall be machined or machine gas cut.

139. Positions of manhole in shell.— Manholes and other openings in cylindrical shells shall be placed as far as possible from the seams, preferably towards the back end to the boiler top. Wherever practical, oval openings shall be arranged with the minor axis parallel to the longitudinal centre line of the boiler. In no case shall the circumferential length of any opening exceed twice the longitudinal width of the opening.

140. Compensation rings to manholes.— Compensation shall be provided in every case for the part cut of a cylindrical shell for a manhole. The strength of the net section of compensating ring and also welds securing them to the shell, compared with that part of the shell cut out, shall not be less than the efficiency of the longitudinal seam.

141. Compensation for cutting large holes in shell type boilers.— Where holes are cut in the cylindrical shell for the purpose of attaching a seating of frame or door, compensation shall be provided such that the added sectional area, including parts of the frame within 101.6 mm of the shell shall be not less than the sectional area of the plate removed which shall be the product of the diameter of the opening and the calculated thickness of the plate as found by Equation(4/2). Where holes are cut in the cylindrical shell for the purpose of fixing seating for mountings and the diameter of the holes is greater than $2\frac{1}{4}$ times thickness of the shell plate plus 70 mm, compensation shall be provided. Where a large opening is cut in a cylindrical shell to receive another part of the structure, the sides where cut away shall be efficiently cross-stayed or strengthened in some other effective manner.

CHAPTER -4

FUSION WELDED DRUMS FOR WATER TUBE BOILERS AND SUPERHEATERS

142. General requirements.— Where applicable the general terms of Chapter-1 relating to Certificates from Makers, Inspecting Authorities, etc., and of Chapter-3 concerning construction shall be followed.

PART-I

143. Materials of construction for fusion welded Boiler Drums.—(1) For plates to be used in the construction of fusion welded boilers drums, requirements of Chapter-2 shall apply.

(2) Plates having thickness of more than 50 mm, before being fabricated, shall be uniformly heat treated to produce grain refinement and heat treatment involving quenching in a liquid medium is not permitted.

PART-II

144. Fusion Welded Drums.— The term 'Fusion Weld', for the purpose of this Chapter, is applicable to all welded joints made by the metal arc process with covered electrodes or other electric arc process, in which the arc stream and the deposited weld metal are shielded from atmospheric contamination.

145. This Chapter shall apply to the single run or heavy run welding process and that welded boiler drums manufactured by that process shall conform with all regulations of this Chapter, except those in which divergence is necessary solely because of special requirements essential for the most efficient utilisation of that process and all regulations governing quality of material, construction workmanship and testing (both non-destructive and otherwise) are applicable.

146. Equipment of workshop.— (1) The welding plant and equipment shall be of good quality and maintained in an efficient working condition.

(2) The welding apparatus shall be installed under cover and shall be arranged so that the welding work may be carried out in positions free from draughts and adverse weather conditions.

(3) The procedure shall be such that there is regular and systematic supervision of the welding works, and the welding operators are subjected to periodic tests for quality of workmanship by the works officials.

(4) Records of these periodic tests shall be kept and made available by works office to the Competent Person for scrutiny.

147. Testing Laboratory.—

(1) The works shall be equipped with an efficient testing laboratory which shall include apparatus suitable for carrying out tensile, bend and impact tests, micro-examination of specimens and x-ray examination of the actual joints in pressure vessels.

(2) The works shall also be equipped with a suitable heat treating furnace having satisfactory means for temperature control, but as an alternative arrangement may be made whereby the drums can be heat-treated elsewhere.

148. Constructional details and preparation for welding.— (1) Before starting the construction work, the manufacturer shall furnish to Inspecting Authority, a fully dimensioned sectional drawing reflecting therein complete details of construction of the drum for approval.

(2) Fully dimensioned drawings of the proposed welds preparations of the main seams drawn to a scale, clearly reflecting therein all the relevant details shall be furnished.

(3) Sketches showing details of the welds preparations for the attachment of the stand pipes, branch pipes and seating and their locations relative to the longitudinal and circumferential seams and to other openings shall be furnished.

149. Preparation of plates.— For the purpose of preparation of plates, requirements contained under regulation 77 shall apply.

150. Cylindrical Shell of Drums.—

(1) Each drum shell plate shall be of cylindrical form to the extreme edges of the plate.

(2) The bending shall be done entirely by machine and local heating or hammering is prohibited.

(3) Where the plates are bent to an internal diameter less than 20 times of the plate thickness, they shall be efficiently heat-treated after bending or combined with final post weld heat treatment.

151. Method of making welded joints.—(1) For the purpose of requisite quality of welding, the seams may be welded from both sides of the plate or from one side of the plate with or without a backing strip and If a backing strip is used, it shall be removed and the surface so exposed shall be dressed.

(2) Additional runs of metal shall be deposited at the surface of the welded seams so that the welded metal at the level of the surfaces of the plate is refined as far as possible.

(3) Thickness of such additional welding shall not exceed values given in Table 4/1 below.

Table 4/1

Serial Number	Nominal thickness in mm	Maximum reinforcement in mm	
		Circumferential joint in Pipe and tubing	Other Welds
(1)	(2)	(3)	(4)
(i)	Upto 3	2.5	2.5
(ii)	Over 3 to 5 incl.	3.0	2.5
(iii)	Over 5 to 13 incl	4.0	2.5
(iv)	Over 13 to 25 incl	5.0	2.5
(v)	Over 25 to 50 incl	6.0	3.0
(vi)	Over 50 to 75 incl	Note	4.0
(vii)	Over 75 to 100 incl	Note	5.5
(viii)	Over 100 to 125 incl	Note	6.0
(ix)	Over 125	Note	8.0

Note – The greater of 6 mm or 1/8 times width of weld in mm

(4) The surfaces of the welds which are to be subsequently radiographed shall be sufficiently free from coarse ripples, overlap, grooves, abrupt ridges and valleys, so as to avoid stress raisers and to permit proper interpretation

of radiographs and other Non-Destructive Testing(NDT) methods. If there is a question regarding the surface condition of the weld when interpreting a radiographic film, the film shall be compared to the actual weld surface or provide smooth contours and to be flush with the respective surfaces of the plate before radiography examination is done.

(5) Undercut shall not exceed 0.8mm or 10% of wall thickness, whichever is less and undercut shall not encroach on design wall thickness.

(6) When affixing standpipes, branch pipes, seating, compensating plates, doubling plates or manhole frames, not less than two runs of metal shall be deposited at each weld.

(7) Each run of weld shall be thoroughly cleaned and free from slag that may adversely affect the quality of the succeeding runs.

(8) Welds shall be marked permanently to facilitate their location.

152. Type of welded joints.— The longitudinal and circumferential seams shall be made with butt joints of the single or double U or Vee type.

153. Number of joints.— Where, having regard to the approved design, the dimensions are such that the shell cannot be made from a single plate, it shall be made with the minimum number of joints and the longitudinal seams in successive rings shall not fall in line, except where the rings of the drum are in two halves of unequal thickness.

154. Position of the tube holes.—(1) Tube holes in welded seams shall be avoided as far as possible. Where the holes are unavoidable, they may be machined through welded seams after these seams are radiographed.

(2) In the case of vanadium steels, in addition to radiography, the welded seams shall be stress relieved.

(3) The efficiency of the ligament in the direction of weld shall be multiplied by a weld factor not exceeding 0.95 except where the distance from the edge of the tube hole to the edge of the weld is greater than 13 mm.

(4) The edge of the weld shall be considered to be the edge of the weld groove as machined in the plate prior to welding.

Notwithstanding anything in this regulation, efficiency of the ligament in the direction of weld shall not be multiplied by a weld factor 0.95 where 100 percent radiography of weld joint is done.

155. Circularity of drums.—

(1) (a) The difference between the internal diameter of the drum measured at any cross-section and the nominal internal diameter of the drum shall not exceed 1 per cent of the latter.

(b) Any departure of profile measured on the outside of the drum with a gauge of the designed form of the exterior of the drum and of length equal to a quarter of the internal diameter, shall not exceed the percentage given in Table 4/2 below:

Table 4/2

Serial Number	Nominal internal diameter of drum	Percentage of nominal internal diameter
(1)	(2)	(3)
(i)	Up to and including 915 mm	0.375
(ii)	Over 915 mm up to and including 1150 mm	0.35
(iii)	Over 1150 mm	0.3

Flats at the welded seams shall not be permitted and any local departure from circularity shall be gradual.

- (2) (a) The deviation from circularity in any section shall, in the case of normalised drums, not exceed 2% and in the case of stress-relieved drum 1% and the deviation from a straight line shall not exceed 0.3% of the cylindrical length.
- (b) (i) In order to determine the deviation from circularity of the drums the maximum and minimum internal diameter at one cross section shall be measured.
- (ii) From these measured values the percentage deviation from circularity shall be calculated according to the following formula, —

$$C = \frac{2(d_{\max} - d_{\min})}{(d_{\max} + d_{\min})} \times 100$$

Where, C = percentage deviation from circularity of the drums.

d = internal diameter at one cross-section.

(c) In order to determine the deviation from a straight line, a stretched line should be placed longitudinally against the sides and its largest distance from the shell line concerned shall be measured. From this distance, and from the cylindrical shell, the deviation from the straight line shall be calculated.

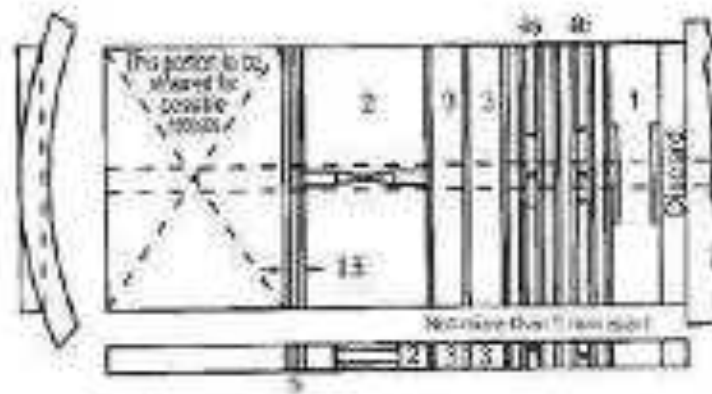
156. Mechanical test and test plates of fusion welded seams.—(1) Fusion welded joints shall comply with the mechanical tests herein specified. Not less than one set of test plates shall be provided to represent the welding of each longitudinal seam and the test plates may be attached at each end of the longitudinal seam or the set may be located at one end only.

- (2) Where the drum shell is formed in two or more courses, the staggered longitudinal seam shall be regarded as a continuous longitudinal seam provided the welding be effected in one reasonably continuous operation and by the same operator or operators.
- (3) Where there are circumferential seams only or where the method of welding the circumferential seam differs from that employed for the longitudinal seams, the method of providing the test plates shall be decided by the Inspecting authority.
- (4) (a) The test plates shall be of a size sufficient for the preparation of the test pieces specified in sub-regulation (1) of regulation 157 and for any repeat test pieces that may be required.
- (b) The material for each set of test plates shall be cut from the respective plate or plates forming the appropriate seam, and before being cut shall be stamped by the Competent Person.
- (5) When the analysis of the plate is approved by the Inspecting authority and is considered sufficiently similar, the test plates may be cut from one drum shell plate only.
- (6) In the case of insufficient material being available on the shell plate to permit the cutting of test pieces, these shall be acceptable if they are made from another plate provided it is made from the same cast.
- (7) (a) The weld groove in the test plates shall be similar to that adopted for the corresponding edges of the longitudinal seam, and the respective fusion faces shall be in continuous alignment.
- (b) The test plates shall be reinforced or supported during welding in order to prevent undue warping.
- (c) The weld metal in the plates and the seam shall be of the same grade of electrode and shall be deposited continuously at the same operation.
- (8) The weld in any test plate shall not be repaired unless agreed by the Inspecting Authority and the repairs shall be done in such a manner as will ensure that the repaired seam in the test plate is still representative of the material in the main seam.
- (9) Where it is desired to straighten test plates which have warped during welding they may be straightened at a temperature below the temperature of heat treatment of the drum to which they belong. Straightening shall take place before final heat treatment.
- (10) Heat treatment requirements shall comply with regulation 123.

- (11) If any defects in the weld metal of a test plate are revealed by radiographical examination, the position of these shall be clearly marked on the plate and test pieces shall be selected from such parts of the test plates as may be decided by the Inspecting Authority.

157. Selection of test pieces*.—(1) From the test plates or plates on each longitudinal seam, test pieces shall be selected for the following tests, the specimens being cut out as showing Figs. 4/1 and 4/2 and stamped by a Competent Person for identification.

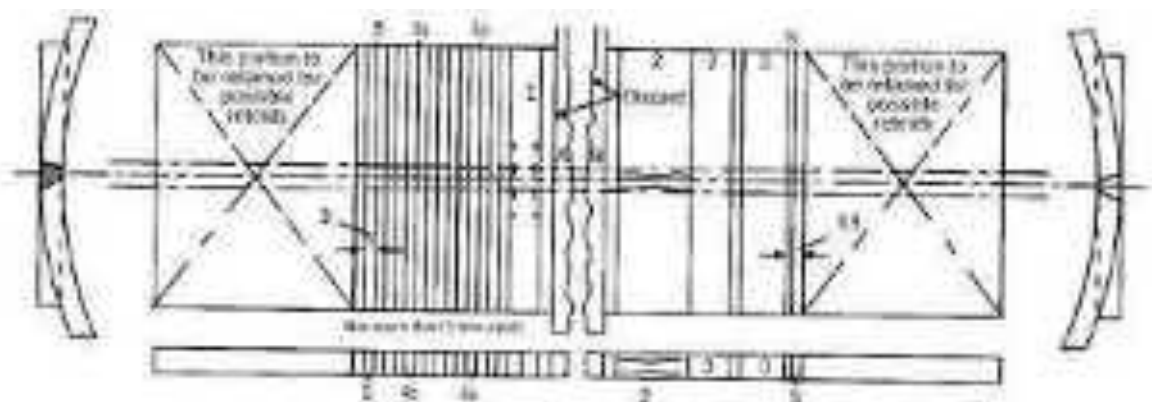
- (a) One tensile test specimen for the welded joint.
- (b) One all-weld metal tensile test specimen.
- (c) Two bend test specimens.
- (d) Three notched-bar impact test specimens.
- (e) One specimen for micro and macro examination.



All dimensions are in mm.

1. Tensile test for joint
2. Tensile test for all-weld metal
3. Bend test, outer and inner surfaces of plate (at weld)
4. Notched bar impact test specimen.
5. Micro and macro specimen.

Fig. 4/1: Details of Test Plates



All dimensions are in mm.

1. Tensile test for joint.
4. (a) Charpy impact test, outer surface of plate.

2. Tensile test for all-weld metal
3. Bend test, outer and inner surfaces of plate (at weld)
- (b) Charpy impact test, inner surface of plate.
5. Micro and macro specimen.

Fig. 4/2: Details of Test Plates

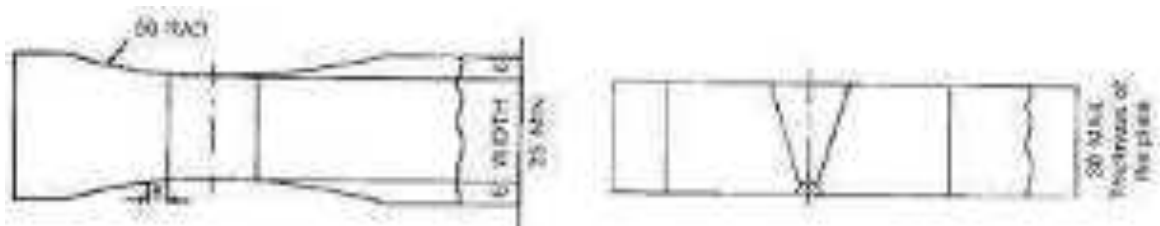
*Examples showing approximate disposition of the test pieces in the test plates are shown in Figs. 4/1 and 4/2.

The remainder of each set of test plates shall be retained for any retests required. Any specimen for re-test shall be cut off from the same set of test plate, as the original specimen.

- (2) Surfaces of tensile, bend and impact test specimens corresponding with the outside of the drums shall be only lightly dressed so that the rolled surface of the parent metal is not wholly removed, except that where the rolled surfaces of the abutting plates are not level with one another, one plate may be machined at each face of the weld provided the depth of metal removed does not exceed 0.8 mm.

158. Tensile test pieces.—(1) (a) The dimension of the reduced tensile section shall be as shown in Fig. 4/3 and the width of the reduced section shall be at least 25 mm.

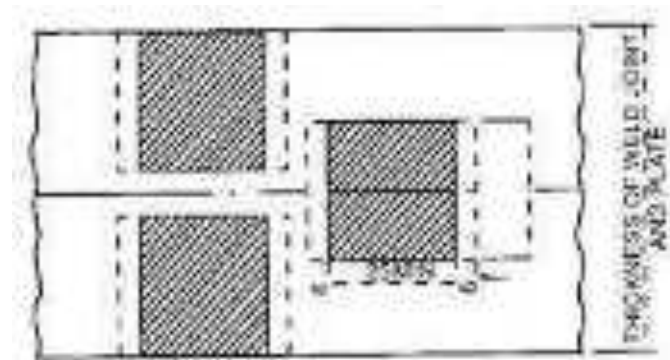
- (b) If the thickness of the plate does not exceed 30 mm, the thickness of the specimen shall be equal to the plate thickness and the plate surface of the specimen which shall be machined to take away the surface irregularities of the plate and the weld.



All dimensions are in mm.

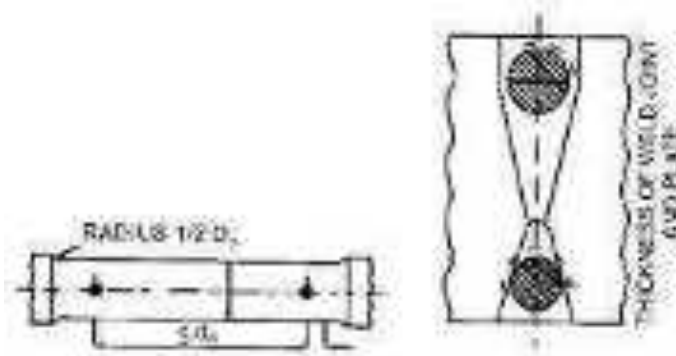
Fig. 4/3: Reduced Section Tensile Specimen

(c) If the plate thickness exceeds 30 mm, the tensile test shall be carried out on several reduced section specimens, each having a thickness of at least 30 mm and a width at the effective cross-section of at least 25 mm. These Specimens shall be taken out of the test piece in such a way that the tensile test covers the whole thickness of the weld joints as shown in Fig. 4/4. In this case the result of the test of every test specimen concerned shall meet the requirements specified in sub-regulation (1) of regulation 159.



All dimensions are in mm.

Fig. 4/4: Reduced Section Tensile Specimen in Thick Plate



All dimensions are in mm.

Fig. 4/5: All-Weld Metal Test Specimen

- (2) The dimensions of the all weld metal tensile test specimens shall be those given in Fig. 4/5. The diameter shall be the maximum possible, consistent with the cross-section of the weld but in no case more than 20 mm. The gauge length shall be equal to five times the diameter.

159. Tensile tests.—(1) The tensile strength of different grades of material shall be within the limits specified in regulation 37.

- (2) The upper yield point at room temperature shall be not less than 50% of the specified minimum tensile strength at room temperature.
- (3) The breaking elongation in percentage shall be not less than $(N-R_m)/C$
Where R_m = Tensile strength at room temperature in kgf/mm^2

N = a quality index of 100 for plate thickness upto 50 mm or 95 for plate thickness over 50mm.

$C = 2.2$ for only gauge lengths of $L_o = 5 d_o$ or $L_o = 5.65 / \sqrt{A_o}$

Where L_o = gauge length

A_o = original cross section of the rectangular test piece.

d_o = original diameter of the round test piece.

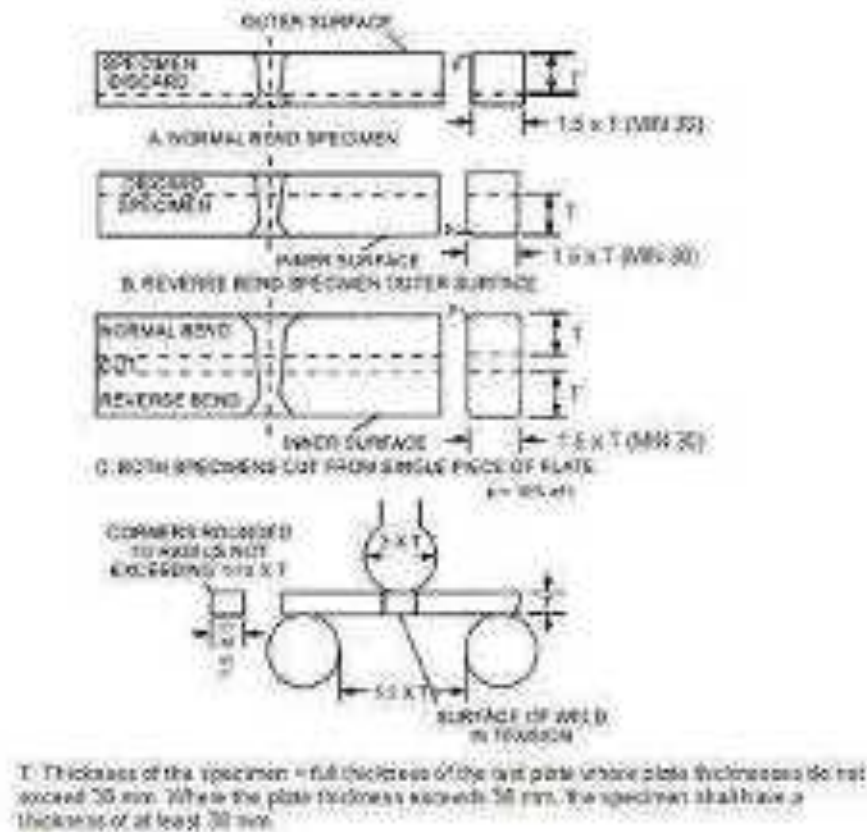
NOTE: $C = 1.9$ for gauge lengths of $4 \sqrt{A_o}$ for test piece of Appendix-D.

- (4) The minimum values of the stress at proof limit 0.2% at elevated temperature (E_t) may be calculated by multiplying the minimum specified tensile strength at room temperature (R_{20}) by the value of the ratio (E_t/R_{20}) given in the Table 2/5 in regulation 37.

160. Bend test pieces.—(1) One for direct and one for reverse bending shall be taken transversely to the weld and where the thickness of the plate permits, one should be above the other. The specimens shall be rectangular in section so as to have width equal to one and half times the thickness of the specimen but not less than 30 mm. The surface of the specimens shall be machined just to remove the surface irregularities of the plate and the weld. The corners of the specimens shall be rounded to a radius not exceeding 10% of the thickness of the specimen.

- (2) Where plate thicknesses do not exceed 38 mm, the thickness of the specimen shall be equal to the full thickness of the test plate. Where the plate thickness exceeds 38 mm, the specimen shall in all cases have a thickness of at least 38 mm. The specimen to be tested with the outer surface of the weld in tension shall be prepared by cutting to waste the metal local to the inner surface of the weld so that the desired specimen thickness is obtained (see Fig.4/6, Specimen A). The specimen to be tested with the inner surface in tension shall be prepared by cutting to waste the metal local to the outer surface of the weld so that the desired specimen

thickness is obtained (see Fig. 4/6, Specimen B). Where the thickness of the plate permits, both specimens may be cut from the same piece of plate, the specimen being located in the plate one above the other (see Fig. 4/6, Specimen C).



All dimensions are in mm.

Fig. 4/6: Specimen Three Bend Test

161. Bend tests.—(1) The specimen shall be mounted in such a way that the axis of the former is in the middle of the weld, and on roller supports the faces of which are separated by a distance determined by the thickness of the specimen.

(2) The best specimen shall be pushed through the supports by a former having a diameter also determined by the thickness of the specimen. The requirements of table 4/3 given below, relating to the thickness of test specimen, shall apply.

(3) On completion of the test, no crack or defect on the outer surface of the specimen shall be greater than 1.5 mm measured across the specimen, or 3 mm measured along the specimen. Premature failure at the corners of the specimen shall not be considered as a cause for rejection.

Table 4/3: Bend Test Requirements

Serial Number	Specified minimum tensile strength of plate	Diameter of Former	Free space between support at the end of list
(1)	(2)	(3)	(4)
(i)	Below 44 kgf/mm ²	2 T	4.2 T
(ii)	From 44 to 54 kgf/mm ²	3 T	5.2 T
(iii)	Above 54 kgf/mm ²	4 T	6.2 T

162. Notched-bar-impact test.— (1) The notched bar impact test specimens shall be of the type and dimension as shown in Fig. 4/7, the notch shall be contained in the weld-metal at approximately the axis of the weld and the axis of the notch is to be perpendicular to the surface of the plate.

(2) The test shall be carried out as follows:

For the V-Notch specimen at a temperature of $20 \pm 2^\circ\text{C}$. In the case of V-Notch specimen, the machining of the bottom of the notch shall be done very carefully. The minimum result to be obtained from the impact test pieces shall be:

- V-Notch specimen: 3.46 kgf/cm²
- One test shall consist of three test specimens and the value specified above is the average of three specimen values.
- Out of the three values, no single value shall be less than one third of the average value.

Note: Above value is equivalent to 2.76 kgf/cm² divided by sectional area below the notch.



All dimensions are in mm.

Fig. 4/7: Standard V-Notch Test Piece

163. Additional tests before rejection.— (1) In case any of the test specimens taken in accordance with regulations 156 to 162 fail to meet the specified requirements, one retest shall be allowed for each specimen that fails, provided the following minimum figures have been obtained.

- Reduction in area 30 per cent.
 - Any other test except the bend and impact tests, 90 percent of the specified requirements.
- (2) In case, a cold bend specimen fail to meet the specified requirements, two re-tests shall be taken from the same test plate and these shall comply with the requirements of regulations 160 and 161.

- (3) If Charpy impact test fails to meet the specified requirements, two re-tests shall be taken from the test plate on each side of the original specimen and separated from it by not more than 5 mm. Both re-tests shall show a minimum Charpy impact test value of 2.76 kgfm.
- (4) If it is found that there is insufficient metal to permit the preparation of specimen for re-test from the remainder of the test may be cut from the test plate relating to the opposite and of the same longitudinal seam.

164. Non-Destructive test.— (1) Micro and Macro Examination— A specimen, the full thickness of the plate and not less than 13 mm wide may be taken from each set of test plates by the Inspecting Authority for the purpose of micro and macro examination. Macro-etching of a complete cross-section of the weld including the heat effected zone, should show satisfactory penetration, fusion and absence of significant inclusions or other defects. In case of a doubt as to the condition of the weld as shown by micro-etching, the area concerned shall be microscopically examined for defect investigation.

- (2) Radiographical examination—(a) Every portion of the longitudinal and circumferential welded joints of the drums shall be subjected to radiographical examination or ultrasonic examination. Where ultrasonic examination is used, it shall be demonstrated to the satisfaction of the Inspecting Authority that the equipment and the technique used are satisfactory. The manufacturer shall ensure that the operator employed is competent to use the equipment, apply the technique and interpret the results of the examination. NDE operator and evaluator shall possess qualification as per ASNT SNT-TC-1A or ISO 9712 or equivalent.
- (b) The method employed in obtaining the radiographs shall be such as to show clearly defects having a magnitude equal to 2 per cent of the thickness of the welded joint. To determine whether this result is being obtained and indicator of approved form which includes a portion equivalent to not more than 2 per cent of the joint thickness, shall be placed in the vicinity of the weld so as to make a record on each radiograph. Each section of every weld shall be marked so that the radiographs can be easily correlated to the particular part of the joint represented. Radiographic or Ultrasonic testing shall be carried out as per written down procedure specifying technique, IQI sensitivity, density requirements and acceptance norms in line with established International boiler codes subject to acceptance by the Competent person.
- (c) The examination shall be made from the original films and the acceptability of the welds shall be rejected or dealt with under regulation 165 and be radiographed again.
- (d) PAUT or TOFD or both in lieu of Radiographic test may be used subject to establishing a procedure to include techniques, set ups, calibrations, operator qualification, acceptance norms in line with International Codes.
- (3) Magnetic Particle Flaw Detection- Magnetic method of flaw detection shall be employed wherever possible for ferritic steel.
- (4) Dye-Penetrant Flaw Detection- Dye penetrants or equivalent method of flaw detection shall be employed for Austenitic or other non-magnetic steel.
- (5) All butt welded joints shall be subjected to non-destructive examination by radiographic, radioscopy or other approved methods such as ultrasonic testing, magnetic particle inspection or liquid dye penetrant inspection. When radioscopy examination is to be performed in lieu of radiography on welded components, the following requirements shall be met, namely: -
 - (a) A written procedure shall be submitted for approval to the Inspecting Authority which shall contain the following:
 - (i) material and the thickness range;
 - (ii) equipment qualifications;
 - (iii) test object scan plan;
 - (iv) radioscopy parameters;
 - (v) image processing parameters;

- (vi) image display parameters;
 - (vii) image archiving requirements;
 - (viii) accept-reject criteria (Code reference);
 - (ix) performance evaluation;
 - (x) Operator identification.
- (b) The system shall be aided with an image processor to enhance the quality of the radioscopic images and system performance quality shall exhibit:
- (i) a thin section contrast sensitivity of 3%;
 - (ii) a thick section contrast sensitivity of 2%;
 - (iii) a spatial resolution of 3 line pairs per mm;
 - (iv) IQI sensitivity - 2% of the joint thickness when wire IQI's are to be used, the wire diameter axis shall be oriented along the axis of the least sensitivity of the system.
- (c) Radioscopes shall be properly marked to co-relate with particular part of joint represented.
- (d) The radioscopic examination data shall be recorded and stored on videotape, magnetic disk or optical disk or any other electronic storage device at the maker's plant for a sufficient period after the date of radioscopic examination as specified by the Inspecting Authority, Efficient radioscopic examination record recall shall be made available at any time over the record retention period and shall be traceable to the test objects.
- (e) When repair has been performed as a result of radioscopic examination, the repaired areas shall be re-examined using the same radioscopic technique to evaluate the effectiveness of the repair.
- (f) To aid in proper interpretation of the radioscopic examination data, the details of the technique used shall accompany the data. As a minimum, the information shall include the approved procedure requirements and system performance test data.

165. General.— (1) (a) Any repair to a weld carried out by the manufacturer shall first be agreed to by the Inspecting Authority.

(b) Where defects occur in distributed positions in a seam, repairs to the extent of 15 per cent, of the total length of the seam shall be permitted to replace the defective welding.

(c) Where defects are located in a single continuous length, the permissible extent of repair shall be decided by the Inspecting Authority.

(2) Where the weld metal in any way fails to comply with the requirements specified, the whole of the weld metal may be removed and the seam re-welded provided that;

(a) the original test plates are similarly treated, or

(b) New test plates of the same thickness as the joint and of similar quality of material are attached to the end of the seam and re-welded with it.

(c) In either case the plates shall be tested in accordance with regulations 156 to 164 and the requirement for heat treatment shall be in accordance with regulation 166.

(3) With regard to the extent of permissible repair and when agreed by the Inspecting Authority, a circumferential seam shall be treated in the same manner as a longitudinal seam. The Inspecting Authority shall be entitled to call for representative tests for a re-welded circumferential seam.

(4) Defects shall be cut out by chipping or machining or by burning out by the Air Arc Weld Process.

(5) Where a defective part has been cut out, the Inspecting Authority shall be entitled to make an examination before re-welding.

(6) Only metallic arc welding shall be used for repairs.

- (7) All repaired areas shall be subjected to radiographical examination or radiosopic examination by the approved techniques.
- (8) The Inspecting Authority shall be entitled to call for specimen representing any welded repair, for the purpose of examination and test.
- (9) On completion of all welded repairs, the manufacturers shall, if requested, supply for record purposes a detailed diagram showing the positions, length depth and width of all such repairs.

166. Heat treatment.—(1) (a) After completion of the welding of the seams and the welding on the stand pipes and including welding repairs but before the hydraulic test, each drum shall be heat treated for stress relieving; during this heat treatment the official test plates shall be lying inside the drum.

(b) For heat treatment requirements refer regulation 123.

- (2) Where shell is subjected to a primary stress relieving treatment identical to the final heat treatment to be given to the drum, the test plates may be placed inside the shell during the primary treatment and thereafter cut up and tested without waiting for the final treatment of the drum.
- (3) Where the shell is not subjected to primary stress relieving treatment or is subject to a primary stress relieving treatment which is not identical with the final heat treatment, the test plates may be placed inside any other drum of comparable dimensions which is to be heat treated in accordance with this Chapter. The heat treatment is to take place in the furnace in which the drum relating to the test plates will eventually be given its final heat treatment.
- (4) Temperature charts shall be submitted to indicate that the test plates and the drum they represent have been subjected to identical heating soaking and cooling treatment.
- (5) (a) For the heat treatment, the drum shall be placed in a furnace sufficiently larger to accommodate the whole drum.

(b) The furnace shall have proper means of temperature measurement and control and shall be capable of heating the whole of the drum to a uniform temperature. It shall be so designed as to prevent direct impingement of flame on the drum.

(c) Thermocouples shall be attached to the drum at appropriate locations. A temperature time diagram of the stress-relieving process shall be provided for a welded shell or drum and a similar diagram for other welded pressure part shall be provided where inspecting Authority requires it.

- (6) Alternative procedure for the heat treatment of the drum may be submitted to the inspecting Authority for approval.
- (7) In special cases it may be permissible to heat treat the test plates separately from the drum, provided the inspecting Authority is satisfied with the means adopted to ensure that the following factors shall be the same for the drum as for the test plates, namely:-
 - (i) Rate of heating
 - (ii) Maximum temperature
 - (iii) Time held at maximum temperature
 - (iv) Conditions of cooling.

167. Hydraulic test at makers' works.—(1) Boiler drum having internal diameter greater than 600 mm and other cylindrical component having internal diameters greater than 1000 mm shall be hydraulically tested on completion of manufacture at the makers works in the presence of Competent Person to $1\frac{1}{2}$ times the maximum allowable working pressure without indication of weakness and defects.

- (2) All components which are not reasonably accessible for inspection after assembly into the boiler or have been tested hydraulically prior to welding at a pressure less than that specified in sub-regulation (1) shall be tested hydraulically to $1\frac{1}{2}$ times the maximum allowable working pressure before assembly into the boiler.
- (3) Tubular products that have been hydraulically tested to the required pressure prior to welding or ultrasonically tested shall not require further hydraulic testing as components provided they were joined during assembly by circumferential butt joint which have been welded and non-destructively tested as per relevant provisions of these regulations.
- (4) Components other than tubular products shall not require hydraulic testing before assembly into the boiler if the completed boiler is tested hydraulically to $1\frac{1}{2}$ times the design pressure at site.
- (5) In case of drums, headers which are to be fitted with tubes, the test may be made before drilling of tube holes but after attachments of nozzles and similar fittings.
- (6) The test pressure shall be raised gradually under proper control at all times so that it never exceeds by more than 6% of the required pressure and maintained for 30 minutes whereupon the pressure shall be reduced to maximum allowable working pressure and maintained for sufficient time to permit close visual inspection for leakages of the pressure parts.
- (7) The temperature of water used as medium of pressure testing shall not be less than 20°C and more than 50°C.
- (8) (a) In case of drums of 'composite' construction and partly reverted and partly welded seams or seamless forged drum shell with ends attached by fusion welding.
- (b) The test pressure shall be the same as for fusion welded drums.
- (9) In case the hydraulic test reveal any defects in the welded steam, it shall not be repaired unless the Inspecting Authority permits to do so.
- (10) On completion of agreed repairs to a drum which has previously been stress relieved by heat treatment, further heat-treatment, if required by the Inspecting Authority shall be done and the drum shall again be subjected to hydraulic test.

PART-III

168. Inspection during construction.— Inspection during construction and fees therefor shall be governed in accordance with the provisions of Appendix-A and regulation 324.

PART-IV**MAXIMUM ALLOWABLE WORKING PRESSURE OF WATER TUBE BOILERS WITH FUSION WELDED DRUMS SHELLS**

169. Shell of steam and water drums.— (1)(a) The maximum allowable working pressure shall be determined by the following formula:

$$P = \frac{2fE(T - 0.75)}{D + (T - 0.75)} \quad \text{Equation (4/1)}$$

Where, P = Maximum Allowable Working pressure in kg/cm² (g)

T = Actual thickness of shell in mm,

D = maximum internal diameter of shell in mm,

F = permissible working stress in kg/cm² (g) at working metal temperature (see regulation 170),

E = the efficiency of ligaments between the tube holes or other uncompensated opening in shell, or the weld factor of the longitudinal joints,

For Class I boilers, the weld factor shall be taken as 1, In the particular case of an unpierced wrapper plate of a fusion welded drum,

E = 1,

(b) The minimum required thickness of shell shall be determined using the following formula:

$$t = \frac{P \times D}{(2 \times f \times E) - P} + 0.75 \quad \text{Equation (4/2)}$$

Where

t = Calculated minimum required thickness of the shell in mm,

P = Maximum Allowable Working pressure in kg/cm² (g)

D = maximum internal diameter of shell in mm,

f = permissible working stress in kg/cm² (g) at working metal temperature (see regulation 170),

E = Ligament efficiency as per regulation 171).

Irrespective of the thickness obtained by the use of the foregoing formula “t” shall not be less than: -

- (i) For tube plates (where the tubes are expanded therein) the thickness shall be at least such as to allow a minimum parallel belt width of tube seat of 10 mm, this seating to be measured as explained below.

- (ii) All tubes shall be carefully expanded into the holes in the tube plates. The tubes shall be belled or beaded to resist withdrawal and if belled they shall project through the parallel tube seat at least 6 mm.

(2) The belling shall be as shown in Table 4/4 below:

TABLE 4/4

Serial Number	Outside diameter of tube	Amount of diameter of belling over diameter of the tube hole (in) mm
(1)	(2)	(3)
(i)	Upto and including 38 mm	2 mm
(ii)	Over 38 mm upto and including 50 mm	3 mm
(iii)	Over 50 mm upto and including 83 mm	4 mm
(iv)	Over 83 mm upto and including 101 mm	5mm

- (3) The tube holes in the tube plates of drums pockets of headers shall be formed in such a way that the tubes can be effectively tightened in them. Where the tube ends are not normal to the tube plate, there shall be a neck or belt of parallel seating at right angle to the axis of the tube at least 13 mm in depth measured in a prime containing the axis of the tube at the hole.
- (4) Where the tubes are practically normal to the tube plate or the header, this parallel seating shall, where or practicable be not less than 10 mm in depth.

170. Permissible working stresses for shells of boiler and integral super heater drums and headers.—(1) The maximum permissible stress for drum shells and headers shall be taken as available in governing Boiler codes of the country of the material to which it belongs. In case of non-availability of the value, the following procedure for evaluating shall be adopted.

- (i) For temperatures at or below 454°C, the smaller of the two values:-

$$f = \frac{E_t}{1.5} \quad \text{or} \quad \frac{R}{2.7}$$

- (ii) For temperatures above 454°C, the least of the following three values:-

$$(a) \frac{E_t}{1.5} \quad (b) \frac{S_r}{1.5} \quad (c) S_c$$

Where,

t = Working metal temperature,

R = Minimum specified tensile strength of the steel at room temperature,

E = Minimum specified Yield point at room temperature,

E_t = Yield Point (0.2% proof stress) at the temperature 't',

S_c = The average stress to produce an elongation of 1% (creep) in 100,000 hours at temperature 't',

S_r = The average stress to produce rupture in 100,000 hours at the temperature 't' and in no case more than 1.33 times the lowest stress to produce rupture at the temperature.

Note: In case S_c values are not available in Material Standard and such materials are known to have been used in boilers in India or abroad, then for such materials the allowable stress may be taken as the lower of

$$\frac{E_t}{1.5} \quad \text{or} \quad \frac{S_r}{1.5}$$

(2) For fusion welded drums, when the wall thickness exceed 60 mm, a deduction of 1 per cent in the value of "f" so determined shall be made for each increase of 5 mm in the thickness. Such deduction need not be made provided the minimum specified values of R and E at any part of the section of the steel plate used in the manufacture of the Boiler drum are guaranteed by a "Well known Steel Maker" or certified by an Inspecting Authority.

(3) The working metal temperature shall be taken as:-

(a) For saturated steam, water and mud drums, the saturation temperature corresponding to the pressure WP plus 28°C.

(b) For superheated steam the designed maximum steam temperature for that drum plus 28°C.

(4) Where the drums are adequately protected from the gases of combustion or swept by such gasses in the third or subsequent pass of a boiler, the working metal temperature shall be taken as the saturation or designed maximum steam temperature as defined above, whichever applies. A covering of refractory or insulating material which may be liable to become dislodged shall not be deemed adequate protection.

NOTE: Where steels are for service at temperatures in excess of 370°C it shall be so stated as the silicon content shall be 0.10 per cent minimum or alternatively the material must pass the "Proof Test for Creep Quality of Carbon Steel Plate of Boiler Plate Quality" as in the Appendix-E.

171.Efficiency of ligament.— When a shell or drum is drilled for tubes in a line parallel to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows:

(a) When a pitch of the tube holes on every row is equal (as in Fig. 4/8), the formula is:

$$\frac{p - d}{p} = \text{efficiency of ligament} \quad \text{Equation (4/3)}$$

Where,

p = pitch of tube holes, mm.

d = diameter of tube holes, mm.

The pitch of tube holes shall be measured either on the flat plate before rolling or on the median line after rolling.

Example: Pitch of tube holes in the drums as shown in Fig. 4/8 = 133.3 mm. Diameter of tube = 82.5 mm. Diameter of tube holes = 83.3 mm.

$$\frac{p - d}{p} = \frac{133.3 - 83.3}{133.3} = 0.375, \text{ efficiency of ligament.}$$

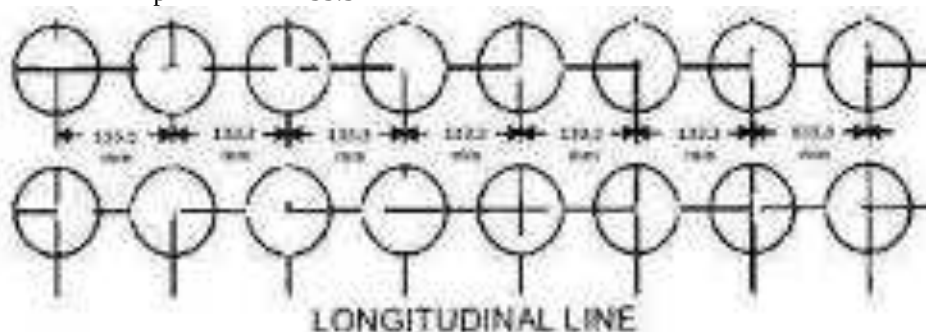


Fig. 4/8 – EXAMPLE OF TUBES SPACING WITH PITCH OF HOLES EQUAL IN EVERY ROW

(b) When the pitch of tube holes on any one row is unequal (as in Fig. 4/9 & 4/10), the formula is:

$$\frac{p - nd}{p} = \text{efficiency of ligament} \quad \text{Equation (4/4)}$$

Where,

p = unit length of ligament, mm.

n = number of tube holes in length p .

d = diameter of tube holes, mm.

Example: Spacing shown in Fig. 4/9 Diameter of Tube hole = 83.3 mm

$$\frac{p - nd}{p} = \frac{304.8 - (2 \times 83.3)}{304.8} = 0.453, \text{ efficiency of ligament.}$$

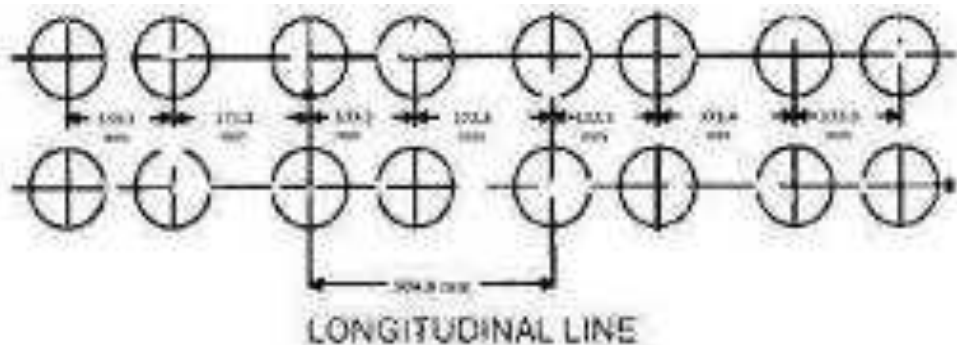


FIG. 4/9 – EXAMPLE OF TUBES SPACING WITH PITCH OF HOLES UNEQUAL IN EVERY ROW

Example: Spacing shown in Fig. 4/10 Diameter of tube hole = 83.3 mm

$$\frac{p - nd}{p} = \frac{742.9 - (5 \times 83.3)}{742.9} = 0.439, \text{ efficiency of ligament.}$$

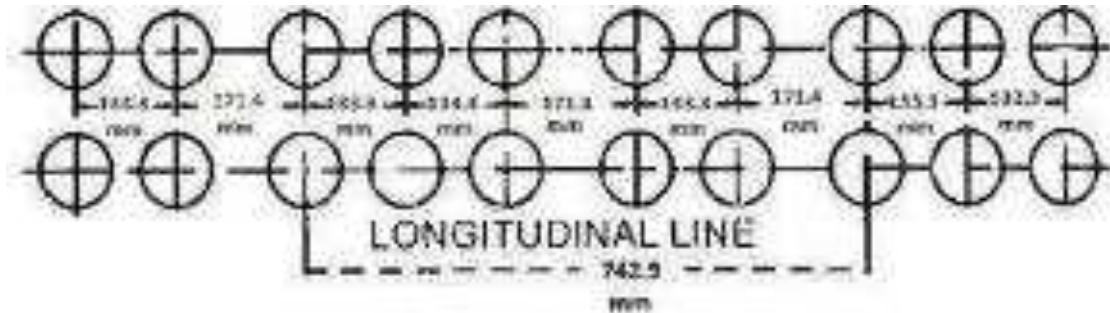


FIG. 4/10 – EXAMPLE OF TUBE SPACING WITH PITCH OF HOLES VARYING IN SECOND AND THIRD ROW

- (c) The strength of those ligaments between the tube holes which are subjected to a longitudinal stress shall be at least one-half times the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.
- (d) (i) When bending stresses due to weight are negligible and the tube holes are arranged along a diagonal line with respect to the longitudinal axis, the efficiency (z) of corresponding ligaments is given in Fig. 4/11, with the ratio b/a on the abscissa and the ratio

$$\frac{2a - d}{2a} \quad \text{or} \quad \frac{d}{a} \quad \text{used as a parameter.}$$

Where, a and b are measured as shown in Figs. 4/13 and 4/14,

d = diameter of the tube holes.

Notes: 1. The dimension should be measured either on the flat plate before rolling or on the medium line after rolling.

2. The data given on Fig. 4/11 are based on the following formulae:

$$Z = \frac{2}{A+B+\sqrt{(A-B)^2+4C^2}}$$

Where,

$$A = \frac{\cos 2\alpha + 1}{2 \times \left(1 - \frac{d \cos \alpha}{a}\right)}$$

$$B = \left(\frac{1}{2}\right) \times \left(1 - \frac{d \cos \alpha}{a}\right) (\sin^2 \alpha + 1)$$

$$C = \frac{\cos \alpha \sin \alpha}{2 \times \left(1 - \frac{d \cos \alpha}{a}\right)}$$

$$\cos \alpha = \frac{1}{\sqrt{1 + \frac{b^2}{a^2}}}; \sin \alpha = \frac{1}{\sqrt{1 + \frac{a^2}{b^2}}}$$

(α = angle of centre line of cylinder to centre line of diagonal holes).

- (ii) The same rule as in paragraph (i) should apply for the case of drilling holes to a regular saw-tooth shown in Fig. 4/15.
- (iii) In the case of a regular staggered spacing of tube holes (*see* Fig. 4/13, the smallest value of the efficiency z of all the ligaments, longitudinal, circumferential and diagonal, is given in Fig. 4/12 by the ratio P_c/P_L on the abscissa, and the ratio

$$\frac{P_L - d}{P_L} \quad \text{or} \quad \frac{d}{a} \quad \text{used as a parameter.}$$

Where,

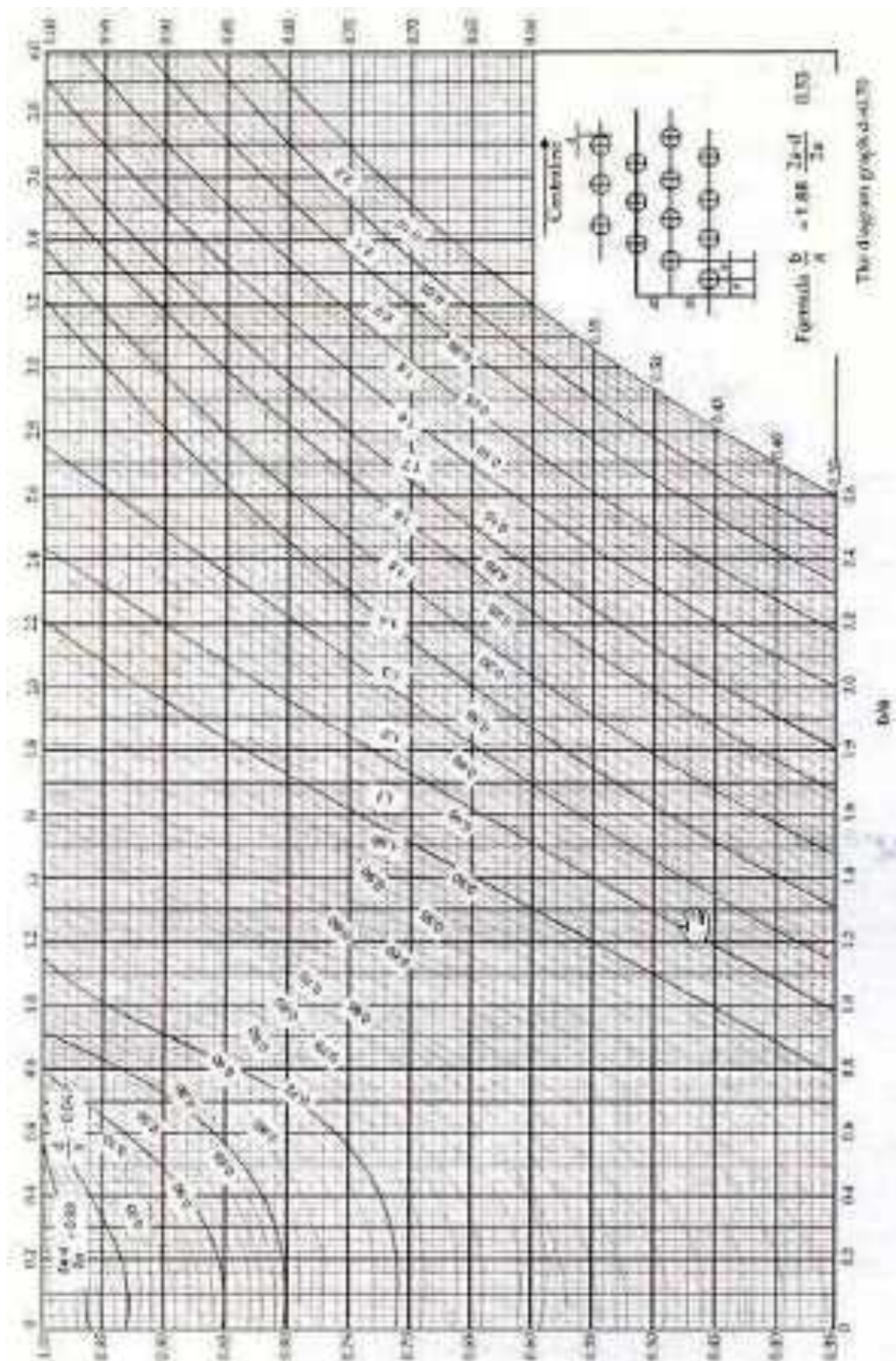
$d =$ diameter of tube holes, mm.

$P_c = 2b =$ twice the distance between circumferential rows of holes;

$P_L = 2a =$ twice the distance between axial row holes;

Note: The dimension P_c should be measured on the flat plate before rolling or on the medium line after rolling. The data on Fig. 4/12 are based on the same formulae as shown in Fig. 4/13.

- (e) When holes spaced longitudinally along a drum are not in a straight line, the equivalent longitudinal pitch for each spacing may be used in the application of the above rules. The equivalent pitch is obtained by multiplying the actual longitudinal pitch by the equivalent efficiency obtained from Fig. 4/11 for each spacing.



EFFICIENCY

Fig. 4/11: Efficiency of Ligament along a Diagonal Line

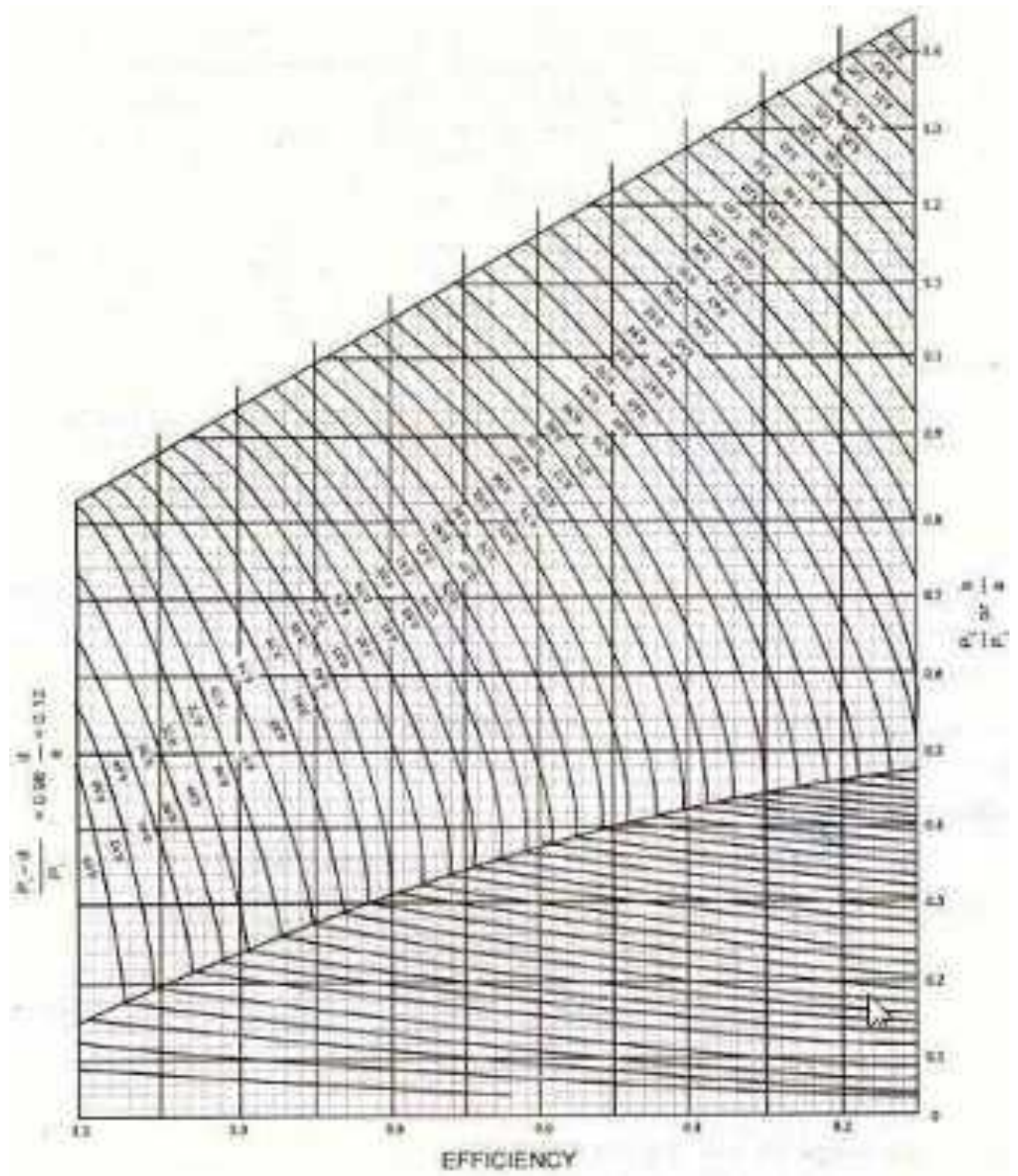


Fig. 4/12: Efficiency of Ligaments between Holes

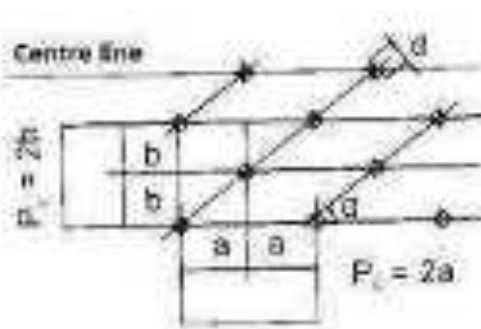


Fig. 4/13: Regular Staggering of Holes

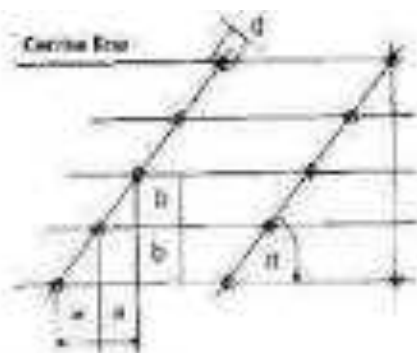


Fig. 4/14: Regular Saw-Tooth Pattern of Holes

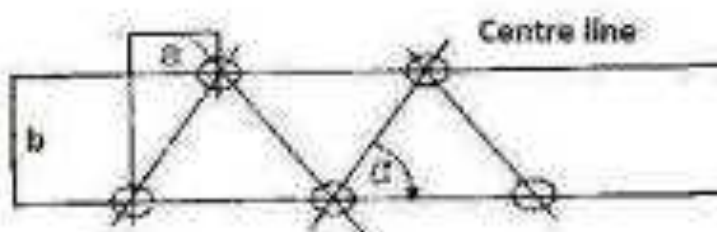


Fig. 4/15: Regular Saw-Tooth Pattern of Holes

172. Longitudinal stress.— (1) Notwithstanding the maximum allowable working pressure as calculated by equation (4/1), the thickness of drum or cylindrical header shells shall be such that in no case does the longitudinal stress resulting from the combination of stress arising from internal steam pressure, the self-weight of the drum or header and its contents and all externally applied loads, exceed the permissible working stress corresponding to the working metal temperature as prescribed in regulation 170.

- (2) The maximum direct longitudinal stress due to the internal steam pressure acting on the drum ends shall be calculated as follows:

$$f_d = \frac{PD^2}{1.273A} \quad \text{Equation (4/5)}$$

Where,

f_d = Maximum direct longitudinal stress in kg/cm^2 ,

P = Maximum Allowable Working Pressure in kg/cm^2 (g),

D = Internal diameter of the drum or header in cm,

A = Net cross-sectional area of the drum or header in cm^2 taken through the tube holes in a plane at right angles to its axis.

- (3) The resultant bending moments M at any section shall be the algebraic sum of the bending moments due to the eccentricity of the end pressure and that due to the externally applied loads.

$$M = M_e + M_w \quad \text{Equation (4/6)}$$

The bending moment due to the eccentricity of end pressure shall be calculated as follows.

$$M_e = \frac{PD^2 \cdot e}{1.273} \quad \text{Equation (4/7)}$$

Where,

M_e = Resultant bending moment due to eccentricity in kgf-cm,

P = Maximum Allowable Working Pressure in kg/cm² (g),

D = Internal diameter of drum or header in cm,

e = Eccentricity of the net cross-section i.e., the distance from the neutral axis of the net cross section to the drum or header axis in cm.

The bending moment (M_w) due to externally applied loads shall be calculated by treating the drum or header as a beam carrying the externally applied loads, including the self-weight of the drum or header and its contents under working conditions.

- (4) The stress due to bending shall be calculated as follows:

$$f_b = \frac{M_r Y}{I} \quad \text{Equation (4/8)}$$

Where,

f_b = Stress due to bending in kg/cm².

M_r = resultant bending moment at the section in kgf-cm,

Y = Distance from the neutral axis of the net cross-section to the extreme fiber of the drum or header shell in cm.

I = Moment of inertia of the net cross-section taken about its neutral axis in (cm⁴).

The resultant longitudinal stress is the algebraic sum of the stresses given under (2) and (4).

- (5) In calculating the longitudinal stress due to bending in a drum supported at or near its ends and connected to a lower drum by a bank of tubes (so arranged as to form substantial struts between the drums) the value of the moment of inertia I_a used in the formula in sub-regulation (4) shall be : -

Moment of inertia of upper drum (I_b) plus a proportion (S) of the moment of inertia of lower drum (I_c).

$$S = 1 - \frac{\alpha^2}{240} \quad \text{Equation (4/9)}$$

Where, α the angle in degrees between the vertical and the line joining the centers of the upper and lower drums. Where α is equal to or greater than 15½°; S shall be taken as 0. In no case shall the actual value of I_a used in Equation (4/8) be taken as more than 1.33 times the moment of inertia of the upper drum (I_b).

In the foregoing, unless otherwise agreed the term “bank of tubes” shall be defined as consisting of four or more rows of tubes extending over at least three quarters of the drum length between supports, and pitched longitudinally at not greater than an average pitch of four tube diameters.

173. Intermediate boiler drum supports.— Where a boiler drum is supported at Intermediate points in its length at a distance greater than one internal diameter from the end of the parallel portion of the drum shell, the shell shall be thickened locally to the supports or so designed that when the local stress set up by the supports in the drum shell are added, algebraically to those caused by the internal steam pressure and supported loads, the maximum resultant stress does not exceed the permissible working stress at the working metal temperature.

PART-V

174. Shape of dished end plate.— When the end plate is dished to semi-ellipsoidal, partial spherical or hemispherical form, it shall comply with the following: (see Fig. 4/16, 4/17, and 4/18);

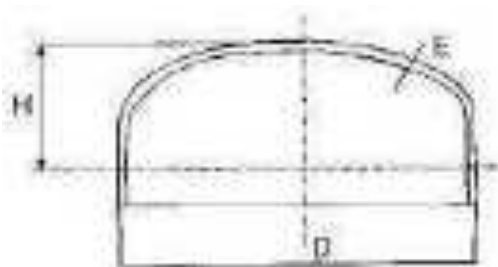


Fig. 4/16: Elliptical Head

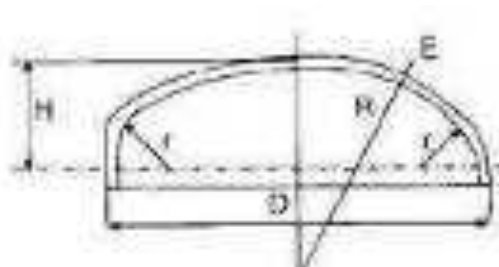


Fig. 4/17: Torispherical Head

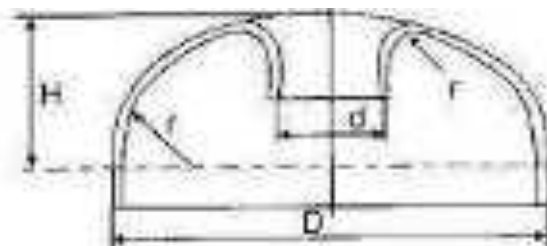


Fig. 4/18: Head with Manhole (Elliptical or Torispherical)

- (a) Hemispherical heads without limitation;
- (b) Elliptical heads sufficiently dished so that $H \geq 0.2 D$;
- (c) Partial spherical heads satisfying all the following requirements:

$$r \geq 0.1 D$$

$$r \geq 3 T$$

$$R \leq D$$

$$H \geq 0.18D$$

A value of $R < 1.2 D$ is permitted for ends in which the ratio H/D falls between 0.18-0.2.

In accordance with Figs. 4/16, 4/17, 4/18, 4/19, 4/20, 4/21 –

D = outside diameter of the head;

H = height of the head measured on its outside surface from the junction of the dished part with the cylindrical shell;

R = inside radius of the spherical part of partial spherical heads;

r = inside knuckle radius of partial spherical heads.

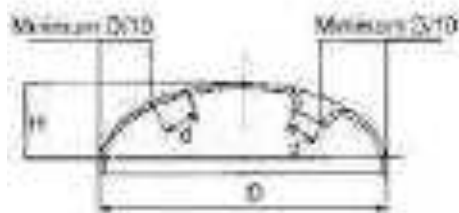


Fig. 4/19: Opening in Heads

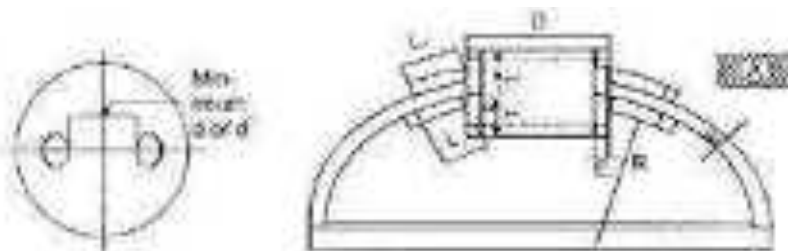
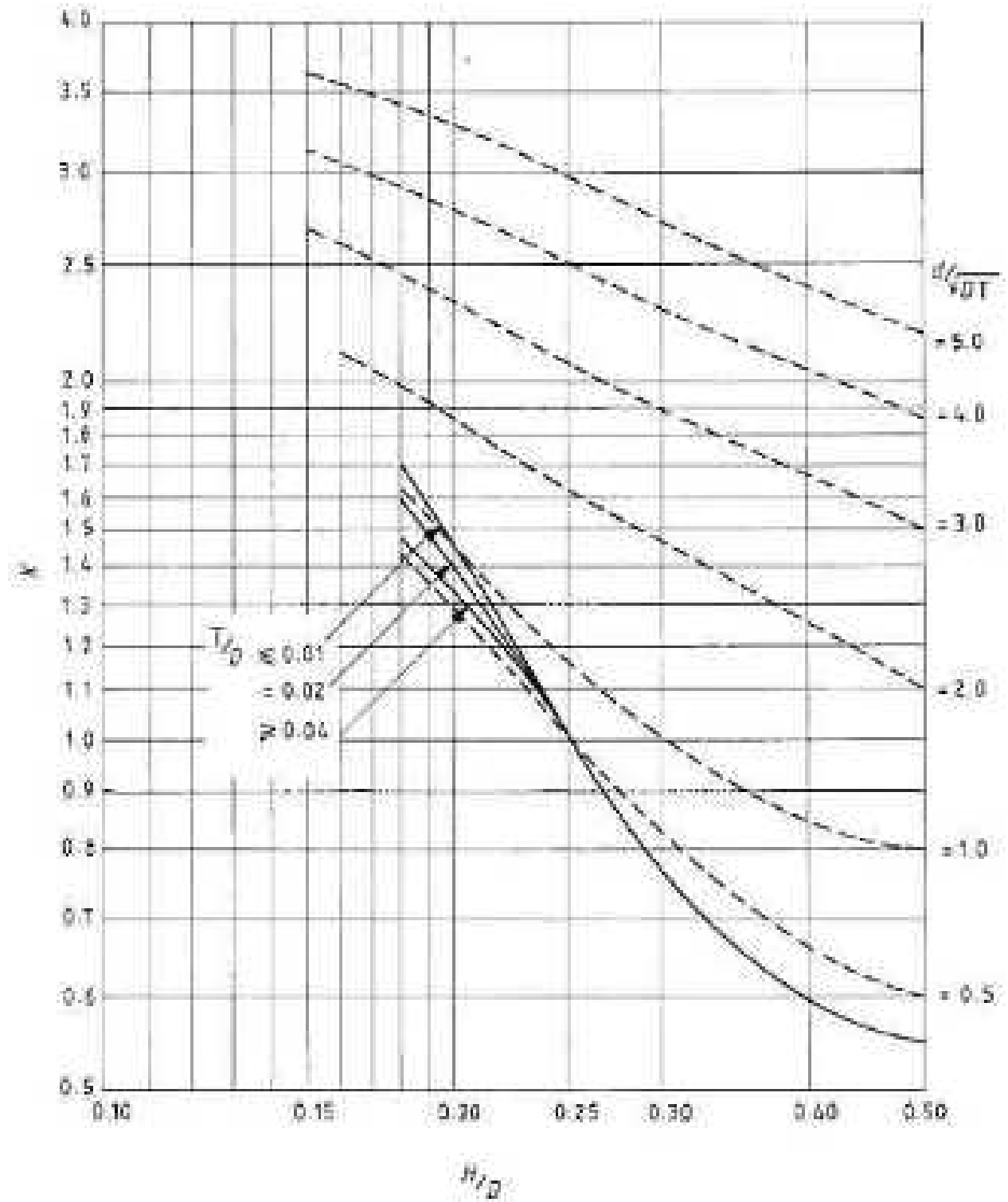


Fig. 4/20: Reinforced opening



DEPTH RATIO H/D

Note 1: The curve drawn with continuous line in the series is for determining value of K for plain unpierced heads. Other curves with dotted lines are for heads with opening on it.

Note 2: If the H/D ratio is less than 0.25 (torispherical heads), additional consideration shall be given to the ratio of T/D in determining the value of K

Fig. 4/21: Graph of Shape Factor K for Dished Heads

175. General.— (1) The thickness 'T' specified in equation (4/10) of regulation 177 is the thickness of the end plate after manufacture and is applicable over the whole area of the end plate up to the point where, for ends of partially spherical shape, the dishing radius joins the corner radius; from this joint a gradual thinning is permissible up to maximum of 10 per cent of the thickness 'T' at the point where the corner radius joins the straight portion of flanged end plate.

(2) A similar gradual thinning is permissible for end plates of semi-ellipsoidal shape.

(3) This permissible reduction in thickness applies also to the flange for the manhole opening. In no case, however, when the end plate is butt welded to the drum shell, shall the thickness of the edge of the flange for connection to the shell be less than the thickness of an unpierced seamless shell of the same diameter and material, determined by equation (4/2).

176. Dished end with opening.— (1) (a) Holes cut in the heads (manholes or tube holes) shall be round or elliptical.

(b) Small size openings complying with conditions of sub-regulation (3) do not require any additional thickness of head or reinforcement of opening.

(c) Large size openings require an increase in thickness of the head, according to sub-regulation (2) or a reinforcement of the opening according to sub-regulation (4) .

(2) (a) The shape factor 'K' to be used in calculating the thickness of heads varies depending on the height of the head 'H' and on the dimension of the largest opening. The value of K is indicated in Fig. 4/21, by means of curves, each of which corresponds to a value of the ratio--

$$\frac{d}{\sqrt{DT}}$$

Where,

d = diameter or the largest opening in the head (in the case of an elliptical opening, the larger diameter of the ellipse);

D = outside diameter of the head; and

T = minimum thickness after dishing.

(b) In addition, the following conditions shall be satisfied;

$$\frac{T}{D} \leq 0.1 \quad \text{and}$$

$$\frac{d}{D} \leq 0.5$$

(c) The same condition and the same curves apply for openings simply cut in the plate of the head as well as to those which are flanged inwards. In the latter case, the radius 'r' of the flanging (see Fig. 4/18) should not be smaller than 25 mm. The thickness of the flanged portion may be smaller than the calculated thickness 'T'.

(d) Unreinforced openings and flanged-in openings in dished heads shall be arranged so that the distance from the edge of the head is not less than as shown in Fig. 4/19.

(e) In all case the width of the band separating two adjacent openings should, in projection, be at least equal to the diameter of the smallest opening as shown in Fig. 4/19.

- (3) (a) Small openings which do not require any reinforcement; Fig. 4/21 indicates that, for a given ratio of H/D, the shape factor K of a plain head corresponds to a certain value of the ratio,

$$\frac{d}{\sqrt{DT}}$$

- (b) Piercing of holes with a diameter smaller than or equal to that which corresponds to this value can thus be made without any reinforcement in a head, the thickness of which is equal to the minimum required for a plain head.
- (c) The position of those openings shall however comply with the conditions stated in sub-regulation (2).
- (4) (a) Reinforcement of large openings; large holes may be cut without increasing the thickness of the head provided they are sufficiently reinforced.
- (b) The reinforcement may consist either of a welded nozzle or one or two reinforcing welded plates, or of a combination of these two procedures.
- (c) To determine the strength of the construction, one shall proceed as follows (see Fig. 4/20) Let the imaginary diameter d' of the opening be given by the formula.

$$d' = d - \frac{A}{T}$$

Where,

d = actual diameter of the opening in the head (outside diameter of the nozzle);

T = minimum thickness of the head; and

A = effective cross-section of reinforcement.

- (d) This effective area 'A' corresponds, within the Limits given below, with the actual cross-section of the reinforcing plates and with the cross-section of the nozzle decreased by the cross-section necessary to support the pressure, for those parts of the nozzle situated outside the internal surface of the head.

- (e) The shape factor K can then be read from Fig. 4/21, corresponding to the ratio $d' / \sqrt{DT}$

- (f) The maximum limits for the area of reinforcement that shall be taken into account are

- (a) $L_1 = \sqrt{2RT}$ for the width of a reinforcing plate;

- (b) $L_2 = \sqrt{dT_1}$ for the length of a nozzle

Where,

R = internal radius of the spherical part of the head (or for elliptical heads the internal radius of curvature of the meridian at the centre of the opening).

T_1 = actual thickness of the nozzle,

L_1 and L_2 = dimensions given in Fig. 4/20.

- (g) The position of the outer edges of the reinforcement shall comply with the provisions of sub-regulation (2) and Fig. 4/19.

- (h) In cases where the allowable stress of a part of the reinforcement is lower than that of the head, the corresponding area A should be multiplied by the ratio:

$$\frac{\text{allowable stress of the reinforcement material}}{\text{allowable stress of the head material}}$$

177. End plate subject to pressure on the concave side.—(1) Dished ends subjected to pressure on the concave side shall be determined by the following formula;

$$P = \frac{2f(T - 0.75)}{DK} \quad \text{Equation (4/10)}$$

Where,

T = Actual thickness of dished end in mm;

P = Maximum Allowable Working Pressure in kg/cm² (g);

D = Outside diameter of dished end in mm;

f = is the maximum permissible stress values as available in the governing codes of the country of the material to which it belongs in kg/cm²;

K = Shape factor as defined in sub-regulation (2) of regulation 176 and Fig. 4/21;

0.75 = additive thickness in mm.

(2) The minimum head thickness shall, however be not less than 5 mm.

(3) The minimum required thickness of dished end shall be determined by the following formula:

$$t = \frac{P \times D \times K}{2 \times f} + 0.75 \quad \text{Equation (4/11)}$$

Where,

P = Maximum Allowable working pressure in kg/cm² (g),

t = Calculated minimum thickness of dished end in mm;

D = Outside diameter of dished end in mm;

f = is the maximum permissible stress values as available in the governing codes of the country of the material to which it belongs in kg/cm²;

K = Shape factor as defined in sub-regulation (2) of regulation 176 and Fig. 4/21; and

0.75 = additive thickness in mm

178. Internal doors.— Requirements of regulation 137 shall apply.

PART-VI

179. Stand Pipes, nozzles and openings.— (1) Where openings in drums, shells, pipes are drilled in a definite pattern, the efficiency of the ligaments shall be determined by the methods given in regulation 171 provided the largest hole in the group doesn't exceed the following:-.

The maximum diameter of any unreinforced opening shall not exceed 'd' as calculated from the following equation (subject to a maximum of 203mm).

$$d = 8.08 \{(1-K) Dt\}^{1/3}$$

$$K = PD / 1.82 f t$$

	where ,
D	= nominal OD of the Drum, Shell, Header, Pipe or Dished end containing opening (mm)
t	= actual thickness (mm)
P	= Maximum Allowable Working Pressure (kg/cm ² (g))
f	= maximum permissible stress as available in the governing codes of the country to which material belongs (kg/cm ² (g)).

When K has a value of unity or greater, maximum diameter of unreinforced opening should be taken as 51mm. Larger openings shall be compensated in accordance with sub-regulation (2) of regulation 179.

- (2) (a) Where standpipes or nozzles are secured by welding, adequate compensation for the hole cut shall be provided. Compensation shall be considered adequate when the sectional area 'X' to be compensated measured through the axis of the shell is less than the compensating area 'Y' given in Fig. 4/22 and Fig. 4/23.
- (b) In case where 'Y' is less than 'X', a compensating plate shall be fitted to the shell at the standpipe and secured by fillet welds as in Fig. 4/22 and Fig. 4/23.

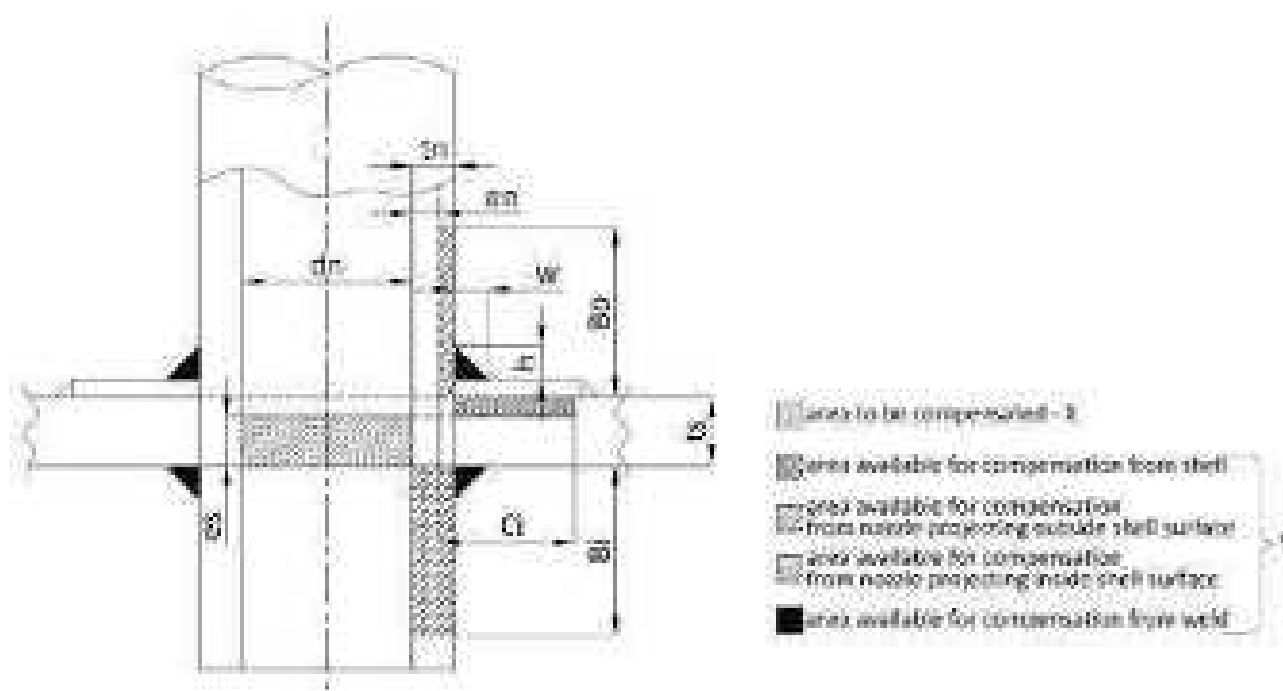


Fig. 4/22: Compensation of Set through branch openings

d_n = nozzle maximum inside diameter for set on type nozzles or hole diameter for set through type nozzles

t_n = actual thickness of nozzle

e_n = thickness of nozzle required to withstand the required pressure, temperature and external loads on the nozzle.

f_s = allowable stress for shell material at the working metal temperature

f_n = allowable stress for nozzle material at the working metal temperature

C_i = greater of $(t_s + 76, d_n/2)$

B_o & B_i = least of (2.5 times the actual thickness of shell, 2.5 times the actual thickness of nozzle).

Note: In any case if the length of nozzle is less than the condition specified above, then 'Bi' & 'Bo' should be limited to actual length of the nozzle.

w = width of weld

h = height of weld

No credit should be taken for additional strength of material having higher stress value than that of shell used for nozzle or reinforcing pad.

The area of cross-section of the compensation plate shall be governed by the ratio between the permissible stress at the working metal temperature for the materials of the shell and the compensating plate.

(3) Where the standpipe or nozzles are welded to dished end plates, the compensation shall be considered adequate if calculated on the same basis as in sub-regulation (1) and (2) above. But the cross-sectional area of the end plate to be compensated shall be calculated on the basis of Equation (4/10) and the height of standpipe above the outer surface on within the inner surface of the end plate shall be measured along the radial line passing through the centre of the opening.

(4) The minimum thickness of the flanges and the body of standpipes shall be in accordance with regulation 127. Flanges conforming to International codes and standards such as ASME, BS, EN, DIN can also be used if it is meeting required pressure and temperature ratings.

180. Attachment of stand blocks and branch pipes by welding.— (1) Typical methods of attachment are shown in figures, namely:-

Fig. 4/24, 4/25, 4/26, 4/27, 4/28, 4/29, 4/30, 4/31, 4/32, 4/33, 4/34, 4/35 and 4/36.

All weld dimensions shown shall be regarded as minimum dimensions those defining the grooves refer to the actual preparation for welding.

t_n = Specified thickness of standpipe or branch pipe.

t_s = Specified thickness of drum or header shell at standpipe or branch connection.

t_e = Actual thickness of compensating ring.

The application of certain of the constructions illustrated may be limited by consideration of design pressure and temperature or size (in combination) and although certain dimensions are given, each case must be considered on its merits.

Other methods may be adopted subject to agreement between the Inspecting Authority and manufacturer.

- (2) Welding consumables shall comply with the requirements of regulation 71 to 76.
- (3) Not less than two runs of metal shall be deposited at each weld. Each run of weld metal shall be thoroughly cleaned and freed from slag before the next run is deposited. In the case of water tube boiler or boilers fitted with super heater, the feed water connection and stop valve need not be shut off and if the total valve area is lifted and found to be adequate by calculations, the requirement of the accumulation test may be assumed to have been satisfied if the valves area has been found so adjusted that at least one safety valve on each boiler shall lift at or below the design pressure of the boiler and all valves shall lift so that are steam which can be generated by the boiler can be discharged with a pressure rise not exceeding 10 per cent of the design pressure.
- (4) The final finish of the weld shall be such that change of section from drum to standpipe, or from flange to standpipe is gradual and free from sharp notches. After completion of welding (except in the case of seal welds) the drum shall be stress-relieved by heat treatment.

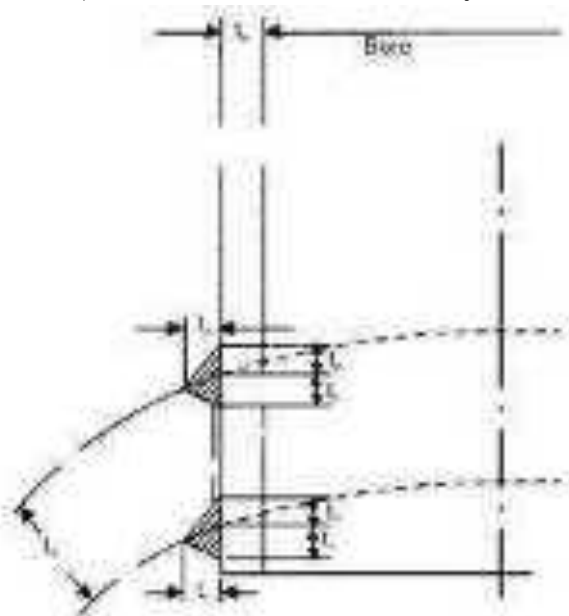


Fig. 4/24: Welded in Stand Pipe or Branch for Stand Pipes and Branches up to and including 101.6 mm Bore

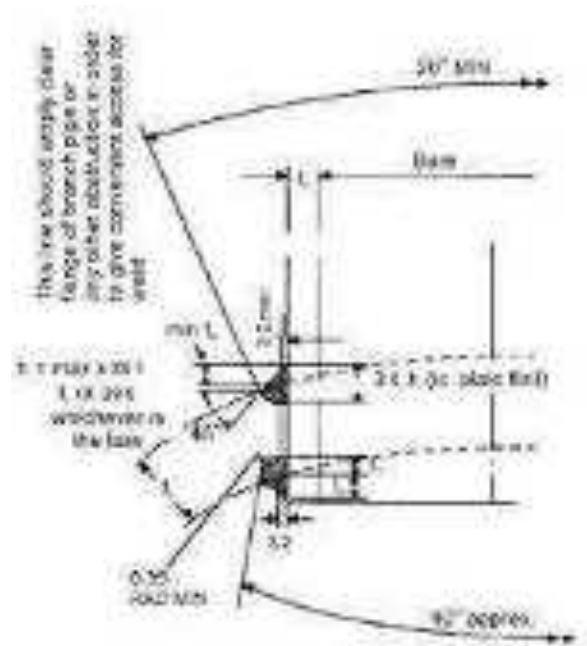


Fig. 4/25: Welded to Stand Pipe or Branch or Branches up to any and including 101.6 mm Bore

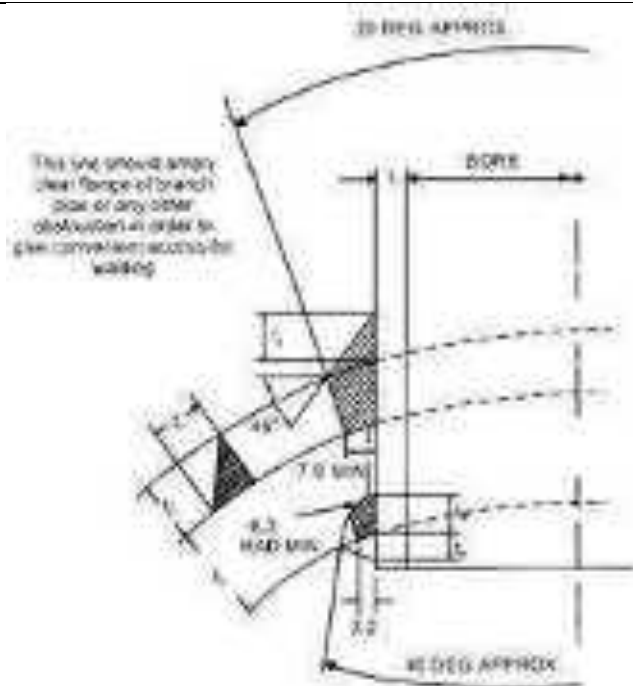


**Fig. 4/26: Welded in Stand Pipe or Branch with
Compensating Ring for Stand Pipes or Branches
including 101.6 mm Bore**

All dimensions are in mm.

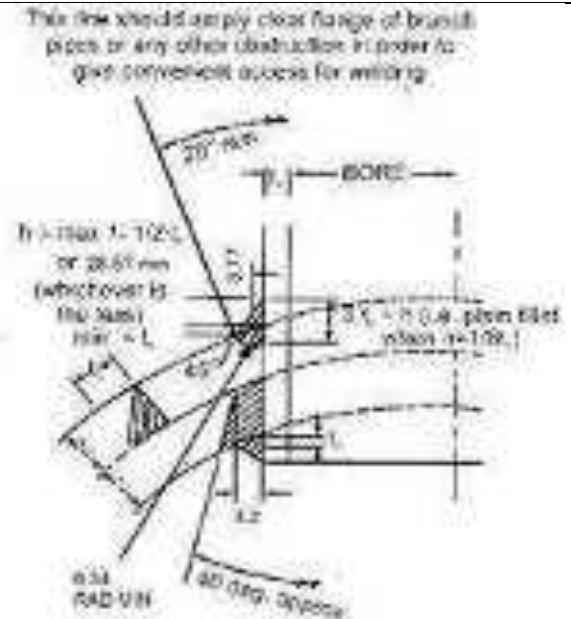


**Fig. 4/27: Welded in Stand Pipe or Branch with
Compensating Ring For Stand Pipes and Branches
up to and including 101.6 mm Bore**

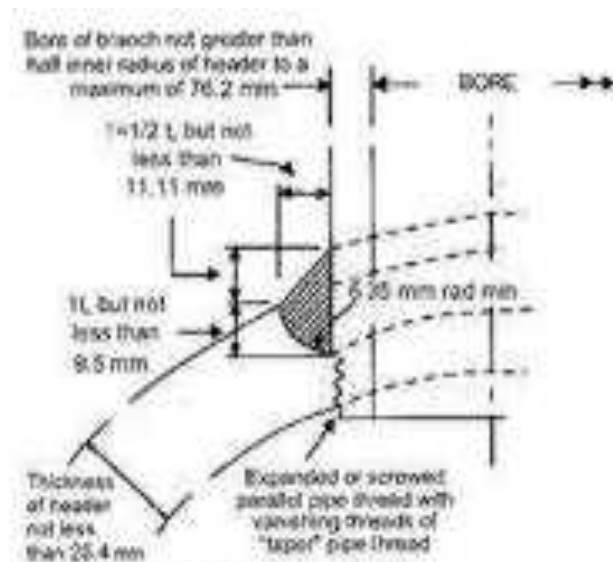


Fig. 4/20

A header branches. Welding accessible from outside only. Maximum design pressure 31.63 kg/cm² maximum design temperature 127°C. Applicable to the circular section of headers with above limiting size of branch or flat sides of headers without limiting size of branch.

Note: This type of weld is not recommended where the inside of the header is accessible for welding.

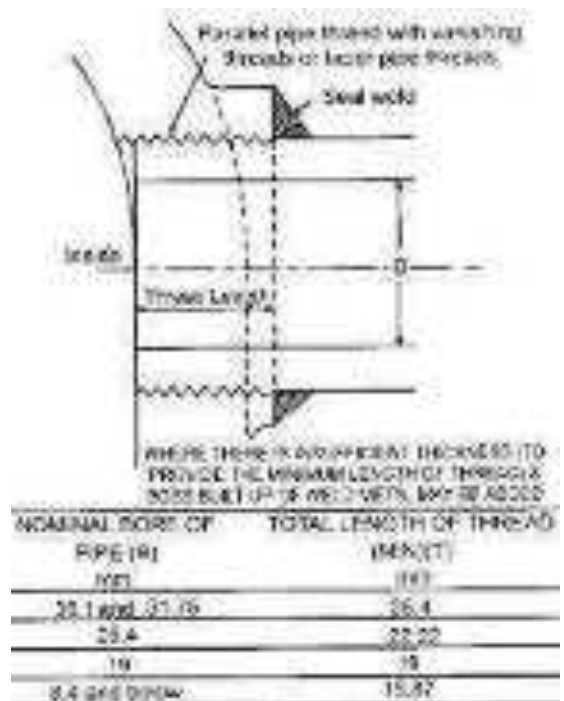


Fig. 4/29: Screwed and Seal Welded Connection

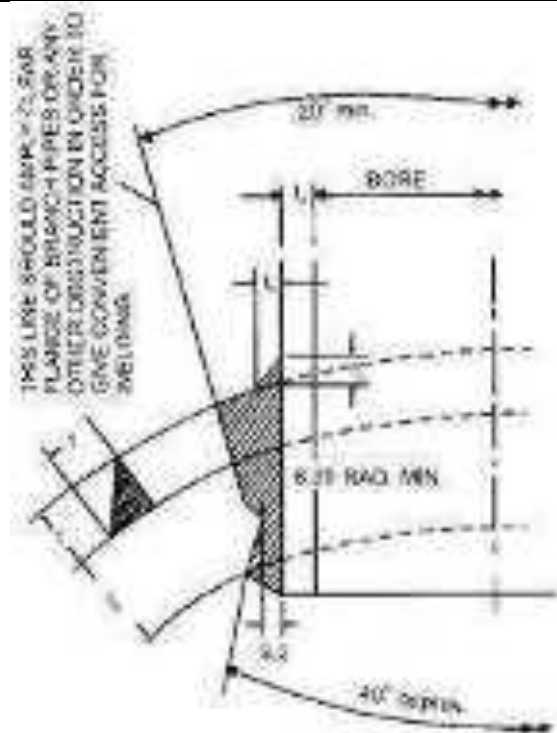


Fig. 4/30: Welded in Stand Pipe or Branch with Compensating Ring

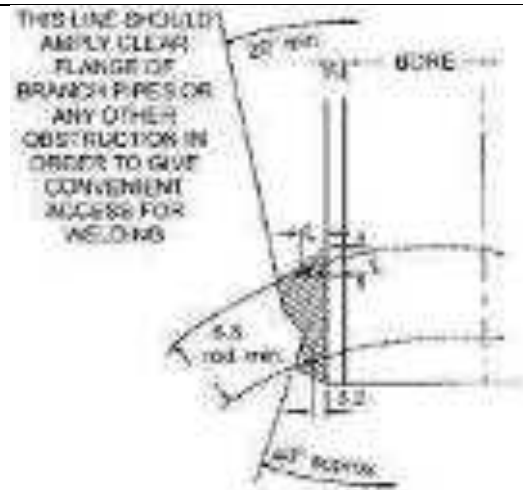


Fig. 4/31: Welded in Stand Pipe or Branch

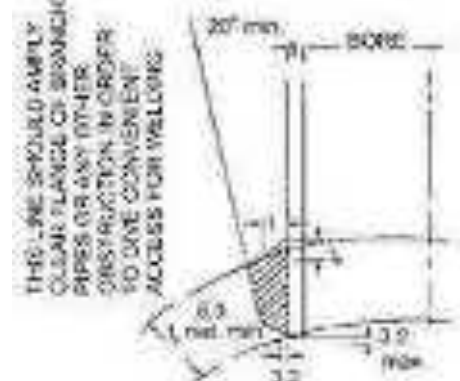


Fig. 4/32: Welded in Stand Pipe or Branch

All dimensions are in mm.

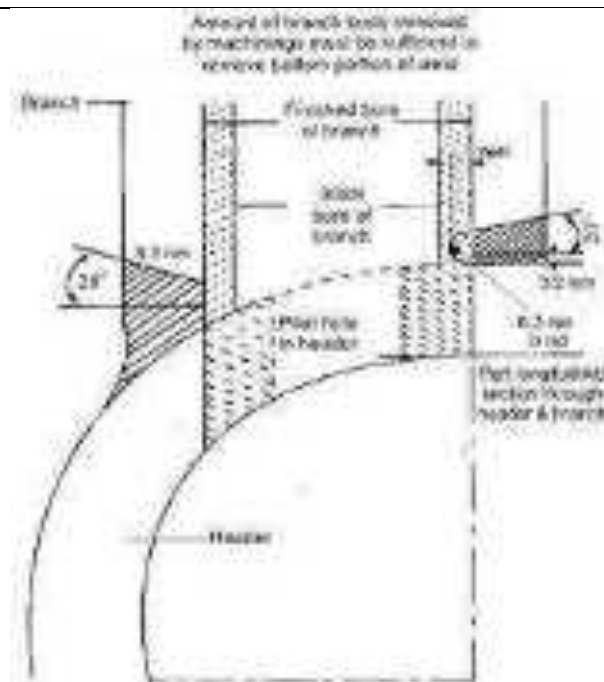


Fig. 4/33: Branch Welded on Header with Internal Machinery

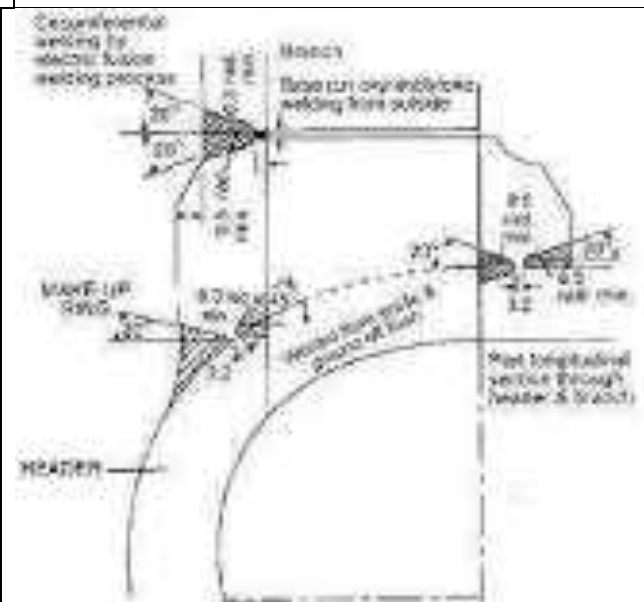


Fig. 4/34

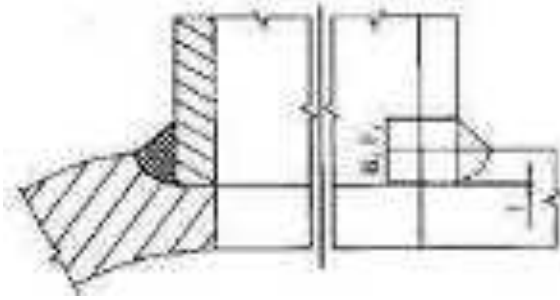


Fig. 4/35: Unreinforced Branches Inaccessible for Welding Inside Shell

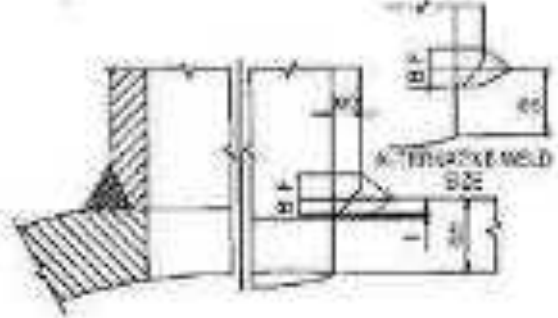


Fig. 4/36: Unreinforced Branches Inaccessible for Welding Inside Shell

Notes:

The branch must be loose fit in the hole but the gap at any point, should not exceed 3 mm or $en/2$ whichever is less.

Welded sizes $B_1 + F_1 = 1.5en$.

F_1 should not exceed 16 mm not be less than $en/2$. Weld size $B + F = 1.5en$ minimum or $1.5es$ minimum, whichever is less.

F should not exceed 16 mm nor be less than $en/2$.

en = Thickness of nozzle.

es = Thickness of shell.

All dimensions are in mm.

CHAPTER-5
VALVES, GAUGES AND AUXILIARIES

PART-I

181. Requisite Mountings, fittings and Auxiliaries. — (1) Every boiler shall be provided at least with the following, namely: -

- (a) Two safety valves, one of which may be a high steam and low water type safety valve and in no case the bore of the seat of the valve should be less than 19 mm.
- (b) Two means of indicating the water level;
- (c) A steam pressure gauge;
- (d) A steam stop valve;
- (e) A feed check valve;
- (f) One feed apparatus;

Provided that for boilers fired by gaseous, liquid or solid fuels in suspension where heating surface exceeds 20 m², shall be provided with minimum two feed apparatus which shall have a combined capacity of not less than the maximum continuous rating of the boiler: Provided further that for other boilers where residual heat is there even after fuel supply cut-off, two feed apparatus each having a capacity of not less than maximum continuous rating of the boiler shall be provided. (For boilers in battery see regulation 242);

- (g) A blow-down cock or valve;
 - (h) Fusible plugs as provided under Regulation 236;
 - (i) An attachment for Competent Person's test gauge;
 - (j) A manhole, where size and construction permit, and such mud holes or sight holes as are necessary for effectively cleaning the boiler.
- (2) In the case of boilers fitted with integral super heaters, an additional safety valve shall be fitted at the end of the super heaters outlet header.
- (3) In the case of boilers with no fixed steam and waterline, the fitting of such accessories that are manifestly not needed or used, such as water gauges, water columns and gauge cocks, may not be insisted upon.
- (4) In the case of a single boiler of the Shell type and not connected in a battery with other boilers, the heating surface of which does not exceed 102 m², two independent source of power supply to the two feed apparatus shall not be necessary.
- (5) In the case of miniature boilers coming under Chapter-14, the Steam pressure gauge may be connected to the steam space or to a steam connection to the water column by a syphon tube or equivalent device that will keep the gauge tube filled with water and if brass or bronze composition is used, the minimum size of the syphon tube shall be 6 mm standard pipe size; for other materials the minimum inside diameter of the pipe or tube shall be 13 mm.
- (6) For Electrode boilers, see regulation 356.

- (7) In case of boilers with reheaters, the reheaters shall be protected with one or more relieving devices of 105% capacity (15% of the total capacity shall be located in the steam flow path between reheater outlet and first stop valve) to avoid over pressure in case of internal failures.

182. Additional Requirements for Automatic Boilers.—(1) Every boiler which is provided with the appropriate water level and /or firing control, to allow for automatic working, shall comply with the following requirements:

- (a) In the event of failure of automatic control, boiler shall be capable of being brought under immediate manual control.
- (b) In those cases where the control and alarm devices are housed in chambers external to the boiler, the following shall apply, namely:-
 - (i) The boiler shall have provision made for isolating the steam and water connections of the chambers from the boilers. Such isolating valves shall be capable of being locked in the open position and shall preferably be of the parallel slide type but if screw down stop valves are fitted, those on the water connection shall be mounted with the horizontal spindle to avoid the possibility of an air lock. The steam and water connections of the chambers shall be not less than 25 mm bore. In those cases where sequencing control water valves are fitted, the steam isolating valve may be omitted;
 - (ii) The boiler shall be provided means to test operation of the control or alarm and to blow through separately the water connection and the chamber to prevent the accumulation of deposits. The means provided for flowing through shall be sequencing valves or equivalent devices so arranged that the water connection to the boiler cannot be shut off unless the drain connections to the chamber is open;
 - (iii) The boiler shall have a drain system from the chambers which provides a visual indication of flow. Tundishes of adequate size, placed in a prominent position shall be used wherever practicable.
- (c) Where the boiler is provided with electrical equipment for water level and firing control, it shall have this equipment so designed that any fault in the circuits caused, both in the fuel and air supply, the boiler to be automatically shut off. Positive means requiring manual resetting shall be provided to cut off the fuel and air supplies to the boilers should there be a failure of electricity supply to water level and / or firing control equipment. All electrical conductors and equipment in connection with water level and firing controls shall be of adequate size and shall be properly insulated and protected against danger including adequate protection against the ingress of moisture and the effects of high temperature.
- (d) Where the evaporating capacity of the boiler is greater than 3700 Kg/h, it shall have automatic water level alarms and firing controls and can be tested regularly without altering the level of water in the boiler. The water level alarms may be incorporated in the automatic control system. With a perceptible water level which are arranged for automatic working and not intended for continuous supervision, shall be provided with an entirely independent and separately operated over-riding control in addition to the water level and firing control specified in sub-regulations (2) and (3). The over-riding control shall comply with the following requirements:
 - (i) Cut off fuel supply to the burners or the fuel and air supply to solid fuel stoker and operate an audible alarm when the water level in the boiler falls to a pre-determined low water level;
 - (ii) Be of the lock-out type and so arranged that control or its electrical circuit has to be manually reset before the boiler can be brought back into operation;

- (iii) Be provided with its own entirely independent electrical control circuit.
- (e) Where mounted externally to the boiler, the over-riding control shall -
 - (i) be provided with its own chamber;
 - (ii) Comply with the requirements of clause (b).
- (2) Automatic water level control shall be as follows:-
 - (a) float or displacer operated; or
 - (b) operated by electrical probe or thermostat; or
 - (c) operated by other approved principle to the satisfaction of the Inspecting Authority.

The control equipment shall regulate the feed-water supply to the boiler in order to effectively maintain the level of water in the boiler between predetermined limits.
- (3) Automatic firing controls shall comply with the following requirements-
 - (a) At all times they shall effectively control the supply of fuel and air to the combustion equipments.
 - (b) They shall shut off the fuel supply to the burners or the fuel and air supply to the stoker under the following conditions:-
 - (i) Flame failure or pilot flame failure in the cases of gas, oil or pulverised fuel fired boilers. This control shall be of the lockout type required to be manually reset;
 - (ii) Failure to ignite the fuel at the burner within a pre-determined time. The control shall be of the lock-out type required to be manually reset;
 - (iii) When the water level in a boiler falls below a pre-determined safe level. The control shall also cause an audible alarm.
 - (iv) Failure of forced or induced draught fans or any automatic flue damper.
 - (v) Increase in furnace pressure to a pre-determined value.

Note: The above provisions shall not apply to once-through forced circulation boiler.

PART-II

183. Materials, Temperature and Pressure Limits.—(1)The materials used in the manufacture of the bodies of the fittings shall comply with the following requirements, namely: -

- (i) Castings of Carbon, Alloy and Stainless Steel shall comply with regulations 50 to 57.
- (ii) Steel forgings shall comply with regulations 58 to 62.
- (iii) Iron casting shall comply with the regulations 63 to 70.
- (iv) Bronze castings shall comply with the following table 5/1:

Table 5/1

Serial No.	Chemical Composition	Grade A	Grade B
(1)	(2)	(3)	(4)
1.	Tin	5.5 to 8.0%	4 to 6%
2.	Lead	1.0 to 3.0%	4 to 6%
3.	Zinc	3.0 to 6.0%	4 to 6%
4.	Total of all elements other than those set out above and excluding Copper and incidental Nickel	0.50%	0.50%
5.	Copper plus incidental Nickel	Balance	Balance
6.	Physical Properties Ultimate tensile Strength	22 kg/mm ²	20.5 kg/mm ²
7.	Sand Cost Elongation per cent minimum (cast on) on standard test piece C	8%	15%
8.	Ultimate tensile Strength	23 kg/mm ²	20.5 kg/mm ²
9.	Sand cost Elongation percent minimum (separately cast) on standard test piece C	12%	15%

- (v) The seats and discs of valves shall be made of non-corrodible metal*.

*By non-corrodible metal is meant specially resistant to corrosion and /or erosion.

- (2) Cast Iron shall not be used for:-

- (i) Temperatures above 220°C.
- (ii) Pressure exceeding 13 bar gauge.
- (iii) Valves exceeding 200 mm nominal bore which are connected directly to the boiler.
- (iv) Wedge or double disc gate valves which are connected directly to the boiler.
- (v) Boiler blow down fittings.

Explanation- The expression connected directly to the boilers covers the valve which cannot itself be isolated from the boiler.

Note: Spheroidal iron may be used for temperature not exceeding 282°C and pressure not exceeding 17.58 kg/cm²(g) provided it complies with the following requirements in respect of the physical properties.

- (a) 0.2% proof stress 250 kg/mm²;
- (b) Minimum elongation percent 12.

- (3) Copper alloy shall not be used for temperatures above 225°C, where the valves are connected directly to the boiler. In the case of valves not connected directly to the boiler this temperature limitation may be increased to 260°C.

PART-III

184. Castings.—(1) All castings shall be smooth, sound and free from flaws or other injurious defects. Variations in thickness at any part shall be gradual and substantial fillets shall be provided.

- (2) The body of a boiler mounting shall be connected to the boiler flange by a strong and stiff neck. In no case, the thickness of the neck of bronze mounting shall be less than 5 mm for sizes up to and including 19 mm bore or 6 mm size over 19 mm bore.

185. Packing of Cocks.—(1) The bodies of all cocks except those for pressure gauges shall be packed with any non-asbestos heat resisting material and shall be of substantial design and those over 25 mm bore shall have special provision, other than the gland for securing the plug.

- (2) Water gauge column cocks may be any non-asbestos heat resisting material packed or solid plug type.

186. Covers and Spindles.—(1) Valves of 38 mm bore and above directly connected to boilers, and other valves of 63 mm bore and over where fitted with a cover shall have such cover secured by bolts or studs and the screwed portion of the spindle shall be outside the stuffing box. All valves for superheated steam shall be fitted with an external screwed spindle.

- (2) (a) Where the covers of valves are secured by studs shall be screwed into the body with full thread for a length of at least one diameter.
(b) The stud holes shall not penetrate into the pressure space of any casting.

- (3) Valves with screwed covers shall be fitted with suitable locking device to prevent rotation of the cover.

187. Direction of Operation.—Valves shall be clearly marked to indicate the direction of flow. Valves directly connected to boilers shall be fitted with indicators to clearly show whether the valve is closed or open and all valves shall open by anti-clockwise rotation.

188. Moving Parts.— The valves and spindles shall be efficiently guided and means shall be provided in every case to prevent them leaving their guides. The working parts shall have sufficient clearance to ensure freedom of movement under all conditions of service.

189. Flanges.—(1) Flanges shall be in accordance with the tables for the appropriate pressure (Appendix-F).

- (2) In the case of safety valves the drilling, thickness and bolting of inlet flanges shall be in accordance with tables for the appropriate pressure and material and for the diameter of flange adopted. In the case of outlet flanges the pressure taken shall be the pressure on the outlet side of the valve.
- (3) For the purpose of determining particulars of flanges for blow down and scum pipe fittings, the design pressure of the fittings shall be assumed to be design pressure of the boiler.
- (4) All flanges shall be machined on the face, spot faced, or machined at the back, and the bolt holes shall be drilled.

190. Valve Seatings.— Where separate seats are fitted, they shall be efficiently secured and means shall be provided in every case to prevent the valves leaving their guides.

191. Chests and fittings in General.—(1) (a) All chests and fittings shall be smooth, sound and free from flaws, cracks or other injurious defects and after completion, the chests shall be hydraulically tested at minimum one and half times the maximum allowable working pressure of the valve for which they are intended.

(b) Hydraulic test shall be made with water which may contain a corrosion inhibitor, with kerosene or with other suitable liquid provided its viscosity is not greater than that of water at a test temperature not above 52°C.

(2) (a) (i) Valves may be fabricated from seamless steel pipes for pressures not exceeding 17.6 kg/cm²(g) and temperatures not exceeding 426°C. The welding shall conform to regulation 97 and valve chest shall be stress relieved after fabrication.

(ii) Valves meant for use in pipe work may also be fabricated by welding from seamless steel pipes but no restriction as above regarding pressure and temperature shall apply to them provided the welding complies with all the relevant requirements of fusion welding such as stress relieving and radiographic inspection of the weld as prescribed in Chapter-4 of these regulations.

(b) The maximum allowable working pressure of the chests shall be determined by equation (7/3), where the term '2 fE' shall be substituted by the term '1.8 x f'.

(3) The maximum allowable working pressure and the thickness of the bronze and cast Iron valve chests shall be determined by the following formulae, subject to the minimum thickness as specified in sub-regulation (2) of regulation 184.

$$P = \frac{R \times (T - C)}{4.5 \times D} \quad \text{Equation (5/1)}$$

$$T = \frac{4.5 \times P \times D}{R} + C \quad \text{Equation (5/2)}$$

Where,

P is maximum allowable working pressure

R is the minimum specified tensile strength of the grade of the material,

D is the external diameter of the chest,

T is the minimum thickness of the chest, excluding tolerance, and

C is the minimum positive tolerance as specified hereunder:

For Bronze Chests C = 1.5 mm

For Cast Iron Chests C = 5 mm

(4) The maximum allowable working pressure and the thickness of the steel valve chests of circular cross-section shall be determined by the following formulae, namely: -

$$P = \frac{2f(T - C)}{D - T + C} \quad \text{Equation (5/3)}$$

$$T = \frac{P \times D}{2f + P} + C \quad \text{Equation (5/4)}$$

Where,

P is maximum allowable working pressure in kg/cm²(g)

f = maximum allowable stress as available in the governing codes of the country of the material to which it belongs in kg/mm^2 . In case of non-availability of the value, the following procedure for evaluating the allowable stress values shall be adopted.

For temperature at or below 454°C is the lower of the following two values:

$$f = \frac{E_t}{1.5} \quad f = \frac{R}{2.7}$$

For temperature above 454°C the least of the following three values-

$$(a) f = \frac{E_t}{1.5} \quad (b) f = \frac{S_r}{1.5} \quad (c) f = S_c$$

Where,

E_t = Minimum value of yield point (0.2 per cent proof stress) at temperature 't',

R = Minimum specified tensile strength for the grade of steel concerned at room temperature,

S_r = the average stress for the grade of steel concerned to produce rupture in 100,000 hours.

If the width of the scatter band of results obtained when determining this value exceeds ± 20 per cent of the average value, then S_r shall be taken as 1.25 times the minimum stress at temperature 't' to produce rupture in 100,000 hours.

S_c = The average stress to produce an elongation (creep) for the grade of steel concerned of 1 percent in 100,000 hours at temperature 't'. For metal temperature 't' below 250°C values 'f' for 250°C shall be used.

Note: In case S_c values are not available in Material Standard and such materials are known to have been used in boiler in India or abroad, then for such materials, the allowable stress may be taken as the lower of

$$\frac{E_t}{1.5} \quad \text{or} \quad \frac{S_r}{1.5}$$

Note: The allowable stress for cast steel shall be 80 per cent of that determined on the above basis.

D = the external diameter of the chest,

T = the minimum positive tolerance as specified hereunder:

For cast steel chest $C = 5 \text{ mm}$

For forged or stainless chest $C = 2.5 \text{ mm}$

Note: Over and above the calculated thickness, additional thickness needed for assembly stresses, Valve closing stresses, shapes other than circular and stress concentrations, shall be provided by the manufacturers to the satisfaction of the Inspecting Authority.

- (5) (a) The number of valves and fittings which shall be made available to the Competent Person (excluding mechanical tests) shall be, following, namely:-

Table 5/1A

Serial No.	Size of valves and fittings	Number
(1)	(2)	(3)
1.	Up to and including 51 mm	10 per cent
2.	Over 51 mm and up to and including 76 mm	15% of the number of chests
3.	Over 76 mm and up to and including 114 mm	20% of the number of chests
4.	Over 114 mm	100 per cent.

(b) If the Inspecting Authority is satisfied that the manufacturer has adequate facilities for testing and inspection of valves intended for service pressure exceeding 10.5 kg/cm²(g) or temperature exceeding 204°C and actually tests each fitting at his works, the Inspecting Authority may, at his discretion, undertake test on a sample basis.

- (6) The maximum allowable working pressure and the minimum thickness of the steel valve chest of spherical cross section shall be determined by the following formula, namely,

$$P = \frac{4f(T - C)}{D - 0.8(T - C)} \quad \text{Equation (5/5)}$$

$$T = \frac{P \times D}{4f + 0.8 P} + C \quad \text{Equation (5/6)}$$

Where,

P = maximum allowable working pressure,

T = the minimum thickness of the chest,

D = the external diameter of the chest,

f = allowable stress for the material to be determined on the basis given in clause (d) above.

C = the minimum positive tolerance as specified hereunder:

For Cast Steel Chest C = 5 mm.

For forged or stainless steel chest C = 2.5 mm.

PART-IV

192. Special requirements for safety valves.— Safety valves, ordinary, high lift, and full lift, shall be so constructed that breakage of any part shall not obstruct the free and full discharge of steam from the boiler.

193.ordinary Lift Safety Valve.— (1) A safety valve in which the valve head lifts automatically a distance of at least D/24 with an over-pressure not exceeding 10% of the set pressure.

(2) There shall not be any mechanical stop which would prevent the valve head from being lifted a distance of at least D/8. D is the minimum bore of the body of seat.

194.High Lift Safety Valve.— (1) A safety valve in which the valve head lifts automatically a distance of at least D/12 with an over-pressure not exceeding 10% of the set pressure.

(2) There shall not be any mechanical stop which would prevent the valve head from being lifted a distance of at least $D/8$. D is the minimum bore of the body seat.

195. Full Lift Safety Valve.—(1) A safety valve in which the valve head lifts automatically a distance such that the area of discharge which limits the flow through the valve is between 100% and 80% of the minimum area at any section at or below the body seat.

(2) This lift is achieved by a rapid opening within an over pressure not exceeding 5% of the set pressure.

196. Discharge Capacity of Safety Valves.—(1) The rated discharge capacity of a safety valve which discharges saturated steam shall be calculated using the following equation;

$$E = CAP \quad \text{Equation (5/7)}$$

Where,

E = is the rated discharge capacity of saturated steam (kg/h.)

P = is the highest pressure of any safety valve mounted on the boiler (bar absolute),

A = is the area (mm^2).

For the ordinary lift and high lift safety valve, “A” is the area of the minimum bore of the body seat. For full lift safety valve, “A” is the area of discharge described regulation 195 and its value can only be obtained from the safety valve manufacturers. “C” is a constant taken from the following table, appropriate to the type of the valve or as established by tests carried out in accordance with Appendix-G

Table 5/2

<i>Serial No.</i>	<i>Type of valve</i>	<i>Value of the constant 'C'</i>
(1)	(2)	(3)
1.	Ordinary lift	0.05
2.	High lift	0.10
3.	Full lift	0.24

(3) The rated discharge capacity of a safety valve which discharges superheated steam shall be calculated using the following equation :-

$$E_s = \frac{E}{\sqrt{\frac{1 + 2.7 T_s}{1000}}} \quad \text{Equation (5/8)}$$

Where,

E_s = is the rated discharge capacity of superheated steam (kg/h),

E = is the rated discharge capacity of saturated steam calculated using equation (5/7) (kg/h),

T_s = is the degree of superheat ($^{\circ}\text{C}$)

Equation (5/8) may be used to determine the rated discharge capacity of safety valves at super-critical steam pressure. In these cases, the saturation temperature of the steam shall be taken as 375°C .

(3) (a) The Total peak load evaporation of a boiler shall be calculated on the basis of evaporation not less than 30 kg/hr/m^2 of heating surface (exclusive of super heater and non-steaming economiser).

(b) In the case of Waste Heat Boilers, however, when the evaporation per square meter of the heating surface is certified by the manufacturers to be less than 30 kg. The minimum number of safety valves required may be calculated on the basis of the actual maximum evaporation of the boiler.

197. Over Pressure of Safety Valves.—(1) The safety valves shall be so designed that they attain rated discharge capacity with the over pressure not greater than that given in regulation 193 to 195; provided that the safety valves which have a discharge area less than 80 per cent of the flow area, the over pressure at which the design lift is attained shall not exceed 10 percent of the set pressure.

(2) For safety valves having discharge area 80 per cent or more of the flow area, the over pressure at which the design lift is attained shall not exceed 5 per cent of set pressure.

198. Pressure Drop (Blow Down).—(1) The safety valves shall be reset at a pressure at least 2.5% below, but not more than 5% below the safety valves set pressure.

(2) The 5% limit shall be increased to 6% for set pressures up to 25 kg/cm² and 10% for valves having a body seat bore less than 32 mm.

199. Mountings of Safety Valves.—(1)(a) Safety valves shall be mounted without any intervening valve on pads or branches used for no other purpose. The axis of the valve shall be vertical.

(b) The cross-sectional area of the bore of each pad or branch shall be at least equal to the area of the bore at the inlet of the safety valve, or where two or more safety valves are mounted on the same pad or branch, at least equal to the sum of the areas of the inlet bores of all the safety valves.

(2) (a) Branches shall be as short as possible so as not to impair proper action of the safety valves or impose any undue stress on the branches at their point of attachment to the boiler.

(b) Nothing shall obstruct free flow to the safety valve. Branches, particularly when full lift safety valves are mounted on them, should be radiused at the inlet.

(c) The inlet and outlet flanges shall be drilled in accordance with the approximate table in Appendix-F for the diameters of flanges adopted.

200. Openings in Shell.—(1) No accessories other than those integral with the Safety Valve shall obstruct the openings in the boiler shell.

(2) Discharging steam shall have direct access to the safety valve without flowing through internal pipes.

201. Discharge Passage.—(1) (a) The safety valve discharge pipes shall comply with the requirements of sub-regulations (2), (3) and (4) of this regulation.

(b) The discharge pipe shall be as short and straight as possible and be fitted with open drain to prevent accumulation of water in the pipe. Suitable arrangement shall be provided in the discharge pipe system so that the discharge can readily be heard by the Boiler Attendant.

(2) Where a waste steam-pipe is fitted the pipe and the passage leading to it shall have a cross-sectional area not less than the minimum combined area of the safety valves required by regulation 196.

(3) For full lift valves, the area of waste steam pipe and passage leading to it shall have a cross-sectional area not less than twice "A", or such area above this minimum as maybe required for valves having a higher approved constant, where "A", "E" and "P" are as defined in regulation 196.

(4) (a) The area of the discharge pipe from an economiser safety relief valve shall be at least twice the area of the valve seating.

(b) Where the discharge from several economiser safety relief valves is connected to the main discharge pipe, the diameter of the main discharge pipe shall be designed to prevent accumulation of pressure due to the formation of steam under the particular conditions of temperature and pressure which may be applicable.

202. Drainage.—(1) For each enclosed safety valve chest, a means of draining shall be provided.

(2) The drain pipe shall be laid with a continuous downward gradient clear of the boiler to a place where the discharge is visible and cannot do injury to any person.

203. Moving Parts.—(1) The valves and spindles shall be efficiently guided and means shall be provided in every case to prevent their lifting out of their guides.

(2) The working parts shall have sufficient clearance to ensure freedom of movement under all conditions of service. The spindle shall not be fitted with a stuffing box.

204. Bearings for Levers.— (1) The bearings of the levers of lever valve shall be so designed as to allow free working of the valve under all condition of service.

(2) Where the lever is mounted on pin bearings, the holes in the lever shall be bushed with non-corrodible metal, or the pins shall be of non-corrodible metal.

205. Attachments of Weights and Springs.—(1) In a lever and weight safety valve, the weight shall be in one piece and attached to the lever in such a way that the safety valve cannot be over loaded.

(2) (a) In the case of spring loaded safety valves, washers or ferrules shall be fitted under the adjusting screws so that the valves cannot be over loaded when under the steam. Interference with load on the spring after the safety valve has been adjusted shall be prevented by the fitting of a ferrule under the adjusting screw collar, or by using a lock nut on the adjusting screw which shall be further safe-guarded by means of a padlock or other suitable device.

(b) Where springs are in tension, links or the suitable stops shall be fitted to prevent the spring being extended a greater amount than that corresponding to a valve lift of $D/4$.

Where, D = diameter of valve seating.

206. Easing Gear.— Safety valves shall be so arranged that they can be eased off seats when under pressure and the easing lever shall positively lift the valve.

207. Lift.— Safety valves shall be capable of being lifted a distance such that the area of the discharge edge shall not be less than the minimum aggregate area “A” in regulation 196.

208. High and Low Water Alarms.— High and low water alarms shall be adjusted so that the alarm is sounded with the water level visible in the gauges.

209. Final Settings.— Before leaving the maker’s works, each safety valve shall be adjusted to blow-off at the specified pressure.

210. Adjustment of Safety Valve Set Pressure.— The set pressure of a safety valve may be adjusted using air or other gas as the test medium provided that the safety valve has been subjected previously to hydraulic test in accordance with the requirement of sub-regulation(1) of regulation 191.

211. Change of Safety Valve Set Pressure.— The spring in a safety valve shall not be reset for any pressure more than 5% above or below that for which the valve is marked and the set pressure may be changed to the satisfaction of registering authority.

212. Materials.—(1)(a)The springs shall be manufactured from steel made by the Acid Open Hearth or Electric Process and the Chemical composition shall be within the following limits:

Table 5/3: Carbon Steel

Serial No.	Element	Minimum (Percent)	Maximum(Percent)
(1)	(2)	(3)	(4)
1.	Carbon	0.90	1.20
2.	Silicon		0.30
3.	Manganese	0.45	0.80
4.	Sulphur		0.050
5.	Phosphorus		0.050

Table 5/4: SILICON MANGANESE STEEL

Serial No.	Element	Minimum (Percent)	Maximum(Percent)
(1)	(2)	(3)	(4)
1.	Carbon	0.5	0.65
2.	Silicon	1.50	2.00
3.	Manganese	0.70	1.00
4.	Sulphur		0.050
5.	Phosphorus		0.050

Table 5/5: ALLOY STEEL

Serial No.	Element	<i>Grade I</i>	<i>Grade II</i>	<i>Grade III</i>	<i>Grade VI</i>
(1)	(2)	(3)	(4)	(5)	(6)
1.	Carbon %	0.55 to 0.65	0.46 to 0.54	0.55 to 0.65	0.55 to 0.65
2.	Manganese %	0.70 to 1.00	0.70 to 0.90	0.70 to 1.00	0.70 to 1.00
3.	Silicon %	0.10 to 0.35	0.10 to 0.35	0.10 to 0.35	1.70 to 2.10
4.	Chromium %	0.60 to 0.90	0.80 to 1.10	0.40 to 0.60	0.20 to 0.40
5.	Molybdenum %	--	--	0.15 to 0.25	0.20 to 0.30
6.	Vanadium %	--	0.15 min.	--	--
7.	Nickel %	--	--	0.40 to 0.70	--
8.	Phosphorous %	--	--	--	--
9.	Sulphur %	--	--	--	--

Table 5/6: TUNGSTEN ALLOY STEEL

Serial No.	Element	H12		H21	
		Min.	Max.	Min.	Max.
(1)	(2)	(3)	(4)	(5)	(6)
1.	Carbon %	0.30	0.40	0.26	0.36
2.	Manganese %	0.20	0.60	0.15	0.40
3.	Phosphorus max %	-	0.03	-	0.03
4.	Sulphur max %	-	0.03	-	0.03
5.	Silicon %	0.80	1.25	0.15	0.50
6.	Chromium %	4.75	5.50	3.00	3.75

7.	Vanadium %	0.20	0.50	0.30	0.60
8.	Tungsten %	1.00	1.70	8.50	10.00
9.	Molybdenum %	1.25	1.75	-	-

- (b) The manufacturers shall supply an analysis of each cast when required by the Inspecting Authority to do so. Should independent analysis be required, these shall be made at the rate of one per cent.
- (c) All springs shall be formed hot and suitably hardened and tempered.
- (d) All the springs above 16 mm bar diameter shall be formed hot and the springs below 16 mm bar diameter shall be formed hot or cold. The springs shall be suitably hardened and tempered.
- (2) Torsion bars shall be manufactured from steel which shall have a yield point of not less than 141 kg/mm².

Note: Special steels developed by individual manufacturers may be accepted by the Chief Inspector of Boilers at their discretion.

213. Dimensions.—(1) For ordinary lift valves, the compression or extension of safety valve springs required to load the valves to the set pressure shall not be less than one quarter of the diameter of the valve due consideration being given in the case of spring loaded level safety valves to the ratio of leverage.

(2) The proportion of unloaded length to external diameter of the spring shall not exceed 4:1.

(3) These requirements do not apply to full lift and high lift safety valves.

214. Determination of Maximum Allowable Working Pressure.—(1) The maximum allowable working pressure to be allowed for steel springs of round, square or rectangular section shall be determined from the following formulae for springs in extension.

(a) Round section ---

$$P = \frac{10,000 \pi d^3}{DAK} \quad \text{Equation (5/9)}$$

(b) Square Section ---

$$P = \frac{33,333d^3}{DAK} \quad \text{Equation (5/10)}$$

(c) Rectangular section ---

$$P = \frac{160,000 B^2 H^2}{DAK (3B + 1.8H)} \quad \text{Equation (5/11)}$$

Note: For Springs in Compression, the maximum allowable working pressure calculated by the above equation may be increased by 25 per cent.

Where, (all dimensions in inches):-

$$K = \frac{4(D-1)/d}{D} + \frac{0.615}{D} \quad \text{Equation (5/12)}$$

(In case of rectangular section substitute B for d)

- P = maximum allowable working pressure in lb. Square inch (set pressure)
 A = Loading area of valve,
 D = diameter of round or side of square steel,
 B = Breadth of wire (radial to spring axis).
 H = Depth of wire (parallel to spring axis).
 D = Mean diameter of coil,

$$C = \text{Constant} = \frac{L_1 + L_2}{L_1} \quad \text{Equation (5/13)}$$

- L₁ = Initial compression or extension of the spring to give the required loading (P x A),
 L₂ = the further compression or extension of the spring to give the lift as defined in regulations 193 to 195 and 207.

EXAMPLES:

- C = 2 where compression or extension of spring to give the required loading is ¼ diameter of valve.
 C = 1.5 where compression or extension of spring to give the required loading is ½ diameter of valve.
 C = 1.25 where compression or extension of spring to give the required loading is full diameter of valve.

- Note:** (1) The above formulae are based on the maximum allowable safe stress of 5,624 kg/cm²(g) on the section of the springs under extension and 7,030 kg/cm²(g) where they are in compression.
 (2) The above values of “C” apply only to the case of “full-lift” Safety Valves, where L₂ is equal D/4 in case of “high-lift” and “ordinary lift” Safety Valves, respective values of “C” may be worked out by using appropriate values of L₂.

- (2) In the case of torsion bars, the maximum shear stress as calculated from the following formula shall not exceed 55 kg/mm².

$$f_s = \frac{TDC}{2J} \quad \text{Equation (5/14)}$$

Where,

- f_s = Shear stress
 T = Torque at set pressure,
 D = Outside diameter of the bar,

J = Polar moment of inertia of the section the bar, and

$$C = \frac{\text{Angle of twist at full lift valve}}{\text{Angle of twist at set pressure}}$$

(as furnished by the manufacturer).

The dimensions of sleeve transmitting the torque shall be of substantial proportions for the material used.

215. Test.—(1) The permanent set in the spring (defined as the difference between free height and height measured ten minutes after the spring has been compressed solid three additional times, after pre-setting at room temperature) shall not exceed 0.5% the free height.

(2) Torsion bars shall not show a permanent distortion after being twisted to an angle fifty per cent in excess the working angle.

216. Extension Springs.— Extension springs shall be made from round section wire.

217. Number of Effective Coils.— The number of effective or free coils in a compression or extension spring shall be determined from the following formulae:

(i) For Round or Square wire

$$N = \frac{KCd^4}{SD^3} \quad \text{Equation (5/15)}$$

(ii) For Rectangular Wire

$$N = \frac{66B^3H^3K}{(B^2 + H^2) SD^2} \quad \text{Equation (5/16)}$$

Where,

N = Number of effective coils,

K = Compression or tension in inches at set pressure,

C = 22 for round, 30 for square steel,

d = diameter or side of square steel in 16th of an inch,

S = load on spring in lbs. at blow off pressure,

D = mean diameter of coil in inches,

B = breadth of wire in 16th of an inch,

H = Depth of wire in 16th of an inch.

218. Spacing of Coils.—The space between the coils when the valve is lifted to 1/4th of its diameter, shall be not less than 1.6 mm for full lift valves and 0.8 mm for ordinary and high lift valves.

219. Finishing of Ends.—Compression springs shall have their ends ground flat and smooth and at right angles to the axis of the springs over the full circumference so that when placed on end on a horizontal plane the springs will stand perpendicular.

PART-V

220. Lever valves.— Where the valve is operated by means of a lever, whether hand or mechanically controlled, the lever shall be of ample strength and the bearings shall be so designed as to allow free working of the valve under all conditions of service.

221. Steam stop valve.—(1) (a) The stop valve connecting the boiler or super heater to the steam-delivery pipe shall be located as near the outlet from the final superheater header as is convenient and practicable or in case of boilers without super-heaters as close as practicable to the drum.

(b) Where two or more boilers are connected with a steam receiver or any other vessel, a steam stop valve shall be fitted between the boiler and such receiver or vessel.

(2) (a) Steam stop valves shall be attached direct to the boiler shell or to suitable pads or stand blocks and the neck or the valve chest shall be reasonably short and of strong construction.

(b) The steam stop valve may also be attached to a stand pipe, a connecting pipe or the super-heater header.

(c) The attachment may be made by bolted flanges or butt-welded joints. Such butt- welded joints shall be suitably stress relieved, where necessary:

Provided that in the case of a larger boiler in which it is proposed for the purpose of drainage or owing to obstruction to connect the steam-pipes to the steam stop valve at a higher level than would be obtained under this regulation, a vertical stand pipe not exceeding 5 diameters in height will be permitted between the stop valve and the boiler. Such stand pipes shall be of strong construction and of wrought iron, mild steel, or cast steel. The flanges of wrought or mild steel pipes shall be welded to the pipes, and there shall be no branch on the stand pipe for any other connection:

Provided also that in the case of large boiler in which it is desired to fit a tee piece for the purpose of providing a branch connection between the stop valve and the boiler, such a tee piece may be so fitted, the tee piece shall be of strong construction, of wrought iron, mild steel, or cast steel and shall not exceed 2½ diameters in height and a stop valve shall be fitted direct to each tee piece branch.

(3) When two or more boilers are connected to a common steam main and there are no combined stop and isolating valves fitted to them an automatic isolating valve shall be compulsory. In the case of boilers fitted with welded pipes, fitting of an independent automatic isolating valve shall be compulsory.

PART -VI

222. Blow-down cock or valve and pipes.— (1) The blow-down cock or valve shall be of substantial construction.

(2) The waste pipe attached to the cock or valve shall not be bound fast in arch or brick work and shall discharge at a point where there is no danger of injury to any person.

(3) These pipes shall not be connected to a pipe common to another boiler.

(4) The continuous blow-downs may, however be connected to a common header discharging freely to an adequately vented tank or sump.

(5) The headers shall be of sufficiently large cross- section and the blow- off tank shall be provided with a vent pipe free from valves and of sufficient size to prevent accumulation of pressure. If, however, the tank is intended for collecting flash steam, a safety valve of adequate capacity shall be provided.

(6) The tank shall be so located that all parts will be accessible for inspection.

223 Blow-Down mountings.—(1) Each boiler shall be fitted with a suitable blow-down valve or cock placed at, or as near as practicable, to the lowest point of the boiler.

(2) (a) For locomotive, vertical and marine type boilers, the valve or cock shall be attached direct to the boiler or to a suitable pad or stand pipe.

(b) For water tube boilers the valve or cock shall be outside the brick work with a substantial steel pipe between it and the mud box.

- (3) For Cornish and Lancashire boilers, the cocks or valve may be attached to a cast steel elbow pipe of substantial section bolted to a suitable stand pipe or pad welded to the boiler. But cast iron elbow pipes shall not be permitted.

224. Blow-Down Valve or Cock.—(1) Each valve or cock shall be fitted with a device which shall clearly indicate its open and closed positions, and any key or similar device for operating the valve or cock shall be such that it cannot be removed unless the valve or cock is fully closed.

(2) The locking feather shall be secured by welding.

(3) Cocks fitted with taper plugs shall be of the bolted cover type with separate packing glands.

PART -VII

225. Water Gauges.—(1) Every boiler shall have two means of indicating the water in it, out of which one shall be conventional gauge glass:

Provided that in the case of boiler drums below 91 cm diameter where there is difficulty in fitting two water gauges, two test cocks and a glass water gauge shall be fitted.

(2) (a) The lowest visible part of the glass of the water gauge and lower test cocks shall be fixed at safe working level.

(b) For locomotive type and vertical boilers this shall not be less than 50 mm above the highest part of the firebox roof plate. Minimum length of the visible portion of the gauge glasses shall be 200 mm.

(c) The length may be increased depending upon the capacity of the boiler by the Inspecting Authority.

(3) (a) Glass water gauges shall be so placed as to be easily seen and reached by the boiler attendant.

(b) The fittings of glass water gauges and test cocks shall be of substantial make with large passage ways through them to facilitate cleaning.

(c) The gauge cocks when open shall have their handles in a vertical direction and each handle at its junction with the plug shall be plainly marked with a deep line to indicate the direction of the passage way through the plug.

(d) When detachable handle are provided arrangement shall be made to prevent incorrect fitting of the handles.

226. Drains.— A drain cock or valve with a suitable discharge pipe shall be fitted to each water gauge.

227. Protectors.—(1) Where tubular glass water gauges are fitted, substantial protectors shall be provided.

(2) The glass shall be suitably treated to prevent splintering.

228. Glass Size.—Tubular water gauge glasses shall be not less than 13 mm and not more than 19 mm outside diameter.

229. Safety Devices.— Water gauge glass mountings shall be fitted with self-closing devices in the bottom arms and it is recommended that a similar device may be fitted in the top arm.

230. Gauge Columns.—Where the gauges are mounted on a column, there shall be no connecting passage between the top and bottom arms of the column unless valves or cocks are fitted between the columns and the boiler.

231. Isolating Cocks.— Where isolating cocks or valves connecting water gauge pipes to the boiler are fitted, they shall be not less than 25 mm bore and of the bolted cover type with separate packing gland.

PART -VIII

232. Pressure Gauges Dials.— (1) For pressure upto 35 kg/cm² (g), pressure gauge dials shall be graduated in kg/cm²(g) from zero to twice the pressure as nearly as may be practicable.

- (2) For pressure exceeding 35 kg/cm²(g), the range of the graduation shall be from zero to one and a half times the maximum allowable working pressure, as nearly as may be practicable, but in no case shall the maximum graduation on the gauge be less than 70 kg/cm² (g).
- (3) The scale on the dial shall be clearly and permanently marked in kg/cm² (g).
- (4) The maximum allowable working pressure shall be marked in red on the dial of each pressure gauge.
- (5) (a) Where the gauge is compensated for a head of water between the gauge and the boiler connection, the amount of such compensation shall be marked on the dial. Pressure gauge shall be calibrated within an accuracy of +1 percent.
(b) Boiler pressure gauges shall not be less than 150 mm in diameter.
- (6) The travel of the pointer of the dial gauge shall not exceed 325°.

233. Connections.— All pressure gauges shall be fitted with a syphon pipe and a cock or valve integral with, or adjacent to, the gauge in such manner that the gauge may be shut off and removed whilst the boiler is under steam.

234. Gauge Cocks.— The handles of the gauge cocks shall be parallel to the pipes in which they are located when the cocks are open and marks shall be cut on the shank of the cock indicating open position.

235. Test Connections- Competent Person's Pressure Gauge Attachment.— (1) Every boiler shall be fitted with a valve or cock carrying in a vertical position a receiving screw for attachment of the Competent Person's pressure gauge.

- (2) The receiving socket shall be tapped for M/20 x 1.5 metric threads and shall be fitted with an easily removable cap.

PART -IX

236. Fusible Plugs.— (1) Fusible plugs shall be of sufficient height and fitted in such a position as to give early protection to all parts of the boiler liable to damage by the direct application of furnace heat in the event of shortness of water.

Note: For example - In Lancashire boilers the fusible plugs shall be in the crowns of the furnaces from 305 mm to 457 mm in front of the brick work fire bridge.

- (2) (a) On boilers having wet back reversing chamber, a minimum of two fusible plugs shall be fitted; one on the crown of the reversing chamber and the other on one of the tube plates. On boilers not having wet back reversing chamber, at least one fusible plug shall be provided on the front end tube plate.
(b) The plug shall be fitted in such a way that in the event of fusion of the plug, the pressure inside the boiler shall push the pellets out.

237. Type.— (1) Fusible plugs shall consist of an outer body with a central conical passage.

- (2) The smallest part to be not greater than 13 mm for plugs suitable for pressures up to 7 kg/cm²(g) and not greater than 10 mm for plugs for pressures exceeding 7 kg/cm² (g).
- (3) The passage shall be closed by a plug secured by an annual lining of fusible alloy so that the plug may drop clear if the lining melts.

(4) The portion of the body carrying the fusible metal shall preferably be detachable from the base to allow of easy replacement without removing the whole fitting from the boiler.

238. Material.—(1) The non-fusible portions of the plug shall be of bronze except where the nature of the boiler water precludes the use of non-ferrous material.

(2) The fusible metal shall be of an alloy melting readily at a temperature not less than 66°C in excess of the saturated steam temperature at the design pressure of the boiler.

239. Attachment to Boiler.—(1) Wherever practicable, fusible plugs shall be screwed into the boiler plates from the water side.

(2) The screwed portion shall have threads of Whitworth form not more than 11 per 25 mm.

PART -X

240. Feed Valves.—(1) Feed check valves shall be of the non-return type.

- (2) Where the valve is not of screw-down non-return type, a separate screw-down valve shall be provided.
- (3) The discharge from the feed check valve or from the internal feed pipe (if provided) shall be above low water level and in the case of Lancashire and Cornish boilers, shall be at least 152 cm beyond the fire bridge:

Provided that the aforesaid restriction regarding the position of feed discharge level shall not apply in the case of water tube boilers.

241. Operating Position.— Feed check valves or regulating valves shall be so arranged as to enable them to be satisfactorily operated from the boiler floor.

242. Requirements as to Feed Apparatus in certain cases.— In the case of a battery of boilers connected to a common feed range, the requirements of regulation 181 in respect of the number of feed apparatus shall be considered to have been fulfilled provided a total supply of feed water, not less than the combined maximum continuous rating of all active boilers can be maintained even if any one of the sources of power supply fails.

CHAPTER -6 BOILER AND SUPERHEATER TUBES, HEADERS AND OTHER PARTS

PART-I

243. Material and Construction of Tubes.— The requirements shall comply with regulation 122.

244.(1)(a)(i) The maximum allowable working pressure of the tubes shall be determined by the following formula: -

$$P = \frac{2f(T - C)}{[D - (T - C)]} \quad \text{Equation (6/1)}$$

Where,

T = minimum thickness of tubes, that is, nominal thickness less the permissible negative tolerance in mm,

C = 0.75 mm for working Pressure up to and including 70 kg/cm² (g) or

C = 0 for working Pressure exceeding 70 kg/cm² (g).

P = Maximum allowable working Pressure of boiler in kg/cm² (g),

D = External diameter of tube in mm,

f = maximum permissible stress values as available in the governing codes of the country of the material to which it belongs in kg/cm². In case of non-availability of the value, the following procedure for evaluating the permissible stress values shall be adopted.

(ii) The minimum required thickness of tubes shall be determined by the following formula:

$$t = \frac{P \times D}{2 \times f + P} + C \quad \text{Equation (6/2)}$$

Where,

t = minimum thickness of tube in mm,

C = 0.75 mm for working pressure up to and including 70 kg/cm² (g) or

C = 0 for working pressure exceeding 70 kg/cm² (g).

P = maximum allowable working Pressure of boiler in kg/cm² (g),

D = External diameter of tube in mm,

f = maximum permissible stress values as available in the governing codes of the country of the material to which it belongs in kg/cm². In case of non-availability of the value, the following procedure for evaluating the permissible stress values shall be adopted.

(A) For temperature at or below 454°C,

$\frac{T_s}{2.7}$ or $\frac{E_t}{1.5}$ whichever is lower

(B) For temperature above 454°C

$\frac{S_r}{1.6}$ or S_c whichever is lower

Where T_s = minimum tensile strength of the material at room temperature,

E_t = yield point (0.2 % proof stress) at working metal temperature 't',

S_r = the average stress to produce rupture in 100,000 hours and in no case more than 1.33 times the lowest stress to produce rupture at the working metal temperature,

S_c = the average stress to produce an elongation of 1 percent (creep) in 100,000 hours, at the working metal temperature.

Note: In case S_c values are not available in Material Standard and such materials are known to have been used in boilers in India or abroad, then for such materials the allowable stress may be taken as the lower of

$$\frac{E_t}{1.5} \quad \text{or} \quad \frac{S_r}{1.6}$$

(b) The working metal temperature shall be taken as following, namely:-

- (i) for integral economiser tubes, the maximum water temperature for which the part of the element is designed plus 11°C.
 - (ii) for furnace and boiler tubes, the saturation temperature corresponding to the working pressure plus 28°C.
 - (iii) for convection super heater tubes, the maximum steam temperature for which the part of the element is designed plus 39°C.
 - (iv) for radiant super heater tubes the design maximum steam temperature plus 50°C.
- (2) However, in no case, the thickness of tubes as supplied shall be less than those given in the table below (subject to tolerances specified in sub-regulation (5) of regulation 47 and sub-regulation (5) of regulation 49:

TABLE 6/1

Serial No.	Outside diameter	Seamless Hot finished	Seamless Cold drawn or electric resistance welded
(1)	(2)	(3)	(4)
1.	Upto and including 32 mm	2.9 mm	2.03 mm
2.	Over 32mm upto and including 51 mm	3.25 mm	2.34 mm
3.	Over 51mm upto and including 76 mm	3.35 mm	2.64 mm
4.	Over 76 mm upto and including 89 mm	3.25 mm	3.25 mm
5.	Over 89 mm upto and including 114 mm	3.66 mm	3.66 mm

In the case of coiled tubes for boilers of forced circulation type, the minimum thickness of tubes as supplied may, however, shall be as follows:

Table 6/2

Serial No.	Outside diameter of tubes in mm	Minimum thickness
(1)	(2)	(3)
1.	Upto and including 29 mm.	1.62 mm.
2.	Over 29 mm. Upto and including 35 mm.	1.83 mm.
3.	Over 35 mm. upto and including 42 mm	2.34 m.

- (3) (a) Tubes that are hot or cold bent for parts of boilers, including economizers, furnace walls, superheaters and reheaters, shall comply with this clause and suitably heat treated as under:

For Carbon steel / Alloy steel (except P-91 and Austenitic Stainless steel)

- If percentage thinning is more than 25% - Post Bend Heat Treatment (PBHT) required.
- If Outer Diameter (OD) is less than 141.3 mm and $R/D \leq 1.30$ – PBHT required.
- If Outer Diameter (OD) is more than 141.3 mm and $R/D \leq 2.5$ – PBHT required.

For P-91 and Austenitic stainless steel – requirements as specified in the material specifications shall be followed.

Where, R is the mean radius of the bend to the centre line of the tube (in mm) and D is the outside diameter of the tube (in mm).

Butt welds shall not be permitted within bends.

Thinning and departure from circularity limits shall be demonstrated by one of the following methods.

- (a) relevant and satisfactory service experience;
- (b) a procedure test;
- (c) by measurement of 2% of the bends, including the first bend of each shift.

The method selected shall be at the option of the manufacturer.

- (b) Thinning on tube bends shall comply with the following:

- (i) At any location around the bend extrados, the reduction in thickness (in per-cent) below the calculated minimum permissible design thickness of the straight tube, except where permitted by (ii), shall not exceed:

$$\frac{100}{\frac{4R}{D} + 2}$$

Where,

R is the mean radius of the bend to the centre line of the tube (in mm).

D is the ordered outside diameter of the tube (in mm).

- (ii) Bend thickness below the minimum value required under (i) shall be permitted in cases where the manufacturer can demonstrate by bursting tests carried out on at least three bends that the strength of the bend is not less than that of the straight tube.
- (iii) Where the amount of thinning at any location around the bend extrados on cold formed bends exceeds 25% of the actual thickness of the tube on the straight the bends shall be suitably heat treated. The actual thickness of the same plans as the line of the extrados at each end of the bend.

(c) The departure from circularity at the bend apex shall not exceed 10% for bends performed in a single bending operation and 15% for bends which are hot pressed after the primary, bending operation.

The departure from circularity (in percent) shall be calculated from:

$$\frac{D_{\max} - D_{\min}}{D} \times 100$$

Where,

$D_{\max}$ = is the maximum outside diameter measured in the tube bend apex (mm),

$D_{\min}$ = is the minimum outside diameter measured at the same cross section As $D_{\max}$ (mm)

D is the ordered outside diameter of the tube (in mm).

PART-II

245. Material and construction of Headers and similar pressure parts.— The materials and construction shall comply with Chapter-2 and Chapter-3.

246. Rectangular Headers symmetrical in form.— (1) The maximum allowable working pressure shall not exceed the smaller of the value obtained from the following formula:

$$(a) \quad P = \frac{cf(t - C_1)^2}{b^2} \quad \text{Equation (6/3)}$$

$$(b) \quad P = \frac{6.25t^2.f.E}{w^2} \quad \text{Equation (6/4)}$$

Where, P = maximum allowable working pressure,
 t = thickness,
 b = internal breadth between the supporting sides of the header,
 c = 3.413 for wrought steel and 2.926 for steel castings,
 Where the sides are corrugated or otherwise reinforced by substantial supports so that the length of the portion between the corrugations or supports does not exceed b, shall be taken as 5.82 for wrought steel and 5.12 for steel castings,
 f = permissible stress at working metal temperature as given in the table 6/3 under sub-regulation (3),
 C_1 = 0.08 cm,
 w = internal width of the header between the tube plate and the Opposite side,
 E = efficiency of ligaments between the holes.

- (2) If the faces of the headers are machined locally at the tube holes or hand holes, the thickness at the part may be as much as 4.8 mm less than given by the above equation; but irrespective of the thickness obtained by the use of the formulae, the thickness of the headers at the tube holes shall not be less than:-

$$t = \sqrt{(C \times d + C_1)} \quad \text{Equation (6/5)}$$

where, t = thickness,
 d = diameter of the hole,
 C = 0.2235 mm,
 C₁ = 6.4 mm.

In no case shall the thickness be less than 8 mm except that in small patches not exceeding 322 mm² in area, the thickness may be 50 percent of the thickness used in the Equations (6/3) and (6/4)

- (3) The permissible stress at working metal temperature shall be as given in the table below:-

Table 6/3: Permissible Stress at Working Temperature for Rectangular Section Headers

Serial No.	Working Metal Temperature in degrees	Cast steel 44-45 kg/mm ²	Carbon and Alloy Steels
	C	kg/cm ² (g)	The lower value obtained in each case at the specified temperature calculated on the following basis:
(1)	(2)	(3)	(4)
1.	288	703	For temperatures at or below 454°C $\frac{T.S}{2.7}$ or $\frac{E_t}{1.5}$ For temperatures above 454°C S_r or S_c 1.6
2.	316	633	
3.	343	562	
4.	371	532	
5.	399	505	
6.	427	475	
7.	454	443	
8.	482	309	

Where, Ts = minimum tensile strength of the material at room temperature,

Et = yield point (0.2% proof stress) at the working metal temperature 't',

Sr = the average stress at the temperature 't' to produce rupture in 100,000 hours and in no case more than 1.33 times the lowest stress to produce the rupture in 100,000 hours,

Sc = the average stress at the temperature 't' to produce an elongation of 1% (creep) in 100,000 hours.

- (4) The working metal temperature shall be taken as follows:

- (a) For saturated steam and water drums and headers, the saturation temperature corresponding to the working pressure of the boiler plus 28°C.
 (b) For superheater headers, the designed maximum steam temperature for the header plus 28°C.

- (5) (a) Where headers are adequately protected from the gases of combustion or swept by such gases in the third or subsequent pass of a boiler, the working metal temperature shall be taken as the saturation or designed maximum steam temperature as defined above, whichever applies.

- (b) A covering or refractory or insulating material which may be liable to become dislodged shall not be deemed adequate protection.
- (6) (a) The ends of rectangular headers may be formed integral with the header or attached by welding.
- (b) The maximum allowable working pressure for the flat ends shall be calculated by the following formula: -

$$P = \frac{f(t - C)^2}{d^2 K} \quad \text{Equation (6/6)}$$

- where,
- P = Maximum allowable working pressure in kg/cm² (g),
- f = maximum permissible stress values as available in the governing codes of the country of the material to which it belongs (kg/cm²),
- t = thickness of the plate at the weakest part in mm,
- d = the least width between the walls of the rectangular header in mm,
- C = 1 mm,
- K = 0.32 for ends integral with or flanged and butt welded to the header,
- = 0.40 for ends directly strength welded to the header in an approved manner.

247. Headers irregular in form.— (1) In cases where the headers are of such irregular form as to render the application of a formula for the determination of thickness impracticable, the manufacturer shall show the suitability of the headers for the working conditions by indicating practically the maximum internal hydraulic pressure which a header, made to the same design and of similar material, will withstand without permanent deformation.

(2) The maximum working pressure for similar headers may then be determined by the following formulae: -

Permissible stress at working metal temperature

$$P = P_1 \times \frac{\text{Permissible stress at working metal temperature}}{F \times C} \quad \text{Equation (6/7)}$$

Where,

- P = The maximum allowable working pressure in lbs. per sq. in.,
- P₁ = The maximum internal hydraulic pressure withstood without permanent deformation,
- F = 1.75 for wrought steel and 2 for cast steel,
- C = 15500 for wrought steel of 24 tons per sq. in. minimum ultimate tensile stress,
- = 16500 for wrought steel of 26 tons per sq. in. minimum ultimate tensile stress,
- = 18000 for wrought steel of 28 tons per sq. in. minimum ultimate tensile stress,
- = 21000 for wrought steel of 32 tons per sq. in. minimum ultimate tensile stress,
- = 22000 for wrought steel of 34 tons per sq. in. minimum ultimate tensile stress,
- = 15500 for cast steel of 28 tons per sq. in. minimum ultimate tensile stress.

248. Cylindrical Headers.— (1) Where cylindrical headers are provided, their maximum allowable working pressure shall be determined by Equation (6/1).

- (2) The attachment of ends and the method of calculating the maximum allowable working pressure shall be in accordance with clause (b) of sub-regulation (6) of regulation 246, subject to the following modifications:-

K = 0.19 for ends integral with or flanged and butt welded to the header.
 = 0.28 for ends directly strength welded to the header in an approved manner, and
 d = internal diameter of the header.

The required thickness shall be determined by the following formula:

$$t = d \times \sqrt{\frac{P \times K}{f}} + C \quad \text{Equation (6/8)}$$

Where,

P = maximum allowable working pressure in kg/cm² (g),
 f = maximum permissible stress values as available in the governing codes of the Country of the material to which it belongs (kg/cm²),
 t = thickness of the plate at the weakest part in mm,
 C = 1 mm,
 K = 0.19 for ends integral with or flanged and butt welded to the header.
 = 0.28 for ends directly strength welded to the header in an approved manner,
 d = internal diameter of the header.

CHAPTER -7**PIPES AND FITTINGS**

249. Pipes.—(1)(a) Steam-pipes may be of carbon steel, cast steel, alloy steel and nickel alloys.

(b) Pipes may be solid drawn (cold or hot finished), butt welded or electric resistance welded.

(2) Where, material used is in conformity with the code of the country of manufacture and in accordance with provisions of these regulations, the permissible stress figures specified in the code at different temperatures may be accepted in lieu of figures computed from the data required to be furnished under regulation 256 in any of the following cases, namely:-

(a) Where a certificate is furnished from the Inspecting Authority to the effect that the steel complies with requirements of the steel grade (to be specified by the Inspecting Authority) and that the permissible stress for the working condition as allowed for in the code of the country of manufacture falls within the permissible limits under these regulations.

(b) Where the basis upon which these stresses have been arrived at is made available and such basis is not found as to give rise to stresses higher than those permissible under the regulations.

(c) Where pipes have to be fabricated by longitudinal fusion butt electric arc welding of plates rolled to shape, the limits provided for butt welded pipes in Table 7/4 under regulation 255 shall not apply.

(d) The requirements other than those relating to the minimum thickness of shell for fusion butt welding provided in Chapter-12 shall be applicable to such pipes.

(3) Notwithstanding anything contained in Chapter-7, the hydraulic test for pipes in maker's premises may be dispensed with by the Inspecting Authority:

Provided that these pipes have been fully tested by non-destructive examination by radiographic or ultrasonic techniques:

Provided further that in the case of pipes having internal diameter 1000 mm and more, the plates used for the manufacture of pipes and the long seam welds of pipes are fully tested by non-destructive examination like ultrasonic or radiographic testing and the soundness of pipes both in the parent material and in the weld is established in the maker's premises; and the whole component of the pipes, after completion of any further fabrication and erection at site, are hydraulically tested at a pressure not less than 1.5 times the maximum allowable working pressure of the piping system:

Provided also that in the event of detection of any defect after conducting hydraulic test of these pipes at site, it shall be the responsibility of the manufacturer to repair or replace the defective pipes, as may be deemed necessary by the Inspecting Authority.

(4) Electric fusion welded pipes in which the butt-welds are fully radiographed or ultrasonically tested need not be hydraulically tested in the shops provided the pipe system as a whole is hydraulically tested at site to the requisite test pressure in accordance with regulation 292.

(5) In the case of fusion welded pipes, test plates to represent all welded seams shall be attached at each end of longitudinal seam and tested in accordance with the Chapter -12 provided that one test plate may represent a lot of pipes up to 60 m in length and of the same grade of material and same thickness of the pipe subject to the same heat treatment.

PART-I

250. Material of steel pipes.—(1) (a) The pipes shall be made from steel made by an Open Hearth or Electric Process or by any of the Oxygen Processes.

(b) Hot finished seamless pipes may, however, be made of Bessemer Steel.

(c) Bessemer Steel shall not be used for pressures exceeding 21 kg/cm² or temperatures exceeding 260°C and If the Bessemer process is used, the steel shall be made by a manufacturer approved by Inspecting Authority.

(d) When pipe is used for temperatures exceeding 399°C the steel shall be of non-segregated or fully killed type.

(2) Carbon and alloy steel pipes shall not be used for design temperatures exceeding those given in Table 2/1 of regulation 30.

(3) For design temperature over 427°C, precaution shall be taken to ensure that the surface condition of the pipe is suitable for such requirements.

(4) (a) The material from which seamless pipes are made, shall conform to appropriate specifications of pipes as in regulation 49 and electric resistance welded pipes are made, shall conform to the appropriate specification of tubes as in regulation 30.

(b) The materials from which butt welded pipes are to be made shall conform to the requirements of Table 7/3 under regulation 253.

251. Condition of pipes.—(1) All pipes shall be commercially straight, free from longitudinal seaming, grooving, blistering or other injuries surface marks and the ends of the pipes shall be cut square.

(2) The pipes shall be made within the limits of tolerances as given below:-

Table 7/1

Serial No.	Class	Tolerance on		
		Outside diameter		Nominal thickness
		Up to and including 51 mm	Over 51 mm	
(1)	(2)	(3)	(4)	(5)
1.	Seamless or Electric Resistance Welded(*E.R.W)	As per regulation 49.		
2.	Butt welded	± 1%	± 1%	+ no limitation - 12.5%

PART-II

252. Number of sets of mechanical tests .— (1) The number of pipes on which mechanical tests are to be performed shall be as follows:-

Table 7/2

Seamless pipes	As per regulation 49
Welded pipes	2 per cent of the lengths of pipes as made.

(2) In the case of pipes for designed temperatures over 454°C, every pipe over 114 mm outside diameter shall be tested.

253. Tests.— (1) For pipes up to and including 102 mm Nominal bore, flattening test shall be as per requirements of Chapter-2as under,-

(a) For cold drawn seamless construction – Sub-regulation (4) of regulation 48.

- (b) For hot finished seamless construction – Sub-regulation (10) of regulation 49.
 (c) For Electric resistance welded pipes – As per relevant material specifications.

For pipes where the ratio between the wall thickness and the diameter would not permit the maintenance of the distance between the flat surfaces specified in the above regulation, this shall be limited to $2/3^{\text{rd}}$ of the bore of the pipe.

- (2) For cold Bend Test for pipes over 102 mm Nominal bore, a strip not less than 38 mm wide cut circumferentially from one end of each selected pipe shall when cold withstand, without showing either crack or flaw being doubled over in the direction of original curvature round a bar, the diameter of the bar being:

For pipes up to and including 10 mm thick 3 Times the thickness
 For pipes over 10 mm thick 4 Times the thickness

- (3) For Bend Test on the Weld; a strip not less than 38 mm wide cut circumferentially from one end of each selected pipe with the weld near the middle of the strip, shall when cold withstand, without showing either crack or flaw, being doubled over in the direction of original curvature round a bar, the diameter of the bar being equal to eight times the thickness of the test piece, the weld being placed at the point of maximum bending.

In cases where the outside diameter of the pipe is less than 8 times the wall thickness, the diameter of the former shall be equal to 4 or $2/3^{\text{rd}}$ of the nominal bore of the pipe, whichever is less.

- (4) Additional Tests; In case a pipe selected for testing fail in any one or more of the tests specified above, two further tests of the same kind may be made from the same or another pipes from the same batch. In case either of these further tests fail, the pipes represented may be reheated and then re-tested. If the repeat tests are satisfactory, the pipes shall be accepted provided they comply with other requirements, but if failure again occurs, the pipes which the test pieces represent shall be rejected.

- (5) Tensile Test shall be as per Chapter-2.

- (6) Test for Valves and Fittings shall be as per sub-regulation (5) of regulation 191.

Table 7/3: Carbon Steel

Serial No.	Kind of pipes	Butt welded pipes						Sulphur percentage (maximum)	Phosphorus percentage (maximum)
		Ultimate tensile strength in kg/mm ²		Minimum elongation percentage					
				On 203 mm		On 51 mm			
		Not less than	Not more than	6mm thick & over	Less than 6 mm thick	6 mm thick & over	Less than 6 mm thick		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Strips cut from the pipes clear of the welds and tested in their curved position	35	44	20	18	32	30	0.05	0.05
2.	Test lengths taken from finished pipes (ends of pipes to be plugged for grips)	35	44	25	23	-	-	0.05	0.05

3.	Selected Samples cut transversely	Ultimate tensile strength in Kg/Sq. mm		Minimum elongation per cent on 203 mm			Sulphur percentage (maximum)	Phosphorus percentage (maximum)
4.		Not less than	Not more than	13mm thick & over	Less than 13mm thick and not less than 6 mm thick	Less than 6 mm thick		
5.		36	44	23	20	18	0.05	0.05

254. Method of manufacture, heat treatment and marking.— (1) On completion of any work which involves heating, whether for hot bending of the pipe or for any other similar purpose, the pipe shall be carefully annealed.

(2) (a) The cold drawn seamless carbon steel pipes and welded carbon steel pipes shall be supplied in normalised condition.

(b) Hot finished seamless carbon steel pipes shall be supplied in hot finished condition or in normalised condition at the option of the manufacturer.

(c) The seamless alloy steel pipe either cold finished or hot finished and welded pipes shall be supplied in normalised and tempered condition.

(d) By agreement between the users and the manufacturer, the pipes may be delivered in a condition other than normalised and tempered condition in which case they shall be suitable for subsequent manipulation and the user shall be informed of the heat-treatment necessary to give required properties.

(3) (a) (i) Pipe bending and forming (reducing or swaging) operation shall be done by any hot or cold method and to any radius which shall result in a surface free from cracks, buckles or other defects as determined by the method of inspection specified in the design.

(ii) A post bending or post forming heat treatment for carbon steel material is required with a nominal wall thickness in excess of 19 mm unless the bending or forming operation are performed and completed at normalizing temperatures, where no further heat treatment is required.

(iii) The heat treatment where required, shall be normalised or stress relieved, as the case may be.

(b) A post bending or post forming heat treatment shall be required for all ferritic alloy steel material with nominal pipe size 100 mm and larger or with a nominal thickness 13 mm or greater.

(c) (i) If hot bending or forming is performed the material shall receive normalize and temper or tempering heat-treatment as required by the design.

(ii) For cold operation, tempering heat-treatment shall be applied.

(4) Marking shall be carried out in accordance with regulation 329.

255. Steam pipes and fittings.— The pressure and temperature limits within which pipes, tees, branches, etc., are to be used, shall be in accordance with Table 7/4as given below:

Table 7/4: Maximum allowable working pressure and temperature

Serial Number	Material group as per Regulation 8	Method of manufacture	Maximum allowable working pressure	Maximum permissible temperature	Product Form
				°C	
(1)	(2)	(3)	(4)	(5)	(6)
1.	M1/Gr1, M1/Gr2	Cold drawn seamless	No restriction	As per Table 2/1 of Regulation 30	Straight, bends or fittings
2.		Hot finished seamless	No restriction	As per Table 2/1 of Regulation 30	-do-
3.		Butt welded [Max. nominal bore allowable 102mm]	21 kg/cm ² (g)	260	-do-
4.		Electric Resistance welded	No restriction	As per Table 2/1 of Regulation 30	-do-
5.	Cast Steel	Castings	No restriction	454	-do-
6.	M3/Gr1, M3/Gr2, M4/Gr1	Cold drawn seamless and Castings	No restriction	As per Table 2/1 of Regulation 30	-do-
7.	M5A/Gr1	Cold drawn seamless and hot finished seamless	No restriction	As per Table 2/1 of Regulation 30	-do-

256. Steel pipes.— The maximum allowable working pressure allowed on steel pipes shall be determined as per the following formula: -

(a) Where the outside diameter is the basis for calculation.

$$P = \frac{2 f E (t - C)}{D - t + C} \quad \text{Equation (7/1)}$$

Where,

t = minimum thickness of pipe (mm),

P = maximum allowable working pressure (kg/cm² (g)),

f = allowable stress as provided under regulation 170(kg/cm²),

D = outside diameter of pipe (mm),

E = efficiency factor,

= 1.0 for seamless and for electric resistance welded steel pipes and for electric fusion welded steel pipes comply with the requirements of Chapter-2 in which the weld is fully radiographed or ultrasonically tested,

= 0.95 for electric fusion welded steel pipes complying with the requirements of Chapter-2,

= 0.90 for welded steel pipes for values of t up to and including 22 mm,

= 0.85 for welded steel pipes for values of t over 22 mm and up to and including 29 mm,

= 0.80 for welded steel pipes for values of t over 29 mm,

$$C = 0.75 \text{ mm.}$$

The minimum thickness of pipe required shall be as per the following formula:

$$t = \frac{P \times D}{(2 \times f \times E) + P} + C \quad \text{Equation (7/2)}$$

Where,

- t = calculated minimum required thickness of pipe (mm),
 P = maximum allowable working pressure (kg/cm² (g)),
 f = allowable stress as provided under regulation 170(kg/cm²),
 D = outside diameter of pipe (mm),
 E = Ligament efficiency as per regulation 171,
 C = 0.75 mm.

(b) Where the inside diameter is the basis for calculation.

$$P = \frac{2 f E (t - C)}{d + t - C} \quad \text{Equation (7/3)}$$

Where,

- t = minimum thickness of pipe in mm,
 P = maximum allowable working pressure (kg/cm² (g)),
 f = allowable stress as provided under regulation 170 (kg/cm²),
 d = inside diameter of pipe (mm),
 E = efficiency factor,
 = 1.0 for seamless and for electric resistance welded steel pipes and for electric fusion welded steel pipes comply with the requirements of Chapter-2 in which the weld is fully radiographed or ultrasonically tested,
 = 0.95 for electric fusion welded steel pipes complying with the requirements of Chapter-2,
 = 0.90 for welded steel pipes for values of t up to and including 22 mm,
 = 0.85 for welded steel pipes for values of t over 22 mm and up to and including 29 mm,
 = 0.80 for welded steel pipes for values of t over 29 mm,
 C = 0.75 mm.

The minimum thickness of pipe required shall be as per the following formula:

$$t = \frac{P \times d}{(2 \times f \times E) - P} + C \quad \text{Equation (7/4)}$$

Where,

- t = calculated minimum required thickness of pipe (mm),
 P = maximum allowable working pressure in kg/cm² (g),
 f = Allowable stress as provided under regulation 170 (kg/cm²),
 d = inside diameter of pipe (mm),

- E = Ligament efficiency as per regulation 171,
C = 0.75 mm.

257. Cast steel pipes.— (1) The material shall comply with regulations 50 to 57.

(2) The maximum allowable working pressure allowed on cast steel pipes shall be as per the following formula: -

$$P = \frac{2S(t - 0.15D - C)}{D} \quad \text{Equation (7/5)}$$

Where,

- t = minimum thickness,
P = Maximum Allowable Working Pressure,
D = External diameter of pipe,
S = Allowable working stress as specified in Table 7/5 or regulation 249,
C = 0.64 cm.

Table 7/5: Maximum Permissible Working Stress for Carbon and Alloy Cast Steel Pipes

Lower value obtained in each case at the specified temperature calculated on the following basis:-	
For service temperature at or below 454°C	$\frac{T.S.}{2.7}$ or $\frac{E_t}{1.5}$ and $\frac{E_t}{1.5}$ or $\frac{S_r}{1.5}$ or S_c
For service temperature above 454°C	$\frac{E_t}{1.5}$ or $\frac{S_r}{1.5}$ or S_c .
Where T.S. = Minimum Tensile strength of the material at room temperature, E _t = Warm yield point (0.2% proof stress) at temperature t, S _c = The average stress at the service temperature to produce an elongation of 1% (creep) in 100,000 hours, S _r = The average stress at the service temperature to produce rupture in 100,000 hours at the temperature and in no case more than 1.33 times the lowest stress to produce rupture at service temperature.	

PART-III

258. Flanges of carbon steel pipes.—(1) The material for carbon steel flanges, where forged, cast or cut from the plates (excluding branches forged integral with the pipes) shall be made of steel produced by an Open Hearth or Electric process or any of the Oxygen processes.

- (2) Carbon steel flanges shall not be used for temperatures exceeding 454°C and such flanges shall be made without a weld and free from lamination or other defects secured by welding.

- (3) Blank flanges shall be of mild steel or cast steel and shall be not less in thickness than the flanges to which they are attached. The material shall comply with the requirements specified in relevant regulations of chapter-2 or Chapter-4 of these regulations.

259. Flanges of alloy steel pipes.— (1) (a) The material for alloy steel flanges where forged, cast or cut from plates (excluding branches forged integral with the pipes), shall be made from the steel produced by an Open Hearth or Electric process.

(b) Flanges shall be made without a weld and shall be free from lamination or other defects.

(c) The material of alloy steel flanges shall comply the provisions of regulation 30.

(d) The material for flanges shall be similar to that of the pipes to which they are to be attached.

(e) The flanges are to be so designed that the total stress induced in them does not exceed the maximum permissible stress as per criteria mentioned in regulation 170.

(2) Blank flanges of alloy steel shall be not less in thickness than the flanges to which they are to be attached and the material shall be similar to that of the flanges.

260. Non-ferrous flanges.— (1) The material for non-ferrous flanges shall be of bronze.

(2) The chemical composition shall comply with the requirements of clause (iv) of sub-regulation (1) of regulation 183.

(3) When flanges are attached to copper pipes by brazing, they shall be secured in such additional way like forming a conical bore in the flange so that the resistance to withdrawal from the flange does not depend wholly on the brazing.

261. Screwed on flanges.— (1) Where flanges are secured by screwing, the screw thread on the pipes and in the flanges shall be arranged to end at a point just inside the back of boss of the flange and after the flange has been screwed on, the pipe shall be expanded into the flange by a roller expander.

(2) Such screwed and expanded flanges may be used for steam for a maximum allowable working pressure of 31.5 kg/cm² (g) and maximum temperature of 399 °C and for feed for a maximum allowable working pressure of 42 kg/cm² (g).

262. Loose flanges.— (1) (a) Loose flanges may be used where the joints are made by metal faces integral with ends of the pipes and alternatively these joints may be welded or seal welded.

(b) The loose flanges shall conform to the table given in Appendix-F.

(2) Where the joint is formed by integral flanges, after machining these shall be not less in thickness than the designed thickness of the pipe as calculated by Equation (7/2)

263. Welded on flanges.— (1) Where flanges are welded on, the welding shall be done by the oxy-acetylene or metal arc process; the latter with covered electrodes which shall comply with regulations 71 to 76.

- (2) (a) The proportion of the weld shall be as indicated in the Figs. 7/10 to 7/34 (part V of this chapter) for the following types as mentioned in the Table below, -

Type	1. Welding Neck Flange, Fig. 7/10.
	2. 'Face and Back' welded – on flange for metal arc welding. fig. 7/26.
	3. 'Bore and Back' welded- on flange for metal arc welding. fig. 7/27 and 7/28.
	4. 'Face and Fillet' welded- on flange for metal arc welding. fig. 7/29.
	5. 'Bore and Fillet welded- on flange for metal arc welding. fig. 7/30 and 7/31.
	6. 'Slip on' welded- on flange for metal arc welding. fig. 7/32.
	7. 'Slip on' welded- on bossed flange for oxy-acetylene welding. fig. 7/33.
	8. Socket welded flange, Fig. 7/34.
The Flange shall not be a tight fit on the pipe.	

- (b) The maximum clearance between the bore of the flange and the outside diameter of the pipe shall be 3 mm at any point, and the sum of clearance diametrically opposite shall not exceed 5 mm.

Note: All dimensions shown in the figures of types 1 to 7 relate to finished sizes.

The design conditions for each type are as follows:

Types 1, 2 and 3 flanges for all maximum allowable working pressure and temperature conditions.

Types 4 and 5 flanges for all pressure conditions up to and including 42 kg/cm² (g) and design temperature not exceeding 399°C.

Types 6 and 7 flanges for all pressure conditions up to and including 17.6 kg/cm² (g) and temperature not exceeding 399°C except that Bossed flanges of type 6 shall not be used on pipes over 304 mm in nominal bore, nor Bossed flanges of type 7 on pipes 152 mm in nominal bore.

Type 8 flanges for all maximum allowable working pressure and temperature conditions and this type shall be used only for pipes up to and including 51 mm nominal bore. These flanges shall not be used where severe erosion or corrosion is expected to occur.

(3) Type 1,2,3,4 and 5 Carbon Steel types flanges welded on by the metal arc process shall have the welds stress relieved where the design depth of the weld recess is greater than 20 mm and all welds joining flanges to alloy steel pipes shall be stress relieved.

- (4) Where type 1 flanges are attached by oxy-acetylene welding, the welds shall be normalised in accordance with the following requirements:

(a) Welds in mild steel pipes shall be normalised by heating the metal to a temperature between 900° and 950°C, the temperature then being maintained for not less than two minutes for pipes up to and including 102 mm bore, and for not less than five minutes for pipes over 102 mm bore.

(b) Welds in pipes made from the alloy steel shall be normalised by heating the metal to a temperature between 925° and 975°C, the temperature then being maintained for not less than two minutes for pipes up to and including 102 mm bore, and for not less than five minutes for pipes over 102 mm bore.

(c) The higher temperatures of between 950° and 975°C, shall be used for alloy steels having a carbon content up to and including 0.12 percent and the lower temperatures of between 925° and 950°C shall be used for alloy steels having a carbon content of more than 0.12 percent.

(d) After normalising the joint shall be covered with a suitable muff or asbestos cloth to ensure slow and even cooling.

(e) The normalising of welds in pipes up to 102 mm bore may be carried out with welding flames the temperature being judged with the aid of a colour card, or measured by means of one or more thermo-couples or an optical pyrometer.

(f) The normalising of welds in pipes over 102 mm bore shall preferably be carried out in a portable pipe normalising furnace or muffle, the temperature being measured by means of one or more thermo-couples or an optical pyrometer.

(g) The width of the zone to be heat treated to the specified temperature shall extend at least 13 mm on either side of the weld reinforcement.

- (5) The procedure to be observed in the stress relieving of welds shall be in accordance with regulation 123 and stress relieving shall be carried out by any of the following methods:-

(a) (i) Local heating using a portable muffle furnace, induction coils or other suitable appliances and due care shall be taken to apply heat uniformly over the area to be treated.

- (ii) The use of procedures not providing adequate control such as manual operated gas torches are not permissible.
- (iii) The temperature shall be measured by the thermo-couples pinned, welded or otherwise suitably attached to the surface of the pipe and where necessary, protection from flame impingement shall be taken.
- (b) The temperature of the joint during heating in a stationary industrial furnace shall be measured by thermo-couples appropriately placed within the furnace as to give a true measure of the joint temperature.

264. Standard flanges.— The size and thickness of flanges and the number and size of their bolts shall be as shown in Appendix-F.

265. Joints.— (1) These regulations provide for ordinary bolted flange joints and special types of joints may be used, subject to the approval of the Inspecting Authority or Chief Inspector, as the case may be.

- (2) Welded butt joints of pipes or socket welded joints for pipes, valves and fitting shall be made by arc welding process and post weld heat treated effectively as per regulation 123.

- (3) Heat treatment shall be carried out by one of the following methods:-

- (a) (i) Local heating using a portable muffle induction coils, or other suitable heating appliance.
- (ii) Due care shall be taken to apply heat uniformly over the area to be treated.
- (iii) The use of procedures not providing adequate control such as manual operated gas torches are not permissible.
- (iv) The temperature shall be maintained symmetrically over peripheral band of metal of a minimum width of three times the width of the butt welded preparation.
- (v) The temperature shall be measured by thermo-couples pinned, welded or otherwise suitably attached to the surface of the pipe and, where necessary, protected from flame impingement.

- (b) In case of heating in stationary furnace, temperature of the joint shall be measured by thermo-couples so disposed with in the furnace as to give a true measure of the joint temperature.

- (c) In case of the materials made to the foreign codes or standards are accepted under clause (a) of sub-regulation (2) of regulation 3, the method of heat treatment shall conform to that specified in the codes or standards.

- (4) Such Butt-welded joints conform to Fig. 7/10.

266. Tests on completed welds on pipelines.— (1) For tests on completed welds on pipelines, pipelines shall be divided into following two classes, namely:-

- (a) Class-I: Pipelines for service conditions in which any one of the following limits are exceeded.

(i)	Design temperature	218°C
(ii)	Maximum allowable working Pressure	17.6 kg/cm ² (g)
(iii)	Feed water pressure	24.6 kg/cm ² (g)

- (b) Class II: Pipelines for service conditions in which none of the foregoing limits is exceeded.

- (2) For identification of welds, the welders' identification mark shall be stamped without indentation, or stencilled adjacent to each completed weld.

267. **Tests for Class I pipelines.**—(1) Where the completed pipelines are not tested by the application of hydraulic pressure, the welds shall be subjected to the following inspection procedure, namely:-

- (a) (i) For piping of over 102 mm bore, all butt-welds shall be subjected to non-destructive examination by radiographic or other approved methods.
(ii) The entire circumference of the first five welds made by each welder shall be non-destructively examined and if these are found to be satisfactory and Competent Person is satisfied with the welding techniques, methods of control and supervision employed, relaxation in the extent of non-destructive examination may be considered, but this relaxation shall in no case permit the non-destructive examination of less than one-third of the circumference of each of remaining welds made by the welder concerned.
- (b) For piping of 102 mm bore and under, but not less than 38 mm bore, five percent of the butt-welds made by each welder with a minimum of two welds per welder, selected at random shall be subjected to non-destructive examination by either radiographic or other approved methods or may be cut out for visual examination and bend tests.
- (c) For piping of less than 38 mm bore, special tests are not normally required but two percent of the welds by each welder on a pipeline may be cut out from the pipe-line for visual examination and bend tests.

(2) Where the completed pipelines are tested by the application of hydraulic pressure, the welds shall be subjected to the following inspection procedure, namely:-

- (a) For piping of over 102 mm bore, ten percent of the welds made by each welder on a pipeline with a minimum of two welds per welder, selected at random, shall be subjected to non-destructive examination by radiographic or other approved methods.
- (b) For piping of 102 mm bore and under, but not less than 38 mm bore, two per cent of the welds made but each welder on a pipeline with a minimum of one weld per welder, selected at random, shall be subjected to non-destructive examination by radiographic or other approved methods or may be cut out for visual examination and bend tests.
- (c) For piping of less than 38 mm bore, special tests are not normally required, but two percent of the welds by each welder on a pipeline may be cut from the pipeline for visual examination and bend tests.

268. **Tests for Class II pipelines.**—(1) All pipelines under this classification shall be subjected to hydraulic test on completion of erection.

- (2) (a) On completion of the first ten production welds made by each welder, one of the welds shall be cut out for test purposes or alternatively, the welder shall prepare a test specimen made up of two similar lengths of piping welded in a position as closely representative of a selected production weld as is practicable.
(b) The test specimen shall be subjected to visual examination and bend tests.
- (3) Two percent of the remainder of the welds made by each welder shall be selected at random and cut out for test purpose, or, alternatively the welders shall prepare a test specimen made up of two similar lengths of piping welded in a position as closely representative of a selected production weld as far as practicable and the test specimen shall be subjected to visual examination and bend tests.
- (4) Notwithstanding anything contained in sub-regulations (2) and (3), the bend tests shall be dispensed with, in case the welds have been non-destructively tested in the following manner:

- (a) For piping of over 102 mm bore, five per cent of the welds made by each welder on a pipeline with a minimum of two welds per welder, selected at random shall be subjected to a non-destructive examination by radiographic or other approved methods.
 - (b) For piping of 102 mm bore and under, one per cent of the welds made by each welder on a pipeline with a minimum of one weld per welder, selected at random shall be subjected to non-destructive examination by radiographic or other approved technique.
269. **Re-tests.**— (1) If any test specimen is unsatisfactory, two further weld specimen for re-test shall be selected from the production welds and subjected to tests.
- (2) In the events of failure of any of the re-test specimens, the production welds carried out by this welder subsequent to the previous tests shall be subject of special consideration.
270. **Socket weld joints.**— (1) Socket weld joints may be used with carbon and low alloy steel pipes not exceeding 60.3 mm. outside diameter.
- (2) Such welds shall not be used where fatigue, severe erosion or severe corrosion is expected to occur.
- (3) The maximum allowable working pressure of the socket weld fittings shall be determined in accordance with equation (7/1) (regulation 256).
- (4) The thickness of the socket weld fittings shall not be less than $1\frac{1}{4}$ times the nominal thickness of pipe and the material shall be compatible with the associated piping.
271. **Butt welded joints.**— (1) Butt welded joints as applicable shall be subjected to non-destructive examination by radiographic, radioscopy or other approved methods such as ultrasonic testing including phased array ultrasonic testing, magnetic particle inspection or liquid dye penetrant inspection.
- (2) When radioscopic examination is to be performed in lieu of radiography on welded components, the following requirements shall be met:-
- (a) A written procedure shall be submitted for approval to the Inspecting Authority which shall contain the following:-
 - (i) material and the thickness range;
 - (ii) equipment qualifications;
 - (iii) test object scan plan;
 - (iv) radioscopic parameters;
 - (v) image processing parameters;
 - (vi) image display parameters;
 - (vii) image archiving requirements;
 - (viii) accept-reject criteria (code reference);
 - (ix) performance evaluation;
 - (x) Operator identification.
 - (b) The system shall be aided with an image processor to enhance the quality of the radioscopic images and system performance quality shall exhibit-
 - (i) a thin section contrast sensitivity of 3%;
 - (ii) a thick section contrast sensitivity of 2%;
 - (iii) a spatial resolution of 3 line pairs per mm;
 - (iv) IQI sensitivity - 2% of the joint thickness when wire IQI's are to be used, the wire diameter axis shall be oriented along the axis of the least sensitivity of the system.
 - (c) Radioscopes are to be properly marked to co-relate with particular part of joint represented.
 - (d) The radioscopic examination data shall be recorded and stored on videotape, magnetic disk or optical disk or any other electronic storage device at the maker's plant for a sufficient period after the date of radioscopic examination as specified by the Inspecting Authority, Efficient radioscopic examination

record recall shall be made available at any time over the record retention period and shall be traceable to the test objects.

- (e) When repair has been performed as a result of radioscopic examination, the repaired areas shall be re-examined using the same radioscopic technique to evaluate the effectiveness of the repair.
- (f) To aid in proper interpretation of the radioscopic examination data, the details of the technique used shall accompany the data. As a minimum, the information shall include the approved procedure requirements and system performance test data

PART-IV STEAM-PIPE FITTINGS AND CONNECTIONS

272. Wrought Bends.— The minimum wall thickness at any point on the pipe bend shall be determined according to either of the following methods, namely :-

- (a) (i) The minimum wall thickness at any point in the finished bend shall not be less than required by equation (7/2) or (7/4) given in regulation 256.
- (ii) The bend thinning allowance shall be selected based on the manufacturing process to ensure the minimum thickness requirements after bending.
- (iii) The bend thinning allowance thus selected is to be provided on all parts of the cross section of the pipe circumference without any detrimental effects on the final product.
- (b) The minimum required thickness t_m of a bend, after bending, in its finished form, shall be determined in accordance with equation (i) or (ii), namely:-
- (c)

$$t_m = \left(\frac{P \times D}{2 \times (f \times e / I) + P} \right) + C \quad \text{[equation (i)]}$$

When outer diameter 'D' is the basis for calculation

$$t_m = \left(\frac{P \times d}{2 \times (f \times e / I) - P} \right) + C \quad \text{[equation (ii)]}$$

When Inner diameter 'd' is the basis for calculation

where,

- t_m = minimum wall thickness of a bend in mm,
- P = maximum allowable working pressure in kg/cm²(g),
- D = outside diameter of pipe in mm,
- d = inside diameter of pipe in mm,
- f = allowable stress as provided under regulation 170 in kg/cm²,
- e = efficiency factor,
- $=$ 1.0 for seamless and for electric resistance welded steel pipes and for electric fusion welded steel pipes complying with the requirements of Chapter-2 in which the weld is fully radiographed or ultrasonically tested,

- = 0.95 for electric fusion welded steel pipes complying with the requirements of Chapter-2,
- = 0.90 for welded steel pipes for values of t (minimum thickness of pipe) up to and including 22 mm,
- = 0.85 for welded steel pipes for values of t (minimum thickness of pipe) over 22 mm and up to and including 29 mm,
- = 0.80 for welded steel pipes for values of t (minimum thickness of pipe) over 29 mm,
- C = 0.75 mm.

$$I = \frac{[4x (R/D) - 1]}{[4x (R/D) - 2]} \quad \{\text{at the intrados (inside of bend)}\},$$

$$= \frac{[4x (R/D) + 1]}{[4x (R/D) + 2]} \quad \{\text{at the extrados (outside of bend)}\},$$

$$= 1.0 \quad \{\text{at the side wall of the bend centre line}\},$$

Where, R = Bend radius of pipe bend in mm (see figure below),
D= outside diameter of pipe

Thickness variations from the intrados to the extrados and at the ends of the bend shall be gradual and the minimum thickness requirements calculated above should be met at the extrados, intrados and bend centre line of the finished bend (see figure below).

The minimum thickness at the ends of the bends shall not be less than the requirements of equation (7/2) or (7/4) given in regulation 256 and the bend thinning allowance shall be selected based on the manufacturing process to ensure the minimum thickness requirements after bending.

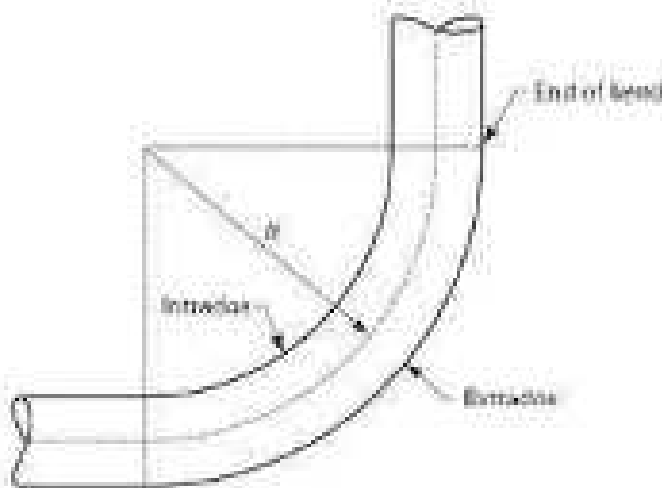


Fig. 7/1

273. Butt welding fitting.— The butt- welding fittings shall conform to the dimension and tolerances given in the figure and table given below:

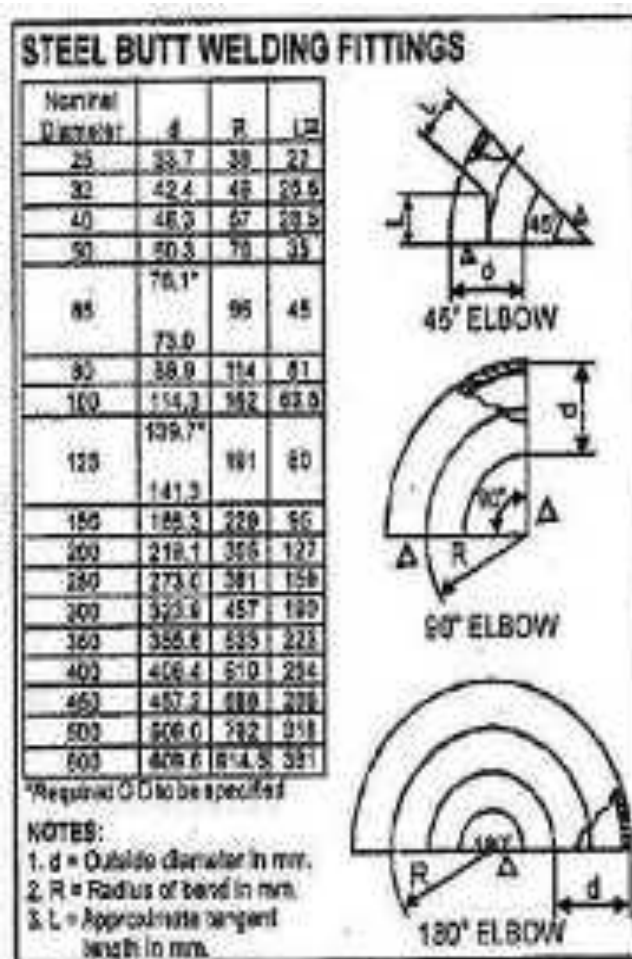


Fig. 7/2: Steel Butt Welding Fittings – Regulation 273

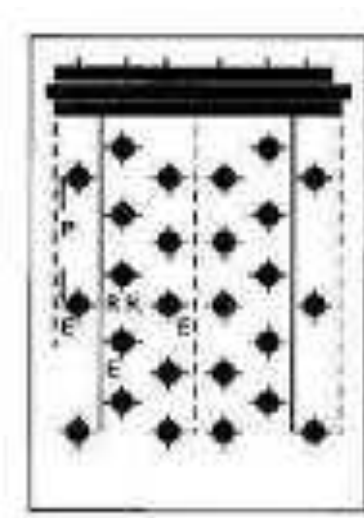
PART-V

274. Steel butt Welded fittings.— (1) (a) Branches, bosses and drain pockets welded to the pipes shall conform to the requirements of regulations 148 to 152.

(b) Branches shall not be welded to any main at an angle of less than 60°.

(2) (a) If the thickness of the main or branches of a single or multiple branch piece is less than given by the Equation(7/6), external reinforcement shall be provided.

(b) Such reinforcement may take the form of multiple radial plates of 'horse shoe' form or the form of collars or other reinforcement, approved by the Inspecting Authority or Chief Inspector as the case may be, applied to or around the junction between the branch and the main.



- (3) (a) Thickness where no external reinforcement is provided; where more than one branch is attached to a pipe, the opening of each branch shall be projected perpendicularly on the axis of the main and the distance between each pair of these projection measured. If the distance so measured between two branches is less than the sum of their bores, the two branches are deemed to affect each other; if this distance is equal to or greater than the sum of their bores, the two branches are deemed not to affect each other and in calculating the reinforcement required, each branch is to be considered in turn together with all the branches by which it is affected.
- (b) In case a branch not affected by any other branch, where no external reinforcement is to be applied to a branch piece the thickness of the branch shall be determined from Equation (7/6).

$$t_m = \frac{PD}{(2SE + P)X} + C \quad \text{Equation (7/6)}$$

- Where, t_m = nominal thickness of the branch less the permissible negative tolerance,
 P = Maximum allowable working pressure,
 S = Maximum permissible stress values available in the governing codes of the country of the material to which it belongs,
 E = Efficiency factor given in regulation 256.
 $X = 1 - B(1 - 0.7 \sin y)$ Equation (7/7)
 B = ratio of bore of branch to bore of main
 y = angle between branch and main in degrees
 D = outside Diameter
 C = 0.75 mm

The values of t_m derived from Equation (7/6) is the minimum thickness and further provision shall be made for any minus tolerance.

No reinforcement is required if –

$$B \text{ is less than } \frac{Y}{Y + 90} \quad \text{Equation (7/8)}$$

- (c) In case a branch affected by one or more other branches (see Fig. 7/6), determine the 'X' values for each branch alone from equation (7/7). Let 'X' be the value for the branch under consideration and X_a , X_b , the value for the other branches.

$$\left. \begin{array}{l} \text{Then } X_1 = 1 - C (1 - X_a) \\ X_2 = 1 - C (1 - X_b) \end{array} \right\} \text{Equation (7/9)}$$

Where, C is a factor the value of which is to be taken from Table 7/6.

Table 7/6

Serial No.	$\frac{L}{d_1 + d_2}$	C
(1)	(2)	(3)
1.	1 or greater	0
2.	0.9	0.10
3.	0.8	0.34
4.	0.7	0.66
5.	0.6	0.80
6.	0.5	0.90
7.	0.4	0.94
8.	0.3	0.97
9.	0.2	0.98
10.	0.1	0.99
11.	0.0	1

(L = distance between projections of bores, d_1 and d_2)

Intermediate values by linear interpolation:

It is to be specially noted that a branch may form part of two distinct, multiple branches, when its thickness shall be the greater of the thickness calculated for it as a component of each multiple branch.

The thickness of each branch which is a component of a multiple branch shall be determined from Equation (7/10). Equation (7/6) shall not apply:

$$* t_m = \frac{Pd}{2 (Se + P) X} \times \frac{1}{X_1 \cdot X_2} + C \quad \text{Equation (7/10)}$$

Where C = 0.75 mm.

***SHAPE OF PROFILE** - Unless the weld is dressed flush, there shall be external weld reinforcement, preferably within the limits recommended in Table 7/7 below and this reinforcement shall be substantially symmetrical about the centre line of the joint and the shape of the reinforcement may vary according to the type of electrode or welding technique used and the welding position, but shall in all cases be of smooth contour, the profile running out smoothly into the pipe on each side without notching or reduction of thickness of the pipe at the edges of the weld.

Table 7/7: Amount of weld Reinforcement

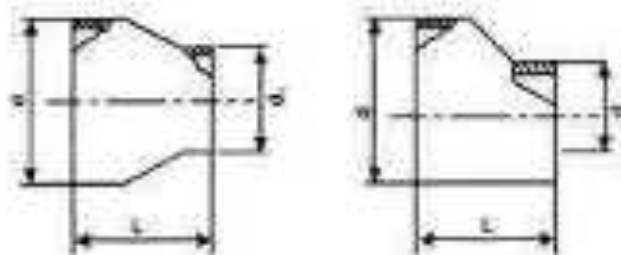
Serial No.	Pipe thickness		Recommended limits	
	Over	Upto and including	Minimum	Maximum
	mm.	mm.	mm.	mm.
(1)	(2)	(3)	(4)	(5)
1.	-	6	1.6	5
2.	6 mm	13	1.6	5
3.	13 mm	-	1.6	6

(d) For mains (see Figs. 7/6, 7/7, 7/8 and 7/9), (i) the thickness of main carrying a single or a multiple branch shall be determined as for the single branch or one component of the multiple branch except that the symbols 'D' and 'E' shall apply to the main.

(ii) The thickness of a main carrying more than one branch, single or multiple, shall be the greatest of the thickness of the main calculated in connection with each branch separately.

(iii) The additional thickness of a main for branch reinforcement shall extend over the length covered by the branch and beyond it for a distance not less than the bore of the branch on each side.

STEEL BUTT WELDING REDUCERS



CONCENTRIC REDUCER

ECCENTRIC REDUCER

Nominal Diameter	Outside Dia.		L
	d	d ₁	
25 × 10	31.7	17.2	51
25 × 15		21.3	
25 × 20		25.8	
32 × 15	42.4	21.3	51
32 × 20		25.8	
32 × 25		33.7	
40 × 15	48.3	21.3	64
40 × 20		25.8	
40 × 25		33.7	
40 × 32	48.3	42.4	76
50 × 20		25.8	
50 × 25		33.7	
50 × 32	60.3	42.4	89
50 × 40		48.3	
65 × 25		33.7	89
65 × 32	76.1	42.4	
65 × 40		48.3	
65 × 50	76.1	60.3	89
80 × 25		33.7	
80 × 32		42.4	
80 × 40	86.0	48.3	89
80 × 50		60.3	
80 × 65		76.1	

Nominal Diameter	Outside Dia.		L
	d	d ₁	
100 × 25	114.3	33.7	102
100 × 32		42.4	
100 × 40		48.3	
100 × 50		60.3	
100 × 65		76.1	
100 × 80		88.9	
125 × 50	135.7	60.3	127
125 × 65		76.1	
125 × 80		88.9	
125 × 100	141.3	114.3	140
150 × 50		60.3	
150 × 65		76.1	
150 × 80	168.3	88.9	140
150 × 100		114.3	
150 × 125		139.7	
200 × 80	219.1	88.9	152
200 × 100		114.3	
200 × 125		139.7	
200 × 150	219.1	168.3	178
250 × 80		88.9	
250 × 100		114.3	
250 × 125	273	139.7	
250 × 150		168.3	
250 × 200		219.1	

Nominal Diameter	Outside Dia.		L
	d	d ₁	
300 × 300	323.8	114.3	203
300 × 125		139.7	
300 × 150		168.3	
300 × 200	323.8	219.1	203
300 × 250		273.0	
350 × 150	365.0	168.3	203
350 × 200		219.1	
350 × 250		273.0	
350 × 300	365.0	323.8	203
400 × 200		219.1	
400 × 250	406.4	273.0	256
400 × 300		323.8	
400 × 350		365.0	
450 × 250	457.2	273.0	256
450 × 300		323.8	
450 × 350		365.0	
450 × 400	457.2	406.4	256
500 × 300		323.8	
500 × 350	508	365.0	256
500 × 400		406.4	
500 × 450		457.2	
600 × 400	609.6	406.4	256
600 × 450		457.2	
600 × 500		508.0	

* Required O.D. to be specified.

Notes:

1. d = Outside diameter of the big end.
2. d₁ = Outside diameter of the small end.
3. L = Overall length.

Fig. 7/3: Steel Butt Welding Reducers

UNEQUAL TEE

Nominal Diameter	Outside Dia		L	r	Nutrient Diameter	Core Dia		L	L ₁	Approx. Diameter	Outside Dia		L	r
	φ	φ ₁				φ	φ ₁				φ	φ ₁		
25 × 25 × 18	35.7	17.3	30	18	100 × 100 × 40	134.3	48.3	100	88	300 × 300 × 180	114.3	204	218	
25 × 25 × 18		21.3			100 × 100 × 50		68.3		88	300 × 300 × 185			219	
25 × 25 × 28		30.9			100 × 100 × 60		78.1		98	305 × 305 × 150			213	
25		—			100 × 100 × 80		88.9		108	305 × 305 × 200			219.1	
32 × 32 × 18	42.4	21.3	40	40	125 × 125 × 40	141.3	—	104	—	300 × 300 × 250	223	204	241	
32 × 32 × 28		28.9			125 × 125 × 50		68.3		105	305			—	
32 × 32 × 28		32.7			125 × 125 × 60		78.1		126	305 × 305 × 190			224	
32		—			125 × 125 × 80		88.9		141	305 × 305 × 200			224	
40 × 40 × 18	48.3	21.3	40	40	125 × 125 × 100	141.3	114.3	104	117	305 × 305 × 250	223	202	257	
40 × 40 × 28		28.9			125		—		—	305 × 305 × 300			223.9	
40 × 40 × 28		35.7			150 × 150 × 50		80.3		121	350			—	
40 × 40 × 28		42.4			150 × 150 × 60		78.1		121	400 × 400 × 150			160.3	
40	—	—	—	—	150 × 150 × 80	156.3	88.9	143	124	400 × 400 × 300	213	205	273	
50 × 50 × 20	30.9	40	150 × 150 × 100	114.3	130		400 × 400 × 250		223					
50 × 50 × 25	33.7	51	150 × 150 × 125	120.7	137		400 × 400 × 300		223.9					
50 × 50 × 32	42.4	62	180	—	—		400 × 400 × 340		244.8					
50 × 50 × 40	48.3	48.3	65	65	200 × 200 × 80	156.3	88.9	143	132	400	—	—	—	
50		—			—		200 × 200 × 100		114.3	135			450 × 450 × 200	219.1
50 × 50 × 24		35.7			67		200 × 200 × 125		124.7	138			486 × 486 × 240	271
55 × 55 × 32		42.4			64		200 × 200 × 150		135.3	155			450 × 450 × 300	230.0
55 × 55 × 40	72.3	48.3	75	75	300	—	—	—	450 × 450 × 350	457.2	340.0	230.3		
55 × 55 × 50		50.3			75		150 × 150 × 80		88.9			134	450 × 450 × 400	400.0
55		—			—		250 × 250 × 100		114.3			154	450	—
60 × 60 × 25		35.7			67		200 × 200 × 125		124.7			138	500 × 500 × 200	279.1
60 × 60 × 30	48.3	42.4	75	75	250 × 250 × 100	156.3	144.3	218	198	500 × 500 × 250	275	341	335.4	
60 × 60 × 40		48.3			73		200 × 200 × 200		219.1	200			500 × 500 × 300	320.0
60 × 60 × 50		50.3			75		250		—	—			500 × 500 × 350	355.0
60 × 60 × 60		76.1			89		—		—	—			500 × 500 × 400	400.0
60	—	—	—	—	—	—	—	—	500 × 500 × 450	457.2	—	350.0		
60	—	—	—	—	—	—	—	—	500	—	—	—	—	

Notes:

1. d = Outside diameter of the run pipe and branch in case of equal tee.
2. d_1 = Outside diameter of the branch in case of unequal tee.
3. L = Distance of centre to end of run.
4. L_1 = Distance of centre to end of branch.

Fig.7/4: Steel Butt Welding Tees

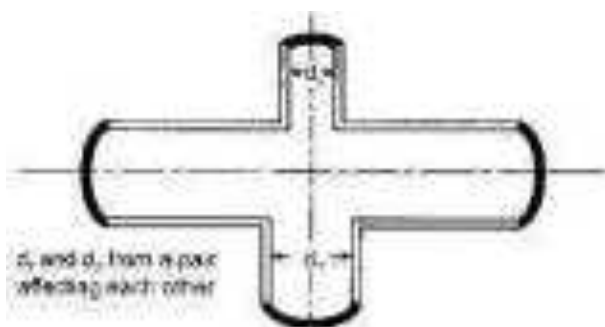


Fig. 7/6: Typical Branch Pieces

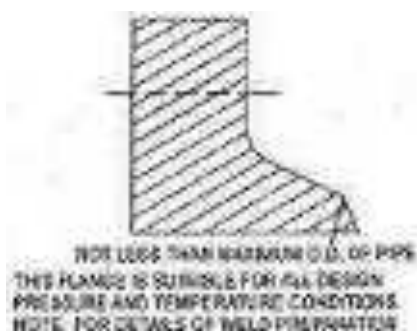


Fig. 7/10 – Welding Neck Flange

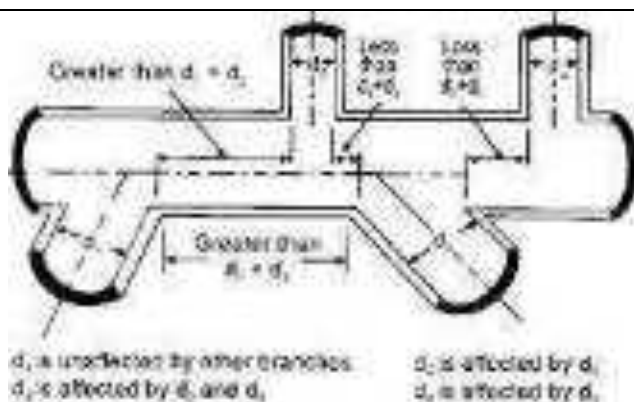


Fig. 7/7: Typical Branch Pieces

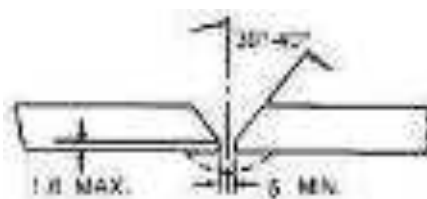


Fig. 7/11: Plain Vee for Use with Backing Ring

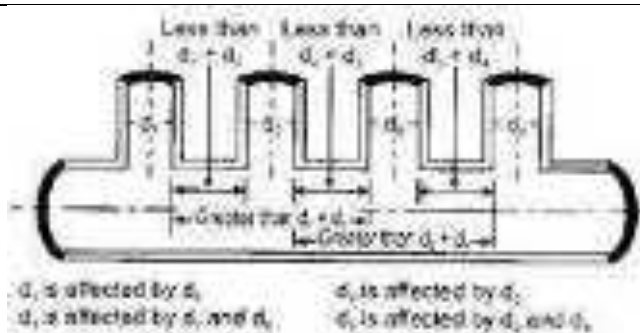
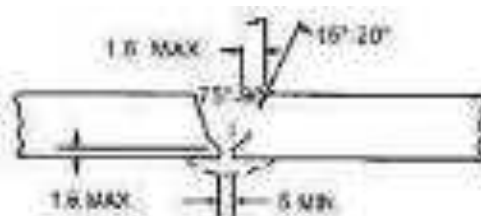


Fig. 7/8: Typical Branch Pieces



[Pipes Over 13 mm Thick]

Fig. 7/12: Double Angle Vee for Use with Backing Ring

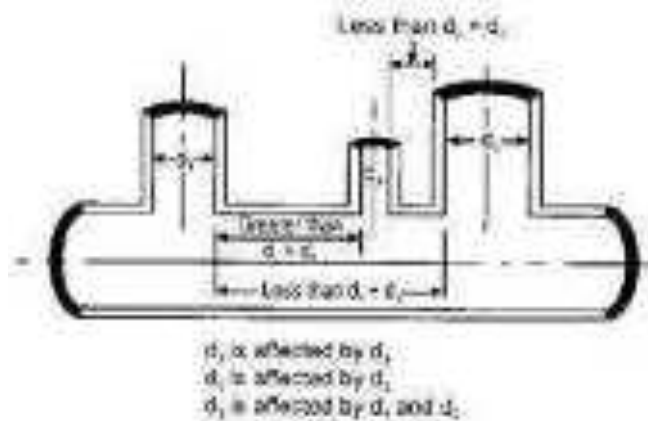
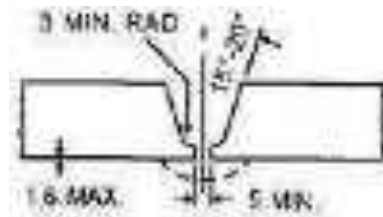


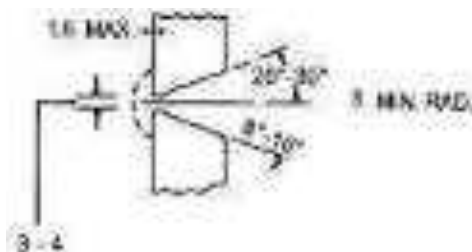
Fig. 7/9: Typical Branch Pieces

All dimensions are in mm.



[Pipes over 13 mm Thick]

Fig. 7/13: Normal preparation U-Groove for use with backing ring



[Pipes over 13 mm Thick]

Fig. 7/14: Permissible Alternative Preparation for Vertical or Nearly Vertical Pipe U-Groove for Use with Backing Ring

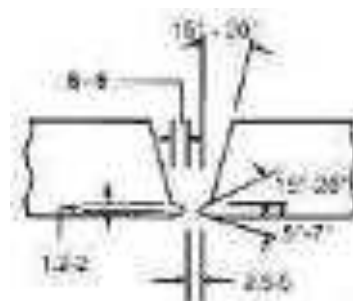
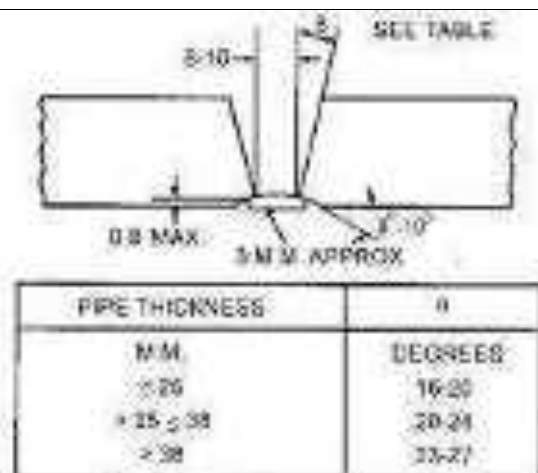
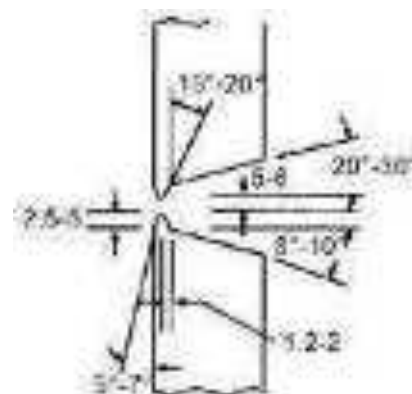


Fig. 7/18: Normal Preparation Double Angle Vee for Use with Oxy-Acetylene Base Run



[For Pipes over 8 mm Thick]

Fig. 7/15: Preparation of Groove for Use with Taper Backing Ring and Double Root Run



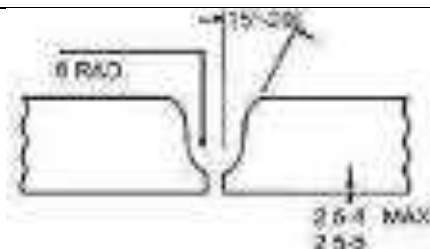
Permissible Alternative Preparation for Vertical or Nearly Vertical Pipe

Fig. 7/19: Double Angle Vee for Use with Oxy-Acetylene Base Run



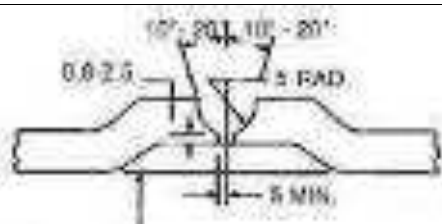
For Pipes 13 mm and Thinner

Fig. 7/16: Groove for Use with Recessed Backing Ring



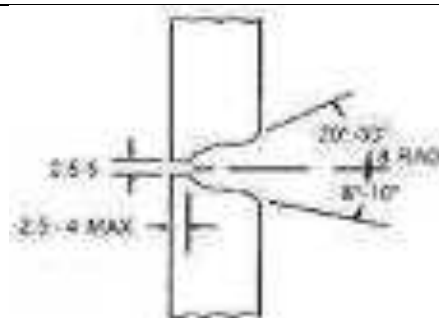
Normal Preparation

Fig. 7/20: U-Groove for Use With Oxy-Acetylene Base Run



Approx. Flush with Bore for Pipes Thicker than 13 mm.

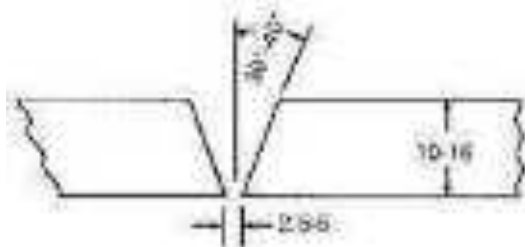
Fig. 7/17: Groove for User with Recessed Backing Ring



Permissible Alternative Preparation for Vertical or Nearly Vertical Pipe

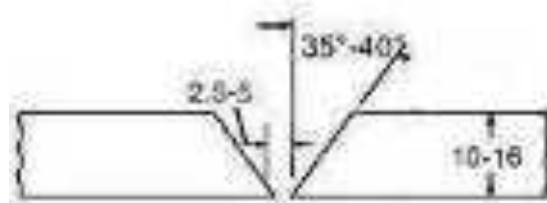
Fig. 7/21: U-Groove for Use With Oxy-Acetylene Base Run

All dimensions are in mm.



[Pipes 10 to 16 mm Thick inclusive]

Fig. 7/22: Plain Vee for Use With Oxy-Acetylene Base Run



For Use with Special Welding Technique

Fig. 7/24: Plain Vee for Use Without Backing Ring

Normal Preparation

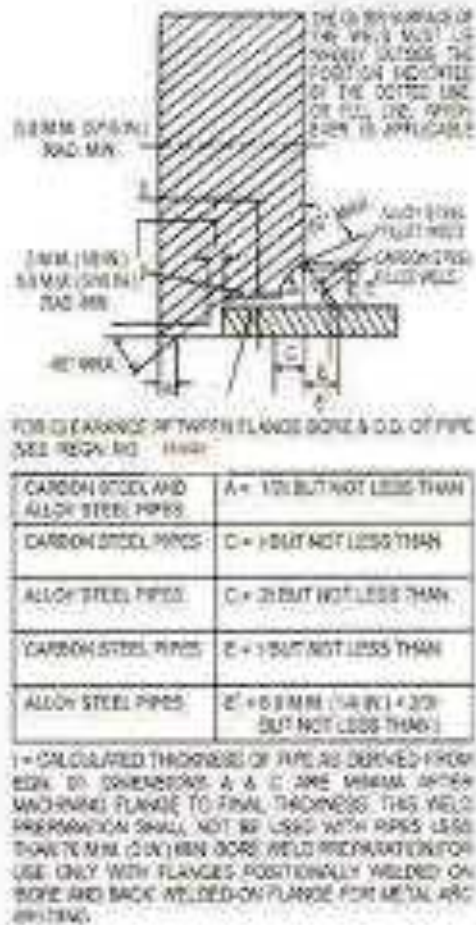


Fig. 7/28

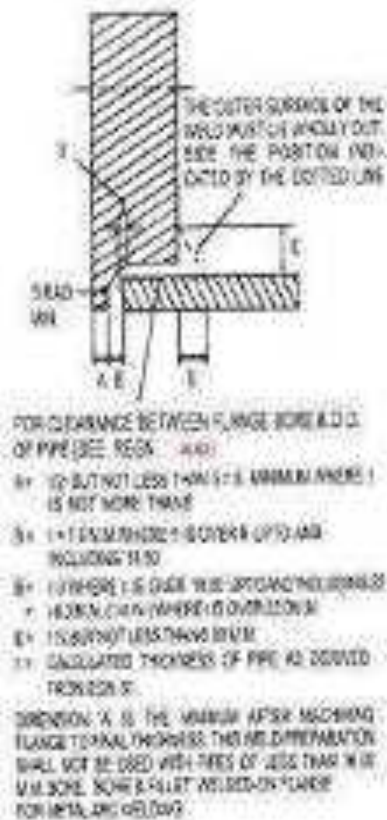


Fig. 7/30

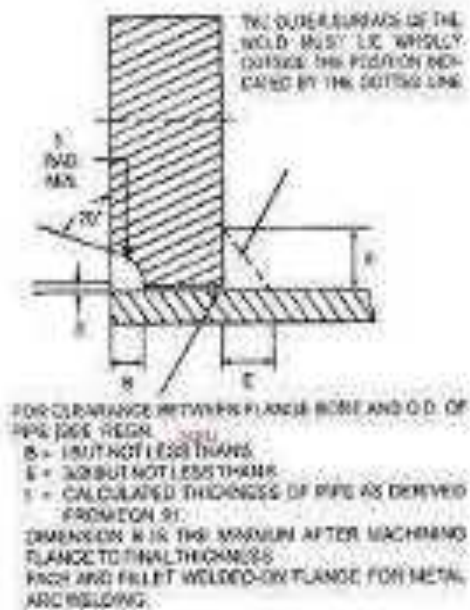


Fig. 7/29

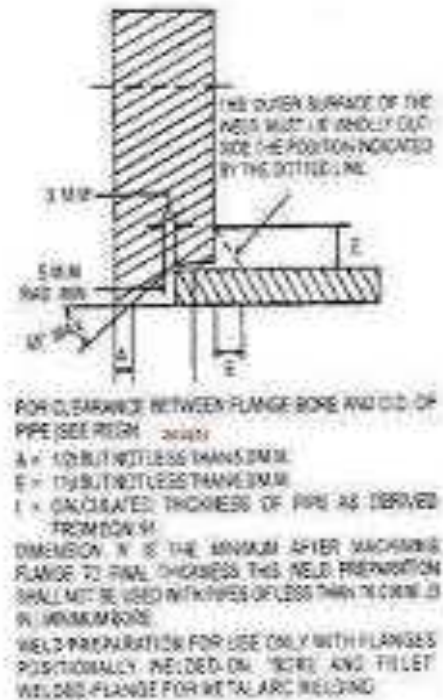


Fig. 7/31

All dimensions are in mm.

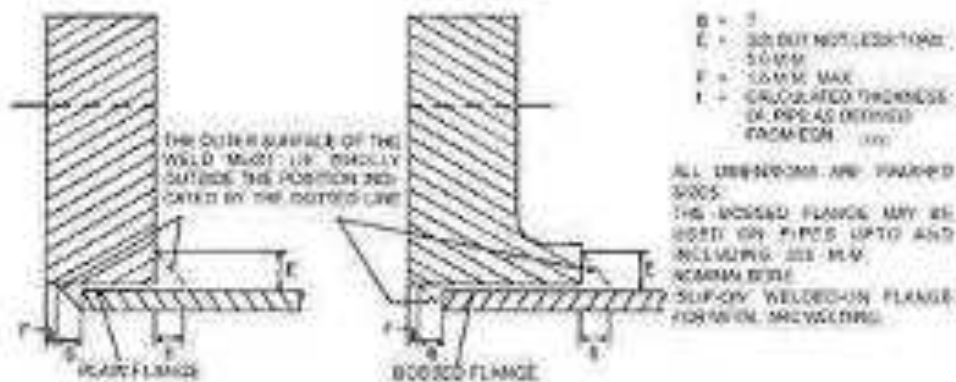


Fig. 7/32: For Clearance Between Flange Bore & O.D. of Pipe [See regulation 263(2)]

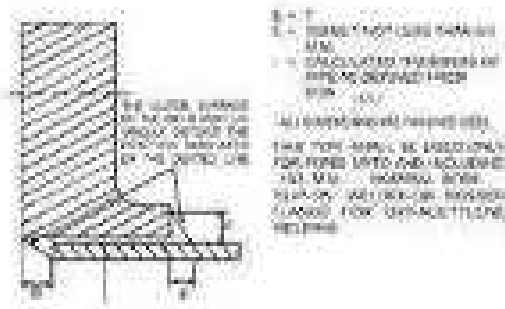


Fig. 7/33: For Clearance Between Flange Bore & O.D. of Pipe [see regulation 263(2)]

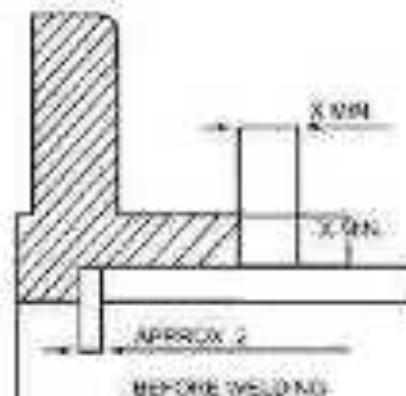


Fig. 7/34: Socket Welded Flange

All dimensions are in mm.

275. Blow-down pipes .— (1) Blow-down pipes which can be subjected to full boiler pressure shall be considered as saturated steam-pipes at that pressure.

(2) Blow-down pipes which cannot be subjected to full boiler pressure shall be considered as saturated steam-pipes at half the design pressure of the boiler.

276. Valves chests .— (1) Chests of stop-valves, isolating valves, reducing valves, steam traps, etc., forming parts of wrought steel main steam piping when for use with saturated steam up to a gauge pressure of 11kg/cm² (g) or a temperature of 204°C may be made of cast iron, cast steel or wrought steel in accordance with the requirements of regulation 191.

(2) When superheated steam is used above 204°C or when pressures are above 11kg/cm² gauge, such chests shall be made of cast or wrought steel or other approved material in accordance with the requirements of regulation 191.

PART-VI

277. Materials in the construction of steam receivers, separators, catch waters, accumulators and similar vessels.—(1) Material for plates, bars and sections used in the construction of steam receivers, separators, catch waters, accumulators and similar Vessels shall comply in all respects with the requirements of relevant regulations of Chapters-2 and 4, depending upon the mode of construction.

- (2) Branches, bosses and drain pockets may be solid forged, fabricated by fusion welding, machined from solid bars or made from tubes.
- (3) Materials for flanges shall comply with the appropriate provisions of regulation 258.
- (4) Forgings shall comply with the requirements of regulations 58 to 62
- (5) Steel castings for shells or pressure parts of shell shall comply with regulations 51 to 57.

278. Construction and workmanship.—(1) Shell ends formed separately from the shell may be dished or flat or the ends of the shell may be forged down and closed by manhole doors or by plugs or branches welded in.

- (2) (a) (i) Each dished end shall be made from one rolled plate.
 - (ii) If this is impracticable, owing to the large diameter, the dished end plate may be made from two plates fusion butt welded together and in such cases, the line of weld shall be parallel to the horizontal axis of the vessels and the weld shall be radiographed after forming.
 - (iii) The shape of dished end shall conform to the requirements of regulation 174.
 - (iv) Dishing end peripheral flanging shall be done by machine.
 - (v) Cold flanging shall not be adopted.
 - (vi) All plates which have been dished, flanged or locally heated shall afterwards be efficiently heat treated for the purpose of relieving internal stresses, unless during the last stage of manufacture, they have been uniformly heated throughout to a suitable temperature.
 - (vii) Care shall be taken to see that the flanges are cylindrical, of good surface and free from local irregularities.
- (b) Where flats are pressed in dished ends for the attachment of connections, they shall be formed with an ample radius at the junctions of the flat and curved surfaces and shall be free from sharp corners and tool marks.
- (c) Dished ends shall be attached to the cylindrical part of the shell by one of the following methods:
 - (i) Welding with butt Joints of the Single or Double U or V Type; where the internal diameter of the shell is 610 mm or over, the joints shall in all cases, be welded from both sides of the plate.
 - (ii) Where the internal diameter of the shell is less than 610 mm the joints may be welded from one side only, when efficient welding from inside is considered impracticable.
 - (iii) In the construction of unfired boilers when the dished ends do not form part of the heating surface, cold spun dished ends conforming to IS: 2825 may be used.
- (3) (a) Flat ends shall be of forged steel or plate steel and shall be welded to the cylindrical part of the shell or bolted to flanges which shall be attached to the cylindrical part of the shell in accordance with regulation 263.
- (b) The attachment of flat ends shall be by one of the methods shown in figure 7/35, 7/36, 7/37 and 7/38 of this chapter.
- (c) When ends are attached as shown in figure 7/38, welding shall be from both side of the shell plate wherever practicable and where welding is done from one side only, care shall be taken to ensure full penetration using backing strips.

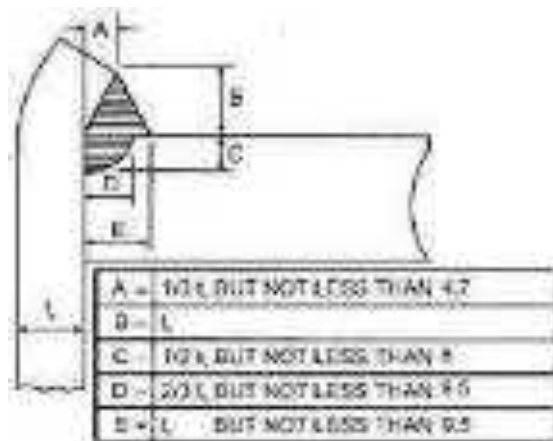


Fig. 7/35

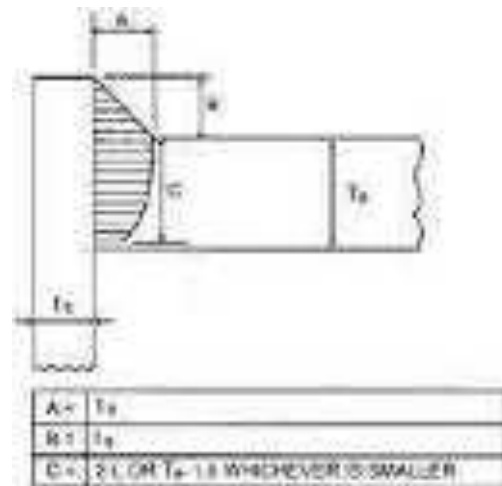


Fig. 7/37

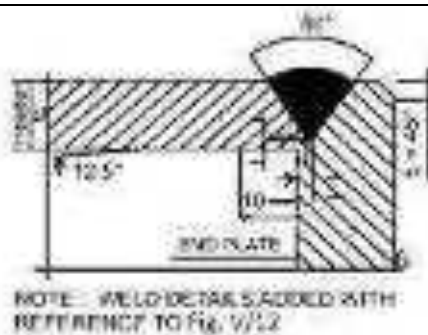


Fig. 7/36

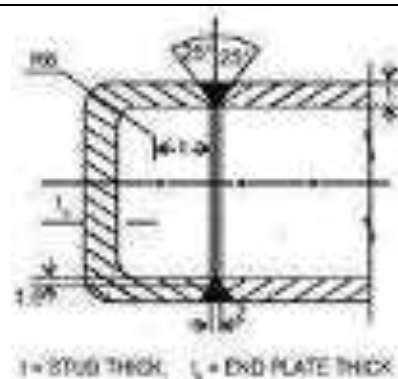


Fig. 7/38

All dimensions are in mm.

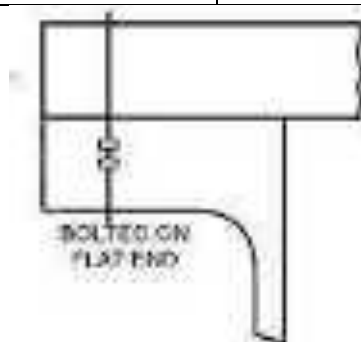


Fig. 7/39

- 279. Access to Shells.**— (1) At least one manhole shall be provided to allow access for thorough cleaning and inspection, except that where the shell is too small to permit entry, cleaning and inspection openings of sufficient size and number shall be provided.
- (2) When there is an elliptical opening in the cylindrical part of the shell, the minor axis shell, wherever practicable be parallel to the longitudinal axis of the shell.

280. Compensating rings to openings and doors.— The material, construction and workmanship of compensating rings and doors shall comply with the relevant provisions of Chapters 2, 3 and 12.

281. Branches and other connections.—(1) (a) Connections to shell shall be made by means of branches, pressed plate saddles, forged pads or bosses or where the thickness of the shell is sufficient to allow suitable surface to be obtained, connections may be attached directly to the shell, provided that the minimum thickness at the hole in the shell is not less than the thickness required for the maximum allowable working pressure and temperature considering the shell as being unpierced and that the diameter of the hole does not exceed the maximum diameter of an uncompensated hole as defined in regulation 141 and 179.

(b) Studs for securing such connections shall have a full thread holding in the shell for a length of at least one diameter and the stud holes shall not penetrate the whole thickness of the shell.

(c) All holes for bolts and studs in branches, saddles and forged pads shall be drilled.

(d) Where such connections are secured by welding alone, a minimum of two runs of metal shall be deposited at each weld, except for seal welds.

(e) Each run of weld metal shall be thoroughly cleaned and free from slag before the next run is deposited.

(f) The final finish of the welds shall be such that change of section from shell to branch is gradual and free from sharp notches.

(g) Where the diameter of the shell is 610 mm and over, welding shall be from both sides of the plate.

(h) Where the internal diameter of the shell is less than 610 mm, external and internal welds shall be applied unless it is considered that efficient welding from both sides is impracticable.

(i) This does not apply to the methods of attachment shown in Fig.7/40 and 7/41 in which the welding shall always be from both sides.

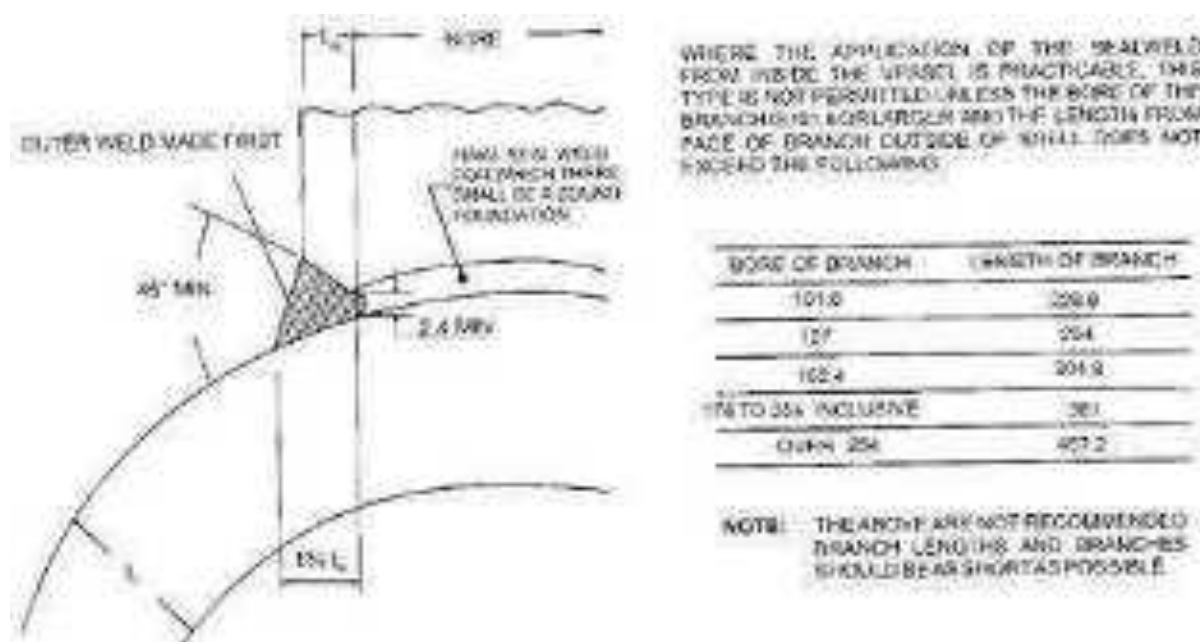
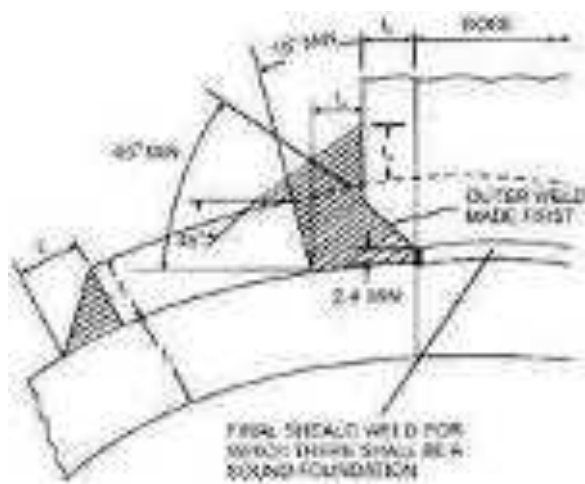


Fig. 7/40



WHERE THE APPLICATION OF THE SEAL WELD FROM INSIDE THE VESSEL IS APPROPRIATE, THIS TYPE OF WELD PERMITTED. FOR THE BORE OF THE BRANCH IS 101.6 MM OR LARGER AND THE LENGTH FROM FACE OF BRANCH TO OUTSIDE TO SHELL DOES NOT EXCEED THE FOLLOWING:

BORE OF BRANCH	LENGTH OF BRANCH
101.6	320.0
127	254
152.4	203
177.8 TO 254 INCLUSIVE	152
OVER 254	101.6

NOTE: THE ABOVE ARE NOT RECOMMENDED BRANCH LENGTHS AND BRANCHES SHOULD BE AS SHORT AS POSSIBLE.

Fig. 7/41

All dimensions are in mm.

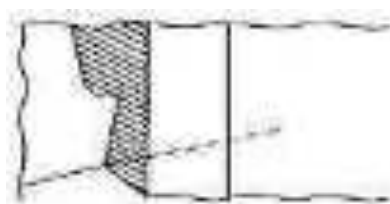


Fig. 7/43

WELDING PROCEDURE FOR TYPES SHOWN IN FIG. 7/42 AND 7/43 TO BE AS FOR DOUBLE WELDED BUTT JOINT. OUTER WELD TO BE MADE FIRST. BACK OF OUTER WELD TO BE CHIPPED OUT. BEFORE COMMENCEMENT OF INNER WELD BUTT DEEP PENETRATION WELDING MAY BE USED SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.



Fig. 7/44

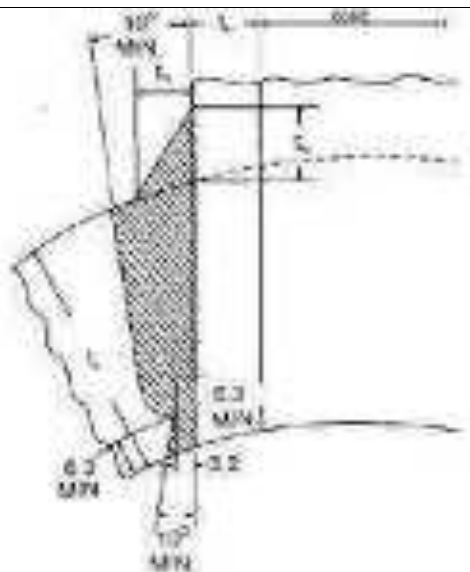


Fig. 7/42

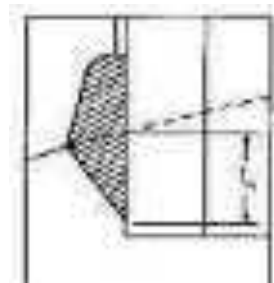


Fig. 7/45

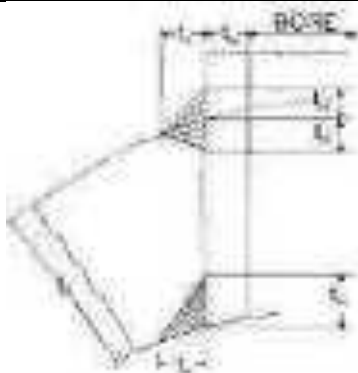
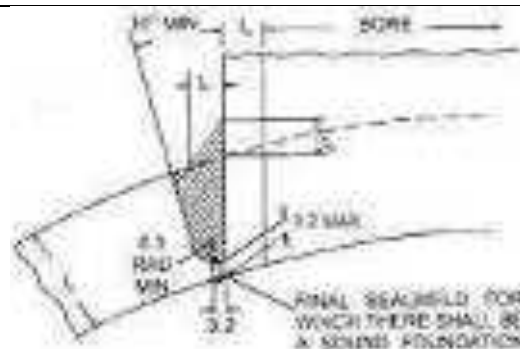
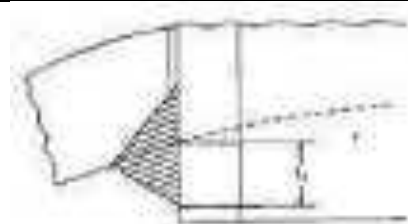


Fig. 7/46



THE TYPE SHOWN IN FIG. 7/49 IS NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 25.4 MM

Fig. 7/49



THE TYPES SHOWN IN FIG. 7/47 ARE ONLY PERMITTED WHERE THE ELECTRODES AND TECHNIQUE TO BE USED HAVE BEEN SHOWN, BY SEPARATELY PREPARED TEST SPECIMENS, TO GIVE FULL PENETRATION WITH SOUND WELD METAL AT THE ROOT OF THE GROOVES. THEY ARE NOT PERMITTED WHERE THE BORE OF THE BRANCH EXCEEDS 127 MM.

Fig. 7/47

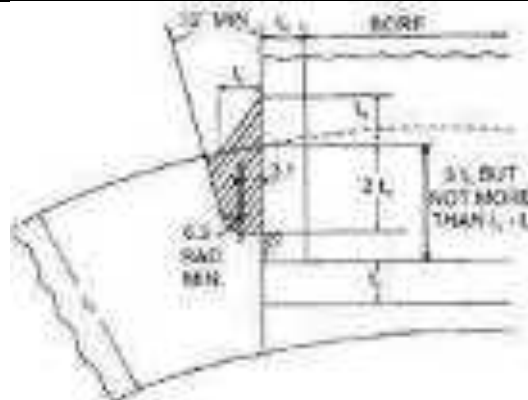
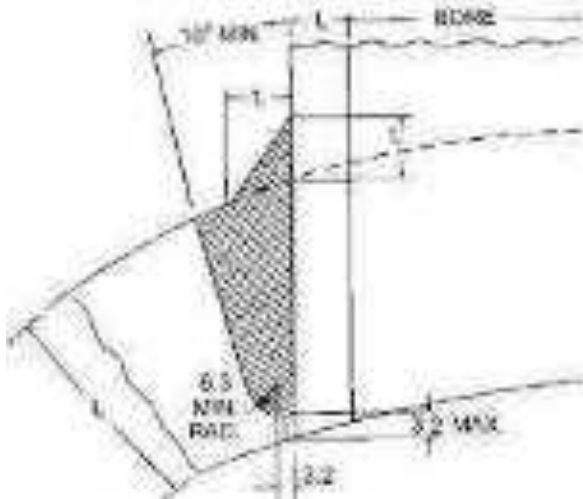


Fig. 7/50

All dimensions are in mm.



THE TYPE SHOWN IN FIG. 7/48 IS NOT PERMITTED WHERE THE INSIDE OF THE VESSEL IS ACCESSIBLE FOR WELDING FIG. 7/51 IS PREFERRED WHERE THE INSIDE OF THE BRANCH IS ACCESSIBLE FOR WELDING, WHERE IT JOINS THE SHELL.

Fig. 7/48

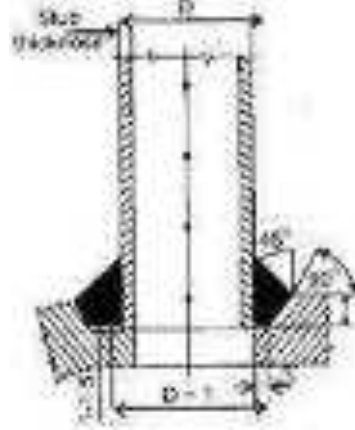


Fig. 7/51

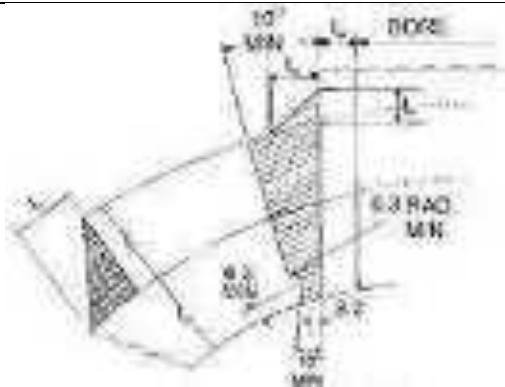


Fig. 7/52

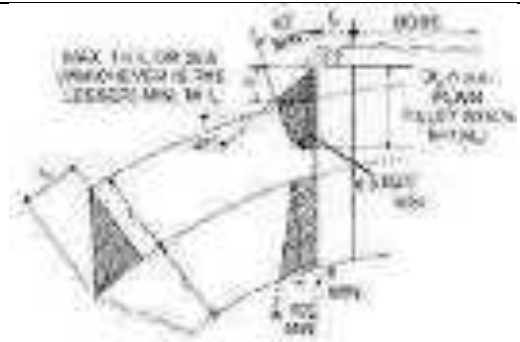
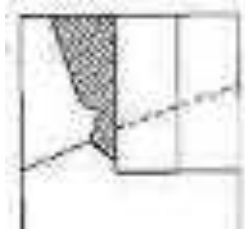


Fig. 7/56



WELDING PROCEDURE FOR TYPES SHOWN IN FIGS. 7/52 AND 7/53 TO BE AS FOR DOUBLE WELDED BUTT JOINT. OUTER WELD TO BE MADE, FIRST BACK OF OUTER WELD TO BE CHIPPED OUT BEFORE COMMENCEMENT OF INNER WELD. BUT DEEP PENETRATION WELDING MAY BE USED SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.

Fig. 7/53

All dimensions are in mm.

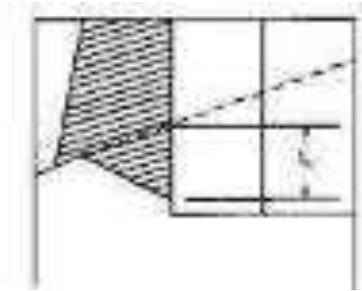


Fig. 7/57

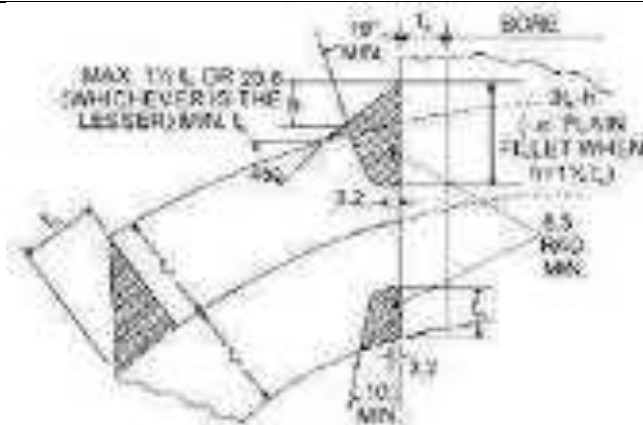


Fig. 7/54

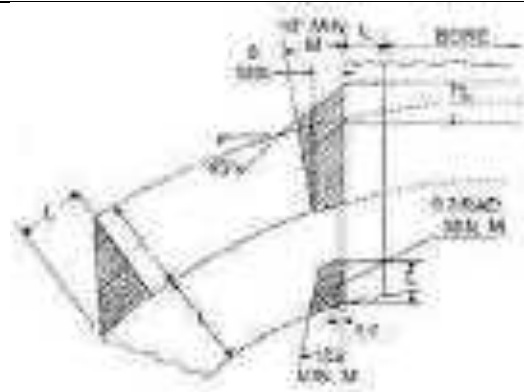


Fig. 7/58

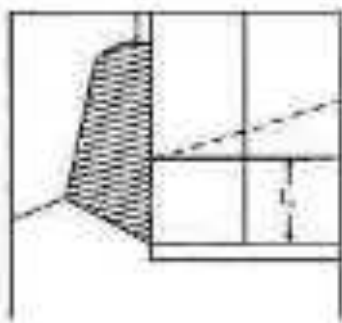


Fig. 7/55

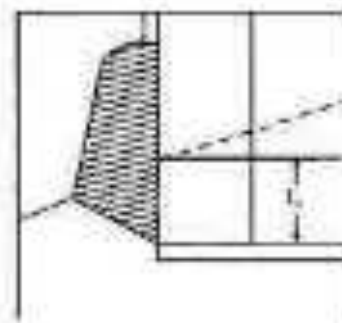
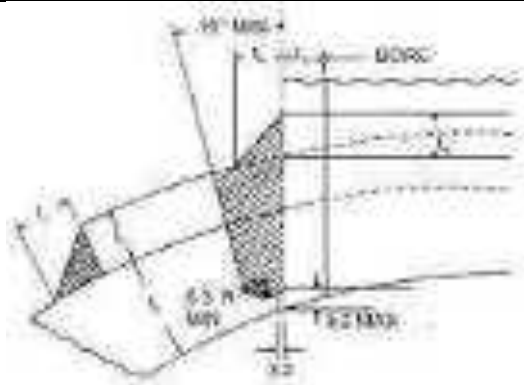


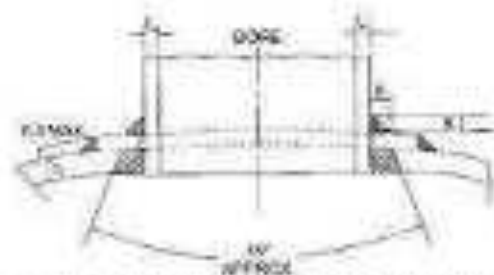
Fig. 7/59



THE TYPE SHOWN IN FIG. 7/60 IS NOT PERMITTED WHERE THE INSIDE OF THE VESSEL IS ACCESSIBLE FOR WELDING. FIG. 7/61 IS PREFERRED WHERE THE INSIDE OF THE BRANCH IS ACCESSIBLE FOR WELDING WHERE IT JOIN THE SHELL.

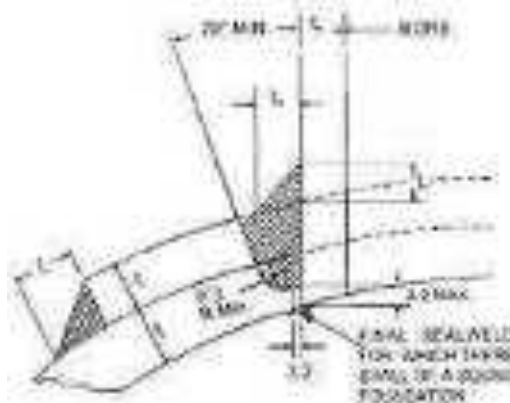
Fig. 7/60

All dimensions are in mm.



After type I and II, the preparation of gaskets in thin steel plate. The ring is a backing ring only and not a compressing ring. The type shown in Fig. 4 (a) is not perfect. The worse any of the following can be seen. Small thickness of 1.2 mm design procedure. 7.5 kg/cm². Design temperature 373°C.

Fig. 7/63



THE TYPE SHOWN IN FIG. 7/61 IS NOT PERMITTED
WHERE THE SHELL THICKNESS EXCEEDS 25.4 MM.

Fig. 7/61

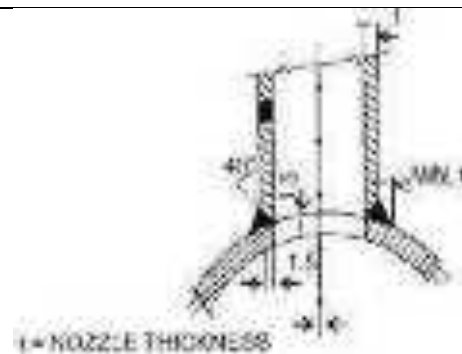
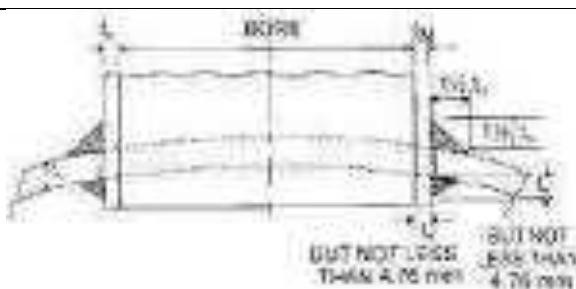
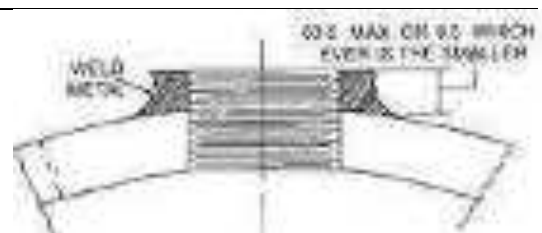


Fig. 7/64



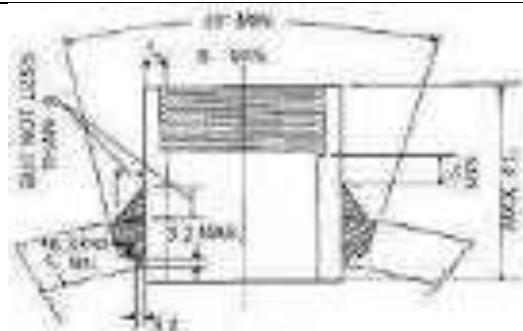
TYPE SHOWN IN FIG. 7/62 IS NOT PERMITTED WHERE ANY OF THE FOLLOWING LIMITS IS EXCEEDED SHELL THICKNESS 19 MM MAXIMUM ALLOWABLE WORKING PRESSURE 7.4 kg/cm² (g)DESIGN TEMPERATURE 171°C.

Fig. 7/62



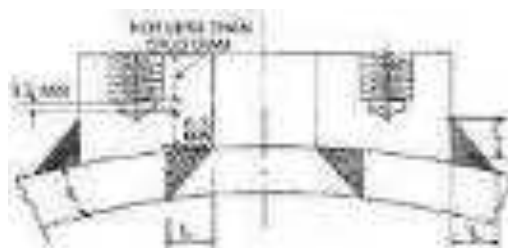
TAPPED BOSSES EXCEEDING 38.1 MM
STANDARD PIPE SIZE ARE NOT
PERMITTED.

Fig. 7/65



THE TYPE SHOWN IN FIG. 7/66 IS NOT PERMITTED WHERE THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING.

Fig. 7/66



THE TYPE SHOWN IN FIG. 7/70 IS NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 19 MM.

Fig. 7/70

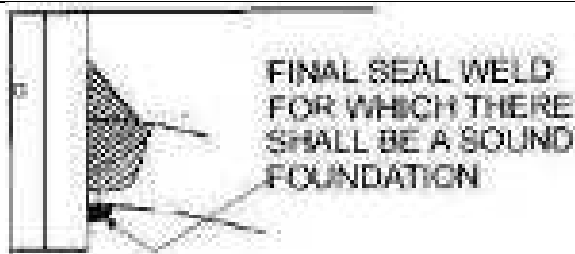
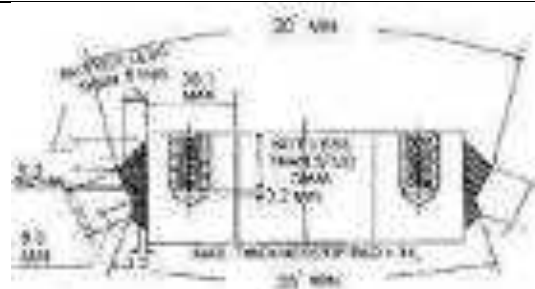


Fig. 7/67



DIMENSION B MAY BE GREATER THAN NOMINAL BORE OF CONNECTION BUT MUST NOT EXCEED: PITCH CIRCLE DIAMETER MINUS (STUD DIAMETER + 12.7 MM). WELDING PROCEDURE FOR TYPE SHOWN IN FIG. 7/71 TO BE AS FOR DOUBLE WELDED BUTT JOINT. OUTER WELD TO BE MAKE FIRST. BACK OF OUTER WELD TO BE CHIPPED OUT BEFORE COMMENCEMENT OF INNER WELD. BUT DEEP PENETRATION WELDING MAY BE USED SUBJECT TO PROOF OF REQUISITE PENETRATION BEING PRODUCED BY THE MANUFACTURER WHERE CALLED FOR BY THE INSPECTING AUTHORITY.

Fig. 7/71

All dimensions are in mm.



THE TYPE SHOWN IN FIG. 7/68 IS ONLY PERMITTED WHERE THE INSIDE OF THE SHELL IS NOT ACCESSIBLE FOR WELDING

Fig. 7/68

THE TYPES SHOWN IN FIGS. 7/68 & 7/69 ARE NOT PERMITTED WHERE ANY OF THE FOLLOWING LIMITS IS EXCEEDED: SHELL THICKNESS 19 MM; MAXIMUM ALLOWABLE WORKING PRESSURE 10.6 kg/cm²(g); DESIGN TEMPERATURE 260°C; TAPPED BOSSES EXCEEDING 38.1 MM STANDARD PIPE SIZES ARE NOT PERMITTED

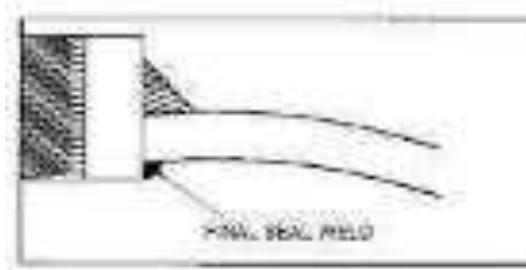


Fig. 7/69: FINAL SEALWELD

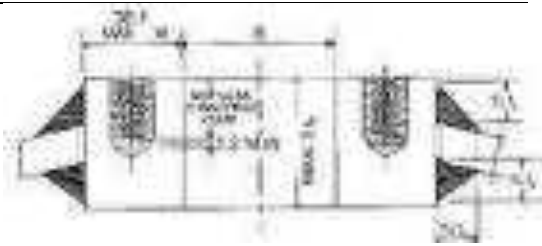
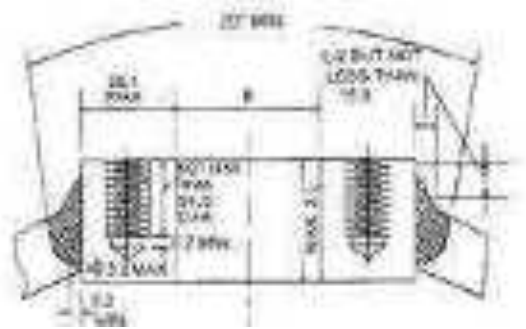


Fig. 7/72



THE TYPE SHOWN IN FIG. 7/73 IS NOT PERMITTED WHERE THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING

Fig. 7/73

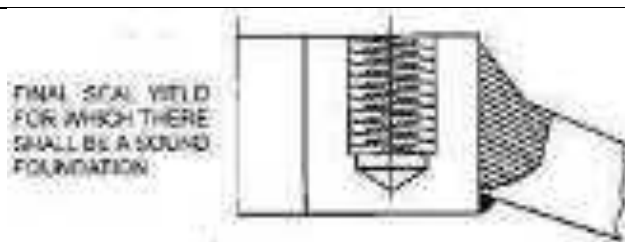


Fig. 7/74

DIMENSION B MAY BE GREATER THAN NOMINAL BORE OF CONNECTION BUT MUST NOT EXCEED: PITCH CIRCLE DIAMETER MINUS (STUD DIAMETER + 12.7 MM) THE TYPES SHOWN IN FIGS. 7/72, 7/73 AND 7/74 ARE NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 19 MM.

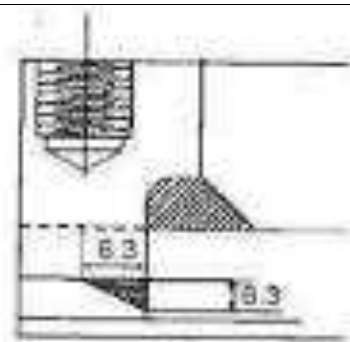
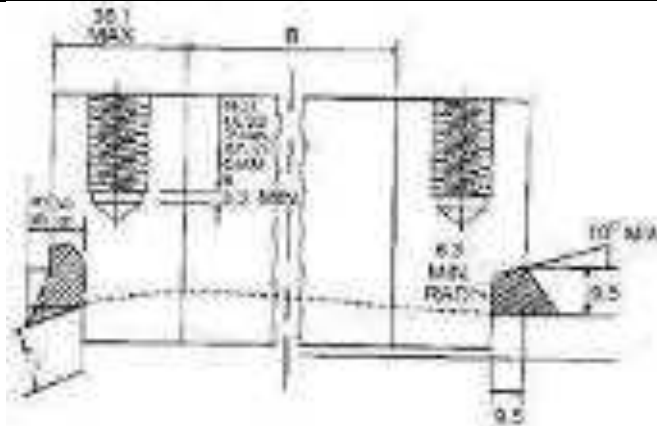


Fig. 7/76

DIMENSION 'B' MAY BE GREATER THAN NOMINAL BORE OF CONNECTION BUT MUST NOT EXCEED: PITCH CIRCLE DIAMETER MINUS (STUD DIAMETER + 12.7 MM) THE TYPES SHOWN IN FIGS. 7/75 AND 7/76 ARE NOT PERMITTED WHERE THE SHELL THICKNESS EXCEEDS 19 MM.

All dimensions are in mm.



THE TYPE SHOWN IN FIG. 7/75 IS NOT PERMITTED WHEN THE INSIDE OF THE SHELL IS ACCESSIBLE FOR WELDING.

Fig. 7/75

All dimensions are in mm.

- (2) (a) Branches of not more than 38 mm nominal bore may be screwed into the shell with a taper thread and seal welded, provided that the thickness of the shell is sufficient to allow for a length of thread equal to the diameter of the branch.
- (b) Where the thickness of the shell is not sufficient for the purpose, a boss may be welded on so that the total thickness of the boss and shell is at least equal to the required length of thread.
- (c) Methods of attachment of such bosses are shown in Figs. 7/65 to 7/69.
- (3) (a) Branches, pressed plate saddles, forged pads or bosses shall be secured to the shell by one of the following methods,-
 - (i) Welding;
 - (ii) Screwing and Seal Welding.
- (b) (i) Methods of attachment secured by welding are shown in Figs. 7/40 to 7/64 of this chapter.
- (ii) Branches may be provided with flanges for ordinary bolted joints. Joints of special type may also be used.
- (iii) Flanges for ordinary bolted joints shall be in accordance with the appropriate table of Appendix-F and shall be forged solid with the branches or attached in accordance with regulation 263.
- (iv) They shall be machined on the jointing and bolt bearing surfaces.
- (c) (i) Where pressed plate saddles are used, they shall be formed to bed closely to the shell and shall be machined on the face adjoining the connection and machined or flame cut by machine on the edges.
- (ii) The studs for the attachment of the connection, if screwed through the saddle, shall each be fitted with a nut on the inside.
- (iii) Where the stud holes do not penetrate through the saddle, the length of the screwed portion of the stud in the plate shall be not less than the diameter of the stud.
- (d) The joint faces of all pads shall be machined.
- (e) (i) The pads shall be sufficiently thick to allow the drilling of stud holes for connections without the inner surface being pierced.
- (ii) The length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud.
- (iii) Method of attachment of pads secured by welding are shown in Fig. 7/70 to 7/76 of this chapter but where pads of the type shown in Fig. 7/70 are used, they shall be formed to bed closely to the shell.

- (f) (i) Tapped bosses of not more than 38 mm standard pipe welded to the shell, may be used for maximum allowable working pressure not exceeding 14 kg/cm^2 (g) and design temperatures not exceeding 343°C .
(ii) Such bosses shall have taper threads.
(iii) Methods of attachment of bosses secured by welding are shown in Fig. 7/65, 7/69 of this chapter
- (g) (i) All welded attachments other than flange connections shall be by the metal arc process and the electrodes used shall comply with the requirements of regulations 71 to 76.
(ii) Where tack welds are used, they shall be sound and unless cut out, shall be carefully fused into the main runs.
- (h) All parts secured by welding shall be effectively heat treated after completion of all welding and before hydraulic test.

282. Shell joints .— (1) Fusion Welded Shells shall be classified as follows:

- (a) Class I – No limit to scantlings.
- (b) Class II – When none of the following limits exceeds:—
 - (i) maximum allowable working pressure- 35 kg/cm^2 (g)
 - (ii) product of maximum allowable working pressure and internal diameter in centimeters – 3750.
 - (iii) design temperature – 343°C .
- (c) Class III – When none of the following limits exceeds:—
 - (i) maximum allowable working pressure - 7.4 kg/cm^2 (g)
 - (ii) product of maximum allowable working pressure and internal diameter in centimeters – 940.
 - (iii) design temperature – 171°C .

(2) Fusion welds, preparation of seams, the method of formation of cylindrical shells including heat treatment after bending, method of making welded seams, types of welded joints, test plates and circularity of shells, all shall conform to the requirements of Chapter -4, except for the following, namely:-

- (a) (i) Whenever practicable, seams shall be welded from both sides of the plate. Additional runs of metal shall be deposited at both surfaces of the welded seams to build up to a thickness 10 per cent greater than thickness of the plate.
- (ii) The surfaces of welds wherever carried out on both sides shall be ground smooth and flush with the respective surfaces of the plates.
- (iii) Where the seam is welded from one side only, these provisions shall apply to the exposed of the surface weld.

(b) Tests for Class I fusion welded seams shall comply with the requirements of the relevant regulations of Chapter -4.

(c) Tests for Class II fusion welded seams shall comply with the requirements of those of Chapter-12, except that an additional provision for one micro and macro examination shall be made.

(d) Tests for Class III fusion welded seams shall comply with the requirements of Chapter -12.

(e) Class I and Class II shells shall be effectively stress-relieved by heat treatment when the wall thickness exceeds 20 mm or the carbon content exceeds 0.25% or the pipes are made of alloy steel.

283. Determination of maximum allowable working pressure.—(1) (a) The maximum allowable working pressure of shells shall be determined as per the following formula: -

$$P = \frac{2f E (T - 0.75)}{D + (T - 0.75)}$$

Where,

- T is thickness in mm,
D is maximum internal diameter in mm,
P is maximum allowable working pressure in kg/cm² (g),
f is maximum permissible working stress as prescribed in regulation 170 or 256 whichever is applicable in kg/cm² at the working metal temperature,
E is Efficiency factor for fusion welded shells as given in table below,
is 1.00 for seamless shells or shells made from seamless tubes,
is Efficiency of ligaments between holes or openings in shell expressed as a fraction.
0.75 is the additive thickness in order to take corrosion into account.

Table 7/8

Serial No.	Class	Efficiency Factor (E)
(1)	(2)	(3)
1.	I	0.90
2.	II	0.75, if welded from both sides 0.50, if welded from both sides
3.	III	0.45

Table 7/9: Minimum thickness of shells

Serial No.	Classification	Internal diameter in mm	Minimum thickness in mm
(1)	(2)	(3)	(4)
1.	Fusion welded class I		6.3
2.	Fusion welded Class II and Class III,	Upto and including 610	6.3
3.	Shells other than fusion welded	Over 610 and up to & including 914	8
4.	Shells	Over 914	9.5

- (b) Where steels are intended for service at temperatures in excess of 371°C, this shall be so stated and silicon contents shall be not less than 0.10 per cent or alternatively, the material must pass the 'Proof test for creep quality of carbon steel plate of boiler quality' as in Appendix-E.
- (c) For compensation for openings in shells, where the major axis of diameter of any hole cut in cylindrical part of the shells is greater than 2½ times the thickness of the shell plate plus 70 mm, compensation shall be provided.
- (d) The sectional area to be compensated measured in the plane parallel to the longitudinal axis of the shell, which makes this area a maximum, shall be the product of the length of the opening and the thickness of a seamless shell of similar material calculated in accordance with Equation (4/2) (regulation 169) for the same conditions of pressure and temperatures.
- (e) Where frames, pads or branches are secured by welding, the compensating area shall be calculated as per the method given in regulation 141.
- (2) (a) The maximum allowable working pressure for dished end plates with 'pressure on concave side' shall be determined as per regulations 175 to 177.

(b) For manholes formed by welding on pressed frames to dished end plates as in Fig. 7/77, the value of "E" may be taken as unity when the diametral cross-sectional area of the compensating frame and or ring is equal to or greater than the diametral cross-sectional area of the opening in the end plate to be compensated. For ends which are butt welded to the cylindrical parts of the shell, the thickness of the edge of the flange for connection to the cylindrical part of the shell shall be not less than that required for seamless unpierced shell as determined as per Equation (4/2) as mentioned under regulation 169.

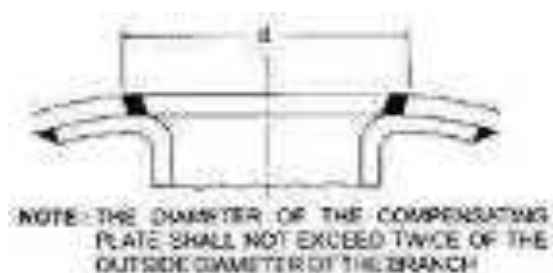


Fig. 7/77: Elliptical Manhole Frame Welded to Dished End Plate

(3) (a) The maximum allowable working pressure for welded flat end plates as mentioned in Fig. Nos. 7/35, 7/37 and 7/38 of this chapter shall be determined as per the following formula; -

$$P = \frac{f T^2}{C d^2}$$

Where, T = Minimum thickness of end plate in inches,
d = Internal diameter of shell in inches,
P = Maximum allowable Working pressure in lbs./sq.in.
C = 0.28.

(b) Maximum permissible working stress "f" at working metal temperature as prescribed in regulation 170.

- (c) Where steels are intended for service at temperatures in excess of 371°C, this shall be so stated and silicon content shall not be less than 0.10 per cent or alternatively, the material shall pass the 'Proof test for creep quality of carbon steel plates of boiler plate quality' as in Appendix-E.
- (d) Where flat end plates are bolted to flanges as in Fig. 7/39, the dimensions of the flanges shall be as given in Appendix-F. The thickness of the end plates shall be not less than that of the corresponding flanges.
- (e) Where the diameter of a hole in the flat end plate exceeds $2\frac{1}{2} T + 70$ mm, compensation shall be provided in accordance with regulations 141 and 179.
- (4) (a) Where branches of saddles are secured to the shell by studs, the minimum thickness of the flange adjoining the shell shall be as per the Table 7/10 given below,-

Table 7/10

Serial No.	Thickness of shell plate in mm	Minimum thickness of flange in mm
(1)	(2)	(3)
1.	9.5 to 19	13
2.	Above 19 to 25	16
3.	Above 25 to 51	19
4.	Above 51	25

- (b) The actual dimensions of the flanges shall be governed by the requirements of compensation for the opening.
- (c) (i) The dimensions of flanges of branches remote from the shell for ordinary bolted joints and those of bolts of all pads and saddles shall be as per the appropriate table given in Appendix-F for the maximum allowable working pressure and temperature corresponding to the maximum allowable working pressure and temperature of the shell.
(ii) The dimensions of the flanges for special joints shall be subject to approval of the Inspecting Authority or Chief Inspector as the case may be.
- (d) The maximum allowable working pressure for the body of the branch shall be determined by the equation as given in clause (a) of sub-regulation (1) above, subject to the requirements of compensation for the opening.
- (e) (i) Notwithstanding the result obtained from the equation the minimum thickness of the body of the branches shall be such that in no case does the total stress, resulting from the combination of the stress due to internal pressure and to all externally applied loads, exceed the permissible stress corresponding to the design temperature.
(ii) The method of calculating the total stress shall be subject to the approval of the Inspecting Authority or Chief Inspector as the case may be. Where the magnitude of the externally applied loads cannot be determined, the minimum thickness of the body of the branch shall be as given in the table 7/11 as given below,-

Table 7/11: Minimum thickness of Branches where External Loads are not known

Serial No.	Nominal bore of branch in mm	Thickness of cylindrical part of shell in mm	Minimum body thickness
(1)	(2)	(3)	(4)
1.	Up to and including 63.5	19 and above 9.5	

2.	Over 63.5 up to and including 108	22 and above 11	For thinner shells, not less than one half the thickness of the cylindrical part of the shell subject to approval of Inspecting Authority.
3.	Over 108 up to and including 203	25 and above 13	
4.	Over 203 up to and including 254	32 and above 16	
5.	Over 254	above 32	

284. Inspection during construction.— All parts of steam receivers, separators, catch waters and similar vessels shall be inspected at all appropriate stages of construction detailed in Appendix-A of these regulations.

285. Steel screwed and socketed joints and mountings of steel.—(1) Steel couplings or sockets may be used on pipes within the limits given in Table-7/12 below:-

Table 7/12

Serial No.	Nominal bore	Maximum Allowable Working Pressure	Maximum permissible temperature
		kg/cm ² (g)	°C
(1)	(2)	(3)	(4)
1.	Upto and including 25 mm Over 25 mm upto and including 38 mm	12.25	260
		10.5	260
2.	Over 38 mm upto and including 75 mm	8.75	260
		7	260
3.	Over 76 mm upto and including 102 mm	8.5	177
4.	Over 102 mm upto and including 127 mm	7	171

(2) Screwed joints shall be permitted at temperatures exceeding 260°C and size or pressure limits in excess of those given in the Table 7/12 of this regulation provided that the following conditions are satisfied, namely:-

- all threads are tapered unless pressure tightness depends on a seal weld or a seating surface other than the threads and experience or test demonstrates the suitability of the joint.
- pressure or temperature rating in appropriate component standard like BS, ASME, DIN or calculated as per relevant regulation is not exceeded.
- minimum specified tensile strength of screwed pipes is greater than 30.5 kg/mm².
- the minimum thickness of screwed pipes is not to be less than that given in Table 7/13 of this regulation.
- the design temperature does not exceed 495°C.
- the pressure limits given in Table 7/14 of this regulation are not exceeded.

- (3) Screwed joints are permitted for temperatures in excess of 495°C and pressure in excess of those given in Table 7/14 of this regulation for instrument insertion and tapping and for plug for access opening for radiographic inspection provided following conditions are satisfied:-
- They do not exceed 50 mm nominal bore size or one quarter of nominal pipe size, whichever is the smaller.
 - The minimum thread engagement is not less than –
 - 6 for up to and including 20 mm nominal bore;
 - 7 for over 20 mm up to and including 40 mm nominal bore; and
 - 8 for 40 mm up to and including 50 mm nominal bore.
 - The connection is seal-welded.
 - The design of instrument insertion withstands the fluid characteristics, fluid flow and any vibrations.
- (4) Screwed joints are permitted for pressure in excess of those given in Table 7/14 up to 345 bar for dead end instrument lines at the outlet end and downstream of shut off valves and instruments, control apparatus or discharge of a sample cooler provided that the nominal bore size of the pipe does not exceed 12 mm.

Table 7/13: MINIMUM THICKNESS OF SCREWED PIPES

Serial No.	Nominal Pipe size (mm)	Minimum thickness	
		17.5 kg/cm ² (g) or less for steam 7 kg/cm ² (g) and less for water over 105°C (mm)	Over 17.5 kg/cm ² (g) for steam Over 7 kg/cm ² (g) for water over 105°C (mm)
(1)	(2)	(3)	(4)
1.	8	2.24	3.02
2.	10	2.31	3.20
3.	15	2.77	3.75
4.	20	2.87	3.91
5.	25	3.38	4.55
6.	32	3.56	4.85
7.	40	3.68	5.08
8.	50	3.91	5.54
9.	65	5.16	7.01
10.	80	5.49	7.62

Table 7/14: MAXIMUM ALLOWABLE WORKING PRESSURE FOR SCREWED PIPES

Serial No.	Nominal pipe size (mm)	Maximum allowable working pressure [kg/cm ² (g)]
(1)	(2)	(3)
1.	Over 50 up to and including 80	28
2.	Over 25 up to and including 50	42
3.	Over 20 up to and including 25	84.5
4.	Up to and including 20	105.5

286. Bronze screwed and socketed joints and mountings and fittings of bronze.—

(1) Mountings and fittings of bronze up to 76 mm diameter may be attached directly to steel pipes by screwing, when the pressures and temperatures do not exceed 8.5 kg/cm² (g) and 225°C respectively; where tapered threads are employed, such joints may be used for pressures not exceeding 17.6 kg/cm² (g).

(2) Bronze fittings above 76 mm diameter shall be of flanged construction.

287. Reducing valve.— Where a reducing valve is installed in a pipe line, the pipe line and accessories on the low pressure side of the reducing valve shall be protected by a suitable safety valve or valves so adjusted as to permit the steam to escape as soon as the maximum allowable working pressure is exceeded or by a suitable appliance for cutting off automatically the supply of steam as soon as the maximum allowable working pressure is exceeded.

288. Flexibility.—(1) The pipe shall be arranged so that the system is sufficiently flexible to absorb the whole of their expansion and the imposed movement of the connected equipment without the actual expansion stress (SE) exceeding the allowable stress range (SA) determined as per the following equation,—

$$SA = F (1.25 SC + 0.25 SH) \quad \text{Equation (7/11)}$$

Where, SC = Basic material allowable stress at the minimum (cold) temperature,

SH = Basic material allowable stress at maximum (hot) temperature,

SE = Actual calculated expansion stress obtained from the stress analysis,

F = Stress range reduction factors of cyclic conditions for total number “N” of full temperature cycles over the total number of years during which the system is expected to be in operation as in table given below:

Table 7/15: Stress range reduction factors:

Serial No.	N	F
1.	7,000 and less	1.0
2.	7,000 - 14,000	0.9
3.	14,000 - 22,000	0.8
4.	22,000 - 45,000	0.7
5.	45,000 - 100,000	0.6
6.	100,000 and above	0.5

- Notes:**
1. Value of SC and SH shall be guaranteed by the manufacturer of steel from which pipes are made and furnished to the pipe makers / Inspecting Authority until such time such values of SC and SH are incorporated in the regulations.
 2. In case of imported pipes conforming to a recognized foreign standard or code the values of SC and SH may be taken from the table of allowance stress as given in that code or the value may be determined on the basis given in that code.
 3. The sum of the longitudinal stress due to pressure, weight and other sustained load including bending stresses caused by external loads shall not exceed the allowable stress in the hot conditions (SH), Where the sum of these stress is less than SH, the difference between SH and this sum may be added to the term 0.25 SH, in the above formula for determining the allowable stress range SA.
 4. Calculation of the expansion stress, SE shall be based on modulus of elasticity at room temperature.
- (2) Where practicable, the requisite flexibility shall be provided in the layout of the pipes without having recourse to special expansion bends or expansion joint except for the safety valves discharge piping. Where lack of space or other considerations prohibits the use of this method, expansion fittings like expansion joints or the bellows type of corrugated pipes may be used provided that the limitations imposed by maximum shall be given to the design of anchors, guides and ties to ensure that they adequately protect the expansion fitting and accommodate the additional loads due to pressure.
- (3) Notwithstanding anything in sub-regulation (1) of this regulation, the complete analysis of the piping system may be waived, if the system meets any of the criteria given below,-
- (a) the piping system duplicates a successfully operating installation or replaces a system with a satisfactory service record.
 - (b) the piping system can be adjudged adequately by comparison with previously analysed system.
 - (c) the piping system is of uniform size with not more than two anchors and no intermediate restraints and satisfied the following :-

$$\frac{DY}{(L-U)^2} = 208$$

Where, D = Nominal pipe size in mm.

Y = Resultant of movements to be absorbed by pipelines in mm,

L = Developed length of line axis in meters,

U = Anchor distance (length of straight line joining anchors) in meters.

- Notes:**
1. If the system is not meeting the above criteria or where reasonable doubt exist as in the adequate flexibility of the system, shall be analysed on the basis given in sub-regulation (1) of this regulation by simplified, approximate or comprehensive methods of analysis that are appropriate for the specific case.
 2. Approximate or simplified method may be applied only if they are used for the range or configurations for which their adequate accuracy has been demonstrated.
 3. Data for thermal expansion, modulus of elasticity, poisson's ratio, flexibility factors and stress intensity factors may be taken from any code or specification.
 4. Nominal diameter and nominal thickness may be used in the calculation of expansion stress.

289. Pipe work supports.—(1) All pipe work shall be adequately supported in order to permit free movement for expansion and contraction, and the amount of such movement shall be proportioned throughout the whole of any main by the provision of anchors at suitable points.

- (2) Where pipes may be subject to vertical movement, spring supports designed to carry the load under all conditions shall be provided.
- (3) Points of supports shall, as far as practicable, be arranged adjacent to the pipe joints.
- (4) Slings are in general preferable to roller supports and the latter shall be used only where necessary.
- (5) All pipe supports shall as far as practicable, be of mild steel and pipe anchors either of mild steel or cast steel.

290. Drainage.— (1) (a) In the case of steam mains, attention shall be paid to the adequate provision of drainage points in the form of drain pockets.

(b) Drainage points connected to steam-traps, shall be provided wherever water can collect under working conditions.

(c) Hand drains shall be provided at all points at which water can collect in any portion of the steam main, by valve leakage or other means, when shut down, or when warning up prior to use.

- (2) Wherever practicable, a suitable gradient shall be provided in the pipe work to ensure the passage of condensed water in the direction of flow of steam towards the drainage points.
- (3) It is recommended that a bypass shall be fitted at each steam trap.
- (4) Where the volume of water deposited is likely to be of serious proportions, separator shall be installed.
- (5) Each separator shall be furnished with a steam trap which shall be connected to it by means of a three-way cock, one end of which is connected to a manually operated drain.

291. Freedom from rust and other foreign matter.— All pipes, valves and fittings shall be thoroughly cleaned as far as possible of rust and other foreign matter before erection and pipe lines shall be blown through with steam or air before being put into service.

292. Test Pressures.—(1) Each completed pipe and fitting shall be tested by hydraulic pressure as per Chapter-2.

- (2) (a) Pipes and fittings with flanges for steam pressures exceeding 7 kg/cm² (g) shall be tested with blank flanges bolted or clamped on.
- (b) All other pipes, if straight, may be tested between the heads of an ordinary hydraulic pipes testing machine.
- (3) (a) The piping system shall, after erection, be subjected to a hydrostatic test pressure.
- (b) The hydrostatic test pressure at any point in the piping system shall not be less than 1.5 times the design pressure but shall not exceed the maximum allowable test pressure of any non-isolated components such as vessels, pumps or valves.
- (c) At no time during the hydrostatic tests, any part of the piping system shall be subjected to a stress greater than 90 per cent of its yield strength (0.2 per cent off set) at test temperature.

Notwithstanding anything contained in this sub-section, for boiler external piping and non-boiler external piping which are open to atmosphere such as vent and drain pipes, the hydraulic test for the portions of such pipes located beyond the last isolation valve may be dispensed with provided the weld joints in the pipe under reference are tested 100% by approved non-destructive examination and found satisfactory.

- (4) Special arrangement shall be made, according to circumstances, for testing bends and other fittings which are not flanged.
- (5) Hydraulic testing of butt welded and socket welded joints shall be conducted either at makers work or at user's premises on completion of fabrication of pipes by the Inspecting Authority.
- (6) (a) Hydrostatic testing of fabricated pipes having attachments of flanges, fittings, butt joints, branch joints and weldolets shall be done at manufacturer's works or alternatively at site at 1.5 times the maximum allowable working pressure.
- (b) Where hydraulic testing of fabricated pipe joints is not carried out at manufacturer's works, dye-penetrant test shall be carried out on the welded joints along with five per cent radiography of such joints.

CHAPTER -8

INSPECTION AND TESTING OF BOILERS AND PIPES DURING CONSTRUCTION AND BOILER REGISTRATION

293. General.— (1) The Inspecting Authority shall follow the procedure provided under these regulations during construction of a boiler at shop, field-site, in dealing applications for the registration of a boiler and examinations of boilers.

(2) The boiler components shall be erected at site based on the final inspection report as per Form-VIII approved by Competent Person and there is no need for any ground inspection or submission of any other document like manufacturing drawings, design calculations.

294. Boiler component's identification marking.— (1) Convection bank tubes, loose tubes, coils - evaporator super heater and economiser, riser downcomer and saturated supply pipes, attemperator link piping, boiler integral and non integral piping, water wall panel without header shall be stencilled as per the table given below irrespective of material grade, outside diameter and thickness.

(2) There shall be no hard stamping of competent person on these component.

Table 8/1

IDENTIFICATION ON BOILER PRESSURE PART COMPONENTS				
Serial No.	Component	Punching with Location / Stencilling	Competent Person Stamp	Identification
(1)	(2)	(3)	(4)	(5)
1	Boiler Block Assembly	Hard Punching on D/E	Yes	As per Form-I(Part-C)
2	Fire tube Boiler Assembly	Hard Punching on shell	Yes	As per Form-I(Part-C)
3	Steam Drum	Hard Punching on D/E	Yes	As per Form-I(Part-C)
4	Water Drum	Hard Punching on D/E	Yes	As per Form-I(Part-C)
5	Panel with Header	Hard Punching on Header	Yes	As per Form-I(Part-C)
6	Convection Bank Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
7	In bed Super Heater Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
8	Super Heater Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
9	Bi Drum Evaporator Assembly	Hard Punching on D/E	Yes	As per Form-I(Part-C)
10	In bed Evaporator Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
11	HRSG Harp	Hard Punching on Header	Yes	As per Form-I(Part-C)
12	HRSG Modular Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
13	Economiser Modular Assembly	Hard Punching on Header	Yes	As per Form-I(Part-C)
14	Headers	Hard Punching on Header	Yes	As per Form-I(Part-C)

15	Tanks	Hard Punching on shell	Yes	As per Form-I(Part-C)
16	Water Collecting tank	Hard Punching on Pipe	Yes	As per Form-I(Part-C)
17	Vertical Steam separator	Hard Punching on Pipe	Yes	As per Form-I(Part-C)
18	Panel without Header	Stencilling on tube	No	Boiler No, Drawing No, Part no
19	Riser, Down comer Saturated Supply Pipe	Stencilling on Pipe	No	Boiler No Drawing No, Part no
20	Attemperator Link	Stencilling on Pipe	No	Boiler No, Drawing No, Part no
21	Boiler Integral Piping	Stencilling on Pipe	No	Boiler No, Drawing No, Part no
22	Boiler Non Integral Piping	Stencilling on Pipe	No	Boiler No, Drawing No, Part no
23	Convection Bank Tube	Stencilling on tube	No	Boiler No, Tube no / Part no
24	Loose Tubes	Stencilling on tube	No	Boiler No, Tube no / Part no
25	Coils - Evaporator, Superheater& Economiser, Re-heater coils , Platen super heater coils	Stencilling on tube	No	Boiler No, Item Description, Part No

295. Preparations of Inspection.— (1)(a)(i) At every boiler examination or grant of renewal of a certificate, the boiler shall be empty and all its parts shall be thoroughly cleaned. Except as provided for in sub-regulation (6), all doors of manholes, hand holes and sight holes and cleaning plugs and all caps in the headers and mud drums of water tube boilers, all fire bars, bearers, front plates, bridge plates, fire bridges brick arches, oil fuel burners and mechanical stoker fitting shall be removed.

(ii) All valves and cocks comprising the boiler mounting shall be opened up and taken apart and the valves or cocks grounded, when necessary, before the Competent Person's visit.

(b) The removal of fire bars, bearers, front plates, bridge plates, fire bridges, brick arches, oil fuel burners and mechanical stoker fitting is not required at the time of registration for boilers for which boiler pressure part assembly is completed and hydraulic test has been carried out at manufacturer works by Competent Person.

(2) (a) In case of requirement for inspection by the Competent Person, provision shall be made for removal of lagging or brick-work or other concealing part for drilling of plates, and for verifying the pressure gauge and safety valve dimensions and weights.

(b) The removal of lagging or brick-work or other concealing part shall not be required at the time of registration of boilers for which boiler pressure part assembly is completed and hydraulic test carried out at manufacturer works by Competent Person.

(3) All smoke tubes, exterior of water tubes, smoke boxes, and external flues shall be swept clean.

(4) Provision shall be made for effective disconnection of all steam and hot water communication with another boiler under steam as required in Chapter-9.

(5) No blank flange or plug shall be inserted between a safety valve chest and the boiler generally and where it is permitted by the Competent Person, the blank flange or plug shall be removed in his presence.

(6) At alternative annual inspections and subject to a minimum of three bottom rows or all tubes subject to the first pass of heat being opened up for inspection, the Competent Person may at his discretion relax the preparation for inspection specified under sub-regulation (1) above in favour of boilers having an evaporative capacity of 90 tons per hour and over, and using treated feed water to the satisfaction of the Competent Person.

- (7) For boilers used for electric power generation, the inspection shall be carried out as per the provisions of Appendix-H.
- (8) (a) For Waste Heat Boilers (Fired and Unfired) used exclusively in continuous process plants, the inspection shall be carried out as per the provisions of Appendix-I.
(b) The boilers used in corrosive environment such as sulphuric acid plants shall not be covered under the provisions of Appendix-I.
- (9) In the case of forced flow and forced circulation types of boilers, proper circulation in every section of the circuit shall be ensured by the flow of water.

296. Hydraulic test of boilers.— (1) Every boiler shall be hydraulically tested in the presence of an Inspector.

- (2) Boiler working at a pressure of 50 kg/cm² (g) or more, and used exclusively for electric power generation need not be hydraulically tested for issue of certificate every year, provided the inspection of such boiler is carried out as per the provisions of sub-regulation (7) of regulation 295.
- (3) Waste Heat Boilers (Fired and Unfired) used exclusively in continuous process plants need not be hydraulically tested for issue of certificate every year, provided the inspection of such boilers is carried out as per the provisions of sub-regulation (8) of regulation 295.

297. Preparation for hydraulic tests.— (1) The chest of all mountings subject to steam pressure shall be in place and shut tight or blank flanged.

- (2) The safety valves shall be invariably removed and the chest opening blank flanged.
- (3) The attachment for the Competent Person's pressure gauge shall be in order.
- (4) (a) All doors shall be properly jointed and tightened up.
(b) The boiler shall be completely filled with water with care being taken to allow all air to escape and, if possible, a preliminary test not exceeding the design pressure of the boiler shall be taken before the Competent Person's visit, to test the tightness of the joints.
- (5) When a boiler is hydraulically tested for the first time, it shall be entirely cleared of lagging or brick work; at subsequent tests the lagging or brick work, or portions thereof, shall be removed, if required by the Competent Person, provided the Competent Person may, at his discretion, allow the lagging and brick work to remain in situ, in case of boilers where the covered parts have been fabricated and tested before erection in position.

298. Procedure of hydraulic tests.— (1) (a) Subject to the provisions of sub-regulation (1) of regulation 300, every sub-critical boiler shall be hydraulically tested after erection at site in presence of the Competent Person to 1.25 times the design pressure as certified by the Inspecting Authority in Form-I(Part-B) or Form-I(Part-C) as the case may be, to be stamped on the boiler, as free from any indication of weakness or defects and every Super critical boiler, with no fixed steam and waterline, having pressure parts designed for different pressure levels along the path of water-steam flow, shall be hydraulically tested after erection at site in presence of the Competent Person to a pressure of not less than 1.5 times the design pressure at the super heater outlet but not less than 1.25 times the design pressure of any part of the boiler as certified by the Inspecting Authority in Form-I(Part-B) or Form-I(Part-C) as the case may be, to be stamped on the boiler, as free from any indication of weakness or defects.

- (b) If all components of the boiler in the manufacturer's premises have not been tested hydraulically as per regulation 167, the test, on completion, shall be taken to 1.5 times the design pressure.

- (c) The temperature of the water used as medium of pressure testing shall not be less than 20°C and greater than 50°C.
- (d) The test pressure shall be raised gradually under proper control at all times so that it never exceeds by more than 6% of the required pressure and maintained for 30 minutes whereupon the pressure shall be reduced to maximum allowable working pressure and maintained for sufficient time to permit close visual inspection for leakage of pressure parts.
- (e) The hydraulic test at site for the components meant for renovation or retrofit or spares shall be carried out at 1.25 times of the design pressure and these components need not be hydraulically tested at manufacturer's premises.
- (2) The boiler shall satisfactorily withstand such pressure without appreciable leakage or undue deflection or distortion of its parts for at least ten consecutive minutes. If the test is not satisfactory, the design pressure allowable by calculation shall be suitably reduced, unless the owner desires to make such alterations as will enable the boiler to withstand the hydraulic test satisfactorily, in which case the boiler shall again be examined after the alterations have been made, the pressure recalculated, if necessary and the boiler tested to satisfaction of the Competent Person.
- (3) At the first hydraulic test of a boiler prior to the issue of an original certificate, deflection measurements shall be made before, during and after test of each furnace length, fire-box and flat end or other plates.
- (4) After application of the hydraulic test, the Competent Person shall carefully examine the boiler inside and outside and satisfy himself that it has satisfactorily withstood the test.
- (5) (a) In case any part of the boiler show undue deflection or indication of permanent set during the progress of the test, the pressure shall be released immediately such indications are observed.
(b) The maximum allowable working pressure for the part shall be 40 per cent of the test pressure applied when the point of permanent set was reached. This procedure shall apply to any boiler at any test.
- (6) Hydraulic tests of boilers at subsequent examination shall be at 1.25 times the design pressure of the boiler.
- (7) When the internal construction or size of a boiler does not permit the Competent Person to get inside it for examining all its parts closely, he shall see it tested by hydraulic pressure to 1.5 times the design pressure at each inspection or the grant or renewal of a certificate.
- (8) Water tube locomotive type boiler and all tubular boilers shall be hydraulically tested at each inspection for the grant or renewal of a certificate, unless such test is waived under the orders of the Chief Inspector.
- (9) The Competent Person may if he considers it necessary, apply a hydraulic test to any boiler at any inspection.
- (10) Except in the case of vertical boilers having heating surface of less than 18.5m² portable and vehicular boilers, which do not require re-erection or building in brick work, the hydraulic tests of all boilers shall be conducted only after the erection of the boiler in situ and all boilers shall after re-erection in a position different from that in which were last examined by hydraulically tested.
- (11) A hydraulic test shall also be taken granting an increased pressure certificate and after repairing a boiler. However, in the case of minor repairs to the water tube boilers where non-destructive testing (NDT) has been carried out, hydraulic testing may be dispensed with provided non-destructive testing is carried out by an approved method.

- (12) When carrying out hydraulic test, Competent Person shall ensure that the pressure gauges have valid calibration.

299. Steam tests.— (1) Every boiler before registration and every boiler of which the design pressure has been altered shall, before the issue of an original or renewal certificate for such boiler, be tested under steam to the satisfaction of the Inspector. Inspector shall send notice to the owner for the date fixed for the steam test and on completion of the test the Inspector shall enter all relevant details in the memorandum of inspection books.

- (2) At the time of test, the safety valves shall be left free and capable of being adjusted to the approved design pressure.
- (3) After adjustment of the valves to the correct blowing pressure, the boiler shall be tried under full steam and firing with the feed water shut off and the stop-valve closed, and the Inspector shall note the accumulation of pressure and other details of the test as accumulation of pressure and other details of the test as well as the loading and adjustment of the safety valves.

- (a) In the case of sub-critical water tube boiler or boilers fitted with super heater, the feed water connection and stop valve need not be shut off and if the total valve area is lifted and found to be adequate by calculations, the requirement of the accumulation test may be assumed to have been satisfied if the valves are or have been found so adjusted that at least one safety valve on boiler shall be set at or below design pressure and remaining safety valves can be set up to three per-cent above the design pressure:

Provided that all valves shall be lifted so that all steam which can be generated by the boiler can be discharged with a pressure rise not exceeding ten per-cent of the design pressure;

- (b) In the case of super critical boiler or boilers, with no fixed steam and waterline, having pressure parts designed for different pressure levels along with the path of water-steam flow, safety valves shall be set up to ten per-cent above the maximum allowable working pressure:

Provided that all the valves shall be lifted so that all steam which can be generated by the boiler can be discharged with a pressure rise not exceeding thirteen percent of the individual component maximum allowable working pressure, provided the boiler is having automatic burner management system and Master Fuel Trip (MFT) on main steam pressure. High lifting of safety valves can be tested by hydraulically actuated methods.

- (4) Before the safety valve test, the Inspector shall satisfy himself that the water gauges are in working order and that the feed apparatus is capable of supplying the boiler with sufficient water.
- (5) Where as per rules, a person-in-charge of a boiler holding certificate of competency is not required, the Inspector may, when he thinks fit, satisfy himself by questioning or by practical test, whether the person-in-charge of the boiler understands the use and purpose of the water gauges, the pressure gauge, the safety valves, the feed water-supply and blow down.
- (6) When witnessing safety valves test, Inspector shall ensure that the pressure gauges have valid calibration.
- (7) No steam gauge shall be used without a syphon filled with water between it and the boiler.
- (8) When the accumulation of pressure at a steam test exceeds ten per cent of the design pressure the area of the safety valves shall be considered insufficient, and a certificate shall be refused until the safety valve area is increased.

- (9) An Inspector may, when visiting a factory for any purpose, verify the correctness of the safety valve and pressure gauge of any boiler under steam by comparison with his standard pressure gauge.

***Note:** A steam test is primarily intended for ascertaining that the safety valves are sufficient to relieve boilers effectively of excess steam and operate at the time when the maximum allowable working pressure is reached.

300. Procedure for Registration.— (1) On receipt of an application for registration under sub-section (1) of Section 12 of the Act, along with certificates and drawings as provided in regulation-8, the Inspector shall, when the boiler has been properly prepared for examination proceed to inspect it with a view to satisfy himself that the boiler has not suffered any damage during its transit from the place of manufacture to the site of erection and if he is satisfied with the correctness of the maker's certificate and other particulars relating to the material and construction as mentioned under clause (c) of sub-section (1) of section 19 of the Act and regulation 7, take due account of the workmanship and details of the construction of each part;

- (2) Subject to any discretionary power exercised by the Chief Inspector, he may accept the permissible working pressure of the boiler as certified by the Inspecting Authority in Form-I(Part-B) or Form-I(Part-C) as the case may be and Form-IV(Part-A) and after inspecting the boiler, the Inspector shall conduct hydraulic test as per requirements of regulations 298 and a provisional order under section 14 in Form-X shall be issued after the hydraulic test.
- (3) If the requirements of provisional order under sub-regulation (2) are not fulfilled, fresh provisional orders shall be issued for a maximum of another six months but not exceeding twelve months from the date of issue of first provisional order, without any subsequent inspection and payment of fees.
- (4) The Inspector shall enter the above particulars and dimensions of the boiler, together with details of the hydraulic test, in Form-XI (Memorandum of Inspection Book) provided under regulation 306 and with all the makers' papers for the boiler, shall be submitted to the Chief Inspector with the Inspector's report after issue of registry number, the Inspector shall conduct steam test as per regulation 299 and enter the details of steam test in Form-XI.

301. Engraving of registry number.— (1) (a) (i) The registry number of every boiler shall, within a period of one month from the date of receipt thereof, shall be cut in the front plate or any such position as shall be pointed out by the Inspector.

(ii) The device for each State or Union territory shall be distinguished by the following letters as mentioned in the Table below, namely:-

Table

Serial No.	Name of State/Union territory	Letters
(1)	(2)	(3)
1.	Andaman and Nicobar Islands	A&N
2.	Andhra Pradesh	AP
3.	Arunachal Pradesh	ARP
4.	Assam	A
5.	Bihar	BR
6.	Chhattisgarh	CG
7.	Dadra and Nagar Haveli	DNH
8.	Delhi	D
9.	Goa	G
10.	Gujarat	GT
11.	Haryana	HA
12.	Himachal Pradesh	HP
13.	Jammu & Kashmir	JK

14.	Jharkhand	JH
15.	Karnataka	KTK
16.	Kerala	K
17.	Laccadive, Minicoy & Amindivi Islands	LI
18.	Ladakh	LA
19.	Madhya Pradesh	MP
20.	Maharashtra	MR
21.	Manipur	MA
22.	Meghalaya	ML
23.	Nagaland	NL
24.	Orissa	OR
25.	Pondicherry	PY
26.	Punjab	PI
27.	Rajasthan	RI
28.	Tamil Nadu	T
29.	Telangana	TG
30.	Tripura	TR
31.	Uttar Pradesh	UP
32.	Uttarakhand	UR
33.	West Bengal	WBL

(b) (i) The distinguishing letters shall be engraved above a number and separated there from by a horizontal line 64 mm in length.

(ii) The letters and figures shall be 25 mm in height and of suitable breadth, provided that in the case of small boilers the letters and figures of the device may, in the discretion of the Chief Inspector, be reduced to 10 mm in height. The whole shall be enclosed in a rectangle, the upper and lower sides of which shall be 76 mm apart and 6 mm clear of the top of the letters and the bottom of the figures respectively as indicated below:

Example:-

MR
1234

(c) In the case of registration of small industrial boilers, the letter “S” shall be added as a prefixed to the registration number below the distinguishing letters for State or Union territories as indicated below: -

Example:-

UP
S- ----

(d) The side lines shall be at equal distance clear from the figures and the engraving shall not be less than 0.4 mm in depth.

(2) The engraving shall be complete and ready for verification within one month from the date of receipt of registry number, and the fact shall be reported to the Chief Inspector of Boiler within this period.

(3) (a) Boilers having registry devices differing from those prescribed herein shall have such devices altered or crossed out and engraved a new one in conformity with those prescribed above.

(b) The original numbers of such boilers shall be retained in the new device, provided that in the case of boilers which were registered in a State or Union territory which has since become extinct, a new number shall be given by the State or Union territory where the Boiler is operating and any number once allotted to a boiler shall not be used again for another boiler.

302. Measurement of Heating Surface.— (1) For the purpose of regulating the area of the safety valves and the amount of registration and inspection fees, the heating surface of a boiler shall be the total surface of all plates and tubes exposed to heat on one side and in contact with water on the other measured on the water side or the fire side, whichever is larger.

(2) (a) For Lancashire and Cornish boilers, the total heating surface shall include the wetted surface of the furnaces between the end plates, the fire surface of cross tubes where fitted, and the part of the external shell below the side flue covers. In estimating the areas, furnaces shall be considered as plain cylinders and the area of their wetted surface shall be taken as their mean external circumference X the length of the boiler between end plates. For the shell, the width of that part of the circumference below the flue covers shall be taken as = 2D, and this width multiplied by the length between end plates, shall be taken as the area of shell heating surface.

(b) The part of the surface of the back end plate exposed to heat shall be omitted from the calculation.

Example – The formula for the total heating surface of a Lancashire boiler having plain furnaces without cross tubes is as follows: -

Heating Surface in square meter = $2 L (3.14 d + D)$. “L” is the length of the boiler between end plates in meter, “d” is the mean external diameter of the furnaces in meter and “D” is the internal diameter of the largest belt of shell in meter.

(3) (a) For steam and water drums of water tube boilers, the heating surface of the drum shall be taken as half the external mean circumference multiplied by the clear length of drum between the outer brick walls or centers of cross boxes, as the case may be.

(b) The heating surface of the tubes shall be taken as the external surface of the tubes between the tube plates or heaters.

(c) The heating surface of the heater shall be omitted from the calculation.

(4) (a) For marine boilers of the fire-tube type, the heating surface shall include the wetted surface of the furnaces between the tube plates (considered in the same way as for Lancashire boilers), the wetted surface of the combustion chambers (less the area of the tube holes) and the wetted surface of the tubes between tube plates.

(b) The parts of the front tube plate exposed to heat shall be omitted from the calculation.

(5) (a) For locomotive type boilers, the heating surface shall include the wetted surface of the fire-box above the foundation ring (less the area of the tube holes and the fire hole and ring) and the wetted surface of the tubes between the tube plates.

(b) The smoke box tube plate shall be omitted from the calculation.

(6) For vertical boilers of ordinary type, the heating surface shall include the wetted surface of the fire-box above the foundation ring (less the area of fire hole and ring and tube holes if any) and the surface of any cross or other tubes and uptake below the lowest water level shown in the gauge glass.

(7) For Electrode boilers, the heating surface shall be calculated as per the following formulae,-

$$\text{Heating surface} = \frac{E}{6}$$

Where,

E = the equivalent evaporation at 100°C under normal load, which x K.W,

K.W.= the kilowatts absorbed at the stated volume when the water in the boiler has a specific resistance of not less than 200 ohms per inch tube at 65°C and while the boiler is delivering its normal output of steam at its design pressure with the feed water temperature of 15°C.

(8) No deduction shall be made for stays, in calculating the heating surface.

(9) For any other heating surface not provided for in the foregoing instructions, the same general procedure shall be observed.

303. Boiler rating.— The boiler rating shall be the number of square meters (to the nearest whole number) in the heating surface of the boiler as determined under regulation 302.

304. Registration fee.— (1) The fee required for registration under sub-section (2) of section 12 of the Act shall be as per table 8/2 of this regulation:

Provided that the Chief Inspector may direct that no fee shall be payable in respect of a fresh application made in pursuance of sub-section (2) of section 19 of the Act.

(2) Inspection fee for separately fired super-heater, re-heater and economiser shall be charged at the same rate as the registration fee.

(3) For heat recovery steam generators with finned tubes, the fee shall be calculated on heating surface area of bare tubes and on one fourth of heating surface area of fins.

TABLE 8/2
Registration Fee (regulation 304)

Serial No.	Boiler Ratings	Fee in rupees
(1)	(2)	(3)
1	For Small Industrial Boiler as per Chapter-14 and Small solar boilers as per Chapter-17	1200
2	For Boiler Rating not exceeding 10 sq. meters	1800
3	For Boiler Rating exceeding 10 sq. meters but not exceeding 30 sq. meters	2400
4	For Boiler Rating exceeding 30 sq. meters but not exceeding 50 sq. meters	2700
5	For Boiler Rating exceeding 50 sq. meters but not exceeding 70 sq. meters	3300
6	For Boiler Rating exceeding 70 sq. meters but not exceeding 90 sq. meters	3900
7	For Boiler Rating exceeding 90 sq. meters but not exceeding 110 sq. meters	4500
8	For Boiler Rating exceeding 110 sq. meters but not exceeding 200 sq. meters	5100
9	For Boiler Rating exceeding 200 sq. meters but not exceeding 400 sq. meters	5700
10	For Boiler Rating exceeding 400 sq. meters but not exceeding 600 sq. meters	6600
11	For Boiler Rating exceeding 600 sq. meters but not exceeding 800 sq. meters	7200
12	For Boiler Rating exceeding 800 sq. meters but not exceeding 1000 sq. meters	8100
13	For Boiler Rating exceeding 1000 sq. meters but not exceeding 1200 sq. meters	9600
14	For Boiler Rating exceeding 1200 sq. meters but not exceeding 1400 sq. meters	10800
15	For Boiler Rating exceeding 1400 sq. meters but not exceeding 1600 sq. meters	12600
16	For Boiler Rating exceeding 1600 sq. meters but not exceeding 1800 sq. meters	13500

17	For Boiler Rating exceeding 1800 sq. meters but not exceeding 2000 sq. meters	15000
18	For Boiler Rating exceeding 2000 sq. meters but not exceeding 2200 sq. meters	16200
19	For Boiler Rating exceeding 2200 sq. meters but not exceeding 2400 sq. meters	18000
20	For Boiler Rating exceeding 2400 sq. meters but not exceeding 2600 sq. meters	18900
21	For Boiler Rating exceeding 2600 sq. meters but not exceeding 2800 sq. meters	20400
22	For Boiler Rating exceeding 2800 sq. meters but not exceeding 3000 sq. meters	21600
23	For Boiler Rating exceeding 3000 sq. meters	21600 + 600 for every 200 sq. meters or part thereof

Note: The State governments may, by notification may make rules for fees as per clause (b) of sub-section (1) of section 42 of the Act, which shall prevail

305. Inspection fee for renewal of certificate. — (1) The required fee to accompany an application under sub-section (3) of section 13 of the Act shall be as per table 8/3 of this regulation:

Provided that the Chief Inspector may direct that no fee shall be payable in respect of a fresh application made in pursuance of sub-section (2) of section 19 of the Act.

- (2) Inspection fee for separately fired super-heater, re-heater and feed water heater shall be charged at the same rate.
- (3) For heat recovery steam generators with finned tubes, the fee shall be calculated on heating surface area of bare tubes and on one fourth of heating surface area of fins.
- (4) For renewal of certificate for a period of six months or less on the request of owner, half of applicable fee shall be payable.
- (5) Applicable fee shall be payable again for the re-inspection of a defective boiler after completion of repairs.
- (6) For inspection on Sundays or on any public holiday notified under the Negotiable Instrument Act, 1881 (26 of 1881), on the request of owner, additional fee equivalent to half of applicable fee shall be payable.

TABLE 8/3
Inspection fee for renewal of Certificate (regulation 305)

Serial No.	Boiler Ratings	Fee in rupees
(1)	(2)	(3)
1	For Small Industrial Boiler as per Chapter-14 and Small solar boilers as per Chapter-17	1000
2	For Boiler Rating not exceeding 10 sq. meters	1600
3	For Boiler Rating exceeding 10 sq. meters but not exceeding 30 sq. meters	2100
4	For Boiler Rating exceeding 30 sq. meters but not exceeding 50 sq. meters	2400
5	For Boiler Rating exceeding 50 sq. meters but not exceeding 70 sq. meters	2700
6	For Boiler Rating exceeding 70 sq. meters but not exceeding 90 sq. meters	3400
7	For Boiler Rating exceeding 90 sq. meters but not exceeding 110 sq. meters	4000
8	For Boiler Rating exceeding 110 sq. meters but not exceeding 200 sq. meters	4500
9	For Boiler Rating exceeding 200 sq. meters but not exceeding 400 sq. meters	5000
10	For Boiler Rating exceeding 400 sq. meters but not exceeding 600 sq. meters	5800
11	For Boiler Rating exceeding 600 sq. meters but not exceeding 800 sq. meters	6300
12	For Boiler Rating exceeding 800 sq. meters but not exceeding 1000 sq. meters	7100
13	For Boiler Rating exceeding 1000 sq. meters but not exceeding 1200 sq. meters	8400
14	For Boiler Rating exceeding 1200 sq. meters but not exceeding 1400 sq. meters	9500
15	For Boiler Rating exceeding 1400 sq. meters but not exceeding 1600 sq. meters	11100
16	For Boiler Rating exceeding 1600 sq. meters but not exceeding 1800 sq. meters	11900
17	For Boiler Rating exceeding 1800 sq. meters but not exceeding 2000 sq. meters	13200
18	For Boiler Rating exceeding 2000 sq. meters but not exceeding 2200 sq. meters	14300
19	For Boiler Rating exceeding 2200 sq. meters but not exceeding 2400 sq. meters	15800
20	For Boiler Rating exceeding 2400 sq. meters but not exceeding 2600 sq. meters	16600
21	For Boiler Rating exceeding 2600 sq. meters but not exceeding 2800 sq. meters	18000
22	For Boiler Rating exceeding 2800 sq. meters but not exceeding 3000 sq. meters	19000
23	For Boiler Rating exceeding 3000 sq. meters	19000 + 500 for every 200 sq. meters or part thereof

306. Memorandum of Inspection Book .— (1) A Memorandum of Inspection Book shall be prepared for each boiler in Form-XI and the Inspector shall enter all particulars in ink and dimensions of the boilers with the particulars of hydraulic test and steam test and his inspection notes in this book;

- (2) At subsequent inspection, Competent Person shall enter the dates of the Inspections, hydraulic tests and steam tests, when such are made with their notes thereon;
- (3) the Inspector or Competent Person, as the case may be, shall also enter in the Memorandum of Inspection Book, the general condition of the boiler and of repairs, to what extent boilers have been cleared of brick work, a report of all casual visits for inspection of repairs, for inspection of main steam pipes, and reports on accidents;
- (4) (a) On submission of the Memorandum Book to the Chief Inspector, he will in the case of newly registered boilers, check all particulars and calculations and approve the design pressure that is to be permitted.
 (b) In the case of old boilers, the Chief Inspector shall examine the Inspector's notes of inspection and proposals made for repairs or reduction of pressure.
 (c) A pressure once approved for the boiler shall not be altered without the written authority of the Chief Inspector.
 (d) The Memorandum of Inspection Book shall be kept clean and up-to-date and the Inspection Book except when actually required by the Competent Person, shall be kept in the office of the Chief Inspector.

307. Registration book.— (1) A registration book or copy of memorandum of inspection book containing all the particulars required for registration shall be maintained in the office of the Chief Inspector in Form-XI and any orders passed by him regarding the boiler shall be entered in the registration book under his initials.

- (2) The Chief Inspector shall also see that the note of subsequent inspections entered in the Memorandum of Inspection Book are copied in the Registration book.

308. Maintenance of records.— (1) The Inspecting Authority shall maintain the records pertaining to the boiler or the economiser, as the case may be, including all the certificates provided in Form-I(Part-B), Form-I(Part-C), Form-IV(Part-A), Form-IV(Part-B), Form-IV(Part-C), Form-IV(Part-D), Form-V(Part-A) and Form-XVI and the copies of the approved drawings for a period of at least three years after registration of the boiler and thereafter these records may be sent to the owner of the boiler by the Inspecting Authority.

- (2) The owner of a boiler or economiser shall maintain the records pertaining to the boiler or economiser as the case may be, including the certificates provided in Form-I(Part-B), Form-I(Part-C), Form-IV(Part-B), Form-IV(Part-C), Form-V(Part-A), and Form-XV and the copies of the approved drawing for the entire life of the boiler or economiser as the case may be.
- (3) In the event of any transfer of the ownership, the records mentioned above shall be transferred to the new owner and the new owner will maintain the record in accordance with the provision of sub-regulation (2) above.
- (4) The manufacturer of boiler or economiser or steam pipe shall maintain the record pertaining to the boiler or economiser or steam pipe, as the case may be, including the certificates provided in Form-I(Part-B), Form-I(Part-C), Form-IV(Part-B), Form-IV(Part-C), Form-IV(Part-D), Form-V(Part-A), Form-V(Part-B), Form-XV, and Form-XVI and the copies of the approved drawings for a period of at least five years.

309. Transfer of memorandum of inspection book and registration book.— On transfer of a boiler from one state to another, the memorandum of inspection book and the registration book shall, on the request of Chief Inspector of the state to which the boiler has been transferred, be forwarded to that officer who shall take over their custody and maintain them.

310. Grant of Certificate.— (1) A certificate for the use of a boiler shall be granted in Form-XII.

- (2) In the certificate, the design pressure at which the boiler shall be worked, the load to be placed on the safety valves or the thickness of the washers or ferrules required as safeguard against overloading and the date and pressure of the last hydraulic test of the boiler shall be entered.
- (3) The Inspector's remarks shall be as brief as possible.

311. Procedure for inspection of installed boilers.— (1) (a) It is essential to have every part of the boiler that is accessible, open and properly prepared for examination, internally and externally.

(b) All boilers have openings through which an examination may be made and for which operation are closed; all such parts shall be opened whether for access to water surfaces, or heater surfaces.

(c) In cooling a boiler down for inspection or repairs, the water should not be withdrawn until the setting is sufficiently cooled to avoid damage to the boiler and when possible allowed to cool down naturally.

(d) It is not necessary, in order to comply with ordinary prudence, to remove insulation material, masonry, or fixed parts of the boiler, unless defects or deterioration peculiar to certain types of in accessible parts of boilers are suspected and where there is moisture or vapour showing through the covering should be removed at once and a complete investigation made.

(e) Particular attention shall be paid to the external parts of boilers in the way of seating blocks, especially when the situation is damp. Saddle tanks and engine fittings of locomotive type boilers shall be removed to facilitate the inspection of the parts underneath at the first inspection, and at any reasonable period afterwards, if the Competent Person cannot otherwise satisfy himself as to the condition of those parts.

(f) Upon sufficient visible evidence or suspicion due to age or other causes, every effort shall be made to discover the true condition, even to the removal of insulating material, masonry or fixed parts of a boiler. Sometimes drilling or cutting away of parts is justifiable and necessary to positively determine this condition.

- (2) The Competent Person shall, whenever the size permits, go inside it and make a thorough inspection of all its internal parts. Before doing so, he shall, satisfy himself that proper provision has been made for disconnecting the boiler from any other boiler under steam. In case he find that proper provision for disconnection has not been made or that the boiler has not been properly cleaned, or scaled, or that is unreasonably hot, he shall decline to proceed with the inspection and shall report the facts to the Inspecting Authority or Chief Inspector as the case may be, for orders. When a boiler is of such a size or its construction is such that the Competent Person cannot go inside it, there should be sufficient sight holes or hand holes provided to enable him to see the principal internal parts; if any important part of a boiler is so constructed that the Competent Person cannot examine it, he should report the facts to the Inspecting Authority or Chief Inspector as the case may be, for orders.
- (3) In the case of forced circulation and forced flow boilers which are not accessible to close visual inspection, the Competent Person shall, besides thorough examination, ensure by the flow of water that proper circulation is maintained through all sections of the water circuits.
- (4) (a) Upon entering a boiler, the Competent Person shall examine all surfaces of the exposed metal to observe the action caused by the use of water, oil scale solvents, or other substances which may have intentionally or unintentionally gone in with the feed water. Any evidence of oil is dangerous and immediate steps shall be taken to prevent any further entrance of oil into the boiler.
- (b) Oil or scale in the tubes of water-tube boilers or on plates over the fire of any boiler is particularly bad, often causing them to rupture.
- (5) A given amount of corrosion along or immediately adjacent to a seam is more serious than a similar amount of corrosion in the solid plate away from the seams. Grooving along longitudinal seams is especially significant as grooving or cracks are likely to occur when the material is highly stressed. Severe corrosion is likely to occur at points where the circulation of the water is poor and such places shall be examined most carefully for evidences of corrosive action.
- (6) If the Competent Person decides that a boiler in one or more of its parts is no longer fit for the pressure approved for it, he shall without delay report his proposal for reducing the pressure to the Chief Inspector and at the same time submit his calculation for the wasted parts for check and approval of pressure.

- (7) With regard to the pitting and wasting of shell plates, the Competent Person shall bear in mind that thickness of shell plates may reduce to an appreciable extent and still be stronger than longitudinal seams.
- (8) (a) All flanging shall be thoroughly inspected and particularly the flanges of circular and plates that are not stayed.
 (b) Internal grooving in the fillet of such heads and external grooving in the outer surfaces of heads concave to pressure is very common since there is slight movement in the heads of this character which produces this kind of defect. Some types of boilers have what is known as the OG or reversed flange construction in some of their parts that may be inaccessible to the eye, but the condition shall be determined by the insertion of a mirror which at a proper angle will reflect back to the eye the condition of such a place, or any other feasible manner.
- (9) (a) All stays, whether diagonal or through, shall be examined to note that they are in even tension.
 (b) All fastened ends shall be examined to note whether cracks exist where the stays are punched or drilled or rivets or bolts and, if not found in proper tension, the Competent Person shall recommend their proper adjustment.
- (10) (a) The manhole and other reinforcing plates, as well as nozzles or other connection flanged or screwed into a boiler, shall be examined internally as well as externally to see that they are not cracked or deformed, and wherever possible observation shall be made for the inside of the boiler, as to the thoroughness with which its pipe connections are made to the boiler.
 (b) All openings to external attachments, such as water column connections, openings in dry pipes and opening to safety valves, shall be noted to see that they are free from obstructions.
- (11) (a) Particular attention shall be given to the plate or tube surface exposed to the fire. The Competent Person shall observe whether any part of the boiler has become deformed during operation by bulging or blistering; bulging is a distortion of the entire thickness of the plate or tube where it takes place, while the blistering is a lamination or separation of the plate due to foreign material being embedded in the ingot before the plate is rolled.
 (b) If bulges or blisters are of such size as would seriously weaken the plate or tube and especially when the leakage is noted coming from those defects, the boiler shall be discontinued from service until the defective part or parts have received proper repairs.
 (c) Careful observation shall be made to detect leakage from any portion of the boiler structures, particularly in the vicinity of seams and tube ends.
 (d) Fire tubes sometimes blister but rarely collapse, the Competent Person shall look through the tubes for such defects and if they are found with a sufficient degree of distortion they shall be removed.
- (12) (a) Lap joint boilers are apt to crack where the plates lap in the longitudinal or straight seam; if there is any evidence of leakage or other distress at this point, it shall be thoroughly investigated and, if necessary rivets removed or the plate slotted in order to determine whether cracks exist in the seam. Any cracks noted in shell plates are usually dangerous except fire cracks that run from the edge of the plate into the rivet holes of girth seams.
 (b) A limited number of such fire cracks is not usually a very serious matter.
- (13) The Competent Person shall test stay bolts by tapping one end of each bolt with a hammer and when practicable a hammer or other heavy tool shall be held on the opposite end to make the test more effective.
- (14) (a) (i) Tubes in horizontal fire tube boilers deteriorate more rapidly at the ends toward the fire, and they shall be carefully tapped with a light hammer on their outer surface to ascertain whether there has been serious reduction in thickness.
 (ii) The tubes of vertical tubular boilers are more susceptible to deterioration at the upper open ends when exposed to the products of combustion without water protection.
 (iii) They shall be reached as far as possible either through the hand holes if any, or inspected at the ends.

- (b) (i)The surfaces shall be carefully examined to detect bulges or cracks, or any evidences or defective welds.
(ii)Where there is a strong draft, the tubes may become thinned by corrosion produced by the impingement or particles of fuel and ash, or the improper use of soot blowers.
(iii)A leak from a tube frequently causes serious corrosive action on a number of tubes in its immediate vicinity.
- (c) (i)Where short tubes or nipples are employed in joining drums or headers, there is a tendency for waste products of the furnace to lodge in the junction points and such deposits are likely to cause corrosion if moisture is present.
(ii)All such places shall be thoroughly cleaned and examined.
- (15)(i)The ligaments between tube holes in the heads of all types of fire-tube boilers and in shells of water-tube boilers shall be examined.
(ii)If leakage is noted, it may denote a broken ligament.
- (16) Steam pockets on surfaces are sometimes found in new or replacement work, and wherever, this is possible or likely, the Competent Person shall make observation and, if any are found, recommend the necessary changes.
- (17)(a)(i) The steam and water pipes, including connections to the water column, shall be examined for leaks, and if any are found, it shall be determined whether they are the result of excessive strains due to expansion and contraction, or other causes.
(ii)The general arrangement of the piping in regard to the provisions, for expansion and drainage, as well as adequate support at the proper points, shall be carefully noted.
(iii)The location of the various stop valves shall be observed to see that water will not be pocketed when the valves are closed and thereby establish cause for water-hammer action.
- (b)The arrangement of connections between individual boilers and the main steam pipes shall be especially noted to see that any change of position of the boiler due to setting or other causes, will not produce an undue strain on the piping.
- (c) It shall be ascertained whether all pipe connections to the boiler possess the proper strength in their fastenings, whether tapped into the boiler, a fitting, or flange **riveted** to the boiler.
- (d) (i)The Competent Person shall determine whether there is provision for the expansion and contraction of such piping, and that there is no undue vibration tending to crystalize the parts subjected to it.
(ii)This includes all steam and water pipe and special attention shall be given to the blow off pipes with their connections and fittings, because the expansion and contraction due to rapid change in temperature and water-hammer action create a great strain upon the entire blow off system, which is more pronounced when a number of blow off pipes are joined in one common discharge.
(iii)The freedom of the blow off connection on each boiler shall be tested whenever possible by opening the valve for a few seconds, at which time it can be determined whether there is excessive vibration. Blow off pipes should be free from external dampness to prevent corrosion.
- (18)(a)(i)The piping to the water column shall be carefully noted to see that there is no chance of water being pocketed in the piping forming the steam connection to the water column. The steam-pipe shall preferably drain towards to the water column.
(ii)The water pipe connection to the water column must drain towards the boiler.
- (b) (i)The relative position of the water column to the fire surfaces of the boiler shall be observed to determine whether the column is placed in accordance with the regulations. The attachments shall be examined to determine their operating condition.

- (19)(a) In Water-Tube boilers, it shall be noted, as far as possible, whether or not the proper baffling is in place.
 (b) In many types of boilers, the absence of baffling often causes high temperatures on portions of the boiler structure which are not intended to be exposed to such temperatures, from which a dangerous condition may result. The location of combustion arches with respect to tube surfaces shall be carefully noted. These are sometimes arranged so as to cause the flame to impinge on a particular part of a boiler and produces overheating of the material and consequent danger of the rupture of the part.
- (20) Localisation of heat brought about by improper or defective burner or stoker installation or operation creating a blow pipe effect upon the boiler, shall be condemned.
- (21) Where boilers are suspended, the supports and setting shall be carefully examined specially at points where the boiler structure comes near the setting walls or floor. Often accumulation of ash and soot will bind the boiler structure at such points and produce excessive strains on the structure owing to the expansion of the parts under operating conditions.
- (22)(a) As the safety valves are the most important attachments on the boiler, they shall be inspected with the utmost caution. There shall be no accumulations of rust, scale, or other foreign substances located in the casings so as to interfere with the free operation of valves. The setting and freedom of the safety valves shall be tested preferably by raising the steam pressure to the blow-in-off point, or if this cannot be done, the valves shall be tested by means of the try levers to ascertain if they are free. Where the steam discharged from a safety valve is led through a pipe the Competent Person shall determine at the time the valve is operating whether or not the drain, opening in the discharge pipe is free and in accordance with the Regulations.
 (b) If the Competent Person deems it necessary, in order to determine the freedom of discharge from a safety valve, the discharge connections shall be removed. Under no circumstances a stop valve shall be permitted between a boiler and its safety valve.
- (23) The steam gauges on all boilers shall be removed and the Competent Person shall test them and compare their readings with a standard test gauge. The readings of the steam gauges shall be observed and compared when making an inspection with steam on the boiler, where several boilers are in service connected to a common steam main. The location of the steam gauges shall be noted to see whether or not it is exposed to high temperature either externally, as would be the case if placed close to the smoke flue or other high heated part of the boiler or setting, or exposed to heat internally due to lack of protection of the gauge spring with a proper syphon or trap to prevent steam from coming in contact with the spring. The Competent Person shall see that the provisions are made for blowing out the pipe leading to the steam gauge.

312. Calculation of wasted shell.—(1) When any part is wasted and the Competent Person is doubtful of its fitness for the pressure, he shall cause one or more small holes to be bored and from them ascertain the average thickness of the parts from which he can satisfy himself by calculation, in accordance with the formula applicable to the part. He shall enter such gauging and calculations in the Memorandum of Inspection Book.

- (2) In making calculations for a wasted part of a boiler shell, e.g., along the line of seating blocks of a Lancashire boiler, the Competent Person shall use the following formula:

$$P = \frac{2t \times S}{D \times F} \quad \text{Equation (8/1)}$$

Where,

- t = thickness of wasted plate, where thinnest in mm,
 S = minimum tensile strength of material of shell in Kg/mm²,

- D = internal diameter of shell in mm,
 F = factor of safety, which shall not be less than 4.
 P = maximum allowable working pressure in Kg/mm²

313. Ageing of shell type boilers.—(1) In order to take the ageing effect on boilers, the design pressure as calculated from the formulae in these regulations shall be reduced as per the table given below:

TABLE 8/4

Age of boiler exceeding (in years)	25	35	45	50	60	70	80	90	100
Design Pressure (Percentage)	95	90	85	80	70	60	50	40	30

(2) For those boilers, the plates of which have already been cut and tested shall be given a further lease of life of fifty years from the date of the test of the boilers. The design pressure that shall be allowed after the testing shall be reduced as per the table given below:

TABLE 8/5

Period after date of test (in years)	10	20	30	40	50
Design pressure allowed (percentage)	90	80	70	50	30

- (3) (a) Shell type Waste Heat Boilers (un-fired), on completion of a life of twenty-five years, shall be non-destructively tested by a Remnant Life Assessment Organization (RLAO) approved by Central Boilers Board.
- (b) Pressure parts, such as shell, end-plates, stand pipes etc., of such boilers, shall be inspected by Ultrasonic testing, Magnetic particle testing and Dye Penetrant testing.
- (c) If results are acceptable as per the standards laid down by the Central Boilers Board, a certificate shall be issued by the Chief Inspector or Director of Boilers as the case may be, for extending the life of the boiler for a further period of twelve years or such less period as recommended by the Remnant Life Assessment Organisation.
- (d) The working pressure of such boilers may be reduced on the recommendation of the Remnant Life Assessment Organisation.
- (e) The assessment or remnant life by non-destructive testing shall be carried out thereafter every twelve years by a Remnant Life Assessment Organisation (RLAO) approved by the Central Boilers Board. Such agency shall work in close coordination with the office of the Chief inspector or Director of Boilers as the case may be.

Note:

- (1) It shall be at the option of the owner to opt for the provisions of sub-regulation (1) or sub-regulation (2) above or opt for the Remnant Life Assessment of boiler as per sub-regulation (3).
- (2) Wherever, it is not possible to carry out non-destructively testing of boiler for Remnant Life Assessment, provisions of sub-regulation (1) or sub-regulation (2) shall be applicable.

314. Ageing of Water Tube Boilers.—(1) (a) The boilers which are operating at temperature of 400°C (main steam outlet temperature) and above shall be tested by the Remnant Life Assessment Organisation for the components as per Table 8/6 of regulation 315 after they are in operation for 100,000 hours for assessment of the remnant life of the components.

(b) If results are acceptable as per the standards laid down by the Central Boilers Board, a certificate shall be issued by the Chief Inspector or Director of Boilers as the case may be, for extending the life of the boiler for a further period of six years or such less period as recommended by the Remnant Life Assessment Organisation. This assessment of remnant life shall be carried out thereafter every six years by a Remnant Life Assessment Organisation approved by the Central Boilers Board. The Remnant Life Assessment Organisation shall work in close coordination with the office of the Chief Inspector or Director of Boilers as the case may be, in the field of remnant life assessment and extension. The design pressure of such boilers may be reduced on the recommendations of the Remnant Life Assessment Organisation;

- (2) (a) The boilers which are operating at a temperature of less than 400°C (main steam outlet temperature) on completion of a life of twenty-five years shall be tested by the Remnant Life Assessment Organisation for the components as per Table 8/7 given in regulation 315 for assessment of the remnant life of the components.

(b) If results are acceptable as per the standards laid down by the Central Boilers Board, a certificate shall be issued by the Chief Inspector or Director of Boilers as the case may be, for extending the life of the boiler for a further period of twelve years or such less period as recommended by the Remnant Life Assessment Organisation. This assessment of remnant life shall be carried out thereafter every twelve years by a Remnant Life Assessment Organisation approved by the Central Boilers Board. The Remnant Life Assessment Organisation shall work in close coordination with the office of the Chief Inspector or Director of Boilers as the case may be, in the field of remnant life assessment and extension. The design pressure of such boilers may be reduced on the recommendations of Remnant Life Assessment Organisation.

(c) Notwithstanding anything contained in this regulation, for boilers working at a pressure less than 50 kg/cm² (g) and temperature less than 400°C (main steam outlet temperature), such elaborate remnant life assessment is not mandatory. However, in such cases, drums and headers of such boilers, shall be inspected by Ultrasonic testing, Magnetic particle testing and Dye Penetrant test.

315. Ageing of heat recovery steam generators (HRSGs).—Heat Recovery Steam Generators (HRSGs) which are operating at a temperature of 400°C (main steam outlet temperature) and above shall be non-destructively tested by the Remnant Life Assessment Organisation for the components as per Table 8/8 given below under this rule after they are in operation for 100,000 hours for assessment of remnant life of the components.

TABLE 8/6

Serial No.	Component	Visual	Ultra-Sonic Testing	Magnetic Particle inspection	Liquid Dye Penetrant Inspection	Replication	Sampling	Deposit Analysis	Outside Diameter and thickness	Fibre Optic Inspection	Hardness	Others
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Steam Drum	Yes	Yes	Yes	Yes	Yes	No	Yes@	Yes*	No	Yes	
2.	Water drum	Yes	Yes	Yes	Yes	Yes	No	Yes@	Yes*	No	Yes	
3.	Bottom Headers	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	
4.	Low Temperature header (Less than 400°C)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	
5.	Attemperator header	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes	Swell measurement
6.	Economiser Tubes	Yes	No	No	No	No	Yes	No	Yes	No	Yes#	
7.	Convention Super-heater Coils	Yes	No	No	No	No	Yes	No	Yes	No	Yes#	
8.	Primary Superheater Coils	Yes	No	No	No	No	Yes	No	Yes	No	Yes#	Non-destructive oxide thickness inspection
9.	Prefinal Super-heater Coils	Yes	No	No	No	No	Yes\$	No	Yes	No	Yes#	
10.	Final Super-heat Coils	Yes	No	No	No	No	Yes\$	No	Yes	No	Yes#	
11.	Reheater Coils	Yes	No	No	No	No	Yes\$	No	Yes	No	Yes#	
12.	High temperature headers (400°C & above)	Yes	Yes	No	Yes	Yes	No	YNo	Yes	Yes	Yes	
13.	Main steam piping	Yes	No	No	No	Yes	No	No	Yes	No	Yes	
14.	Cold Reheat Piping	Yes	No	No	No	Yes	No	No	Yes	No	Yes	
15.	Hot Reheat Piping	Yes	No	No	No	Yes	No	No	Yes	No	Yes	
16.	SH/RH Links	Yes	Yes	No	Yes	Yes	No	No	Yes	No	No	
17.	Boiler Banks tubes	Yes	No	No	No	No	No	No	Yes	No	No	
18.	Furnace Water walls	Yes	No	No	No	No	Yes	Yes@	Yes	No	No	

Note: Other Components shall be checked/examined visually.

*OD or ID measurement to be taken for steam drum and water drum/bottom headers.

Hardness of Tube samples (both inside and outside) to be checked at Laboratory.

@ Deposit analysis to be done.

\$\$ Sample shall be subjected to accelerated creep rupture test.

TABLE 8/7

Serial No.	Component	Visual	Ultra-Sonic Testing	Magnetic Particle inspection	Liquid Dye Penetrant Inspection	Replication	Sampling	Deposit Analysis	Outside Diameter and thickness	Fibre Optic Inspection	Hardness	Others
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Steam Drum	Yes	Yes	Yes	Yes	Yes	No	Yes@	Yes*	No	No	
2.	Water drum	Yes	Yes	Yes	Yes	Yes	No	Yes@	Yes*	No	No	
3.	Economiser Tubes	Yes	No	No	No	No	Yes	No	Yes	No	No	
4.	Convection Superheater Coils	Yes	No	No	No	No	Yes	No	Yes	No	No	
5.	Primary Superheater Coils	Yes	No	No	No	No	Yes	No	Yes	No	No	
6.	Final Superheater Coils	Yes	No	No	No	No	Yes	No	Yes	No	No	
7.	Water Headers	Yes	Yes	No	Yes	No	No	No	Yes	Yes	No	
8.	Steam headers	Yes	Yes	No	Yes	No	No	No	Yes	Yes	No	
9.	Bank Tubes	Yes	No	No	No	No	No	No	Yes	No	No	
10.	Furnace Water wall	Yes	No	No	No	No	Yes	Yes@	Yes	No	No	
11.	Main Steam Piping	Yes	No	No	Yes	No	No	No	Yes	No	No	

Note: Other Components shall be checked/examined visually.

*OD or ID measurement to be taken for steam drum and water drum/bottom headers.

Hardness of Tube samples (both inside and outside) to be checked at Laboratory.

@ Deposit analysis shall be undertaken at laboratory.

TABLE 8/8

Serial No.	Component	Visual	Ultra-Sonic Testing	Magnetic Particle inspection	Liquid Dye Penetrant Inspection	Replication	Sampling	Deposit Analysis	Outside Diameter and thickness	Fibre Optic Inspection	Hardness	Others
1	2	3	4	5	6	7	8	9	10	11	12	13
1.	SH/RH Tubes	No	No	No	No	No	Yes*	No	No	No	Yes*	
2.	SH/RH Inlet & Outlet Header	Yes	No	No	No	Yes #	No	No	Yes	No	Yes	
3.	DESH Header	Yes	No	No	No	Yes#	No	No	Yes	No	Yes	
4.	DESH Inlet & Outlet Link	Yes	No	No	No	Yes#	No	No	Yes	No	Yes	
5.	Drum	Yes	Yes	Yes	Yes	Yes	No	Yes	ID & Thickness	No	Yes	
6.	Down Comers	Yes	No	No	No	No	No	No	Yes	No	Yes	
7.	Evaporator Outlet Links	Yes	No	No	No	No	No	No	Yes	No	Yes	
8.	Evaporator tubes	No	No	No	No	No	Yes*	Yes*	No	No	Yes*	
9.	Economiser Tubes	No	No	No	No	No	Yes*	Yes*	No	No	Yes*	
10.	Economiser Inlet & Outlet Header	Yes	No	No	No	No	No	No	No	No	Yes	
11.	Economiser to Drum Link	Yes	No	No	No	No	No	No	Yes	No	Yes	

* To be decided based on history of failure.

For the SH/RH headers above 400°C.

316. Repairs to boiler and steam pipes.—(1) Major repairs or replacements such as tubes, coils, headers, drums, fusion welded patches to shells, fireboxes and end plates of boilers and extensive building up of wasted parts of boilers permitted under these regulations, the renewal of furnaces and end plates, parts of shell, fireboxes, girders and steam-pipes, etc., shall only be entrusted to a firm who is recognised as a repairer under these regulations.

(2) Any firm seeking recognition shall apply in 'Form-XIII' to the Chief Inspector of Boilers of the State in which the recognition is sought along with the fee specified in table 8/9.

(3) A firm seeking recognition as a repairer shall meet the following requirements depending upon the class of boilers, namely: —

(a) For Class I boiler repairer, the owner of the firm himself shall have a degree in mechanical or Production or Power Plant or Metallurgical engineering or the firm shall have on its rolls a permanently employed engineer having a degree in mechanical or Production or Power Plant or Metallurgical engineering and the said owner or the permanently employed engineer shall also have an experience of at least five years in an organisation engaged in fabrication, erection, repair or maintenance and quality control of boilers; and the firm shall also have qualified and permanently employed welders as per the provisions of these regulations;

(b) For Class II boiler repairer, the owner of the firm himself shall have a diploma in mechanical engineering or the firm shall have on its rolls a permanently employed engineer having a diploma in mechanical engineering and the said owner or the permanently employed engineer shall also have an experience of at least three years in an organisation engaged in fabrication, erection, repair or maintenance and quality control of boilers; and the firm shall also have qualified and permanently employed welders as per the provisions of these regulations;

(c) For Class III boiler repairer, the owner of the firm himself or a person permanently employed with the firm shall have a minimum three years' experience in repair, maintenance, operation, erection or inspection of boiler and the firm shall also have qualified and permanently employed welders as per the provisions of these regulations;

(d) For Special class boiler repairer, the owner of the firm himself shall have a degree in mechanical or welding engineering along with specialised experience in welding technology for a minimum period of three years or the firm shall have on its rolls a permanently employed engineer having a degree in mechanical or welding engineering along with specialised experience in welding technology for a minimum period of three years, and have permanently employed welders as per the provisions of these regulations who should also have valid certificate for carrying out Tungsten Inert Gas welding;

(e)(i) Where the power stations, fertilizer plants, chemical and petrochemical plants or refineries apply for repair of their own boilers, they shall have all the facilities in-house and may apply to the Chief Inspector of Boilers of the State for permission to repair their own boilers in accordance with these regulations;

(ii) On receipt of the application for permission to repair to a boiler, the Chief Inspector of Boilers of the State shall reply to the request within a period of two days of the receipt of the application.

(4) The Chief Inspector shall scrutinise and evaluate the application along with the replies to the questionnaire and after satisfying himself that the following requirements are fulfilled, shall recognise the firm as a repairer within a period of thirty days, in the category applied for, namely: —

(a) that the firm possesses rectifier or generator, grinder, general tools and tackles, dye-penetrant kit, expander and measuring instruments;

- (b) that the electric arc or oxy-acetylene welding sets and all other tools and plant in his possession for carrying out repairs are suitable for the work undertaken;
 - (c) that the quality of material used conforms to the specifications prescribed in these regulations;
 - (d) that the supervisory and operational staff employed by the firm possesses the necessary training and experience for the work undertaken;
 - (e) that all welders employed by the firm possess certificates issued as required under Chapter-13 of these regulations;
 - (f) Standard of work should be of high order and comply with all the requirements and test that may be specified by the Chief Inspector.
- (5) The recognition of the firm as a repairer shall be for a period of two years and thereafter it shall apply for renewal of its recognition at least two months before the expiry of said period.
- (6) A repairer recognised in one State shall be eligible to work in any other State by getting his recognition endorsed from the Chief Inspector or Director of Boilers of the concerned State on making payment of fee as prescribed in this regulation.
- (7) In case the repairer is found indulging in violating the provisions of the Act or regulations, the firm shall be blacklisted under intimation to Chief Inspector or Director of Boilers of all the States and Union territories and Secretary, Central Boilers Board, and renewal shall not be done in any case.

TABLE 8/9
Fees for repairer to boiler and steam pipes (regulation 316)

Serial No.	Class of boiler repairer	Fee for recognition in rupees	Fee for renewal of recognition in rupees	Fee for endorsement in rupees
(1)	(2)	(3)	(4)	(5)
1.	Special Class	15,000/-	7,500/-	5,000/-
2.	Class I	10,000/-	5,000/-	4,000/-
3.	Class II	5,000/-	2,500/-	2,000/-
4.	Class III	2,500/-	1,250/-	1,000/-

317. Procedure for repairs.—(1) The repair work shall be carried out under the supervision of Inspector or Competent Person and when the fireboxes and smoke tubes of locomotive tube boilers are withdrawn, the internal parts, which are otherwise inaccessible to close inspection, shall be inspected by the Inspector or Competent Person, as the case may be.

- (2) Repair to boilers shells shall be carried out by patching or by removing a strip of worn or damaged plate and inserting the new strip with covering straps over the longitudinal butt ends, the strength of the riveted joints shall be not less than that of the longitudinal joints of the shell.
- (3) (a) Patches for fire exposed plates shall be fitted metal to metal without joint of any description;
- (b) The affected part shall be cut out, leaving the corners of the hole well-rounded.
- (c) Patches shall be secured, wherever possible, properly spaced rivets with a width of plate at least equal to the diameter of rivet between the edge of the rivet hole and the edge of the plate.
- (d) Where riveting is impracticable, the plate shall be secured by welt fitting countersunk headed screw pins.
- (4) The thickness of a patch plate shall not be less than the original thickness of the plate which it is used to patch.
- (5) Bulged or distorted furnaces or circular section may, if the bulge or distortion is not too great, be pressed back to shape.
- (6) Circular furnaces of horizontal boilers that have become distorted may be suitably reinforced.
- (7) (a) Anti-collapse rings shall be substantial section either of single or double angles bolted back to back with screw stays not less than 22 mm in diameter and about 178 mm in pitch passed through flat of angle and screwed into the furnace, the ends being rounded over on the fire side and fitted with nuts at the other.
- (b) The stay bolts shall be fitted with ferrules not less than 25 mm in depth between furnace and angle ring.
- (8) Welding shall not be accepted for the repair of any part of a boiler for which welding is forbidden for a new boiler under these regulations and boiler shells shall not be repaired by welding beyond the filling up of a small isolated corroded or pitted part or the making up of wasted edges of openings.
- (9) Cracks or grooving in dished or flat end plates of cylindrical shells or in the bends of furnace flanges in a circumferential direction may be weed out and welded.
- (10) Wasted parts of circular furnaces and fireboxes and fire exposed flat plates as in rectangular fireboxes and combustion chambers may be cut out and be replaced by new pieces welded in or they may be built-up by welding.
- (11) Longitudinal cracks in circular furnaces and fireboxes and cracks in rectangular fireboxes and combustion chambers may be welded.
- (12) No stay bar shall be welded.
- (13) Smoke tubes may be butt-welded either by fusion welding, flush welding or oxy-acetylene welding, and these may be tested hydraulically at the discretion of the Inspecting Authority.

318. Procedure for welding during repairs. The repairer shall satisfy the inspecting Authority :-

- (1) That the electric arc or oxy-acetylene welding sets and all other tools and plant in his possession for carrying out repairs are suitable for the work undertaken.
- (2) That the quality of material used conforms to the specification that are prescribed.
- (3) That the supervisory and operational staff employed by him possess the necessary training and experience for the work under taken.
- (4) That all welders employed by him possess certificates issued as required under Chapter-13 of these Regulations.
- (5) Standard of work shall be of high order and comply with all the requirements and test that may be prescribed by the Chief Inspector.

319. Riveting and other repairs.— The repairer shall satisfy the Chief Inspector:-

- (1) That he possesses the necessary equipment and tools and engages trained and experienced workmen and staff for the work underwork taken.
- (2) Standard of work shall be of a high order and comply with all the requirements and test that may be prescribed by the Chief Inspector, and all material used shall be boiler quality.

320. Miscellaneous provisions for repairs.— (1) (a) The repairs shall be supervised, so far as his other duties permit by the Competent Person.

(b) When the fire boxes and smoke tubes of locomotive tube boilers are withdrawn, the opportunity shall be taken to inspect the internal parts which are otherwise inaccessible to close inspection.

(2) Repairs to boiler shells shall be effected either by patching or by removing a strips of worn or damaged plate and inserting the new strip with covering straps over the longitudinal butt ends, the strength of the riveted joints shall be not less than that of the longitudinal joints of the shell.

(3) (a) Patches for fire exposed plates shall be fitted metal to metal without joint of any description. The affected part shall be cut out, leaving the corners of the hole rounded.

(b) Patches shall be secured, wherever possible, properly spaced rivets with a width of plate at least equal to the diameter or rivet between the edge of the rivet hole and the edge of the plate.

(c) Where riveting is impracticable, the plate shall be secured by welt fitting countersunk headed screw pins.

(4) The thickness of a patch plate shall not be less than the original thickness of the plate which it is used to patch.

(5) Bulged or distorted furnaces of circular section may, if the bulge of distortion is not too great, be pressed back to shape.

(6) Circular furnaces horizontal boilers that have become distorted may be suitably reinforced.

(7) Anti-collapse rings shall be of substantial section either of single or double angles bolted back to back with screw stays not less than 22 mm in diameter and about 178 mm in pitch passes through flat of angle and

screwed into the furnace, the ends being rounded over on the fire side and fitted with nuts at the other. The stay bolts shall be fitted with ferrules not less than 25 mm in depth between furnace and angle ring.

- (8) Welding shall not be accepted for the repairs of any part of a boiler for which welding is forbidden for a new boiler under these Regulations. Boiler shells shall not be repaired by welding beyond the filling up of a small isolated corroded or pitted or the making up of wasted edges of openings.
- (9) Cracks or grooving in dished or flat end plate of cylindrical shells or in the bends of furnace flanges in circumferential direction may be weed out and welded.
- (10) Wasted parts of circular furnaces and fire boxes and fire exposed flat plates as in rectangular fire boxes and combustion chambers may be cut out and be replaced by new pieces welded in or they may be built up by welding. Longitudinal cracks in circular furnaces and fire-boxes and cracks in rectangular fire-boxes and combustion chambers may be welded.
- (11) No Stay bar shall be welded.
- (12) For the purposes of these Regulations renewed part shall be deemed to be parts of a new boiler intended for use at the pressure at which the boiler under renewal is used.
- (13) For Butt Welding of Smoke Tubes, Smoke tubes may be butt welded either by fusion welding, flush welding or oxy-acetylene welding, and these should be tested hydraulically at the discretion of the Chief Inspector.

321.Submission of manufacturing drawings and the particulars of boilers in advance.— (1) In the case of land boilers and boiler components including spares made in India for use in the States, the manufacturing drawings and the particulars of materials, design and construction of boilers shall be submitted by the makers of the boilers or boiler components or spares, as the case may be to the Inspecting Authority of the State, where the principal parts of the boilers will be manufactured, for examination and approval before commencement of the manufacture of boilers.

- (2) In the case of boilers and boiler components including spares made outside India for use in the State, the manufacturing drawings and particulars of the material, design and construction, of boilers shall be submitted initially to the Inspecting Authority in the country of manufacture for examination and approval.
- (3) The manufacturing drawings and the particulars of materials, design and construction in the case of fired boilers of steam generating capacity 100 Tons/hour and above and that of Waste heat boiler of 20 Tons/hour and above including boiler components and spares thereof shall then be submitted to the Technical Adviser (Boilers) for selection of latest materials with high strengths and use in high temperature and pressure, for the safety. Thereafter, the manufacturing drawings and the particulars of materials, design and construction approved by the Inspecting Authority shall be sent to the Chief Inspector of Boilers of the State where the boiler will be installed and used, for final examination and approval before commencement of manufacture so as to avoid questions arising at the time of erection and registration of the boiler.
- (4) The manufacturing drawings and the particulars of materials, design and construction in the case of fired boilers of steam generating capacity less than 100 Tons/hour and that of Waste heat boiler of less than 20 Tons/hour including boiler components and spares thereof approved by the Inspecting Authority shall be submitted to the Chief Inspector of Boilers of the State where the boiler will be installed and used, for final examination and approval before commencement of manufacture so as to avoid question arising at the time of erection and registration of the boiler.

- (5) The Inspecting Authority or the Chief Inspector or both, as the case may be, shall, after examination of the manufacturing drawings and the particulars intimate to the proposer whether they are satisfied with materials, design, construction and fitness of the parts for the intended pressure and, if not, what modification is necessary therein. When the manufacturing drawings and the particulars of boilers have been approved, the Inspector or Competent Person, as the case may be, in making his examination shall see that the design and the particulars of construction as approved have been carefully followed and that the material corresponds with the approved particulars.
- (6) The fees for the scrutiny of the manufacturing drawings and the particulars of the materials, design and construction of boilers and boiler components including spares under sub-regulations (1) or (2) shall be on the scale prescribed in Table 8/3 subject to a maximum of Rs. 50,000. When the manufacturing drawings have been scrutinised and in respect of them alterations have been suggested and the same are resubmitted for scrutiny, separate fee at the rate of ten percent of the fee for the first scrutiny of the drawing shall be payable, if the manufacturing drawings contain alterations other than those previously suggested.
- (7) The arrangement drawings showing the broad details of modifications or conversions of the existing boiler shall be subject to the approval of the Chief Inspector of Boilers of the State where the boiler is intended for modification or conversion is registered.
- (8) If the detailed manufacturing drawings are got approved by the Inspecting Authority of the State where parts will be manufactured and inspected, no separate compliance of sub-regulation (7) is required.

Table – 8/10
Fees for scrutiny of manufacturing drawings (regulation 321)

Category No.	Product	Regulation No.	Calculation criteria	Fee in Rs.	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
1	Boilers, and boiler components including spares	321(6)	Heating Surface Area	Corresponding Fee specified in regulation 305 (Maximum Rs. 50,000)	Scrutiny
2	Boilers, and boiler components including spares	321(6)	Heating Surface Area	10% of Scrutiny Fee	Alteration

322. Inspection of pipes.—(1) Pipes shall be inspected and hydraulically tested before use in place, in test pressure to be that prescribed in the standard conditions for steam pipes. A certificate from the Inspecting Authority in Form-IV(Part-B), stating that this has been done by him may be accepted. If the Competent Person is satisfied with the test, the pipes may be erected in position. The Chief Inspector shall intimate his approval to the owner regarding the suitability of the pipe line for use at the pressure and temperature to be specified.

- (2) At subsequent inspection of the boiler or at any other time, the Competent Person may make an external inspection of the steam-pipes and for this purpose may require a part of the lagging at the flanges to be removed, and the pipe

made bare. If as a result of this inspection the Competent Person is of opinion that the pipes or any positions of then are in an unsatisfactory condition he shall report the matter to the Chief Inspector, who may require the whole of the lagging to be removed and may require any pipe or pipes to be hydraulically tested. The test pressure at such hydraulic test shall be not less than one and half times, the design pressure of the boiler or the maximum allowable working pressure of pipe as the case may be.

- (3)(a) A memorandum of Inspection Book shall be prepared in respect of steam pipe and fittings in Form-XIV. In this book, the Inspector shall enter in ink, all particulars and dimensions of the steam pipe and fitting with calculations for the various parts in detail, particulars of hydraulic test and his inspection notes.
- (b) At subsequent inspection, the Competent Person shall enter the date of the inspection and hydraulic test together with notes thereon.
- (c) The Competent Person shall also enter in the Memorandum of Inspection Book remarks regarding the general condition of the steam pipes and fittings, and repairs, replacements of alterations, if any, and the extent to which the steam pipes have been cleaned of lagging and covering so that the book provides a useful record of the steam-pipes and fittings for the information and guidance of Competent Person at subsequent inspection.
- (d) In the event of an accident to a pipe line or its fittings, necessary remarks shall also be entered in the book.
- (e) The Memorandum Book shall be submitted to the Chief Inspector, who will check all particulars and calculations and approve the maximum allowable working pressure and temperature that are to be permitted for the various parts of the pipe line and fittings. The pressure and temperature once approved for the particular steam pipe line shall not be altered except on a written authority from the Chief Inspector.

323. Submission of plans of steam-pipes.— (1) Plans of steam pipes including mountings and fittings shall be submitted with the prescribed fee to the Inspecting Authority before construction and to the Chief Inspector at the time of registration of the boiler for his decision whether the pipes and their arrangement comply with the regulations.

- (2) (a) The fees for examination of plans and the particulars of materials, design and construction of steam pipes before the commencement of manufacture of the steam pipes shall be at the rate specified in Table – 8/11.
- (b) The fees for examination of plans and the particulars of materials, design and construction of any fitting, mountings and for fittings like de-superheaters, steam receivers, separators, fee shall be as specified in Table 8/11.

Table – 8/11
Fees for scrutiny of plans of steam pipes and fittings (regulation 323)

Category No.	Product	Regulation No.	Calculation Criteria	Fee in Rs.	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
1	Plans of Steam Pipes	323(2)(a)	For 30 meters of piping or part thereof	200 (Min Rs 500)	Scrutiny

2	Plans of Steam Pipes	323(2)(a)	Based on Scrutiny Fee	10% of Scrutiny Fee	Alteration
3	Fittings, Mountings and components (without heat transfer) like valves, dished ends, hand hole covers, man hole covers, flanges etc.	323(2)(b)	Each Category of identical fittings	300 for each category	Scrutiny and alteration
4	Fittings like De-superheaters, steam receivers, separators	323(2)(b)	Each Category of identical fittings	500 for each category	Scrutiny and alteration

Note: Scrutiny: Scrutiny of manufacturing drawings
Alteration: Alteration of manufacturing drawings

324. Inspection fee for boilers and parts thereof constructed in India.— Inspection fee for boilers and parts thereof constructed in India shall be as specified in Table 8/12.

Table – 8/12
Inspection fee for Boilers and parts thereof constructed in India (regulation 324)

Category No.	Product	Calculation Criteria		Inspection Fee in Rs.	Input	Remarks
(1)	(2)	(3)		(4)	(5)	(6)
1	Boilers (at manufacturers works)	Heating Surface Area (HSA)		HSA * Corresponding Fee specified in Reg. 305 * 4	Pressure Part Arrangement (PPA) drawing	4 times the Inspection fee for renewal of certificate (Reg. 305)
2	Tubes and Pipes	Per metric tonne or part thereof		360	Weight in metric tonne	
3	Boilers (at site of Construction)	Heating Surface Area		HSA * Corresponding Fee specified in Reg. 305* 4	PPA drawing	4 times the Inspection fee for renewal of certificate (Reg. 305)
4	Forged Pipe fittings	<= 25 mm	for a batch of 50 or part thereof	225	Nominal Bore and Batch size	At the rate specified for

		<= 25 mm	for a batch of 100 or part thereof	390		forged and cast flanges (Reg.326)
		> 25 mm <= 50 mm	for a batch of 50 or part thereof	435		
		> 50 mm <= 100mm	for a batch of 25 or part thereof	435		
		> 100 mm <= 250 mm	for a batch of 10 or part thereof	465		
		> 250 mm	for a batch of 5 or part thereof	540		
5	Pipe fittings other than forged pipe fittings	<= 25 mm	for a batch of 50 or part thereof	450	Nominal Bore and Batch size	At the rate specified for forged and cast flanges (Reg. 326)* 2
		<= 25 mm	for a batch of 100 or part thereof	780		
		> 25 mm <= 50 mm	for a batch of 50 or part thereof	870		
		> 50 mm <= 100mm	for a batch of 25 or part thereof	870		
		> 100 mm <= 250 mm	for a batch of 10 or part thereof	930		
		> 250 mm	for a batch of 5 or part thereof	1080		

6	Pipe bends and tube bends	Per Meter	10 (Min 300)	Length in Meter	
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325. Inspection fee for pipes.— Inspection fee for pipes shall be as specified in Table 8/13.

Table 8/13
Inspection fee for pipes (regulation 325)

Category No.	Product	Calculation Criteria		Inspection Fee in Rs.	Input
(1)	(2)	(3)		(4)	(5)
1	Pipes (Inclusive of all fittings excepting fittings like de-superheaters, steam receivers, feed heaters and separately fired superheaters)	NB ≤ 100 mm	For 30 meters of pipe or part thereof	500 (Min 500)	Length in Meter
		NB > 100 mm	For 30 meters of pipe or part thereof	1200 (Min 1200)	

326. Inspection fee for valves and flanges.— Fees for inspection of valves and flanges shall be charged as specified in Table 8/14.

Table 8/14
Inspection fee for valves and flanges (regulation 326)

Category No.	Product	Calculation Criteria		Inspection Fee in Rs.	Input	Remarks
(1)	(2)	(3)		(4)	(5)	(6)
1	Valves	≤ 25 mm		15 per piece	Nominal Bore	Min Rs. 600 per inspection
		> 25 mm		45 per piece		
		≤ 100 mm				
		> 100 mm		270 per piece		
		≤ 250 mm				
		> 250 mm		720 per piece		
2	Forged and Cast Flanges	≤ 25 mm	for a batch of 50 or part thereof	225	Nominal Bore and Batch size	

		<= 25 mm	for a batch of 100 or part thereof	390		
		> 25 mm <= 50 mm	for a batch of 50 or part thereof	435		
		> 50 mm <= 100mm	for a batch of 25 or part thereof	435		
		> 100 mm <= 250 mm	for a batch of 10 or part thereof	465		
		> 250 mm	for a batch of 5 or part thereof	540		
3	Plate Flanges	<=25 mm	for a batch of 50 or part thereof	112	Nominal Bore and Batch size	Half the rate as charged for Forged and Cast Flanges
		<=25 mm	for a batch of 100 or part thereof	195		
		> 25 mm <= 50 mm	for a batch of 50 or part thereof	217		
		> 50 mm <= 100mm	for a batch of 25 or part thereof	217		
		> 100 mm <= 250 mm	for a batch of 10 or part thereof	232		

		> 250 mm	for a batch of 5 or part thereof	270		
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327. Fees for inspection of components of valves.— The fees for inspection of components of valves shall be charged as under:

- (1) 50% of the inspection fees of the valves shall be charged by the chief inspector of the state where the components of the valves, are manufactured, for inspection of the components manufactured in a State other than the State where the valves are assembled and remaining 50% of the inspection fees shall be charged by the chief inspector of the state, where the valves are assembled, for inspection of assembled, and final inspection of the valves.
- (2) Where the inspection, so far as the material testing is concerned, has been carried out by a “well Known Foundry” or “Well Known Forge” full inspection fees shall be charged by the chief inspector of the state where the valves have been assembled and finally tested.
- (3) Where the components of the valves are inspected and tested in the same manufacturing work where the valves are assembled and finally tested, full inspection fees shall be charged by the chief inspector of the state where the manufacturing work is located.
- (4) In case, in a state, components are manufactured by one firm and finally fitting and assembly of the valves are made by another, both the firms shall pay inspection fees on 50: 50 basis.

328. Inspection fee for feed water heaters and other fittings.— Inspection fee for feed water heaters and other fittings shall be as specified in Table 8/15 given below,-

Table 8/15
Inspection fee for feed water heaters and other fittings

Category No.	Product	Calculation Criteria	Inspection Fee in Rs.	Input
(1)	(2)	(3)	(4)	(5)
1	Feed Water Heaters and other fittings	Per Heater	10000	Quantity
2	De-superheaters, Steam receivers and separately fired Superheaters	Per Fitting	2500	Quantity

329. Markings.— (1) Carbon steel tubes or pipes which are both over 50 mm outside diameter or over 1000 mm in length shall be marked legibly to show-

- (a) The identification symbol for the type of the steel.

- (b) The brand of the manufacture; and
- (c) Whether seamless or electric resistance welded tubes or pipes.
- (2) In the case of Carbon steel tubes or pipes less than 50 mm outside diameter or less than 1000 mm in length, the information specified in sub-regulation(1) shall be marked on a tag securely attached to the bundle or box.
- (3) For alloy steel tubes or pipes markings shall not be stamped on the body of the tubes or pipes. The information specified in sub-regulation (1) shall be stamped on the end face of plain end pipes or on the rims of flanges or on identification plates suitably attached to the pipes or tubes. Inspection or identification marks may be painted on the alloy steel tubes or pipes provided iron oxide base or titanium base paints are used.
- (4) Tubes or pipes conforming to a foreign standard or code, which have been accepted under regulation 3(2), marking shall be stamped in accordance with the provision of that standard or code, as the case may be.

330. Inspection fee for spares and boiler components.— Inspection fee for spares and boiler components shall be as specified in Table 8/16 as given below,-

Table 8/16
Inspection fee for spares and boiler components

Category No.	Product	Calculation criteria	Inspection fee in Rs.	Input
(1)	(2)	(3)	(4)	(5)
1	Spares and Boiler Components (All types of Coils namely Economiser Coils, Superheater Coils, Reheater Coils)	Heating Surface Area	Fee specified in regulation 305	Heating surface area specified in drawing
2	Tube and tube Bends	Per Meter	10 (Min Rs. 500)	Length in Meter

NOTE : Wherever boiler components are outsourced by the main boiler manufacturer for manufacturing in vendor works, Inspection fees need not be paid by the vendor if the inspection fees are paid by the main boiler manufacturer.

331. Fees for examination of welders or welding operators.— (1) Fees for examination of welders or welding operators under these regulations shall be Rs. 600 and this shall be borne by the applicant or sponsor, as the case may be and in addition, the applicant or sponsor shall bear all other expenses like cost of material and workshop and testing facilities as fixed by the Competent Authority.

(2) The fee for endorsement of welder's certificate shall be Rs. 200 and will be borne by the applicant or sponsor, as the case may be.

(3) Fee for issue of duplicate certificate shall be Rs. 300.

- 332. Penalty.**—(1) Whoever employs a person in welding a boiler component or steam-pipe in contravention of these regulations, shall be punishable with penalty as per section 31 of the Act.
- (2) Any manufacturer or repairer who fails to maintain the records as required under regulation 542 shall be punishable with penalty as per section 31 of the Act.

CHAPTER-9

SAFETY OF PERSONS INSIDE BOILERS

- 333. Safety of persons working inside boilers.**— (1) The owner or person in charge shall not compel or allow any person to go inside a steam boiler for any purpose whatsoever unless the boiler is effectively disconnected from any steam or hot water communication with any other boiler, in the manner provided in this regulation.
- (2) (a) Effective disconnection shall be made either by the removal of the boiler stop valve or of a length of piping from all steam and hot water connection with any other boiler, vessel or pipe containing steam or hot water by the insertion of substantial blank flanges between the boiler stop valves and piping.
(b) The shutting of a stop valve, stop cock or automatic isolating valve shall not be deemed to compliance with this regulation.
(c) In the case of welded pipe work, however, if a vent pipe of not less than 50 mm internal diameter (bore) is fitted between the main stop valve and the intermediate stop valve on the steam main and between the feed check valve and intermediate check valve on the feed line, this regulation shall be considered to have been complied with, provided such vent pipes are fitted with bolted-on blank flanges and the flanges are removed so as to effectively discharge any leakage steam or water to the atmosphere which the valves on either side of it have been closed.
- (3) The owner of a boiler to which this regulation is applicable shall obtain the approval of the Chief Inspector in writing to the method of disconnection which he proposes to use and shall be responsible for ensuring that the method so approved is followed in practice.
- (4) When electric light is used for work inside a boiler shell or drum or any confined space within a boiler, the voltage shall not exceed 24 volts and the owner of the boiler shall provide a hand lamp with lamp-guard, keyless socket, insulated handle and extension cord of approved type.
- (5) Where power is used for working any equipment inside a boiler the metallic portion of the equipment shall be effectively earthed.

CHAPTER-10

ELECTRODE BOILERS

PART-1

334. Application.— This Chapter applies to electrode steam boilers for all voltages for any working pressure and for temperatures not exceeding 343°C and electrode boilers shall only be of the following construction:

- (a) Fusion welded steel boilers;
- (b) Seamless shell steel boilers.

335. General requirements.— Wherever applicable, the provisions of Chapter-1 relating to certificates from makers, Inspecting Authorities etc., and of Chapter-3 relating to construction shall be followed.

336. Materials.— The material specifications for structural parts of electrode boilers shall comply with Chapter-2, as regards the process of manufacture, chemical composition, mode of manufacture and test, and the certificates for the steel plates, provided that the ultimate tensile stress and elongation of materials shall be between the following limits:-

- (a) For fusion welded construction, as mentioned in Chapter-2.
- (b) For seamless construction as mentioned in regulation 250 and for seamless carbon steel pipes as mentioned in Table 7/3 of regulation 253.

PART-2

337. Construction and workmanship of fusion welded boilers.— Construction and workmanship shall comply with the provision made in chapter-4 for fusion welded drums subject to the following conditions, namely:-

- (a) Class I boilers shall comply with the requirement of chapter-4;
- (b) For end plate connection by welding, the type of seam shown in Fig. 10/1 of this regulation may be adopted;
- (c) Class II boilers shall comply with the following requirements;
- (d) The longitudinal seam shall comply with regulation 152 and for end plate connections by welding, any of the following types of seams may be adopted (see Figs. 10/1 to 10/6 of this regulation).

TYPES OF WELDED JOINTS FOR CIRCUMFERENTIAL SEAMS – ACCEPTABLE FOR ALL CLASSES OF BOILERS

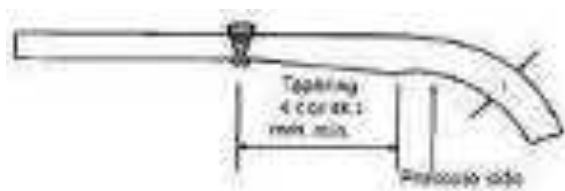


Fig. 10/1

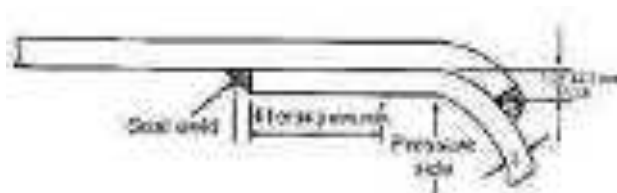


Fig. 10/4

TYPES OF WELDED JOINTS FOR FLAT END PLATES FOR CLASS II BOILERS NOT EXCEEDING 508 MM DIAMETER

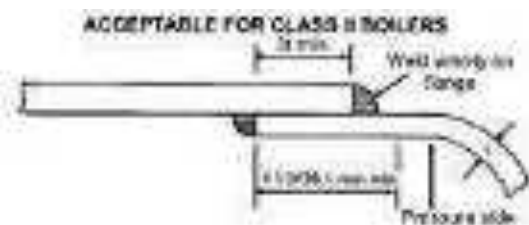


Fig. 10/2

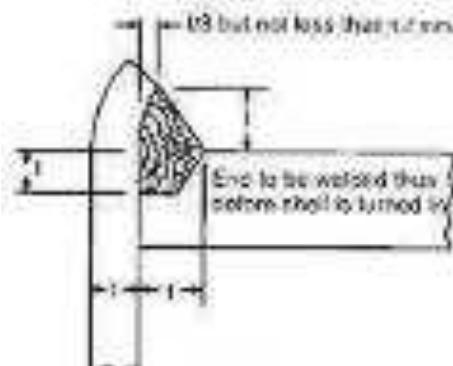


Fig. 10/5

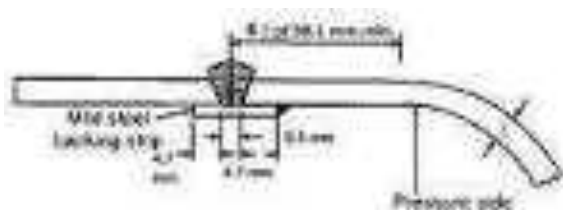


Fig. 10/3

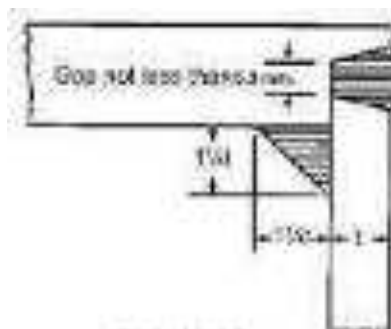


Fig. 10/6

All dimensions are in mm.

Notes:

1. Class I Boilers, the design pressure of which exceeds 11 kg/cm^2 (g) or the product of the design pressure in kg/cm^2 (g) and the internal diameter exceeds 1400 centimeters.
2. Class II Boilers, the design pressure of which is 11 kg/cm^2 (g) and below or the product of the design pressure in kg/cm^2 (g) and the internal diameter is below 1400 centimeters .
3. Types of welded joints for circumferential seams acceptable for seamless shell boilers and for class II welded boiler for plates over 19 mm thick with gap between the edges of the plates shall be agreed upon by the Inspecting Authority and the manufacturer.

PART-3

TESTS FOR CLASS I FUSION WELDED SEAMS

338. Selection of test pieces.—(1) From the test plate of plates on each longitudinal seam, test pieces shall be selected for the following test, the specimens being cut out as shown in Fig. 10/7 of this regulation and stamped by the Competent Person for identification:

- (a) One Tensile test specimen for the welded seam;
- (b) Two bend test specimens;
- (c) One nick break test specimen

(2) The remainder of each set of test plates shall be retained for any retest required and any specimen for retest shall be cut from the same set of test plates as the original specimen.

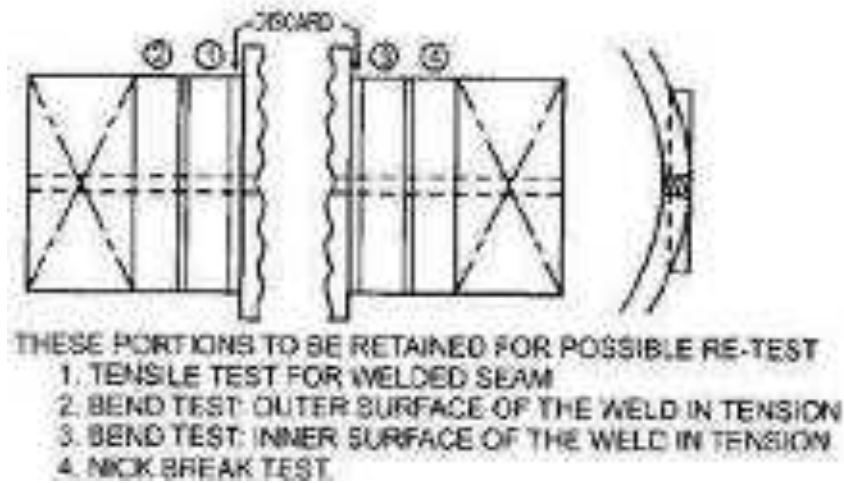


Fig. 10/7: Details of Test Plates

(3) Surface of tensile and bend specimens corresponding with the outside and inside of the shell shall be only lightly dressed so that the rolled surface of the parent metal is not wholly removed, except that where the rolled surfaces of the abutting plates are not level with one another, one plate may be machined at each face of the weld provided the depth of metal removed does not exceed 0.8 mm.

339. Tensile Test.— (a) The specimen shall be cut out transversely to the welded seam (see Fig. 10/7 of regulation 338) and shall be of the full thickness of the plate at the welded seam and the breadth “W” shall be as large as the testing machine will reasonably allow, provided the effective cross-sectional areas is not less than 322.5 sq.mm (see Fig. 10/8 below).

(b) The ultimate tensile stress of the welded seam specimen shall be not less than the lower limit specified for the plate (see under regulation 37).

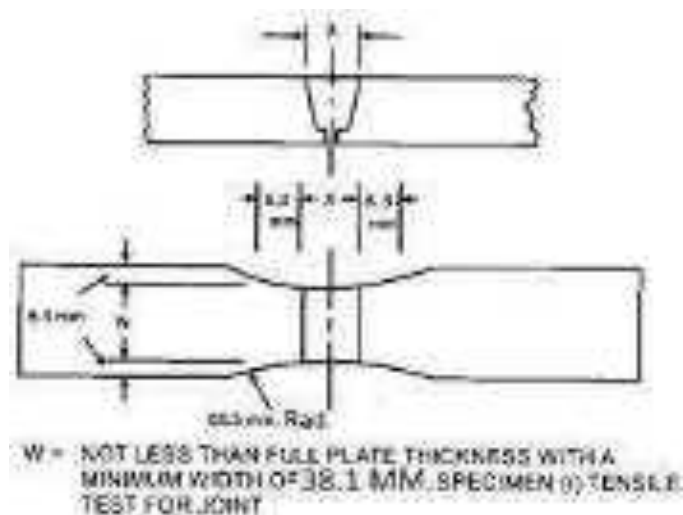


Fig. 10/8: Tensile Test for Joint

340. Bend Test.— (1) (a) Two bend tests shall be made for welded seams.

(b) One specimen shall be tested with the outer surface or the weld in tension, and the other with the inner surface in tension.

(c) The specimen shall be rectangular in section and shall be cut out transversely to the weld so as to have a width of not less than $1\frac{1}{2}$ times the thickness of the plate.

(d) The sharp corners of the specimens shall be rounded to a radius not exceeding ten percent of the thickness of the specimen.

(2) (a) Where the plate thickness does not exceed 32 mm, the thickness of the specimen shall be equal to the full thickness of the test plate.

(b) Where the plate thickness exceeds 32 mm, the thickness of the specimen shall be at least 32 mm.

(c) The specimen to be tested with the outer surface of the weld in tension shall be prepared by cutting to waste the metal local to the inner surface of the weld, so that the desired specimen thickness is obtained.

(3) (a) The specimen to be tested with the inner surface in tension shall be prepared by cutting to waste the metal local to the outer surface of the weld so that the desired metal thickness is obtained.

(b) Where the thickness of the plate permits, both specimen being located in the plate one above the other.

(c) Each specimen shall be mounted with the weld midway between the support, set apart at a distance of not more than 5.2 times the thickness of the specimen and pushed through the supports with a former having a diameter equal to three times the thickness of the specimen (see Fig. 4/6 of regulation 160 of chapter 4).

(4) (a) On completion of the test, no crack or defect at the outer surface of the specimen shall be greater than 1.5 mm, measured across the specimen or 3 mm measured along the length of the specimen.

(b) Premature failure at corners of the specimen shall not be considered cause for rejection (see Fig. 4/6, specimen A).

341. Nick Break Test.— (a) The specimen shall be rectangular in section and cut transversely to the well so as to have a width not less than one-half times its thickness.

(b) The slot shall be cut in one side of the specimen through the center of the weld and perpendicular to the outer face of the vessel.

(c) The specimen shall then be broken in the weld and the fracture shall reveal a sound homogeneous-weld, substantially free from slag inclusions, porosity and coarse crystallinity.

342. Retests.— In case any of the tests fail, two retests shall be made on specimens cut from the same plate and both retests shall meet the specified requirements.

343. Specimens after Tests.— If required by the inspecting Authority, the specimens after test shall be forwarded for examination.

344. Heat Treatment.— All fusion welded electrode boilers shall be stress relieved by heat treatment and the heat heat-treatment shall be in accordance with regulation 123.

345. Hydraulic Test.— Hydraulic Test shall comply with regulation 167.

346. Determination for maximum allowable working pressure.—(1) The maximum allowable working pressure of cylindrical shells with fusion welded seam shall be calculated as per the following formula:

$$P = \frac{(t - 2) \times S \times c}{D} \quad \text{Equation (10/1)}$$

Where,

t = thickness of shell plate in thirty- seconds of an inch,

D = internal diameter of shell in inches,

S = Ultimate tensile stress in tons per square inch,

c = 32 for Class I boilers,

c = 27 for Class II boilers,

(2) In no case, the thickness of cylindrical shells with fusion welded seams shall be less than those in table below:

Table 10/1: Minimum Thickness for fusion Welded Shells

Serial No.	Class	Internal diameter (mm)	Minimum thickness (mm)
(1)	(2)	(3)	(4)
1	II	(a) Upto and including 610	6
		(b) Over 610 upto and including 914	8
		(c) Over 914	10

(3) In no case, the factor of safety of the cylindrical shell and ends shall be less than 4.

347. Welds and compensation for manholes and branches.— Welded compensating ring fitted to manhole and over opening shall conform to Figs. 10/9 to 10/13.

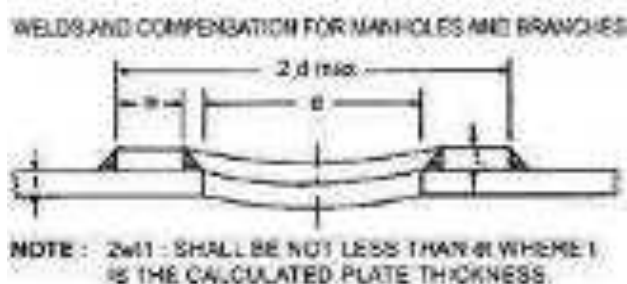


Fig.10/9: External Compensating Ring

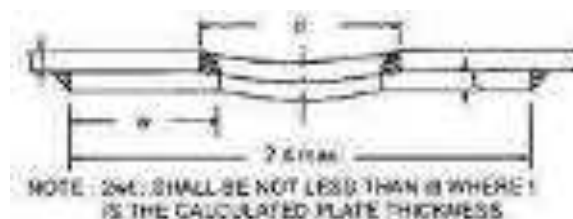


Fig. 10/10: Internal Compensating Ring

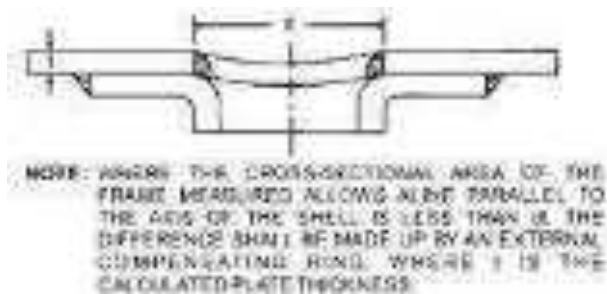


Fig. 10/11: Elliptical Manhole Flanged Frame Welded to Shell

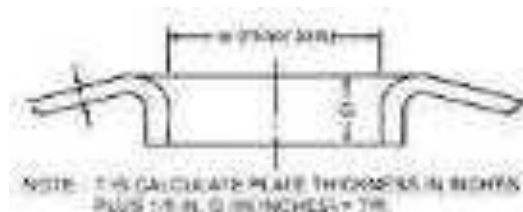


Fig. 10/12: Elliptical Pressed Manhole in Dished End Plate

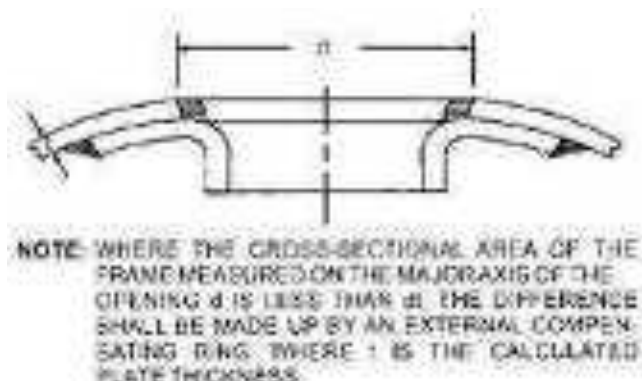


Fig. 10/13: Elliptical Manhole Frame Welded to Dished End Plate

All dimensions are in mm.

348. Manholes and other opening in shells.— (a) Manholes and other opening in boilers shall be placed away from any welded seam and Oval opening shall be arranged with their minor axis parallel to the longitudinal center line of the boiler.

(b) Un-compensated and compensated openings shall comply with regulation 179.

349. Dished end plates with pressure on concave side.— This shall comply with regulations 174, 176 and 177.

350. Unstayed flat end plates.— (1) The working pressure of unstayed flat-end plates shall be determined as per the following formula:

$$P = \frac{2S(t - 2)^2}{D^2} \quad \text{Equation (10/2)}$$

where, t = thickness of plate in thirty-seconds of an inch,

P = working pressure in pounds per square inch,

D = diameter in inches of the pitch circle of the bolts or rivets when the plate is attached to an outside flange or the internal diameter of the shell when the plate is attached to an inside flange,

S = minimum tensile stress of the plate in tons per square inch.

(2) In no case the thickness of an unstayed flat-end plate shall be less than 10 mm.

(3) Compensation is not required where an unstayed flat-end plate is pierced for electrodes or other fittings by opening having a diameter not greater than 63 mm and the pitch of the openings is not less than four times of the diameter of the openings.

(4) Where the diameter of the opening in an unstayed flat end plate is greater than 63 mm or the pitch is less than four times the diameter of the holes, full compensation shall be provided as in regulation 179.

351. Seating and Mounting.— (1) Where the working pressure is not greater than 18 Kg/Cm², mountings having screwed ends not exceeding 19 mm, standard pipe thread may be used.

(2) The mountings may be screwed.—

(a) directly into the boiler shell plates, nuts being fitted on the waterside; or

(b) into steel distance piece (see Fig. 10/14) the length of thread engaged being in no case less than the bore of the mounting plus 6 mm.

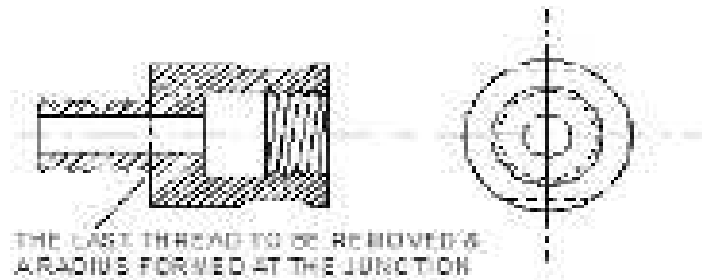


Fig. 10/14: Typical mild steel Distance piece for mountings

(3) (a) The distance piece shall be made solid from mild steel and shall be screwed into the boiler pieces and fitted with nuts on the water side.

(b) The walls of the distance plates shall be not less than 6 mm in thickness at the bottom of the thread.

(4) Where castings are fabricated by fusion welding, they shall be stress-relieved heat treatment before attachment to the boiler.

(5) Method of attachment by welding of connectors to shells are shown in Figs 10/15 to 10/19 of this regulation.

(6) (a) Water gauges and pressure gauge syphons may be attached direct to the boiler shell or ends without the intervention of a pad or standpipe, provided they are flanged and secured by studs.

(b) Nuts of full thickness shall be fitted on inside of the boiler, if the studs are screwed through the plate.

(7) Where the design pressure exceeds 18 Kg/cm² or the nominal bore of the mounting exceeds 19 mm, mountings shall be attached by short standpipes or pads.

(8) Flanges and pads in contact with the boiler shall be formed to bed closely to the plate to which they are attached.

- (9) (a) (i) Where short standpipes are used, the flanges shall be machined on the jointing and bolting surfaces and shall be close to the plate.
- (ii) The caulking edge of the flange shall be machined or flame cut by machine.
- (iii) Where separate flanges are fitted they shall be attached as shown in Figs. 7/10, 7/26, 7/27 and 7/32 of chapter 7.
- (b) Standpipes fabricated by fusion welding shall be stress-relieved by heat treatment before attachment to the boiler. Where the outside diameter of a standpipe is not greater than 127 mm plus twice the thickness of the shell plate in mm, the standpipe may be secured by fusion welding in the manner shown in Figures 10/20 and 10/21 of chapter 10 without subsequent stress-relieving by heat treatment.
- (c) Where minimum weld attachment for standpipes bore is 127 mm and under, with plate thickness(T_s) equal to $1.5 T_n$ or greater as shown in Fig. 10/20 and 10/21, minimum weld attachments for standpipes shall not require compensating plates.
- (d) Where the outside diameter of the standpipe exceeds 127 mm plus twice the thickness of the shell plate, the standpipe may be secured by fusion welding as shown in Figs. 10/22, 10/23, 10/24 and 10/25 of chapter 10 and the standpipe and the entire plate to which it is attached shall be stress-relieved by heat treatment.

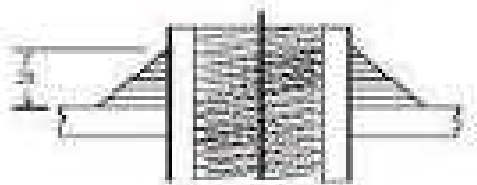
WELDED ATTACHMENT OF
CONNECTORS TO SHELL

Fig 10/15

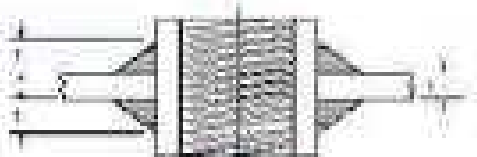


Fig 10/16

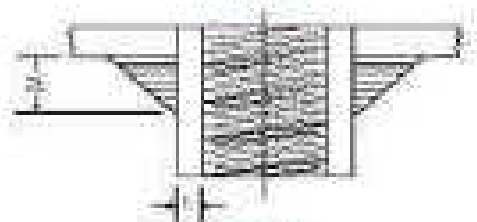


Fig 10/17

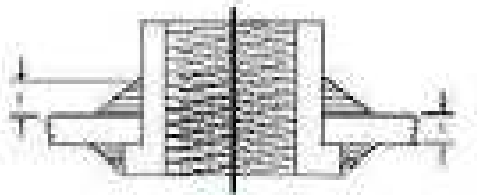


Fig 10/18

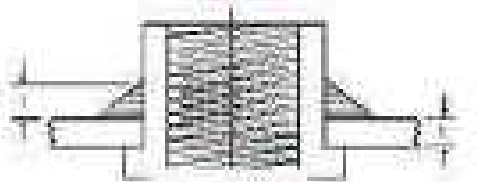


Fig 10/19

(e) Standpipes shall be designed to withstand the internal pressure, but additional thickness may be required for:

- (i) Compensation (see regulation 179).
- (ii) Stresses imposed on the standpipe by expansion and contraction of externally attached pipe work.

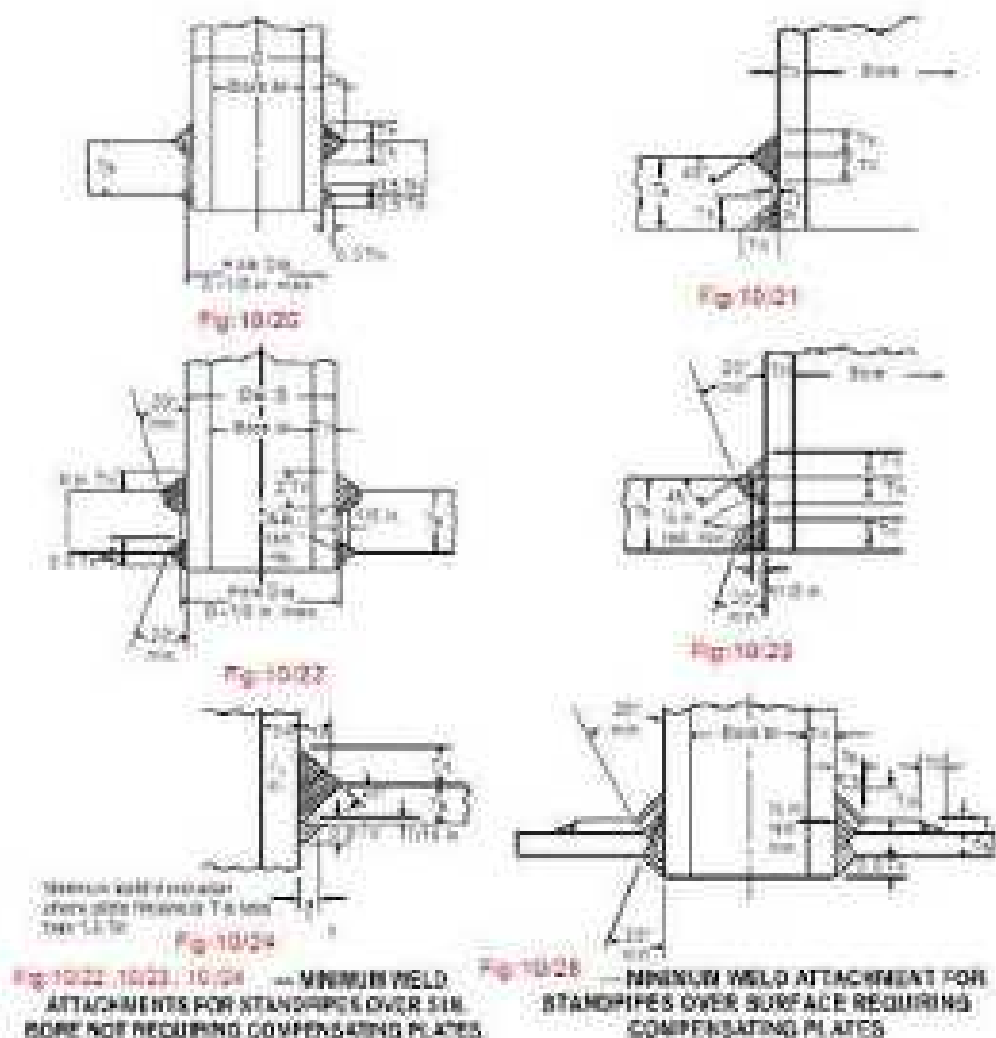
(f) The thickness of the standpipe shall be not less than 6 mm or that given by the following formulae, whichever is the greater:

- (i) for working pressure upto and including 250 lb./sq. in.,
 $t = D + 4$
- (ii) for working pressure above 250 lb./sq. in., $t = 1.4 D + 6$

where,

t = thickness of standpipe in thirty-seconds of an inch,

D = outside diameter of the standpipe in inches.



352. Hydraulic Test.— The hydraulic test shall comply with sub-regulation (1) of regulation 298.

PART-4

SEAMLESS SHELL BOILERS

353. Determination of maximum allowable working pressure.—(1) The maximum allowable working pressure shall be determined as per with regulation 346 except the minimum thickness of the shell shall be as mentioned in the following table: -

Table 10/2

Serial No.	Internal diameter in mm	Minimum thickness in mm
(1)	(2)	(3)
1.	Upto and including 610	6.3
2.	Over 610 upto and including 914	8
3.	Over 914	10

(2) In no case the factor of safety of the cylindrical shell and ends shall be less than 4.

(3) The value of “c” in the equation shall be taken as 35.

(4) Where the ends are welded to shell or mechanically secured and welded, they shall be stress-relieved.

354. End Plates.— (1) The end plates shall comply with regulations 174, 176 and 177 or 350 as the case may be depending upon they are dished or flat .

(2) When end plates are mechanically secured and welded to seamless shell as shown in Figs. 10/4 and 10/5 of chapter 10 and the welded are stress-relieved, the pressure and other limitations specified in respect of class II boilers in regulation 337 shall not apply.

355. Manholes and others opening in the shells.— These shall comply with regulation 179 .

356. Mounting, fittings and connections.—(1) For all types of electrode boilers, mounting, fitting and connections shall comply with regulation 181 for all types of electrode boilers.

(2) For electrode boilers, one means of indicating water level of the tubular glass type water level gauge and one means of feeding the boilers shall be sufficient and the safety valves shall be spring loaded type.

(3) If an Electrode boiler is fitted with a magnetic valve, the said valve will be accepted in lieu of the second safety valve provided the source of power supply to both the valves and the boiler are the same and both are operated by one signal switch.

CHAPTER -11**STANDARD CONDITIONS FOR THE DESIGN AND CONSTRUCTION OF ECONOMISERS, FEED PIPES, FEED HEATERS AND OTHER SIMILAR VESSELS****PART-1****ECONOMISERS**

357. Application of standard condition and exceptions thereto.— (1) An economiser shall not be registered under sub-section (5) of section 12 of the Act and a certificate shall not be issued under sub-section (6) of that section with reference to an economiser unless the standard conditions in respect of material design and construction, which are specified in this chapter are satisfied in respect of such economiser.

(2) Notwithstanding anything contained in sub regulation (1), the chief Inspector may, subject to the provisions of regulation 359, register an economiser and order the issue of a certificate authorising the use thereof, although the standard conditions are not fully satisfied in respect of such economiser.

358. General requirements.— (1) All cast iron and steel headers and parts used in the assembly of an economiser shall conform to the requirements of this Chapter in respect of material specification and test workmanship and structural requirements.

- (2) All economisers shall be constructed under the supervision of an Inspecting Authority and shall be so certified by that authority.
- (3) A certificate from the Inspection Authority in Form--XV certifying that material was tested and the economizers built under their supervision shall be furnished to the chief inspector before or with the first application for registration.
- (4) In advance or along with application for registration, the following shall be furnished:-
 - (a) A certificate of manufacture and test in Form-XVI signed by the maker or by a responsible representative of the Maker, containing the description of the economiser, particulars of the materials used in its construction and the dimensions of the several parts with the declaration that the limits of tensile breaking strength and tests comply with the standard conditions.
 - (b) A certificate from the maker of the material stating the tensile breaking strength and the elongation provided that if the maker and manufacturer be the same, the manufacturer's precise statements showing the above information shall be accepted.
- (5) To suit owners' convenience, wherever possible it is recommended that economiser be installed in two or more sections.

359. Modification of formula.— Where no certificate is produced, the maximum allowable working pressure as found by formula will be reduced by 10%. However, when the workmanship is doubtful in any way and the chief Inspector is not satisfied that any of the foregoing conditions would be sufficient to meet the circumstances, he may at his discretion reduce the maximum allowable working pressure by such percentage as he deems fit.

360. Maker's certificate for steel economisers.— The maker shall furnish a certificate to the Competent Person in the following form:

We hereby certify that the material described below has been made by the Open Hearth or an Electric process acid/basic and has been satisfactorily tested in the presence of the Competent Person in accordance with the standard Tests.

361. Hydraulic test for new economisers.—(1) The hydraulic test for all new economisers shall be conducted as per Table 11/1 given below,—

Table 11/1

Serial No.	On components before assembly	Maximum allowable working pressure in kg/cm ² (g)	Hydraulic test pressure in kg/cm ² (g)
(1)	(2)	(3)	(4)
1.	Cast Iron tubes, headers and bends	Twice Maximum allowable working pressure. Minimum pressure 49.	
2.	Steel tubes and bends	35 or less	70
3.	Steel tubes and bends	Above 35 but not exceeding 70	Twice the Maximum allowable working pressure
4.	Steel tubes and bends	Above 70	70 above the Maximum allowable working pressure
5.	Headers	Below 70	Twice the Maximum allowable working pressure
6.	Headers	Above 70	Maximum allowable Working pressure plus 70 kg/cm ² (g)

(2) For all assembled sections, the hydraulic test pressure shall not be less than 1.5 times of the maximum allowable working pressure.

(3) Maximum allowable working pressure shall be the highest pressure at which the economiser relief valves are to be set.

(4) The above test pressure shall be held for a minimum period of ten minutes.

362. Workmanship and manufacture.— All materials used in the construction of pressure parts shall be tested and shall conform to the following requirements:—

- (i) The workmanship shall be of highest standard. All castings shall be well finished, free from defects, porous places and blow holes, and true to dimensions without warping. Where chaplets are used, there shall be satisfactory fusion with the metal and chaplets shall be properly tinned with metal free from lead.
- (ii) The screw threads of all bolts shall be of whitworth forms.
- (iii) Wherever necessary, all component parts shall be manufactured to limit gauges to secure interchangeability throughout.

PART-2
CAST IRON, TUBES AND HEADERS

363. Process of manufacture.—(1) (a) The castings shall be cast from metal melted or refined in any suitable metallurgical plant other than an iron ore smelting furnace.

(b) The minimum test results required on test bars 30 mm in diameter shall be as per Table 11/2 given below, —

Table 11/2

Serial No.	Material for tubes and other pressure parts	Minimum tensile strength in kg/mm ²	Transverse test on span of 45.8 cm	
(1)	(2)	(3)	(4)	(5)
1.			Minimum transverse breaking load in kg	Minimum deflection in cm
2.	Grade 16.5	23.2	1,052	0.434
3.	Grade 14 iron	19.7	934	0.407
4.	Grade 12 iron	16.9	839	0.382

Note: Grade 16.5, 14 and 12 iron correspond to 23.2, 19.7 and 16.9 kg /mm² minimum tensile strength respectively.

(2) On analysis, the sulphur and phosphorus contents shall not exceed the percentages given in Table 11/3 below,—

Table 11/3

Serial No.	Components	Maximum Sulphur percentage	Maximum Phosphorus percentage
(1)	(2)	(3)	(4)
1.	Tubes	0.15	1.00
2.	Headers	0.15	1.00

(3) (a) Minimum manganese content shall be related to sulphur content by the following formula:—

$$(\% \text{ Sulphur} \times 1.7) + 0.3 = \% \text{ Manganese.}$$

(b) It shall be shown to be satisfied by routine quality control Laboratory analysis and in any case, the manganese shall not be less than 0.5 per cent and shall be within the range 0.50 - 0.90 percent.

(c) Phosphorous content shall be kept as low as economically possible but in no circumstances it shall exceed 1.0 per cent.

364. Test bars.— (1) (a) When test bars are cast separately, they shall be poured at the same time and from the same ladle of metal as the casting or castings they represent.

(b) The number of test bars specified in regulation 365 shall be applicable to all casting of each melt.

(2) When the bars are cast on the mould for the casting and the mould for the test piece shall be joined together in such a manner that the liquid metal fills both moulds at the same operation.

(3) All test bars shall be cast in the same type of sand moulds viz. green sand or in loam or dry sand as used in casting or castings they represent.

- (4) The test bar shall not be subjected to any heat treatment after leaving the moulds except where the castings are heat treated.

365. Number of tensile tests.— (1) The number of tests required for each batch of castings shall be as per the table 11/4 given below where the castings have been divided in four groups and tests required have been mentioned there in, —

Table 11/4

Serial No.	Group	Weight of casting	Test requirements
(1)	(2)	(3)	(4)
1.	1	Up to 13 kg	One test for each 1524 kg of casting or part thereof.
2.	2	Over 13 kg and up to 50 kg	One test for each 2000 kg of castings or part thereof.
3.	3	Over 50kg and up to 1000 kg	One test for each 3000 kg of casting or part thereof.
4.	In the Groups 1,2 and 3, all castings represented by one test shall be poured from the same ladle of same heat as the bar or bars provided for the test.		
5.	4	Over 1000 kg and important castings	One test for each 4000 kg of castings or part thereof or for each casting weighing 4000 kg or more.

- (2) Conditions for acceptance and for rejection shall be as under:

Table 11/5

Serial No.	Test	Result	Conclusion
(1)	(2)	(3)	(4)
1.	1 st	Pass	The batch or separate casting represented shall be accepted.
2.		Tensile or Transverse test fails	Two more tests shall be made.
3.	2 nd	If both pass	The batch or separate casting represented shall be accepted.
4.		If either fails	The batch or separate castings represented shall be rejected.

Provided that, in the case of failure of any test piece showing obvious casting defects, another test piece shall be taken from spare test bars or cut from a casting from the same batch and the results obtained from this shall be substituted for those results obtained from the defective test bars.

366. Standard test piece.— (1) The tensile test bar shall conform to the dimensions shown in the Figure 11/1 given below and bars may be tested with either plain or screwed ends, —

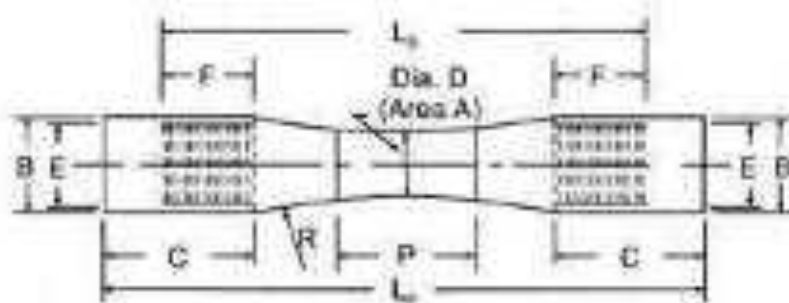


Fig. 11/1

Table 11/6

B	D	A	P	R	C	E	F	L _p	L _s
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
mm	mm	mm.	mm	mm	mm	mm	mm	mm	mm
30	20	13	51	89	51	29 SF 29 SW	29	210	149

(2) The test bars shall be cast as cylindrical bars of the diameters given in Column (1) and machined to the dimensions given in Columns (2) & (4) in the above Table.

PART-3

CONSTRUCTION REQUIREMENTS FOR CAST IRON ECONOMISERS

367. Design requirements.— The manufacturer, on the basis of design details, shall satisfy the Inspecting Authority regarding the design and the strength of all parts of cast iron economisers subject to the following maximum allowable working pressures:

Table 11/7

Serial No.	Type	Max allowable working pressure in kg/cm ² (g)
(1)	(2)	(3)
1.	Ordinary Vertical Tube	22.8
2.	Ordinary Vertical Tube with Strengthened Tubes	26.3
3.	Ring Stay Vertical Tube	33.3
4.	Gilled Tube Type approved Design	45.7

368. Joint bolts and studs for cast iron economisers.— (1) The maximum allowable working pressure for the bolts and studs shall be calculated as per regulation 375.

- (2) The use of studs tapped into cast iron shall be permissible where;
- The studs and nuts are not in the path of the flue gases;
 - The studs are carefully threaded to gauge and fitted into tapped holes of ample depth.

(3) For economiser of gilled tube type of approved design made from 16.5 grade iron, the limitation for a maximum allowable working pressure may be increased to 52.7 kg/cm² (g).

369. Economiser water outlet temperature.— The design condition shall be such that the maximum outlet water temperature of the economiser shall be at least 22°C below the saturated steam temperature in the boiler drum:

Provided that this requirement shall not apply to economizers used on low pressure water heating system working at pressure less than 36.5 m head of water.

PART-4

CONSTRUCTION REQUIREMENTS FOR STEEL ECONOMISERS WITH OR WITHOUT CAST IRON SLEEVES ON THE TUBES

370. Construction of Tubes.— (1) The tubes shall be manufactured as per regulation 122.

(2) Suitable provision shall be made for supporting horizontal tubes at one or more interval in their length to relieve bending stresses and these supports as well as the end connections shall permit free expansion.

371. Maximum allowable working pressure of tubes.— The maximum allowable working pressure of the tubes shall be calculated as per sub-regulation (1) of regulation 244, but the working metal temperature shall be taken as the maximum water temperature for which the part of the elements is designed plus 11°C.

372. Construction of headers.—(1) The headers shall be constructed in accordance with regulation 125.

(2) Branches shall be secured by one of the following methods, namely: -

- (a) Expanded, belled and welded.
- (b) Strength welded with additional securing means.
- (c) Full depth strength weld.
- (d) Branches less than 51 mm bore may be screwed and seal welded.

(3) Open ends of forged seamless steel tube headers may be closed by forging, or the ends may be secured by bolting, screwing, or welding in an approved manner.

373. Maximum allowable working pressure of headers.—(1) The maximum allowable working pressure of rectangular headers shall be calculated as per regulation 246.

(2) The maximum allowable working pressure of cylindrical headers shall be calculated as per regulations 169 and 170.

374. Attachment of tubes to headers.—(1) Tubes shall be connected to the tube plates by one of the following methods, namely:-

- (a) Expanding with bell mounting or seal welding.
- (b) Strength welding.
- (c) Mechanical bolted joint.

- (2) Roller expanded tubes shall project through the neck or bearing part in the holes by at least 6 mm and shall be secured from drawing out by being bell mouthed to the extent of 0.8 mm for each 25 mm in diameter plus 1.6 mm.
- (3) (a) Tubes expanded into headers may be seal-welded inside or outside the header.
(b) Where a seal weld is provided inside the header, the tube end projection and bell mouthed specified in sub-regulation (2) is not required.
- (4) In the case of roller expanded tubes the tube holes in the headers shall be formed in such a way that the tubes can be effectively tightened in them, there shall be a neck or belt of parallel seating of at least 13 mm.
- (5) Where the tubes are strength welded direct to the headers, the technique followed shall be approved by the Inspecting Authority and all welds shall be suitably heat treated.
- (6) Bolted joints shall be designed as per regulation 375.
- (7) Tubes spacers supporting clips and lugs may be welded to the tubes.
- (8) The tubes shall be so arranged that they are accessible for cleaning internally and externally.

PART-5

375. Bolts, studs joints and Flanges.— (1) The maximum allowable working pressure for the bolts shall as per the following formula, —

$$P = \frac{N \times C}{A} \left(D - \frac{1.28}{n} \right)^2 \quad \text{Equation (11/1)}$$

Where,

N = No. of bolts securing the parts,

n = No. of screws threads per inch,

D = Bolt diameter in inches measured over the threads,

A = The area exposed to pressure which is assumed to be bounded by a line midway between the pitch line of the bolts and the inner edge of the flange where flat joints are used with joints rings. Where conical joints faces are used with joint rings, of curvilinear cross-section, the area exposed to pressure shall be assumed to extend to the root of the thread where the tube ends are screwed, or to a corresponding boundary if the flanges are attached by other means.

C = 4,700 for steel bolts or studs of 28 tons/sq.in. minimum ultimate tensile stress where the diameter over thread is less than 3/4 inch,

C = 5,100 for steel bolts or studs of 30 tons /sq. in. minimum ultimate tensile stress where the diameter over thread is less than 3/4 inch.

- C = 5,600 for steel bolts or studs of 35 tons /sq. in. minimum ultimate tensile stress where the diameter over thread is less than 3/4 inch.
- C = 5,600 for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is not less than 3/4 inch and not greater than 7/8 inch.
- C = 7,000 for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is greater than 7/8 inch.

Where the bolts or studs used have a tensile strength exceeding 32 tons sq. in., a plate shall be permanently fixed to the economiser structure in a prominent position drawing attention to this fact in case replacements of bolts or studs are necessary. In no case shall the nuts be exposed to the action of the flue gases.

- (2) The thickness of each flange shall be not less than that given by the following equation:

$$t = \sqrt{\frac{[P.D. (D_1 - D)]}{2}} \quad \text{Equation (11/2)}$$

Where,

t = Thickness of flange in thirty-seconds of an inch.

P = Maximum Allowable Working pressure, in lbs. per square inch (gauge)

D = Outside diameter of the tube in inches.

D₁ = Pitch circle diameter or bolts or studs in inches.

Provided that such flange is cast integral with the body and with the appropriate internal corner radius.

In no case, however, the thickness of a flange shall be less than 24 thirty -seconds of an inch.

PART-6

376. Valves and mountings.— (1) All economisers shall be provided with thermometers for measuring water temperature adjacent to the inlet and outlet connections.

- (2) (a) A valve which shall prevent increase of pressure beyond a predetermined limit shall be fitted to every economiser and the design shall provide against unauthorized interference with the loading. Economisers with pressure parts of cast iron and arranged in groups of tiers connected by circulating piping shall have a relief valve fixed on each group or tier. Relief valves shall have a minimum orifice diameter of 19 mm.

(b) The relief valve capacity shall be calculated on the basis of economiser thermal capacity.

- (3) Pressure gauge for indicating the pressure in the economiser shall be constructed as per regulation 232.

(4) Air release valves shall be provided for the release of air at all points where air accumulation may occur.

(5) Blow off drain valves shall be provided for complete drainage of water in the economiser.

- (6) Economiser provided with means for heating the incoming feed by mixing it with hot water from the economiser outlet, shall have a non-return valve in the hot water return line.
- (7) In every case, a reserve flue shall be provided for by passing the flue gases when no water is being fed to the boiler through the economiser where it is not integral with boiler.
- (8) To relieve the economisers of excessive pressure accumulation due to internal explosion doors preferably of horizontally hinged 'self-sealing' type shall be fitted.
- (9) All valves and mountings shall satisfactorily withstand a hydraulic test to the same pressure as will be applied to the economiser during its registration.
- (10) Alternative means of feeding the boiler other than through the economiser shall be provided.
- (11) A non-return valve shall be provided in the hot feed line between the economiser and the boiler to prevent the discharge of steam or water from the boiler into the economiser.

PART-7 FEED PIPES

377. Maximum allowable working pressure for feed piping .—The maximum allowable working pressure shall be the maximum pressure generated in overcoming friction and other losses in the feed piping under ordinary working conditions, or the maximum pressure which can be generated by the boiler feed pumps unless special provision is made to prevent that pressure being communicated to the pipe line.

Note: For boilers operating at design pressure 100 kg/cm² (g) and above feed water discharge piping for feed water system without economizer inlet isolating valve can be designed based on boiler design pressure with provision of mechanical relief device or a three way valve for bypassing H.P Heater, to prevent Boiler Feed Pump (BFP) shut off pressure being communicated to the piping system and with such a feed water system, boiler shall be hydro tested up to the last isolation valve in the feed water line.

378. Steel feed pipes.—Steel feed pipes shall be in accordance with chapter -7.

379. Feed Heaters and similar vessels fitted to feed pipes.—(1)(a) If welded construction, such vessels shall comply with the requirements of Chapter-12, provided that radiographic examination of welds may be waived for pressure not exceeding 17.5 kg/cm² (g).

(b) For parts of vessels of composite construction, the requirements of the appropriate regulations of the above Chapters shall be complied with as may be applicable to each such part.

- (2) Maximum allowable working pressure of all parts shall be determined as per appropriate formulae given in these regulations and due consideration shall be given to the following additional points while calculating the stresses, namely. —

The stresses due to self-weight of vessels and its contents, any super-imposed vessel or other equipments, pipes and other similar parts attached to the vessels, insulation and stresses due to static head, if any.

- (3) Every such vessel shall be protected with a relieving device of sufficient capacity to avoid over pressure in case of internal failure.
- (4) Inspection during construction, stamping and testing shall comply with the appropriate regulation of chapter-1.

PART-8

REGISTRATION AND INSPECTION OF ECONOMISER AND FEED PIPES

380. Preparation for inspection.— (1) (a) At each inspection, the economiser shall be emptied and thoroughly cleaned internally and externally and in the flues.

(b) All mountings shall be opened up and all caps, doors and blank flanges removed to permit adequate inspection.

(2) The owner of an economiser to which this regulation is applicable shall obtain the approval of the chief inspector in writing to the method of disconnection which he proposes to use and shall be responsible for ensuring that the method so approved is followed in practice.

381. Procedure for registration.— (1) On receipt of an application for registration, the Inspector after the economiser has been prepared for examination, shall take full particulars of the design and ascertain the maximum allowable working pressure allowed by the regulations.

(2) The fitness of the economiser parts shall be determined as per the following formulae:

(a) For Headers of approximately rectangular cross –section:–

$$P = \frac{C (t - 2)}{b^2} \quad \text{Equation (11/3)}$$

Where,

t = Thickness in thirty-seconds of an inch.

b = Distance between the sides of header supporting the surface, in inches.

P = Maximum allowable working pressure, in lbs. per square inch (gauge),

C = 11 where the water side surface is flat.

= 22 where the water side surface is curved, provided that the curvature is continued without interruption and the thickness at each end of the side is not less than that determined with C = 11.

In no case, however, shall the thickness of the side of a header be less than 16 thirty-seconds of an inch at any part.

(b) For Headers of approximately circular cross-section :–

$$P = \frac{0.6K (t - 5)}{D} \quad \text{Equation (11/4)}$$

Where,

t = thickness in thirty-seconds of an inch.

P = Maximum allowable working pressure, in lbs. per square inch (gauge),

D = Outside diameter of header in inches.

K = 265 for Grade 16.5 Iron

= 240 for Grade 14 Iron

= 220 for Grade 12 Iron

The minimum thickness of plain cylindrical portions of header in that part of the length which does not contain tube holes shall comply with the requirements of clause (d).

In no case, however, shall the thickness at any point may be less than 16 thirty-seconds of an inch.

(c) For Tubes :—

$$P = \frac{K (t - c)}{D} \quad \text{Equation (11/5)}$$

Where,

t = Thickness in thirty-seconds of an inch.

P = Maximum allowable working pressure, in lbs. per square inch (gauge),

D = Outside diameter of tube in inches.

K = 265 for Grade 16.5 Iron,

= 240 for Grade 14 Iron,

= 220 for Grade 12 Iron,

C = 4 for portion where gills act as reinforcement.

= 5 for portion not reinforced.

In no case, however, shall the thickness at any point may be less than 11 thirty-seconds of an inch.

(d) For Manifold pipes-

$$P = \frac{0.8K (t - 5)}{D} \quad \text{Equation (11/6)}$$

Where,

t = thickness in thirty-seconds of an inch

P = Maximum allowable working pressure, in lbs. per square inch (gauge),

D = Outside diameter of pipes in inches,

K = 265 for Grade 16.5 Iron,

= 240 for Grade 14 Iron,

= 220 for Grade 12 Iron.

In no case, however, shall the thickness of a manifold pipe or branch be less than 14 thirty-seconds of an inch.

(e) For Cast iron economisers with extended surface horizontal tubes, connector bends: —

$$P = \frac{K (t - 5)}{D} \quad \text{Equation (11/7)}$$

Where,

t = thickness of bend in thirty- seconds of an inch.

P = Maximum allowable working pressure, in lbs. per square inch (gauge).

D = Outside diameter of bend in inches.

K = 265 for Grade 16.5 Iron

= 240 for Grade 14 Iron

= 220 for Grade 12 Iron.

In no case, however, shall the thickness of a connected bend be less than 10.3 mm (13 thirty-seconds of an inch) for 18.75 kg/cm² (g) (12.0 tons sq. in.) and 22.00 kg/cm² (g), (14.0 tons/sq. in.) Grade irons and 9.0 mm (11 thirty-seconds of an inch), for 26.00 kg/cm² (g) (16.5 tons/sq. in.) Grade iron.

(f) Tubes to comply with equation (11/5).

(g) Manifold pipes to comply with equation (11/6).

- (3) The Inspector shall enter full particular of the economisers together with the required calculations of various parts in a Memorandum of the Inspection book (Form-XVIII) and submit it to the Chief Inspector.
- (4) If no formula or co-efficient applicable to any part, other than what is mentioned above, is contained in the regulations, the Chief Inspector shall at his discretion determine the fitness of the part.
- (5) After inspecting the economiser and ascertaining, the maximum working pressure to which it may be worked, the Inspector shall witness the hydraulic test as per regulation 383 and may issue a provisional order in Form-XVII.
- (6) If the requirements of provisional order under sub-regulation (5) are not fulfilled, fresh provisional orders shall be issued subject to a maximum period of twenty four months from the date of issue of first provisional order, without any subsequent inspection and payment of fee.

382. Procedure at subsequent Inspection.— (1) (a) After economiser has been cleaned, the Competent Person shall make a thorough examination so far as its construction permits.

(b) The external condition of the tubes shall be carefully noted for wasting especially at the feed inlet end and all accessible tubes shall be calibered.

(c) The internal surfaces of cast iron tubes shall be closely observed for graphitic wasting as far as it is possible and in the event of any tube failure, these shall be broken up for scrutiny so that the general internal condition of the other tubes may be estimated.

(2) Where tubes or other parts are wasted, the strength shall be re-calculated.

(3) The scraper gear shall be examined to note if any parts are missing, if the length of travel is adequate and if the scrapers are correctly adjusted.

(4) All cap bolts shall be inspected and also the condition and position of the dampers and baffles.

(5) The record of each inspection and calculations shall be entered in the Memorandum of Inspection Book.

383. Procedure for Hydraulic Test.—(1) Every economiser for registration shall be hydraulically tested in the presence of Inspector to 1½ times the maximum allowable working pressure. Hydraulic tests of economisers at subsequent examination when required by the Competent Person, shall be made after the inspection.

(2) The test pressure to be applied to economisers at subsequent examinations shall be from 1.25 to 1.5 times the maximum allowable working pressure of the economisers. During the test, all parts externally and in the flues shall be noted for leakage.

384. Memorandum of Inspection Book .— (1) A Memorandum of Inspection Book shall be prepared for each economiser in Form-XVIII and the Inspector shall enter all particulars in ink and dimensions of the economisers with the particulars of hydraulic test and his inspection notes in this book;

- (2) At subsequent inspection, Competent Person shall enter the dates of the Inspections, hydraulic tests when such are made with their notes pertaining to the condition of the various parts;
- (3) the Inspector or Competent Person, as the case may be, shall also enter in the Memorandum of Inspection Book, the general condition of the economiser and of repairs;
- (4) (a) On submission of the Memorandum Book to the Chief Inspector, he will in the case of newly registered economisers, check all particulars and calculations and approve the design pressure that is to be permitted.
(b) In the case of old economisers, the Chief Inspector shall examine the Inspector's notes of inspection and proposals made for repairs.
(c) A pressure once approved for the economiser shall not be altered without the written authority of the Chief Inspector.
(d) The Memorandum of Inspection Book shall be kept clean and up-to-date and the Inspection Book except when actually required by the Competent Person, shall be kept in the office of the Chief Inspector.

385. Registration book.— (1) A registration book or copy of memorandum of inspection book for economiser containing all the particulars required for registration shall be maintained in the office of the Chief Inspector in Form-XVIII and any orders passed by him regarding the economiser shall be entered in the registration book under his initials.

- (2) The Chief Inspector shall also see that the note of subsequent inspections entered in the Memorandum of Inspection Book are copied in the Registration book.

386. Transfer of memorandum of inspection book and registration book - On transfer of an economiser from one state to another, the memorandum of inspection and registration book shall, on the request of the Chief Inspector of the State to which the economiser has been transferred, be forwarded to that Officer who shall take over their custody and maintain them as prescribed.

387. Grant of certificate.— A certificate for the use of an economiser shall be granted in Form-XIX.

388. Casual visits.— (1) The Inspector shall note that the economiser is working satisfactorily, the relief valves are correctly adjusted, the scraper gear is operating and the external brick work is free from cracks.

- (2) He shall also ascertain that the maker's instructions for working are being strictly followed by the owner.

Note: It is recommended that the feed inlet temperature to the economiser shall not be less than 38°C, to prevent sweating and consequent external corrosion of the tube and bottom headers.

389. Economiser rating.— The rating shall be equivalent to the area of the heating surface in square meters which shall be computed from the tubes and the headers.

390. Registration fee.— An application for registration of Economiser shall be accompanied by appropriate fee as specified in regulation 304.

391. Fee for renewal of certificate.— An application for renewal of certificate of registration of economiser shall be accompanied by appropriate fee as specified in regulation 305.

392. Engraving of registry number.—(1)(a) Every economiser shall have a plate with its registry number engraved, secured in a conspicuous place and wherever practicable stamped for identification with that number in a prominent place.

(b) The engraving shall be done within a period of thirty days from the date of receipt of the registry number.

(2) A letter “E” shall be prefixed to the registry number in the denominator of the appropriate device as shown in regulation 301.

Example: UP
 E-53

(3) The engraving shall be completed and ready for verification within thirty days from the date of receipt of the engraving slip from the Chief Inspector of the State.

(4) (a) Economisers having registry devices different from those prescribed in sub-regulations (1) and (2) shall have such devices crossed out or erased and engraved a new registry number in conformity with those prescribed in the aforesaid sub-regulations.

(b) The original numbers of such economisers shall be retained in the new device, provided that in the case of economisers operating in an area which consequent upon the reorganization of State forms part of another State, new numbers shall be given by the Chief Inspectors of the State.

(c) A number once allotted shall not be used again in another economiser.

393. Inspection of feed pipes.—(1) (a) Feed pipes shall be inspected and hydraulically tested before erection in place, and the hydraulic test pressure shall be not less than twice the maximum allowable working pressure of the economiser.

(b) A certificate from the recognized maker or Inspecting Authority certifying that this has been done may be accepted.

(c) If the Inspector or Competent Person, as the case may be, is satisfied with the test, the pipes may be erected.

(d) Neither separate certificate for feed pipes shall be issued, nor separate fee shall be charged for their inspection.

(e) The engraving shall be done within a period of two months from the date of receipt of the registry number.

(2) At subsequent inspection or at any other time, the Competent Person may make an external inspection of feed pipes and if found in an unsatisfactory condition, he shall report the matter to the Chief Inspector who may require the pipes to be hydraulically tested.

394. Submission of plans of feed pipes.— (1) The fees for the scrutiny of plans and particulars of the material, design and construction of feed pipes, before commencement of manufacture of the feed pipes, shall be at the rate of Rs. 200 for 30 metres of piping or part thereof.

(2) The fees for scrutiny of plans and particulars of the material, design and construction of any such fittings like feed water heater shall be charged at Rs. 2500 per fitting.

CHAPTER-12**SHELL TYPE BOILERS OF WELDED CONSTRUCTION****PART-I**

395. Application.— (1) These regulations shall apply to all boilers of fusion welded construction other than Water Tube boilers and Electrode boilers referred to in Chapters-4 and 10 respectively.

(2) Where the design of the boiler is of composite construction viz. combination of Fire tube and Water Tube, it shall comply with the relevant regulations governing that particular type of construction.

396. General requirements. — Wherever applicable, the general requirements of Chapter-1 relating to certificates from Makers, Inspecting Authorities, and the like and of Chapter-3 concerning construction, shall be followed.

397. Equipment of workshop. — (1) The welding plant and equipment shall be of good quality and maintained in an efficient working condition. The welding apparatus shall be installed under cover and arranged so that welding work may be carried out in positions free from draughts and adverse weather conditions. The procedure shall be such that there is regular and systematic supervision of the welding works, and the welding operators shall be subjected to periodic tests for quality of workmanship by the works officials. Records of these tests shall be kept and shall be made available to the Competent Person for scrutiny.

(2) The works shall be equipped with welding plant equipment and quality control personnel. However, the equipment for destructive, non-destructive testing and heat treatment are not necessary. The manufacturer can tie-up for these facilities outside and a letter from the party with whom he makes a tie-up shall be made available to the Chief Inspector of Boilers or the Inspecting Authority or his representative and shall be allowed to inspect the material of the party in the laboratory during the test.

398. Materials of construction. — Plates, sections and bars used in the construction of these boilers shall comply with the requirements of Chapter-2 in all respects. However, where the tensile strength exceeds 49.6 kg/mm^2 , the full details of the welding technique including pre-heating and post-heating, and the plate preparation to be used, shall be submitted to Inspecting Authority for approval before commencement of manufacture.

399. Welding consumables. — Where welding consumables are used, they shall comply with the requirements of regulations 71 to 76, save in the case of the weld metal as deposited, where the tensile strength shall not be less than the lower limit specified for the plate.

400. Plain and Stay Tubes. — (1) Tubes shall comply with the provisions of regulations 30, 47 and 48.

(2) Seamless steel cross-tubes and uptake tubes shall come with regulations 99 and 100 respectively.

401. Construction and workmanship.— The manufacturer shall provide Inspecting Authority with a fully dimensioned sectional drawing showing the construction of the boiler in full detail for approval before putting the work in hand. Full details including dimensions of plates preparation for the longitudinal and circumferential seams shall also be shown on the drawing. Fully dimensioned sketches showing in details the attachment for stand-pipes, branch pipes and seatings, the position of these attachments relative to the longitudinal and circumferential seams and other opening shall also be given in the drawing.

402. Preparation of plates. — For preparation of plates, requirements of regulation 77 shall apply. When plates of different thickness are aligned, the welding shall be matched to the lower thickness plate and tolerance as required for thinner plate. (refer Figure 12/1).

403. Stress relieving. — Requirements of regulation 78 shall apply.

404. Cylindrical shells. — Requirements of regulation 80 shall apply.

405. Circularity. — (1) The difference between the maximum and minimum internal diameters of the shell measured at any one cross section shall not exceed one per cent of the nominal internal diameter.

(2) The profile as measured on the outside of the boiler by means of a gauge of the designed form of the exterior of the boiler, having a length equal to one quarter of the internal diameter, shall not depart from the designed form by more than the percentage given in Table 12/1.

TABLE 12/1: Maximum percentage departure from designed form of welded boilers

Serial Number	Nominal internal diameter of boiler 'D' in mm	Maximum departure from designed form in percentage
(1)	(2)	(3)
1.	Up to and including 915	0.375
2.	Over 915, up to and including 1150	0.350
3.	Over 1150	0.300

(3) There shall be no flats at the welded seams and any local departure from circularity shall be gradual.

406. End plates, crown plates and tube plates.— (1) End plate of welded Lancashire and Cornish boilers shall be flanged for attachment to shell plates.

(2) For requirements of end plates of boilers, sub-regulation (1) of regulation 86 shall apply.

(3) For requirements of hemispherical crowns, regulation 89 shall apply.

(4) For requirements of flanging, sub-regulation (2) of regulation 86 shall apply.

(5) In the construction of unfired boilers when the dished ends do not form a part of the heating surface, cold spun dished ends conforming to IS: 2825 may be used.

(6) Where flats are pressed in dished end plates, for the attachment of mountings they shall be formed with an ample radius at the junction of the flat and curved surfaces, and shall be free from sharp corners or tool marks. The plate shall not be unduly thinned.

(7) (a) Plates which are flanged in accordance with sub-regulation (4), shall be welded to the parts to which they are to be connected as follows:

- (i) to shells or cylindrical fireboxes as shown in Figures 12/7, 12/8, 12/9, 12/10 or 12/11.
- (ii) to internal flue tubes as shown in Figures 12/14, 12/15 or 12/16.
- (iii) to uptake as shown in Figure 12/16.
- (iv) to combustion chamber or firebox wrapper plates as shown in Figure 12/19.

(b) Plates which are not flanged shall be welded to the parts to which they are to be connected as follows:

- (i) to shells as shown in Figure 12/12 or 12/13.

- (ii) to internal flue tubes or uptakes as shown in Figure 12/17.
- (iii) to combustion chamber or firebox wrapper plates as shown in Figures 12/20, 12/21 or 12/22.

(c) Where dished ends or crowns are used, they shall be flanged for connection to the shell or the cylindrical portion of the firebox. Flat shell and firebox crown plates of vertical boilers shall also be flanged for connection to the cylindrical portions of the shell or firebox.

(d) The opening in the firebox crown plate of a vertical boiler for the uptake shall be flanged and the connection to the uptake made by means of a circumferential butt-weld. (see Figures 12/3, 12/4, 12/5, 12/6).

407. Internal flues.— (1) Sections of internal flues shall each be made from one plate, which shall be rolled while cold to circular form. The longitudinal seam shall be fusion butt-welded by the metal arc process.

- (2) The maximum permissible variation in diameter of any cross-section shall not exceed 6 mm or half of the thickness of the plate, whichever is greater.
- (3) The longitudinal welds shall be placed at lower part of the furnace and shall break joint in successive sections at least by 150 mm. This requirement shall not be applicable if successive sections are separated by tube plate or end plate or bowling hoops.
- (4) Where flue sections are flanged for circumferential joints, the flanging shall be carried out at one heat by suitable machinery.
- (5) Edges of all flue flanges shall be machined or flame-cut by machine (see regulation 402).
- (6) Flanged circumferential seams shall be so arranged that they do not fall in line with those of the adjacent flue or with circumferential seams of the shell.
- (7) The minimum mean internal diameter of furnaces shall not be less than those given in Figure 12/23 depending on the net heat input.
- (8) Where furnace flue is made up of plain or corrugated sections or both, they may be connected to each other by fusion butt welded circumferential seams.
- (9) (a) Plain furnaces shall not exceed 3 meter in length except in the case of reverse flame boilers, which are considered to be inherently flexible or as provided in clause (d). In all other cases flexibility shall be provided in the furnace by means of corrugations or bowling hoops or stepping of a minimum of 150 mm in the diameter of the furnace. (see figures 12/24 to 12/28).
 - (b) If corrugations are used to provide flexibility, at least one-third of the furnace length shall be corrugated.
 - (c) Breathing spaces as per regulation 483 shall be provided for boilers made as per this clause.
 - (d) Notwithstanding the provisions of clauses (a) and (b), plain furnaces longer than 3 meter are allowed to be used in a boiler when the length between boiler end plates do not exceed 6.5 meters provided that breathing spaces used in this case are in accordance with regulation 484 .
- (10) Where a complete flue is constructed of short plain sections, the ends of each adjoining section shall either be swaged out to a radius to provide an adequate point of support and longitudinal flexibility and butt-welded

together or be butt-welded to each side of a bowling hoop. The dimensions shall comply with Figures 12/31, 12/32 or 12/33.

- (11) Stress relieving by heat-treatment shall be carried out when the construction of a flue involves the use of a circumferential weld such stress relieving being carried out on the completion of all welding in accordance with regulation 453.
- (12) The forms of flue connections to end plates shall be as shown in Figures 12/14, 12/15, 12/16, 12/17 and 12/18 or be in any other form of welding groove subject to the approval of the Inspecting Authority.

408. Uptakes.— (1) The uptakes shall be formed from seamless or electric resistance welded or fusion butt-welded pipes by electric arc process. The tolerances on these pipes shall comply with the requirements of regulation 251. The uptakes shall be fusion butt welded to the upward flange of the opening of the furnace crown plate in accordance with Figures 12/3 and 12/4. The depth of the flange of the firebox crown plate opening from the commencement of the curvature of flange shall be not less than twice the plate thickness with a minimum of 25 mm. Unless the whole boiler is to be subsequently stress relieved, the uptake and firebox crown plate shall be effectively stress relieved after welding. Where the firebox crown plate is also fusion welded to the body of the firebox as in Figure 12/16, the firebox complete with uptake shall be effectively stress relieved by heat treatment on completion of all welding.

(2) The uptake may be attached to the shell crown as indicated on Figure 12/17 before the boiler is finally stress relieved by heat treatment.

(3) Where the vertical seam of the uptake is fusion welded, the welding shall comply with regulation 432 and the weld shall be so arranged that it is welded externally and internally (see Figure 12/42)

(4) It is desirable that the uptake shall be fitted with an internal cast iron liner extending below the low water level.

409. Cross-tubes.—Requirements of regulation 99 shall apply.

PART-2

Fireboxes and Combustion chambers

410. Furnace of vertical boilers.— (1) The furnaces of vertical boilers may be constructed in one or more lengthwise sections, each section being rolled from one plate to a full circle. In such cases, the component sections may be jointed circumferentially by electric butt-welding. The welding shall be stress relieved in accordance with regulation 432.

(2) In the case of vertical boilers where tube plates form part of the firebox, the tube plate portion may be constructed in two vertical sections and the welding of the vertical seams when welded shall be stress relieved.

(3) The maximum permissible variation in diameter, at any cross-section shall not exceed 6 mm for fireboxes up to 900 mm in diameter, or 10 mm for fireboxes over 900 mm in diameter, or half the thickness of the plate whichever is the greater.

(4) Circular fireboxes shall preferably be tapered. A taper of 38 mm in diameter per 300 mm of height is recommended. The water space at the bottom between the firebox and the shell shall be not less than 50 mm for boilers up to and including 760 mm in diameter and shall be not less than 63 mm for boilers over 760 mm in diameter.

(5) The method of welding shall be in accordance with regulation 432.

(6) Flats formed in the firebox for the insertion of water tubes shall have an ample radius at the junction of the flat and the curved surfaces and shall be free from sharp corners or tool marks. The plate shall not be unduly thinned.

(7) Ogee flanging whether integral with the firebox or made as separate ring shall preferably be formed in one heat by suitable machinery and shall be allowed to cool gradually to avoid internal stresses.

(8) Rings of fire holes mouthpieces or foundation rings shall be made of mild steel. 'Z' sections shall not be used for foundations rings.

(9) Attachment of fireboxes to cylindrical shells shall be in accordance with Figures 12/34, 12/35, 12/36 or 12/37.

(10) The method of attachment of fire holes mouthpieces shall be in accordance with Figures 12/40 or 12/41).

411. Hemispherical Fireboxes.—(1) Hemispherical fireboxes shall be pressed to form by machine in progressive stages without thinning and shall be annealed on completion.

(2) Methods of attachment of firebox to the shell be in accordance with Figures 12/34, 12/35, 12/36 or 12/37.

(3) The method of attachment of fire-hole mouthpieces and throat pieces shall be in accordance with Figures 12/40 or 12/41, 12/43 or 12/44.

412. Loco-type fireboxes.— (1) Loco-type firebox wrapper plate sides shall preferably be tapered. The water space at the bottom between the fire-box and the shell shall be not less than 63 mm.

(2) Where the firebox tube plate or fire-hole plate is flanged for connection to the wrapper plate, the weld shall be located between the commencement of curvature of the flange and first row of screwed stays.

(3) Rings for fire-hole mouthpieces of foundation rings shall be made of materials as specified in chapter -2.

(4) Z-sections shall not be used for foundation rings. The attachment of the firebox to the outer casing shall be in accordance with Figures 12/37 or 12/30 or 12/31.

(5) The method of attachment of fire hole mouthpieces shall be in accordance with Figures 12/40 or, where the outer casing and the firebox plate are flanged towards the water side to form the fire hole, a ring of screwed stays located at not more than half the average pitch of the stays distant from the commencement of the curvature of the flanging shall be provided (see Figure 12/45).

413. Water-cooled combustion chambers.—(1) The attachment of the combustion chambers—tube plates and back plates to the wrapper plate shall be in accordance with Figures 12/19, 12/20, 12/21, 12/22 and where the tube plate is flanged for connection to the wrapper plate the weld shall be located between the commencement of curvature of the flange and first row of screwed stays.

(2) The method of attachment of furnace of the flue tubes shall be in accordance with Figures 12/15, 12/16 or 12/17 and access openings shall be in accordance with Figures 12/40 or 12/46.

PART-3

414. Bar stays and firebox stays.— (1) Each bar stay or firebox stay shall be made from a solid rolled bar without weld in its length, except where it is attached to the plate it supports.

(2) Bar stays which have been worked in the fire shall be subsequently annealed.

(3) It is preferred that when the stay is in position in the boiler, its axis shall be normal to the plate it supports, but where this cannot be so arranged, then, if the stay is fitted with nuts, bevelled washers shall be provided between the nuts and the plate.

- (4) Stays shall be secured to the plates they support by one of the following methods as given in regulations 415 to 418.

415.Bar stays.— (1) Plain bars, passing through clearing holes in the plates and welded thereto (see Figure 12/50).

(2) Plain bars passing through clearing holes in the plates and fitted with washers on the outside, the stay and washers being welded to the plates in accordance with any one of the methods shown in Figures 12/52, 12/53, 12/54, 12/55, 12/56, 12/57, 12/58, 12/59.

Note: Clearing hole for the purpose of this regulation mean a machined cylindrical hole having a diameter not exceeding that of bar stay by more than 2%.

416.Firebox Stays.— (1) (a) Screwed stays, screwed through the plates and riveted over at each end to form substantial heads, or fitted with nuts, or the projecting ends fillet-welded as indicated in Figures 12/47 and 12/48.

(b) It is recommended that where the stays are screwed, this shall be with a fine thread and the stays and holes shall be screwed with a continuous thread.

(c) The stays shall be screwed with fine threads of not less than 11 threads per 25 mm.

(d) The screw threads on the stays shall be clean, free from checks or imperfections, of full depth, or a correct standard form and a good fit in the holes. The middle portion shall preferably be turned down to the bottom of the thread.

- (2) Plain stays shall be strength welded to the plates (see Figure 12/49 and 12/50).

NOTE: This form of attachment is also suitable for plain bar stays.

- (3) All screwed stays less than 350 mm long shall preferably be drilled with a tell-tale hole of 5 mm diameter to a depth of 13 mm beyond the inner face of the plate. Stays which are obscure on one side shall preferably be made from hollow stay bar.

417. Girder stays for firebox and combustion chamber crowns.— (1) Where girder stays are attached with stay bolts and nuts, they shall be bedded to the corners or ends of side plates.

(2) The attachment of girder stays welded directly to the crown plates shall comply with Figures 12/60, 12/61, 12/62, 12/63 or 12/64. Such girders shall be welded to the crown plate prior to stress-relieving.

(3) Each girder shall be of sufficient strength to support its due proportion of the load on the crown plate independently of the crown plate, and the bolts or weld attachments shall have sufficient cross-sectional area to carry the applied load.

(4) The waterways between the underside of the girder and the crown plate shall be as large as practicable, but in no case less than 38 mm deep.

418. Gusset Stays.— Requirements of sub-regulation(1) of regulation 112 shall apply.

PART-4

419. Access.— (1) The requirements specified in sub-regulations (1), (2),(3) and (4) of regulation 135 shall apply in addition to the requirements given in sub-regulations (2), (3) and (4).

(2) At the bottom of the narrow water space in vertical boilers where internal access is not possible, mud holes shall be arranged at equal distances round the circumference of the boiler not less in number than as given in Table 12/2.

TABLE 12/2: Number of lower cleaning holes or mud holes

Serial number	Diameter of boiler	No. of Holes
(1)	(2)	(3)
1	610 mm and over but not exceeding 915 mm	3
2	Over 915 mm and not exceeding 1525 mm	4
3	Over 1525 mm and not exceeding 1830 mm	5
4	Over 1830 mm and not exceeding 2290 mm	6
5	Over 2290 mm and not exceeding 2590 mm	7
6	Over 2590 mm and not exceeding 2745 mm	8

(3) Cleaning holes or mud holes in loco-type boilers shall be provided at each bottom corner or as nearly as possible in the corners of the outer firebox casing and at the top corners above fire hole opening and also at each corner of the saddle plate in line with the bottom of barrel Smoke box tube shall be provided with a mud hole.

(4) A manhole shall be provided in the lower part of front end plates of Lancashire boilers and in similar boilers with internal flues wherever practicable.

420. Manhole frames, mouthpieces and doors.— (1) Manhole frames, mouth-pieces, doors or cover plates shall be of mild steel. Frames shall be oval and where of the flanged type, shall be formed to bed closely to the shell and provide a flat joining surface to the door. Alternatively, raised circular mouth-pieces may be fitted externally and where of the flanged type shall be bedded closely to the shell.

(2) Wherever practicable, the frame shall be attached to the inside of the shell with the shorter axis parallel to the longitudinal centre line of the boiler. In all cases where the shell thickness exceeds 14 mm, oval frames or circular mouth-pieces shall be fitted.

(3) Oval frames and externally raised circular mouthpieces shall be either:

(a) Formed in one piece without weld, or

(b) Formed from a suitable rolled section and forge-welded, or fabricated by fusion welding, provided they are stress-relieved by heat-treatment after welding and before attaching to the boiler unless the whole boiler is to be subjected to heat-treatment on completion.

(4) Welds shall be positioned so that they are located on the transverse centre line of the boiler (see regulation 430).

(5) The joining flanges of mouthpieces and covers shall be machined on the face and edges and on the bearing surface for the bolts. Bolts and nuts shall be machined where in contact with the flanges and the joints shall

be formed inside and outside the pitch line or pitch circle of the bolts to preclude the possibility of flange distortion. Cover plates shall be dished outwards to a depth of approximately one-eighth of the internal diameter of the frame.

- (6) All edges shall be machined or flame-cut by machine (see regulation 402).
- (7) Forms of manhole frames and attachments are shown in Figures 12/65, 12/66, 12/67, 12/68 and 12/69. For Manhole, head hole or access opening connections, where compensation calculation performed as per regulation 463, does not require compensating plates, Figure 12/108 to be used for attachment to shell.

421. Internal doors.— Requirements of regulation 137 shall apply.

PART-5

422. Seatings for mountings.— For requirements of seatings for mountings, refer regulation 129. For requirements of attachment of mountings, refer regulation 130.

423. Stand Pipes.— Where stand pipes are used, the flanges shall be machined or flame-cut by machine on the edges. The bolting flanges shall be machined on the jointing and bolting surfaces.

424. Saddles.— Where saddles are used, the edges of the flanges shall be machined or flame-cut by machine. The joining surfaces shall be machined. The studs for the attachment of the mountings, if screwed through the saddle, shall be fitted on the inside with nuts of full thickness. Where the stud holes do not penetrate through the saddles the length of the screwed portion of the stud in the plate shall be not less than the diameter of the stud.

425. Pads.— Where pads are used, the joining surfaces shall be machined. The pads shall have sufficient thickness to allow drilling of the stud holes for mountings without inner surface being pierced and the length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud.

426. Attachment of standpipes.—(1) The following constructions as to standpipes attached to shells and end plates shall be permissible:-

- (i) When the internal diameter of the standpipe does not exceed 25 mm the standpipe may be screwed into the plate with a nut on the waterside.
- (ii) Where the internal diameter of the standpipe exceeds 25 mm but does not exceed 50 mm, it may be screwed in and seal welded.
- (iii) Where the diameter of the standpipe exceeds 50 mm, it may be welded to the end plate.

(2) The provisions in sub-regulation (1) as to the standpipe attachment shall be regulated by the following conditions-

- (i) When standpipes are screwed, the screwing shall be of standard pipe thread.
- (ii) Standpipes shall be attached by one of the methods shown in Figures 12/104, 12/105, 12/106, 12/107, 12/108, 12/109, 12/110, 12/111, 12/112, 12/113 and 12/118 or by any other method approved by the Inspecting Authority.

- (iii) Where the standpipes are fabricated by fusion-welding, they shall be stress relieved by heat-treatment before attachment to the boiler, unless the whole boiler is subject to heat-treatment on completion.
- (iv) Where the bore of the standpipe does not exceed 127 mm or the diameter of the opening in the shell does not exceed 127 mm plus twice the thickness of the plate to which it is attached, the standpipe may be welded to the plate without subsequent heat-treatment of the welds made. If these limits are exceeded, the whole plate to which the standpipe is attached shall be stress relieved by heat-treatment on completion of welding.

427.Attachment of pads.—(1) Pads welded to the shell or end plate shall be welded internally and externally.

(2) Methods of attachment of pads shall be as shown in Figures 12/115, 12/116 or 12/117. Where the bore of the seating does not exceed 127 mm or the diameter of the opening in the shell does not exceed 127 mm plus twice the thickness of the plate to which it is attached, the pad may be welded to the plate without subsequent heat-treatment of the welds so made. If these limits are exceeded the whole plate to which the pad is attached shall be stress relieved by heat-treatment on completion of welding.

428.Attachment of water and pressure gauges.— Water gauges and pressure gauge siphons may be attached direct to the front end plate without the intervention of a pad or standpipe, provided they are flanged and secured by studs. If the studs are screwed through the plate, nuts of full thickness shall be fitted on the inside of the plate.

429.Bolts and Nuts.— All holes for bolts and studs shall be drilled and bolts and nuts shall be machined where in contact with the flanges.

PART-6

430. Compensating plates.— Compensating plates shall be of same material as that of shell and before attachment, shall bed closely to the plates to which they are to be connected. Any weld therein shall be on the transverse centre line.

431. Definition of the term ‘fusion weld’.— (1) For the purpose of this chapter, the term ‘fusion weld’ is applicable to all welded seams made by the metal arc process with covered electrodes or by any other electric arc process in which the arc stream and the deposited weld metal are shielded from atmospheric contamination.

(2) The relevant provisions of this chapter shall also apply to the single run or heavy run welding process and that welded boilers manufactured by that process shall comply with all regulations of this chapter excepting those in which divergence is necessary solely because of special requirements essential for the most efficient utilisation of that process. Thus all regulation governing quality of material construction workmanship, and testing (both non-destructive and otherwise) are applicable.

(3) Where welded shells conforming to the regulations of this chapter are made by single or heavy run process, it shall be understood that regulations 431,432 and 433 do not apply in their entirety. The method of making the welds shall be approved by the Inspecting Authority.

432. Methods of welding.— (1) The seams shall be fusion welded from both sides of the plates. The main welding may be on either side of the plate, whichever it is most convenient to the manufacturer. Before the second side of the plate is welded, the weld metal at the bottom of the first side shall be removed by grinding, chipping, machining or other approved method.

(2) Provided the requisite quality of welding is achieved, the seams may be welded from both sides of the plate or from one side of the plate. Before the second side of the plate is welded, the metal at the bottom of the first side shall be removed by grinding, chipping, machining or other approved method.

(3) Additional runs of metal shall be deposited at both surfaces of the welded seams to ensure that the weld metal at the level of the surfaces of the plate is refined as far as possible.

(4) Thickness of such additional welding shall not exceed values given in following table.

TABLE 12/3: Thickness of additional welding

Serial number	Nominal thickness in mm	Maximum reinforcement in mm	
		Circumferential joint in Pipe and tubing	Other Welds
(1)	(2)	(3)	(4)
1	Upto 3	2.5	2.5
2	Over 3 to 5 incl.	3.0	2.5
3	Over 5 to 13 incl.	4.0	2.5
4	Over 13 to 25 incl.	5.0	2.5
5	Over 25 to 50 incl.	6.0	3.0
6	Over 50 to 75 incl.	Note	4.0
7	Over 75 to 100 incl.	Note	5.5
8	Over 100 to 125 incl.	Note	6.0
9	Over 125	Note	8.0

Note – The greater of 6 mm or 1/8 times width of weld in mm

- (5) The surfaces of the welds which are to be subsequently radiographed shall be sufficiently free from coarse ripples, overlap, grooves, abrupt ridges and valleys, so as to avoid stress raisers and to permit proper interpretation of radiographs and other Non-Destructive Test (NDT) methods. If there is a question regarding the surface condition of the weld when interpreting a radiographic film, the film shall be compared to the actual weld surface or provide smooth contours and to be flush with the respective surfaces of the plate before radiography examination is done.
- (6) In the case of circumferential shell seams welded by submerged arc or any other approved automatic process producing a similar surface finish, such circumferential welds, need not be flush dressed, subject to their surface finish and shape being acceptable to the Inspecting Authority.
- (7) Undercut shall not exceed 0.8mm or 10% of wall thickness, whichever is less and undercut shall not encroach on design wall thickness.
- (8) The positions of the welds shall be marked, compensation plates, doubling plates or manhole frames, not less than two runs or metal shall be deposited at each weld.
- (9) When affixing standpipes, branch pipes, seatings, compensation plates, doubling plates or manhole frames, not less than two runs or metal shall be deposited at each weld.
- (10) Each run of weld metal shall be thoroughly cleaned and freed from slag before the next run is deposited.

433. Types of welded shell seams.— The longitudinal and intermediate circumferential seams shall be made with butt joints of the single or double U or V type (see Figures 12/3, 12/4, 12/5, and 12/6) or of any other type approved by the Inspecting Authority. End circumferential seams shall be in accordance with Figures 12/7, 12/8, 12/9, 12/10, 12/11 or 12/12 or with any other form approved by the Inspecting Authority.

434. Repairs to welded seams.—(1) Any repair to a weld carried out by the manufacturer shall first be agreed to by the Competent person.

(2) (a) Where defects are distributed over the whole length of the seam, the total length of the portions which may be cut from any one longitudinal or circumferential seam to remove all defects shall not exceed 15 percent of the total length of the seam.

(b) When, however, the defects are all located in a single continuous length which may be cut out to remove all defects shall not exceed 10 percent of the total length of the seam.

(3) Defect shall be cut out by chipping, machining or other approved methods.

(4) In the case of Class I boilers, all repaired areas shall be subjected to radiographic examination.

435. Tests on welded seams of shell.—(1) Test plates to represent all welded seams shall be attached at each end of each longitudinal seam. These shall be of a size sufficient for the preparation of the test pieces specified. In the case of shell plates, the test plate may be located at one end only (see Figure 12/58). Where the shell is formed in two or more rings, the staggered longitudinal seam shall be regarded as a continuous longitudinal seam provided the welding be effected in one reasonably continuous operation and by the same operator or operators. The material for the test plates shall be cut from the respective plate or plates forming the appropriate seam.

(2) In the case of insufficient material being available on the shell plate to permit the cutting of test pieces, these shall be acceptable if they are made from another plate, provided it is made from the same cast. The test plates shall be stamped by the Inspecting Authority before being cut.

(3) The weld groove in the test plates shall be similar to that adopted for the corresponding edges of the longitudinal seam, and the respective fusion faces shall be in continuous alignment. The test plates may be reinforced or supported during welding so that any relative displacement due to warping during welding does not exceed 5°. The weld metal in the test plates and the seam shall be deposited continuously at the same operation.

(4) The weld in any test plate shall not be repaired. If any defects are revealed in the weld metal of a test plate the position of this shall be clearly marked on the plate and the test pieces shall be selected from such parts of the test plates as may be decided by the Competent Person.

(5) Test plates warped during welding by not more than 5° may be straightened before heat-treatment. For the heat-treatment of the test plates (see regulation 453).

(6) Where there are circumferential seams only or where the method of welding the circumferential seams differ from that employed for the longitudinal seams, the test plates shall be provided.

PART-7

436. Test of Class I boilers .—(1) Specimens for the following tests shall be selected from the test plate or plates and stamped by the Competent Person for identification (see Figures 12/71 and 12/72).

- (i) One tensile test specimen for the welded seam.
- (ii) One all weld metal tensile test specimen.
- (iii) Two bend test specimens.
- (iv) Two impact test specimens.

- (v) One specimen from each test plate for macro examination.

(2) The dimensions of the specimens shall be in accordance with the sketches in Figures 12/73, 12/74, 12/76, 12/77 and 12/78. The remainder of the test plates shall be retained for re-tests, if required. Any specimen for re-test shall be cut from the same test plate as the original specimen. Specimens representing welded seams shall, if necessary, be straightened cold before the commencement of machining. Tensile and bend specimens shall, if practicable, be of the full plate thickness. Surfaces of tensile, bend and Charpy specimens corresponding with the outside or inside of the boiler shall be lightly dressed only so that the rolled surface of the parent metal is not wholly removed. Where the rolled surfaces of the abutting plates are not level with one another one plate may be machined at each face of the weld so long as the depth of the metal removed does not exceed 0.8 mm.

437. Tensile tests.— (1) Welded joint; the dimensions of the reduced tensile section shall be as shown in Figure 12/73. The width of the reduced section shall be at least 25 mm.

- (2) If the thickness of the plate does not exceed 30 mm, the thickness of the specimen shall be equal to the plate thickness and the plate surface of the specimen shall be machined to take away the surface irregularities of the plate and the weld.
- (3) If the plate thickness exceeds 30 mm, the tensile test shall be carried out on several reduced section specimens, each having a thickness of at least 30 mm and width at the effective cross-section of at least 25 mm. These specimens shall be taken out of the test piece in such a way that the tensile test covers the whole thickness of the weld joints as shown in Figure 12/74. The tensile strength shall not be less than the lower limit specified for the plate.
- (4) The dimensions of the all weld metal tensile test specimen shall be those given in Figure 12/77. The diameter shall be the maximum possible consistent with the cross section of the weld but in no case more than 20 mm, the gauge length shall be equal to five times the diameter. The tensile strength shall not be less than the lower limit specified for the plate. The elongation shall not be less than 20% on a gauge length of five times the diameter of the specimen or 5.65 times the square root of the cross-sectional area of the specimen, and the reduction in area not less than 35 percent.

438. Cold bend tests.— (1) Two bend tests shall be made as given in this regulation.

- (2) One specimen shall be tested with the outer surface of the weld in tension and the other with the inner surface in tension. The specimen shall be rectangular in section and shall be cut out transversely to the weld so as to have a width not less than one-and-a half times the thickness of the plates. The sharp corners of the specimens shall be rounded to a radius not exceeding 10% of the thickness of the specimen.
- (3) Where the plate thickness does not exceed 32 mm, the thickness of the specimen shall be equal to the full thickness of the test plate. Where the plate thickness exceeds 32 mm, the specimen shall in all cases have a thickness of at least 32 mm. The specimen to be tested with the outer surface of the weld in tension shall be prepared by cutting to waste the metal local to the inner surface of the weld, so that the desired specimen thickness is obtained (see A, Figure 12/78).
- (4) The specimen to be tested with the inner surface in tension shall be prepared by cutting to waste the metal local to the outer surface of the weld so that the desired specimen thickness is obtained (See B, Figure 12/78). Where the thickness of the plate permits, both specimens may be cut from the same piece of plate, the specimens being located in the plate one above the other (see C, Figure 12/78). Each specimen shall be mounted with the weld midway between the supports set apart at a distance of not more than 5.2 times the thickness of the specimen and pushed through the supports with a former having a diameter equal to three times the thickness of the specimen.
- (5) On completion of the test, no crack or defect at the outer surface of the specimen shall be greater than 1.5 mm measured across the specimen or 3 mm measured along the length of the specimen. Premature failure at corners or the specimen shall not be considered cause for rejection.

439. Impact tests.— Impact tests shall be as per regulation 162.

440. Macro and micro examinations.—(1) A specimen of the full thickness of the plate and not less than 13 mm wide shall be provided from each set of test plates for the purpose of macro and micro examinations.

(2) Micro-etching of a complete cross-section of the weld including the heat affected zone shall show satisfactory penetration, fusion and absence of significant inclusions or other defects. In case there is any doubt as to the condition of the weld as shown by macro-etching, the area concerned is to be microscopically examined for defect investigation.

441. Additional tests before rejection.—(1) In case any of the test specimens taken in accordance with regulations 435 to 443 fail to meet the specified requirements, retests shall be allowed for each specimen that fails as follows:

- (2) Where any result of the tensile test is not less than 90% of the specified figures, one retest shall be made. Where any result falls below 90%, two retests shall be made.
- (3) Where a bend specimen fails to meet the specified requirements, two retests shall be made.
- (4) If an impact test fails to meet the specified requirements, two retests shall be taken from the test plate, one on each side of the final specimen and separate from it by not more than 5 mm.
- (5) If it be found there is insufficient metal to permit the preparation of specimens for retests from the remainder of the test plate from which the original specimen was taken, the specimen for retest may be cut from the test plate relating to the opposite end of the same longitudinal seam.
- (6) In case any of the additional tests fail to meet the specified requirements, the welded seams represented by these tests shall be rejected.

442. Specimens after tests.— If required, the specimens after test shall be at the disposal of the Inspecting Authority for examination.

443. Radiographic examinations.— (1) Every portion of the longitudinal and circumferential butt-welded seams of the shell of the boiler shall be subjected to radiographic or ultrasonic examination. Each Longitudinal and circumferential butt welded seams of Furnace, Reversal chamber, Access tube and drop pipes shall be subjected to 10% radiographic examination. The percentage of welds to be examined shall include each intersection of longitudinal and circumferential seams. Where ultrasonic examination is used, it shall be demonstrated to the satisfaction of the Inspecting Authority that the equipment and the technique used are satisfactory. The manufacturer shall ensure that the operator employed is competent to use the equipment, apply the technique and interpret the results of the examination.

- (2) The methods employed in obtaining the radiographs shall be such as to show clearly differences equal to 2% of the thickness at the welded joints. To determine whether this result is being attained, an indicator of approved form which includes a portion equivalent to not more than 2% of the joint thickness shall be placed in the vicinity of the weld so as to make a record on each radiograph. Each section of every weld shall be marked so that the radiographs can be easily correlated to the particular part of the seam represented.
- (3) The examination shall be made from the original films and the acceptability of the welds shall be decided by the Inspecting Authority. The welds deemed unsatisfactory shall be rejected or dealt with under the condition of regulation 434 and can be radiographed again. The films shall be retained by the manufacturer for minimum three years for reference.

Notes: (1) Magnetic Particle Flaw Detection, Magnetic methods of flaw detection shall be employed wherever possible for ferrite steel.

(2) Dye-Penetrant Flaw Detection; Dye-penetrant or equivalent methods of flaw detection shall be employed for Austenitic or other non-magnetic steel.

(3) All butt-welded joints shall be subjected to non-destructive examination by radiographic, radioscopy or other approved methods such as ultrasonic testing, magnetic particle inspection or liquid dye penetrant inspection. When radioscopy examination is to be performed in lieu of radiography on welded components, the following requirements shall be met, namely:-

- (a) A written procedure shall be submitted for approval to the Inspecting Authority which shall contain the following:
 - (i) material and the thickness range;
 - (ii) equipment qualifications;
 - (iii) test object scan plan;
 - (iv) radioscopy parameters;
 - (v) image processing parameters;
 - (vi) image display parameters;
 - (vii) image archiving requirements;
 - (viii) accept-reject criteria (Code reference);
 - (ix) performance evaluation;
 - (x) Operator identification.
- (b) The system shall be aided with an image processor to enhance the quality of the radioscopy images and system performance quality shall exhibit-
 - (i) a thin section contrast sensitivity of 3%;
 - (ii) a thick section contrast sensitivity of 2%;
 - (iii) a spatial resolution of 3 line pairs per mm;
 - (iv) IQI sensitivity - 2% of the joint thickness when wire IQI's are to be used, the wire diameter axis shall be oriented along the axis of the least sensitivity of the system.
- (c) Radioscopes are to be properly marked to co-relate with particular part of joint represented.
- (d) The radioscopy examination data shall be recorded and stored on videotape, magnetic disk or optical disk or any other electronic media at the maker's plant for a sufficient period after the date of radioscopy examination as specified by the Inspecting Authority, Efficient radioscopy examination record recall shall be made available at any time over the record retention period and shall be traceable to the test objects.
- (e) When repair has been performed as a result of radioscopy examination, the repaired areas shall be re-examined using the same radioscopy technique to evaluate the effectiveness of the repair.
- (f) To aid in proper interpretation of the radioscopy examination data, the details of the technique used shall accompany the data. As a minimum, the

information shall include the approved procedure requirements and system performance test data.

PART-8

444. Test for class II boilers.— (1) Test pieces shall be selected from each longitudinal seam for the following tests and stamped by the Competent Person for identification.

- (i) From the test plate or plates:
- (ii) One tensile test specimen for welded seam.
- (iii) One bend test specimen.
- (iv) One reverse bend test specimen.
- (v) One nick-break test specimen.

(2) The disposition of the specimen shall be in accordance with the sketches in Figure 12/79. The remainder of each test plate shall be retained for retests, if required.

445. Tensile test.— The dimensions of the test specimen shall be in accordance with the sketch in Figure 12/73: Specimen 1A, and the specimen shall be cut out transversely to the welded seam. When the capacity of the available testing machine does not allow full specimen to be tested, two narrower tensile specimens shall be substituted. These specimens shall be the full thickness of the plate at the welded joint and their breadth shall be as great as the testing machine will reasonably allow, provided the effective cross sectional area of the test piece is not less than 968 mm² (see Figure 12/74: specimen 1B). The tensile strength of the welded joint specimen shall not be less than the lower limit specified for the plate.

446. Cold bend tests.— (1) Two bend tests shall be made as given in this regulation.

- (2) One specimen shall be tested with outer surface of the weld in tension, and the other with the inner surface in tension. The specimens shall be rectangular in section and shall be cut out transversely to the weld so as to have a width not less than one-and-a-half times the thickness of the plate. The sharp corners of the specimens shall be rounded to a radius not exceeding 10 percent of the thickness of the specimen.
- (3) The specimen to be tested with the outer surface of the weld in tension shall be prepared by cutting to waste the metal local to the inner surface of the weld, so that the desired specimen thickness is obtained (see A, Figure 12/78). The specimen to be tested with inner surface in tension shall be prepared by cutting to waste the metal local to the outer surface of the weld so that the desired specimen thickness is obtained (see B, Figure 12/78). Where the thickness of the plate permits, both specimens may be cut from the same piece of plate, the specimens being located in the plate one above the other (See C, Figure 12/78).
- (4) Each specimen shall be mounted with the weld midway between the supports set apart at a distance of not more than 5.2 times the thickness of the specimen and pushed through the supports with a former having a diameter equal to three times the thickness of the specimen.
- (5) On completion of the test, no crack or defect at the outer surface of the specimen shall be greater than 1.6 mm measured across the specimen, or 3 mm measured along the length of the specimen. Premature failure at corners of the specimen shall not be considered cause for rejection.

447. Nick-break specimen .— (1) This specimen shall have a width not less than one and a half times its thickness and the slot shall be cut in each side of the specimen through the centre of the weld and perpendicular to the outer face of the boiler.

(2) The specimen shall then be broken in the weld and the fracture shall reveal a sound homogenous weld substantially free from slag inclusions, porosity and coarse crystallinity.

448. Additional tests before rejection.— In case any of the test specimens fails, two retests shall be made and both shall meet the specified requirements.

449. Specimen after tests.— If required, specimens after tests shall be at the disposal of the Inspecting Authority for examination.

450. Radiographic or ultrasonic examination.— Each longitudinal and circumferential seams in class II boiler (including shell to end plate) shall be subjected to spot radiographic or ultrasonic examination.

PART-9

451. Test for Class III boilers.— Specimens for the following tests shall be selected from the test plate or plates and stamped by the Competent Person for identification.

(i) One forward bend test.

(ii) One reverse bend test.

452. Radiographic or ultrasonic examination.— Each longitudinal and circumferential seams in class III boiler (including shell to end plate) shall be subjected to spot radiographic or ultrasonic examination.

PART-10

453. Heat treatment.— All boilers constructed to Class I or Class II requirements shall be stress-relieved by heat treatment after completion of all welding and before hydraulic test as per regulation 123.

454. Classification of fusion-welded boilers.— The boilers covered by this chapter shall be classified in accordance with Table 12/4.

TABLE 12/4: Classification of fusion-welded boilers

Serial number	Classification	Limits of application	Minimum thickness
(1)	(2)	(3)	(4)
1	Class I	No limit	8 mm
2	Class II	When the following limits are not exceeded: (a) Maximum Allowable Working pressure 7 kg/cm ² . (b) Maximum Allowable Working pressure in kg/cm ² multiplied by internal diameter in cm – 940	Boilers upto and including 915 mm internal diameter 8 mm.
3	Class III	When the following Limits are not exceeded: (a) Maximum Allowable Working pressure 2 kg/cm ² . (b) Maximum Allowable Working pressure in kg/cm ² multiplied by internal diameter in cm – 535	Boiler over 915 mm internal diameter 10 mm.

455. Shells.— (1) The Maximum Allowable working pressure of cylindrical shells for Class I boilers shall be determined in accordance with regulations 169 and 170.

(2) (a) The Maximum allowable working pressure of cylindrical shells for Class II and Class III boilers shall be determined by the following formula:

$$P = \frac{(T-1.5) SC}{0.7 D} \quad \text{Equation (12/1)}$$

Where,

- T = is minimum thickness of shell plate in mm,
P = is Maximum Allowable working pressure in kg/cm²,
D = is maximum internal diameter in mm,
S = is minimum tensile strength of plate in kg/mm²,
C = is a constant, as given below.

(b) In no case, however, shall be the factor of safety of shell be less than 4 or the plate thickness be less than specified in Table 12/4 given under regulation 454,

C=27, where Class II requirements are complied with,

C=23, for Class III boilers when stress relieved,

C=21, for Class III boilers when no stress relieved.

(3) Where boilers have a nest of horizontal tubes, so that there is a direct tension on the tube plates during the vertical load on the boiler ends or to tube plate acting as horizontal ties across the shell:

(a) Each alternate tube in the outer vertical row tubes shall be a stay tube;

(b) The thickness of the tube plates and the pack of the tubes shall be such that the section metal taking the load is sufficient to keep stress within that allowed on the shell plate determined by the following formula:

$$P = \frac{(T-2) SJ}{2D} \quad \text{Equation (12/2)}$$

Where,

- T = is thickness of the tube plate in mm,
P = is Maximum Allowable working pressure in kg/cm²,
S = is the minimum tensile strength in kg/mm²,
D = is twice the radial distance of the centre of outer row of tube holes from the axis of the shell in mm,
J = is the percentage strength of the plate through the tube holes, i.e.

$$J = \frac{100 (p-d)}{P} \quad \text{Equation (12/3)}$$

- p = is the vertical pitch of tubes in mm,
d = is the diameter of the tube holes in mm.

Note: The tube plates between the stay tubes shall come with the requirements for tube plates (see regulation 469).

456. Horizontal shelves of tube plates forming part of the Shell.—(1) The number of gusset required to support the horizontal shelves of tube plates to withstand vertical load due to the pressure on the boiler end shall be determined in the following manner:

(a) For combustion chamber tube plates, the minimum number of the gussets shall be:-

Where C exceeds 4560	1 gusset.
Where C exceeds 6240	2 gussets.
Where C exceeds 7440	3 gussets.

(b) For smoke box tube plate, the minimum number of gussets shall be:-

Where C exceeds 4560	1 gusset.
Where C exceeds 8400	2 gussets.

$$\text{And } C = \frac{PAD}{t} \quad \text{Equation. (12/4)}$$

Where,

- A = is maximum horizontal dimension of the shell from the inside of the shell plate to the outside of the tube plate in inches (See Figure 12/75),
D = is inside diameter of the boiler in inches,
P = is Maximum Allowable working pressure in pounds per square inch,
t = is thickness of tube plate in thirty-seconds of an inch.

(2) The shell plates to which the sides of the tube plates are connected shall be not less than 1.5 mm thicker than is required by the formula applicable to shell plates with continuous circularity; and where gussets or other stays are not fitted to the shelves, the strength of the parts of the circumferential seams at the top and bottom of these plates from the outside of one tube plate to the outside of the other, shall be sufficient to withstand the whole load on the boiler end, with a factor of safety of not less than 4.5.

457. Dished end plates for Lancashire and Cornish boilers.— (1) For the dished ends of Lancashire and Cornish boilers without stays and subject to internal pressure, the maximum allowable working pressure shall be determined by the following formula:

$$P = \frac{(32 \ t - 203.2) \ S}{R (67.35617)} \quad \text{Equation (12/5)}$$

Where,

- t = is minimum thickness of the end plate in mm,
P = is maximum allowable working pressure in kg/cm²(g),
R = is the inner radius of curvature of the end plate in mm,
S = is minimum tensile strength of the plate in kg/cm².

- (2) The inner radius of curvature of the end plate shall not exceed $1\frac{1}{2}$ times the external diameter of the shell which it is attached.
- (3) The inner radius of flanging of the end plate shall be not less than 4 times the thickness of the plate but in no case less than 63 mm.
- (4) Where the end plate has a manhole, compensation shall be obtained by flanging the edge of the opening or by providing a fabricated ring (see Figure 12/65).
- (5) In either case the depth of the flanging or ring measured at the minor axis shall not be less than that determined by the following formula:

$$D = \sqrt{TW} \quad \text{Equation (12/6)}$$

Where,

D = is depth of Flange or ring in mm measured from the outside of the plate to the joint face,

T = is thickness of the plate in mm,

W = is width of the opening in mm measured on the minor axis.

458. Dished Ends subject to internal pressure.— (1) For unstayed ends of shells and tops of vertical boilers and the like boiler parts, when dished to partial spherical form the maximum allowable working pressure shall be determined by the following formula:

$$P = \frac{0.216 \ S(t-0.79)}{R} \quad \text{Equation (12/7)}$$

Where,

P = is the maximum allowable working pressure in kg/cm²(g),

t = is the thickness of the end plate in mm but in no case this shall be less than the thickness of the shell to which it is attached,

R = is the inner radius of curvature of the end in mm, which shall not exceed the external diameter of the shell to which it is attached,

S = is the minimum tensile breaking strength of plate in kg/cm², or whatever is allowed for it.

- (2) The inside radius to which a crown plate is dished shall be not greater than the external diameter of the cylinder to which it is attached.
- (3) The inside radius of curvature of the flanges to the shell shall be not less than 4 times the thickness of the crown plate and in no case less than 63 mm.
- (4) The inside radius of curvature of flanges shall be not less than twice the thickness of the crown plate and in no case less than 25 mm.
- (5) When the end has a manhole in it (t-3.97), shall be substituted for (t-0.79) in the formula.
- (6) The total depth of flange of manhole from the outer surface measured on the minor axis shall be at least equal to -

$$\sqrt{(T \times W)} \text{ depth of flange in mm.} \quad \text{Equation (12/8)}$$

Where T is the thickness of the plate in mm and W is the minor axis of the hole in mm.

- (7) The depth of the crown plate opening from the commencement of the curvature of the flanging radius shall be not less than twice the plate thickness with a minimum of 25 mm.

459. Nothing in regulation 458 shall preclude the use of dished ends in compliance with regulations 174 to 177, where not fitted with an uptake.

460. Dished Ends subject to external pressure.— (1) In the case of unstayed dished ends, for the co-efficient 0.216 in equation 12/7, the co-efficient 0.173 shall be substituted, and R shall be the outer radius of the curvature of plate, which shall not exceed the external diameter of the shell to which it is attached.

- (2) For plates exposed to furnace-flame, the co-efficient shall be 0.151.
- (3) In no case shall R/t exceed 2.75.
- (4) The inside radius of curvature at the flange shall be not less than 4 times the thickness of the end plate and in no case less than 63 mm.
- (5) The inside radius of the curvature of the flange to uptake shall be not less than twice the thickness of the crown plate and in no case less than 25 mm.

461. Hemispherical Crowns.— (1) The maximum allowable working pressure for hemispherical crowns subjected to internal pressure shall be determined by the following formula:

$$P = \frac{(t - 1.5875) S \times C}{R} \quad \text{Equation (12/9)}$$

Where,

- t = is thickness of plate in mm,
- P = is the maximum allowable working pressure in kg/cm²(g),
- R = is inner radius of curvature in mm,
- S = is minimum tensile strength of the plate in kg/cm²,
- C = is a constant, as given in sub-regulation (2).

(2) In no case, however, shall the factor of safety to the crown plate be less than 4, nor the plate thickness be less than specified in Table 12/4 given under regulation 454.

- C = 0.4608 where Class-1 requirements are compiled with,
- C = 0.3888 where Class-2 requirements are compiled with,
- C = 0.3312 for Class-3 boilers when stress relieved,
- C = 0.3024 for Class-3 boilers when stress relieved.

462. Manholes and other openings in Shells.— Requirements of regulation 139 shall apply.

463.Compensation for openings in Shells.— (1) Where the width of any opening (measured in a direction parallel to the longitudinal axis of the boiler) exceeds two-and-a half times the thickness of the shell plate in mm plus 70 mm, compensation shall be provided.

- (2) The area to be compensated shall be the product of the maximum width of the opening cut in the shell (measured in a direction parallel to the longitudinal axis of the boiler) and the thickness of an unpierced seamless shell of similar material. For Class I boiler, thickness will be determined in accordance with regulations 169 and 170. For Class II & Class III boiler by Equation 12/1, with constant C = 35 for the same maximum allowable working pressure.
- (3) Compensating Area shall be considered adequate when the sum of the following area is not less than the area to be compensated:
 - (a) The area obtained by multiplying the difference the actual thickness of the shell and the thickness required for an equivalent unpierced seamless shell by a length $2(75 \text{ mm} + T_s)$, where T_s is the actual thickness of the shell plate in mm.
 - (b) The net cross-sectional area of the frame or pad, or in the case of a branch or manhole, head hole ring, the cross-sectional area of the wall of the branch or manhole, head hole ring minus the sectional area of a branch or manhole, head hole ring of the same bore having thickness equal to that calculated in accordance with regulations 169 and 170, plus the thickness required to withstand external loads. The area shall be measured within limits such that (a+b) in Figure 12/80 does not exceed 100 mm.
 - (c) For Manhole & Head hole rings of Oval shape diameter to be taken in calculation is to be calculated from formula below

$$D = a^2 / b$$

Where,

a is major axis of Oval frame in mm.

b is minor axis of Oval frame in mm.

- (d) Where material of a frame, pad or branch has a tensile strength which differs from that of the shell to which it is attached, the compensating area shall be multiplied by the ratio:

$$\frac{\text{Tensile strength of compensating part}}{\text{Tensile strength of shell plate}}$$

- (e) The cross-sectional areas of the welding fillets.
- (4) (a) In cases where the sum of (a), (b) and (e) in sub-regulation (3) is less than the area to be compensated, a compensating plate shall be welded to the shell, its total cross-sectional area being equal to the amount of the deficit and due allowance being made as above when the tensile strength of the material of the plate differs from that of the shell.
- (b) The compensating plate may be fitted on the inside or outside of the shell plate as most convenient and its diameter shall not exceed twice the longitudinal width of the opening in the shell.

(5) (a) Figure 12/80 shows a welded branch to which foregoing requirements apply where:

- W = is width of the opening in the shell in mm,
 T_s = is actual thickness of shell in mm,
 T_1 = is thickness of an equivalent unpierced seamless shell as given in regulation sub-regulation (2),
 T_n = is actual thickness of branch in mm,
 T_2 = is minimum thickness body of branch given in regulation 463(3)(b),
 T_3 = is thickness required to withstand external loads in mm = 3 mm unless the loading is known to be such as to require a greater thickness and is=0 where there is no external loading,
 T_c = is minimum thickness of compensating plate in mm,
 S_1 = is minimum tensile strength of shell plate in kg/cm²,
 S_2 = is minimum tensile strength of branch in kg/cm²,
 S_3 = is minimum tensile strength of compensating plate in kg/cm²,
 W = is width of compensating plate in mm measured in the same plate as the shell opening.

(b) AREA TO BE COMPENSATED

$$A = W \times T_1$$

(c) Portion of shell available for compensation:

$$B = 2(75 + T_s) (T_s - T_1)$$

(d) Portion of branch available for compensation:

$$C = 2 (100 + T_s) [T_n - (T_2 + T_3)] \frac{S_2}{S_1}$$

(e) Portion of welds available for compensation:

D = Total cross-sectional area of the internal and external welding fillets.

If A is greater than $(B+C+D)$, additional compensation is required to make up the difference. In the example shown in Figure 12/80 this is provided by means of a compensating plate, the total compensating area being such that $(B+C+D) + Z$ is not less than A where:

$$Z = 2 \times W \times T_c \times \frac{S_3}{S_1}$$

464. Raised manhole frames, cover plates and joint bolts.— Requirements of regulation 138 shall apply.

465. Standpipes and branches.— (1) The thickness and bolting of all flanges for joining the mountings and fittings shall be in accordance with the dimensions as laid down in Appendix-F to these regulations. In no case, however, shall the thickness of flanges be less than 13 mm. Flanges conforming to International codes and standards such as ASME, BS, EN, DIN can be used meeting required pressure and temperature ratings.

(2) (a) The wall thickness of nozzles and other connections shall not be less than that specified for the applicable loading, namely, internal pressure, bending and static loads.

(b) The pressure loading shall be determined by regulation 455, but in no case shall the thickness be less than that calculated by the following formula:

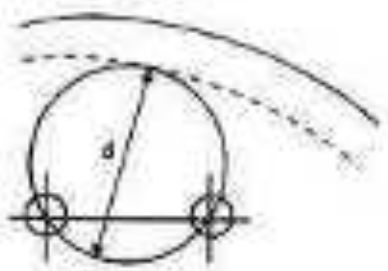
$$t = 0.04D + 2.5 \text{ mm} \quad \text{Equation (12/10)}$$

Where t is the thickness of standpipe and 'D' is the outside diameter of connection. If the branch is connected by screwing, the thickness 't' shall be measured at the root of the thread.

- (3) Where a double flanged steam pipe is tapered, the thickness of flange joining the boiler and fitting shall correspond to the bore of pipe at the flange connection in accordance with Appendix-F to these regulations.

466. Stayed flat surfaces (other than crowns of vertical boilers).— For various braced and stayed flat plates and those which by these regulations require staying as flat surfaces with braces or stay bolts of uniform diameter symmetrically spaced, the thickness shall be calculated by the following formula; namely:-

$$e = Cd \sqrt{\frac{P}{f_1} + e_1} \quad \text{Equation (12/11)}$$



Where,

P = maximum allowable working pressure in kgf / cm^2 ,

e = thickness, in mm,

d = diameter of the largest circle taken between staying points of the plate (in mm),

f_1 = $0.85 f$ (' f ' as defined in regulation 169), kgf/cm^2 ,

e_1 = additional thickness equal to 0.75 mm,

C = coefficient having values given in table 12/5 below, depending upon the form or method of support adopted.

Table 12/5

S. No	Component	Value for 'C'
(1)	(2)	(3)
1	Flanged End Plate	0.32
2	Flat end plates welded to shell from both sides, with following end plate thickness to shell plate thickness ratios	
	≤ 1.4	0.33
	$> 1.4 \leq 1.6$	0.36
	$> 1.6 \leq 1.8$	0.39
	$> 1.8 \leq 2.0$	0.42

3	Plain Furnace Less than or equal to 6.5 meters long	0.3
4	Corrugated furnace with corrugation depths ≤ 50 mm	0.32
5	Corrugated furnace with corrugation depths > 50 mm with a length ≤ 6 meter with a length > 6 meter	0.35 0.37
6	Bowling hoop furnace	0.35
7	Access ring welded from both sides	0.3
8	Access ring welded from one side only	0.45
9	Gusset or Link stays	0.3
10	Stay tube in tube nest	0.39
11	Isolated stay tube	0.45
12	Stay bar in group	0.39
13	Isolated stay bar	0.45

Notes:

- For Flanged end plates, the diameter of largest circle shall be taken from the commencement of the curvature of flange.
- When largest circle is arrived with different types of supports as mentioned above, average value of 'C' shall be taken for calculation.
- If the plate is Flame swept, the thickness shall be increased by 10%.
- The welding material used in the manufacture of these plates shall not have the ultimate tensile strength less than that of the plate used.

467. Flat crown plates for vertical boilers.— (1) Flat crown plates shall be supported by the uptake and/or bar stays.

- The inside radius of curvature of the flange to the shell or fire box shall be not less than four times the thickness of the plate and in no case less than 63 mm where the plate is flanged for attachment to the uptake, the inside radius of curvature of the flange shall be not less than twice the thickness of the plate and in no case less than 25 mm.

- The thickness of flat crown plates shall be determined in accordance with regulation 466.

468. Wide water spaces between and around tube nests.— The thickness of plate at wide water spaces shall be calculated as per regulation 466 taking

$$d = \sqrt{A^2 + B^2}$$

Where,

A = is width of the wide water space between the tube nests in mm measured from centre to centre of the tubes; and

B = is pitch of the tubes in the boundary rows of the wide water space in mm.

469. Flat tube plates and tubes nests.— (1) Stay tubes are tubes having a weld depth equal to the nominal tube thickness plus 3 mm as shown typically in figures 12/84(i) to (iv). These stay tubes are not required within tube nests except when the tube nests comprise tubes which are expanded only as shown typically in figure 12/82(iii).

- If tube nests comprise plain tubes which are expanded and beaded, expanded and belled as shown typically in figure 12/82(iv) or expanded and welded (as shown typically in figures 12/82(i) and (ii), welded stay tubes [as shown typically in figures 12/82 (i) to (iv)] shall be used in boundary rows in sufficient numbers to carry the flat plate loadings outside the tube area.

- (3) For plain tubes and stay tubes exposed to flame or gas temperatures exceeding 600°C, the ends of welded tubes shall be dressed flush with the welds and the ends of the expanded tubes shall be as shown in figures 12/82(iii) and (iv). If not so exposed, the ends of welded tubes shall extend a maximum of 10 mm beyond the weld or, in the case of expanded tubes, the tubes shall project beyond the tube plate up to a maximum of 15 mm.
- (4) Each stay tube shall be designed to carry its due proportion of the load on the plates which it supports. The thickness of stay tubes welded into tube plates shall be such that the axial stress on the thinnest part of the tube does not exceed 7.14 kg/mm².
- (5) If stay tubes are used within tubes nests, the thickness of the tube plate shall be calculated in accordance with regulation 466.

470. Manhole openings in flat plates.—(1) Where manholes are located in flat plates, the openings shall be suitably compensated.

(2) Compensation shall be obtained by flanging the edge of the opening, or by providing a fabricating ring (see Figures 12/65, 12/66, 12/67, 12/68 and 12/69).

- (3) The manhole in the lower portion of the flat front end plates shall be fitted with a flanged strengthening ring, the thickness of the flat portion of which shall be not less than $(1.5 T + 3 \text{ mm})$,

where, T = the thickness of the end plate in mm, and in boilers of 2280 mm and over, the manhole frame shall be fitted with a peak to reinforce the portion of the end plate between and below the furnaces and this peak shall be securely welded thereto.

- (4) In all cases the depth of the flanging or ring shall not be less than that determined by Equation 12/6.

Note: Where the manhole is located in or between tube nests in Multi-tubular boilers or below the furnaces of other Boilers, the stay tubes in the boundary rows, or the gusset stays, as applicable, shall be arranged as closely as practicable to the manhole.

471. Plain Tubes.—(1) Plain tubes may be welded at both ends, welded at the inlet and expanded at the outlet end, or expanded at both ends. Where the tubes are expanded only, the process shall be carried out with expanders having parallel rollers, and the expanded portion of the tube shall be parallel through the full thickness of the tube plate. In addition of expanding tubes may be bell-mouthed or beaded at the inlet end. Where the tube is welded to the tube plate, the tube should be lightly expanded to grip the tubes hole before welding.

- (2) The thickness of tubes under external pressure shall be calculated as under:

$$T = \frac{P'D}{1.6f} + C \quad \text{Equation (12/12)}$$

Where,

t = minimum thickness of tube in mm,

P' = External maximum allowable working pressure in kg/cm² (g),

D = Outside tube diameter in mm,

C = Corrosion allowance to be taken as 0.75 mm but for stainless steel C = 0.

Higher value may be adopted if desired by user.

f = allowable stress as per regulation 244.

- (3) In no case, the thickness of straight tubes under external pressure shall be less than as specified below:

Table 12/6

Serial number	Tube outside diameter (mm)	Minimum thickness (mm)
(1)	(2)	(3)
1	Not exceeding 32	2.10
2	Exceeding 32 but not exceeding 39	2.28
3	Exceeding 39 but not exceeding 51	2.81
4	Exceeding 51 but not exceeding 70	3.12
5	Exceeding 70 but not exceeding 77	3.38
6	Exceeding 77 but not exceeding 89	3.96
7	Exceeding 89 but not exceeding 102	4.26

- (4) The thickness of tubes under internal pressure shall be calculated as under:

$$t = \frac{P.D}{P + 2f} + C \quad \text{Equation (12/13)}$$

Where,

P = Internal maximum allowable working pressure, kg/cm² (g), and other symbols as per clarifications indicated at sub-regulation (2) above.

- (5) In no case, the thickness of straight tubes under internal pressure shall be less than as listed below in Table 12/7:

Table 12/7

Serial number	Tube outside diameter (mm)	Minimum thickness (mm)
(1)	(1)	(2)
1	Not exceeding 39	1.75
2	Exceeding 39 but not exceeding 51	2.16
3	Exceeding 51 but not exceeding 70	2.40
4	Exceeding 70 but not exceeding 77	2.60
5	Exceeding 77 but not exceeding 96	3.05
6	Exceeding 96 but not exceeding 102	3.28
7	Exceeding 102 but not exceeding 127	3.50

472. Pitch of Tubes.— The spacing of tube holes shall be calculated as per either of the methods given below:

- (i) The spacing of tube holes shall be calculated such that the minimum width (in mm) of any ligament between the tube holes shall be not less than:

$$\frac{D}{8} + 12.7$$

Where D is diameter of tube hole in mm.

- (ii) The thickness and cross-section of the plate between the tube holes shall be not less than:

$$0.125D + 5.08 = \text{minimum thickness in mm,}$$

$$4.318D + 16.13 = \text{minimum cross-section in mm}^2,$$

- (iii) Spacing of tube hole = minimum cross-section in square mm / provided tube plate thickness.

Where, D is diameter of the tube hole in mm.

In no case shall the minimum thickness of any tube plate in the tube area be less than following limits:

T = 13 mm, where the diameter of the tube hole does not exceed 51 mm.

T = 14 mm, where the diameter of the tube hole is greater than 51 mm.

473. Stay Tubes.— (1) Stay tubes shall be of seamless steel or electrically resistance welded steel.

- (2) The minimum thickness of stay tubes shall be as per regulation 119.
- (3) The maximum allowable working pressure for screwed in stay tube shall be calculated by the following formula:

$$P = \frac{414.81108}{A} \left[\left(D - \frac{1.28}{N} \right)^2 - D_1^2 \right] \quad \text{Equation (12/14)}$$

Where,

- P is maximum allowable working pressure in kg/cm² (g)
- D is diameter of the stay tube over threads in mm.
- D₁ is internal diameter of the tubes under the threads in mm.
- N is number of threads per mm.
- A is the area in square mm supported by one Stay tube, measured from centre to centre of stay tubes. When the area contains tubes or parts of tubes their aggregate area, calculated from their smallest external diameter of body when in tension and smallest internal diameter when in compression, shall be deducted from the area of the containing figure and the remainder used as A in the formula.

- (4) Where stay tubes have their thickness increased at the screwed ends to provide for plus threads, the increased thickness shall be obtained by upsetting and not by welding, and the tubes shall be subsequently annealed.
- (5) Stay tubes may be attached to the tube plates either by screwing or by metal arc welding.
- (6) Where stay tubes are screwed into the tube plates, they shall be screwed with a continuous thread not finer than 4 threads per centimeter at both ends and shall be expanded into the tube plates, by roller expander and, if desired, may be seal welded.
- (7) Welded attachment of stay tubes be as shown in Figures 12/81, 12/82, 12/83, 12/84 and 12/85.

474. Compression of Tube Plates.— (1) For fire-box or combustion chamber tube plates which are subject to compression due to the pressure on the roof plate, the maximum allowable working pressure shall be:

$$P = \frac{C (p-D) 32 t}{L p} \quad \text{Equation (12/15)}$$

Where,

t is thickness of the tube plate in mm.

p is pitch of the tubes in mm, measured horizontally where the tubes are chain pitched or diagonally where the tubes are zigzag pitched and the diagonal pitch is less than the horizontal.

D is internal diameter of the plain tubes in mm.

L is internal length of the fire-box or combustion chamber in mm measured at top between tube plate and Firehole plate or back plate, or between tube plates in double ended boilers with combustion chambers common to two opposite furnaces.

C = 61.16706

Provided that the above formula shall not apply in the cases of fire-boxes where the girders do not rest on the tube plate, or where the roof plate is stayed direct to the outer shell or to girders supported by the shell.

(2) Where girders rest on the side plates or the roof plate is so formed that the load is carried both by side and end plates, the compressive stress on the plates shall not in either case exceed 984 kg/cm².

475. Girders for fire-box and combustion chamber crowns.—(1) For girders supporting crown plates of rectangular fire-boxes, where the ends of the girders are supported by the vertical end or side plates, their proportions shall be calculated by the following formula:

$$P = \frac{CSTd^2}{L^2Y} \quad \text{Equation (12/16)}$$

Where,

P is maximum allowable working pressure in kg/cm² (g)

S is Minimum tensile stress of the material in kg/cm²,

T is Total thickness of the stay in mm.

d is Depth of the girder stay in mm,

L is Length of girder stay in mm measured between the inside of the tube plate and the fire-hole plate, or between the inside of the side plates, according to the method of support.

Y is Pitch of girder stays in mm.

C = 0.352 for steel plates or steel forgings,
= 0.304 for steel castings.

(2) Where girders are welded to the crown plate the dimensions of the welds shall be such that the stress calculated on an area equal to the sum of the effective lengths of the welds attaching each girder multiplied by the effective throat thickness shall not exceed 527 kg/cm² multiplied by the appropriate weld factor in Table 12/13, ("effective length" and "effective throat thickness" are defined in regulation 486. The load on the welds shall be taken as that due to the maximum allowable working pressure acting on the area 'LY', 'L' and 'Y' being as defined in this regulation.

476. Girder sling stays.— For slung girders, the proportion in slings, links, pins and connections to the shell shall be sufficient to carry the whole load that would otherwise be carried on the toes of the girders and for any of the above parts in tension a stress of 633 kg/cm² of net section, and for parts in shear a stress of 562 kg/cm² of net section shall not be exceeded. In the case of parts in double shear, the net area of the section should be taken as 1.875 times the single section.

477. Stays for fire boxes and circular furnaces.— (1) For solid crew stays to combustion chambers and fire-boxes and for longitudinal and cross Stays, the maximum allowable working pressure for the stays is to be calculated from the appropriate one of the following formulae:

$$P = \frac{C}{A} \left(\frac{1.28 D}{N} \right)^2 \quad \text{Equation (12/17)}$$

$$P = \frac{C \times D_1^2}{A} \quad \text{Equation (12/18)}$$

Where,

P = is the maximum allowable working pressure in kg/cm²,

D = is diameter of stays over threads in mm,

D₁ = is diameter of body of stay at its smallest part in mm,

N = is number of threads of stay per mm,

A = is area in square mm supported by one stay for area to be supported by stays near tubes in fire-box tube plates of Loco-type boilers,

C = 499.17943 for steel or special wrought iron screw stays to combustion chamber or fire-boxes,

C = 607.45216 for steel longitudinal or cross stays fitted with nuts,

= 330.44272 for copper stays.

(2) Where stays are made with enlarged ends and the body of the stay is smaller in diameter than at the bottom of the thread, the maximum allowable working pressure shall be calculated from the second Equation (12/18).

(3) In case of circumferential stay for circular furnaces and fire-boxes, the diameter of stay shall not be less than 19 mm or twice the thickness of the fire-box plate, whichever is greater. In the case of screwed threads the diameter shall be measured over the threads. The pitch of the stays at the fire-box shall not exceed 14 times the thickness of the fire-box plate.

478. Fire-box crown stays for Loco-type boilers.—(1) Where fire-box crown stays are directly attached to a semi-cylindrical outer casing, and the fire-box top is chambered and fitted with stays arranged as shown in Figure 12/94, the thickness of the outer casing shall be sufficient to provide not less than three engaging threads, of which not less than one shall be full thread in stays not normal to the stayed surface, but if the thickness of the plate is not sufficient to give one engaging full thread, the plate shall be reinforced.

(2) Where vertical stays only are used to take part of the load on the fire box top, boilers with shells 1370 mm diameter and over shall be fitted with transverse stays (see Figures 12/95. Stays may be attached as shown in Figures 12/47, 12/48 and 12/49.

479. Longitudinal bar stays.— (1) The maximum allowable working pressure for longitudinal bar stays shall be calculated from the one appropriate formula out of the following two formulae:

$$P = \frac{C}{A} \left(D - \frac{1.28}{N} \right)^2 \quad \text{Equation (12/19)}$$

$$P = \frac{C \times D_1^2}{A} \quad \text{Equation (12/20)}$$

Where,

P = is maximum allowable working pressure in kg/cm² (g),

D = is diameter of stays over threads in mm,

D₁ = is diameter of a body of stays at its smallest part in mm,

N = is the number of threads of stay per mm,

A = is area in square mm supported by one stay,

C = is values given in Table 12/8 below.

TABLE 12/8: Stress on Longitudinal Bar Stays

Serial number	Range of Tensile strength of bar (kg/cm ²)	Value of C (kg/cm ²)
(1)	(2)	(3)
1	3656 - 4218	551.90966
2	3937- 4500	607.45216
3	4218 - 4781	655.26089
4	4500 - 5062	717.13102

(2) Where bar stays are fitted in vertical boilers, not less than four bar stays shall be fitted to boilers of 1200 mm and over but under 1500 mm in diameter; five bar stays to boilers of 1500 mm and over but under 1800 mm in diameter; six bar stays to boilers of 1829 mm and over in diameter.

(3) In no case, shall the diameter of the stay at any part be less than 25 mm. Where joined stays are fitted, the strength of the knuckle joint employed shall be at least equal to the strength of the remainder of the bar stay.

480. Loads on stay tubes and bar stays.— Requirements of regulation 121 shall apply.

481. Flat plate margins.— (1) The amount of support in relief of the stays which may be attributed to the shell, furnaces or flues to which flat plates are attached, shall not exceed that determined by the following formulae:

$$\text{Width of margin in mm} = \frac{C (32 t - 25.4)}{\sqrt{P}} \quad \text{Equation (12/21)}$$

Where,

t is plate thickness in mm

P is maximum allowable working pressure in kg/cm² (g)

C = 0.92008 for plates exposed to flame.

C = 0.98107 for plates not exposed to flame.

- (2) Where the plates are flanged, the margin shall be measured from the commencement of curvature of flanging, or from a line 3½ times the thickness of the plate measured from the outside of the plate, whichever is nearer to the flange. Where the flat plate is not flanged for attachment to the shell or flue tubes and is welded as shown in figured 12/12 or 12/17, the width of the margin shall be measured from the inside of the shell or the outside of the flue tube, whichever is applicable.

- (3) In no case, however, shall the diameter 'D' of the circle forming the boundary of the margin supported by the uptake of a vertical boiler be greater than that found by the following formula:

$$D = \sqrt{\frac{0.54488 A}{P} + \frac{d^2}{645.12}} \quad \text{Equation (12/22)}$$

Where,

A is cross sectional area of the uptake tube in square mm,

P is maximum allowable working pressure in kg/cm² (g),

d is external diameter of uptake in mm.

PART-11

482. Breathing space.— Breathing spaces as provided in regulations 483,484 or 485 shall be provided depending on the design of the boiler with special attention to the provision of sub-regulation (9) of regulation 407 regarding furnaces.

483. For boilers as per clause (a) of sub-regulation (9) of regulation 407.—

- (1) Stays shall be arranged to give sufficient breathing space around the furnace connections and tube nests (see figure 12/91 and 12/93), and shall divide the unstayed areas equally.
- (2) (a) In case of multi-tubular boilers, for both front and rear attachment of furnaces, the breathing spaces between furnace and tube nests or between furnace and shell shall be minimum of 50 mm or 5% of the shell inside diameter, whichever is larger, with a maximum requirement of 100 mm.
- (b) Clearances between the furnace and wet-back wrapper plates shall not require consideration as breathing spaces.
- (c) In the case of reverse flame boilers, the breathing space at the front end between furnace and the tube nests shall be not less than 50 mm and the breathing space formed by the outer-annular area of the furnace rear plate shall be not less than 50 mm or 5% of the shell inside diameter, whichever is larger, with a maximum of 100 mm.
- (d) Breathing spaces between gusset or link stays and tube ends shall be not less than 100 mm. Clearances between the tubes and wet-back wrapper plates shall not require consideration as breathing spaces.
- (e) Breathing spaces between tubes and shell shall not be less than 40 mm.
- (f) Breathing spaces between gusset or link stays and furnaces shall be not less than 200 mm except that for shell outside diameters exceeding 1800 mm and furnace length exceeding 6000 mm they

shall be not less than 250 mm and for shell outside diameter less than 1400 mm and furnace lengths less than 3000 mm they shall be not less than 150 mm.

- (g) All other breathing spaces shall be a minimum of 50 mm or 3% of the shell inside diameter, whichever is larger, with a maximum requirement of 100 mm.
- (3) (a) For Cornish and Lancashire boilers, the circle defining the breathing spaces shall be as shown in Figure 12/89i.e. the distance 'AB' between the centre of the stay circle and the centre of the flue shall be not less than $3e+63$, where, 'e' is the thickness of the endplate in mm.

Note: For Lancashire boilers, the proportions shown in Table 12/9 given below are recommended for the portion of the end plates above the furnace and flues.

TABLE 12/9: Breathing Space for Lancashire Boilers

Thickness of end plate (in mm)	13	14	16	18	20	Over 20
Breathing space (in mm) (see Figure 12/70)	255	280	305	330	330	340

- (b) It is recommended that the breathing space below the flue be approximately one-half of the dimensions given in Table 12/9.

484. For boilers as per clause (d) of sub-regulation (9) of regulation 407.— (1) Stays shall give breathing spaces around the furnace connections and tube nests (see Figures 12/86 to 12/93, 12/96, 12/97, 12/98, 12/99 and 12/100) and equally divide the unstayed areas. Breathing spaces between furnace and tube nests shall be a minimum of 50 mm or 5% of the shell outside diameter, whichever is larger, but need not be more than 100 mm.

- (2) Breathing spaces between furnace and shells shall be as given in Table 12/9 or 12/10 as applicable, but shall be not less than 50 mm or, for bowling hoop furnace, not less than 75 mm as measured from the outside diameter of the bowling hoop.
- (3) For the boilers having more than one furnace, breathing spaces between furnaces shall be not less than 120 mm.

- (4) Breathing spaces between gusset or link stays and furnaces shall be not less than 200 mm, except for as under;

Shell outside diameter	>1800 mm	} 250 mm
or furnace length	>6000 mm	
Shell outside diameter	<1400 mm	} 150 mm
or furnace length	<3000 mm	

- (5) Breathing spaces between gusset or link stays and tube nests shall be not less than 100 mm.
- (6) When unflanged flat endplates as used, the breathing spaces between gusset or link stay and furnaces shall be increased as follows:

Increase 200 mm to 220 mm
Increase 250 mm to 275 mm

Increase 150 mm to 165 mm

Increase 100 mm to 110 mm

- (7) All other breathing spaces shall be a minimum of 50 mm or 3% of the shell outside diameter whichever is larger but need not be more than 100 mm.

Table 12/10: Breathing spaces between furnaces and shells when tube plate thickness does not exceed 25 mm (Also see Table 12/11)

Design	Length between the boiler end plates <i>L</i> in meter	Breathing space	
		% of outside diameter (Note)	Maximum mm
(1)	(2)	(3)	(4)
Inserted flat ends	≤ 5.5	5	100
	$5.5 < L \leq 6.0$	5.5	110
	$6.0 < L \leq 6.5$	6	120
Flanged ends	Any length	5	100

Note: But not less than 50 mm or, for bowling hoop furnaces 75 mm.

- (8) When the actual thickness of the end plate exceeds 25 mm, the breathing spaces in accordance with Table 12/10 shall be increased in accordance with Table 12/11.

Table 12/11: Breathing spaces between furnaces and shells when the thickness of the end plate exceeds 25 mm

Length of furnace in meter		Breathing space		
		% of <i>d</i> .	Need note be more than mm	Minimum mm
(1)	(2)	(3)	(4)	(5)
	≤ 5.5	6.5	130	65
$5.5 < L$	≤ 6.0	7.0	140	70
$6.0 < L$	≤ 6.5	8.0	150	75

485. For Boilers not covered under regulations 483 and 484.—(1) Gusset stays shall be arranged to give sufficient bearing space around the furnace connections and tube nests (see figures 12/86 to 12/93, 12/96, and 12/97 to 12/100). The proportions shown in Table 12/12 are recommended for the portion of the end plates above the furnace and the flues.

Table 12/12: Breathing Space

Serial number	Thickness of end plate mm	Dimension 'L' mm
(1)	(2)	(3)
1	< 13	255
2	$\geq 13 \leq 14$	280
3	$> 14 \leq 16$	305
4	$> 16 \leq 20$	330
5	> 20	340

- (2) The breathing space below the flues shall be approximately one-half the dimensions given in Table 12/12.
- (3) For gusset stays above the tube nests, as fitted in multi-tubular waste heat boilers without internal furnaces, a breathing space of 20.3 mm from the centre line of the adjacent tubes to the toe of the gusset angle or plate, may be maintained. For the back end stays below the furnace of multi-tubular dry back boilers, a breathing space of 152 mm may be maintained where the flues are constructed in accordance with regulation 407.
- (4) Where the flues are constructed of corrugated sections welded together, a breathing space of 114 mm may be maintained.

486. Gusset Link, brace and similar stays.— (1) For welded Lancashire, Cornish and Cylindrical Horizontal Multi-tubular type boilers, all welded gusset stays shall not be used. To ensure flexibility, link stays, bar stays, brace stays other than the all-welded type shall be used. All welded gusset stays, however, may be used in cylindrical horizontal waste heat and cylindrical vertical multi-tubular boilers.

(2) Welded gusset stays and brace may be used for welded Lancashire Cornish and Cylindrical Horizontal Multi-tubular type boilers provided their method of attachment is approved by the inspecting Authority.

(3) Each gusset or link stay supporting the flat end plate of a boiler shall be designed to carry the whole load due to pressure on the area it supports. The areas supported by any one stay shall be obtained by considering the total area to be supported which lies within the limits of the flat plate margins and dividing this area by boundary lines drawn between the stays. These boundary lines shall be at all points equidistant from the adjacent points of support in the area under consideration. The effective uniformly distributed load on a triangular gusset plate or on a diagonal link stay shall be assumed to be equal to the perpendicular load on the portion of the end plate to be supported (determined as above) multiplied by L/L_1 (see Figures 12/101, 12/102 and 12/103).

(4) (a) Gusset plates shall be so proportioned that the angle "V" (see Figures 12/101 and 12/102), is not less than 60° .

(b) The thickness of the gusset plate shall be such that the stress in the plate to withstand the effective uniformly distributed load (as defined above) calculated on the smallest cross-section on line XX or YY (Figure 12/101 and 12/102), shall not exceed one-seventh of the minimum tensile stress of the plate used but in no case shall the thickness be less than seven-eighths of the thickness of the shell, plate with a minimum of 11 mm.

(c) Where all-welded gusset stays are used a stiffening plate shall be welded at the toe of the gusset where it is secured to the end plate i.e. where the maximum stress occurs, (see Figure 12/101).

(5) Link stays shall be so arranged that the angle "V" (figure 12/103) is not less than 60° and the dimensions shall be such that stress in the stay at its weakest part does not exceed one-seventh of the minimum tensile stress of the plate used.

(6) The strength of anchor plates, angles and link pins calculated at the weakest section shall be as follows:

(a) Link pins shall be so designed that the shear stress does not exceed 562 kg/cm^2 , the strength of pins in double shear being taken as 1.875 times the strength of pins in single shear.

(b) Anchor plates or angles shall be so designed that the calculated stress does not exceed one-seventh of the minimum tensile stress of the material used, but in no case shall the thickness be less than seven-eighth of the thickness of the shell plate with a minimum of 12.7 mm, nor the length of the portion attached to the end plate be less than the distance between the lines of end to shell flat margin and the breathing space line around the flues of tube nests.

- (7) (a) Where gusset plates, anchor plates or angles are welded to the shell and/ or end plates, the attachments shall be by mean of continuous fillet welds on each side or by butt-welds prepared in accordance with following paragraph and details l, m, n, or p of Appendix –J.
- (b) The welds shall be of such dimension that the stress calculated on an area equal to the effective length of the weld multiplied by the effective throat thickness shall not exceed that permitted for the parent metal multiplied by the appropriate weld factor in Table 12/13.
- (c) The effective length of a weld shall be taken as that length of weld which is of the specified size throughout.
- (d) For open-ended fillet welds the effective length shall be the overall length less twice the weld size.
- (e) For the purpose of stress calculation, the effective throat thickness of a butt weld shall be taken as the thickness of the gusset or another plate and the effective throat thickness of fillet weld shall be taken as 0.7 of the fillet size. For compound welds the effective thickness shall be the sum of those of the constituent parts.

Table 12/13: Weld attachments

<i>Form of weld</i>		<i>Weld factor</i>	
		<i>Not stress relieved</i>	<i>Stress-relieved</i>
(1)		(2)	(3)
Single J or bevel butt-welds (with or without superimposed fillet)	Unsealed	0.35	0.45
	Sealed	0.60	0.70
Double J or bevel butt-welds (with or without superimposed fillets)		0.60	0.70
Double fillet welds		0.55	0.65

PART-12**Furnaces, furnace components, wet-back reversal chambers and fire boxes of cylindrical form subject to external pressure**

487. Furnaces.— (1) The mean diameter of furnace shall not exceed 1800 mm.

(2) Notations shall be as under:

- b = is the pitch of the furnace corrugations (in mm);
- C = is the corrosion allowance = 0.75 mm;
- d = is the mean diameter of furnace (in mm) (see Note 1);
- $d_{\max}$ = is the maximum mean diameter of the furnace (in mm);
- $d_{\min}$ = is the minimum mean diameter of the furnace (in mm);
- e = is the furnace plate thickness (in mm);
- E = is Young's modulus of elasticity (in kg/cm²) at the design temperature.
- E_t = the specified minimum elevated temperature yield stress or the 0.2% proof stress at the design temperature (in kg/cm²) as available in the governing codes of the country of the material to which it belongs;
- F = is the cross-sectional area of a longitudinal section of the corrugated furnace wall, of length b and thickness (e-c) (in mm²) [see figures 12/119(Fig.A to Fig.G)];

- I = is the second moment of area of one complete corrugation about its neutral axis, excluding the corrosion allowance (in mm⁴);
- I_s = is the second moment of area of plain stiffener section (see figures 12/29 and 12/30) about its neutral axis, including a length of the furnace of $0.55\sqrt{de}$ (de) on each side of the stiffener (in mm⁴) (see Note 2);
- L = is the distance between the centre of two effective points of support (in mm) (see Note 3);
- P = is the maximum allowable working pressure (in kg/cm²)
- S₁ = is the factor of safety:
 = 2.5 for furnace in Class I and Class II boilers
 = 3.5 for furnace in Class III boilers
 = 2.0 for furnace and wrapper plates not exposed to flame;
- S₂ = is the factor of safety:
 = 3.0 for Class I and Class II boilers
 = 3.9 for Class III boilers
- u = is the percentage out of roundness to be taken as 1.5 for plain furnace and 1.0 for corrugated furnace;
- W = is the depth of corrugation (in mm).

Notes:

1. For corrugated furnace, mean diameter is equal to inside diameter plus full depth of one corrugation referred to in Fig. 12/119 which is equal to the inside diameter +e+W.
2. When calculating I_s, it is only necessary to take into account a corrosion allowance on the furnace gas side.
3. Stiffeners complying with Figures 12/29 and 12/30 boiler and reversal chamber end plates are considered to be effective points of support.
4. The design temperature of the furnace = Cs + 4e +15 (saturation temperature plus four times the thickness of the furnace plus 15).

- (3) Evaluation of Young's modulus at the design temperature. Value of 'E' shall be obtained from the following table (by linear interpolation if required):

Table 12/14

Serial number	Design temperature in °C	Value of E in Kg/cm ² × 10 ³
(1)	(2)	(3)
1	250	1987
2	300	1947
3	350	1896
4	400	1845
5	450	1814

488.Plain furnaces.— (1) The maximum allowable working pressure of plain furnaces shall be the lower of those obtained using equations 12/23 and 12/24 as follows, but the thickness shall be not less than 7 mm and shall not exceed 22 mm:

$$P = \frac{2 E t (e-C)}{S_1 d} \left[\frac{1 + \frac{d}{15L}}{1 + \frac{0.03 d u}{(e-C) \left(1 + \frac{d}{0.3L}\right)}} \right] \quad \text{Equation (12/23)}$$

$$P = \frac{1.73 E (e-C)^{2.5}}{S_2 L d} \quad \text{Equation (12/24)}$$

(2) Equation 12/23 and 12/24 may be expressed in terms of thickness using equation 12/25 and 12/26 respectively as follows and the greater of the thickness obtained shall be used.

$$e = \frac{B}{2} \left(1 + \sqrt{1 + \frac{0.12 d u}{B \left(1 + \frac{d}{0.3L}\right)}} \right) + C \quad \text{Equation (12/25)}$$

Where,

$$B = \frac{P d S_1}{2 E_1 \left(1 + \frac{d}{15L}\right)}$$

$$e = d^{0.6} \left(\frac{L S_2 P}{1.73 E} \right)^{0.4} + C \quad \text{Equation (12/26)}$$

(3) If the furnace/ combustion chamber has tubes radially to it, the thickness of that portion of the furnace is to be increased by the value of ligament efficiency.

489.Furnace components.— The thickness of furnace components, e.g. ash drop-out tubes and fuel inlet connections, shall be calculated in accordance with regulation 488 with a minimum thickness of 10 mm and a maximum thickness of 22 mm.

490.Corrugated furnaces.— The maximum allowable working pressure of corrugated furnaces shall be determined using the equation 12/27, but the thickness shall not be less than 10 mm and shall not exceed 22 mm. Calculated value of 'I' and 'F' for some of the corrugations are given in figure 12/119 for other shapes and sizes calculations need to be made from basic principles.

$$P = \frac{2 F E t \left(1 + \frac{0.1 d}{L}\right)}{S_1 b d \left[1 + \frac{F W D u}{800 I \left\{ 1 + \frac{5 d}{L} \left(\frac{e-C}{W} \right)^3 \right\}} \right]} \quad \text{Equation (12/27)}$$

491. Tolerances and allowances.— The calculated wall thickness contains a fixed allowance of 0.75 mm for corrosion and wear. For corrugated furnaces, the calculated wall thickness shall be the minimum thickness of the finished furnace. For plain furnaces and reversal chambers, allowance shall be made to take account of any minus tolerances on the plate thickness.

492. Out-of-roundness.—(1) The percentage out-of-roundness is as follows:

$$u = \frac{200 (d_{\max} - d_{\min})}{d_{\max} + d_{\min}} \quad \text{Equation (12/28)}$$

(2) This shall be included in the calculation as $u = 1.0$ for corrugated furnaces and $u = 1.5$ for plain furnaces.

493. Stiffeners.— (1) Stiffeners shall have second moment of inertia not less than that given by the following equation:

$$I_s = \frac{Pd^3 L}{1.35 \times 10^7} \quad \text{Equation (12/29)}$$

(2) (a) If the stiffeners are made in sections from bar or plate, the abutting ends shall be prepared so as to ensure that full penetration welds are made.

(b) The thickness of the stiffening ring shall be kept to the minimum required (for limiting dimensions see Figures 12/29 and 12/30).

(3) Bowling hoops are considered as effective points of support. The minimum pitch of bowling hoop centres shall be not less than 500 mm. If bowling hoops are used, the furnace thickness shall be calculated from regulation 488. The dimensions of bowling hoops shall be in accordance with figures 12/120 (Fig. A, Fig B and Fig C) and their second moment of area determined from the tables given in these figures, shall be not less than required by sub-regulation (1).

(4) If corrugated furnaces are equipped with several stiffeners, e.g. one on each corrugation or on each second corrugation, the cross-sectional area and the second moment of area of the stiffeners shall also be taken into consideration when using the equation 12/27. A height of not more than four times the furnace thickness shall be used for the calculation.

494. Circular reversal chambers.— (1) (a) The thickness of wrapper plates of cylindrical reversal chambers of horizontal multi-tubular boilers shall be calculated in accordance with the equations given in regulation 488. The thickness shall be not greater than 35 mm and shall be not less than 10 mm.

(b) However, the design temperature for reversal chamber wrapper plates shall be determined in accordance with the following equations: -

$$t = (t_s + 2e_2) \text{ or } (t_s + 50) \text{ whichever is greater.}$$

Where, t = Design temperature (in degree centigrade)

t_s = Saturation temperature of water (in degree centigrade) at the maximum allowable working pressure, for both steam or hot water boilers.

e_2 = nominal plate thickness (in mm).

(2) (a) The thickness of access tubes shall be calculated in accordance with regulation 488 with a minimum thickness of 10 mm.

(b) However, the design temperature for access tubes shall be determined in accordance with the following equations: -

$$t = \begin{matrix} (t_s + 2e_2) \text{ or} \\ (t_s + 50) \text{ whichever is greater.} \end{matrix}$$

Where, t = Design temperature (in degree centigrade)

t_s = Saturation temperature of water (in degree centigrade) at the maximum allowable working pressure, for both steam or hot water boilers.

e_2 = nominal plate thickness (in mm).

495. Plain furnaces of vertical boilers.— (1) The maximum allowable working pressure of plain furnaces of vertical boilers shall be the lesser of the two values obtained by Equations (12/23) and (12/24).

Where,

D = external diameter of the fire-box in mm. Where the firebox is tapered the diameter taken shall be the mean of that at the top and at the bottom where it meets the substantial support from the flange or ring,

L = is length of the firebox in mm between points of substantial support measured from the commencement of flange curvature or from the foundation connection, or from a row of screwed stays which comply with regulation 416 and sub-regulation (3) of regulation 477, whichever is applicable.

(2) The thickness shall be not greater than 22 mm and shall be not less than 10 mm.

496. Corrugated fireboxes of vertical boilers.— (1) For the semi-spirally corrugated fireboxes of 'Sentinel' standard motor wagon boilers the maximum allowable working pressure shall be determined by the following formula:

$$P = \frac{C (32 t - 25.4)}{D} \quad \text{Equation (12/30)}$$

Where,

P is maximum allowable working pressure in kg/cm²(g)

t is thickness of the firebox plate in mm

D is mean of the external diameters of firebox measured over the plain part at each end at commencement of curvature of flange in mm

$C = 27.41972$

(2) No corrugated furnace shall be less than 10 mm thick.

497. Hemispherical furnaces of vertical boilers.— (1) When furnaces are hemispherical in form and subject to pressure on the convex side and are without support from stays of any kind, the maximum allowable working pressure shall be found by the following formula:

$$P = \frac{19.33441 (32 t - 25.4)}{R} \quad \text{Equation (12/31)}$$

where

P is maximum allowable working pressure in kg/cm² (g)

t is thickness of the top plate in mm.

R is outer radius of curvature of the furnace in mm.

(2) The thickness of these furnaces shall in no case exceed 22 mm.

PART-13

498. Foundations of Vertical Boiler Furnaces.— When circular furnaces of fireboxes of vertical boilers are not connected to the shell crown by uptake tube, smoke tubes or bolt stays and the whole load on the firebox vertically is borne by the bottom part of the firebox where it is connected to the shell, the maximum allowable working pressure for the part, if firebox is joggled out to meet the shell or if any ogee ring is fitted, shall not exceed that found by the following formula:

$$P = \frac{C(32t - 25.4)^2}{D(D - D_1)} \quad \text{Equation (12/32)}$$

Where,

P is maximum allowable working pressure in kg/cm² (g)

t is thickness of the joggled firebox plate or ogee ring in mm.

D is inside diameter of the boiler shell in mm.

D₁ is outside diameter of the joggled firebox in mm at the commencement of curvature above joggled part or the outside diameter of the firebox where it joins the ogee ring.

C = 9.84297 for Ogee rings (see Fig 12/34 and 12/35)

C = 7.03070 where 'U' ring section is used (see Fig. 12/36).

499. Foundations of Loco type boiler fireboxes.— (1) Where the firebox roof in locotype boilers is not stayed direct to the external casing crown or to girders carried by the casing or if not connected to the casing by slings, the maximum allowable working pressure for the parts, if plates are joggled out to meet the casing or if an ogee ring is fitted, shall not exceed that found by the following formula:

$$P = 70 \frac{(t - 1) \times (L + W)}{L + W (W - W_1)} \quad \text{Equation (12/33)}$$

Where, P = is maximum allowable working pressure in pounds per square inch,

t = is thickness of the joggled firebox side plates of fire hole plate (whichever is less) or ogee ring in thirty-seconds of an inch,

L = is length of firebox casing in inches measured between the water sides of front end plate and saddle plate at the foundation seam,

W = is width firebox casing in inches measured between that water side of casing side plates at the foundation seam,

W₁ = is width of firebox in inches measured between the water sides of firebox side plates at the commencement of curvature above joggled part of where it joins the ogee ring.

(2) Where only a comparatively narrow strip of the firebox roof is stayed directly to the casing crown the area so stayed shall be deducted from the area represented by 'L x W' in the bottom line of the formula thus:

$(L \times W - A) (W - W_1)$ and so used is Equation (12/33) in determining the working pressure for the parts. “A” being the area in square inches of the part of roof supported by the casing crown.

500. Uptakes of vertical boilers.— (1) The maximum allowable working pressure for uptake tubes of vertical boilers shall be determined by the following formula:

(i) When an internal liner is not fitted:

$$P = \frac{7.03070 (32 t - 50.8)}{D} \quad \text{Equation (12/34)}$$

(ii) When an internal liner is fitted extending below the low water level:

$$P = \frac{50.97255 (32 t - 25.4)^2}{D(L + 609.6)} \quad \text{Equation (12/35)}$$

Where,

P is maximum allowable working pressure in kg/cm² (g)

t is thickness of the uptake in mm.

D is external diameter in mm.

L is length of the uptake in mm, measured between the circumferential seams.

(2) In no case, the thickness of an uptake tube shall be less than 10 mm.

501. Cross tubes.— (1) Internal diameter of cross tubes shall not exceed 305 mm. The maximum allowable working pressure of the tubes shall be determined by the following formula:

$$P = \frac{14.06139 (32 t - 177.8)}{D} \quad \text{Equation (12/36)}$$

Where,

t = is thickness in mm of the cross tube,

D = is internal diameter in mm of the cross tube.

(2) In no case, the thickness of a cross tube shall be less than 8 mm.

502. Pads welded to shell or the attachment of flanged mountings.— The size of outer peripheral fillet welds by which circular pads are attached to shell plates shall be determined by the Equation (12/37), but shall in no case be less than the inner welds or nor less than the minimum specified for plate thickness in Table 12/3:

$$L_o = \frac{2A - D_1 L_1}{D} \quad \text{Equation (12/37)}$$

Where,

L_o is size of fillet weld around outer periphery of pad, in mm,

L_1 is size fillet weld around inner periphery of pad, in mm,

A is cross-sectional area of opening in shell (based on minimum thickness in square mm see regulation 463),

D is outer diameter of pad, in mm,

D_1 is inner diameter of pad, in mm.

503.Hydraulic test.— (1) (a) Each Class I Boiler shall, on completion of all welding and/or repairs and after heat-treatment, be subjected to a hydraulic test of 1.5 times the design pressure without any indication of weakness or defect.

(b) Each Class II and Class III Boiler shall be tested to a pressure twice the design pressure.

(2) (a) The test shall be witnessed by the Inspecting Authority or Competent Person.

(b) The test pressure shall be maintained for a period not less than 30 minutes.

(c) In the interest of safety, it is important that the boiler be properly vented, so as to prevent the formation of air pockets, before the test pressure is applied.

Notes:

1. It is recommended that the temperature of the water shall not be less than 7°C during the hydraulic test.
2. It is further recommended that before the boiler is approached for close examination, the pressure shall be reduced to not less than 1.1 times the design pressure and not more than 0.9 times the hydraulic test pressure.
3. On completion of hydraulic test, release of pressure shall be gradual.
4. Deflection of different pressure parts shall be examined carefully and there shall not be any permanent set after release of pressure.

(3) If any repairs are found to be necessary during or subsequent to the hydraulic pressure test, the boiler shall again be subjected to the pressure test specified above after completion of the repairs and after any heat treatment provided repaired weld joint requires heat treatment as per regulation 453.

Note: Observations and remarks of Competent Person/ Inspecting Authority shall be recorded for filing with maker's papers.

504.Safety valves.— Boiler shall be provided safety valves complying with regulations 192 to 219, with following changes:-

(i) The safety valves shall be reset at a pressure at least 2.5% below, but not more than 5% below the safety valve set pressure.

(ii) The 5% limit is increased to 10% for valves having a body seat bore less than 32 mm and or having a set pressure of 24 bar gauge or less.

CROSS BEAMS IN END PLATES

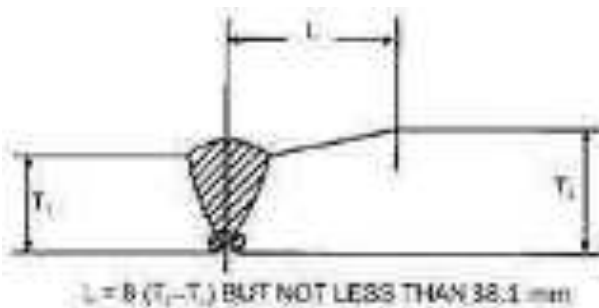


Fig. 12/1

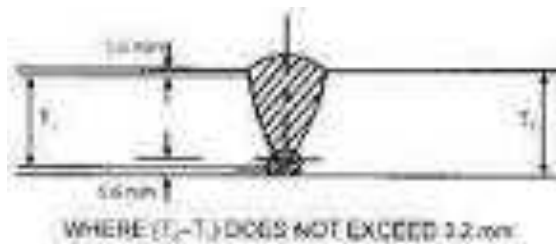


Fig. 12/2

GOUGED OUT BEFORE APPLYING WELD FROM SECOND SIDE

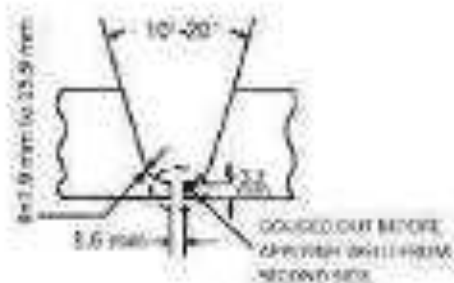


Fig. 12/3

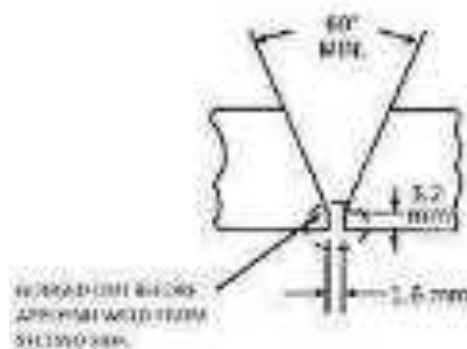


Fig. 12/4

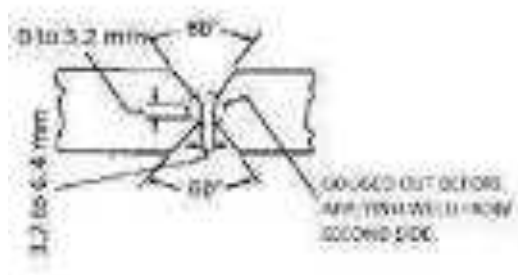


Fig. 12/5

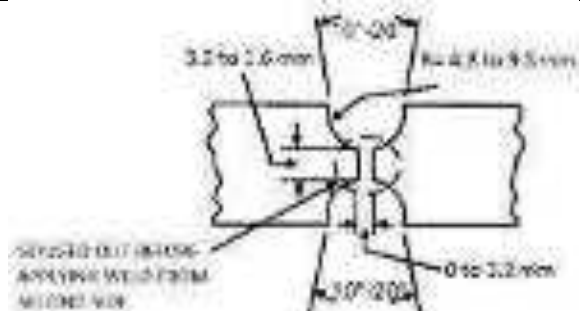


Fig. 12/6

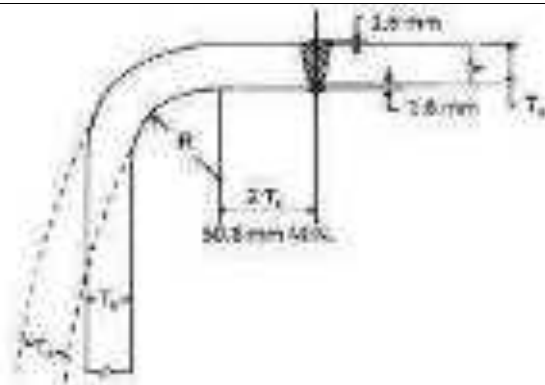


Fig. 12/7

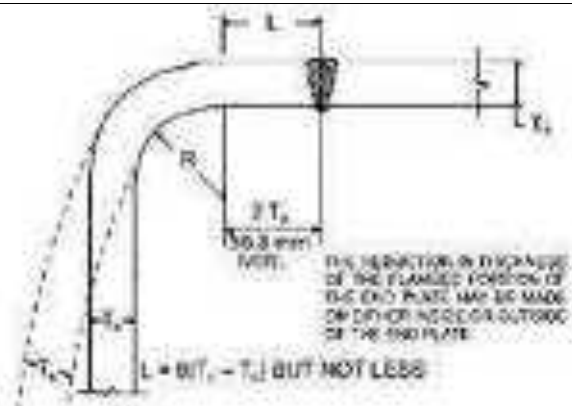


Fig. 12/8: Flanged End Plates Ends Thicker Than Shell

All dimensions are in mm.

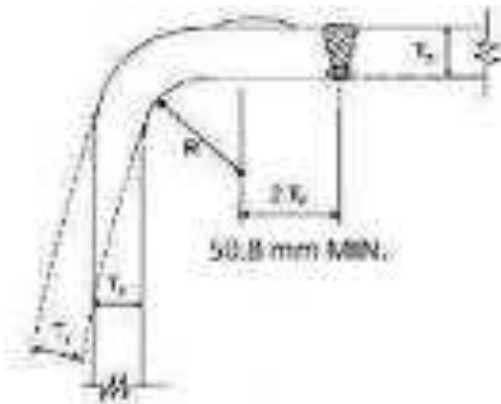


Fig. 12/9: Flanged End Plates Ends Thicker Than Shell

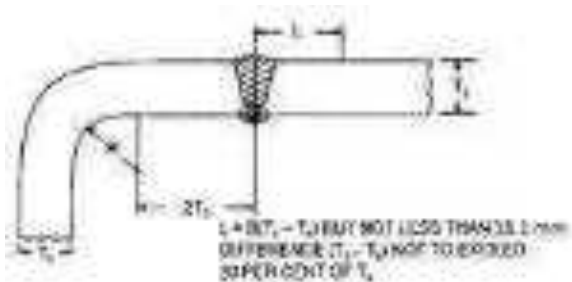


Fig. 12/10: Flanged Flat End Plates

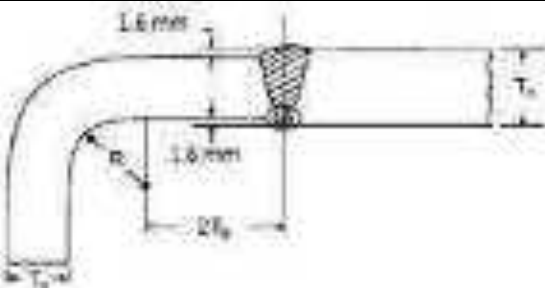


Fig. 12/11: Flanged Flat End Plates to Shell (Shell Thicker than Ends)

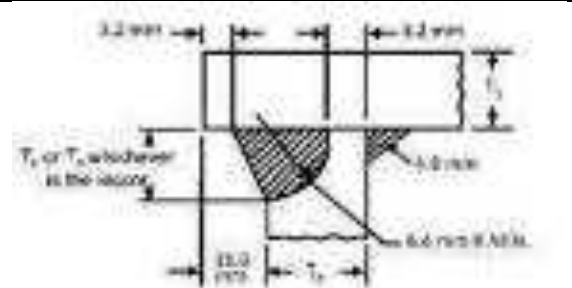


Fig. 12/12: Flat End

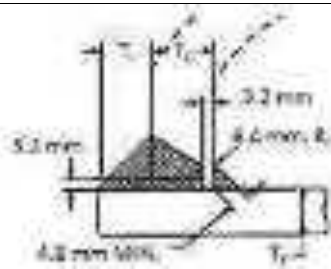
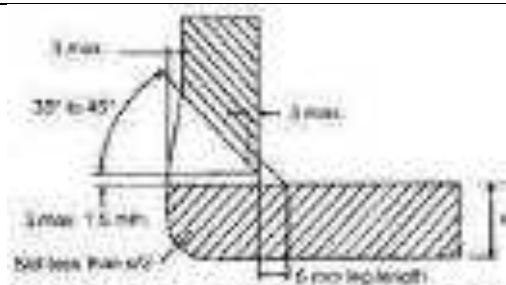


Fig. 12/17: Flue Connections to End Plates (Dished or Flat)



Note: 1. The plate edge radius or fillet less than 3.2 mm is only required when furnace end is expected to be firing at comparatively high temperature, e.g., at the entry to the reversal chamber.
2. The bottom end of the furnace can protrude beyond the wall provided that the insulation and the wall area are adequately insulated to prevent overheating. All dimensions are in millimetres. Attachment of furnace to end plate or reversal chamber.

Fig. 12/18

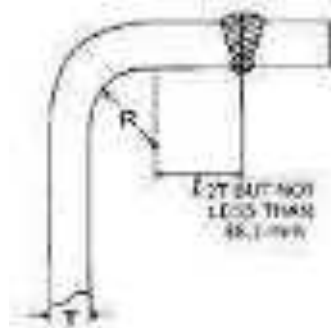


Fig. 12/19

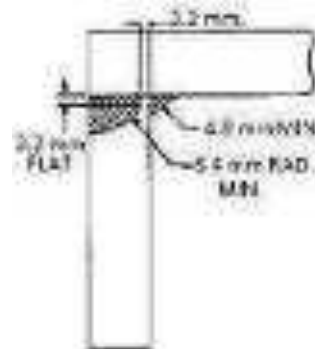


Fig. 12/20

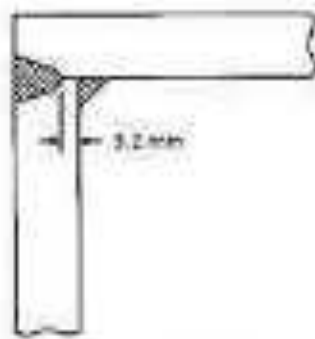
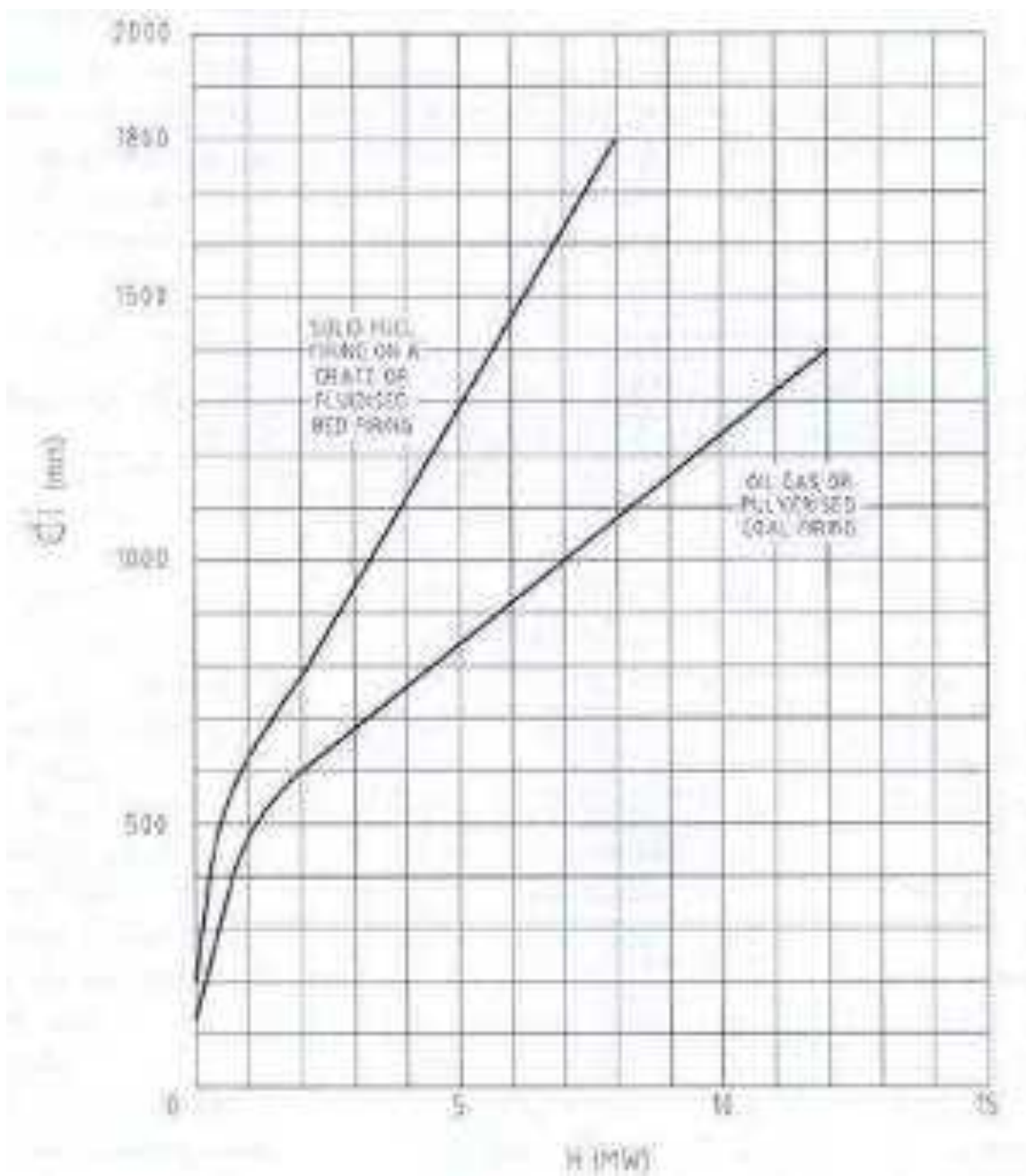


Fig. 12/21



Fig. 12/22

All dimensions are in mm.



d = inner diameter in mm for plain furnace or average diameter of in mm for corrugated furnace

q = Heat input in MW

Fuel oil and gas firing Maximum heat input to be limited 0.35 MW/m² at furnace surface area

Furnace surface area for plain furnace is product of furnace outside diameter & furnace length between boiler front tube plate and reversal chamber tube plate. Reversal chamber length not to be considered while calculating furnace surface area.

Furnace surface area for corrugated furnace is product of furnace outside diameter & furnace developed length between boiler front tube plate and reversal chamber tube plate. Reversal chamber length not to be considered while calculating furnace surface area.

Fig.12/23: — RELATIONSHIP BETWEEN FURNACE DIAMETER AND PERMISSIBLE HEAT INPUT

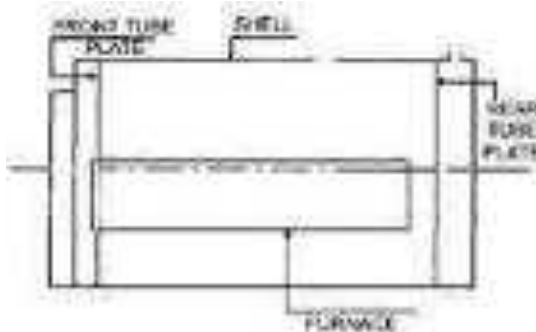


Fig. 12/24: Reverse Fired Boiler

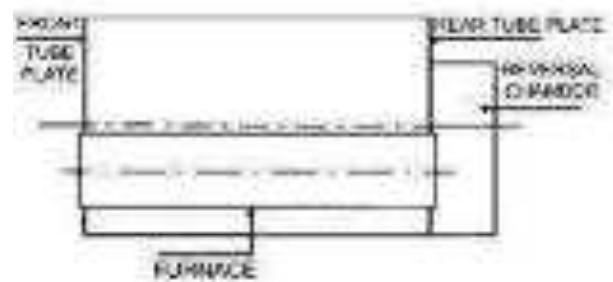


Fig. 12/25: Dry Back Boiler

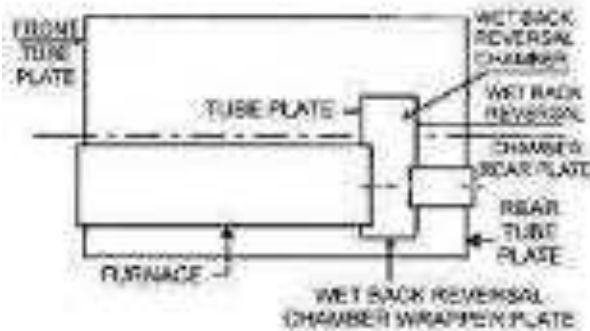
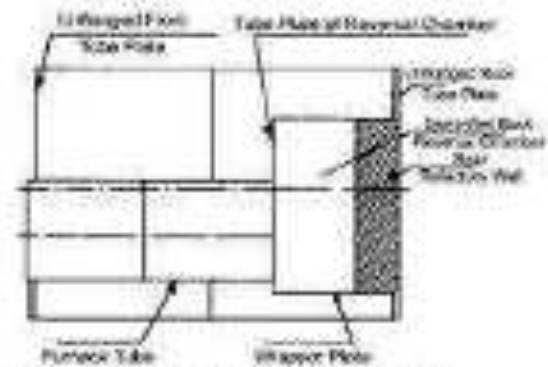


Fig. 12/26: Wet Back Boiler



NOTE: RADIANT HEATING SURFACE COMPRISES FURNACE TUBE AND WRAPPER PLATE.

Fig. 12/27: Semi-Wet Back Boiler

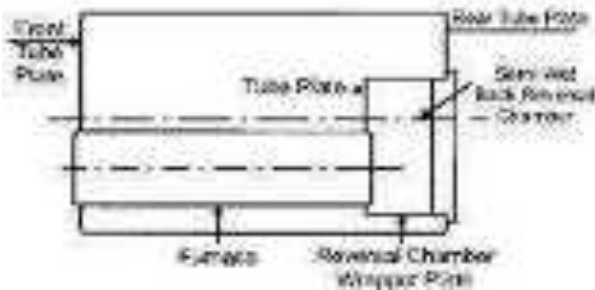


Fig. 12/28: Semi-Wet Back Boiler

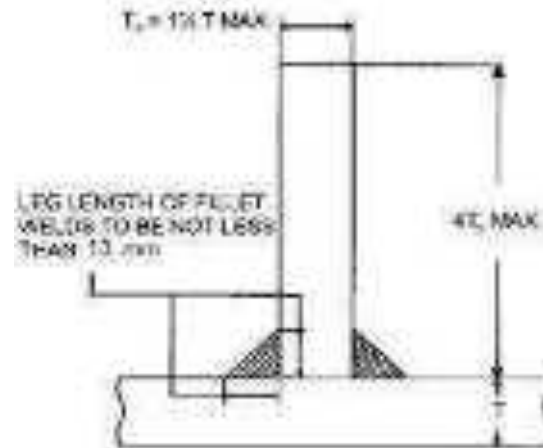


Fig. 12/29: Plain Bar

All dimensions are in mm.

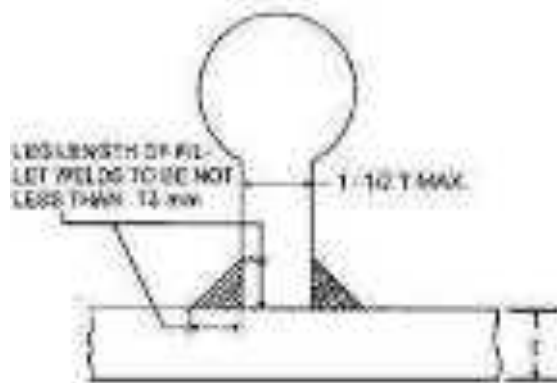


Fig. 12/30: Bulb Bar Stiffeners for Horizontal Flues

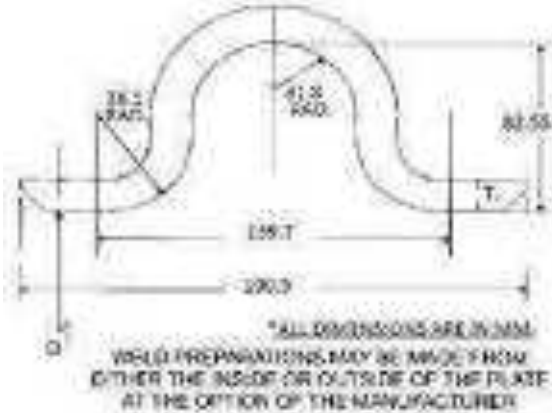


Fig. 12/31: Bowling Hoop

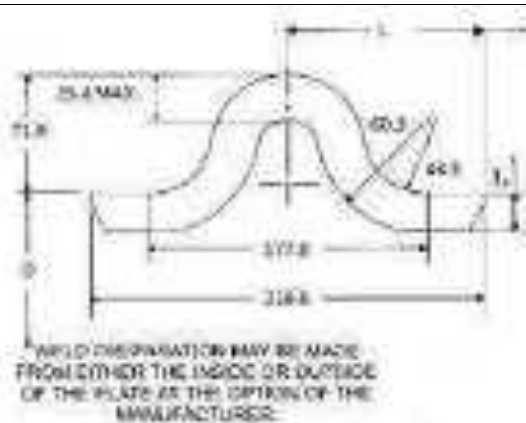


Fig. 12/32: Bowling Hoop

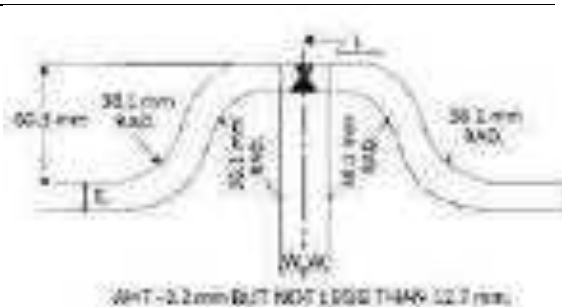


Fig. 12/33: Detail Flue Joint

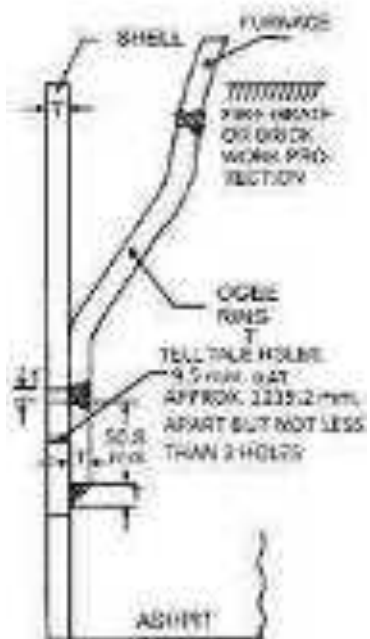


Fig. 12/34

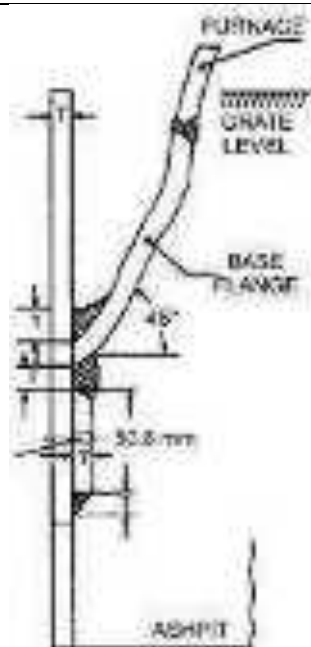


Fig. 12/35

All dimensions are in mm.

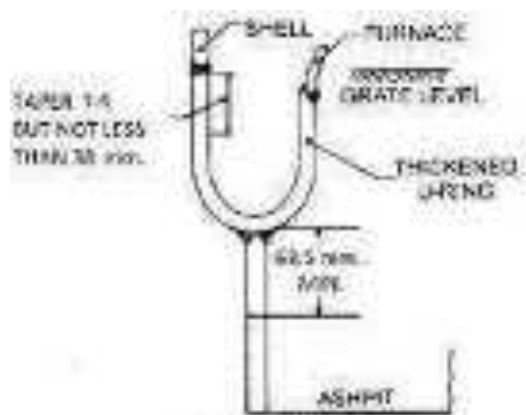


Fig. 12/36

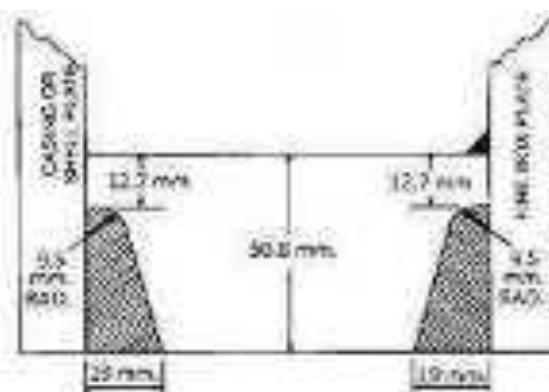
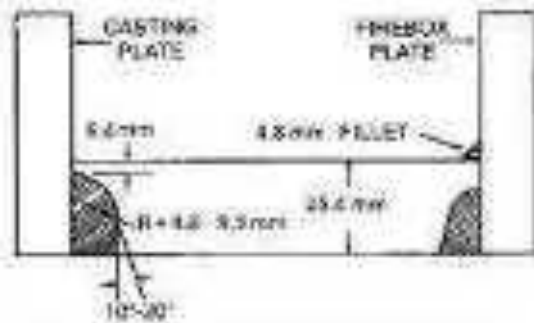


Fig. 12/37: Foundation Rings



PERMITTED ONLY ON LOCOTYPE BOILERS WITH FULLY SUPPORTED FIREBOX SHOWN IN FIG. 12/39 THE USE OF MIN. ANGLE SHOULD BE ASSOCIATED WITH MAX. RADIUS R. OF 3.5 mm. CONVERSELY, THE MAX. ANGLE SHOULD BE ASSOCIATED WITH MIN. RADIUS R. OF 4.0 mm.

Fig. 12/38: Foundation Rings

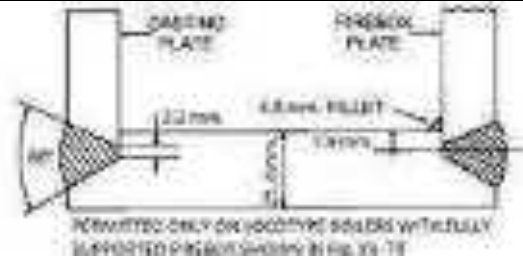


Fig. 12/39: Foundation Rings

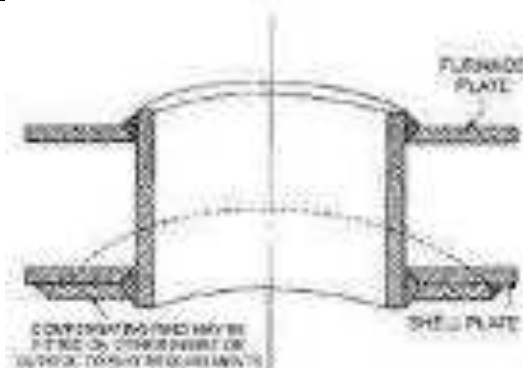


Fig. 12/40: Firehole Mouthpiece

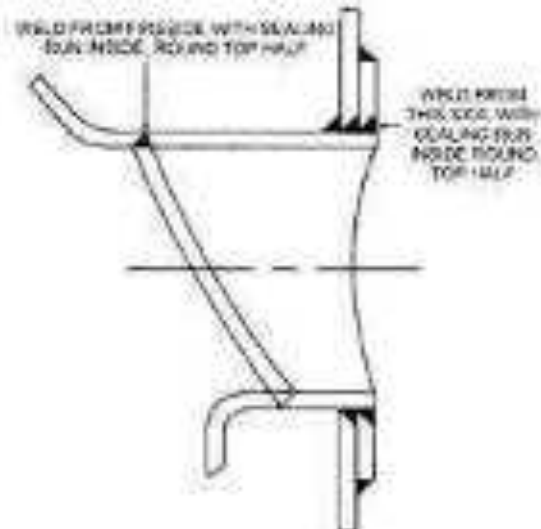
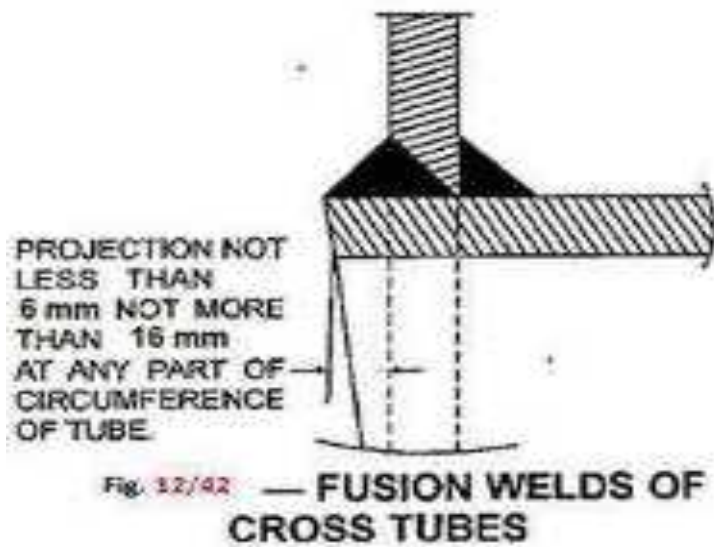


Fig. 12/41: Firehole Mouthpiece

All dimensions are in mm.



WELD FROM INSIDE FLUE PIPE WITH SEALING RUFF ON OUTSIDE AS FAR ROUND AS POSSIBLE

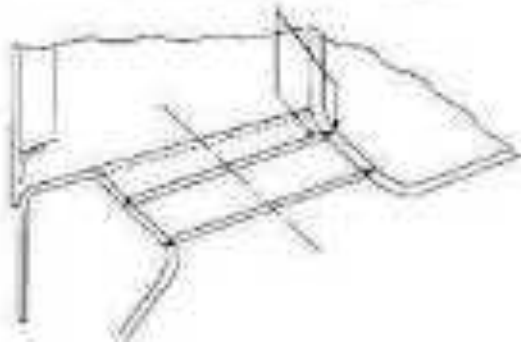


Fig. 12/43: Welding of Flue Pipes

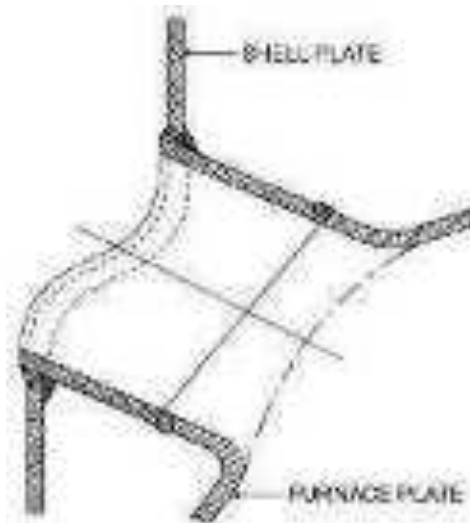


Fig. 12/44: Throat Piece

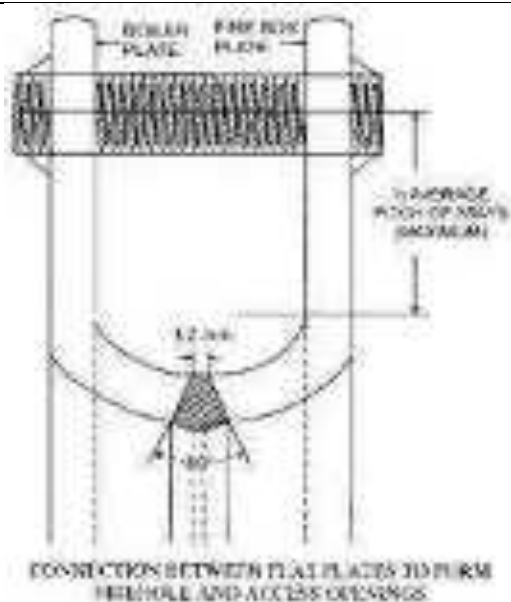


Fig. 12/45

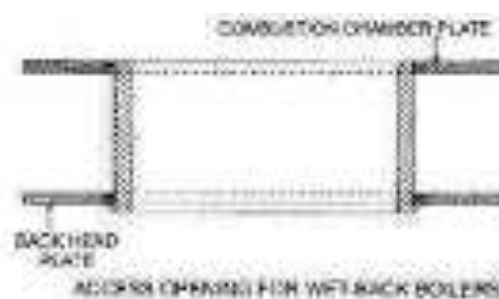


Fig. 12/46

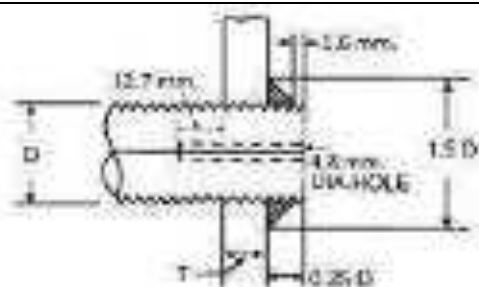


Fig. 12/47: Attachment of Firebox and Combustion Chamber Stays

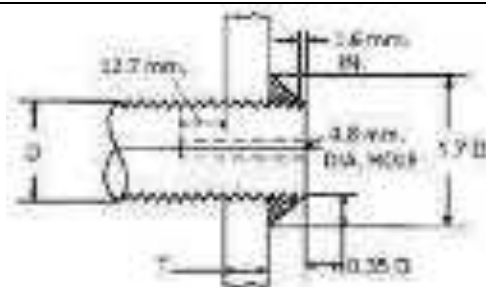


Fig. 12/48: Attachment of Firebox and Combustion Chamber Stays

All dimensions are in mm.

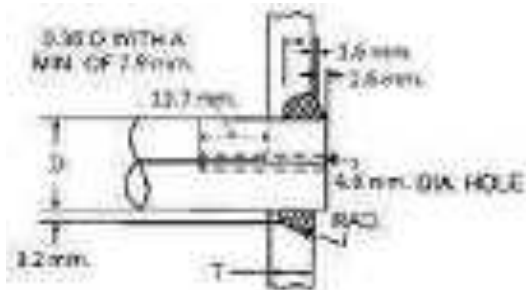


Fig. 12/49: Attachment of Firebox and Combustion Chamber Stays

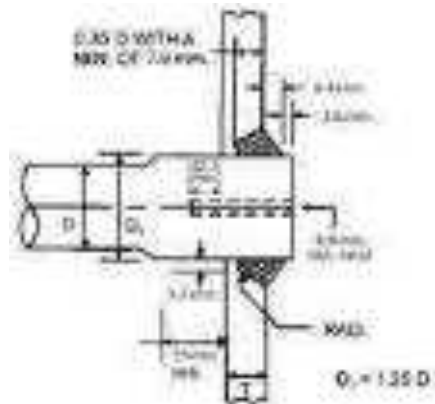
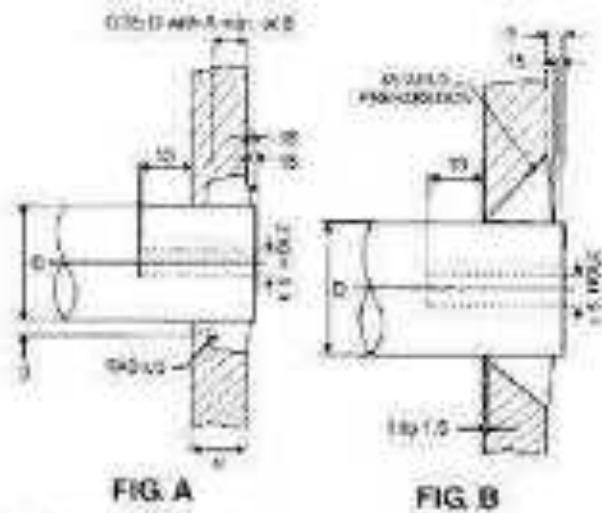


Fig. 12/51: Attachment of Bar Stays



All dimensions are in mm.
Note: This type of attachment is recommended for Plain Bar Stay.

Fig. 12/50: Attachment of Firebox and Reversal Chamber

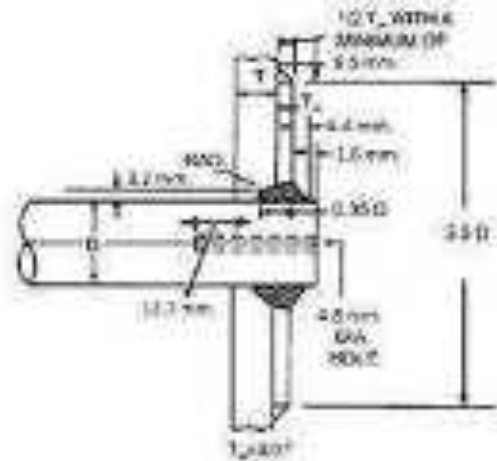


Fig. 12/52: Attachment of Bar Stays

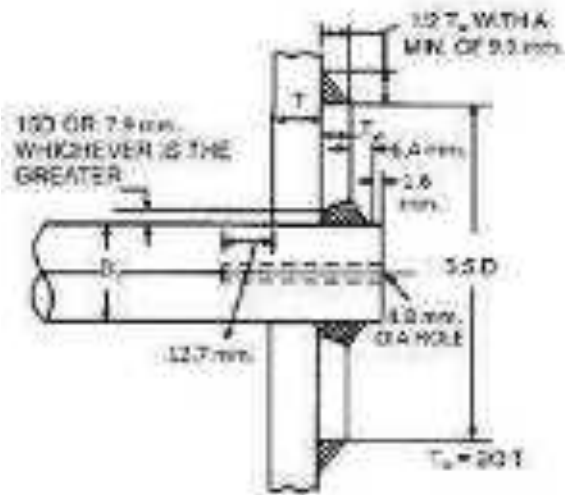


Fig. 12/53: Attachment of Bar Stays

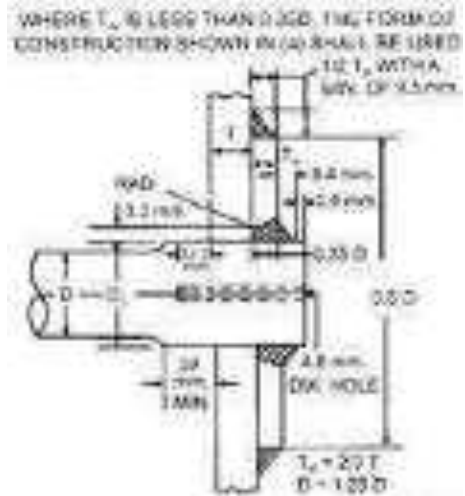


Fig. 12/54: Attachment of Bar Stays

All dimensions are in mm

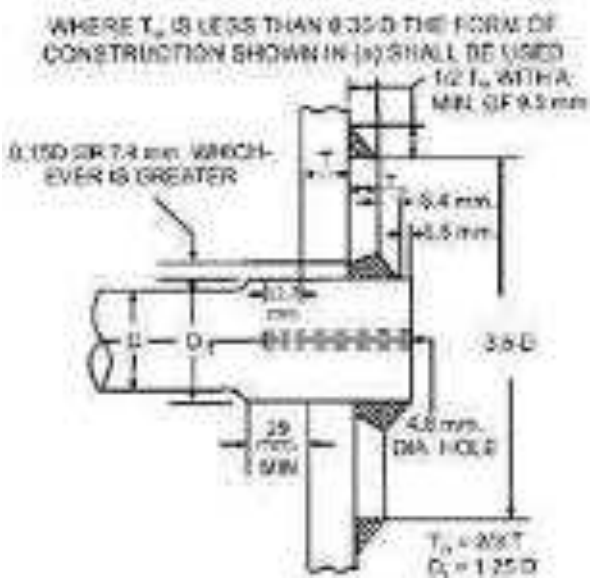


Fig. 12/55 : Attachment of Bar Stays

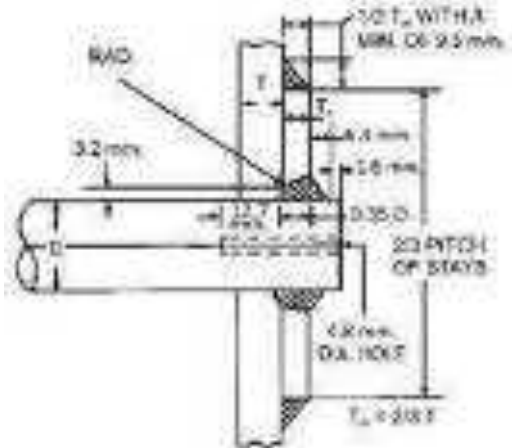


Fig. 12/56: Attachment of Bar Stays

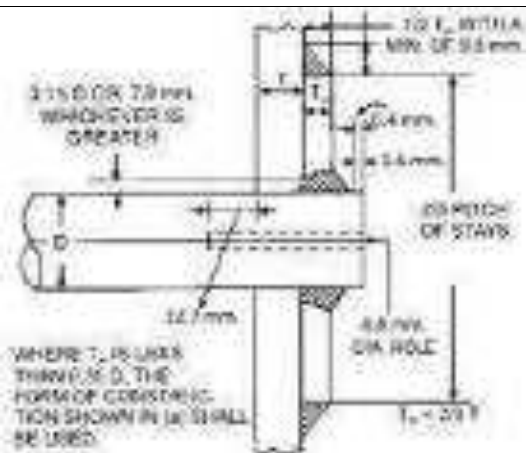


Fig. 12/57: Attachment of Bar Stays

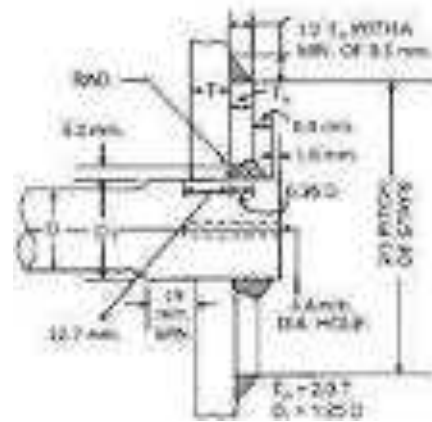


Fig. 12/58: Attachment of Bar Stays

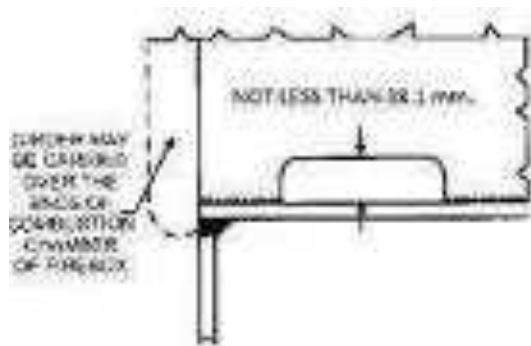


Fig. 12/61*

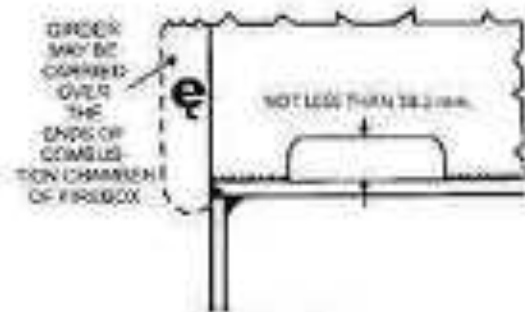


Fig. 12/62*

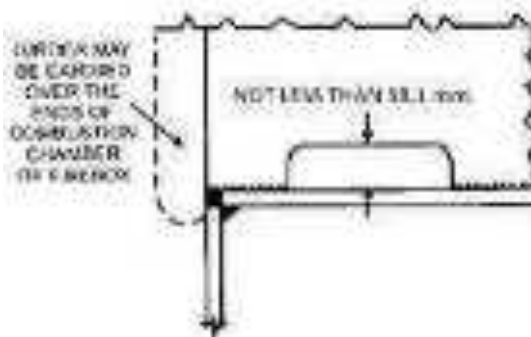
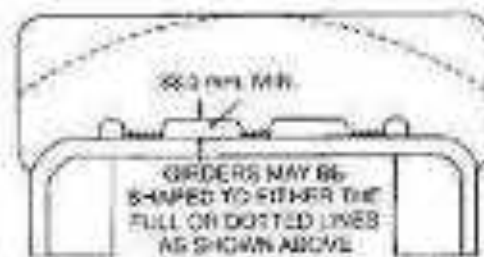


Fig. 12/63*

Fig. 12/64: Typical Methods of Fittings
Welded Grinders to Welded Combustion
Chambers and Fireboxes

***TYPICAL METHODS OF FITTING
WELDED GRINDERS TO WELDED
COMBUSTION CHAMBERS AND
FIREBOXES**

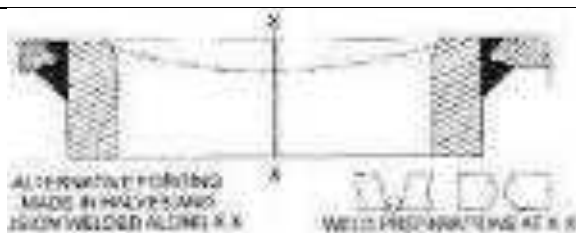
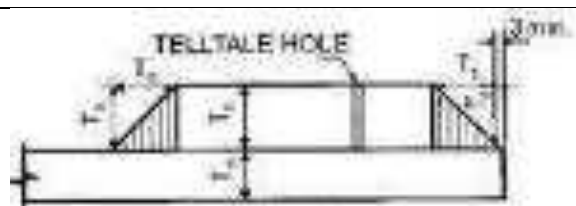
Fig. 12/65: Fusion Welded Oval Manhole
Frame

Fig. 12/66

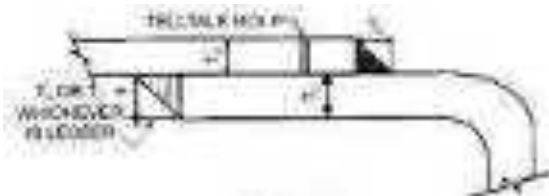


Fig. 12/67

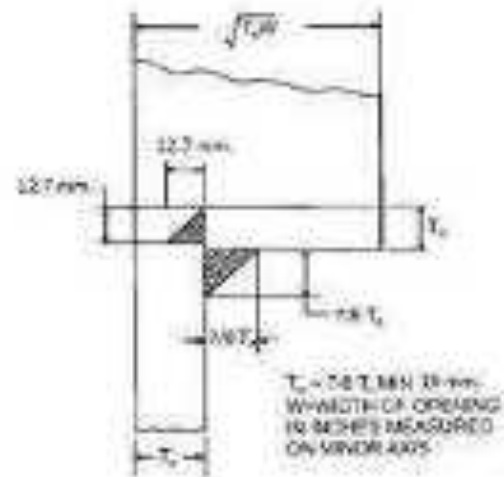


Fig. 12/68: Welding Detail For Manhole in Flat End Plate

All dimensions are in mm.

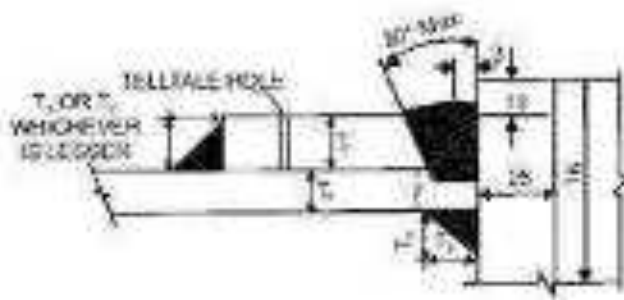


Fig. 12/69

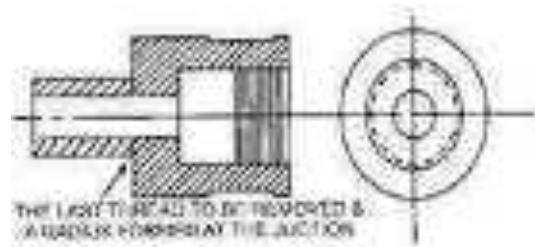


Fig. 12/70: Typical Mild Steel Distance Piece for Mountings

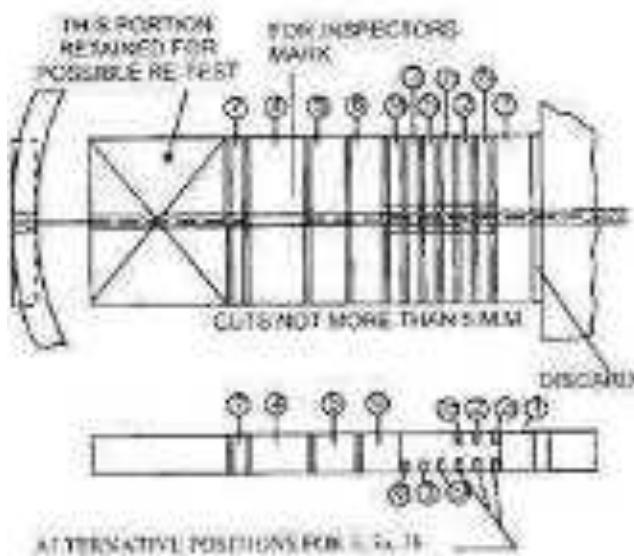


Fig. 12/71: Details of Test Plates

1. Tensile Test for Seam.
2. Impact Test outer surface of plate.
- 2a & 2b. Impact Re-test outer surface of plate.
3. Impact test Inner surface of plate.
- 3a & 3b. Impact re-test inner surface of plate.
4. Tensile test for all-weld metal.
5. Normal bend test-outer surface in tension.
6. Reverse bend test-inner surface in tension.
7. Micro and macro tests.

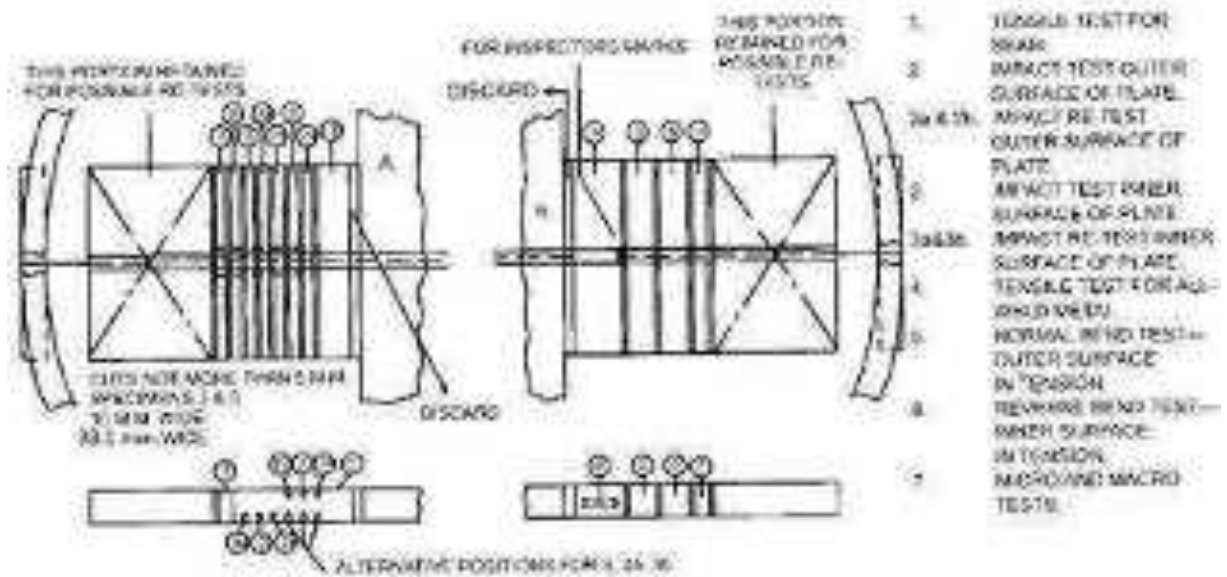


Fig. 12/72

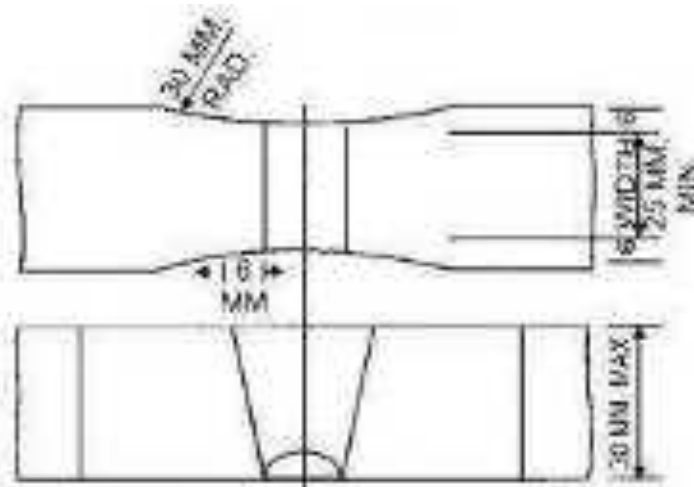
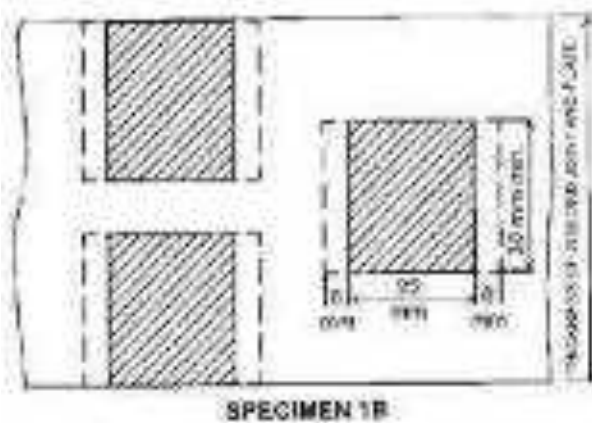
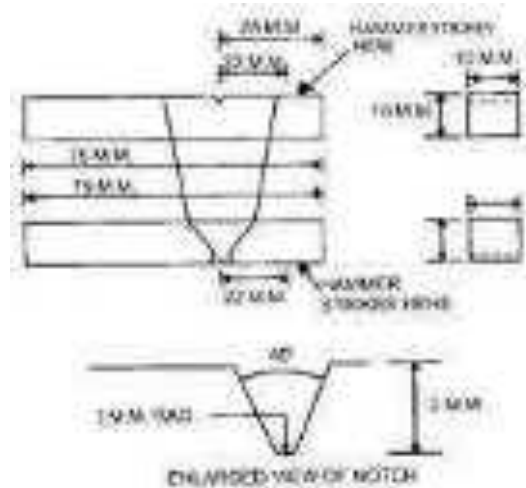


Fig. 12/73: Specimen 1A – Reduced Section Tensile Specimen

All dimensions are in mm.



Fig. 12/75

Fig. 12/74: Reduced Section Tensile Specimen
in a Thick Plate

SPECIMENS (2) AND (3) IMPACT TEST

Fig. 12/76: Izod Impact Test Pieces

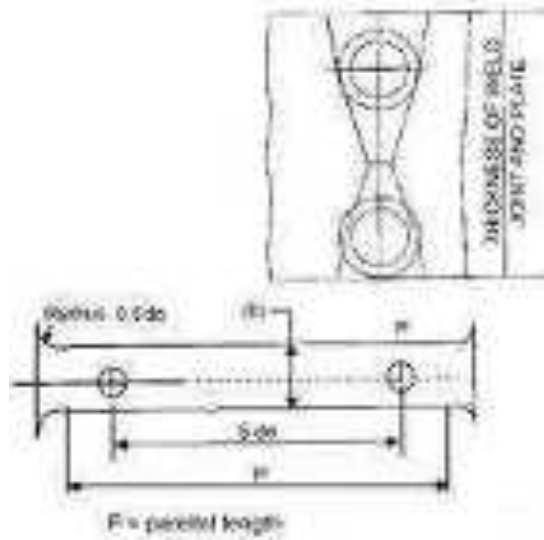
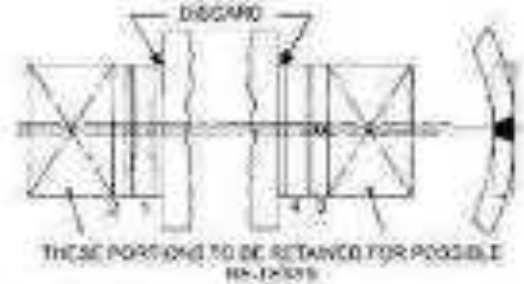


Fig. 12/77: Tensile Test All-Weld Metal



1. TENSILE TEST FOR WELDED SEAM
2. BEND TEST — OUTER SURFACE OF THE WELDED JOINT
3. BEND TEST — FOR INNER SURFACE
4. SIDE WELD TEST

Fig. 12/79: Details of Test Plates

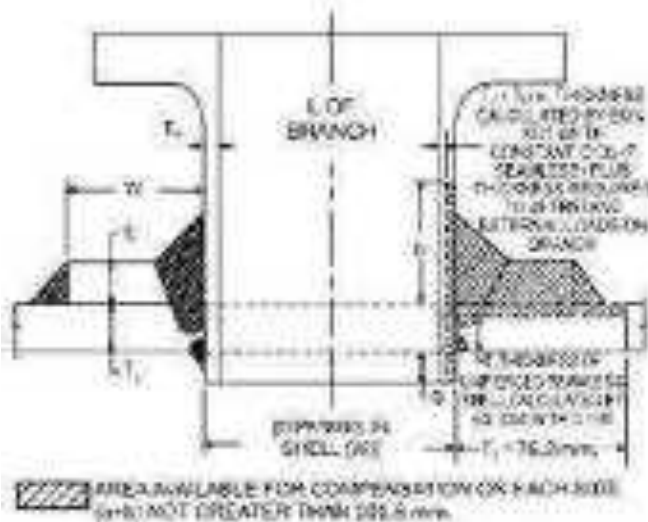


Fig. 12/80: Compensation for Branch

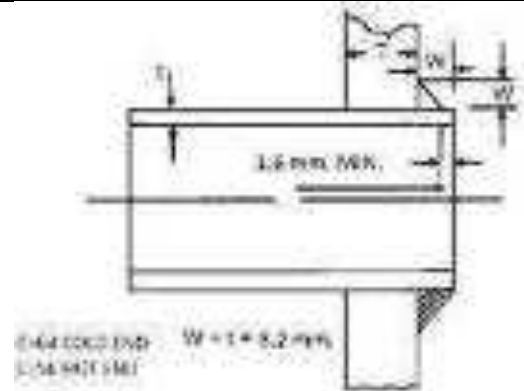


Fig. 12/81: Tubes to be Lightly Expanded into the Plate before Welding

All dimensions are in mm.

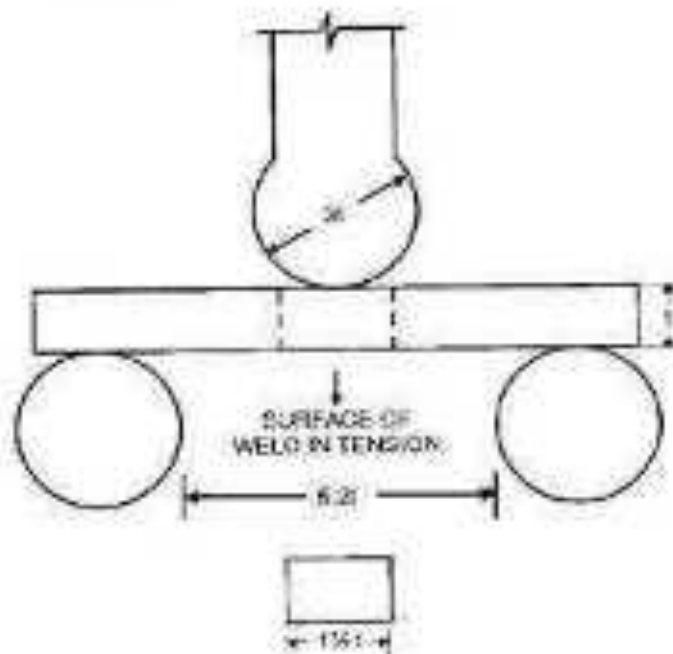
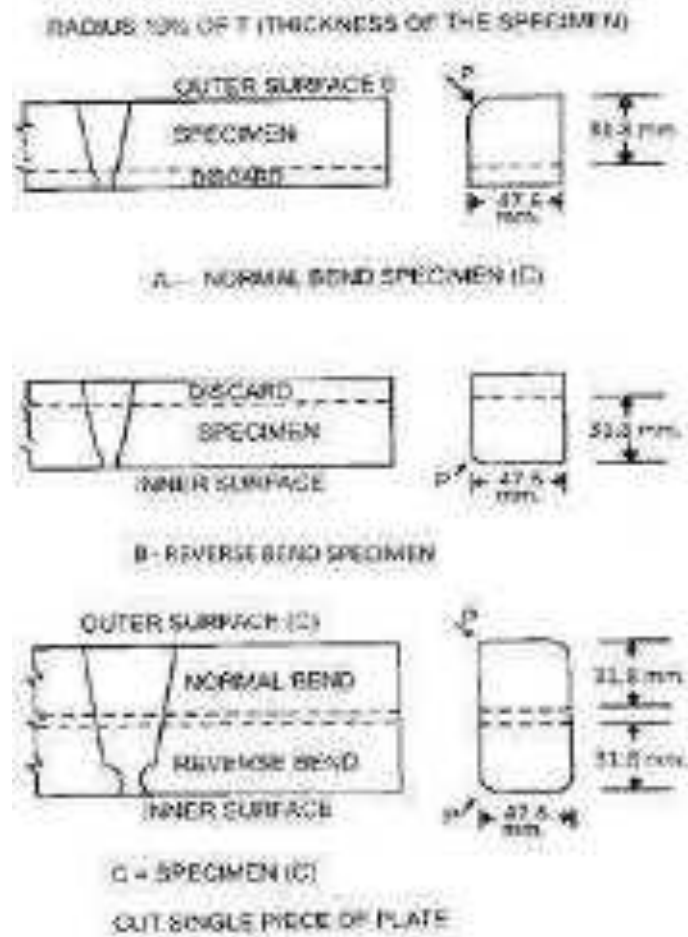


Fig. 12/78

All dimensions are in mm.

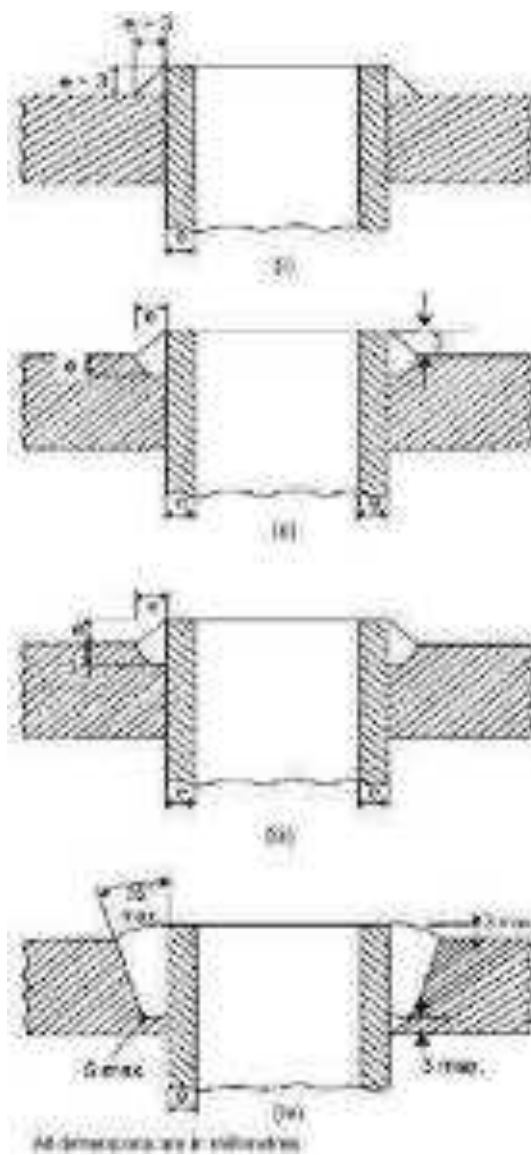


Fig. 12/84: Typical Attachment of Stay Tubes

All dimensions are in mm.

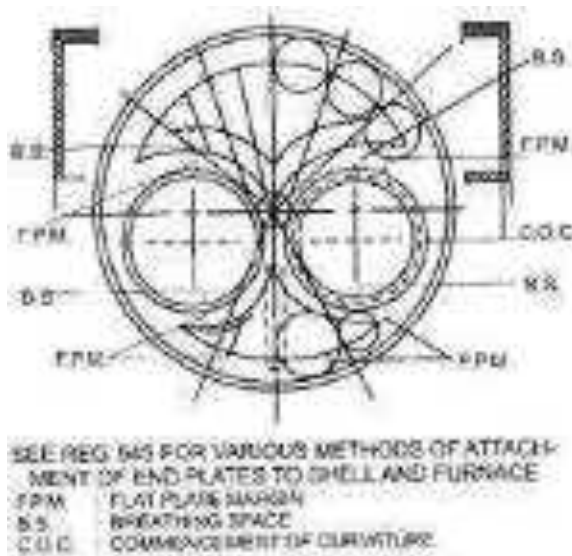


Fig. 12/87: Typical Arrangement of End Plates on Lancashire Boilers

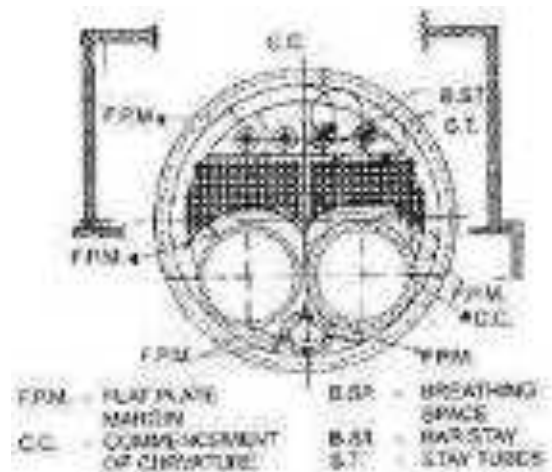


Fig. 12/90*: Typical Arrangement of End Plates of Economic Boilers

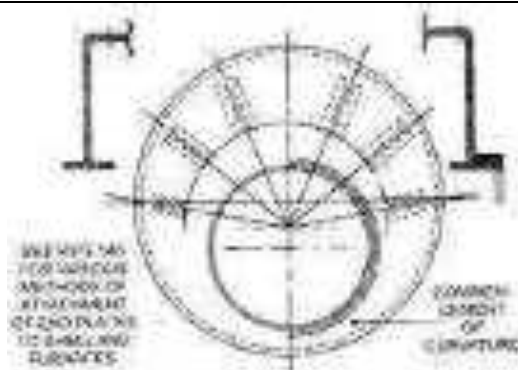


Fig. 12/88: Typical Arrangement of End Plates Cornish Boilers

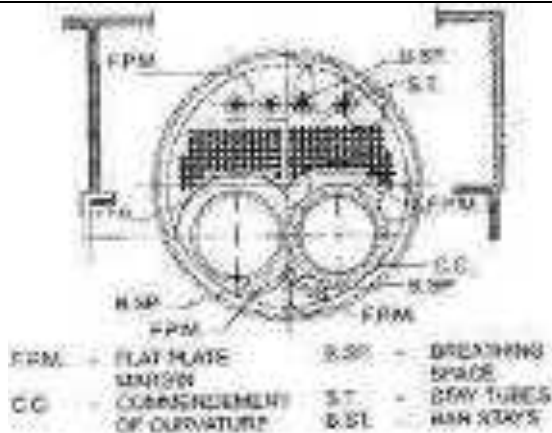


Fig. 12/91*: Typical Arrangement of End Plates on Economic Boilers

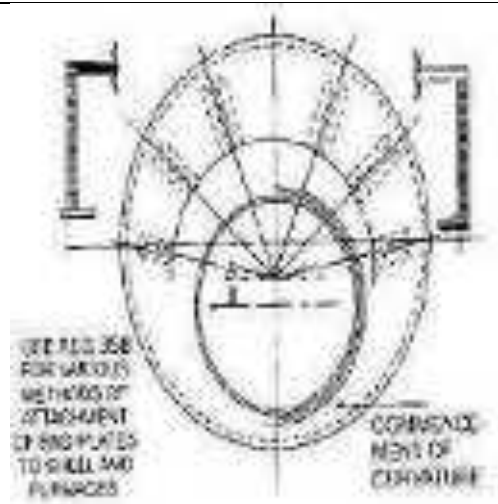


Fig. 12/89: Typical Arrangement of End Plates on Cornish Boilers

All dimensions are in mm.

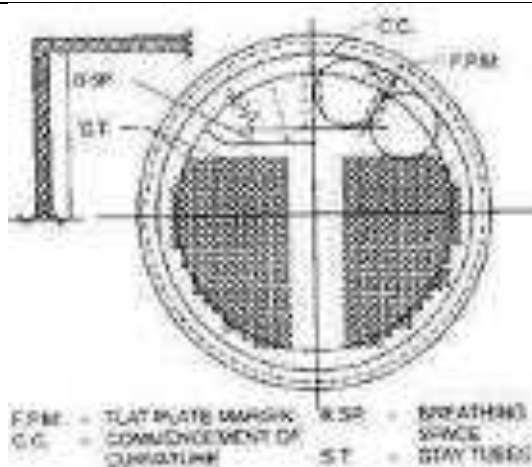


Fig. 12/92*: Typical Arrangement of End Plates on Multi-Tubular Boilers

*See Regulation 406 for various methods of attachment of end plates to shell and furnaces.

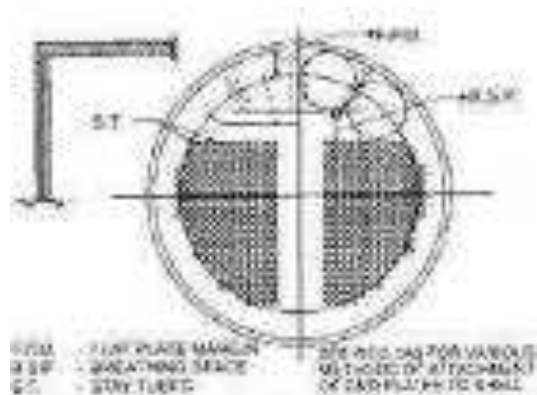


Fig. 12/93: Typical Arrangement of End Plates on Multi-Tubular Boilers

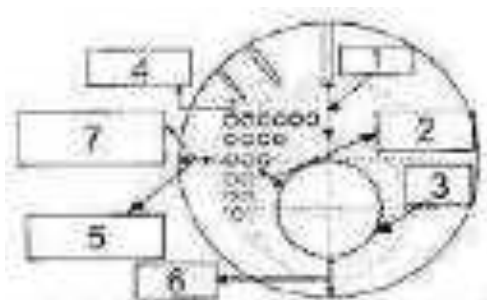
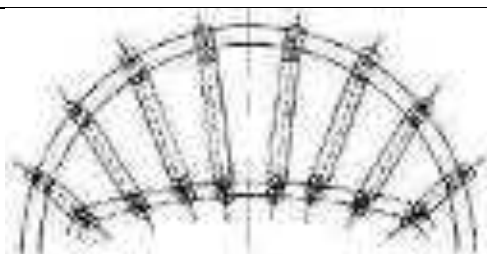


Fig. 12/97: Some of the Breathing Spaces in Small Type Boilers



For Other Method of Attachment See Figs.
12/47, 48& 49

Fig. 12/94: Arrangement of Firebox Crown Stays for Locomotive Boilers

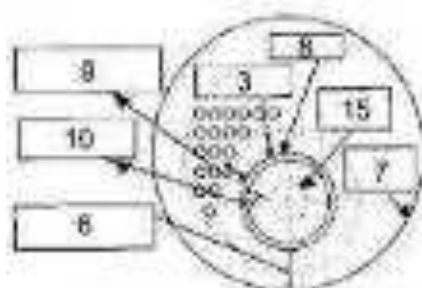


Fig. 12/98: Some of the Breathing Spaces of Reversible Flame Boilers

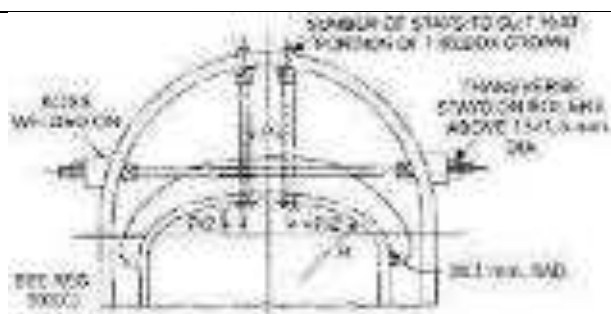


Fig. 12/95: Arrangement of Firebox Crown and Transverse Stays for Locotype Boilers

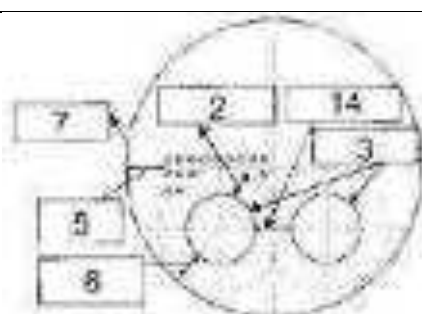


Fig. 12/99: Some of the Breathing Spaces in Boilers with more than one Furnace

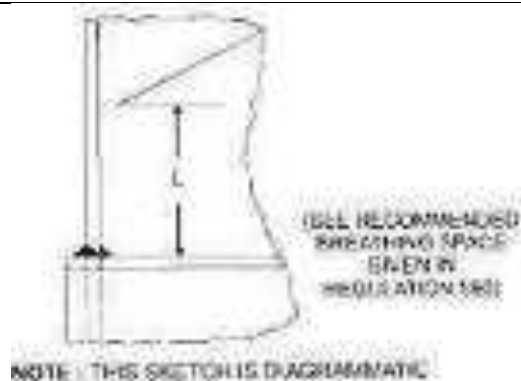


Fig. 12/96: Breathing Space

All dimensions are in mm.

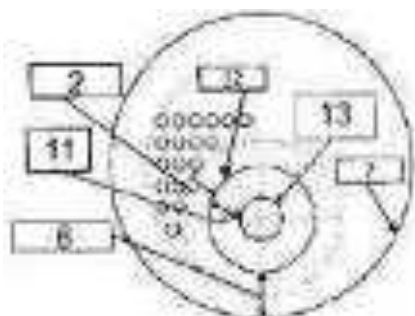


Fig. 12/100: Some of the Breathing Spaces of Stepped Furnace

1. B. Sp. between Gusset/Link Stays and Furnace.
2. B. Sp. between Furnace and Tubes/Tube Nest.
3. Outer Diameter of Furnace.
4. B. Sp. between Gusset/Link Stays and Tubes/Tube Nest.
5. B. Sp. between Shell and Tubes/Tube Nest.
6. B. Sp. between Furnace and Shell.
7. Inner Diameter of Shell.
8. Inner Diameter of the Furnace.
9. B. Sp. at the Front End between Furnace and Tubes/Tube Nest.
10. B. Sp. formed by the outer annular area of the Furnace Rear Plate.
11. Stepping in terms of radius.
12. Outer Dia. of the highest diameter portion of the Stepped Furnace.
13. Outer dia. of the lowest diameter portion if the Stepped Furnace.



Fig. 12/101: Typical Details For All-Welded Gusset Stay

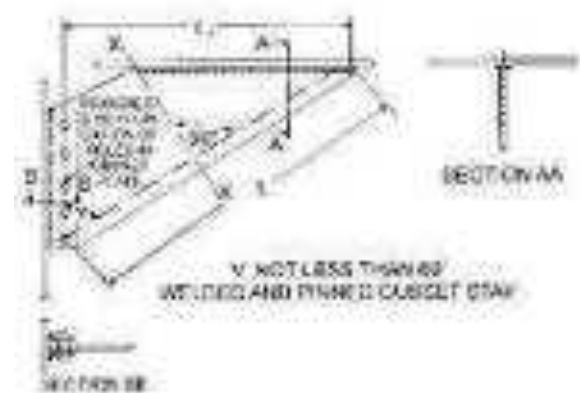


Fig. 12/102: Typical Details for Welded and Pinned Gusset Stay

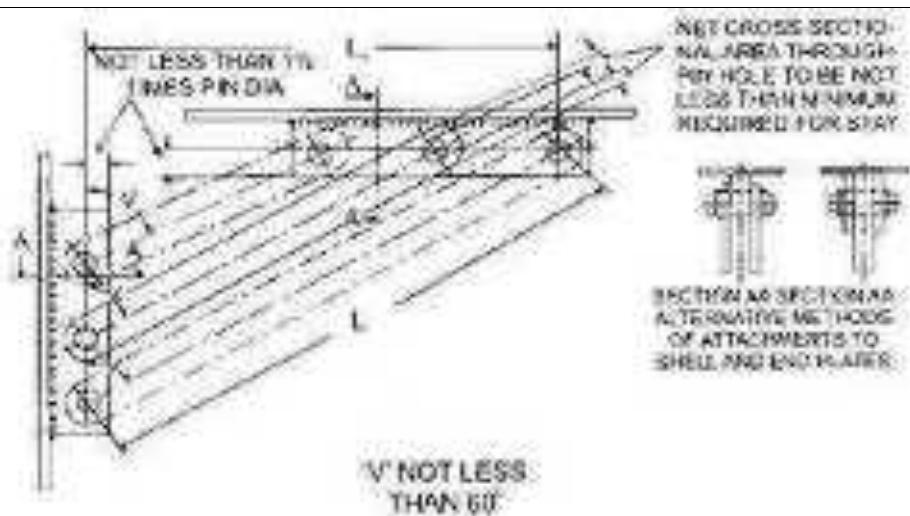


Fig. 12/103: Typical Details for Diagonal Stays
(Chain Lines Indicates Stay with Multiple Links)

All dimensions are in mm.

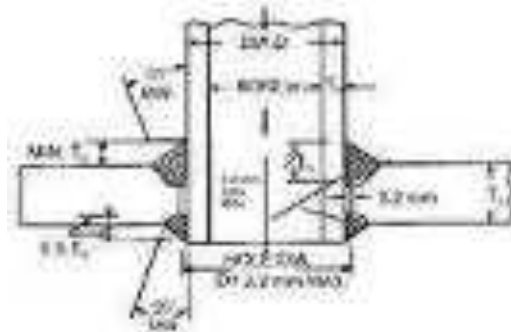
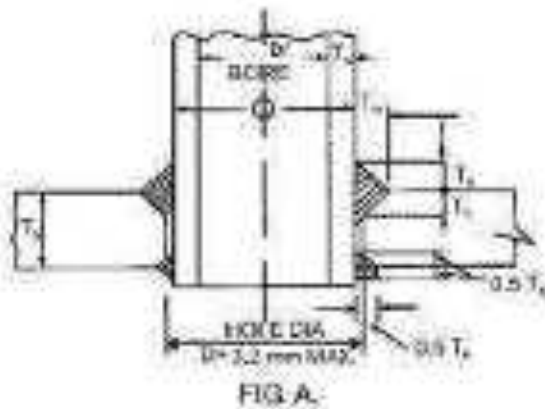
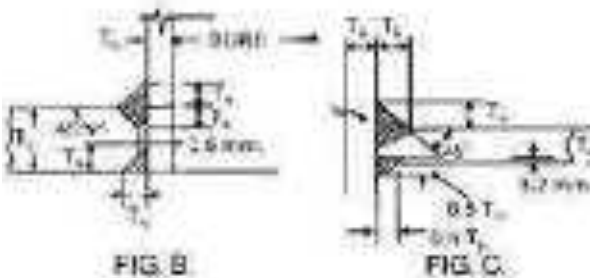


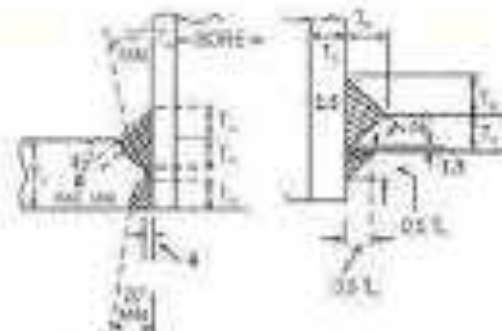
Fig. 12/105



MINIMUM WELD THICKNESS WHERE PLATE THICKNESS T_2 IS LESS THAN 1.5 T.

Note: THE TYPES IN 'A' AND 'B' ARE ONLY PERMITTED WHERE THE ELECTRODES AND TECHNIQUE TO BE USED HAVE BEEN SHOWN BY SEPARATELY PREPARED TEST SPECIMEN TO GIVE FULL PENETRATION WITH SOUND WELD METAL THE ROOT OF THE GROOVES.

Fig. 12/104: Minimum Weld Attachment For Stand Pipes Up to and Including 127 mm Bore Not Requiring Compensating Plates



MINIMUM WELD DIMENSIONS WHERE PLATE THICKNESS T_2 IS LESS THAN 1.5 T.

FIG. 12/105, 12/106 & 12/107

— MINIMUM WELD ATTACHMENTS FOR STANDPIPES OVER 127 mm BORE NOT REQUIRING COMPENSATING PLATES

All dimensions are in mm.

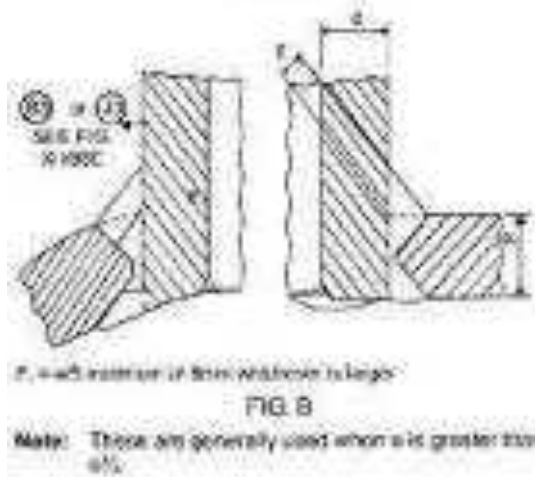
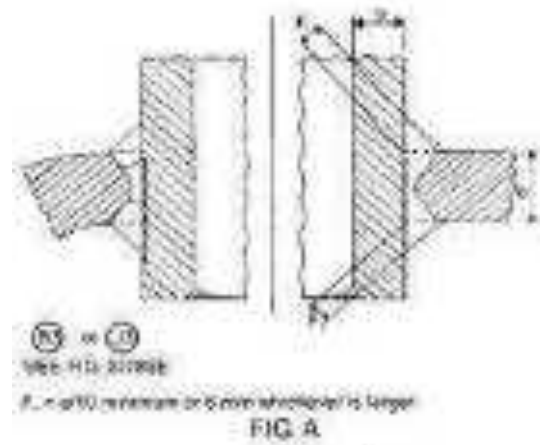
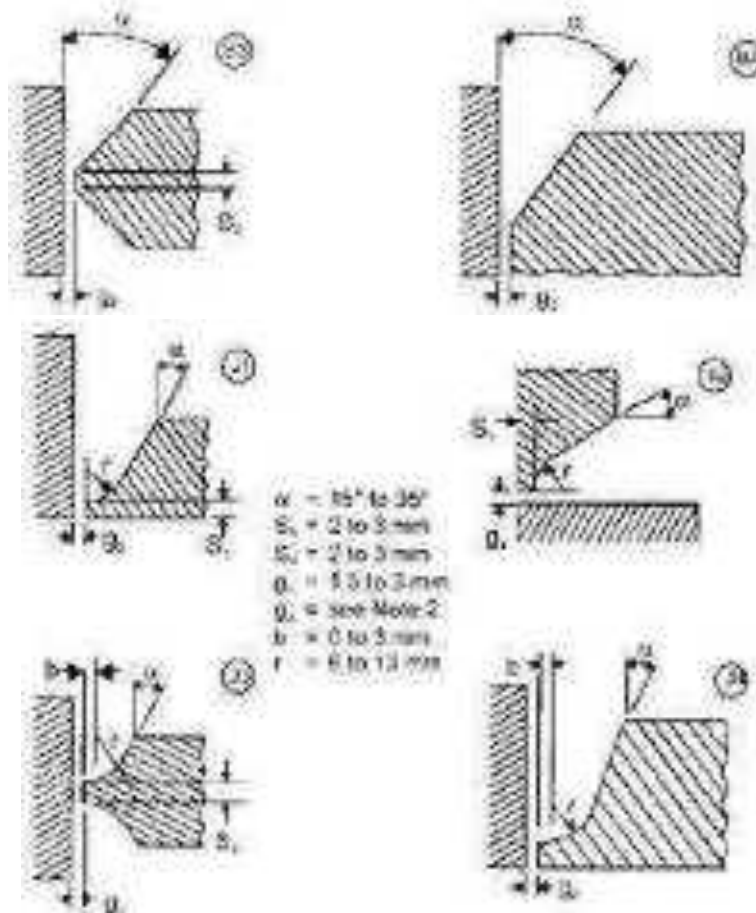


Fig. 12/108: Set in Branches (Full Penetration Weld)





Note 1. These recommendations have been included for general guidance discretion should be used in applying the maximum and minimum dimensions quoted which are subject to variation according to the welding procedure employed for example, size and type of electrodes the position in which the welding is carried out and the practicability of carrying out satisfactory non destructive testing, where necessary.

2. It is recommended that in no case should the gap between the branch and shell exceed 3 mm, wider gaps increase the tendency to spontaneous cracking during welding particularly as the thickness of the parts joined increases.

Fig. 12/109: Standard Weld Preparation Detail

Fig. 12/118: Typical Preparation and Assembly of Set on Right Angle Branches Without Backing

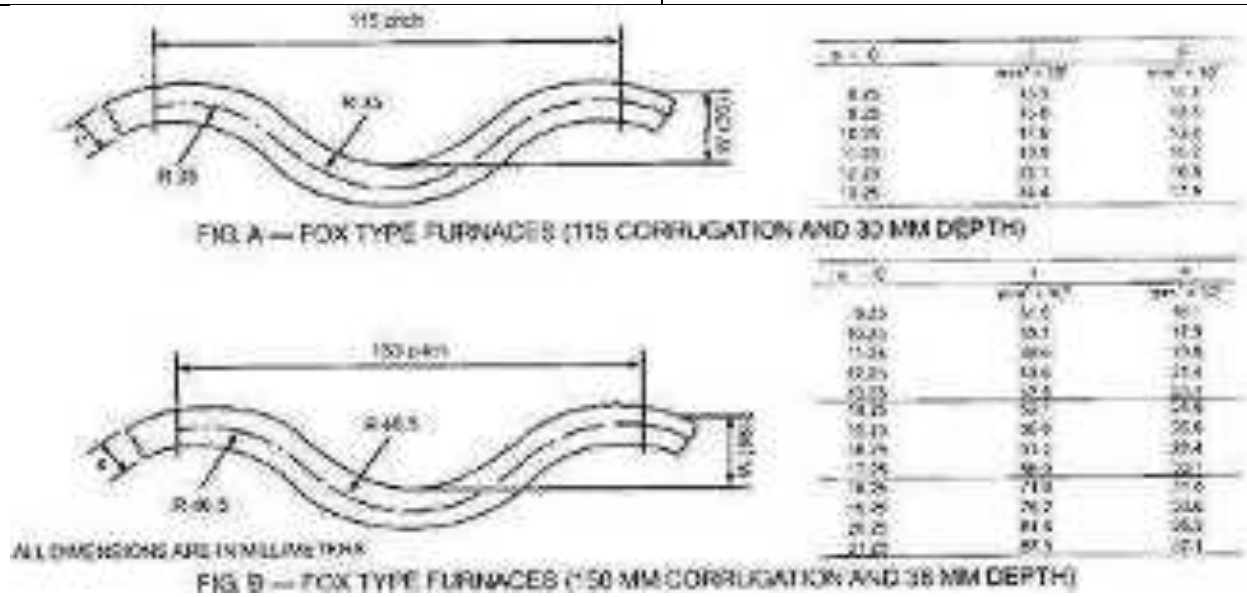


Fig. 12/119: Second Moments of Area and Cross-Sectional Area F (Contd.)...

All dimensions are in mm.

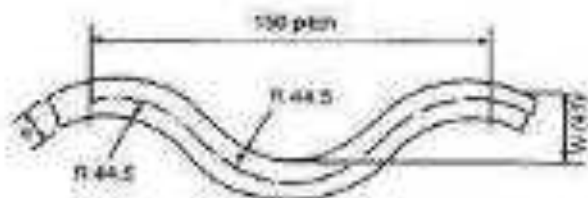


FIG. C — FOX TYPE FURNACES (150 MM CORRUGATION AND 41 MM DEPTH)



FIG. D — MORRISON TYPE FURNACES (200 MM CORRUGATION AND 33 MM DEPTH)

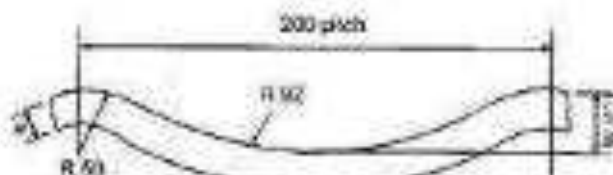


FIG. E — MORRISON TYPE FURNACES (200 MM CORRUGATION AND 41 MM DEPTH)

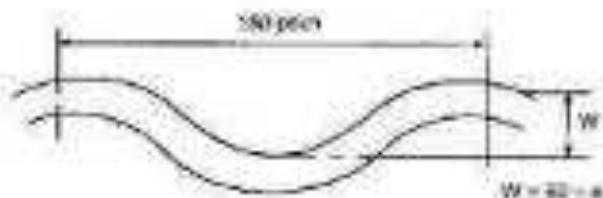


FIG. F — FOX TYPE FURNACES (150 MM CORRUGATION AND 50 MM DEPTH)



FIG. G — FOX TYPE FURNACES (200 MM CORRUGATION AND 75 MM DEPTH)

ALL DIMENSIONS ARE IN MILLIMETERS

$a = 0$	I	F
	$\text{cm}^2 \times 10^4$	$\text{cm}^2 \times 10^4$
8.25	23.7	100
10.25	40.2	143
12.25	66.5	20.1
13.25	67.5	21.3
14.25	81.1	25.4
15.25	88.8	27.2
16.25	71.6	29.6
17.25	70.5	33.6
18.25	83.0	37.8
19.25	88.4	34.2
20.25	95.6	38.1
21.25	102.5	37.9

$a = 0$	I	F
	$\text{cm}^2 \times 10^4$	$\text{cm}^2 \times 10^4$
8.25	59.6	20.2
10.25	63.2	22.4
11.25	47.5	24.5
12.25	22.0	20.8
13.25	27.5	22.5
14.25	32.6	21.2
15.25	40.8	22.8
16.25	73.2	25.6
17.25	78.8	21.8
18.25	84.8	26.9
19.25	96.8	27.1
20.25	98.2	24.2
21.25	100.2	26.5

$a = 0$	I	F
	$\text{cm}^2 \times 10^4$	$\text{cm}^2 \times 10^4$
8.25	48.5	20.5
10.25	60.8	20.3
11.25	26.3	26.0
12.25	61.8	27.3
13.25	47.5	26.4
14.25	72.3	25.6
15.25	70.5	23.4
16.25	80.5	28.7
17.25	87.8	30.1
18.25	62.4	40.2
19.25	106.2	32.1
20.25	113.0	46.8
21.25	79.6	47.2

$a = 0$	I	F
	$\text{cm}^2 \times 10^4$	$\text{cm}^2 \times 10^4$
8.25	15.6	9.1
10.25	11.1	9.8
11.25	20.6	9.9
12.25	47.2	21.7
13.25	42.7	22.1
14.25	41.1	24.1
15.25	34.3	26.3
16.25	46.4	22.4
17.25	47.8	26.5
18.25	48.5	28.4
19.25	46.2	27.9
20.25	50.2	29.1
21.25	51.6	26.8

$a = 0$	I	F
	$\text{cm}^2 \times 10^4$	$\text{cm}^2 \times 10^4$
8.25	120.6	25.2
10.25	138.6	25.1
11.25	147.1	26.1
12.25	160.8	26.8
13.25	185.1	32.8
14.25	200.5	34.9
15.25	207.0	37.7
16.25	193.0	26.4
17.25	198.0	41.6
18.25	191.6	45.7
19.25	198.4	46.8
20.25	200.0	46.0
21.25	206.6	50.0

Fig. 12/119: Second Moments of Area and Cross-Sectional Area F (Concluded).

All dimensions are in mm.

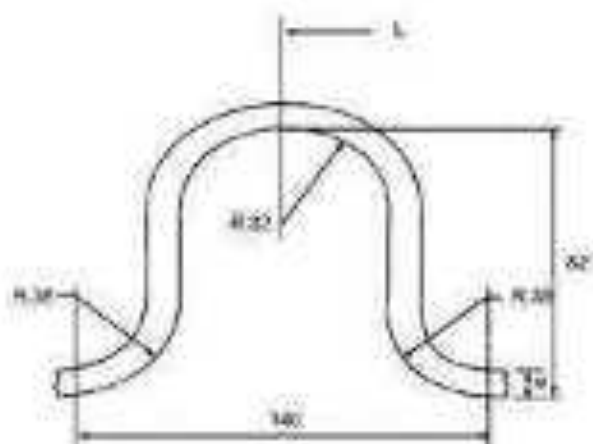


FIG A

a - C	I
	$\text{mm}^4 \times 10^4$
9.25	1.50
10.25	2.11
11.25	2.32
12.25	2.93
13.25	2.74
14.25	2.96
15.25	3.18
16.25	3.40
17.25	3.62
18.25	3.85
19.25	4.06
20.25	4.27
21.25	4.50

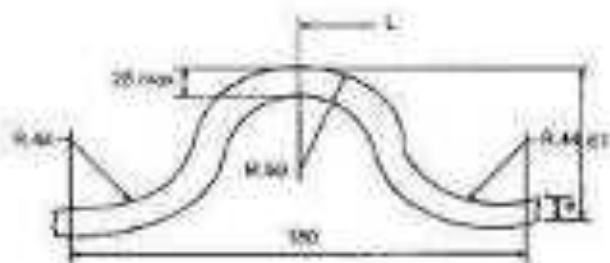


FIG B

a - C	I
	$\text{mm}^4 \times 10^4$
9.25	1.50
10.25	2.11
11.25	2.32
12.25	2.74
13.25	2.96
14.25	3.18
15.25	3.40
16.25	3.62
17.25	3.85
18.25	4.06
19.25	4.27
20.25	4.50
21.25	4.73

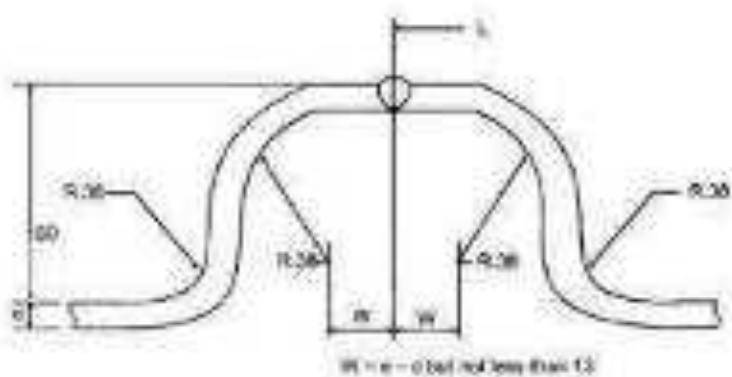


FIG C

a - C	I
	$\text{mm}^4 \times 10^4$
9.25	1.50
10.25	2.11
11.25	2.32
12.25	2.74
13.25	2.96
14.25	3.18
15.25	3.40
16.25	3.62
17.25	3.85
18.25	4.06
19.25	4.27
20.25	4.50
21.25	4.73

ALL DIMENSIONS ARE IN MILLIMETERS

Fig. 12/120

CHAPTER-13**QUALIFICATION TESTS FOR WELDERS AND WELDING OPERATORS ENGAGED IN WELDING AND REPAIR OF BOILERS AND BOILER COMPONENTS, PIPES, HEAT EXCHANGER AND HEAT EXCHANGER COMPONENTS UNDER CONSTRUCTION, ERECTION AND FABRICATION AT SITE.**

505. Application.— (1) These regulations shall apply to testing of welders and welding operators engaged in welding and repair of boilers and boiler components, steam-pipes, heat exchanger and heat exchanger components of ferrous and nonferrous material under construction, erection and fabrication at site.

PART-1**Definitions**

506. Welder.— Welder means a person who performs manual or semi-automatic welding.

507. Welding operator.— Welding operator means a person who operates machine or automatic welding equipment.

508. Reasonable continuity of service.— The continuity of service of the welder or welding operator shall be considered as continuity of service if he retains the initial skill level though not engaged in welding for a period of upto six months.

509. U-Number.—(1) U Number grouping of electrodes and welding consumables in table 13/5 of regulation 520 is based essentially on their usability characteristics, which determine the ability of welders to make satisfactory welds with a given welding consumables.

(2) This grouping is intended to reduce the number of welding performance qualifications.

PART-2**Welding Positions**

510. Plate groove welding.— The welding positions as mentioned in Figure 13/1 of this chapter shall be as following, namely:-

- (i) Flat position 13/LGF; Plate in a horizontal plane with the weld metal deposited from above.
- (ii) Horizontal Position 13/LGH; Plate in a vertical plane with the axis of the weld horizontal.
- (iii) Vertical Position 13/LGV; Plate in a vertical plan with the axis of the weld vertical.
- (iv) Overhead Position 13/LGO; Plate in a horizontal plane with the weld metal deposited from underneath.

511. Plate fillet welding.— The welding positions as mentioned in Figure 13/2 of this chapter shall be as following, namely:-

- (i) Flat Position 13/LFF; Plates so placed that the weld is deposited with its axis horizontal and its throat vertical
- (ii) Horizontal Position 13/LFH; Plates so placed that the weld is deposited with its axis horizontal on the upper side of the horizontal surface and against the vertical surface.
- (iii) Vertical Position 13/LFV; Plates so placed that weld is deposited with its axis vertical.
- (iv) Overhead Position 13/LFO; Plates so placed that the weld is deposited with its axis horizontal on the underside of the horizontal surface and against the vertical surface.

512. Pipe groove welding.— The welding position of pipe groove welding as mentioned in Figure 13/3 of this chapter shall be as following, namely:-

- (i) Horizontal Rolled 13/PGR; Pipe with its axis horizontal and rolled during welding so that the weld metal is deposited from above with the axis of the weld horizontal.
- (ii) Vertical Fixed 13/PGV; One test of groove welded joint with the axis of the pipe in a vertical position and the seam welded circumferentially in a horizontal position.
- (iii) Horizontal Fixed 13/PGH; One test of groove welded joint with the axis of the pipe in a horizontal position and the seam welded without rotating the pipe.
- (iv) Pipe Inclined 13/PGI; One test of groove welded joint with the axis of the pipe inclined 45 degree to the horizontal axis and the seam welded without rotating the pipe.

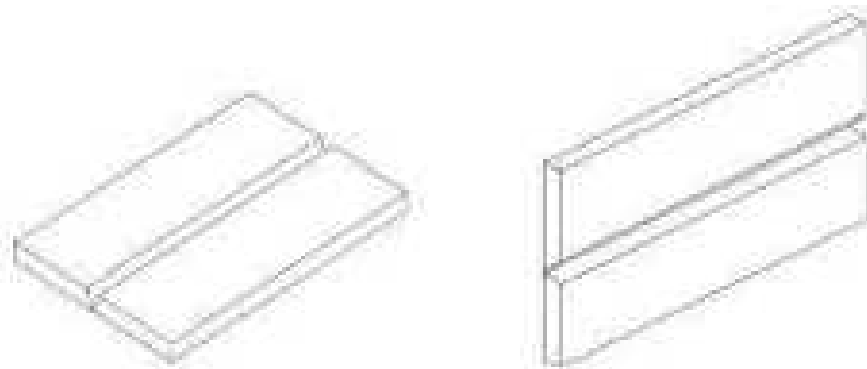


FIGURE13/LGF: Plate Groove Flat Position **FIGURE13/LGH:** Plate Groove Horizontal Position

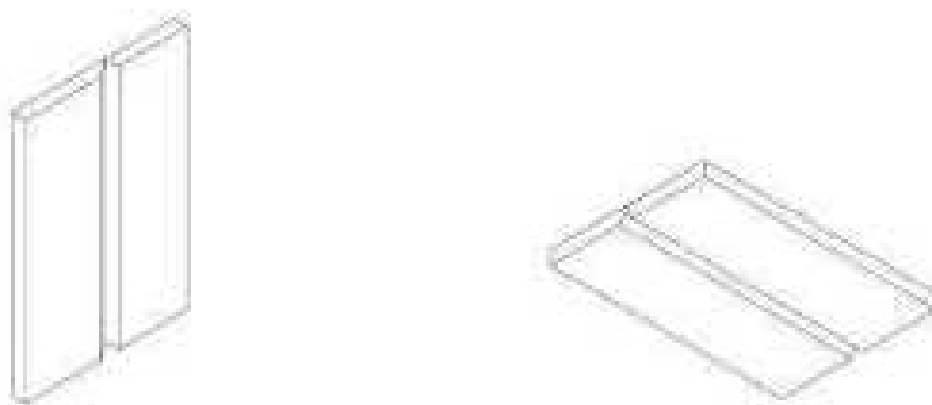
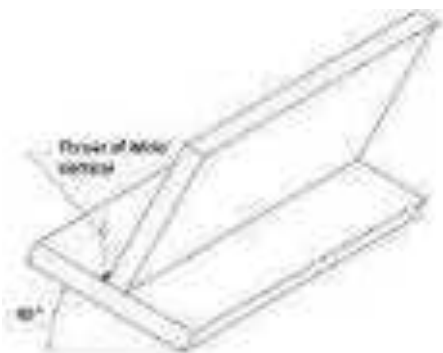
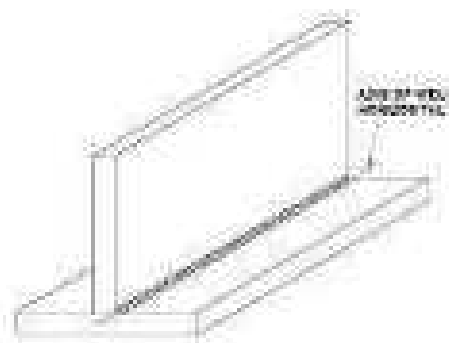
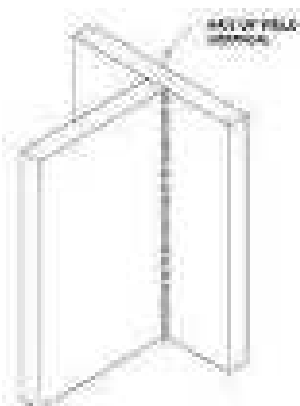


FIGURE13/LGV: Plate Groove Vertical Position **FIGURE13/LGO:** Plate Groove Overhead Position

Size: 16 x 150 x 400 mm -- 2 Nos.

TEST POSITIONS

FIGURE :13/1 PLATE GROOVE JOINTS

**FIGURE13/LFF:** Plate Fillet Flat Position**FIGURE13/LFH:** Plate Fillet Horizontal Position**FIGURE13/LFV:** Plate Fillet Vertical Position**FIGURE13/LFO:** Plate Fillet Overhead Position

Size: 16 x 75 x 300 mm -- 2 Nos

TEST POSITIONS

FIGURE13/2: PLATE FILLET JOINTS (TEE)

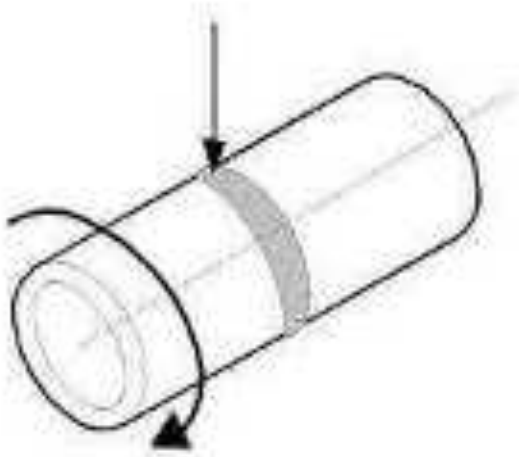


FIGURE13/PGR: PIPE Axis Horizontal
Welding from Top Flat Position (Pipe Rotated)

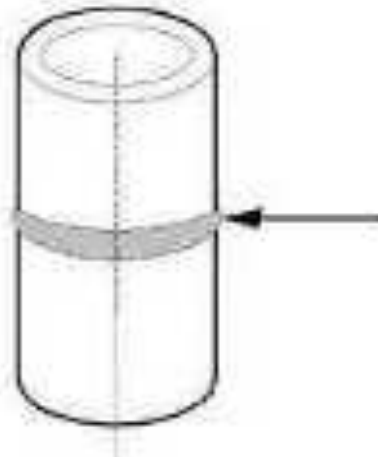


FIGURE13/PGV: Pipe Axis Vertical
Weld Horizontal position (Pipe Fixed)

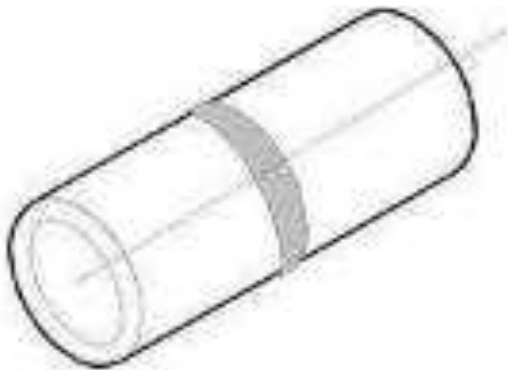


FIGURE13/PGH: PIPE Axis Horizontal
Weld All around (Pipe Fixed)

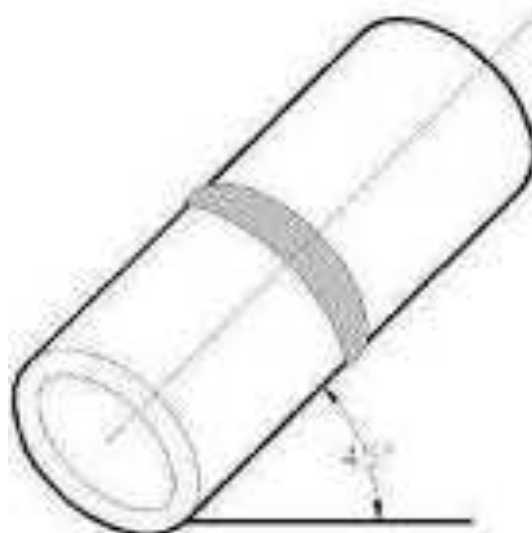


FIGURE13/PGI: Pipe Axis Inclined at 45°
Weld All around (Pipe Fixed)

Size: Pipe Dia 127.5mm x 12.5mm thick or more

Tube Dia 76.1mm X 8.8mm thick or less

TEST POSITIONS

FIGURE13/3 PIPE/TUBE GROOVE JOINTS

PART-3

513. Engagement of certified welders or welding operators.— (1) No welder or welding operator shall be engaged for welding on boilers or steam-pipes under construction, erection or fabrication at site or in the repair of boilers or steam-pipes, unless he possesses a certificate as required under the regulations and attains the age not less than eighteen years.

- (2) He shall have undergone a regular apprenticeship of two years from a recognised Industrial training institute or have at least one year regular on the job industrial experience as a welder or welding operator.
- (3) The holder of such certificate shall be bound to produce it when called upon to do so by the Inspecting Authority or Competent Person.
- (4) In case of engaging experienced welders or welding operators, reasonable continuity of service shall be ensured by the employer before engaging them by maintaining proper records of test conducted by the employing organisation.

514. Initial qualification test and issue of certificate.— (1) Every welder or welding operator shall meet the qualification requirement to the satisfaction of the Competent Authority who shall assess his performance for qualifying for the certificate.

(2) The Competent Authority may, thereafter, issue a certificate in the Form-II indicating the class and type of welding in which he has qualified.

515. Issue of duplicate certificate.— (1) In case of loss of a certificate issued to a welder or welding operator in Form-XXI, a duplicate certificate may be issued by the Competent Authority who issued the original certificate provided that the Competent Authority is satisfied with the genuineness of the case.

(2) Fee for issue of duplicate certificate shall be as per regulation 331.

516. Validity of certificate.— (1) The certificate issued to a welder or welding operator under these regulations shall remain valid for a maximum period of twenty-four months from the date of issue, provided that the holder thereof has, subsequent to the test, been employed with reasonable continuity on the class and type of work for which he is qualified.

517. Revalidation or renewal of certificate.— (1) The certificate may be renewed after the validity of 24 months from the date of qualification from time to time, for a period not exceeding twenty-four months at a time, in case the welder or welding operator is continuously engaged in qualified process and certified by the organisation for which he is working.

(2) The details of welding continuity shall be filled up in the Form-XX duly signed by the organisation and preserved along with the original certificate and put up to Competent Authority for renewal.

(3) In case of non-fulfilment of continuity criteria the welder or welding operator shall appear for the re-qualification test to the satisfaction of the Competent Authority.

518. Revoking of qualification.— (1) The performance qualification of a welder or welding operator can be revoked by the Competent Authority if there is a specific reason to question his ability to make welds that meet the specification.

(2) The qualification that support the welding that he is doing shall be revoked.

519. Hierarchy of qualifications. — (1) (a) Initially, a welder or welding operator may be qualified in carbon steel plate and subsequently, allowed to appear for qualification testing in alloy steel plate, carbon steel or alloy steel pipe and tube qualification. or, a welder or welding operator may be tested for higher grades, pipe and tube directly.

(b) The range of qualification covered by testing of a particular grade of material or product form shall be as shown in Table 13/1.

(2) The qualification certificate of such a welder or welding operator who has successfully completed qualification test, may be extended as per regulation 517.

Table 13/1. Range of qualification for a welder or welding operator in material and product form

Serial No.	Tested with	Qualified for			
		Carbon steel plate	Carbon steel pipe and tube	Alloy steel plate	Alloy steel pipe and tube
(1)	(2)	(3)	(4)	(5)	(6)
1.	Carbon steel plate	Yes	No	No	No
2.	Carbon steel pipe and tube	Yes	Yes	No	No
3.	Alloy steel plate	Yes	No	Yes	No
4.	Alloy steel pipe and tube	Yes	Yes	Yes	Yes

520. Essential variables for welder or welding operator requalification. — A welder or welding operator shall require requalification whenever a change is made in one of the following essential variables, namely:-

- (i) An omission of backing- A welder or welding operator needs requalification when the backing is removed and double-welded groove welds are considered welding with backing.
- (ii) An addition of the backing in gas welding - A welder or welding operator shall require requalification when the backing is introduced in gas welding process.
- (iii) A change in U number of electrode - A welder shall require requalification when the consumable group designation is changed from one U number to other U number (refer Table 13/5 & Table 13/6 of this regulation).
- (iv) A change in the base metal (M number) to be welded - A welder shall require requalification when the base metal is changed (refer Table 2/1 in Chapter-2 and Table 13/7 in this Chapter). However, a welder who is qualified in a higher grade of steel shall be permitted to weld a lower grade of steel.
- (v) A change from one welding process to any other process - A welder shall require requalification when the welding process is changed.
- (vi) A change from direct current to alternating current, and vice versa - A welder shall require requalification when the current type is changed from 'dc' to 'ac' and vice versa.
- (vii) A change in welding position —(a) A welder shall require requalification when the position in which he is qualified is changed.

- (b) A welder who is qualified in more difficult position shall be deemed to be qualified for a less difficult position as given in tables 13/2, 13/3 and 13/4.
- (viii) Change in pipe diameter from qualified range.
- (ix) Change in welding progression in vertical welding.
- (x) Change in deposited weld metal thickness qualified (see Table 13/8)

Table 13/2: Additional positions in which a welder is qualified (plate groove welding)

Serial No.	Test position	Additional qualified position			
		Flat (Fig. 13/1)	Horizontal (Fig. 13/2)	Vertical (Fig. 13/3)	Overhead (Fig. 13/4)
(1)	(2)	(3)	(4)	(5)	(6)
1.	Flat (Fig. XIII/1)	Yes	No	No	No
2.	Horizontal (Fig. XIII/2)	Yes	Yes	No	No
3.	Vertical (Fig. XIII/3)	Yes	No	Yes	No
4.	Overhead (Fig. XIII/4)	Yes	No	No	Yes

Table 13/3: Additional positions in which a welder is qualified (plate fillet welding)

Serial No.	Test position	Additional qualified position			
		Flat (Fig. 13/LFF)	Horizontal (Fig. 13/LFH)	Vertical (Fig. 13/LFV)	Overhead (Fig. 13/LFO)
(1)	(2)	(3)	(4)	(5)	(6)
1.	Flat (Fig. 13/LFF)	Yes	No	No	No
2.	Horizontal (Fig. 13/LFH)	Yes	Yes	No	No
3.	Vertical (Fig. 13/LFV)	Yes	Yes	Yes	No
4.	Overhead (Fig. 13/LFO)	Yes	Yes	No	Yes

Table 13/4: Additional positions in which a welder is qualified (pipe groove welding)

Serial No.	Test position	Additional qualified position			
		Horizontal rolled (Fig. 13/PGR)	Vertical fixed (Fig. 13/PGV)	Horizontal fixed (Fig. XIII/PGH)	Pipe Inclined to 45° (Fig. 13/PGI)
(1)	(2)	(3)	(4)	(5)	(6)
1.	Horizontal rolled (Fig. 13/PGR)	Yes	No	No	No
2.	Vertical fixed (Fig. 13/PGV)	Yes	Yes	No	No
3.	Horizontal fixed (Fig. 13/PGH)	Yes	No	Yes	No
4.	Pipe Inclined to 45° (Fig.13/PGI)	Yes	Yes	Yes	Yes

Table 13/5: Electrode classification Groups

Serial No.	Group Designation	Electrode Classification
(1)	(2)	(3)
1	U1	EXX10, EXX13, EXX13-X.
2	U2	EXX15, EXX16, EXX18, EXX48, EXX15-X, EXX16-X, EXX18-X, E410-15/16, E347-15/16, E308-15/16, E309-15/16, E310-15/16, E316-15/16, E2209-15/16
3	U3	ERXXS-X, ERXXX (Austenitic stainless steel), ERXXXX (Duplex Stainless Steel), EXXT-X, EXXC-X
4	U4	All Nickel and Nickel Alloy
5	U5	ECrCo-A/B/C/E,
6	U6	ERCoCr-A/B/C/E/F/G

Note: The letters “XX” used in the classification designation in this table stand for the various strength levels (60[415], 70[485], 80[550], 90[620], 100[690], 110[760], 120[830]) of electrodes, “X” stands for weld metal chemical analysis.

Table 13/6: Alternate U-No. Qualified for welders and welding operator’s qualification

Serial No.	Tested with	Qualified range
(1)	(2)	(3)
1	U1	U1 only
2	U2	U1 and U2
3	U3	U3 only
4	U4	U4 only
5	U5	U5 only
6	U6	U6 only

Table 13/7: Alternate ‘M’ Nos. qualified for welders and welding operator’s qualification

Serial No.	Tested with ‘M’ Number	Range of Qualified ‘M’ Numbers
(1)	(2)	(3)
1	M1 Gr2	M1 only
2	M5A or M5B or M15E	M1 to M15E
3	M8	M1 & M8
4	M43	M43 only

Table 13/8: Qualified thickness range for Welder / Welding operator qualification

Serial No.	Deposited Thickness of Weld t (mm) ^a	Range of Qualified thickness
(1)	(2)	(3)
1.	$t < 12$	2t
2.	$t \geq 12$ ^b	Unlimited

Note:

a For multi process welding “t” is the deposited thickness of each processes

b The test piece has to be welded with minimum 3 layers

Table 13/9: Welder and welding operators’ qualification thickness limits and test specimens for Hard-facing (Wear resistant) and corrosion –resistant overlays

Serial No.	Thickness of test coupon (T)	Corrosion –resistant and Hard-facing overlays
		Base Metal Thickness Qualified
(1)	(2)	(3)
1	Less than 25 mm	T qualified to unlimited
2	25 mm and over	25 mm to unlimited

PART-4

521. Tests for initial qualification of a welder or welding operator.— For qualification of a welder, the welder or welding operator has to appear for the tests as given in regulations 522 to 526.

522. Theoretical examination.— A welder or welding operator shall be required to answer questions on the following subjects, orally or otherwise-

- (i) Weld preparation
- (ii) Elementary knowledge of the working of welding equipment.
- (iii) Elementary knowledge of properties of material to be welded – cold and hot working, thermal conductivity, fusion point, oxidation (for welders engaged in alloy steel welding).
- (iv) Elementary knowledge of electro-technical principles, - kinds of current, striking arc voltage, welding – arc voltage (for arc welders).
- (v) Kinds of welds, welding defects and their prevention, welding technique (forward and backward), influence of electrical parameters like amperage (for electric arc welders), preheating of base material and subsequent heat treatment.
- (vi) Electrodes and filler metals for different types of welds and steels and joints in different positions.

523. Practical tests.—(1) The welder or welding operator shall be required to undergo and pass the tests as given in regulations 524 to 526.

(2) The material of plates, tubes, pipes and electrodes used for these tests shall conform to the requirements of appropriate regulations as may be applicable in each case.

524. Plate Welding.— (1) One groove welded joint of two pieces of plates with single V, double V or double U grooves on boiler quality plates in the required positions (see Fig. 13/1 of regulation 512).

- (2) One fillet welded joint over a length of 381 mm using plates of not less than 16 mm thick in the required positions (see Fig. 13/2).

525. Pipe and tube Welding.— (1) A butt welded joint of two pieces of pipes with the axis in a horizontal position. (see Fig. 13/PGH) with a pipe diameter 127.5 x 12.5 mm thickness (minimum).

- (2) A butt welded joint of two pieces of boiler tubes of diameter 76.1 mm x 7.1 mm thickness (maximum) with the axis in a vertical position and tubes of same size fixed in adjoining positions at a pitch distance of 300 mm (see figure 13/PGV).
- (3) A weld between a branch tubes of diameter 88.9 mm (minimum) to a pipe (see Fig. 13/7). The branch tube shall not be of size less than 89 mm diameter x 6 mm thick.

526. Cladding.—(1) This test is required only for welders or welding operators doing corrosion resistant/hard facing overlay.

- (2) The qualification test coupon shall be of minimum size of 150 mm × 150 mm x T (thickness of base metal).
- (3) The weld overlay cladding shall be of 38 mm wide (minimum) and 5 mm thick (minimum two layers).
- (4) The weld overlay shall consist of a minimum of three weld beads in the first layer. (See Table 13/9 of chapter 13 for qualification limits.)

Note - Every welded test piece for the examination of welders shall be stamped with an identification mark on either side of the weld.

527. Tests for requalification of a welder / welding operator.— (1) The material of plates, tubes, pipes and electrodes used for practical tests shall conform to the requirements of appropriate regulations as may be applicable in each case.

(2) For requalification, the welder or welding operator need not be examined in theoretical subjects. He shall be required to qualify in the following practical tests, namely: -

- (i) Plate Welding; a groove welded joint shall be made in a position originally qualified.
 - (ii) Pipe and Tube welding; as mentioned in regulation 525.
 - (iii) Cladding; as mentioned in regulation 526.
- (3) When a welder is continuously engaged on production weld, test on the actual production joints to the satisfaction of the Competent Authority may be accepted as an alternative to the tests prescribed as above under clauses (i), (ii) and (iii) of sub-regulation (2).

PART-5

Examination of Test Specimens for Initial Qualification Tests

528. Groove welded plate specimens.—(1) (a) The Groove welded plate specimens after welding may be lightly pressed cold to remove any distortion due to welding.

(b) The test specimen shall be then subjected to visual examination and radiographic examination as mentioned in sub-regulation (2) of regulation 164 and thereafter test pieces shall be marked and cut out in the order shown in Fig. 13/4.

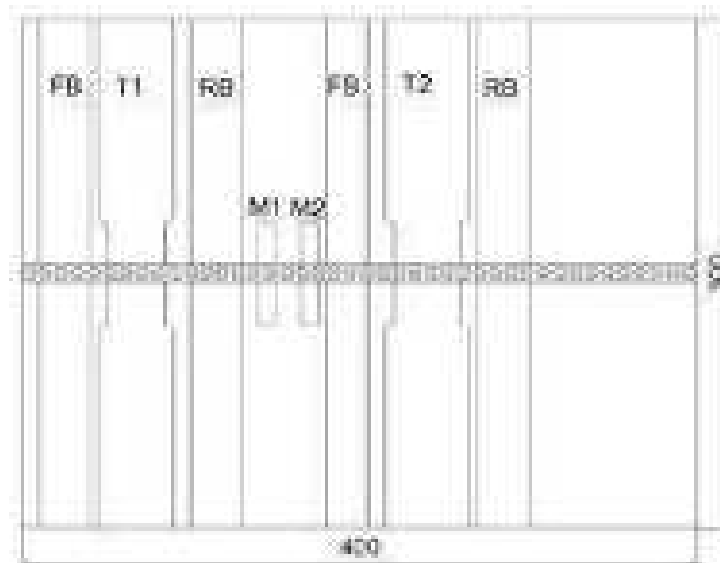


Fig. 13/4: ORDER OF REMOVAL OF TEST SPECIMEN FROM TEST PLATE FOR INITIAL QUALIFICATION TEST

(2) The tensile test specimens (T_1 and T_2) shall be prepared as per regulation 158. The bend test specimens two each (FB & RB) shall be prepared and tested as per regulations 160 and 161. Two specimens (M_1 & M_2) shall be prepared, one for macro and the other for micro examination as per sub-regulation (1) of regulation 164 and the results of macro and micro examination shall be satisfactory

(3) The test shall be deemed to have been satisfactory when the requirements as given in sub-regulation (4) are met. The tensile strength of the both the test specimens shall meet the strength requirement for the material.

(4) The convex side of the bend test specimen after bending to 180° with a mandrel diameter of three times the thickness of the specimen shall show no discontinuities more than 3 mm in size in any direction. In the case of alloy steel specimen, the angle of the bend shall be decided by the competent authority, provided that in no case, the angle shall be less than 120° .

529. Fillet welded plate specimens.— (1) (a) The preparation of the fillet-weld test specimen shall conform to Fig. 13/5 of chapter 13.

(b) The test specimen shall not contain any visible cracks. It shall be cut transversely to provide a centre section (254 mm) long and two end sections each approximately (25 mm) long.

(2) (a) The centre section shall be loaded laterally in such a way that the root of the weld is in tension.

(b) The load shall be steadily increased until the specimen fractures or bends flat upon itself.

(3) The cut end of one of the end sections shall be polished and etched with a suitable reagent to give a clear definition of the structure of the weld.

(4) The test shall be deemed to have been satisfactory when the requirements as specified in sub-regulation (5) are met.

(5) (a) The bend specimen shall not fracture during loading and if the specimen fractures, then the fractured surface shall show no evidence of cracks or incomplete root penetration, and the sum of the lengths of inclusions and gas pockets visible on the fractured surface shall not exceed (51 mm).

(b) Visual examination of the cross-section of the weld shall show the following:

(i) Complete fusion at the root and freedom from cracks.

(ii) Convexity or concavity of the weld profile not more than 1.6 mm

(iii) The length of two legs of the fillet within 1.6 mm difference.

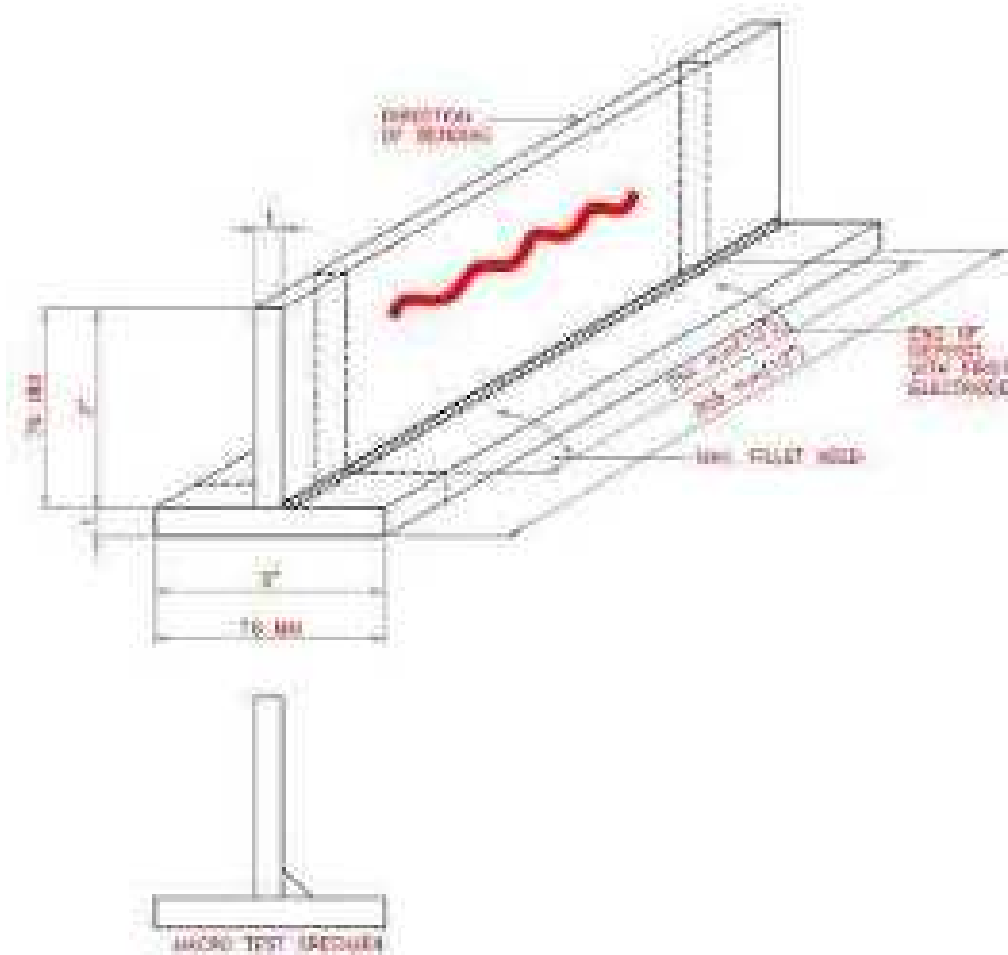


FIG. 13 / 5: FILLET WELD SOUNDNESS TEST FOR PERFORMANCE QUALIFICATION

530. Groove and Fillet Welded Pipe and Tube Specimens.— (1)(a) The groove welded pipe and tubes specimens shall be marked and test pieces cut out as in Fig. 13/6.

(b) The test pieces shall be prepared for face bend, root bend and etch test.

(2) (a) The pipes shall not be flattened, but tested in their curved conditions with the reinforcement at the root not exceeding 0.8 mm.

(b) Any excess weld metal may be removed by grinding.

(3) The bend test specimens shall show no discontinuity more than 3 mm on the convex side of the specimen.

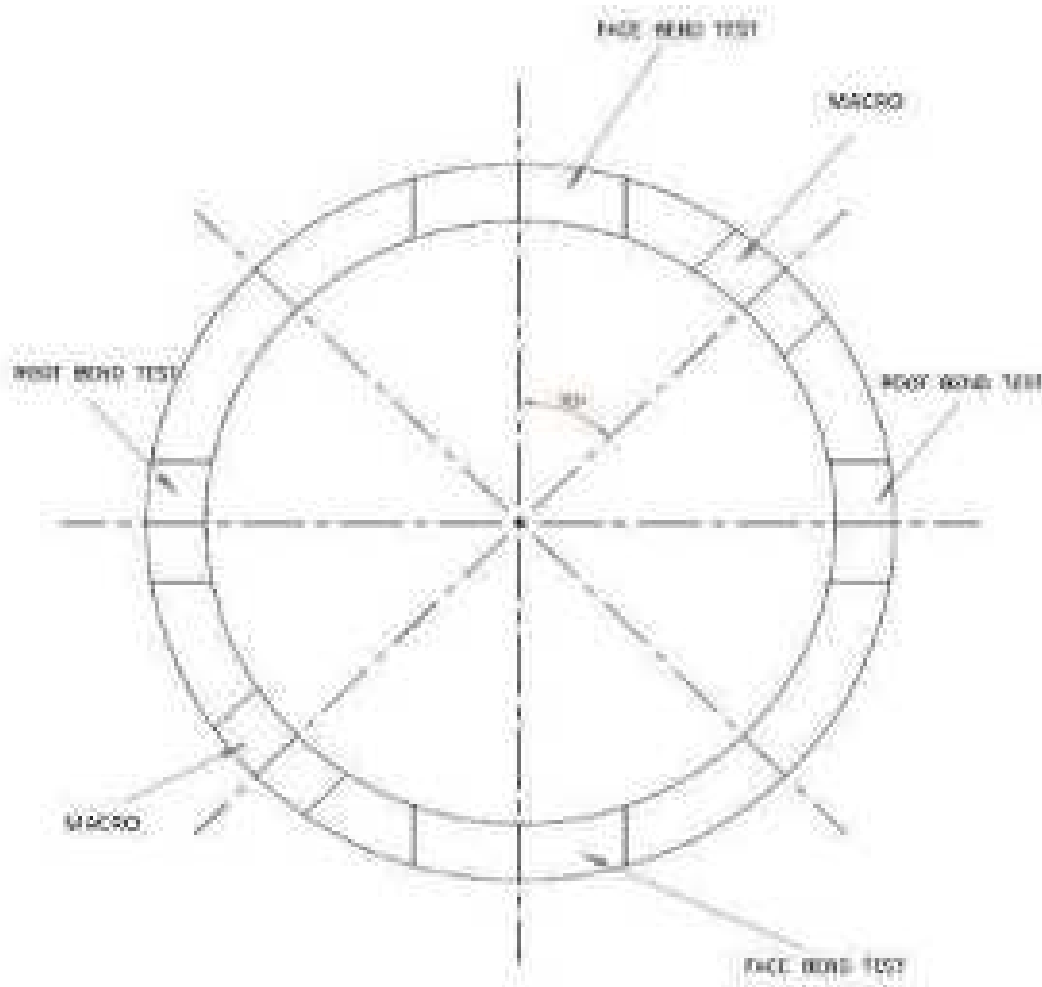
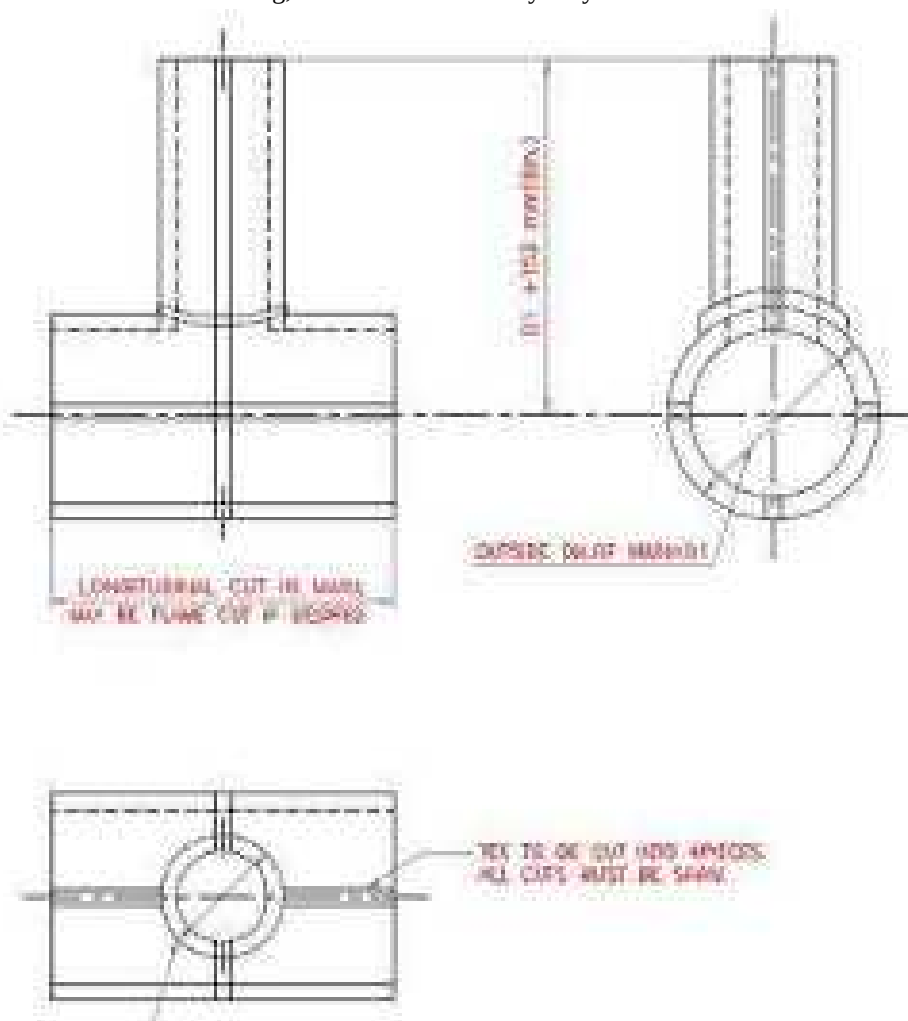


FIG. 13/6: ORDER OF REMOVAL OF TEST SPECIMEN FROM WELDED PIPE / TUBE

(4) Fillet welded branches shall be tested by visual examination and macro examination as under:

(a) The test weld so obtained shall be visually examined for root penetration, freedom from undercut, disposition of runs, uniformity of surface, shape of profile, smoothness of joint, freedom from cavities and slag, dimensions of weld deposit, quality of weld metal (overheating, surface cracks, spongy surface, etc.) Any piece showing serious defect shall be rejected.

- (b) Each branch weld test piece shall be sawn as shown in Fig. 13/7 and each portion so produced shall be prepared and etched. The sections shall then be examined for degree of fusion, degree of root penetration, absence of non-metallic (slag) inclusions and quality of weld metal. The joint should show good root fusion, complete freedom from basal cracking, and the absence of any very minor defects.



Outside Dia. of Pipe Main D1 – Dia.127 x 10 mm thick or more

Outside Dia. of Branch D2 – Dia. 89mm x 6mm thick or more

FIG. 13/7: ORDER OF REMOVAL OF SPECIMEN FOR BRANCH WELDS

531. Welded Tube Joints.— (1) A test length approximately 203 mm long shall be cut from the tube with the welded joint disposed approximately at the centre. After visual examination, one test piece not exceeding 13 mm, for tubes 6 mm in thickness and below and thrice the thickness of the tube for thickness of over 6 mm shall be cut longitudinally.

(2) (a) The test piece shall not be less than 76 mm in length on either side of the weld.

(b) The slight excess of internal bead may be filed until it is not more than 0.8 mm proud of the general surface.

(c) The test piece shall then be bent back with the root in tension through 90° round a former of diameter equal to three times the thickness of the tubes.

(d) With regard to alloy steel pipes and tubes, the bend test specimen shall be bent without being straightened, but after removal of the weld reinforcement down to the level of but not below the surface, round a former of diameter $4t$ and through an angle of 90° .

(e) The bending may be carried out by blows or by pressure. Care shall be taken to ensure that the former is so positioned that the weld is maintained at the crown of the bend.

(f) The test specimen shall be capable of being bent through 90° without signs of failure, although slight premature failure at the edges of a specimen need not be considered a cause for rejection.

(g) The opening out of a slight defect due to incomplete root penetration or lack of root fusion need not be considered a cause for rejection; provided the defect has sound metal at the back and on either side of it.

532.Cladded Specimen.— (1) The corrosion resistant or hard facing overlay weld surface shall be examined by the liquid penetrant method and shall meet the acceptance standards in sub-regulation (2) of regulation 164.

(2) The corrosion resistant test coupon shall be sectioned to make four side-bend (B1, B2, B3, B4) test specimens perpendicular to the direction of the welding as per regulations 160 and 161. Test specimens shall be removed at locations specified in Fig. 13/8.

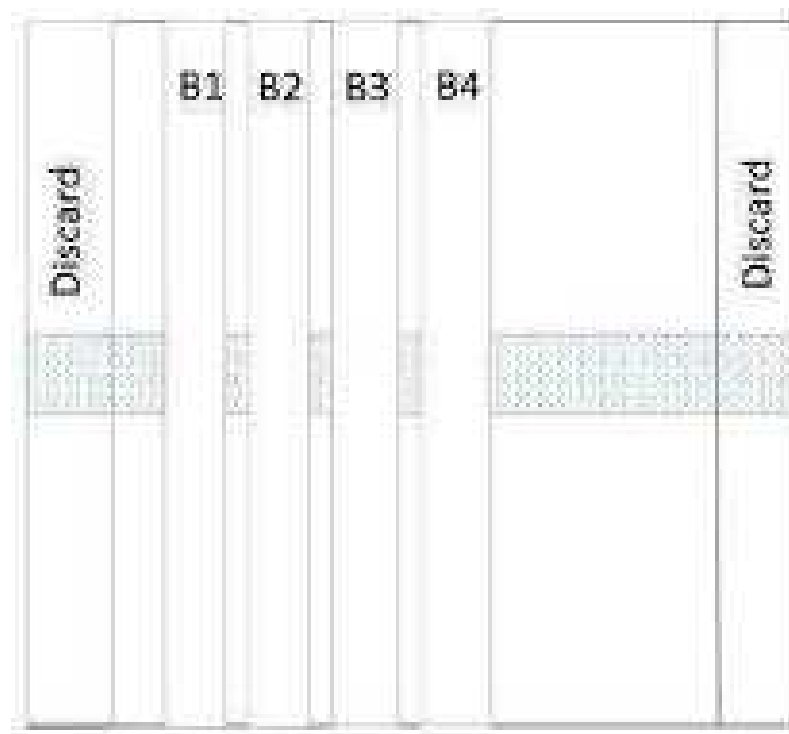


Plate size 150x150 X T (Base metal thickness) mm

FIG. 13 / 8: ORDER OF REMOVAL OF TEST SPECIMEN FROM CORROSION RESISTANT OVERLAY FOR INITIAL / RE-QUALIFICATION TEST

- (3) (a) The hard facing overlay base metal shall be sectioned transversely to the direction of the hard-facing overlay.
 (b) The two faces of the hard-facing exposed by sectioning shall be polished and etched with a suitable etchant and shall be visually examined with 5X magnification.

(c) Cracks, lack of fusion, or other linear defects in the weld metal or the heat-affected zone shall be examined (see Fig. 13/9).

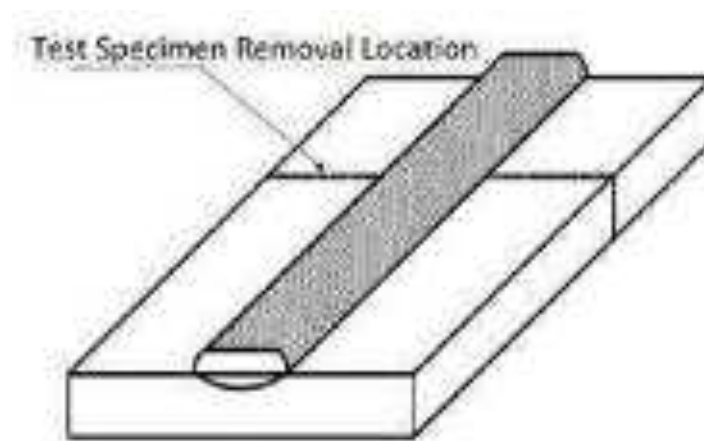


Plate size 150x150 X T (Base metal thickness)

FIG. 13/ 9: ORDER OF REMOVAL OF MACRO TEST SPECIMEN FROM HARD FACING OVERLAY FOR INITIAL / RE QUALIFICATION TEST

533. Additional tests before rejection.—(a) Where any test piece tested as per the regulations 528 to 531 fail to meet the specified requirements, one further strip may be cut from the specimen and subjected to the same test and if any test piece does not reach the required standard, two further welds shall be made and the procedure in the above regulations shall be repeated.

(b) If any of these welds does not reach the required standard, the welder shall be deemed not to have qualified for a certificate.

534. Decision of the competent authority.— The decision of the competent authority on refusal to grant Welder Certificate shall be final.

PART-6

Examination of test specimens for requalification tests

535. Groove Welded Plate Specimens.—(1) (a) The Groove welded plate specimens after welding may be lightly pressed cold to remove any distortion due to welding.

(b) The test specimen shall be then subjected to visual examination and radiographic examination as mentioned in sub-regulation (2) of regulation 164 and thereafter, test pieces shall be marked and cut out in the order shown in Fig. 13/10.

(2) (a) The face and root bend test specimens (FB & RB) shall be prepared and tested as per regulations 135 and 136. Two specimens (M_1 & M_2) shall be prepared, one for micro and the other for macro examination as per sub-regulation (1) of regulation 164.

(b) The test shall be deemed to have been satisfactory when the following requirements are met.

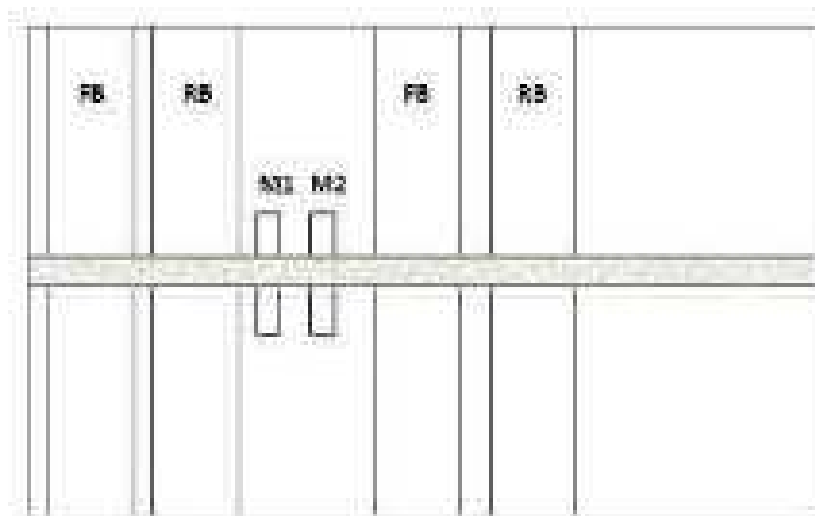


FIG. 13 / 10: ORDER OF REMOVAL OF TEST SPECIMEN FROM TEST PLATE FOR RE QUALIFICATION TEST

- (i) The convex side of the bend test specimen after bending to 180° with a mandrel diameter of three times the thickness of the specimen shall show no discontinuities more than 3 mm in size in any direction and in the case of alloy steel specimen, the angle of the bend is to be decided by the competent authority, provided that the angle shall, in no case, be less than 120°.
- (ii) The macro / micro examination reveal satisfactory microstructure of the weld metal and Heat Affected Zone (HAZ).

536. Fillet Plate Welded Specimen.— They shall be conducted as mentioned in regulation 529.

537. Pipe and Tube Welding.— Specimens shall be prepared and tested as mentioned in regulation 530 or 531, as the case may be.

538. Cladded Specimen.— The cladded specimen evaluation shall be carried out as per regulation 532.

539. Additional test before rejection .— (1) (a) in case any of the test pieces tested in accordance with the regulations 535 to 538 fail to meet the specified requirements, one further weld may be cut from the specimen and subjected to the same test.

(b) If any test piece does not reach the required standard, one further weld shall be made after sufficient retraining, and the procedure in the above regulations shall be repeated.

(c) If the repeat weld does not reach the required standard, the welder shall be deemed not to have qualified for a certificate.

(2) The decision of the competent authority on refusal to grant welder certificate shall be final.

PART-7

540. Awarding of marks.— (1) (a) Marks shall be awarded as per the Form-XXI.

(b) Candidates obtaining marks not less than 60 per cent in the oral or written examination and not less than 75 per cent in the practical tests, shall be deemed to have qualified for a certificate provided that the bend tests are found to be satisfactory and in case a candidate fail in the oral or written examination but passes in the practical test, he may be re-examined in oral or written examination within a period of twelve weeks from the date of examination of

practical test, and if he obtains not less than 60 per cent marks in the re-examination, he shall be deemed to have qualified for a certificate.

(2) The Form shall be attested by the Competent Authority.

541. Award of Certificate.— (1) On successful completion of theoretical tests mentioned in regulation 522 and practical tests mentioned in regulations 523 to 526, the welder may be awarded a certificate in Form-II to the extent of the tests passed by him.

(2) (a) Welder or welding operator who pass the tests for groove welds in plates shall be considered as having qualified for making fillet welds in plates.

(b) Welders or welding operators who pass the tests for fillet welds, shall be qualified to make fillet welds only.

(c) Any certificate issued for any purpose under any rules made by the State Government in this behalf shall be deemed to have been issued for that purpose under this Chapter and any action taken under the said rules, shall be deemed to have been taken under this Chapter.

542. Maintenance of records.— (1) Every manufacturer or repairer of boilers and steam-pipes shall maintain a record of all welding personnel engaged on welding and repairing of boilers and steam-pipes, particulars of each welder and welding operator and the work handled by him. Such record shall be produced to the Inspecting Authority or Competent Person on demand.

(2) In the case of welders or welding operators who undertake welding under their own responsibility, the record as aforesaid shall be maintained by themselves.

543. Fees for examination of Welders or Welding operators.— Fees for examination of Welders or Welding operators shall be as per regulation 331.

544. Penalty.— Penalty shall be as per regulation 332.

CHAPTER -14 SMALL INDUSTRIAL BOILERS

PART-1 GENERAL

545. Scope.— This Chapter shall apply to the design, construction, inspection, registration, operation and maintenance of small industrial boilers.

546. For the purpose of this chapter, “small industrial boiler” shall include;-

- (a) A shell type boiler generating steam for use external to itself under pressure up to 7 kg/cm² (g) and having a volumetric capacity exceeding 25 litres (such capacity being measured from the feed check valve to the main steam stop valves), but not exceeding 500 litres including the volumetric capacity of all pressure parts being heated from the same heating source and connected to the boiler; or
- (b) A coil type or a once through boiler or a water tube boiler having the conditions specified in clause (a) above except -
 - (i) The limitation of pressure shall be 12 kg/cm² (g), and
 - (ii) The capacity shall not be exceeding 150 litres;

Provided that in case of boilers having combined features of clauses (a) and (b), the design pressure shall be restricted to 7 kg/cm² (g) and the volumetric capacity of particular pressure parts shall not exceed the limits specified in the respective clauses above subject to an aggregate of 500 litres.

PART-2

Extent to which variation from the standard conditions laid down in the preceding chapters is permissible

547.—Variations from standards.—The variations from the standard conditions provided in the preceding chapters of these regulations shall be permitted for small industrial boilers as provided in regulations 548 to 554.

548. Materials.—(1) The materials used in the construction of small industrial boilers shall, except as otherwise provided under this chapter, conform to the provisions made in chapter-2 of these regulations.

- (2) (a) Steel plates used in the construction of the boilers shall be of IS: 2062 fully killed or equivalent and the plate for shell and heads shall be not less than 6 mm in thickness and the heads as tube sheets for tubes rolled in shall be at least 8 mm in thickness.
(b) The steel maker certificate provided in Part A of Form V is not required for steel plates of IS: 2062 from the steel maker provided all other certification requirements as specified in applicable regulations are complied with.
- (3) (a) Heads of parts of boilers when not exposed to direct impact of flame may be made of cast iron or malleable iron provided they comply with other requirements of these regulations.
(b) The allowable stress on cast iron or malleable iron shall be based on the tensile strength of material with a factor of safety of not less than 4.5.

549. Design, construction, workmanship and method of computing the Maximum Allowable Working Pressure.— (1) (a) The construction except where otherwise specified shall be the same as those provided in the relevant provisions of the preceding chapters of these regulations.

(b) In case of fusion welded boiler, neither stress-relieving nor radiography of welded joints shall be required.

(2) (a) In small industrial boilers, unflanged steel tube plate may be inserted into the shell and welded for the entire thickness as shown in Figure 14/1 of this regulation with a fillet weld having a throat not less than $1\frac{1}{4}$ times the thickness of the shell or tube sheet whichever is smaller.

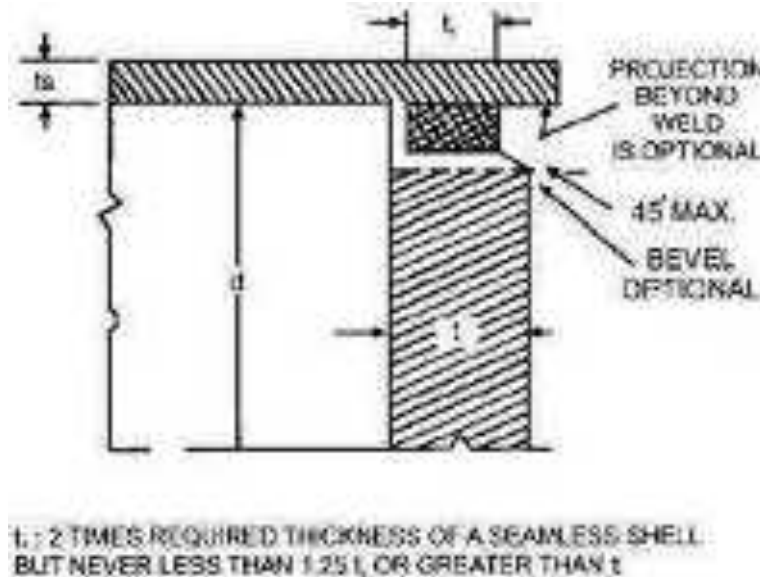


Figure14/1

(b) The minimum thickness of flanged welded tube sheets shall be 10 mm.

(c) The temperature of the heating element of electrically heated steam boilers shall be so controlled that it shall not exceed 650°C.

(3) (a) The tubes shall be made of steel.

(b) (i) The tubes holes shall be drilled full size with shells butt straps and ends bolted up in position or may be punched at least 13 mm smaller in diameter than full size and then drilled, reamed or finished full size with a rotating cutter.

(ii) The sharp edges and chips shall be removed, the plates and butt straps re-assembled metal to metal with pins fittings the holes and with tack bolts.

550. Inspection and Testing.— The small industrial boilers shall be subjected to inspection during construction by an Inspecting Authority and the inspection of the boilers shall be made at the stages as given in regulations 551 and 552:

551. Shell type boilers.—(1) The inspection of shell type boilers shall be made at the following stages, namely:-

- (i) material identification and inspection;
- (ii) inspection of each component after completing welding and drilling;
- (iii) assembly of boiler;

(iv) hydraulic test.

(2) In case of a boiler wholly or partly welded construction, the hydraulic test pressure shall be equal to two times the design pressure of the boiler.

(3) A test coupon shall be provided by the maker for conducting root and face bend tests.

552. Coil type boilers, once through boilers and water tube boilers.— (1) The inspection of coil type boilers, once through boilers and water tube boilers shall be made at the following stages, namely:-

(i) Identification of materials.

(ii) Hydraulic test,

(2) The pressure for hydraulic test shall be two times of the design pressure of the boiler.

553. Certificates and maker's stamps.— (1) The certificate and maker's stamp shall be in conformity with the provisions of Chapter-1 of these regulations.

(2) Where all information cannot be visibly stamped on the boiler plate due to its small size, maker's certificate accompanying the boiler shall contain the necessary details, but in all cases, name, works number and the year of the make shall be stamped or exhibited on the boiler.

PART-3

554. Valves, gauges, fittings and feed supply.— (1) (a) (i) Every boiler shall be fitted with at least three brass wash plugs of not less than 25 mm diameter which shall be screwed into the openings in the shells near the bottom.

(ii) In the boilers of closed system type heated by removable internal electric heating elements, the opening for these elements when suitable for cleaning purposes may be substituted for wash out openings.

(b) (i) Boilers not exceeding 300 mm internal diameter may have two 25 mm openings for cleaning, one of which may be used for the attachment of the blow off valve.

(ii) Wherever possible, the openings shall be opposite to each other.

(iii) All threaded openings in the boiler shall be provided with welded reinforcement, if necessary, to give four full threads therein.

(c) (i) Electric boilers of a design employing removable top cover flange for inspection and cleaning need not be fitted with washout openings and washout plug.

(ii) Level gauges are not required for once through boilers.

(2) Every boiler shall be provided with at least one feed pump or other feeding device except where it is connected with a water main carrying pressure to feed that boiler or where the steam generator is operated with no extraction of steam (closed system). In the latter case, in lieu of the feeding device, a suitable connection or opening shall be provided to feed the boilers. Such connection shall be not less than 13 mm in diameter.

(3) (a) Every boiler shall be fitted with necessary mounting and fittings as provided in Chapter-5 of these regulations, and they shall be of substantial construction suitable for 7 kg/cm²(g).

(b) All these fitting, except safety valves shall be certified by manufacturers of the fittings themselves.

(4) (a) The feed pipe shall be provided with a check valve and a stop valve of a size not less than that of the pipe.

- (b) The feed water may be delivered to the boiler through the openings of the same size in the shell as that of the blow off connection.
- (5) (a) Each boiler shall be equipped with a blow off connection, not less than 18 mm in size located to drain the boiler water from the lowest water space practicable when the boiler is under pressure.
(b) Feed water shall not be introduced through the openings or connection needed for the water column, the water gauge glass or the gauge cock.
- (6) (a) Every boiler other than a coil type or a once through boiler shall be fitted with two gauge glasses not less than 150 mm long for determining the water level.
(b) The boiler shall have the lowest visible part of the water gauge located at least 25 mm above the lowest permissible water level.
- (7) (a) The lowest permissible water level of vertical boilers shall be at a point one-third of the height at the shell above the bottom head or tube sheet.
(b) Where the boiler is equipped with internal furnace, the water level shall not be less than one-third of the length of the tubes above the top of the furnace tube sheet.
- (8) (a) The steam pressure gauge shall have its dial graduated to not less than twice the maximum allowable working pressure of the boiler.
(b) The diameter of the dial shall be at least 100 mm and the pipe connecting the pressure gauge shall be minimum 10 mm and the connection shall be through siphon.
- (9) (a) Each boiler shall be equipped with two safety valves for relieving the steam pressure. The diameter of the valves shall not be less than 13 mm.
(b) The minimum relieving capacity of the safety valve shall be sufficient to discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 10 percent above maximum allowable working pressure.
(c) The safety valve shall be connected to the boiler independently of any other steam connections, without any unnecessary intervening pipe or fitting. Such intervening pipe or fitting if unavoidable shall not be longer than the corresponding face to face dimension of a tee fitting of the same diameter and the minimum opening there through shall be at least equal to the valve inlet.
- (10) No valve of any description shall be placed between safety valve and the boiler not on the discharge pipe from the safety valve to the atmosphere.
- (11) The electrically heated boilers shall be effectively earthed with a lead of substantial cross section.

555. Registration, operation and maintenance.—(1)(a) The fee required for registration under sub-section (2) of section 12 of the Act shall be as per table 8/2 of regulation 304.

- (b) The annual inspection fee for renewal of certificate shall be as per table 8/3 of regulation 305.
- (2) The certificate of manufacture and test for small industrial boilers shall be issued in Form-XXII.
- (3) Operator for these boilers shall possess minimum educational qualification of matriculation or equivalent

CHAPTER-15

FEED WATER FOR BOILER

556. Scope.— This chapter lays down specifications for feed water and boiler water for.—

- (a) Low and medium pressure boilers (boilers operation up to 60 kg/cm² (g)).
- (b) For boilers operating at pressures higher than 60 kg/cm² (g), better quality of water to IS: 10496 shall be adopted.

557. Requirements.— The water shall comply with the requirements given in Table 15/1 of this chapter when tested by the methods provided in Columns 6 and 7 of the table.

558. Sampling.— Sampling shall be done by following general directions mentioned in Part-2 of IS: 3025 issued by Bureau of Indian Standards and in particular, the following points shall be observed, namely:-

- (a) A stainless steel or monel metal coil shall be fitted on the sampling cock so that the temperature of the water sample shall be well below the boiling point at atmospheric pressure and there is no risk of aeration and concentration due to flashing into steam; and
- (b) Samples of feed water shall be collected from the delivery of the boiler feed pump, samples of boiler water from the top drum, and samples of condensate from the delivery of the condensate extraction pump.

559. Test methods.— Tests shall be carried out as provided in the appropriate clauses of IS: 3025 and IS: 3550 and indicated against the characteristics in Table 15/1 of this chapter.

Table 15/1: Chemical requirements of Feed water and Boiler water for Low and Medium Pressure Boilers
(regulations 557 and 559)

Serial Number	Characteristic	Requirement for Boiler Pressure			Method of Test (Ref. to Cl. No. of)	
		Up to 20 kg/cm ² (g)	21 to 39 kg/cm ² (g)	40 to 60 kg/cm ² (g)	IS: 3550+	IS: 3025 *
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Feed Water					
	(a) Total hardness (as CaCO ₂), mg/l, max	5	2	Nil	-	16.1
	(b) pH value	8.8 to 9.5	8.8 to 9.5	8.8 to 9.5	-	8
	(c) Dissolved Oxygen, mg/l, max	-	0.5	0.5	16	-
	(d) Silica (as SiO ₂), mg/l, max	-	0.5	0.5	16	-
(ii)	Boiler Water					
	(a) Total alkalinity φ (as CaCO ₃), mg/l max	700	500	300	-	13
	(b) Caustic alkalinity (as CaCO ₃), mg/l max	350	200	60	-	15
	(c) pH value	9.0 to 12.0	9.0 to 12.0	9.0 to 11.0	-	8
	(d) β Residual sodium sulphite (as Na ₂ SO ₃) mg/l	-	30 to 50	20 to 30	-	21
	(e) Residual hydrazine (as N ₂ H ₄), mg/l	0.1 to 1 (if added)	0.1 to 0.5 (if added)	0.05 to 0.3	26	-
	(f) Phosphates (as PO ₄), mg/l (if added)	20 to 40	15 to 30	5 to 20	14	-
	(g) Total dissolved solids mg/l, max	3500α	2500	1500	9	12
	(h) Silica (as SiO ₂), mg/l, max	-	15	15	16	30

Notes:

1. Recovery Boilers: The boiler feed water used shall be completely de-mineralized and also the boiler feed water and boiler water shall be conditioned in accordance with high pressure boilers working at 60 kg/cm²(g) and above (see IS: 4343).
2. When feed water heaters are of copper or copper alloy constructions, the pH of the feed water shall be maintained between 8.5 and 9.2 while when feed water heaters are of iron constructions, the pH of feed may be maintained between 8.5 and 9.5.
3. Silica in Boiler Water: Lower concentration of silica may be advisable for steam of turbines, which generally requires less than 0.02 mg/l silica in steam.

* Methods of test for routine control for water used in industry.

+ Methods of sampling and test (physical and chemical) for water used in industry.

φ Total alkalinity should preferably be about 20 percent of total dissolved solids.

β Shall not apply if reducing agents other than sodium sulphite are used.

α For shell type boilers depending on parameters, the limits can be relaxed.

CHAPTER -16 HEAT EXCHANGERS AND PRESSURE VESSELS

PART-1

560. Application.—(1) This chapters hall apply to steam accumulators, steam coil air preheaters, high pressure(HP) heaters, deaerators and blow down tanks operating above $3.5 \text{ kg/cm}^2(\text{g})$.

(2) Any steam consuming equipment where steam is condensed or open to atmosphere shall not be covered under this chapter.

561. Construction and workmanship.— The construction and workmanship shall conform to the requirements of relevant regulations for the particular type of construction.

562. Materials.— Materials used in the construction of these vessels shall comply with the applicable regulations of Chapter-2.

563. Welding consumables.— Welding consumables shall comply with the relevant provisions of Chapter-2.

564. Tubes and pipes.— The tubes and pipes shall comply with the relevant provisions of Chapter-2.

565. Heat treatment.— All fusion welded vessels shall be heat treated for stress relief as per regulation 123.

PART-2

Determination of working pressure of vessels of welded construction

566. Shells.— The working pressure shall be calculated as per Equation (4/1) mentioned under regulation 169 of chapter 4.

567.Dished end plates.— The maximum working pressure of dished end plates subject to pressure on the concave side shall be determined as per Equation (4/10) of regulation 177 of chapter 4.

568.Flat end plates.— The maximum working pressure of flat end plates shall be determined as per appropriate regulations in Chapter -3

569. Girth flange.—(1) Non-standard bolted flange connections when used shall satisfy the requirements of these regulations .

(2) The design and construction of a flange shall involve the selection of the gasket (material, type, and dimensions), flange facing, bolting, hub proportions, flange width, and flange thickness.

(3) Flange dimensions shall be such that the calculated stresses in the flange, does not exceed the allowable flange stresses.

570. Standard flanges.— Standard flanges used in heat exchanger shall conform to the Codes or Standards like British Standards (BS), European Standards (EN), American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code and Tubular Exchanger Manufacturers Association (TEMA), commonly used in industrially advanced countries.

571. Bolts and Studs .—(1) Bolts and studs connecting the parts of the vessel such as shell, end plates , tube plates shall be made of steel.

(2)The maximum working pressure for the bolts and studs shall be as per by the following Equation,—

$$P = \frac{N \times C}{A} \left(D - \frac{1.28}{n} \right)^2 \quad \text{Equation (16/1)}$$

Where,

P Maximum allowable working pressure in tons/sq.in,

D is the diameter of bolt or stud over threads in inches,

N is the number of bolts or studs securing the part,

n is the number of threads of screws per inch,

C 4,700 for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than 19 mm,

C 5,100 for steel bolts or studs of 30 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is less than 19 mm,

C 5,600 for steel bolts or studs of 35 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is not less than 19 mm,

C 5,600 for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is not less than 19 mm and not greater than 22 mm,

C 7,000 for steel bolts or studs of 28 tons/sq. in. minimum ultimate tensile stress where the diameter over thread is greater than 22 mm.

‘A’ is the area in square inches of the surface supported by the bolts or studs. For jointed flanges the area shall be taken to extend to mid-way between the pitch lines of the bolts and the inner edge of the flange by which the part is secured.

PART-3

572. Tubes.— Where the tubes are subjected simultaneously to both internal and external pressure, the thickness of the tubes shall be the higher of that determined independently by the equations 12/12 and 12/13 of regulation 471 of chapter 12.

573. Dished end plates.— The shape of dished end plates shall be in conformity with the requirements of regulation 174.

574. End plate attachments.— These shall comply with any one of the figures provided in chapter-10 or chapter-12.

575. Tube plates.— The minimum thickness of tube plates shall comply with the requirements of regulation 472.

576. Stand pipes, nozzles, pads and seating for mounting and their attachments.—Stand pipes, nozzles, pads and seating for mounting and their attachments shall comply the provisions of relevant regulations.

577. U-Tubes.—(1) U-tubes used in heat exchangers shall not have ovality more than 10% after forming.
(2) Carbon and alloy steel U-Tubes up to mean radius $R = 5D$ (where D = Tube outside diameter) shall be stress relieved with minimum soaking time of 15 minutes.

578. Tube bundle assemblies. — Tube bundle assemblies shall be checked for free entry by using a ring gauge having inside diameter of baffle equal to Outside Diameter(OD) of tube + 1.5 mm.

579. Initial qualification of tube to tube sheet joints.—(1) The method of joining tubes to tube sheet shall be any one of the following, namely:-

- (i) Strength expansion only (without welding);
- (ii) Strength welding & light expansion, or
- (iii) Strength expansion & seal welding.

(2) All the above three process shall be carried out with procedure qualified by the manufacturer.

(3) (a) The boiler or boiler component manufacturer shall prepare written procedures for joints that are expanded (whether welded and expanded or expanded only) for joint strength.

(b) The boiler or boiler component manufacturer shall establish the variables that affect joint repeatability in these procedures.

(c) The procedures shall provide detailed descriptions or sketches of enhancements, such as grooves, serrations, threads, and coarse machining profiles.

(4) (a) For strength welded joints, minimum eight mock up welds are required to qualify each procedure.

(b) The mock up assembly shall essentially duplicate the tube hole configuration and tube-to-tubesheet joint design.

(5) The materials group (M No. wise), tube hole size, tube size and tube fit up with tube sheet shall simulate production.

(6) Test block arrangement shall be as given under,—

Minimum number of holes = 3-2-3 for triangular pitch.

= 3-3-3 for Square pitch

Thickness = Tube sheet thickness or 50 mm whichever is less.

(7) (a) The test block simulating the tube-sheet may be circular, square or rectangular in shape, essentially in general conformity with the tube pitch geometry.

(b) The test assembly shall consist of an array of tubes such that the tube to be tested is in the geometric center of the array and surrounded by at least one row of adjacent tubes.

(c) The test block shall extend a distance of at least one tube-sheet ligament beyond the edge of the peripheral tubes in the assembly.

(8) All tubes in the test block array shall be from the same grade of material and shall be installed using identical procedures.

(9) (a) The length of the tube used for testing the tube joint need only be sufficient to suit the test apparatus.

(b) The length of the tubes adjacent to the tube joint to be tested shall not be less than the thickness of the test block to be qualified.

580. Procedure for testing the test block.—(1) The mock-up welds shall be subjected to the tests given in regulations 581 to 583 sequentially and shall meet the applicable acceptance criteria.

581. Acceptance criteria for visual examination.— (1) The accessible surfaces of the welds shall be examined visually with no magnification required.

(2) The welds shall show complete fusion and no evidence of burning through the tube wall, and shall be free from cracking or porosity.

582. Acceptance criteria with liquid penetrant.— Procedure and performance tests examined by liquid penetrant techniques shall be judged unacceptable when the examination exhibits any indication in excess of the limits specified as the following:-

- (i) relevant linear indications;
- (ii) relevant rounded indications greater than 5 mm;
- (iii) four or more relevant rounded indications in a line separated by 1.5 mm or less (edge-to-edge).

583. Acceptance criteria for macro-examination.— (1) The mock up welds shall be sectioned through the center of the tube for macro-examination.

(2) The four exposed surfaces shall be smoothed and etched with a suitable etchant to give a clear definition of the weld and heat-affected zone.

(3) Using a magnification of 10X to 20X, the exposed cross sections of the weld shall conform to as under:-

- (i) minimum leak path dimension required by the design;
- (ii) no cracking;
- (iii) complete fusion of the weld deposit into the tube-sheet and tube wall face;
- (iv) complete penetration of the weld deposit to within 0.4 mm of the root of the joint; and
- (v) porosity shall not reduce the weld throat below the required minimum leak path thickness.

584. Tube thinning calculations.— (1) Tube thinning calculations shall be using the equation given below, based on the measured values.

(2) The thinning shall be within 5% to 8%.

$$\% \text{ Thinning} = \frac{(T-t) - (D - d)}{2 \times \text{Tube thickness}} \times 100 \quad \text{Equation (16/2)}$$

Where,

T = Internal diameter of the tube after expansion

t = Internal diameter of the tube before expansion

D = Tube sheet Hole Diameter

d = Tube outer diameter.

CHAPTER- 17 SMALL SOLAR BOILERS

585. Scope.—This chapter shall apply to the design, construction, inspection, registration, operation and maintenance of small solar boilers.

PART-1 Definitions

586. Solar receivers.— Solar receivers are the devices that receive solar radiation heat from the sun to generate steam.

587. Small solar boiler .— (1) A small solar boiler shall be a solar steam generating system producing steam for use external to itself having area concentration ratio of solar radiation capturing aperture area to receiver area less than 300 and having a volumetric capacity more than 25 litres.

(2) A natural or forced circulation type boiler wherein the receiver is the solar heat receiving device generating steam at pressure up to 12 kg/cm²(g)

588. Heating surface area.— The heating surface area of a small solar boiler shall be the area of receivers exposed to the receiving radiation.

589. Volumetric capacity.— Volumetric capacity of a small solar boiler shall be the total volume from feed check valve to the main steam stop valve at the outlet of steam header.

PART-2 Extent to which Variation from the standard conditions laid down in the preceding chapters is permissible

590. Variations from standards.— The variations from the standard conditions provided in the preceding chapters of these regulations shall be permitted for small solar boilers as provided in regulations 591 to 594.

591. Materials.— (1) The materials used in the construction of small solar boilers shall conform to the provisions made in these regulations.

(2) (a) Plates used in the construction of the boilers shall be either of IS: 2062 or equivalent or as per Chapter-2.
(b) The plate for shell and heads shall be not less than 6 mm in thickness and the heads as tube sheets for tubes rolled in shall be at least 8 mm in thickness.

(3) The tubes and pipes shall be made of carbon steel, alloy steel, stainless steel or copper.

(4) Corrosion allowance of 0.75 mm shall be provided for parts of the boiler directly exposed to atmosphere and solar radiation.

(5) No corrosion allowance is required for stainless steel parts of the boiler.

(6) Materials need not be certified with Indian Boiler Regulations forms from the maker provided all other certification requirements as mentioned in applicable regulations are complied with.

592. Design, construction, workmanship and the method of computing the maximum allowable working pressure.— (1) The construction except where otherwise specified shall be the same as those provided in the relevant provisions of the preceding chapters of these regulations.

(2) In the case of Fusion welded small solar boilers, radiography or stress relieving of the weld joints shall not be mandatory.

593. Inspection and testing.— (1) The small solar boilers shall be subjected to inspection during construction and after completion of construction by an Inspecting Authority.

(2) The inspection of small solar boilers shall be made at the following stages, namely:-

- (i) Material identification and inspection.
- (ii) Hydraulic test; every completed boiler wholly or partly welded construction, the hydraulic test pressure shall be equal to two times the design pressure of the boiler.

594. Certificates and maker's stamps.— (1) The certificate and maker's stamp shall be in conformity with the provisions of Chapter-1 of these regulations.

(2) Where all information cannot be visibly stamped on the boiler plate due to its small size, maker's certificate accompanying the boiler shall contain the necessary details, but in all cases name, works number and the year of make shall be stamped or exhibited on the boiler.

PART-3

595. Valves, gauges, fittings and feed supply.— (1) Small solar boiler shall be fitted with the following, namely:-

- (i) wash plugs for cleaning;
- (ii) suitable provision to indicate the water level;
- (iii) one water feeding device;
- (iv) one feed pipe shall be provided with a check valve and a stop valve of a size not less than that of the pipe;
- (v) suitable provision to drain the boiler water;
- (vi) one steam pressure gauge having minimum 100 mm dial size; and
- (vii) one safety valve for relieving the steam pressure.

(2) Safety valves shall be certified under Indian Boiler Regulations and all other fittings may be certified by the manufacturers of such fittings.

596. Registration, operation and maintenance.— (1) The fees required to accompany an application under sub-section (2) of Section 12 of the Act shall be such as provided in regulation 304.

(2) The inspection fee for renewal of certificate after every four years shall be as provided in regulation 305.

(3) The certificate of manufacture and test for small solar boilers shall be issued in Form-XXIII.

(4) Operator for these boilers shall possess minimum educational qualification of matriculation or equivalent.

Form I(A):R01

Dated: 07.08.2026

FORM-I
(PART-A)
[Regulation 4]

**INSPECTING AUTHORITIES CERTIFICATE OF INSPECTION DURING CONSTRUCTION IN RESPECT
OF A BOILER MADE TO FOREIGN CODE FOR EXPORT**

We hereby certify that the type boilers; length diameter
Design pressure of boiler..... built by Messrs under Shop No.
was constructed under our supervision and inspected at various stages at construction by the Competent
Person and that the design, construction and workmanship were satisfactory and in every respect in
accordance with Code Specification. The boiler is stamped as under:

The boiler on completion was tested to in the presence of the Competent Person on
..... and it satisfactorily withstood the test. Details of tests and inspections are furnished with this
certificate.

We have satisfied ourselves that the design, construction and dimensions of the boiler are as
shown in the Maker's Drawing No. approved and signed by us, and that the particulars
entered in the Maker's Certificate of manufacture are correct to the best of our knowledge and belief.

Maker's certificate, signed by them and countersigned by us, as required by the
Code/Specification, is enclosed.

Name and Signature of Inspecting Authority

Form I(B):R01

Dated: 07.08.2026

FORM-I
(PART-B)
[See regulation 8(a)]

CERTIFICATE OF INSPECTION FOR SHOP ASSEMBLED BOILERS

INSPECTING AUTHORITY: _____ Certificate No. _____

We hereby certify that the _____ Boiler, built by M/s _____ under Maker's number _____ was constructed under our supervision and inspected at various stages of construction by the Competent Person and that the construction and workmanship were satisfactory and in accordance with the standard conditions for the design and construction of boilers as per regulations framed under the Boilers Act, 2025.

The boiler is stamped on the _____ Shell Plate with stamp as shown hereunder: -

MAKER'S NAME	:	_____
MAKER'S NO.	:	_____ YEAR OF MAKE : _____
TESTED TO	:	_____ kg./cm ² (g) ON : _____
Design Pressure of boiler	:	_____ kg./cm ² (g)

COMPETENT PERSON'S OR INSPECTING AUTHORITY'S OFFICIAL STAMP

The boiler on completion was subjected to a Hydrostatic test pressure of _____ kg/cm² (g) in the presence of the Competent Person on _____ day of _____ and satisfactorily withstood the test.

All welded seams were subjected to destructive and Non-Destructive examination wherever applicable and found satisfactory.

We have satisfied ourselves that the construction and dimensions of the boiler are as shown in the Maker's Drawing Number _____ signed by us and that the particulars entered in Maker's certificate of manufacture in Form-IV(Part-A) countersigned by us are correct to the best of our knowledge and belief.

Name and Signature of Competent Person

Name and Signature of Inspecting Authority

Date and Seal

Form I(C):R01

Dated: 07.08.2026

FORM-I
(PART-C)
[See regulation 8(a)]

CERTIFICATE OF INSPECTION FOR SITE ASSEMBLED BOILERS AT MAKER'S WORKS

INSPECTING AUTHORITY: _____

Certificate No. _____

We hereby certify that the _____ boiler; built by
M/s _____

under Maker's Number _____ was constructed under our supervision and inspected at various stages of construction by the Competent Person and that the construction and workmanship were satisfactory and in accordance with the Standard Conditions for the design and construction of boilers as per regulations framed under the Boilers Act, 2025.

The Boiler components are stamped as per details below, wherever applicable.

Component Name

Drawing No.

Stamping Details

Maker's Name : _____ Maker's Number: _____ Year of make: _____

Tested to : _____ kg/cm² (g) on _____Design Pressure of boiler : _____ kg/ cm² (g)

Competent Person's or Inspecting Authority's Official Stamp

Samples of materials used in the constructions of the boiler were tested in the presence of the Competent Person and found to comply with the regulations.

All welded seams were subjected to destructive and Non-Destructive examination wherever applicable and found satisfactory.

We have satisfied ourselves that the construction and dimensions of the boiler are as shown in the Maker's Drawing Number _____ signed by us, and that the particulars entered in the Maker's certificate of manufacture in Form-IV(Part-A) countersigned by us are correct to the best of our knowledge and belief.

Name and Signature of Competent Person

Name and Signature of Inspecting Authority

Date and Seal

Form I(D):R01

Dated: 07.08.2026

FORM-I
(PART-D)
[See regulation 8(a)(iv)]

**INSPECTING AUTHORITY CERTIFICATE OF INSPECTION DURING CONSTRUCTION OF BOILERS
FOR WHICH VARIATIONS FROM STANDARD CONDITIONS HAVE BEEN PERMITTED**

We hereby certify that the type boilers; length diameter Design pressure of boiler..... built by Messrs at under Shop Number was constructed under our supervision and inspected at various stages of construction by the Competent Person, and that the design, construction and workmanship were satisfactory and in accordance with the variations from the standard conditions laid down in the Indian Boiler Regulations, 2026, for material design and construction features have been permitted by the Board of Inspecting Authority under the Boilers Act, 2025.

The Boiler is stamped on the front end plate with our stamp as shown hereunder:—

Maker's Name Year of Make Works Number Tested to on
Design pressure of boiler. Competent Person's or Inspecting Authority's official stamp.

The boiler on completion was

The drum and header were Subjected to a water pressure test of..... in the presence of Competent Person on 20 and satisfactorily withstood the test.

*Samples of materials used in the construction of the boiler were tested in the presence of the Competent Person and found to comply with the requirements. All welded seams were subjected to physical tests and radiographic examination wherever applicable and found satisfactory.

Note: Strike off this paragraph where no such tests have been carried out and the certificate in Form-V(Part-A) by a Well-Known steel Maker is intended to be furnished.

* Strike out which is not applicable.

We have satisfied ourselves that the constructions and dimensions of the boiler are as shown in the Maker's Drawing No. signed by us and that the particulars entered in the Maker's certificate of manufacture in Form-IV(Part-A) countersigned by us, are correct to the best of our knowledge and belief. Particulars of variations from the standard conditions laid down in the said regulations as permitted by the Board or Inspecting Authority are enclosed.

Name and Signature of Inspecting Authority

Dated at this day of 20.....

Form I(E):R01

Dated: 07.08.2026

FORM-I
(PART-E)
[See regulation 8(a)(v)]

**INSPECTING AUTHORITIES CERTIFICATE OF INSPECTION AFTER COMPLETION OF BOILER
ERECTION AT ASSEMBLY SITE**

We hereby certify that the.....type boilers Design pressure of boiler.....kg/cm²(g) built by Messrs..... at..... under makers number was erected under our supervision and inspected at various stages of erection by the Competent Person and that the erection and workmanship were satisfactory and in accordance with the Standard Conditions for construction of land boilers under the Boilers Act, 2025.

All welded seams were subjected to post weld Heat treatment and Non-destructive examination wherever applicable and found satisfactory.

The boiler on completion of erection was subjected to a water pressure tests of kg /cm²(g) in the presence of the Competent Person on.....and satisfactorily withstood the test.

We have satisfied ourselves that the erection of the boiler are as shown in the Maker's Drawing No.....are correct to the best of our knowledge and belief.

Name & Signature of Competent Person

Name and Signature of Inspecting authority

Dated at this..... Day of 20.....

[illegible]

This is to certify that Mr. / Ms. _____ (Welder Name) son/daughter of Mr. _____ has been examined and tested in the prescribed manner in the presence of _____ (Representative of Competent Authority) and is deemed to have satisfactorily proved his ability to make sound welds as per particulars given in page number two and is hereby authorised to undertake such welds. He/She is authorised to undertake welding under these regulation.

The certificate validity is till the date of expiry indicated or the date of expiry of the revalidation whichever is later.

Granted this _____ (date) under the seal and authority of the _____ (name of the office of the competent authority).

Date Seal

(Name and Signature of Competent Authority)

QUALIFICATION DETAILS

Particulars	Observation
Date of Test	
Type & Position of Test	
Material Type	Carbon Steel / Alloy Steel / Nickel & Nickel Alloys
Material Grouping (M & Gr. Number)	
Process of Welding	
Weld with Backing	Yes / No
Electrode Grouping (U Number)/ Filler Wire Name/Specification	
Test Piece X-rayed	Yes / No

PERIOD OF VALIDITY

From	To	Basis of Renewal (Based on continuous engagement / fresh tests)	COMPETENT AUTHORITY Signature & Seal

Form III:R00

Dated: 07.08.2026

FORM-III
[See Regulation 7(1)(b)(v)]

QUESTIONNAIRE FORM FOR MANUFACTURER OF BOILERS/BOILER COMPONENTS UNDER THE INDIAN
BOILER REGULATIONS, 2026

1. Registered name of the firm and its permanent address:

 2. Year of establishment:

 3. Works address(s):

 4. Classification applied for—
 - (a) Special Class
 - (b) Class I
 - (c) Class II
 - (d) Class III
 - (e) Class IV
 - (f) Components manufacturer
- Notes: 1. A higher class boiler manufacturer shall be eligible to manufacture lower class boilers.
2. A boiler manufacturer shall also be eligible to manufacture boiler components as boiler component manufacturer
5. Covered area available for manufacture:
 6. Details of design facilities available and its location:
 7. Details of manufacturing facilities available within the works:

 8. Details of testing facilities available within the works:

 9. Details of R & D facilities , if any:

10. Number of qualified NDT Personnel:

11. Number of qualified welders:

12. Details of Technical Manpower:

13. Details of internal quality control systems:

14. Any other relevant information:

Date

Signature of the authorised signatory

of the firm with stamp

Place

Note 1: The recognition of the firm as a manufacturer shall be for a period of *three* years, thereafter they shall apply for renewal of their recognition at least three months before the expiry of the said period.

Note 2: Information may be submitted on additional sheets, wherever required.

Form IV(A):R01

Dated: 07.08.2026

FORM-IV**(PART-A)**

[See regulation 8(b)]

CONSTRUCTOR'S CERTIFICATE OF MANUFACTURE AND TEST

1. Description	Constructor's Name and address..... Manufactured for/Stock purposes Contract No. Type of Boiler Length overall Diameter inside Largest belt Design pressure of boiler Kg/cm ² (g) Reheater Pressure -----Kg/ cm ² (g) Maker Number of boiler Year of Make Total heating surface Sq. m Evaporation capacity (for calculation of relieving capacity of safety valves) Final Temperature of steam (Design) superheater outlet..... °C reheater Outlet °C Brief description of boiler
2. Parts manufactured at the constructor's works	Name of component(s)..... Drawing No..... Manufactured by Identification marks Part(s) manufactured, inspected at all stages of construction by (Inspecting Authority). Part(s) hydraulically tested and inspected after test by
3. Parts manufactured outside the constructor's works	Name of component(s) Drawing No..... Manufactured by Identification marks Part(s) manufactured, inspected at all stages of construction by (Inspecting Authority). Part(s) hydraulically tested and inspected after test by

Note: Similar information is to be furnished for each part manufactured outside the constructor's Works.

4. Construction

The construction is in accordance with Chapter 3/ 4 / 10 / 12 / 14/16/17 of the Indian Boiler Regulations.

Number of longitudinal seams in shell/drum in each belt

Number of longitudinal seams in furnace in each ring

Number of circumferential seams in shell/drum

(including end seams)

Number of circumferential seams in the furnace.....

Details of repairs, if any carried out in welded seams during construction.....

Details of heat treatment

All welded seams were subjected to Radiographic examination to the satisfaction of the Inspecting Authority, where required.

Note : Strike out whichever is not applicable

5. Details of Drums/Shells

No.	Nomenclature	Nominal dia.	Length	Shell plate		Tube plate		Head			Manholes No. & Size	Hydrostatic test kg/cm ² (g)
				Thickness in mm.	Inside radius mm.	Thickness in mm	Inside radius mm	Thickness in mm	Type*	Radius of dish in. mm		
1	2	3	4	5	6	7	8	9	10	11	12	13

*Indicate (1) Flat (2) Dished (3) Ellipsoidal (4) Hemispherical.

6. Headers and Boxes

Description	Size and shape	Thickness in mm	Head or end		Hydrostatic test kg/ cm ² (g)
			Shape	Thickness in mm	

7. Mountings

No.	Nomenclature	Material	Type	No.	Size
1.	Main stop valve				
2.	Auxiliary stop valves				
3.	Safety valves (a) (b) (c)				
4.	Blow down valves				
5.	Feed Check valves				

8. Details of the safety valves and test results {Regulation 8(d)(vii)}

Manufacturer

Identification marks of valves

Maker's No.

Type

Life (mm) Drawings Nos.

Valves details:

Material

Valve Seat

Flat/Bevel

Diameter of valve seating

Valve Body:

Material

Opening at neck

Opening at outlet

Springs:

Material

Process of manufacture

Chemical composition

Dimensions:

Outside diameter of coil

Section of wire

Number of coils

Free length of coils

Test results:

Place of test Date

Closing down pressure

Remarks:

Does the valve chatter?

Does the valve seat leak?

Blow off pressure

Type of valve and extract of test results

Type of valve

Place of test date

Constant 'C' by test results

Capacity of the valve for the intended blow off pressure

Signature of Maker's representative

INSPECTING AUTHORITY witnessing tests

9. Certified that the particulars entered herein are correct and that parts in sections 2 to 8, against the names of which entries are made have been used in the construction of the boiler.

The particulars shown against the various parts used are in accordance with the enclosed certificates from the respective Makers.

The design of the boiler is that as shown in Drawing Nos.

The boiler has been designed and constructed to comply with the regulations under the Boilers Act, 2025, for a Design pressure of kg/cm²(g) at our Works above-named and satisfactorily withstood a water test of kg/cm²(g) on the day of 20 in the presence of our responsible representative whose signature is appended hereunder.

Maker's Representative

Maker

(Name, signature and stamp)

(Name, signature and stamp)

Name, signature and stamp of

Name, signature and stamp of

Competent Person

Inspecting Authority

Dated the day of 20.....

FORM-IV**(PART-B)**

[See regulation 10]

CERTIFICATE OF MANUFACTURE AND TEST FOR PIPES

Certificate No. -----

Date: -----

Name of part & Quantity.....

Drawing No.....

Maker's name and address.....

Customer's Name & Address.....

*Maximum allowable working pressure Kg/cm²(g)

*Design temperature..... °C

RAW MATERIAL

Process of manufacture.....

Fully killed/rimmed.....

Chemical composition.....

Heat Number.....

Size.....

Test Certificate No.& Date.....

Name of the Steel Maker.....

Name of Inspecting Authority.....

PIPES

Process of manufacture.....

Main dimensions.....

Tolerances.....

Specification.....

Bend test on pipe or weld

Flattening test.....

Other tests.....

Tensile strength

Chemical composition.....

Heat treatment.....

Hydraulic test.....kg/cm²(g)

Identification mark of Inspecting Authority/Well known pipe maker

Certified that the particulars entered herein are correct. The particulars of fabricated component are shown in drawing No.

The pipe has been designed and constructed to comply with the Indian Boiler Regulations for a *Maximum allowable working pressure of _____ kg/cm²(g) and *maximum temperature of _____°C and satisfactorily withstood a water test of _____ Kg/cm²(g) on the _____ day of _____ 20____, in the presence of our responsible representative whose signature is appended hereunder.

Maker's Representative

Maker

(Name and signature)

(Name and Signature)

We have satisfied ourselves that the _____ have been constructed in accordance with Indian Boiler Regulations 2026. The tests conducted on the samples taken from the finished pipes have been witnessed by us and the particulars entered herein are correct.

Name and signature of

Name and signature of

Competent Person

Inspecting Authority/Well Known Pipe Maker

Place _____

Date _____

NOTE (1): This form is intended for the use by both pipe makers and piping fabricators. Only such of the columns or paragraphs that are applicable, or information that can be obtained and furnished from other certificates, need to be filled or entered in this form.

NOTE (2): In the case of fabrications made from steel pipes obtained from elsewhere, particulars in regard to the “material” and “pipes” shall be taken from similar forms of certificates obtained in respect of pipes and noted in the appropriate columns or paragraphs.

NOTE-(3): For Stock and sale purpose, one Form shall be issued for not more than five pipes.

NOTE-(4): From Well-known pipe makers, digitally signed on-line Form shall also be accepted.

NOTE-(5): For Well-known Pipe Makers, Signatures of Competent Person and Inspecting Authority are not required.

NOTE-(6): * Applicable only for Piping fabricators.

In the case of pipes made from steel, made and tested by well-known Steel Makers in India or other countries, particulars regarding the ‘material’ as certified by them in Form V(Part-A) shall be noted in the appropriate columns or paragraphs of Raw material in this certificate.

Form IV(C):R01

Dated: 07.08.2026

FORM-IV
(PART-C)
 [See regulation 11]

CERTIFICATE OF MANUFACTURE AND TEST FOR TUBES

Certificate No. -----

Date: -----

Name of part & Quantity.....

Drawing No.....

Maker's name and address.....

Customer's Name & Address.....

*Maximum allowable working pressure kg/cm²(g)

*Design temperature..... °C

RAW MATERIAL

Process of manufacture.....

Fully killed/rimmed.....

Chemical Composition.....

Heat Number.....

Size.....

Test Certificate No.& Date.....

Name of the Steel Maker.....

Name of Inspecting Authority.....

TUBES

Process of manufacture

Main dimensions

Tolerances.....

Specification.....

Tensile strength.....

Chemical Composition.....

Elongation percentage.....

Bend test.....

Flattening test.....

Crushing test.....

Flare test.....

Flange test.....

Other Tests

Heat treatment.....

Hydraulic test..... kg/cm²(g)

Identification mark of Inspecting Authority/Well known tube maker

Certified that the particulars entered herein are correct. The particulars of fabricated component are shown in drawing No.

The tube has been designed and constructed to comply with the Indian Boiler Regulations for a *Maximum allowable working pressure of _____ Kg/cm²(g) and *maximum temperature of _____ °C and satisfactorily withstood a water test of _____ Kg/cm²(g) on the _____ day of _____ 20____, in the presence of our responsible representative whose signature is appended hereunder.

Maker's Representative

Maker

(Name and signature)

(Name and Signature)

We have satisfied ourselves that the _____ have been constructed in accordance with Indian Boiler Regulations 2026. The tests conducted on the samples taken from the finished tubes have been witnessed by us and the particulars entered herein are correct.

Name and signature of

Name and signature of

Competent Person

Inspecting Authority/Well Known Tube Maker

Place _____

Date _____

NOTE (1): This form is intended for the use by both tube maker and tube fabricators. Only such of the columns or paragraphs that are applicable, or information that can be obtained and furnished from other certificates, need to be filled or entered in this form.

NOTE (2): In the case of fabrications made from steel tubes obtained from elsewhere, particulars in regard to the "material" and "Tubes" shall be taken from similar forms of certificates obtained in respect of tubes and noted in the appropriate columns or paragraphs.

NOTE-(3): For Stock and sale purpose, one Form shall be issued for not more than ten tubes.

NOTE-(4): From well-known tube manufacturers, digitally signed on-line Form shall also be accepted.

NOTE-(5): For Well-known Tube Maker, Signatures of Competent Person and Inspecting Authority are not required.

NOTE-(6): *Applicable only for tube fabricators

In the case of tubes made from steel, made and tested by well-known Steel Makers in India or other countries particulars regarding the 'material' as certified by them in Form V(Part-A) shall be noted in the appropriate columns or paragraphs of Raw material in this certificate.

Form IV(D):R01

Dated: 07.08.2026

FORM-IV
(PART-D)
 [See regulation 12]

CERTIFICATE OF MANUFACTURE AND TEST OF BOILER MOUNTINGS AND FITTINGS

Certificate No.

Date:

Name of part.....

Quantity

Sl. No.....

Drawing No.....

Maker's name and address.....

Customer's Name & Address.....

Maximum allowable working pressure kg/cm² (g)

Design temperature..... °C

Hydraulic test pressure..... kg/cm² (g)

Main dimensions.....

Specification.....

Inspecting Authority's Identification Marks.....

Chemical composition.....

Physical test results.....

(i) tensile strength.....

(ii) transverse bend test.....

(iii) elongation.....

Other Tests.....

RAW MATERIAL

Process of manufacture.....

Fully killed/rimmed.....

Specification.....

Heat Number.....

Size.....

Test Certificate No.& Date.....

Name of the Maker.....

Name of Inspecting Authority.....

Certified that the particulars entered herein by us are correct.

The _____ has been designed and constructed to comply with the Indian Boiler Regulations 2026 for a Maximum allowable working pressure of _____ kg/cm²(g)

and maximum temperature of _____ °C and satisfactorily withstood a hydraulic test using water or kerosene or any other suitable liquid to a pressure of _____ kg/cm²(g) on the _____ day of _____ 20____ in the presence of our responsible representative whose signature is appended hereunder:

Maker Representative

(Name and signature)

MAKER

(Name and Signature)

We have satisfied ourselves and the _____ has been constructed and tested in accordance with the requirements of the Indian Boiler Regulations, 2026. We further certify that the particulars entered herein are correct.

Name and signature of

Competent Person

who witnessed the tests

Name and signature of

Inspecting Authority

Place _____

Date _____

Note:

- (1) In the case of valve chest made and tested by well-known Foundries or Forges recognized by the Central Boilers Board in the manner as laid down in regulations 17 to 21, particulars regarding the material as certified by them, in Form-IV(Part-G) / Form-IV(Part-H)& Form-V(Part-A), shall be noted in the appropriate columns or paragraphs in the certificates and in case of certificates from Well Known Foundries or Forges is produced, such certificate may be accepted in lieu of the certificate from Inspecting Authority in so far as it relates to the testing of material specified in the Form.
- (2) In case of safety valves, details and test results as required in item No.8 of Form-IV(Part-A) shall also be furnished duly signed by manufacturer and inspecting authority.
- (3) For Stock and sale purpose, one Form shall be issued for not more than fifty mountings and fittings.

Form IV(E):R01

Dated: 07.08.2026

**FORM-IV
(PART-E)**

[See regulation 13 and 50 to 57]

CERTIFICATE OF MANUFACTURE AND TEST OF CASTINGS

Certificate No. and date

Heat Number* and date of pouring

Maker's name and address

Customer's name and address

Drawing Nos.

Description and quantity _____ Sl. No. _____

Foundry identification _____

Chemical composition

Heat treatment

Physical test results.

- (i) Tensile strength
- (ii) Transverse bend test
- (iii) Elongation
- (iv) Other tests

Certified that the particulars entered herein by us are correct. This satisfies the requirements of Indian Boiler Regulations, 2026.

Maker's Representative

(Name and signature)

Maker

*(Name and Signature)**Name and signature of**Competent Person**Name and signature of**Inspecting Authority/Well Known foundry*

*for castings of size more than 100mm Heat number must be as Cast except for Investment castings.

NOTE: Castings can be as cast, rough-machined or final machined.

Form IV(F):R01

Dated: 07.08.2026

**FORM-IV
(PART-F)**

[See regulation 14 and 58 to 62]

CERTIFICATE OF MANUFACTURE AND TEST OF FORGINGS

Certificate No. and date

Heat Number

Details of raw material

Maker's name and address

Customer's name and address

Drawing Nos.

Description and quantity _____ Sl.No. _____

Forge shop identification _____

Chemical composition

Heat treatment

Physical test results.

- (i) Tensile strength
- (ii) Transverse bend test
- (iii) Elongation
- (iv) Other tests

Certified that the particulars entered herein by us are correct. This satisfies the requirements of Indian Boiler Regulations, 2026.

Maker's Representative
(Name and signature)

Name and signature of
Competent Person

Maker
(Name and Signature)

Name and signature of
Inspecting Authority/Well Known Forge.

Form IV(G):R01

Dated: 07.08.2026

FORM-IV
(PART-G)
[See regulation 15]

**CERTIFICATE OF MANUFACTURE AND TEST FOR (HEADERS,
DESUPERHEATERS/ATTEMPERATOR, BLOWDOWNTANK, FEEDWATERTANKS, ACCUMULATOR,
DEAERATOR)**

T.C.NO.: DATE:

Name of the Part :

Maker's Name & Address :

Customer's Name & Address :

Drawing No. :

Maximum allowable :
working pressure
(kg/cm²(g))

Process of Manufacture,

Material condition,

chemical composition,

Tensile Strength,

Tolerances,

Bend Test, Flattening Test
etc.

Inspecting Authority Identification Mark:

Refer enclosed Raw
material Test Certificates
or Form-V(Part-B) in lieu
of Raw material Test
Certificates

Design Temp.(°C) :

Heat Treatment :

Hydraulic Test :
Pressure

Non-destructive :
Testing

Item No.	PART NAME	MATERIAL SIZE	QUANTITY	MELT No.
01	PIPE			
02	END COVER			
03	STUBS			
04	BRANCH PIPES			
05				
06				

Certified that the particulars entered herein are correct.

The parts have been constructed to comply with the Indian Boiler Regulations, 2026 for a maximum allowable working pressure of ----- and temperature of ----- and satisfactorily withstood a water test of -----on the -----day of ----- in the presence of our responsible representative whose signature is appended hereunder.

Signature and Seal of Maker's Representative

Signature and Seal of Maker

Final Inspection Date:

We have satisfied ourselves that the..... have been constructed in accordance with Indian Boiler Regulations, 2026. The tests conducted have been witnessed by us, wherever applicable and the particulars entered herein are correct.

Name and Signature of Competent Person

Name and Signature of Inspecting Authority

Place:.....

Date:.....

Form IV(H):R01

Dated: 07.08.2026

FORM-IV
(PART-H)
[See regulation 16]

CERTIFICATE OF MANUFACTURE AND TEST FOR DISHED ENDS / END COVERS

T.C.NO.: DATE:

Name of the Part :

Maker's Name & Address :

Customer's Name & Address :

Drawing No. :

Maximum allowable :
working pressure
(kg./cm²(g))

Process of Manufacture, }

Material condition, }

chemical composition, }

Tensile Strength, :

Refer enclosed Raw
material Test Certificates or
Form-V(Part-B) in lieu of
Raw material Test
Certificates

Design Temp.(°C) :

Heat Treatment :

Hydraulic Test Pressure :

Non-destructive Testing :

Tolerances,

Bend Test, Flattening Test

etc.

Inspecting Authority Identification Mark:

ITEM No.	PART NAME	MATERIAL SIZE	QUANTIT Y	SPECN.	MELT No. / PLATE NO.	TC NO & DATE
01	PLATE / FORGING					

Certified that the particulars entered herein are correct.

Signature and Seal of Maker's Representative

Signature and Seal of Maker

Final Inspection Date:

We have satisfied ourselves that the _____ have been constructed in accordance with the Indian Boiler Regulations, 2026. The test conducted have been witnessed by us and the particulars entered herein are correct.

Name and Signature of Competent Person

Name and Signature of Inspecting Authority

Place:.....

Date:.....

Form V(A):R01

Dated: 07.08.2026

FORM-V
(PART-A)
 [Regulation 8(d)]

STEEL MAKER'S CERTIFICATE OF MANUFACTURE AND RESULTS OF TESTS

We hereby certify that the material described below has been made by M/s. by the process, as per specifications and rolled by and has been satisfactorily tested in the presence of our Test House Manager or his representative in accordance with the stipulated tests and tolerances.

For plates and bars, the physical properties are required to be mentioned whereas, for ingots, billets, blooms, slabs and concast bars which are to be processed further, the physical properties are not required to be mentioned by the steel manufacturer.

RESULTS OF TESTS										
Heat Number	Brand & Number	Name of product	Size			Number of pieces	Ultimate tensile breaking strength in kg/mm ²	Percentage Elongation	Bend Tests	Remarks
			Length (meters)	Breadth (meters)	Thickness or diameter (mm)					

Chemical analysis.....

Other tests

Maker's Representative

Maker

(Name and signature)

(Name and signature)

We have satisfied ourselves that the _____ have manufactured the products in accordance with Indian Boiler Regulations, 2026. The tests conducted on the samples taken from the finished products have been witnessed by us and the particulars entered herein are correct.

Name and signature of

Name and signature of

Competent Person

Inspecting Authority/ Well Known Steel Maker.

Place _____

Date _____

Form V(B):R01

Dated: 07.08.2026

FORM-V**(PART-B)**

[Regulation 8(d)]

CERTIFICATE OF MANUFACTURE AND RESULTS OF TESTS IN LIEU OF ORIGINAL TEST CERTIFICATES

It is hereby certified that original Test Certificate contain the following information in respect of the material used in the manufacture of the boiler or components thereof bearing Makers

Number..... according to

Drawing Number :

<i>Boiler component</i>	<i>Quantity</i>	<i>size</i>	<i>Cast/Heat No. Plate No.</i>	<i>Steel Making Process</i>	<i>Specification</i>
1	2	3	4	5	6

<i>Name of Steel Maker/Part Maker</i>	<i>Certificate No. & Date</i>	<i>Heat Treatment</i>
7	8	9

<i>% Chemical Analysis C Mn P S Si* other alloying elements</i>	<i>Yield strength (Kg/mm²)</i>	<i>U.T.S. (Kg/mm²)</i>	<i>Elongation % Gauge Length</i>	<i>Bend Test</i>	<i>Name of the inspecting authority</i>
10	11	12	13	14	15

*(Carbon, Manganese, Phosphorus, Sulphur, Silicon).

Certified that the particulars entered herein by us are correct. This satisfies the requirements of Indian Boiler Regulations, 2026.

Maker's Representative

Maker

(Name and signature)

(Name and Signature)

Name and signature of Competent Person

Name and signature of Inspecting Authority

Form VI(A):R01

Dated: 07.08.2026

**FORM-VI
(PART-A)**

[See regulation 17(2)]

**QUESTIONNAIRE TO BE ANSWERED BY FIRMS/COMPANIES SEEKING RECOGNITION BY THE CENTRAL BOILERS
BOARD TO BECOME AN “INSPECTING AUTHORITY”**

1. The registered name and address of the company/firm:
2. Address for correspondence:
3. The year in which the company/firm was established.
4. Proposed countries/areas of operation as Inspecting Authority:
5. Is company/firm registered in the proposed countries of operations?
If so, please give details thereof.
6. Have you any Branch or Associate Office?
If so, please give their names and addresses.
7. Is company/firm functioning as an Inspecting Authority under the Indian or International codes and standards?
If so, details thereof.
8. In case of renewal of recognition as Inspecting Authority under the Indian Boiler Regulations, 2026, had you conducted inspection during the last five years?
If yes, details thereof.
9. Is company/firm involved in any commercial activity other than inspection, certification and related activities under the Indian or International Codes and standards?
If so, details thereof.
10. Please state the types, size and the range of design pressure of the boilers which you have so far inspected during manufacture as an Inspecting Authority, also state the classes of service you render, namely: -
 - (a) Please name the various stages of manufacture at which inspections are carried out.
 - (b) Only hydraulic test after the manufacture of the boiler.
11. How many Inspectors/Competent persons have you in your employment? Please give details of the qualifications held by those persons.
12. Have you any Testing Laboratory of your own to conduct all destructive and non-destructive tests required in connection with the manufacture of boilers?
If so, details thereof.
13. Have you in-house design and drawing inspection office?
If so, details thereof.
14. Have you any documented quality programme established and maintained to fulfill the inspection requirements as per Indian Boiler Regulations, 2026?
If so, details thereof.

15. Are you having Curriculum Vitae of all the inspectors/competent persons employed in the organization for inspection and certification work?
16. Are you having a training programme for Inspectors/Competent persons?
If so, details thereof.
17. Are you prepared to conduct the work of Inspection of boilers, economisers and their accessories strictly in conformity with the Indian Boiler Regulations, 2026?
18. Are you prepared to accept full responsibility for the certificate issued by you?
19. Has your request for recognition as an Inspecting Authority been rejected by any Authority? If so, please give details.
20. Are you prepared to issue certificates for the products, you inspect, in the formats of the Indian Boiler Regulations?
21. Are you aware that the recognition is for a period of five years only, which is renewable after every five years on fresh assessment?

NAME, SIGNATURE & SEAL

Form VI(B):R01

Dated: 07.08.2026

**FORM-VI
(PART-B)**

[See regulation 17(2)]

**QUESTIONNAIRE FOR ELICITING INFORMATION REGARDING THE COMPETENCY OF A FIRMOR COMPANY TO BE
RECOGNISED AS “COMPETENT AUTHORITY”**

1. Registered name and address of the company/firm.
2. Address for correspondence.
3. Year in which the company/firm was established.
4. Address of branch or associate office, if any.
5. Principal work of the company/firm.
6. Does the company/firm have any training section for the welders? If so, details of the scheme to be stated.
7. Does the company/firm regularly conduct tests on welds done by its welders? If so, the code followed and the details of tests carried out may please be stated.
8. What are the facilities that can be provided or availed of by the organisation for conducting the tests?
9. Is the company/firm prepared to undertake testing of welders employed by other organisation?
10. In case of renewal of recognition as Competent Authority under the Indian Boiler Regulations, 2026, have you undertaken inspection and certification of welders during the last five years?
If yes, details thereof.
11. Whether the company/firm is prepared to conduct tests as per requirements of the Indian Boiler Regulations, 2026?
12. The amount of fee which the company/firm would charge from a candidate for conducting a test for the issue of certificate. Estimates under the following heads may be given:
 - (a) For the supply of tests pieces, electrodes and/or filler rods:
 - (b) For the use of welding machine:
 - (c) For machining the test pieces and preparation of specimen:
 - (d) For conducting mechanical tests (including specimen preparation):
 - (e) For non-destructive testing:
13. Is the company/firm prepared to examine and issue certificate to welders in accordance with the requirements of the Indian Boiler Regulations, 2026?
14. Is the company/firm prepared to take full responsibility for certificates issued by it.
15. Are you aware that the recognition is for a period of five years only which is renewable after every five years on fresh assessment?

NAME, SIGNATURE & SEAL

Form VI(C):R01

Dated: 07.08.2026

FORM-VI**(PART-C)**

[See regulation 17(2)]

QUESTIONNAIRE TO BE ANSWERED BY STEEL MAKER SEEKING RECOGNITION BY CENTRAL BOILERS BOARD TO BE**NOTIFIED AS “WELL KNOWN STEEL MAKERS”**

1. Registered Name and address of the firm/company:
2. Works address:
3. The year in which the factory was established:
4. Capacity for production of steel:
5. Process of manufacture of steel:
6. Variety of steel products:
7. Range of steel produced in each variety:
8. Various national and international Standards to which the steel products are manufactured:
9. Testing facilities available within the works:
10. Types of tests conducted:
11. If so, by whom conducted:
12. Are the tests conducted by the firm/company acceptable to the other organisations of the country? If so, by whom?
13. Is the firm/company prepared to conduct tests in accordance with the Indian Boiler Regulations, 2026?
14. Is the firm/company recognised as “Well Known Steel Maker” in any other country?
15. Whether the firm/company has minimum two years’ experience to produce steel in accordance with the provision of Indian Boiler Regulations under the inspection of any recognised Inspecting Authority.
If yes, details thereof.
16. Whether the firm/company is prepared to furnish certificates under the provision of Indian Boiler Regulations, 2026.

17. In case of renewal of recognition, had you manufactured and supplied steel as “Well Known Steel Maker” under the Indian Boiler Regulations during the last five years?

If yes, details thereof.
18. Whether the firm/company manufacture steel from the ore itself or from ore and scrap or scrap only:
19. Whether the firm is agreeable to show their manufacturing process and in-house testing facilities to a team consisting of three members appointed by the Board.
20. Are you aware that the recognition is for a period of five years only which is renewable after every five years on fresh assessment?

NAME, SIGNATURE & SEAL

Form VI(D):R01

Dated: 07.08.2026

FORM-VI**(PART-D)**

[See regulation 17(2)]

**QUESTIONNAIRE TO BE ANSWERED BY FOUNDRY/FORGE SEEKING RECOGNITION BY CENTRAL BOILERS BOARD
TO BE NOTIFIED AS “WELL KNOWN FOUNDRY/FORGE”**

1. The registered name and address of the firm/company:
2. Works address:
3. The year in which the factory was established:
4. Capacity of the foundry/forge:
5. (i) Capacity for production of forgings/castings:
(ii) Maximum weight and size of forgings/castings:
6. Detailed description of the type of job done by the firm/company:
7. Materials of castings/forgings (ferrous-plain or alloy steel, non-ferrous alloys):
8. Range of forgings/casting produced in each variety:
9. Testing facilities available within the works:
10. Details of testing facility, namely chemical and physical tests:
11. Types of test conducted:
12. If so, by whom conducted?
13. Are the tests conducted by the firm/company itself acceptable to the other organisations of the country?
If so by whom?
14. Is the firm/company prepared to conduct tests in accordance with the Indian Boiler Regulations, 2026?
15. Is the firm/company recognised as “Well Known Foundry/Forge” in any other country?
16. Whether the firm/company is in a position to produce forgings/casting in accordance with any national/international specifications fulfilling the minimum requirements of Indian Boiler Regulations, 2026:

17. Whether the firm/company has minimum two years' experience to produce forgings/castings in accordance with the provision of Indian Boiler Regulations under the inspection of any recognised Inspecting Authority.
If yes, details thereof.
18. Whether the firm/company is prepared to furnish certificates under the provision of Indian Boiler Regulations, 2026.
19. In case of renewal of recognition, had you manufactured and supplied castings/forgings as "Well Known Foundry/Forge" under the Indian Boiler Regulations during the last five years?
If yes, details thereof.
20. Whether the firm/company is agreeable to show their process of manufacture, in-house testing facilities to a team of members appointed by Central Boilers Board.
21. Are you aware that the recognition is for a period of five years only, which is renewable after every five years on fresh assessment?

NAME, SIGNATURE & SEAL

Form VI(E):R01

Dated: 07.08.2026

FORM-VI**(PART-E)**

[See regulation 17(2)]

**QUESTIONNAIRE TO BE ANSWERED BY TUBE/PIPE MAKER SEEKING RECOGNITION BY CENTRAL BOILERS BOARD
AS "WELL KNOWN TUBE/PIPE MAKER"**

1. Registered name and address of the firm/company:
2. Works address:
3. The year in which the factory was established:
4. Capacity of production of Tube/Pipe and the tonnage details per during the last three years:
5. Steel grades of Tube/Pipes under production:
6. Size range of Tubes/Pipes under production:
7. Process of manufacture of Tube/Pipes:
8. (a) Whether the firm/company is producing the raw material or purchasing the raw material.
(b) If the raw material is purchased, give the details of purchase in last three years.
 - i. from well-known steel makers under Indian Boiler Regulations.
 - ii. from other sources.
9. If purchase is as per 8(b)(ii), state whether the raw material is tested at Tube maker's/Pipe maker's premises under Indian Boiler Regulations.
10. If the firm/company is producing raw material, state whether the firm/company is recognised as Well Known steel maker under Indian Boiler Regulations.
11. Major manufacturing facilities available with the firm/company:
12. Testing facilities available with the works:
13. Types of tests conducted on Tubes/Pipes (enclose complete quality control plan from raw material stage to finished stage along with the quality control and inspection personnel of the firm):
14. The details of failures and rejection
 - (a) By Non-Destructive Testing(NDT)
 - (b) By Destructive Testing.
15. Whether the firm/company is in a position to manufacture Tubes/Pipes and also provide for their necessary testing facilities in accordance with the provision in Indian Boiler Regulations, 2026.
16. Whether the firm/company has minimum two years' experience to produce Tubes/Pipes in accordance with the provision of Indian Boiler Regulations under the inspection of any recognised Inspecting Authority.

If yes, details thereof.

17. Whether the firm/company is prepared to furnish certificates under the provision of Indian Boiler Regulations, 2026.

18. In case of renewal of recognition, had you manufactured and supplied Tubes/ Pipes as “Well Known Tubes/Pipes Maker” under the Indian Boiler Regulations during the last five years?

If yes, details thereof.

19. The name of the firms to whom the firm /company has supplied Tubes/Pipes:

20. Whether the firm/company is agreeable to show their manufacturing process and in-house facilities to a team consisting of three members appointed by the Board.

21. Whether the firm/ company is aware of the fact that the recognition is for a period of five years only, which is renewable after every five years term on fresh assessment?

NAME, SIGNATURE& SEAL

Form VI(F):R01

Dated: 07.08.2026

FORM-VI**(PART-F)**

[See regulation 17(2)]

**QUESTIONNAIRE TO BE ANSWERED BY A LABORATORY SEEKING RECOGNITION BY CENTRAL BOILERS BOARD AS
A “WELL-KNOWN MATERIAL TESTING LABORATORY”**

1. The registered name and address of the laboratory:
2. Address of the laboratory:
3. The year in which the laboratory was established:
4. (a) Whether the laboratory is recognised by the Central Government or by a State Government:
(b) If so, please furnish particulars of recognition:
5. Name and address of branch or associate laboratory, if any:
6. How long the laboratory has been functioning for testing of the products?
7. Equipment or machines available in the laboratory for carrying out the non-destructive or destructive testing:
8. Type and range of tests carried out by the laboratory:
9. Details of testing personnel and their qualifications or experience:
10. Are you prepared to conduct the testing of specimens strictly as per the requirements of the Indian Boiler Regulations, 2026?
11. Has your request for recognition as an approved laboratory been rejected by any authority? If so, please give details.
12. Are you prepared to issue the certificates for the products you test in the formats of the Indian Boiler Regulations, 2026?
13. Whether you have minimum two years' experience of conducting tests in accordance with the provision of Indian Boiler Regulations under the inspection of any recognised Inspecting Authority.
If yes, details thereof.
14. In case of renewal of recognition, had you conducted tests under the provisions of Indian Boiler Regulations during the last five years?
If yes, details thereof.
15. Are you agreeable to show your laboratory and in-house facilities to a team consisting of three members appointed by the Board?
16. Are you aware that the recognition is valid for a period of five years only, which is renewable for five years on fresh assessment?

NAME, SIGNATURE & SEAL

Form VI(G):R01

Dated: 07.08.2026

**FORM-VI
(PART-G)**

[See regulation 17(2)]

**QUESTIONNAIRE TO BE ANSWERED BY A FIRM SEEKING RECOGNITION BY CENTRAL BOILERS BOARD AS
“REMNANT LIFE ASSESSMENT ORGANISATION” UNDER REGULATIONS 313 to 315**

1. The registered name and address of the firm/company:
2. Address of the firm/company:
3. The year in which the firm /company was established:
4. (a) Whether the firm/company is recognised by the Central Government or by State Government:
(b) If so, furnish particulars of recognition:
5. Name and address of branch or associate firm, if any:
6. How long your firm has been functioning for Remnant Life Assessment of Boilers and Boiler Parts:
7. Equipment or machines available in the laboratory for carrying out the non-destructive or destructive testing:
8. Type and range of tests carried out by the firm/company:
9. Details of testing personnel and their qualifications and experience:
10. Are you prepared to conduct the testing of specimens strictly as per the requirements of the Indian Boiler Regulations, 2026?
11. Has your request for recognition as an approved organisation been rejected by any authority?
If so, please give details.
12. Are you prepared to issue the certificates for the tests recommended in the formats of the Indian Boiler Regulations, 2026?
13. In case of renewal of recognition, had you conducted Remnant Life Assessment of Boilers and Boiler parts under the Indian Boiler Regulations during the last five years?
If yes, details thereof.
14. Are you agreeable to show your laboratory and in-house facilities to a team consisting of three members appointed by the Board?
15. Are you aware that the recognition is valid for a period of five years only, which is renewable for five years on fresh assessment.

NAME ,SIGNATURE& SEAL

Form VII(A):R01

Dated: 07.08.2026

**FORM-VII
(PART-A)**

[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR INSPECTING AUTHORITY**

This is to certify that the Inspection and Quality Management System of:
M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026, as an INSPECTING AUTHORITY for operation in

This certificate is valid for five years, i.e. upto.....

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

No. -----

*Date of Issue Certificate*_____
Secretary

Form VII(B):R01

Dated: 07.08.2026

**FORM-VII
(PART-B)**
[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR COMPETENT AUTHORITY**

This is to certify that the Examination of Welder System of:

M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026, as a COMPETENT AUTHORITY for operation in

This certificate is valid for five years, i.e. upto.....

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

Date of Issue

Secretary

Form VII(C):R01

Dated: 07.08.2026

**FORM-VII
(PART-C)**

[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR WELL-KNOWN STEEL MAKER**

This is to certify that the Inspection and Quality Management System of:

M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026, as WELL KNOWN STEEL MAKER, for the manufacture of _____

for their factory at _____

This certificate is valid for five years, i.e. upto _____

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

*Date of Issue*_____
Secretary

Form VII(D):R01

Dated: 07.08.2026

**FORM-VII
(PART-D)**
[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR WELL-KNOWN FOUNDRY**

This is to certify that the Inspection and Quality Management System of:

M/s. _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026 as a WELL KNOWN FOUNDRY for the manufacture of

for their factory at

This certificate is valid for five years, i.e. upto _____

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

Date of Issue

Secretary

Form VII(E):R01

Dated: 07.08.2026

**FORM-VII
(PART-E)**
[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR WELL KNOWN FORGE**

This is to certify that the Inspection and Quality Management System of:

M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026 as a WELL KNOWN FORGE for the manufacture of

for their factory at _____

This certificate is valid for five years, i.e. upto _____

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

*Date of Issue*_____
Secretary

Form VII(F):R01

Dated: 07.08.2026

**FORM-VII
(PART-F)**

[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR WELL KNOWN TUBE MAKER**

This is to certify that the Inspection and Quality Management System of:

M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026, as a WELL KNOWN TUBE MAKER for the manufacture of Tubes of sizes from _____ to _____
for their factory at _____

This certificate is valid for five years, i.e. upto _____

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

*Date of Issue*_____
Secretary

Form VII(G):R01

Dated: 07.08.2026

FORM-VII
(PART-G)
[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL FOR WELL KNOWN PIPE MAKER

This is to certify that the Inspection and Quality Management System of:

M/s _____

has been evaluated by the Central Boilers Board and has been granted recognition under regulation 19 of the Indian Boiler Regulations, 2026, as a WELL KNOWN PIPE MAKER for the manufacture of pipe of sizes from _____ to _____
for their factory at _____

This certificate is valid for five years, i.e. upto _____

Validity is subject to the adherence to the quality control prescribed under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

*Date of Issue*_____
Secretary

Form VII(H):R01

Dated: 07.08.2026

**FORM-VII
(PART-H)**

[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

**CENTRAL BOILERS BOARD
CERTIFICATE OF APPROVAL AS WELL-KNOWN MATERIAL TESTING LABORATORY**

This is to certify that after evaluation of the inspection and material testing system of the following laboratory, the Central Boilers Board has granted recognition to it under regulation 19 of the Indian Boiler Regulations, 2026, as a Well-known Material Testing Laboratory.

M/s _____

This certificate is valid for five years, i.e. upto _____

Note: The recognition will be as per the standards specified under the provisions of the Indian Boiler Regulations, 2026.

Certificate No. _____

*Date of Issue*_____
Secretary

Form VII(I):R01

Dated: 07.08.2026

**FORM-VII
(PART-I)**

[See regulation 19]

NATIONAL EMBLEM

Serial No.....

File No.....

CENTRAL BOILERS BOARD**CERTIFICATE OF APPROVAL AS WELL KNOWN REMNANT LIFE ASSESSMENT ORGANISATION**

This is to certify that after evaluation of the inspection and material testing system of the following firm, the Central Boilers Board has granted recognition to it under regulation 19 of the Indian Boiler Regulations, 2026 as a Well Known Remnant Life Assessment Organisation.

M/s. _____

This certificate is valid for five years, i.e. upto _____

Certificate No. _____

*Date of Issue*_____
Secretary

Form VIII:R00

Dated: 07.08.2026

FORM-VIII**(Regulation 293)****MAKER'S NAME & ADDRESS****FINAL INSPECTION REPORT FOR BOILER COMPONENTS****REPORT NO:****DATE:**

**THIS IS TO CERTIFY THAT THE PRESSURE PARTS DETAILED BELOW HAVE BEEN INSPECTED AND
CLEARED UNDER THE INDIAN BOILER REGULATIONS, 2026.**

BOILER NO.:

SL. NO.	PRODUCT IDENTIFICATION	DRAWING NO.	DESCRIPTION	QTY NO.	COMPETENT PERSON IDENTIFICATION MARK

Signature and Seal of Maker's Representative**Name and signature of Competent Person**

Form IX:R01

Dated: 07.08.2026

FORM-IX

[See regulation 295(7) and 295(8)]

**DETAILS TO BE FURNISHED ALONGWITH APPLICATION FOR INSPECTION OF BOILER AFTER
TWELVE/THIRTY SIX MONTHS OF THE CERTIFICATION UNDER REGULATION 311 AS PER
APPENDIX 'H' AND APPENDIX 'I'**

1. Name and address of the owner
2. Registry number of the boiler
3. Steam pressure and temperature
4. Rate of steam generation
5. Heating surface
6. Year of make
7. Brief description of boiler
8. Type of construction (Whether riveted or welded)
9. Whether fired or waste heat boiler
10. Date of registration
11. Details of past exemption granted by the Government, if any
12. Date of last annual inspection
13. Expiry date of current certificate
14. Maximum working pressure at which last certificate was issued
15. Details of past repairs (year-wise)
16. Remark as entered in the last certificate
17. Quality of boiler feed water
18. Whether requisite number of feed pumps are in satisfactory working condition at present?
19. Number of safety valves mounted on shell/drum and super heater
20. Total number of soot blowers provided in boiler
21. Number of soot blowers in working condition
22. Whether safety valves are blowing satisfactorily at or below design pressure?
23. Whether safety valve assembly is free from jamming as verified by operating casing lever?
24. Whether high and low water level alarm is in good condition?
25. Whether main steam stop valves, feed check valves, blow down valves and master pressure gauge in working condition?
26. Whether additional requirements for automatic boilers as per

regulation 182 are complied with? (If 'No', give details)

27. Last date of calibration for master pressure gauge, temperature indicator/recorder for superheater, hot reheat, cold reheat and main steam line.
28. (a) Last date when boiler protection devices were satisfactorily tested and details thereof
(b) Last date when boiler protection devices were tested by simulation
29. Details of boiler stoppages in last twelve months with reasons and remedies thereof
30. Present irregularities in instruments and controls if any observed in control-room of boiler house
31. Details of present boiler leakage
32. Present operating pressure of the boiler
33. Whether water quality is tested on-line (enclose copy of test report showing values of analysis including Total Dissolved Solids (TDS))
34. State at what intervals such test is carried out
35. When boiler was last opened for internal and/or external cleaning?
36. State at what intervals such cleaning is carried out
37. Whether there was any shut down since last inspection when the boiler could have been offered for inspection?
38. Whether working pressure of the boiler ever exceeded in the past beyond certified limit? If any, give details
39. Details of boiler accident which took place in the past, if any
40. List of Boiler Operation Engineers/Attendants
41. Irregularities, if any, noticed in the past in compliance of the Act
42. Whether guidelines laid down by Central Boilers Board for granting exemption to the waste heat boilers are fulfilled or not?

Name and Signature of General Manager (Generation)

Remarks of the Competent Person who verified correctness of above statement paying check visit to the Boiler House.

Name and signature of Competent Person

Form X :R01

Dated: 07.08.2026

FORM-X

[Regulation 300(2)]

PROVISIONAL ORDER UNDER SECTION 14 OF THE BOILERS ACT 2025

..... are hereby permitted to use the Boiler (Registry No.) Boiler rating made by and bearing Maker's number at a design pressure of kg/cm²(g) pending the issue of or refusal of a certificate within six months from the date thereof after which period this order will become void.

*Dated**Inspector of Boilers*

Form XI:R01

Dated: 07.08.2026

FORM-XI

(Regulation 306)

BOILER INSPECTION DEPARTMENT**BOILER REGISTRY NUMBER**

--

**MEMORANDUM OF INSPECTION BOOK
OR
REGISTRATION BOOK**

GENERAL

District.....

Owner.....

Address of Factory.....

Nearest Railway Station.....

Factory is.....

KMs from station

Works or Factory (Type of Industry)

Working Season

Boiler registered at.....

on.....

Register Book No.

Page.....

Registry Number.....

verified on.....

Design pressure of boiler

Boiler Rating.....

Inspection Fee.....

Registration Book Filed at.....

on.....

Remarks on transfers, etc.

PROVISIONAL ORDER AND CERTIFICATE RECORD

Fee (Rs.)	Date of payment	Date of inspection	Certificate No. and date	Period of certificate	Design Pressure of boiler [Kg/cm ² (g)]	Main Steam outlet Temp. (°C)	Boiler Rating	Fuel used	Evaporation (T/hr or Kg/hr)	Initials of Inspector/ Competent Person

PARTICULARS AND DIMENSIONS

Type of Boiler:

Leading Dimensions:

Maker:

Intended Working Pressure:

Place and Year of make:

Main Steam outlet temperature:

Description of Boiler:

Maker's Number:

Details of Maker's stamp

Position of Stamp

MAKER'S CERTIFICATE

Boiler Name.....
 Maker Manufacture, hydraulic test to.....kg/cm²(g). Drawing No..... received.....
 Inspecting Name.....
 Authority Tests of material, construction, supervision, hydraulic test..... received.....

DETAILS OF PRESSURE PARTS

S NO	NAME OF THE PRESSURE PART	SIZE	MATERIAL SPECIFICATION

CYLINDRICAL SHELL

	(a) <i>Shell or Mud Drum</i>	(b) <i>Steam Drum</i>
Name of parts		
Number		
Length between end plates		
Length between end plates seam		
Diameter inside largest belt		
Thickness of Plates		
Number of belts of plating		
Longitudinal seams		
Position (o'clock)		
Circumferential seams		
No. of seams (end and inner)		

SHELL END PLATES AND STAYS

PLATES	Flat, dished, hemispherical (in..... pieces,) not stayed, not flanged				
	Diameter (outside), front..... back,.....		crown.....	Largest circle	
	Radius of curvature front.....		back, ...	crown	
	Radius of curvature, corner of flange,.....		shell, ...	furnace, ... uptake, ...	
	Plate, thickness, front back, ...		crown.....	tubeplate F,..... B, ...	
	Attach to shell, crown or front, ...				
	Attach to shell, back end, ...				
	Attach to uptake or furnace crown or front,.....				
Attach to furnace flue, back end.....					
STAYS	Gusset Stay, No. F.E., top, ...		Bottom, ...	B.E., top, ...	bottom, ...
	Longtl. Stays No.		dia., ...		, ...
	Longtl. Stays pitch, Vertical		Horizontal.....	Circumferential	
			..		
Diagl. D _o , ...					

MANHOLES, HAND AND SIGHT HOLES, DOORS AND STAND BLOCKS

Parts and materials hereunder.....

MANHOLES	No. and position			
	Framed or plate flanged			
	Boiler opening, length × width			
	Frame opening, length × width			
	Frame inside, outside, raised, pressed			
	Frame solid, welded, cast			
	Frame section on longtl. axis			
	Door, type and thickness			
	Door, if inside, spigot clearance			
	Bolts, No. dia., threads Nut			
	Bolts, pitch circle			
	Compensation ring, width x thickness			

SIGHT HOLES	No.	dimensions	positions
	Compensation rings fitted	section	
	Doors, type	bolts dia.,..... threads.....	spigot clearance.....
	Cleaning plugs, No	dia.	position
BLOCK ETC.	Height	dia. (outside), top,... bottom....	thickness
	Standpipe below stop valve, ...	height,..... dia. (outside)	thickness
	Flanges		

FIREBOX DETAILS**DETAILS OF FLUE TUBES**

I & II PASS TUBES	No. plain, ...	Stay	overall	length	specification
	Plain, dia. (out)	thickness, ...		Front End.,welded, expd., beaded, feruled. Smoke End., welded Expd., beaded, or	
	Stay, dia. (out)	thickness, ...		F.E.,welded, expd., beaded, , S.E,welded, Expd., ..	
	Pitch of plain tubes, V.....	H.....		D.....	C.Z.
	Pitch of stay tubes, V	H.....		D	C.Z.
	No. plain, ...	Stay	overall	length	specification
	Plain, dia. (out)	thickness, ...		Front End.,welded, expd., beaded, feruled. Smoke End., welded Expd., beaded, or	
	Stay, dia. (out)	thickness, ...		F.E.,welded, expd., beaded, S.E,welded, Expd., ..	
	Pitch of plain tubes, V	H		D	C.Z.
	Pitch of stay tubes, V	H.....		D	C.Z.

FURNACE, CROWN AND UPTAKE

HORIZONTAL AND VERTICAL FURNACES	No., ... Type	
	No. of stiffener rings in each Furnace..... Longtl. seams position	
	Length between Centre	
	Inside diameter	
	Plate thickness	
Positions of cross tubes or stiffener		

MOUNTINGS AND FITTINGS

VALVES, ETC.		Number	Diameter	Type	Material	Bolted OR welded to
	Safety					
	Safety					
	Main. Stop					
	Aux. Stop					
	Feed					
	Blow Down					
	Injector					

MISCELLANEOUS FITTINGS	Water gauges, No. type Test cocks No.
	Water gauges, top of lower nut is mm above
	Pressure gauge, Type dia.in mm ... range kg/cm ² (g)
	Pressure gauge, Maker No. red line at kg/ cm ² (g)
	Fusible plug, type position
	Blow down pipe connected to
	Feed apparatus
Additional fittings	

SAFETY VALVES

	(A)	(B)	(C)
No. of valves each chest.....			
Type.....			
Diameter of valve seat (mm).....			
Diameter of Neck (mm)			
Diameter of outlet (mm)			
.....			

REQUISITE AREA OF SAFETY VALVES

For Saturated steam

$$A = \frac{E}{C.P.}$$

For Superheated steam

$$A_s = \frac{E \times \sqrt{1 + \frac{2.7 T_s}{1000}}}{C \times P}$$

E = ; C = ; P = ; A =

A_s = ; T = ; T_s = ;**HEATING SURFACE**

Total Heating Surface Sq. m.

Boiler Rating

.....

HYDRAULIC TEST (REGISTRATION)Inspector Date of test Test pressure kg/ cm²(g)

Duration of test mins. Boiler pressure, gauge No. use at test

Boiler pressure gauge compared with on found

Position of Boiler at test

Brick work Lagging

Condition of boiler under test

Condition of boiler mountings under test

M I book prepared by on submitted on

M I Book Checked by on

Chief Inspector/Director of Boiler's remarks and signature

STEAM TEST (REGISTRATION)

Inspector

Design pressure of boiler kg/ cm²(g)

Boiler connections

Fuel used

Safety Valve lifted at (A) kg/ cm²(g)

Date of Test

Test pressure kg/ cm²(g)

Condition of fire

Draught

(B) kg/ cm²(g). (C) kg/ cm²(g)..

	Beginning	5 mins.	10 mins.	15 mins.	Difference
Timing of test.....					
Height of water in glass.....					
Pressure by Boiler gauge.....					

Accumulation of pressure, in (%).....

Do safety valves efficiently relieve boiler?

Condition of boiler under steam

Condition of mountings under steam

Thickness of washers or ferrules

Feed pump or injector worked

Water gauge tested

Boiler Attendant (or) Boiler Operation Engineer

Limit of load on safety valves to be entered in Certificate

NOTES ON WORKING OF BOILER

Boiler steam is used for

Constant, intermittent or seasonal work

Is boiler relieved by spare boiler?

Nature of feed water

Fuel used Are printed instructions kept near boiler?

Period between cleanings recommended by Inspector

STEAM-PIPES

PLAN OF MAIN STEAM-PIPES

Registry Nos. of connected boilers

Provisions for disconnection from other boiler

RECORDS OF INSPECTIONS AND TESTS

First inspection by on

First hydraulic test to kg/cm²(g) ... by on

INSPECTION NOTES

PARTICULARS OF BOILER ATTENDANTS & BOILER OPERATION ENGINEER				
Date of visit	Name	Grade	Certificate No.	Date of Issue

Form XII:R01

Dated: 07.08.2026

FORM-XII
(Regulation 310)

CERTIFICATE FOR USE OF A BOILER

Registry Number of Boiler	Type of Boiler
Boiler Rating	Place and year of manufacture
Maximum Continuous Evaporation	
Name of Owner	
Situation of Boiler	
Repairs	
Remarks	
Hydraulically Tested on	to kg/cm ² (g)

I hereby certify that the above described boiler is permitted by me/the Chief Inspector under the provisions of Section 12/13 of the Boilers Act, 2025, to be worked at a maximum pressure of kg/cm²(g) for the period from to

The loading of the safety valve is not to exceed kg/cm²(g)

Fee Rs. paid on

Dated at this day of 20.....

Name and signature of
Competent Person

Countersigned

Chief Inspector

See Reverse for "Conditions"

CONDITIONS
(REVERSE OF FORM XII)

- (1) No structural alteration, addition or renewal shall be made to the boiler otherwise than in accordance with section 18 of the Act.
- (2) Under the provisions of Section 13 of the Act this certificate shall cease to be in force:
 - (a) on the expiry of the period for which it was granted; or
 - (b) when any accident occurs to the boiler; or
 - (c) when the boiler is moved the boiler, except a vertical boiler, the heating surface of which is less than two hundred square feet, or a portable or vehicular boiler; or
 - (d) save as provided in section 17 of the Act, when any structural alteration, addition or renewal is made in or to the boiler; or
 - (e) if the Chief Inspector in any particular case so directs when any structural alteration, addition or renewal is made in or to any steam-pipe attached to the boiler; or
 - (f) on the communication to the owner of the boiler of an order of the Chief Inspector or Inspector prohibiting its use on the ground that it or any boiler component attached thereto is in a dangerous condition.

Under Section 15 of the Act, when the period of a certificate relating to a boiler has expired, the owner shall, provided that he has applied before the expiry of that period for a renewal of the certificate be entitled to use the boiler at the design pressure entered in the former certificate, pending the issue of orders on the application but this shall not be deemed to authorise the use of a boiler in any of the cases referred to in clauses (b), (c), (d), (e) and (f) of sub-section (1) of section 13 occurring after the expiry of the period of the certificate.

- (3) The boiler shall not be used at a pressure greater than the pressure entered in the certificate as the Design pressure nor with the safety valve set to a pressure exceeding such design pressure.
- (4) The boiler shall not be used otherwise than in a condition which the owner reasonably believes to be compatible with safe working.
- (5) Form XII shall be countersigned by the Chief Inspector at the time of registration only, as per the provisions of sub-section (6) of section 12 of the Act.

Note: The particulars and dimensions regarding this boiler may be obtained by the owner on payment in the prescribed manner on application to the Chief Inspector.

Form XIII:R01

Dated: 07.08.2026

FORM-XIII

[See regulation 316(2)]

QUESTIONNAIRE FORM FOR REPAIRER OF BOILERS/ECONOMISER/STEAM LINE/FEED WATER LINES

1. (a) Registered name of the firm and its permanent address
- (b) Address of the workshop:
2. Year of establishment.....
3. Classification applied for—
 - (a) Special Class (For any Boiler Pressure)
 - (b) Class I (For Boiler Pressure upto 125 kg/cm²)
 - (c) Class II (For Boiler Pressure upto 40 kg/cm²)
 - (d) Class III (For Boiler Pressure upto 17.5 kg/cm²)
4. Type of jobs executed by the firm earlier, with special reference to their Design pressure, temperature and the materials involved, with documentary evidence
5. (a) Whether the firm has ever been approved by any Boilers' Directorate/Inspectorate? If so, give details
- (b) Has your request for recognition as a repairer under Indian Boiler Regulations, 2026 been rejected by any Authority?
- If so, please give details
6. Whether having rectifier/generator, grinder, general tools and tackles, dye penetrant kit, expander and measuring instruments or any other tools and tackles under regulation 316(4)(a).
7. Detailed list of technical personnel with designation, educational qualifications and relevant experience (attach copies of documents) who are permanently employed with the firm
8. How many working sites can be handled by the firm simultaneously?
9. Whether the firm is prepared to execute the job strictly in conformity with the regulations and maintain a high standard of work?
10. Whether the firm is prepared to accept full responsibility for the work done and is prepared to clarify any controversial issue, if required?
11. Whether the firm is in a position to supply materials to required specification with proper test certificates if asked for?
12. Whether the firm has an internal quality control system of their own? If so, give details
13. List of welders employed with copies of current certificate issued by a Competent Authority under the Indian Boiler Regulations, 2026.

Date

signatory

Place

*Name & Signature of the authorised**of the firm with stamp*

Note 1: The recognition of the firm as a repairer shall be for a period of two years, thereafter they shall apply for renewal of their recognition at least two months before the expiry of the said period.

Note 2: In case the repairer is found violating the provisions of the Act or Regulations knowingly or unknowingly, the firm shall be blacklisted under intimation to Chief Inspectors or Directors of Boilers of all the States/Union territories and renewal shall not be done in any case.

Form XIV:R01

Dated: 07.08.2026

FORM- XIV

[Regulation 322(3)]

THE BOILERS ACT, 2025**Boiler Inspection Department
Steam Pipes and Connected Fittings
Identification Number****Memorandum of Inspection Book**

MISCELLANEOUS

District

Owner

Address

Work of Factory:

Registration Number of Boilers to which the pipes and fittings, particulars of which are given in this
Memorandum are connected.

*Remarks Date**Particulars of additions & alterations*

.....

.....

.....

.....

.....

.....

.....

.....

PLAN OF STEAM PIPES & THEIR CONNECTED FITTINGS**FEE AND APPROVAL TO PLAN RECORD**

<i>Drawing No.</i>	<i>Total length of Steam Pipes</i>	<i>No. of Connected vessels</i>	<i>Fee</i>	<i>Date of Payment</i>	<i>No. & date of approval of Plan & Layout</i>	<i>M.A.W.P. approval Kg/cm²(g)</i>	<i>Temp allowed °C</i>	<i>Remarks & initial of Inspector</i>
------------------------	--	---	------------	----------------------------	--	---	--------------------------------	---

STEAM PIPES—PARTICULARS AND DIMENSIONS

Situation

Ry. No. of connected Boilers

Steam Piping System include

Pipes Material Diameter (outside)

Pipes Thickness Make

Attachment of Flanges

Elbows, Tees etc.

.....

Support

Flexibility

Drainage

Feed pipes

Outside Dia. Thickness

Make

Max. Pressure Max. Temp

Connected Vessel

No.

Type

Maximum allowable working pressure Max. Design Temp.
.....

Date of Installation

First Inspection inside &

Outside

Feed Pipes Hydraulic Test to kg/cm^2 By on

Remarks

CALCULATIONS

Steam Pipes :

.....

.....

.....

CALCULATIONS

Steam Pipes :

.....

.....

.....

CALCULATIONS

Steam Pipes:

.....

.....

.....

CALCULATIONS

.....

.....

.....

.....

INSPECTOR'S NOTE

.....

.....

.....

Form XV:R01

Dated: 07.08.2026

FORM-XV

[Regulation 358(3)]

INSPECTING AUTHORITY'S CERTIFICATE OF INSPECTION UNDER CONSTRUCTION

We hereby certify that type, ... Economiser, consisting of sections and tubes to each section was constructed for a Design pressure of kg/cm²(g). Messrs under our supervision and inspected at various stages of construction by the Competent Person and that the construction and workmanship were satisfactory and in accordance with the standard conditions for the design and construction of Economiser laid down in Chapter-11 of the Indian Boiler Regulations, 2026.

Identification Mark on each section.

Branch Pipe on other pressure part.

Position of same.

The sections on completion were subjected to a water pressure of kg/cm²(g) for ten minutes in the presence of the Competent Person on and satisfactorily withstood the test in accordance with Regulation 361.

Samples of the material used in the constructions of the Economiser were tested in the presence of the Competent Person and were found to comply with the tests prescribed in Chapter-11 of the Indian Boiler Regulations, 2026.

We have satisfied ourselves that the construction and dimensions of the Economiser are as shown in the Maker's Drawing No. signed by us and that the particulars entered in the maker's certificate of manufacture in Form-XVI countersigned by us are correct to the best of our knowledge and belief.

Dated at this day of 20.....

Name and Signature of Inspecting Authority

Form XVI:R01

Dated: 07.08.2026

FORM-XVI

[Regulation 358(4)]

WORKS ADDRESS**Constructor's Certificate of Manufacture and Test**

1. Description	Type of Economiser	No. of tubes
	No. of Sections	kg/cm ² (g)
	Intended working pressure	Total heating
	Year of manufacture	Surface of tubes
	Description	
2. Inspecting	Economiser constructed under supervision of	
Authority	Sections hydraulically tested for minutes and inspected after test by	
3. Construction and	Details are in Drawing No.	
Workmanship	All castings are well finished free from external defects, porous places and blow-holes and true to dimensions without warping.	
	Where chapters are used, there is satisfactory fusion with the metal.	
	Chapters properly tinned with metal free from lead.	
	All screw threads are of Whitworth form.	
	All components parts are manufactured to limit gauges to secure interchangeability throughout.	
4. Economisers and fittings	<i>Parts</i>	<i>Material</i>
	<i>Maker</i>	<i>Competent Person's</i>
	<i>Remarks</i>	
Particulars of	Headers Tubes and/or	
material used	Pipes Valve Chest Bolt	

THICKNESS OF PARTS AND TENSILE TEST—LIMIT

5. Part of Economiser	<i>Thickness in</i> <i>32nds</i>	<i>Tensile strength</i> <i>limits to tons</i>	<i>Elongation</i> <i>limits to %</i>	<i>Gauge</i> <i>Length</i>	<i>Brand and</i> <i>No.</i>
Headers					
Tubes					
Bolts					

Certified that the particulars entered herein are correct and that the parts and fittings mentioned above have been used in the construction and fittings of the Economiser.

The particulars shown against the various parts used are in accordance with the Maker's certificates in our possession.

The design of the economiser in section and end view with principal parts fully dimensioned is that shown in Drawing No. The Economiser has been designed and constructed to comply with the Indian Boiler Regulations for a Design pressure of kg/cm²(g) at our Works above-mentioned and the sections satisfactorily withstood a water test of kg/cm²(g) for minutes on day of 20..... in the presence of our responsible representative whose signature is appended hereunder.

Signature of Engineer who witnessed the test

Designation of Maker

Dated at this day of 20.....

Name and *Signature of Inspecting Authority*

Note: The drawing of the Economiser and Maker's certificate of manufacture showing results of tests for tensile strength and elongation shall accompany this certificate and if the economiser has been built under the supervision of an Inspecting Authority their certificate in Form-XV shall accompany.

Form XVII:R01

Dated: 07.08.2026

<i>Counterfoil</i>	FORM-XVII [Regulation 381(5)]
No.	No.
Name of the person or firm to which	Provisional Order under the Boilers Act, 2025
Provisional Order is granted.	_____
Description of Economiser	are hereby permitted to use the Economiser Ry. No. and
Maker's No.	Economiser Rating made by and bearing Maker's No.
Rating	 at a design pressure of kg/cm ² (g) /maximum
Pressure permitted	temperature of °C pending the issue or refusal of a certificate
Period	within six months from the date thereof after which period this order
Date	will become void.
	Dated at this day of 20.....
<i>Inspector</i>	<i>Inspector</i>

Form XVIII:R01

Dated: 07.08.2026

FORM-XVIII
(Regulation 385)

BOILERS INSPECTION

DEPARTMENT

ECONOMISERS

REGISTRY NUMBER

MEMORANDUM OF INSPECTION
OR
REGISTRATION BOOK
MISCELLANEOUS

District

Owners

Address of Factory

Nearest Railway Station

Economiser Registered at on

Register Book No Page

Registry Number Verified on

Design Pressure Kg/cm²(g).....

Economiser Rating Inspection fee

Registration Book filled at on

Remarks on transfer etc.

PROVISIONAL ORDER AND CERTIFICATE RECORD

<i>Fee</i>	<i>Date of payment</i>	<i>Date of Inspection</i>	<i>Certificate No. and Date</i>	<i>Period of Certificate</i>	<i>Design pressure</i>	<i>Economiser Rating</i>	<i>Remarks and Inspector's initial</i>

Type of Economiser

Maker

Intended Working Pressure

Place and year of make

Maker's No

Description of Economiser

No. of tubes length Dia.

Thickness

Internal dimensions

No. of Headers

Thickness of Headers

Length of Top Branch Pipe

Thickness

Length of Bottom Branch Pipe

Thickness

Dimensions of cap openings

Diameter of cap bolts

MOUNTINGS

<i>No.</i>	<i>Diameter</i>	<i>Type</i>	<i>Position</i>	<i>Material</i>
Relief Valve				
Stop Valve				
Blow Down				
Thermometers				
Pressure Gauge				

Additional Fittings

MAKER'S CERTIFICATE

Name of Maker

Maker's Hydraulic Test Pressure

Maker's Drawing No.

Name of Inspecting Authority

Name of Maker of Material

Tubes

Process Headers

Bolts

Test Results

Tubes T E

Headers T E

Pipes T E

Bolts T

% Sulphur

% Phosphorus

Maker's Identification Mark

Position

CALCULATIONS

HEADERS

TUBES

BRANCH PIPES

BOLTS

HEATING SURFACE

Total Heating Surface

Economiser Ratings

Calculations made by

submitted on

Calculations checked by

on

Maximum Allowable working pressure

Kg/cm²(g).

Chief Inspector's remarks and signature

INSPECTOR'S NOTES

Form XIX:R01

Dated: 07.08.2026

FORM-XIX
(Regulation 387)

CERTIFICATE FOR USE OF AN ECONOMISER

Registry Number of Economiser	Type
No. of tubes	
Number of Headers	
Economiser Rating	Place and year of manufacture
Name of owner	
Situation of Economiser	
Repairs	
Remarks	
Hydraulically tested on . _____ to kg/cm²(g)	

I hereby certify that the above described Economiser is permitted by me/Chief Inspector under the provisions of Section 12/13 of the Boilers Act, 2025 to be worked at a maximum pressure of kg/cm²(g) /maximum temperature of °F or the period from to

This loading of the safety relief valve is not to exceed, ... kg/cm²(g).

Fee Rs. paid on

Dated at

This day of 20.....,

Name and signature of
Competent Person

CONDITIONS

(REVERSE OF FORM XIX)

- (1) No structural alteration, addition or renewal shall be made to the Economiser without a written permission from the Chief Inspector.
- (2) This certificate shall cease to be in force—
 - (a) on the expiry of the period for which it was granted, or
 - (b) when any accident occurs to the Economiser, or
 - (c) when any structural alteration, addition or renewal is made in or to the Economiser, or
 - (d) save as provided in section 17 of the Act, when any structural alteration, addition or renewal is made in or to the Economiser; or
 - (e) on the communication to the owner of the Economiser of an order of the Chief Inspector or Inspector prohibiting its use on the ground that it is in a dangerous condition.
- (3) The Economiser shall not be used at a pressure greater than the pressure/temperature entered in the certificate as Maximum allowable working pressure /temperature not with the relief valve set to pressure/temperature exceeding such Maximum allowable working pressure /temperature.
- (4) The Economiser shall not be used otherwise than in a condition which the owner reasonably believes to be compatible with safe working.

N.B.: Details regarding this Economiser are recorded in a Registration Book No. of which a copy may be obtained on payment on application to the Chief Inspector.

Form XX:R00

Dated: 07.08.2026

FORM-XX**Qualified Boiler Welder's Certification Continuity Form****(as per Regulations 517 and 527(3), to be submitted along with renewal request)**

Issued under

THE INDIAN BOILER REGULATIONS, 2026

Name of the welder :

Father's Name :

Date of Birth :

Organisation Name & Address :

IBR qualification certificate No :

Validity:

Qualified In : Carbon Steel - Plate / Pipe & Tube (M number grouping)

Alloy Steel - Plate / Pipe & Tube (M number grouping)

Process:

Consumable U number:

Continuity details (through a sample detail for reference) :

a. On completion of 6 months

a. Welded Part Name:

b. Date :

b. On completion of 12 months

a. Welded Joint Name:

b. Date :

c. On completion of 18 months

a. Welded Part Name:

b. Date :

d. On completion of 24 months

a. Welded Part Name:

b. Date :

Submitted by

Signature and Seal of the employer with date

Certificate extended up to _____

Approved by

(Name and Signature of Competent Authority)

Date & Seal

Form XXI:R01

Dated: 07.08.2026

FORM-XXI

(Regulation 540)

Record of Welder's Qualifications/Requalification Tests (Indian Boiler Regulations, 2026)

Place of Test

Date

Name of Welder

Father's name

Date of Birth

Address

.....

Service of experience on Gas/Electric Arc years.....

Signature of Welder

Names and addresses of the firms where trained

.....

Tested on (Plate, pipe, tube)

Gas of electric A.C./D.C.

Kind of test (Groove/Fillet/Branch)

Position.....

Thickness of material used

Diameter and thickness of pipe, branch or tubes used

Quality of base material and electrode or filler rod

RESULTS OF OBSERVATIONS

	<i>Marks</i>	
	<i>Maximum</i>	<i>Awarded</i>
A. Procedure		
1. Preparation of specimen	3	
2. Size & Grade of electrode or filler rod	2	
3. Number of runs and manipulation of control	5	

B. Visual Inspection

4. Root penetration	10
5. Freedom from undercut	5
6. Disposition of runs	2
7. Uniformity of surface	1
8. Shape of profile	1
9. Smoothness of joints	2
10. Freedom from cavities & slags	5
11. Dimensions of weld deposit	1
12. Quality of weld metal (Overheating, surface cracks, spongy surface etc.)	3

C. Physical Test

13. Face bend test	10
14. Root bend test	20

D. Etch Test

15. Disposition of runs	2
16. Degree of fusion	5

17. Root Penetration	11
18. Slags inclusions and porosity	5

E. Fractured Surface

19. Quality of weld metal (Excessive oxidation, carburisation, overheating, roughness, porosity, appearance).	7
	100

Name and Signature of Competent Authority

Observation on radiographic examination (if conducted)

Marks awarded %

Results of Oral or Written examination

Marks awarded %

GENERAL REMARKS OF COMPETENT AUTHORITY

TYPE AND CLASS OF WELDING QUALIFIED in Gas or Electric Arc welding.

PERIOD OF VALIDITY OF CERTIFICATE From To

Place

Date

Name and signature of Competent Authority

Form XXII:R01

Dated: 07.08.2026

FORM-XXII**CERTIFICATE OF MANUFACTURE AND TEST FOR SMALL INDUSTRIAL BOILERS**

[Regulation 555(2)]

1. Maker's Name Year of Make
2. Manufactured for
3. Location of Installation
4. Boiler Identification Competent Person's stamp
5. Drawing No. Alteration No.
6. Design pressure (kg/Cm²(g))
7. Size of Boiler

<i>Length (Meters)</i>	<i>Width (Meters)</i>	<i>Height (Meters)</i>	<i>Diameter (Meters)</i>
------------------------	-----------------------	------------------------	--------------------------

8. Material Specification (As applicable)

CHEMICAL COMPOSITION					MECHANICAL PROPERTIES				
<i>C</i>	<i>Si</i>	<i>Mn</i>	<i>P</i>	<i>S</i>	<i>Y</i>	<i>S</i>	<i>U.T.S.</i>	<i>%</i>	<i>EL.</i>

Shell

Furnace

Tube Plates

Flange

Boiler Tubes/Pipe/Pads Details

<i>Diameter Thickness Material</i>	CHEMICAL COMPOSITION					MECHANICAL PROPERTIES				
<i>Specification</i>	<i>C</i>	<i>Si</i>	<i>Mn</i>	<i>P</i>	<i>S</i>	<i>Y</i>	<i>S</i>	<i>U.T.S.</i>	<i>%</i>	<i>EL.</i>

Tube

Pipes

Pads

9. Volumetric Capacity

10. Heating Surface (Sq. Metres)

11. Nozzle connection

(a) Steam Outlet

(No. Size and Type of Nozzles)

(b) Safety Valve

(No. Size and Type of Nozzles)

(c) Auxiliary (Air vent)

(No. Size and Type of Nozzles)

(d) Blow off Valve

(No. Size and Type of Nozzles)

(e) Feed Valve

(No. Size and Type of Nozzles)

12. Shop Hydro Test Pressure (Kg. Cm²) Date*Name and Signature of Manufacturer*

We certify that the above boiler constructed under our supervision and inspected at various stages of construction by the Competent Person and that the construction, workmanship were satisfactory as per Indian Boiler Regulations, 2026.

Name and Signature Competent Person
Authority

Name and Signature of Inspecting

Dated this Day of 20.....

Form XXIII:R00

Dated: 07.08.2026

FORM-XXIII**CERTIFICATE OF MANUFACTURE AND TEST FOR SMALL SOLAR BOILERS****[Regulation 596(3)]**

1. Maker's Name Year of Make
2. Manufactured for
3. Location of Installation
4. Boiler Identification Competent Person's stamp
5. Drawing No. Alteration No.
6. Design pressure (kg/cm^2 (g))
7. Heating Surface (Sq. Metres)

8. *Material Specification (As applicable)*

9. Volumetric Capacity (in liters)
10. Safety Valve (No..... Size.....)
11. Hydro Test Pressure (Kg/cm^2 (g)) Date

Manufacturer

(Name, Signature & Stamp)

We certify that the above boiler was constructed under our supervision and inspected at various stages of construction as specified in chapter-17 by the Competent Person and that the construction, workmanship were satisfactory as per Indian Boiler Regulations, 2026.

Competent Person

(Name, Signature & Stamp)

Inspecting Authority

(Name, Signature & Stamp)

Dated this Day of 20.....

APPENDIX-A**INSPECTION AND TESTING OF BOILERS, BOILER COMPONENTS AND OTHER PARTS DURING MANUFACTURE**

GENERAL. —The Inspecting Authority or Competent Person shall have access to the works of the manufacturer at all reasonable times and shall inspect the manufacture of the boiler at least at the following stages and may reject any part that does not comply with the requirements of the Indian Boiler Regulations, 2026. In case of any doubt, the Inspecting Authority or Competent Person may examine at any stage other than the stages stipulated below. The manufacturer shall give at least four working days' notice to the Inspecting Authority or Competent Person before reaching each stage. Before undertaking any of the stage inspections, the Inspecting Authority or Competent Person shall satisfy himself that the testing equipment/instrument has been properly calibrated.

STAGES OF INSPECTION. — Each boiler shall be inspected during manufacture by a Competent Person nominated by the Inspecting Authority. Sufficient inspections shall be made to ensure that the materials, manufacturing and testing conform to the requirements of these regulations.

Stages of Inspection During Manufacture. —

A. Shell Type Boilers. —(a) (i) When the materials are ready for identification with the relevant material test certificates at boiler maker's works;

(ii) In laying out and cutting the plates, the plate identification mark shall be located so as to be clearly visible after the boiler part is completed. If the plate's identification mark is unavoidably cut out, it shall be transferred by the manufacturer to another part of the component to the satisfaction of the Inspecting Authority or Competent Person;

(iii) The Inspecting Authority or Competent Person shall identify weld test plate material if production weld tests are required;

(b) When the Shell plate and end plates have been formed with plate edges prepared for welding and test plates are attached;

(c) When the welding of main cylindrical shell is completed and checked for circularity;

(d) To examine radiographs and/or reports of non-destructive testing;

(e) When openings have been prepared and stand pipes and similar connections including end plates have been tackwelded in position and subsequently on completion;

(f) When welding of drum or shell is completed and to check the records of heat-treatment when heat treatment is required under these regulations;

(g) When weld test specimens have been prepared from the test plate, previously selected to witness the required testing;

(h) During hydraulic test, followed by external and internal examination and stamping.

B. Water Tube Boilers. —

(I) Welded drums, headers, separators and vessels. —(a) (i) When the materials are ready for identification with the relevant material test certificates at boiler maker's works;

(ii) In laying out and cutting the plates, the plate identification mark shall be located so as to be clearly visible after the boiler part is completed. If the plate's identification mark is unavoidably cut out, it shall be transferred by the manufacturer to another part of the component to the satisfaction of the Inspecting Authority or Competent Person;

(iii) The Inspecting Authority or Competent Person shall identify weld test plate material if production weld tests are required;

(b) When the plates are formed to cylindrical shape with the edges prepared for welding and set up in readiness for commencement of welding and attachment of test plates;

(c) When the welding of the main cylindrical shell is completed, the shell checked for circularity and the radiographic or ultrasonic test reports, records are available for scrutiny;

(d) When the end plates are ready for identification with the mill certificate, formed to shape with weld edges prepared and set on to the cylindrical shell in readiness for the circumferential welding operation;

(e) When the welding of the end plates to the drum or the header is complete and the radiographs or ultrasonic examination records are available for scrutiny;

(f) When each drum or header is prepared to receive any compensation plates and attachments, and when at least 10% of each type of branch of tube stub is set up ready for welding;

(g) When all welding on each drum or header is complete, the Inspecting Authority or Competent Person will check the records of heat treatment, and mark off of specimens for preparation and testing from test plates;

(h) During non-destructive examination, after stress relieving, on alloy steel drums and carbon steel drums with carbon content exceeding 0.25 % or thickness more than 100 mm;

(i) During hydraulic test followed by final examination and stamping.

(II) Seamless drums, headers, separators and vessels. —(a) When materials are ready for identification with the relevant material test certificates, also when each cylinder is prepared for forming, or welding of separate end closures and to identify test plate material;

(b) When the end plates are ready for identification with the mill certificate, formed to shape with weld edges prepared and set on to the cylindrical shell in readiness for the circumferential welding operation;

(c) When the welding of the end plates to the drum or the header is complete and the radiographs or ultrasonic examination records are available for scrutiny;

(d) When each drum or header is prepared to receive any compensation plates and attachments, and when at least 10% of each type of branch of tube stub is set up ready for welding;

(e) When all welding on each drum or header is complete, the Inspecting Authority will check the records of heat treatment, and mark off of specimens for preparation and testing from test plates;

(f) During non-destructive examination, after stress relieving, on alloy steel drums and carbon steel drums with carbon content exceeding 0.25 % or thickness more than 100 mm;

(g) During hydraulic test followed by final examination and stamping.

C. Tubular and piping components. —(a) When the tubes or pipes are ready for identification with the relevant material test certificates at the boiler makers' works;

(b) When all welding of tubes or pipes and their attachments are complete and the non-destructive examination and stress relieving report/records are available for scrutiny;

(c) During hydraulic test followed by final examination and stamping.

D. Inspections and tests to be carried out at Steel Makers' Works Foundry or Forging Units and pipe and tube makers' works by the Inspecting Authority or Competent Person. —

(I) Steel Makers Works. —(a) For manufacture of the billets, ingots, slabs, blooms, plates, bars, concast bars or any other material to be used in the construction of the boilers:

(i) Checking of the chemistry of steel as per regulations;

(ii) When ready for non-destructive examination and selection of mechanical test specimen after heat treatment;

(iii) Testing, final examination and stamping.

Note: Notwithstanding anything specified above where the steel is made by the Well-known Steel Maker as recognised under the Indian Boiler Regulations by the Central Boilers Board, these tests shall be carried out and certified by the Steel Makers themselves and the records maintained properly.

(II) Pipe and Tube Makers. —(i) Identification of materials with relevant material test certificates;

(ii) When ready for non-destructive examination and selection of mechanical test specimens after heat treatment;

(iii) When specimen is tested and pipes or tubes are ready for hydraulic tests.

(iv) Final inspection and stamping

Note : Notwithstanding anything specified above, when the pipes or tubes are manufactured by well-known pipes or tubes makers recognised under the Indian Boiler Regulations by the Central Boilers Board, all the above stages of inspections shall be carried out and certified by the manufacturers of pipes and tubes themselves and records maintained properly.

(III) Forging Units. — (i) Checking of the chemistry of steel as per regulations;

(ii) When ready for non-destructive examination and selection of mechanical test specimen after heat treatment;

(iii) Testing, final examination and stamping.

Note: Notwithstanding anything specified above, when the forgings are made by well-known forging units as recognised under the Indian Boiler Regulations by the Central Boilers Board then tests shall be carried out and certified by the Forges themselves and all records maintained properly.

(IV) Foundry Units. —(i) Checking of the chemistry of molten metal;

(ii) Verification of heat number and stamping of test bars;

(iii) Verification of non-destructive examination report and heat treatment reports/records, mechanical testing, final examination and stamping.

Note: Notwithstanding anything specified above, when the castings are made by well-known foundry units as recognised under the Indian Boiler Regulations by the Central Boilers Board then tests shall be carried out and certified by the Foundries themselves and all records maintained properly.

E. Valves and Mountings. —(a) Identification of materials with the relevant material test certificates;

(b) Hydraulic test and stamping.

APPENDIX-B**TRANSVERSE RUPTURE STRESS (MODULUS OF RUPTURE)**

The transverse strength of cast iron may be expressed by a figure shown as the Transverse Rupture Stress; this figure is obtained by dividing the maximum bending moment at failure by the modulus of the section. Thus, the Transverse Rupture Stress is the maximum stress which would have existed if the material had behaved in accordance with the assumptions made in the ordinary theory of bending, and in that event it would be independent of the size and shape of the section. Bars fractured in transverse, however, are stressed beyond the elastic limit, and under these conditions the theory of bending no longer holds good. Furthermore, the influence of rate of cooling in cast metals is such that the Transverse Rupture Stress of a Thick Bar is less than that of a thinner bar of the same metal. The Transverse Rupture Stress, therefore, is not strictly independent of the size and metal. The Transverse Rupture Stress, therefore, is not strictly independent of the size and shape, of the section, but nevertheless forces a convenient way of expressing the result of transverse tests without the necessity for giving full details of bar dimensions. The formula required is obtained as follows:

A bar supported at both ends and centrally loaded with a load 'W' is subject to a bending Moment $WL/4$, 'L' being the distance between supports. The resistance offered by the bar may be expressed as fZ , 'f' being the stress and 'Z' the modulus of the section. At fracture, 'f' becomes the breaking stress of Transverse Rupture Stress, and $WL/4 = fZ$, where $f = (LW)/(4Z)$. If 'W' is in tons and 'L' in inches, 'f' is in tons per square inch. For a round bar, $Z = 0.0982d^2$, where d diameter in inches.

Since for a standard round bar 'L' and 'Z' are constant, the value $WL/4Z$ is fixed and hence the Transverse Rupture Stress $f = KW$, where 'K' is a constant.

The factor 'K' for converting actual breaking loads into Transverse Rupture Stress are given in the following tables both for the Standard test bars and the test bars varying within the limits of regulation 65. In the same table are given factors for converting actual breaking loads into equivalent breaking loads on the bars of Standard diameter.

Factors X for converting Actual Breaking Loads into Equivalent Breaking Loads on Bars of Standard Diameter.

(Equivalent Breaking Load on Bar of Standard Diameter = X x Actual Breaking Load).

And

Factors K for converting Actual Breaking Loads into Transverse Rupture Stresses.

(Transverse Rupture Stress in tons per sq.in. = K x Actual Breaking Load in lbs.)

0.5 in. Test Bar			0.685 in. Test Bar			0.75 in. Test Bar			1.0 in. Test Bar			2.0 in. Test Bar		
Dia	X	K	Dia	X	K	Dia	X	K	Dia	X	K	Dia	X	K
in.			in.			in.			in.			in.		
—	—	—	—	—	—	—	—	—	1.50	1.214	0.00030	2.00	1.908	0.00041
—	—	—	—	—	—	1.11	1.094	0.0188	1.51	1.190	0.00034	2.01	1.940	0.00035
—	—	—	—	—	—	1.12	1.230	0.0148	1.52	1.080	0.00083	2.02	1.154	0.00031
—	—	—	0.61	1.201	0.0257	1.13	1.193	0.0142	1.53	1.444	0.00071	2.03	1.167	0.00025
—	—	—	0.62	1.216	0.0247	1.14	1.116	0.0128	1.54	1.121	0.00090	2.04	1.091	0.00021
—	—	—	0.63	1.172	0.0230	1.15	1.126	0.0128	1.55	1.130	0.00040	2.05	1.075	0.00017
0.64	1.230	0.0062	0.64	1.130	0.0230	1.16	1.107	0.0121	1.56	1.070	0.00059	2.06	1.058	0.00012
0.67	1.106	0.0032	0.65	1.091	0.0222	1.17	1.079	0.0128	1.57	1.090	0.00029	2.07	1.044	0.00008
0.66	1.187	0.0034	0.66	1.058	0.0214	1.18	1.052	0.0125	1.58	0.975	0.00019	2.08	1.029	0.00005
0.69	1.092	0.0008	0.67	1.017	0.0207	1.19	1.026	0.0121	1.59	1.010	0.00009	2.09	1.014	0.00009
0.70	1.080	0.0074	0.675	1.000	0.0204	1.20	1.008	0.0118	1.60	1.000	0.00089	2.10	1.000	0.00096
0.81	0.952	0.0401	0.68	0.983	0.0200	1.21	0.975	0.0115	1.61	0.991	0.00090	2.11	0.985	0.00020
0.90	0.906	0.0429	0.69	0.993	0.0193	1.22	0.982	0.0113	1.62	0.953	0.00081	2.12	0.972	0.00088
1.05	0.894	0.0420	0.70	0.918	0.0187	1.25	0.925	0.0110	1.65	0.940	0.00072	2.13	0.958	0.00032
1.04	0.874	0.0090	0.91	0.948	0.0181	1.24	0.868	0.0107	1.64	0.929	0.00064	2.14	0.945	0.00007
—	—	—	0.92	0.882	0.0175	1.25	0.883	0.0100	1.65	0.919	0.00065	2.15	0.932	0.00074
—	—	—	0.93	0.893	0.0178	1.26	0.894	0.0102	1.66	0.895	0.00047	2.16	0.919	0.00071
—	—	—	0.94	0.887	0.0164	1.27	0.844	0.0100	1.67	0.879	0.00039	2.17	0.906	0.00067
—	—	—	—	—	—	1.28	0.854	0.0098	1.68	0.864	0.00031	2.18	0.898	0.00063
—	—	—	—	—	—	1.29	0.835	0.0096	1.69	0.849	0.00034	2.19	0.882	0.00068
—	—	—	—	—	—	—	—	—	1.70	0.834	0.00018	2.20	0.870	0.00053

APPENDIX- C (See regulation 75)

(1) Parent metal for test plates.— The parent metal used in preparing test pieces and test specimen shall be equivalent matching mild steel or non-ferrous material as per the relevant American Welding Society (AWS) or Filler Alloys (SFA) specification. A matching material shall be used with buttering with a minimum of 3 mm thickness on groove faces and on backing plate. The thickness and other dimensions shall be as per the relevant American Welding Society (AWS) or Filler Alloys (SFA) specification.

(2) All-weld metal test.— Method of preparation of test pieces. The temperature of the parent metal shall be between 10°- 38°C minimum immediately before deposition the first run of weld metal. Preheat and interpass temperature shall be as applicable to the relevant American Welding Society (AWS) or Filler Alloys (SFA) specification. The test specimen shall not be subjected to any mechanical or thermal treatment other than the required American Welding Society (AWS) or Filler Alloys (SFA) specification. All-weld test pieces shall be prepared as per the applicable American Welding Society (AWS) or Filler Alloys (SFA) specification.

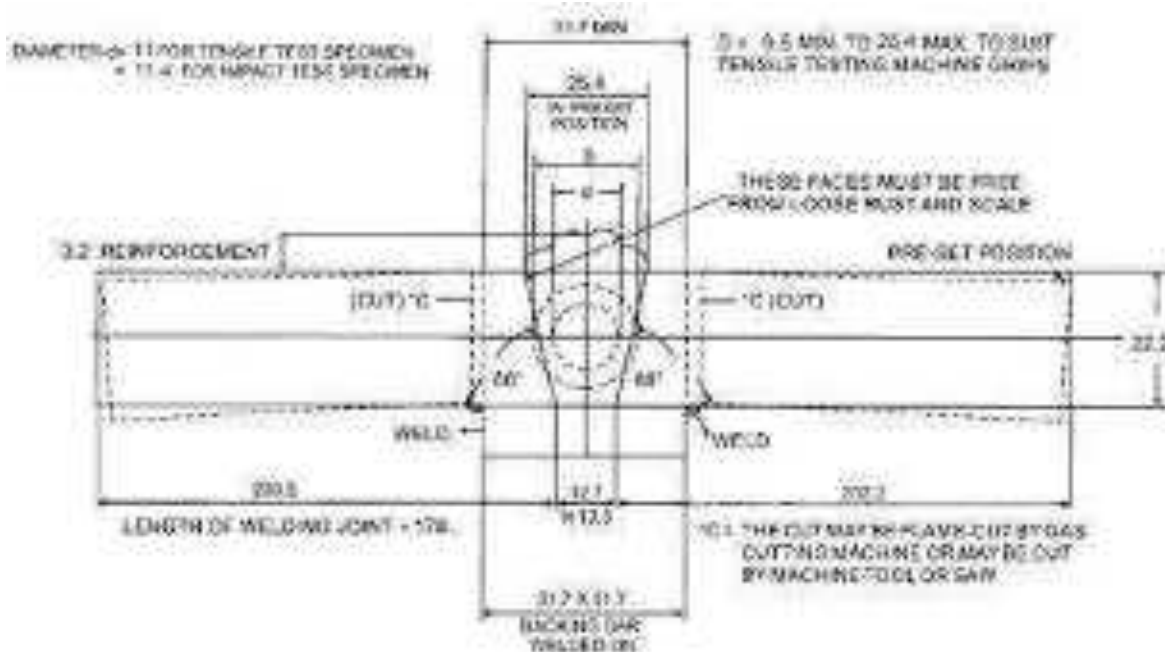


Fig. 2/2: Method of preparation of All-Weld Metal Test Specimen

The assembly shall be welded together with these plates pre-set so that the gap at the top between the chamfered edges of the plates is 25 mm and the plates may be approximately level when the butt-weld is completed.

The weld metal shall be deposited in single or multi-run layers and the direction of deposition of each layer shall be alternatively from each end of the specimen. Each run of weld metal shall not be less than 1.5 mm and not more than 3 mm thick. The time interval between the completion of one run and the commencement of deposition of the succeeding run shall be not less than five minutes. The assembly shall not be quenched between the deposition of individual runs. The welding current used shall be within the appropriate range given by the manufacturer. The welding position for the assembly shall be flat, unless this is contrary to the recommended position for the electrode, in which case the position of weld shall be as recommended by the manufacturer.



Fig. 2/5: METHOD OF MAKING TRANSVERSE TENSILE AND BEND TEST SPECIMENS

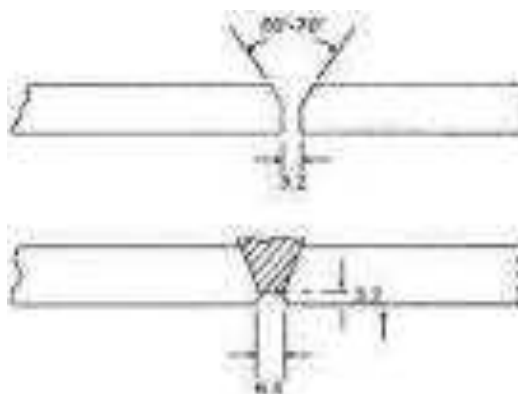


Fig. 2/6: GROOVING IN PREPARATION FOR DEPOSITION OF BACKING RUN

(See Fig. 2/6)

Angle between fusion faces 60°-70°

Root face 3.2 mm.

Maximum gap 3.2 mm.

The plate edges shall be prepared as per Fig. 2/6, and pre-set to allow for slight distortion after welding.

The welding procedure in making out the test pieces shall be according to the position of welding as in Table 2/38 below:

Table 2/38: Welding procedure for preparation of transverse tensile test and bend test piece

Welding position for test pieces (all angles $\neq 5^\circ$) shown in Table 2/39 below	Welding Procedure
(1)	(2)
FLAT Weld slope 0° Weld rotation 0°	1. All runs made with 4 mm electrodes. 2. First run – 5mm. electrodes. Subsequent runs 6.3 mm diameter electrodes (or largest size manufactured).
INCLINED Weld slope 30° Weld rotation 45°	First – 4 mm electrodes. Subsequent runs – 4./5.0 mm electrodes
HORIZONTAL VERTICAL Weld slope 0°	First run – 4 mm electrodes.

Weld rotation 90°	Subsequent runs – 4 /5 mm electrodes
VERTICAL Weld slope 90°	All runs made with 4 mm electrodes.
OVER HEAD Weld slope 0° Weld rotation 180°	All runs made with 4 mm electrodes.

In all cases a backing run shall be made with 4 mm. electrodes in the welding position applicable to the test piece, after cutting out a groove of 3 mm deep if considered necessary, as in Fig. 2/6.

The test pieces for the inclined and vertical positions shall be welded using the ‘upwards’ methods unless the electrodes manufacturer especially recommends that only the ‘downwards’ method shall be used, if both methods are recommended, test pieces welded by each method shall be made. After welding, the test pieces shall be cut by sawing or machining to form one face-bend and one root-bend test specimen, as indicated in Fig. 2/5.

(5) **Transverse tensile test.**— Transverse tensile tests specimens shall conform to the dimensions given in Fig. 2/7. The upper and lower surfaces of the weld shall be filed, ground or machined level with the respective original surfaces of the plates. Where the plates are not level with each other the metal may be cut away to bring them approximately level, provided that the thickness of the plate is not reduced by more than a total of 1 mm. The test specimens shall then be tested for tensile test as in Appendix-D.

(6) **Transverse bend test.**— The bend test specimens shall be 38 mm in width. The upper and lower surfaces of the weld shall be filled, ground or machined level with the respective original surfaces of the plates, with the proviso as in item (6) above. The tool marks should be avoided as they lead to location of stress and may cause premature failure. For this reason the direction of machining of the surfaces should be along the specimens and transverse to the weld. The sharp corners of the test specimens shall be rounded to a radius not exceeding 1.3 mm.

The test specimens shall be bent through an angle of 180° over a former having a diameter equal to three times the thickness of the specimen, as shown in Fig. 2/8. One test specimen shall be tested with the face of the weld in tension and one with the root of the weld in tension.

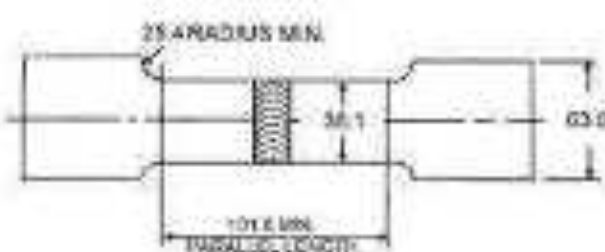


Fig. 2/7: Dimensions of Transverse Tensile Test Specimen

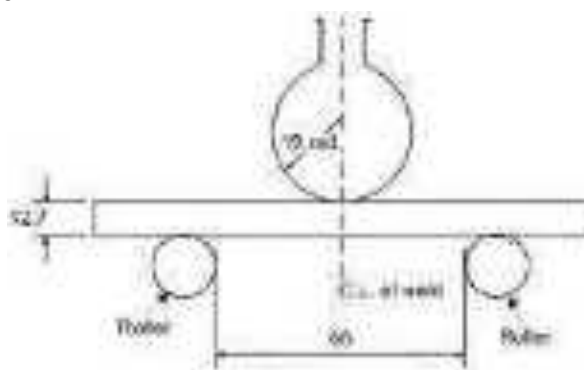


Fig. 2/8: Method of Carrying Out Bend Tests

**DEFINITION OF WELDING TERMS, CLASSIFICATION OF COVERED ELECTRODES,
DEFINITIONS & PRINCIPLES – DEFINITIONS**

Weld Slope: The slope of a weld is the angle formed between the line of weld root and a horizontal reference plane placed below the lowest portion of the weld. (See Fig. 2/9)

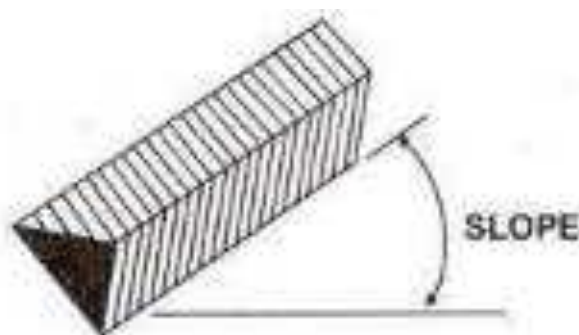


Fig. 2/9: Figure to Illustrate Weld Slope

Weld Rotation: The rotation of weld is the angle formed between the upper portion of vertical reference plane which passes through the line of the weld root and a line drawn from the line of the weld root which intersects the weld surface at a right angle and a point equidistant from either edge of the weld (see Fig. 2/10)

Note: Example of the slope & rotation of various welds are given in Fig. 2/11.

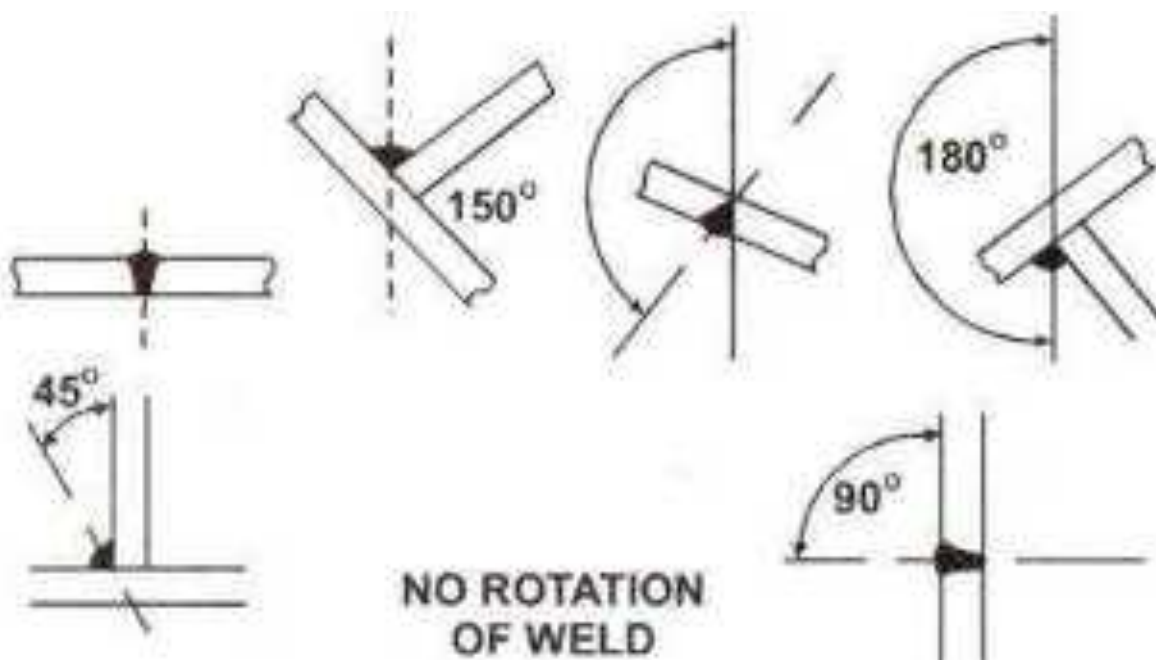


Fig. 2/10: Figures to Illustrate Weld Rotation

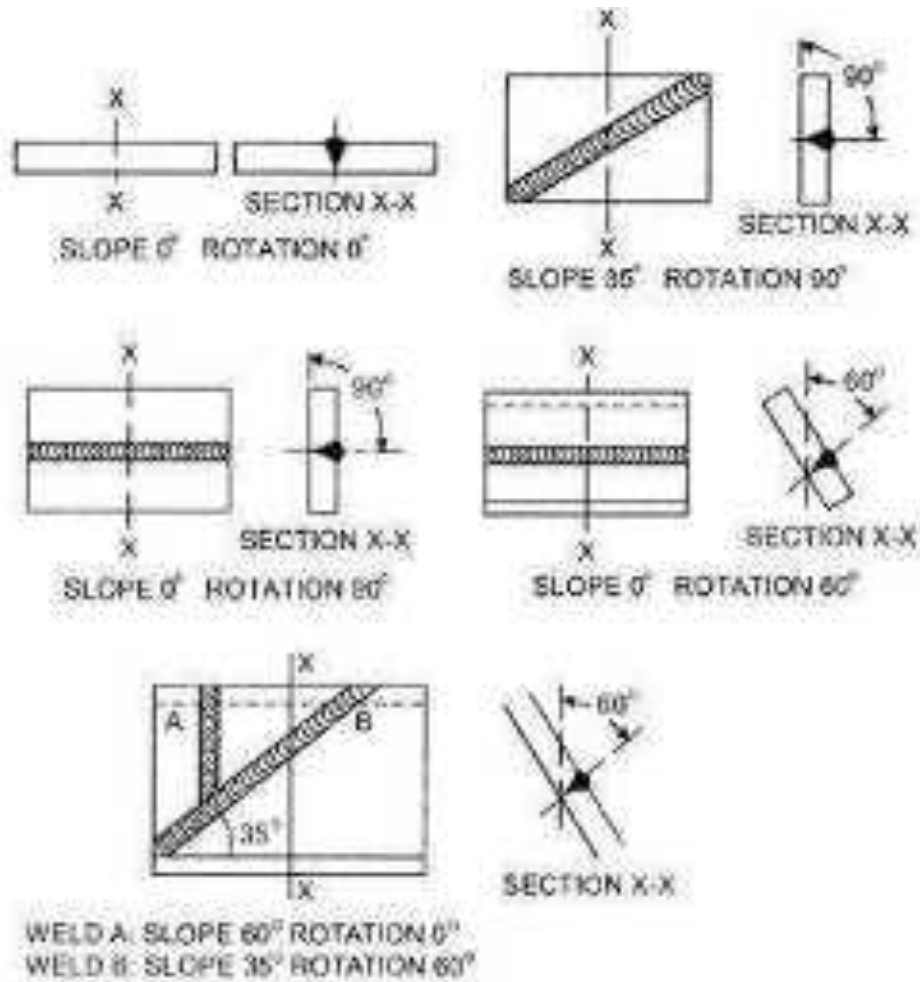


Fig. 2/11: Examples of 'Slope' and 'Rotation'

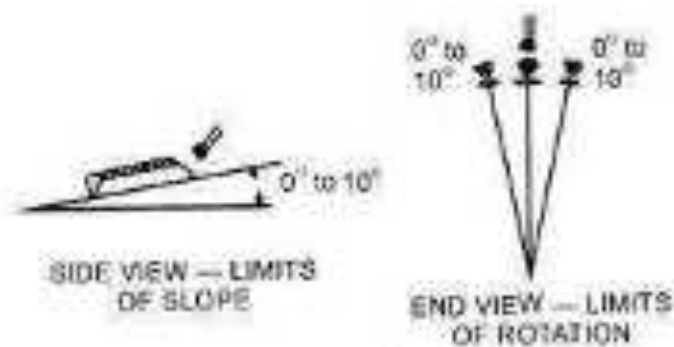


Fig. 2/12: Flat (F)

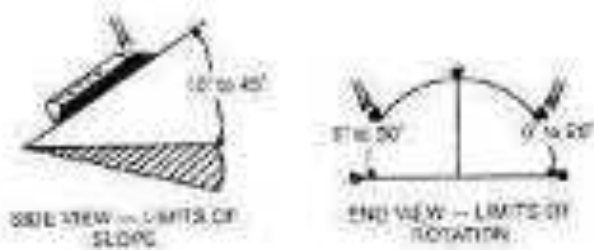
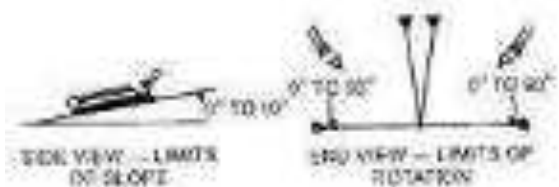
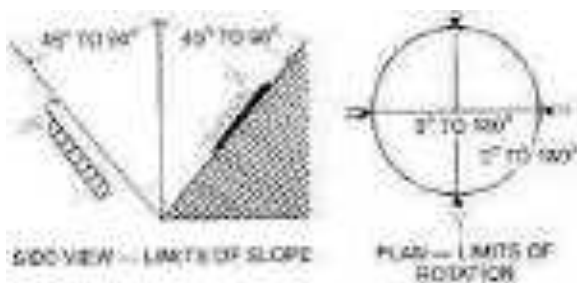
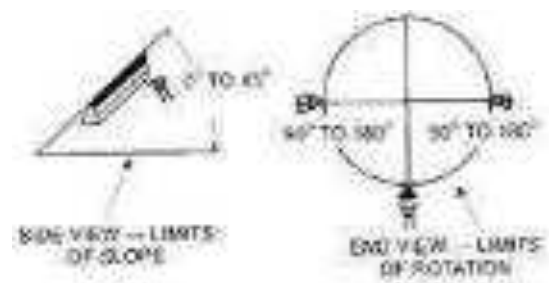
TABLE 2/39

ELDING POSITIONS: WELDING POSITIONS ARE DEFINED AS FOLLOWS

POSITIONS	SLOPE	ROTATION	SYMBOL	ILLUTRATION
(1)	(2)	(3)	(4)	(5)
FLAT	NOT EXCEEDING 10°	NOT EXCEEDING 10°	F	Fig. 2/12
INCLINED	EXCEEDING 10° NOT EXCEDING 45°	NOT EXCEEDING 90°	I	Fig. 2/13
HORIZONTAL VERTICAL	NOT EXCEEDING 10°	EXCEEDING 10° NOT EXCEEDING 90°	H	Fig. 2/14
VERTICAL	EXCEEDING 45°	ANY	V	Fig. 2/15
OVERHEAD	NOT EXCEEDING 45°	EXCEEDING 90°	O	Fig. 2/16

NOTE: The five positions defined above cover any possible combination of slope and rotation so that every weld can be classified in one of these positions.

The table above is for Fig. 2/12.

**Fig. 2/13: Inclined (I)****Fig. 2/14: Horizontal - Vertical (H)****Fig. 2/15: Vertical (V)****Fig. 2/16: Overhead (U)**

APPENDIX-D

FORMS OF STANDARD TENSILE TEST PIECES

STANDARD FLAT TEST PIECES

TEST PIECE A

1. Chief for sheets, plates, strips, flat bars, sections, etc.

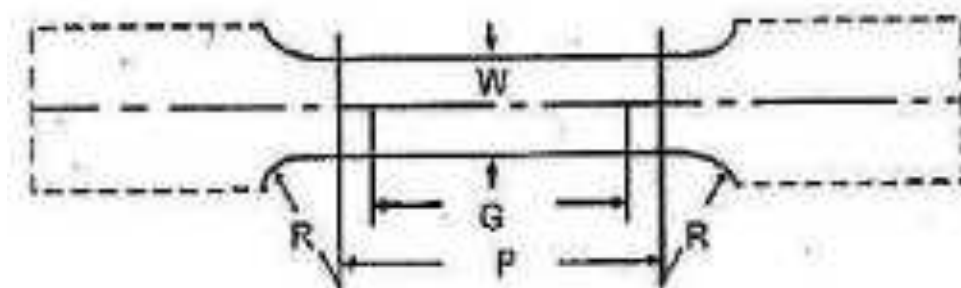


FIG. 1

Nominal thickness of test piece	(i)	(ii)	(iii) (See note 3)	(iv)
	Up to but not including 9.5 mm			9.5 mm and thicker
	mm	mm	mm	mm
Width W	12.7	25.4	38.1 (max.)	38.1 (max.)
Gauge Length L	50.8	101.6	203.2	203.2
Parallel Length P	63.5	114.3	228.6	228.6
Radius as shoulder (Minimum) R	25.4	25.4	25.4	25.4
Approximate total length	203.2	304.8	457.2	457.2

When the width of the material to be tested is insufficient to permit of the preparation of the standard tensile test pieces, a piece of the full width of the material may be used.

Notes:

- (1) For some material it is convenient to use straight parallel test pieces.
- (2) For certain non-ferrous metals it is sometimes convenient to use the standard test pieces that has a width of 12.7 mm and a gauge length of 50.8 mm for thickness exceeding 6.3 mm.
- (3) A test piece of the dimensions given in Col. (iii) for material under 6.3 mm nominal thickness is intended for the ferrous metals only.

TEST PIECE A-1

2. In Tensile tests on special sheet and strip materials (e.g. steel used for deep pressing operations) the following alternative test piece may be used: -

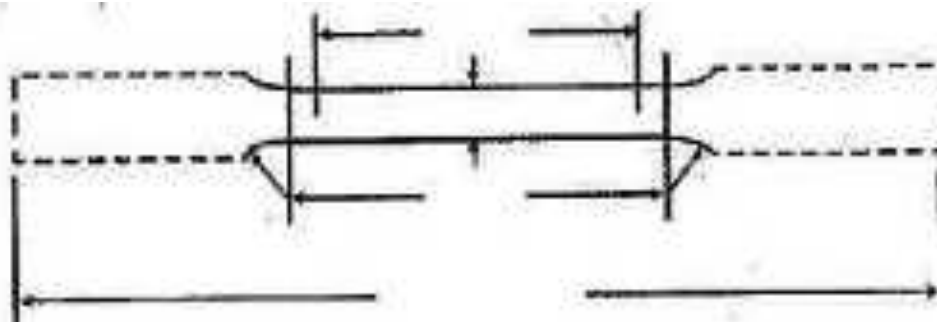
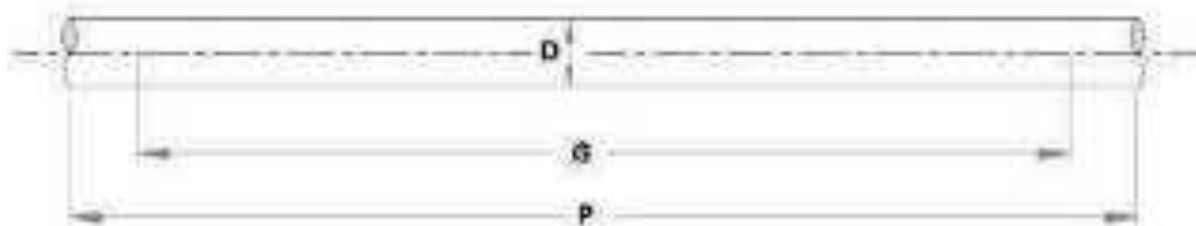


FIG. 2

STANDARD ROUND TEST PIECES

TEST PIECE B

3. Chiefly for un-machined rods and bars not exceeding 25.4 mm diameter (excluding cast metals).



Gauge Length $G = 203.2$

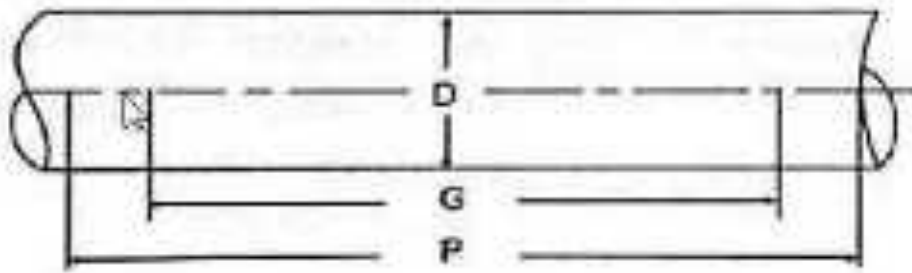
Length between grips P to be not less than $9D$

FIG. 3

All test pieces of form B are strictly similar and for the same material give the same percentage elongation and they give elongation figures nearly the same as those of standard flat test pieces 203.2 mm in gauge length 38.1 mm wide and 12.7 mm thick.

Note: When tensile tests are made on un-machined square and hexagonal bars excluding cast metals the gauge length shall be eight times the distance between the flats and the length between the grips shall be not less than nine times the distance between the flats.

4. For rods and bars over 25.4 mm diameter (excluding cast metals).



Gauge Length $G = 4D$;

Length between grips P to be not less than $4.5D$

FIG. 4

5. Machined Round Test, Piece for general purposes.

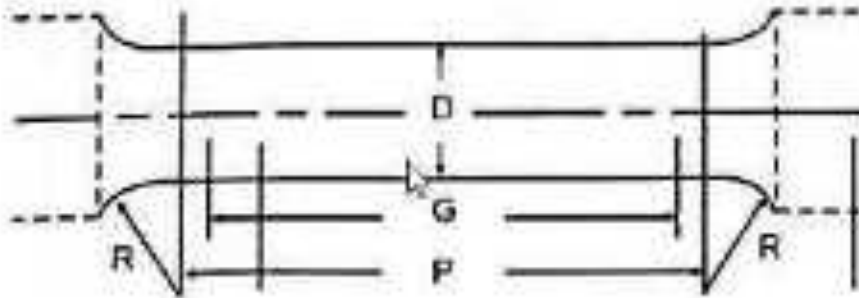


FIG. 5

Gauge Length $G = 50.8 \text{ mm}$;

Parallel length P to be not less than 57.2 mm .

Diameter $D = 14.3 \text{ mm}$;

Cross-sectional area $A = 161.3 \text{ mm}^2$

Radius at shoulder = 12.7 mm minimum for wrought metals and 63.5 mm minimum for cast metals.

6. Machined Test Pieces for general purposes (excluding cast iron).

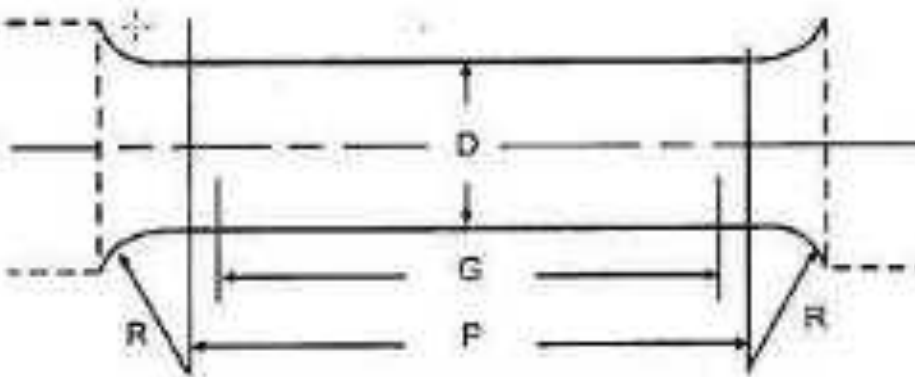


FIG. 6

$$\text{Cross-section Area, } A = \frac{D^2\pi}{4}$$

$$\text{Gauge length, } G = 4\sqrt{A} = 3.54D$$

$$\text{Parallel length, } P = 9/8 G \text{ minimum} = 3.98D \text{ minimum}$$

$$\text{Radius at shoulder for wrought metals} = G/4 \text{ minimum (0.88 D minimum).}$$

$$\text{Radius at shoulder for cast metals} = G/4 \text{ minimum (4.40 D minimum).}$$

All test pieces conforming to the above dimensions are similar to Standard Test Piece C with corresponding shoulder radius, and give the same percentage elongation as Test Piece for the same material.

Recommended dimensions for Subsidiary Standard Round Test Pieces are tabulated below. Standard Test Piece C (14.3 mm diameter) is included for comparison and any test piece, however, in which the diameter is not less than 3.2 mm, and the dimensions of which conform to the subsidiary standard form, is recognised as a subsidiary standard test piece.

Diameter 'D'	Cross-sectional Area 'A'	Gauge Length 'G'	Parallel Length 'P' (minimum)	Radius at Shoulder 'R'	
				Wrought Metal	Cast Metal
mm	mm ²	mm	mm	mm	mm
	(2)	(3)	(4)	(5)	(6)
28.65	645.2	101.6	114.3	25.4	127
24.8	483.8	87.9	98.8	21.8	109.2
20.3	322.6	71.6	80.8	17.8	88.9
14.3	161.3	50.8	57.2	12.7	63.5
10.8	91.1	38.1	42.9	9.4	47
10.1	80.6	35.8	40.1	8.9	44.4
9	64.5	32	36	7.8	39.3
7.2	40.3	25.4	28.4	6.3	31.2
5.7	25.8	20.3	22.9	5	25.4
4	12.9	14.2	16	3.6	17.8
3.2	7.9	11.2	12.7	2.8	14

APPENDIX-E

PROOF TEST FOR CREEP QUALITY OF CARBON STEEL BOILER QUALITY PLATE-SPECIFICATION

1. **NATURE OF TEST.**— The test shall consist of a tensile creep test carried out over a period of at least 48 hours at a temperature of 450°C and with stress of 11.25 kg/mm². Under these conditions the slope of the chord to the creep curve between the 24th and 48th hour shall not exceed $50 \times 10 = 4^\circ$ strain per hour.
2. **CONDITION OF MATERIAL.** — The test shall be made on the material in the normalized condition. The normalizing temperature shall be between 875°C – 925°C, and the plate sample shall be maintained at the normalizing temperature for one hour per inch of thickness and cooled freely in still air.
3. **TEMPERATURE OF TEST.** —
 - (1) **Temperature Measurement.** — (a) The temperature of the specimen shall be measured by thermocouples suitable for the temperature specified. Two thermocouples situated one at each end of the gauge length shall be used in the case of test pieces having gauge lengths upto 51 mm, and for longer gauge lengths and additional thermocouple situated at the middle of the gauge length shall be used.
 - (b) Thermocouples shall make good thermal contact with the test piece and the protected from the direct heat of the furnace of being covered with asbestos tape or equivalent insulation.
 - (c) The cold junction shall be maintained at a known temperature which shall be registered by a mercury thermometer. Alternatively, a suitable means shall be provided for correcting automatically errors in reading due to changes in temperature of the cold junction.
 - (2) **Temperature Control.** —The two (or three) thermocouples specified in clause (a) shall agree with one another within 3°C and the average of these readings shall be taken as the test temperature which shall not vary from 450°C by more than $\pm 2^\circ\text{C}$ throughout the test.
 Either a continuous record of sufficient readings of the temperature shall be made to indicate that the temperature conditions have been satisfactory.
- (3) **Heating period before loading.** — The specimen shall be maintained at the specified temperature for at least an hour prior to the application of the load.
4. **STRESS.** —The load required to produce the specified stress shall be gradually applied without shock during a period not exceeding five minutes and the stress shall be accurate to $\pm 2 \frac{1}{2}$ percent.
5. **SENSITIVITY OF STRAIN-MEASUREING EQUIPMENT.** —The sensitivity of the extensometer must be such that strains can be measured to the nearest 0.00002.
6. **READINGS.** — A sufficient number of strain readings shall be taken clearly to define the creep curve upto 48 hours, and the chord slope shall be measured from a chord drawn between points on the curve at the 24th and 48th hours.
7. **REPEAT TEST.** — If the materials fail to pass the test, but the chord slope does not exceed $60 \times 10 = 6^\circ$ strain per hour, a retest may be made at the request of the manufacturer and shall be accepted if satisfactory, or at the Competent Person discretion a pass test at a stress 5 percent less than that specified may be accepted.

FLANGES FOR PIPES, VALVES AND FITTINGS

Nominal Intl. Dia. of Pipe	Dia- meter of Flange	Dia- meter of Bolt Circle	Number and Diameter of Bolts (off Centre lines)		Thickness of Flange				
					Cost Iron	Cast Steel and Bronze		Stamped or Forged, Wrought Iron or Steel (See Nos.)	
		Upto 50 lb. 100 lb.	Upto 50 lb. 100 lb.	Upto 50 lb.	Upto 100 lb.	Upto 50 lb. 100 lb.	Upto 50 lb.	Upto 100 lb.	Upto 50 lb.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
½	3¾	2-5/8	4½	4½	3/8	3/8	3/8	3/16	¼
¾	4	2-7/8	4½	4½	½	3/8	3/8	3/16	¼
1	4½	3¼	4½	4½	½	3/8	3/8	3/16	9/32
1¼	4¾	3-7/16	4½	4½	5/8	½	½	¼	5/16
1½	5¼	3-7/8	4½	4½	5/8	½	½	¼	11/32
2	6	4½	4-5/8	4-5/8	¾	9/16	9/16	5/16	3/89
2½	6½	5	4-5/8	4-5/8	¾	9/16	9/16	5/16	13/32
3	7¼	5¾	4-5/8	4-5/8	¾	9/16	9/16	3/8	7/16
3½	8	6½	4-5/8	8-5/8	¾	9/16	9/16	3/8	15/32
4	8½	7	4-5/8	8-5/8	7/8	11/16	11/16	3/8	½
*4½	9	7½	8-5/8	8-5/8	7/8	11/16	11/16	7/16	½
5	10	8½	8-5/8	8-5/8	7/8	11/16	11/16	½	9/16
6	11	9¼	8-5/8	8¾	7/8	11/16	11/16	½	11/16
7	12	10¼	8-5/8	8¾	1	¾	¾	½	¾
8	13¼	11½	8-5/8	8¾	1	¾	¾	½	¾
9	14½	12¾	8-5/8	12¾	1	¾	13/16	5/8	13/16
10	16	14	8¾	12¾	1	¾	7/8	5/8	7/8
*11	17	15	8¾	12¾	1-1/8	7/8	15/16	5/8	15/16
12	18	16	12¾	12-7/8	1-1/8	7/8	1	5/8	1
*13	19¼	17¼	12¾	12-7/8	1-1/8	7/8	1	¾	1
14	20¾	18½	12-7/8	12-7/8	1¼	1	1	¾	1
15	21¾	19½	12-7/8	12-7/8	1¼	1	1	¾	1
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.

*See notes at the end of Tables regarding these, also for other particulars.

[illegible]

7	13¼	11½	12¾	1	7/8	1¼
8	14½	12¾	12¾	1-1/8	1	1¼
9	16	14	12-7/8	1-1/8	1	1-3/8
10	17	15	12-7/8	1-1/8	1	1-3/8
*11	18	16	16-7/8	1¼	1-1/8	1½
12	19¼	17¼	16-7/8	1¼	1-1/8	1½
*13	20¾	18½	16-1	1¼	1-1/8	1-5/8
14	21¾	19½	16-1	1-3/8	1¼	1-5/8
15	22¾	20½	16-1	1-3/8	1¼	1¾
16	24	21¾	20-1	1-3/8	1¼	1¾
*17	25¼	23	20-1	1½	1-3/8	1-7/8
18	26½	24	20-1-1/8	1½	1-3/8	1-7/8
*19	27¾	25¼	20-1-1/8	1½	1-3/8	2
20	29	26½	24-1-1/8	1-5/8	1½	2
21	30	27½	24-1-1/8	1-5/8	1½	2-1/8
*22	31	28½	24-1-1/8	1-5/8	1½	1-1/8
*23	32½	29¾	24-1-1/8	1¾	1-5/8	2¼
24	33½	30¾	24-1¼	1¾	1-5/8	2¼

*See Notes at the end of Tables regarding these also for flanges for pipe lines and other particulars

Table C: For Working Steam Pressures above 250 lbs. and upto 350 lbs. per square inch.

Nominal Intl. Diameter of Pipes	Actual External Diameter of Wrought Pipe	Diameter of Flange	Diameter of Bolt Circle	Number and Diameter of Bolts (off centre lines)	Thickness of Flange
					Cast Steel and Bronze Steel (Stamped or forged) (see Notes)
in.	in.	in.	in.	in.	in.
½	27/32	4½	3¼	4-5/8	5/8
¾	1-1/6	4½	3¼	4-5/8	5/8
1	1-11/32	4¾	3-7/16	4-5/8	¾
1¼	1-11/16	5¼	3-7/8	4-5/8	¾
1½	1-29/32	5½	4-1/8	4-5/8	7/8
2	3-3/8	6½	5	4¾	1
2½	3	7¾	5¾	8¾	1
in.	in.	in.	in.	in.	in.

3	3½	8	6½	8¾	1¼
3¼	4	8½	7	8¾	1¼
4	4½	9	7½	8¾	1-3/8
4½	5	10	8¼	8-7/8	1-3/8
5	5½	11	9¼	8-7/8	1½
6	6½	12	10¼	12-7/8	1½
7	7½	13¼	11½	12-7/8	1-5/8
8	8½	14½	12¾	12-7/8	1-5/8
9	9½	16	14	12-1	1¾
10	10½	17	15	12-1	1-7/8
11*	11½	18	16	16-1	1-7/8
12	12½	19¼	17¾	16-1	2
13*	14	20¾	18¾	16-1-1/8	2
14	15	21¾	19¾	16-1-1/8	2-1/8
15	16	22¾	20¾	16-1-1/8	2-1/8
16	17	24	21¾	20-1-1/8	2¼
17*	18	25¼	23	20-1-1/8	2-3/8
18	19	26½	24	20-1¼	2-3/8
19*	20	27¾	25¼	20-1¼	2½
20	21	29	26½	24-1¼	2½
21	22	30	27½	24-1¼	2-5/8
22*	23	31	28½	24-1¼	2-5/8
23*	24	32½	29¾	24-1-3/8	2¾
24	25	33½	30¾	24-1-3/8	2¾

*See Notes at the end of Tables regarding these, also for flanges for pipe lines and other particulars. The actual external diameters of wrought pipes given above apply equally to all tables.

Table D: For Working Steam Pressures above 350 lbs. and upto 450 lbs. per square inch.

<i>Nominal Intl. Diameter of Pipes</i>	<i>Actual External Diameter of Wrought Pipe</i>	<i>Diameter of Flange</i>	<i>Diameter of Bolt Circle</i>	<i>Number and Diameter of Bolts (off centre lines)</i>	<i>Thickness of Flange</i>
					<i>Cast Steel and Bronze Steel (Stamped or forged) (see Notes)</i>
<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
½	27/32	4½	3¼	4-5/8	¾
¾	1-1/16	4½	3¼	4-5/8	¾
1	1-11/32	5	3¾	4-5/8	7/8
1¼	1-11/16	5¼	3-7/8	4-5/8	1/8
1½	1-29/32	6	4½	4¾	1
2	2-3/8	6½	5	8-5/8	1
2½	3	7¼	5¾	8¾	1-1/8
3	3½	8	6½	8¾	1¼
3½	4	9	7¼	8-7/8	1¼
4	4½	9½	7¾	8-7/8	1-3/8
*4½	5	10	8¼	8-7/8	1½
5	5½	11	9¼	12-7/8	1-5/8
6	6½	12	10¼	12-7/8	1-5/8
7	7½	13½	11½	12-1	1¾
8	8½	14½	12½	12-1	1-7/8
9	9½	16	14	16-1	2
10	10½	17	15	16-1	2
*11	11½	18½	16¼	16-1-1/8	2-1/8
12	12½	19¼	17	16-1-1/8	2¼
*13	14	21½	19	16-1¼	2-3/8
14	15	22½	20	16-1¼	2-3/8
15	16	23¾	21¼	20-1¼	2½
16	17	24¾	22¼	20-1¼	3-5/8

Notes:

It is recommended that the use of sizes marked * should be avoided.

The thickness of flanges given in the tables include a raised face for not more than 1/16 in. high if such be used.

For ½ in. and 5/8 in. bolts the diameters of the holes to be 1/16 in. larger than the diameters of the bolts, and for larger sizes of bolts 1/8 in.

Iron or Steel flanges, (stamped or forged) may be screwed or riveted on with boss, or welded with fillet, the flanges being of steel for pressures above 150 lbs. per square inch.

Special welded-on flanges (stamped or forged) for pipe lines 2 in. nominal diameter of pipe and upwards (without valves or fittings) are made as stated below, the flange selected in all cases being, that given for the next smaller size of pipe in the corresponding table or as especially stated.

Table E: Flanges for pipes, Valves and Fittings.**For Working Steam Pressures above 450 lbs. and upto 600 lbs. per square inch.**

<i>Nominal Pipe Size</i>	<i>Approximate Outside Diameter of Wrought Pipe</i>	<i>Diameter of Flange</i>	<i>Diameter of Bolt Circle</i>	<i>Number of Bolts</i>	<i>Diameter of Bolts</i>	<i>Thickness of Flange</i>	<i>Diameter of Jointing Face</i>
						<i>Cast Steel; Steel (Stamped or forged) screwed or riveted on with boss, or welded on with fillet</i>	
<i>1</i>	<i>1(a)</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
½	27/32	4½	3¼	4	5/8	¾	2¼
¾	1-1/16	4½	3¼	4	5/8	¾	2¼
1	1-11/32	5	3¾	4	5/8	7/8	2½
1¼	1-11/16	5¼	3-7/8	4	5/8	7/8	2¾
1½	1-29/32	6	4½	4	¾	1	3
2	2-3/8	6½	5	8	5/8	1	3½
2½	3	7¼	5¾	8	¾	1-1/8	4
3	3½	8	6½	8	¾	1¼	4½
3½	4	9	7¼	8	7/8	1¼	5
4	4½	9½	7¾	8	7/8	1-3/8	5½
4½	5	10	8¼	8	7/8	1½	6
5	5½	11	9¼	12	7/8	1-5/8	6½
6	6½	12	10¼	12	7/8	1¾	7½
7	7½	13½	11½	12	1	1-7/8	8¾
8	8½	14½	12¾	12	1	2	9¾
9½	9½	16	14	16	1	2-1/8	10¾
10	10½	17	15¼	16	1	2¼	11¾
11	11½	19	17	16	1-1/8	2-3/8	12¾
12	12½	20	18	16	1-1/8	2½	13¾
13	14	21¾	19½	16	1¼	2-5/8	15
14	15	23	20¾	16	1¼	2¾	16
15	16	24	21¾	20	1¼	2-7/8	17
16	17	25¼	23	20	1¼	3	18

Table F: Steel Flanges for Pipes, Valves and Fittings.

For Working Steam Pressures above 600 lbs. and upto 900 lbs. per square in. and temperature upto 800°F (427°C).

<i>Nominal Pipe Size</i>	<i>Actual Outside Diameter of Wrought Pipe</i>	<i>Diameter of Flange</i>	<i>Diameter of Bolt</i>	<i>Number of Bolts</i>	<i>Diameter of Bolts</i>	<i>Thickness of Flange</i>	<i>Diameter of Jointing Face</i>
1	1(a)	2	3	4	5	6	7
<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>	<i>in.</i>
½		5	3½	4	¾	7/8	2
¾	1-1/16	5	3½	4	¾	7/8	2
1	1-11/32	5½	4	4	¾	1	2¼
1¼	1-11/16	5¾	4¼	4	¾	1-1/8	2½
1½	1-29/32	6¼	5¾	4	¾	1-1/8	2¾
2	2-3/8	6¾	5¼	8	¾	1¼	3¼
2½	3	7¼	5¾	8	¾	1¼	3¾
3	3½	8	6½	8	7/8	1-3/8	4¼
3½	4	9¼	7½	8	7/8	1½	4¾
4	5	9¾	8	8	1	1-5/8	5¼
4½	5½	10½	8½	8	1	1-5/8	5¾
5	6	11¼	9¼	12	7/8	1¾	6¼
6	7	12¾	10¾	12	1	2	7¼
7	8½	14¾	12½	12	1-1/8	2¼	8½
8	9½	16¼	14	12	1¼	2½	9½
9	10½	17¼	15¼	16	1-1/8	2-5/8	10½
10	11½	19	16¾	16	1¼	2-7/8	11½
*10½	12½	21	18½	16	1-3/8	3-1/8	12¾
*11¾	14	22¾	20	16	1½	3¼	13¾
*12-5/8	15	24	21¼	16	1½	3½	14¾
*13½	16	25½	22¾	20	1½	3¾	16
*14-3/8	17	27½	24½	20	1-5/8	4	17
*15¼	18	29¼	26	20	1¾	4½	18

*The sizes shall be specified by the outside diameter dimensions given in column 1(a). The figures in column 1 (nominal bore) are approximate and are given for information only.

Table G: Steel Flanges for Pipes, Valves and Fittings.
(To be used in Conjunction with the Notes and Appendices)

**For Working Steam Pressures above 900 lbs. and upto 1400 lbs. per square in.
and temperature upto 800°F (427°C).**

Nominal Pipe Size	Maximum Outside Diameter of Wrought Pipe	Diameter of Flange	Diameter of Bolt	Number of Bolts	Diameter of Bolts	Thickness of Flange	Diameter of Jointing Face
1	1(a)	2	3	4	5	6	7
in.	in.	in.	in.	in.	in.	in.	in.
½	27/32	5½	4	4	¾	1	2¼
¾	1-1/16	5½	4	4	¾	1	2¼
1	1-11/32	5¾	4¼	4	¾	1-1/8	2½
1¼	1-11/16	6¼	4¾	4	7/8	1¼	2¾
1½	2-3/8	6¾	5¼	8	¾	1-3/8	3
2	3	7¼	5¾	8	¾	1-3/8	3½
2½	3	8	6½	8	7/8	1-5/8	4½
3	4	9¼	7½	8	1	1-7/8	5
3½	4	10½	8½	8	1-1/8	2-1/8	5½
4	5	11¼	9¼	8	1-1/8	2¼	6
4½	5½	11¾	10	12	1	2-3/8	6½
5	6½	12¾	10¾	12	1-1/8	2-5/8	7
6	7½	14¾	12½	12	1¼	2-7/8	8
7	9	17	14½	12	1-3/8	3¼	9¼
8	10½	18¾	16	12	1½	3½	10½
9	11½	20	17½	16	1-3/8	3¾	11¾
10	12½	22	19¼	16	1½	4¼	12¾

STANDARD PIPE FLANGES

The different tables of flange dimensions (Table F.T.) have been designed to suit pipes and vessels containing steam at a maximum temperature of 427°C.

If the temperature is higher than 427°C and does not exceed 482°C the following Table should be used for the next higher pressure.

Water pipes for a given pressure in which the water temperature does not exceed 232°C may be fitted with Flanges to the next lower Table than that required for steam at the stated pressure and a maximum temperature of 427°C.

In all cases the hydraulic test pressure should be twice the maximum allowable working pressure to which the pipes are subjected in use.

Table H: showing the permissible application of pipe flanges tables.

Pressure Kg/cm ² (g)	Steam at 482°C Table	Steam at 427°C Table	Water at 232°C Table	Hydraulic Test Pressure Kg/cm ² (g)
98.4	-	T	S	196.8
63.3	T	S	R	126.5
42.2	S	R	K	84.3
31.6	R	K	J	63.2
24.6	K	J	H	49.2
17.5	J	H	F	35.1
10.5	H	F	-	21.1

APPENDIX-G
SAFETY VALVE DISCHARGE EFFICIENCY TESTING

A. General.

- (i) The purpose and manner of testing shall be such as to provide suitable data from which a constant 'c' may be determined in Equation (5/7). To this end the following information shall be supplied to the Inspecting Authority before testing is undertaken:
 - (a) Full particulars on the values to be tested and range of valves and springs which they represent.
 - (b) Details of the testing rig including instrumentation and proposed calibration procedure.
 - (c) Proposed source, capacity, pressure, temperature of steam used for the test.
- (ii) All testing shall be witnessed by Inspecting Authority or the Competent Person.
- (iii) Tests shall be made to determine the operative characteristics of the safety valves for which a constant is to be determined and also to establish the discharge efficiency of the safety valve.
- (iv) Where possible, the tests to determine operating characteristics and discharge efficiency shall be carried out using the same steam, the same pressure conditions and the same location. When the tests are carried out separately, the valves in each case shall be complete and shall include all internals, e.g. blow-down adjustments rings.
- (v) The set pressure at which the operating characteristics are determined shall be the minimum set pressure for which the spring used is designed. The tests shall be carried out using steam and shall determine the set pressure, the lift at the over pressure specified for the type of valve, as defined in regulations 193 to 195.
- (vi) The Inspecting Authority may dispense with Operating Characteristic tests described in A(v).
- (vii) Discharge efficiency tests shall be carried out using steam and shall be carried out relative to the operative characteristic tests described in A(v).
- (viii) When the Inspecting Authority is satisfied that the design of valve shall operate satisfactorily it shall if desired, be permissible to hold the valve head mechanically at the proven lift while carrying out the tests to ascertain the discharge efficiency.

B. VALVES USED IN THE TEST PROGRAMME. —

- (i) The safety valves tested shall, as far as is practicable, be representative of the pressure and size range of valve manufactured.
- (ii) The tests for operative characteristics and the discharge efficiency test shall be carried out on the three sizes or half the number of sizes in the range, whichever is smaller, with a minimum of two sizes.
- (iii) When the range is extended, due consideration shall be given, in consultation with the Inspecting Authority, to whether further witnessed tests are necessary.

- (iv) The test for operating characteristics shall be carried out at three significantly different set pressure for each size of valve.
- (v) The discharge efficiency tests shall be carried out relative to one set pressure for each size of valve.
- (vi) Each tests shall be carried out a minimum of three times to obtain acceptable average results.
- (vii) For the case of valves of either novel or special design of which one size only is being manufactured, tests at one set pressure are permitted by agreement with the Inspecting Authority. When the range of sizes or pressure is extended, due consideration shall be given in consultation with the Inspecting Authority, to whether further witnessed tests are necessary.

C. DETERMINATION OF CONSTANT 'C'. —

Let

E_t be the measure capacity, on test of saturated steam (Kg/h.)

P_t be the pressure at safety valve inlet at which the capacity was measured (bar gauge);

A be the area appropriate to the type of valve (mm^2), [see regulation 196(1)].

X be the allowable percentage over pressure for the type of valve under test. (See regulation 196) .

C_t be the constant determined from test.

$$C_t = \frac{E_t}{A \left[1 + \frac{P_t}{1 + \frac{X}{100}} \right]}$$

To accommodate the permitted spread on test results, tolerance on valve parts and springs, this calculated value of 'Ct' shall be derated to 80% to obtain the value of 'C' to be used in equation (5/7) of regulation 196(1). This is to ensure that all production valves shall achieve their rated discharge capacity at not more than the over pressure allowed for the type of valve tested.

The Inspecting Authority may accept a more favourable derating factor of up to 90% of the calculated value of 'Ct' where the performance of the valves under test and the manufacturing and spring tolerance applicable ensure that the allowable overpressure for the type of valve under test shall not be exceeded when a valve is discharging its rated capacity in service.

APPENDIX- H

[See regulation 295(7)]

A. Power Utility Boilers working at a pressure 100 kg/cm²(g) or more and upto 100,000 hours of operations.—

- (1) The boilers working at a pressure 100 kg/cm²(g) or more and up to 100,000 of operations, generating steam for power generation shall be inspected as detailed below after the expiry of twelve months from the date of inspection carried out in accordance with the procedure provided in regulation 311 and certification of fitness shall be issued by the concerned Competent Person in the State, through inspection of the following records which shall be made available to the concerned Competent Person at least thirty days before the expiry of the operating certificate, provided he is satisfied that the boiler can be allowed to be operated for a further period of twelve months.
 - (a) Operation data for superheater and reheater temperature excursions from the output of Data Acquisition System (DAS).
 - (b) History of shut downs during the previous year with their causes and actions taken.
 - (c) Records of any Non-Destructive test carried out on the boiler pressure parts during the year.
 - (d) Water quality to the boiler is maintained up to the requirement of such boilers and on line data of the quality be provided.
 - (e) Boiler tube failure record (location, number of tubes repaired/replaced).
- (2) Inspection shall be carried out by the concerned Competent Person at the expiry of twenty-four months as provided in regulation 311. However, in case shutdown of fifteen days or more is planned any time before expiry of the certification period and after six months of the certification, the Competent Person shall be duly informed so that complete inspection can be scheduled during the said shut down period.

B. Power boiler working at a pressure up to 100 kg/cm²(g) and up to 100,000 hours of operations or 25 years of operations as applicable. —

- (1) The boilers working at a pressure up to 100 kg/cm²(g) and up to 100,000 hours of operations for boiler operating above 400°C and 25 years of operation for boilers operating less than 400°C generating steam for power generation shall at the expiry of twelve months from the date of inspection carried out in accordance with the procedure provided in regulation 311 and certification of fitness by the concerned Competent Person in the State, and having satisfied with the operation records at paragraph 'A', shall be allowed for running for another period of twelve months.
- (2) Inspection shall be carried out by concerned Competent Person at the expiry of twenty-four months as provided in regulation 311. However, if shutdown of fifteen days or more any time before expiry of the certification period and after six months of the certification, Competent Person shall be duly informed so that inspection can be scheduled during the said shut down period.

C. Boilers working at a pressure 100 kg/cm²(g) or more, and more than 100,000 hours of operations. —

- (1) Boiler working at a pressure 100 kg/cm²(g) and more than 100,000 hours of operations, generating steam for power generation, shall continue to be subject to inspection as provided in regulation 311 every year to the satisfaction of concerned Competent Person in States. However, if Remnant Life Assessment (RLA), as per

provisions in these regulations is carried out on the boiler and if found satisfactory, then procedure as per paragraph “A” above shall be applicable.

- (2) Inspection shall be carried out by the concerned Competent Person at the expiry of twenty-four months as provided in regulation 311. However, if shut down of fifteen days or more any time before expiry of the certification period and after six months of the certification, Competent Person shall be duly informed so that inspection can be scheduled during the said shut down period.

D. Boiler working at a pressure up to 100 kg/cm²(g) and more than 100,000 hours of operations or twenty-five years of operations as applicable. —

- 1) Boiler working at a pressure up to 100 kg/cm²(g) and more than 100,000 hours of operations for boiler operating above 400°C and twenty-five years of operation for boilers operating less than 400°C, shall continue to be subjected to inspection every year as provided in regulation 311. However, if Remnant Life Assessment (RLA), as per provisions in these regulations is carried out on the boiler and if found satisfactory, then procedure as per paragraph “B” above shall be applicable.
- 2) Inspection shall be carried out by the concerned Competent Person at the expiry of twenty-four months as provided in regulation 311. However, in case of shut down of fifteen days or more any time before expiry of the certification period and after six months of the certification, Competent Person shall be duly informed so that inspection can be scheduled during the said shut down period.

Note: Wherever High Pressure (HP) and Low Pressure (LP) boilers operate from the same enclosure, the procedure for inspection as applicable to High Pressure (HP) boiler shall also be applicable to Low Pressure (LP) boiler.

APPENDIX-I
[See regulation 295(8)]

A. Waste Heat Boilers (Fired) upto twenty years of age used exclusively in continuous process plant. —

(1) For Waste Heat Boilers (Fired) up to twenty years of age used exclusively in continuous process plant, at the expiry of twelve months and at twenty four months from the date of inspection carried out in accordance with the procedure provided in regulation 311 and certification of fitness issued by the concerned Competent Person in the State, and having satisfied with the operation records as given below received alongwith application in Form-IX duly filled in shall be allowed for running for another period of twelve months:—

- (a) Operation data for superheater and reheater temperature excursions from the output of Data Acquisition System (DAS) or operation data for superheater temperature excursions maintained in the log sheet temperature record;
- (b) History of shut downs during the previous year with their causes and actions taken;
- (c) Records of any Non-Destructive test carried out on the boiler pressure parts during the year;
- (d) Water quality to the boiler is maintained as per the requirement of such boilers and on line data of the quality be provided through Data Acquisition System (DAS) or through water quality record logbook maintained at plant or at source of water;
- (e) Boiler tube failure record (location, number of tubes repaired/replaced).

(2) Inspection shall be carried out by the concerned Competent Person at the expiry of thirty six months as provided in regulation 311. However, in case of shutdown of fifteen days or more any time before expiry of the certification period and after six months of the certification, Competent Person shall be duly informed so that inspection can be scheduled during the said shutdown period.

B. Waste Heat Boilers (Unfired) up to twenty years of age used exclusively in continuous process plant. —

(1) For Waste Heat Boilers (Unfired) up to twenty years of age used exclusively in continuous process plant, at the expiry of twenty-four months from the date of inspection carried out in accordance with the procedure provided in regulation 311 and certification of fitness by the concerned Competent Person in the State, and having satisfied with the operation records at paragraph “A”, shall be allowed for running for another period of twenty-four months.

(2) Inspection shall be carried out by the concerned Competent Person at the expiry of forty-eight months as provided in regulation 311. However, in case of shutdown of fifteen days or more any time before expiry of the certification period and after six months of the certification, Competent Person shall be duly informed so that inspection can be scheduled during the said shutdown period.

C. Waste Heat Boilers (Fired) more than twenty years of age used exclusively in continuous process plant. —

Boiler more than twenty years of age shall continue to be subjected to inspection as provided in regulation 311 every year to the satisfaction of concerned Competent Person in the State. However, if Remnant Life Assessment (RLA) as per the provisions of these regulations is carried out on the boiler and if found satisfactory, then procedure as given at paragraph 'A' above shall be followed.

D. Waste Heat Boilers (Unfired) more than twenty years of age used exclusively in continuous process plant. —

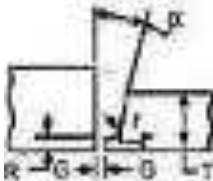
Boiler more than twenty years of age shall continue to be subjected to inspection as provided in regulation 311 every year to the satisfaction of concerned Competent Person in State. However, if Remnant Life Assessment (RLA) as per

the provisions of these regulations is carried out on the boiler and if found satisfactory, then procedure as given at paragraph 'B' above would be applicable.

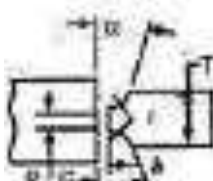
APPENDIX- J

Recommended forms of weld preparation (Modified) details I-p inclusive are suitable for manual welding and normal automatic welding where the automatic deep penetration technique is employed, some modification may be necessary.

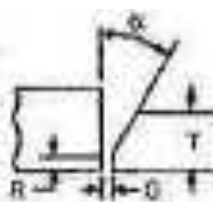
ISINGLE J BUTT WELD

Weld Detail	Welding Position	Thickness T (mm)	Gap G (mm)	Angle α°	Radius r (mm)	Root face R (mm)
Welded from both sides or one side only 	All positions	Over 12.7	0 – 457.2	10° - 20°	4.8 – 9.5	1.6 – 3.2

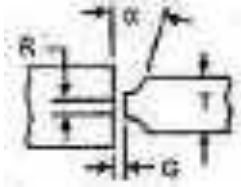
m DOUBLE J BUTT WELD

Weld Detail	Welding Position	Thickness T (mm)	Gap G (mm)	Angle α°	Radius r (mm)	Root face R (mm)
Welded from both sides 	All positions	Over 25.4	0 – 457.2	10° - 20°	4.8 – 9.5	1.6 – 3.2

n SINGLE BEVEL BUTT WELD

Weld Detail	Welding Position	Thickness T (mm)	Gap G (mm)	Angle α°	Root face R (mm)
Welded from both sides or one side only 	All positions	4.8 – 9.5	3.2 – 12.7	45° - 50°	0 – 1.6
		Over 9.5	4.8 – 7.9	45° - 50°	0 – 1.6

p DOUBLE BEVEL BUTT WELD

Weld Detail	Welding Position	Thickness T (mm)	Gap G (mm)	Angle α°	Root face R (mm)
Welded from both sides 	All positions	Over 12.7	4.8 - 7.9	45° - 50°	0 - 1.6

The use of Min. Gap and Min. Angle should be associated with the Max. Radius of 10 mm. Conversely the Max. Gap and Max. Angle should be associated with the Min. Radius r of 5 mm.

APPENDIX- K
Time limits for the various activities

Sl. No.	Activity	Regulation/ Provision in IBR	Time limit	Authority /Person
(1)	(2)	(3)	(4)	(5)
1.	Issue of Certificate for manufacture and test in Form-I(Part-B) and Form- I(Part-C)	8(a)	(i) 3 days for boiler components. (ii) 7 days for boiler	Inspecting Authority
2.	Issue of Inspecting Authority Certificate during erection in “Form-I(Part-E) ”	8(a)(v)	2 days	Inspecting Authority
3.	Steam Tests of boiler	299(1)	30 days	Inspector
4.	Issue of provisional order in Form-X after registration inspection	300(2)	48 Hours	Inspector
5.	Assigning of Registration No. for boilers	300	30 days	Chief Inspector of Boilers
6.	Transfer of Memorandum of Inspection Book & Registration Book	309	15 days	Chief Inspector of Boilers
7.	Issue of Certificate for use of boiler in Form-XII	310	48 Hours	Competent Person
8.	Submission of Remnant Life Assessment report/ recommendations	313 to 315	30 days from date of completion of inspection/tests	Well Known Remnant Life Assessment Organisation
9.	Recognition of repairers boilers & steam pipes	316(5)	30 days	Chief Inspector of Boilers
10.	Permission to carry out repairs/alterations in boilers	316(3)(e)(ii)	2 days	Chief Inspector of Boilers
11	Approval of design and manufacturing drawings for boilers and boiler components made in India	321(1)	(i) 5 days for boilers components & boilers upto 20 TPH capacity. (ii) 15 days for boilers above 20 TPH & upto 100 TPH capacity (iii) 21 days for boilers above 100 TPH capacity	Inspecting Authority

12.	Approval of materials for boilers and boiler components made outside India	321(3)	(i) 5 days, in case of same materials as previously approved for the same design pressure & temperature (ii) 10 days, in other cases	Technical Adviser(Boilers)
13.	Approval of design and manufacturing drawings for boilers and boiler components made outside India	321(3)	21 days	Chief Inspector of Boilers
14.	Issue of Welder qualification certificate in Form-II after submission of satisfactory reports	541	5 days	Competent Authority
15.	Inspection during construction/manufacture	Appendix-A	2 days	Inspecting Authority/ Competent Person

Note: (1) Above time limits shall be applicable from the date of submission of complete details/documents.

(2) After expiry of prescribed time limits for an activity, approval for that activity shall be deemed to have been granted.

APPENDIX-L **CONVERSION TABLE**

Length		
1 centimeter (cm)	=	10 mm
1 foot (ft)	=	304.8 mm
1 inch (in)	=	25.4 mm
1 meter (m)	=	1000 mm
1 millimeter (mm)	=	1 mm
1 yard (yd)	=	914.4 mm
Temperature		
1 °C	=	1 °C
1 °C	=	5/9 [° F – 32]
1 °C	=	[° K -273.15]
Angle		
1 degree (°)	=	1 degree (°)
1 radian (rad)	=	57.2958°
1 minute (')	=	0.0166°
1 second (')	=	0.0002°
Pressure		
1 atmosphere	=	1.033227 kg/cm ² (g)
1 bar	=	1.019716 kg/cm ² (g)
1 kg/cm ²	=	14.223 psi
1 MPa	=	10.19716 kg/cm ² (g)
1 lbs/ft ²	=	0.000488 kg/cm ² (g)
1 lbs/inch ²	=	0.07030696 kg/cm ² (g)
1 ton/ft ²	=	0.9764855 kg/cm ² (g)
1 ton/inch ²	=	140.6139 kg/cm ² (g)
Force		
1kgf	=	9.80665 N

Note: Values shall be rounded off to nearest one decimal point.

SANDEEP SADANAND KUMBHAR, Secy. Central Boilers Board

[ADVT.-III/4/Exty./362/2026-27]