## CHAPTER XI

## STANDARD CONDITIONS FOR THE DESIGN AND CONSTRUCTION OF ECONOMISERS, FEED PIPES, FEED HEATERS AND OTHER SIMILAR VESSELS

### ECONOMISERS

**500. Application of standard conditions and exceptions thereto.**—(*a*) An economiser shall not be registered under sub-section (4) of section 7 of the Act and a certificate shall not be issued under sub-section (5) 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.

Provided that an economiser in use at the time Chapter XI of these Regulations came into force, may be so registered and such Certificate may be issued in respect thereof notwithstanding that such standard conditions are not satisfied in respect of such economiser.

(*b*) Notwithstanding anything contained in sub-regulation (*a*) the Chief Inspector may, subject to the provisions of Regulation 502, 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.

**501. General requirements.**—(*a*) All cast iron and steel headers and the parts used in the assembly of an economiser shall conform with the requirements of this Chapter in respect of material specification and test, workmanship and structural requirements.

(*b*) All economisers under construction shall be under the supervision of an Inspecting Authority and must be so certified by that Authority.

* (*c*) For economisers imported into the States to which these Regulations extend, a certificate from the Inspecting Authority in Form VII certifying that the material was tested and the economisers built under its supervision shall be furnished to the Chief Inspector before or with the first application for registration.

(*d*) In advance of or along with an application for registration, the following shall be furnished—

(*i*) a certificate in Form VIII of manufacture and test signed by the Maker or by a responsible representative of the Maker, containing the description of the economiser, particulars of the material 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;

(*ii*) 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 statement showing the above information shall be accepted.

(*e*) To suit owners convenience where possible it is recommended that economisers be installed in two or more sections.

**502. Modification of formula.**—Where no certificates are produced, the working pressure as found by formula will be reduced by 10%. When the



134/2/M. of Industry/69-70-19

workmanship is, however, in any way doubtful 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 working pressure by such percentage as he deems fit.

**503. Maker's Certificates for Steel Economisers.**—The Maker shall furnish the Inspecting Officer with a certificate 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 Inspecting Officer/our Test House Manager in accordance with the Standard Tests."

**504. Hydraulic test for new economisers.**—For all new economisers the hydraulic test must be applied as shown below:—

| On Components before assembly | Design pressure lbs/sq. in. | Hydraulic test pressure lb./sq. in. |
|---|---|---|
| Cast iron tubes, headers and bends | .. .. .. .. | Twice working pressure Minimum pressure, 700. |
| Steel tubes and bends .. .. | 500 or less .. .. | 1,000 |
| Steel tubes and bends .. .. | Above 500 but not exceeding 1,000 | Twice the working pressure. |
| Steel tubes and bends .. .. | Above 1,000 .. .. | 1,000 above the working pressure. |
| Headers .. .. .. | below 1,000 .. .. | Twice the working pressure. |
| Headers .. .. .. | Above 1,000 .. .. | Working pressure plus 1,000 lbs./sq. in. |

For all assembled sections the Hydraulic Test pressure shall be not less than 1½ times the working pressure.

"Working pressure" shall be the highest pressure at which the economiser relief valves are to be set.

The above test pressure shall be held for a minimum period of ten minutes.

**505. Workmanship and manufacture.**—All material used in the construction of pressure parts shall be tested and shall conform with the following requirements:—

(*a*) The workmanship throughout shall be of the 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 must be satisfactory fusion with the metal. Chaplets must be properly tinned with metal free from lead.

(*b*) The screw threads of all bolts must be of Whitworth forms.

(*c*) All component parts shall where necessary be manufactured to limit gauges to secure interchangeability throughout.

## CAST IRON, TUBES AND HEADERS

**506. Process of manufacture.**—(*a*) The castings shall be cast from metal melted or refined in any suitable metallurgical plant other than an iron ore smelting furnace.

The minimum test results required on test bars 1.2 in. in diameter shall be in accordance with the following table:—

| Material for tubes and other pressure parts | Minimum tensile strength | | Transverse test on span of 45·8 Cm (18 in.) | | | |
|---|---|---|---|---|---|---|
| | | | Minimum transverse breaking load in | | Minimum deflection in | |
| | Kg/mm. | Tons/sq. in. | kg. | lbs. | Cms. | inches |
| Grade 16·5 iron .. | 26·00 | 16·5 | 1,052 | 2,320 | 0·434 | 0·17 |
| Grade 14 iron .. | 22·00 | 14·0 | 934 | 2,060 | 0·407 | ·16 |
| Grade 12 iron .. | 18·75 | 12·0 | 839 | 1,850 | 0·382 | 0·15 |

NOTE—Grade 16·5, 14 and 12 iron correspond to 26, 22 and 18·73 kg/cm2 (16·5, 14 and 12 tons) minimum tensile strength respectively.

(*b*) On analysis, the sulphur and phosphorus content of the iron shall not exceed the following percentages:—

| Components | Sulphur per cent max. | Phosphorus per cent max. |
|---|---|---|
| Tubes .. .. .. .. .. .. .. .. | 0·12 | 1·20 |
| Headers .. .. .. .. .. .. .. .. | 0·10 | 1·00 |

**507. Test bars.**—(*a*) When the 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. The number of test bars specified in Regulation 508 shall be applicable to all castings of each melt.

(*b*) 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.

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

(*d*) The test bars shall not be subjected to any heat treatment after leaving the moulds except where the castings are heat treated.

**508. Number of tensile tests.**—(*a*) The number of tests required for each batch of castings shall be in accordance with the following table the various classes of castings being divided into 4 representative groups:—

| Group | Weight of castings | Test requirements |
|---|---|---|
| 1 | Up to 28 lbs. .. .. .. .. .. | One test for each 30 cwts. of castings or part thereof. |
| 2 | Over 28 lbs. and up to 1 cwt. .. .. .. | One test for each 2 tons of castings or part thereof. |
| 3 | Over 1 cwt. and up to 1 ton .. .. .. | One test for each 3 tons of castings or part thereof. |

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

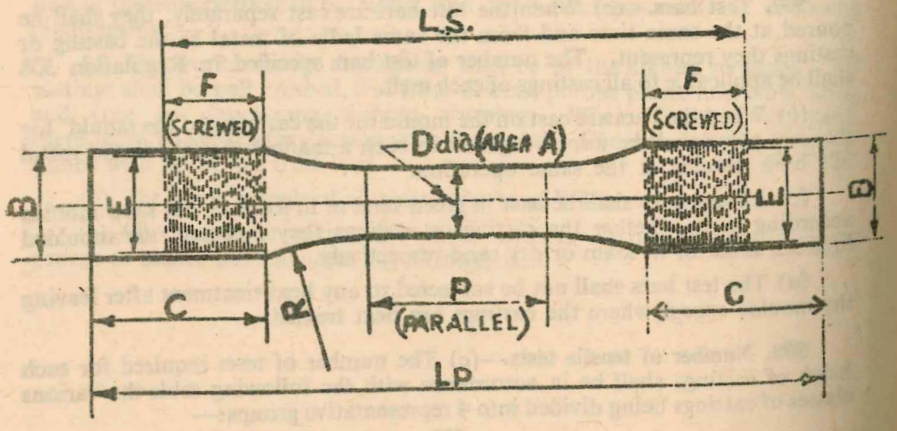
| | | |
|---|---|---|
| 4 | Over 1 ton and important castings .. | One test for each 4 tons of castings or part thereof or for each casting weighing 4 tons or more. |

(*b*) conditions for Acceptance and for Rejection:—

| Test | Result | Conclusion |
|---|---|---|
| 1st | Pass .. .. .. | The batch or separate castings represented shall be accepted. |
| | Tensile or Transverse test fails | Two more tests shall be made. |
| 2nd | If both pass. .. .. .. | The batch or separate castings represented shall be accepted. |
| | If either fails .. .. .. | The batch or separate castings represented shall be rejected. |

Provided always 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 substituted for those obtained from the defective test bars.

**509. Standard test piece.**—The tensile test bar shall conform to the dimensions shown in the following. Bars may be tested with either plain or screwed ends.






| B | D | A | P | R | C | E | F | Lp | Ls |
|---|---|---|---|---|---|---|---|---|---|
| in. 1·20 | in. 0·798 | Sq. in. 0·50 | in. 2 | in. 3-1/2 | in. 2 | in. 1-1/8 SF 1-1/8 SW | in. 1-1/8 | in. 8-1/4 | in. 5-7/8 |

The test bars shall be cast as cylindrical bars of the diameters given in Col. B and machined to the dimensions given in Cols. D & P in the above Table.

## CONSTRUCTIONAL REQUIREMENTS

### Cast Iron Economisers

**510.** The manufacturer shall, on the basis of design details, satisfy the Inspecting Authority regarding the design and the strength of all parts of cast iron economisers subject to the following maximum working pressures:—

| | Max. W. P. |
|---|---|
| (1) Ordinary Vertical Tube .. .. .. | .. 325 lbs./sq. in. |
| (2) Ordinary Vertical Tube with strengthened tubes | 375 lbs./sq. in. |
| (3) Ring Stay Vertical Tube .. .. .. | .. 475 lbs./sq. in. |
| (4) Gilled Tube type approved design .. | .. 45.7 kg/cm² (650 lbs./sq. in.) |

**511. Joint bolts and studs for Cast Iron Economisers.**—(*a*) The maximum working pressure for the bolts and studs shall be calculated by Regulation 518.

(*b*) The use of studs tapped into cast iron is permissible where:—

(*i*) The studs and nuts are not in the path of the flue gases.

(*ii*) The studs are carefully threaded to gauge and fitted into tapped holes of ample depth.

For economiser of Gilled Tube type of approved design made from 16.5 grade iron the limitation for a maximum working pressure may be increased to 52.7 kg/cm² (750 lbs./sq. in.)

**512. Economiser water outlet temperature.**—The design conditions shall be such that the maximum outlet water temperature of the economiser shall be at least 40°F below the saturated steam temperature in the boiler drum:

Provided that this requirement shall not apply to economisers used on low pressure water heating systems working at pressure less than 120 ft. head of water.



## STEEL ECONOMISERS WITH OR WITHOUT CAST IRON SLEEVES ON THE TUBES

**513. Tubes: Construction.**—(*a*) The tubes shall be manufactured in accordance with Regulation 151.

(*b*) Suitable provision shall be made for supporting horizontal tubes at one or more intervals in their length to relieve bending stresses and these supports as well as the end connections must permit free expansion.

**514. Tubes: Working Pressure.**—The working pressure of the tubes shall be calculated in accordance with Regulation 338(*a*), but the working metal temperature shall be taken as the maximum water temperature for which the part of the element is designed plus 11°C (20°F).

**515. Headers: Construction.**—(*a*) The headers shall be constructed in accordance with Regulation 154.

(*b*) Branches shall be secured by one of the following methods:—

(1) Expanded, belled and welded.
(2) Strength welded with additional securing means.
(3) Full depth strength weld.
(4) Branches less than 2 inch bore may be screwed and seal welded.

(*c*) Open ends of forged for seamless steel tube headers may be closed by forging, or the ends may be secured by bolting, screwing, or welding in an approved manner.

**516. Headers: Working pressure.**—(*a*) **Rectangular headers.**—The working pressure shall be calculated in accordance with Regulation 340.

(*b*) **Cylindrical headers.**—The working pressure shall be calculated in accordance with Regulations 270 and 271.

**51[illegible]. Attachment of tubes to headers.**—(*a*) Tubes shall be connected to the tube plates by one of the following methods:—

(1) Expanding with bell mouthing or seal welding.
(2) Strength welding.
(3) Mechanical bolted joint.

(*b*) Roller expanded tubes shall project through the neck or bearing part in the holes by at least quarter of an inch and shall be secured from drawing out by being bellmouthed to the extent of 1/32″ for each inch in diameter plus 2/32″.

(*c*) Tubes expanded into headers may be seal-welded inside or outside the header. Where a seal weld is provided inside the header, the tube end projection and bellmouthed specified in (*b*) is not required.

(*d*) 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 1/2 inch.

(*e*) 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.

(*f*) Bolted joints shall be designed in accordance with Regulation 518.

(*g*) Tube spacers supporting clips and lugs may be welded to the tubes.

(*h*) The tubes shall be so arranged that they are accessible for cleaning internally and externally.

**518. Joint bolts, studs and flanges.**—(*a*) The maximum working pressure for the bolts shall be determined by the following formula:—

$$W.P. = \frac{N \times C}{A}\left(D - \frac{1.28}{n}\right)^2 \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (121)}$$

N=No. of bolts securing the parts.

n=No. of screw 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 joint 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 in 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 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.

(*b*) The thickness of each flange shall be not less than that given by the following equation:—

$$t = \frac{\sqrt{P.D.\ [D_1 - D]}}{2}$$

Where t=Thickness of flange in thirty-seconds of an inch.

P=Working pressure, in pounds per square inch (gauge).

D=Outside diameter of the tube in inches.

$D_1$=Pitch circle diameter of 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, shall the thickness of a flange be less than 24 thirty-seconds of an inch.





**519.** (*a*) **Thermometers.**—All economisers shall be provided with Thermometers for measuring water temperature adjacent to the inlet and outlet connections.

(*b*) **Relief valves.**—A valve which shall prevent increase of pressure beyond a predetermined limit shall be fitted to every economiser and the design shall provide against unauthorised 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 should have a minimum diameter of 2".

(*c*) **Pressure Gauge.**—Means for indicating the pressure in the economiser shall be provided by a Pressure Gauge constructed on the lines of Regulation 327.

(*d*) **Air Release valves.**—Means must be provided for the release of air at all points where air accumulation may occur.

(*e*) **Blow off drain valves.**—Means must be provided for draining the economiser completely of water.

(*f*) **Non-return valves in return feed line.**—Economisers provided with means for heating the incoming feed by mixing it with hot water from the economiser outlet must have a non-return valve in the hot water return line.

* (*g*) **Reserve Flues.**—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.

(*h*) **Explosion Doors.**—To relieve the economisers of excessive pressure accumulation due to internal explosion doors preferably of horizontally hinged 'self-sealing' type shall be fitted.

(*i*) **Hydraulic Test.**—All valves and mountings shall be tested by hydraulic pressure to not less than twice the working pressure subject to a maximum of 1000 lb./sq. in. plus the working pressure.

NOTE.—The working pressure shall be the highest pressure at which the economiser relief are to be set.

(*j*) **Feed Line.**—Alternative means of feeding the boiler other than through the economiser shall be provided.

(*k*) **Non-return valve.**—A 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.

## FEED PIPES

**520. General.**—Feed pipes may be made of steel, cast iron or copper but cast iron pipes will not be accepted for a working pressure over 200 lbs. per sq. in. or 425°F. Copper feed pipes shall be solid drawn and not exceed 8" external diameter and may be used for a working pressure not exceeding 350 lbs. or 300°F.

**Design pressure for feed piping.**—The design 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.

**521. Steel feed pipes.**—Steel feed pipes shall be in accordance with Chapter VIII.

**522. Cast Iron feed pipes.**—(*a*) The standard conditions for material of construction and tests for cast iron pipes shall comply with Regulations 505 to 509.

(*b*) The maximum working pressure shall be determined by the following formula:—

$$W.P. = \frac{130(t-6)}{d} \quad \text{Eqn. (122)}$$

Where t = thickness in thirty-seconds of an inch.

d = the external diameter of the pipe in inches.

**523. Copper feed pipes.**—(*a*) The standard conditions for material of construction and tests for copper pipes shall comply with Regulation 35.

(*b*) The maximum working pressure shall be determined by the following formula:—

$$W.P. = \frac{60(t-3)}{d} \quad \text{Eqn. (123)}$$

Where t = thickness in hundredths of an inch.

d = external diameter of the pipe in inches.

**523A. Feed Heaters and similar vessels fitted to feed pipes.—(*a*) Standard requirements, materials of construction and allowable working pressure.**

These shall comply with the requirements of Chapters I, II and III for riveted construction. If so welded construction, such vessels shall comply with the requirements of Chapter XII, provided that radiographic examination of welds may be waived, for pressures not exceeding 17.5 kg./cm.$^2$ (250 lbs./sq. in.) For parts of vessels of composite construction, the requiremen s of the appropriate regulations of the above Chapters shall be complied with as may be applicable to each such part.

(*b*) **Working pressure.**

Working pressures of all parts shall be determined by the appropriate formulae given in these regulations. Due consideration shall be given to the following additional points while calculating the stresses.





The stresses due to self-weight of vessels and its contents and any superimposed vessel or other equipments, insulation and these due to static head, if any and pipes and other similar parts attached to the vessel.

(*c*) **Safety valve requirement in Feed Heaters and similar vessels.**—Every such vessel shall be protected with a relieving device of sufficient capacity to avoid over pressure in case of internal failure.

(*d*) **Inspection during construction, stamping and testing.**

These shall comply with the appropriate Regulations of Chapter I.

## REGULATIONS FOR REGISTRATION AND INSPECTION OF ECONOMISERS AND FEED PIPES

**524. Preparation for inspection.**—(*a*) At each inspection the economiser shall be emptied and thoroughly cleaned internally and externally and in the flues. All mountings shall be opened up and all caps, doors and blank flanges removed to permit adequate inspection.

(*b*) 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.

**525. Procedure for Registration.**—(*a*) On receipt of an application for registration the Inspector shall, after the economiser has been prepared for examination, take full particulars of the design and ascertain the working pressure allowed by the Regulations.

(*b*) The fitness of the economiser parts shall be determined as per the following formulae:—

**(*i*) Cast Iron Smooth Tube Economisers with Pressed Socket Joints.**

$$WP = \frac{AZ}{70a} + \frac{225N}{n} \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Equation (124)}$$

Where WP = Design pressure in pounds per square inch (gauge).

A = Area of contact surface of a single socket, square inches.

*a* = Cross sectional area measured on the mean diameter of a socket hole, in square inches.

Z = Breakdown load of an unreinforced socket joint in pounds.

N = Number of stays per header.

*n* = Number of sockets per header.

For existing standard designs the breakdown load of an unreinforced socket joint shall be taken as not greater than 13,500 lbs. For designs not already in use before the date of this standard the corresponding figure shall be taken as not greater than 75 per cent of the load as determined by experiment.

**(*ii*) Headers of approximately rectangular cross section.**

$$WP = \frac{C(t-2)}{b^2} \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Equation (125)}$$

Where *t* = Thickness in thirty-seconds of an inch.

*b* = Distance between the sides of header supporting the surface, in inches.

WP = Design pressure, in pounds 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.

**(*iii*) Headers of approximately circular cross section.**

$$WP = \frac{0.6K(t-5)}{D} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Equation (126)}$$

Where *t* = Thickness in thirty-seconds of an inch.

WP = Design pressure, in pounds 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 a header in that part of the length which does not contain tube holes shall comply with the requirements of sub-clause (V).

In no case, however, shall the thickness at any point may be less than 16 thirty-seconds of an inch.

**(*iv*) Tubes.**

$$WP = \frac{K(t-C)}{D} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (127)}$$

Where *t* = Thickness in thirty-seconds of an inch.

WP = Design pressure, in pounds 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 be less than 11 thirty-seconds of an inch.

**(*v*) Manifold pipes.**

$$WP = \frac{0.8K\,(t-5)}{D} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad \text{Eqn. (128)}$$

Where *t* = Thickness in thirty-seconds of an inch.

WP = Design pressure, in pounds 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.

**(*vi*) Cast Iron Economisers with extended surface horizontal tubes. Connector Bends.**

$$WP = \frac{K(t-5)}{D} \quad \text{Eqn. (129)}$$

Where $t$ = Thickness of bend in thirty-seconds of an inch.

WP = Design pressure, in pounds 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 connector bend be less than 13 thirty-seconds of an inch.



**Tubes.**

To comply with equation (127).

**Manifold Pipes**

To comply with equation (128).

(*c*) The Inspector shall enter full particulars of the economisers together with the required calculations of various parts in a Memorandum of the Inspection Book (Form IX) and submit it to the Chief Inspector.

(*d*) 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.

(*e*) After Inspecting the Economiser and ascertaining, as prescribed, the maximum working pressure to which it may be worked, the Inspector shall witness the hydraulic test in accordance with Regulation No. 527 and may issue a Provisional Order in Form X.

**526. Procedure at subsequent inspection.**—(*a*) After the economiser has been cleaned the Inspector shall make a thorough examination so far as its construction permits. The external condition of the tubes should be carefully noted for wasting especially at the feed inlet end and all accessible tubes should be calibered. The internal surfaces of cast iron tubes should be closely observed for graphitic wasting as far as it is possible and in the even of any tube failure these should be broken up for scrutiny so that the general internal condition of the other tubes may be estimated.

(*b*) Where tubes or other parts are wasted, the strength should be re-calculated.

(*c*) The scraper gear should be examined to note if any parts are missing if the length of travel is adequate and if the scrapers are correctly adjusted.

(*d*) All cap bolts are to be inspected, also the condition and position of the dampers and baffles.

(*e*) The record of each inspection and calculations will be entered in the Memorandum of Inspection Book.

**527. Procedure for Hydraulic test.**—Every economiser for registration shall be hydraulically tested in the presence of an Inspector to 1½ times the working pressure. Hydraulic tests of economisers at subsequent examinations shall when required by the Inspector, be made after the inspection. The test pressure to be applied to economisers at subsequent examinations shall be from 1-1/4 to 1-1/2 times the working pressure of the economisers. During the test, all parts externally and in the flues shall be noted for leakage.

**528. Memorandum of Inspection Book.**—In this book the Inspector shal enter all particulars and dimensions of the economiser with the required calculations for the various parts together with details of hydraulic test. At subsequent inspection the Inspector shall enter all notes pertaining to the condition of the various parts.

**529.** (*a*) **Registration Books.**—Registration Books shall be maintained on the lines of Regulation 387.

(*b*) **Transfer of Memorandum of Inspection Book and Registration Books.**—On an economiser passing from one State to another, the Memorandum of Inspection and Registration Books 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.

**530. Grant of certificate.**—A certificate for the use of an economiser shall be granted in Form XI.

**531. Casual visits.**—(*a*) The Inspector shall note if the economiser is working satisfactorily, and if the relief valves are correctly adjusted, if the scraper gear is operating and if the external brickwork is free from cracks.

(*b*) 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 should not be less than 100°F. to prevent sweating and consequent external corrosion of the tube and bottom headers.

**532. Economiser rating.**—The rating shall be equivalent to the area of the heating surface in square feet which shall be computed from the tubes and the headers.

**533. Registration fee.**—An application for registration of economiser shall be accompanied by appropriate fee as specified below:—

| | |
|---|---|
| For Economiser rating not exceeding 500 .. .. .. .. .. .. | 50 |
| For Economiser rating exceeding 500 but not exceeding 1,000 .. .. .. .. | 60 |
| For Economiser rating exceeding 1,000 but not exceeding 1,500 .. .. .. .. | 70 |
| For Economiser rating exceeding 1,500 but not exceeding 2,000 .. .. .. .. | 80 |
| For Economiser rating exceeding 2,000 but not exceeding 2,500 .. .. .. .. | 90 |
| For Economiser rating exceeding 2,500 but not exceeding 3,000 .. .. .. .. | 100 |
| For Economiser rating exceeding 3,000 but not exceeding 3,500 .. .. .. .. | 110 |
| For Economiser rating exceeding 3,500 but not exceeding 4,000 .. .. .. .. | 120 |
| For Economiser rating exceeding 4,000 but not exceeding 4,500 .. .. .. .. | 130 |
| For Economiser rating exceeding 4,500 but not exceeding 5,000 .. .. .. .. | 140 |
| For Economiser rating exceeding 5,000 nut not exceeding 6,000 .. .. .. .. | 150 |
| For Economiser rating exceeding 6,000 but not exceeding 7,000 .. .. .. .. | 160 |
| For Economiser rating exceeding 7,000 but not exceeding 8,000 .. .. .. .. | 170 |
| For Economiser rating exceeding 8,000 but not exceeding 9,000 .. .. .. .. | 180 |
| For Economiser rating exceeding 9,000 but not exceeding 10,000 .. .. .. .. | 190 |

And above 10,000 rating for every 2,000 or part thereof, an additional fee of Rs. 10 shall be charged.

**534. Engraving of Registry number.**—(*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*) A letter "E" shall be refixed to the registry number in the denominator of the appropriate device as shown in Regulation 382.

Example: UP / E-53

**534-A. (*a*) Inspection of Feed Pipes.**—Feed pipes shall be inspected and hydraulically tested before erection in place, and the hydraulic test pressure shall be not less than twice the working pressure of the economiser. A certificate from the recognised maker or Inspecting Authority that this has been done may be accepted. If the Inspector is satisfied with the test, the pipes may be erected. No separate certificate for feed pipes shall be issued, nor shall a separate fee be charged for their inspection.