INDIAN BOILER REGULATIONS, 1950.

COC 43] of inbia EXTRAORDINARY PART 11—Section 3 PUBLISHED BY AUTHORITY NEW DELHI, FRIDAY, SEPTEMBER 15, 1950 GOVERNMENT OF INDIA MINISTRY or WORKS, MINES AND POWER CENTRAL BOILERS BOARD NOTIFICATION BOILERS New Delhi, the 15th September 1950 S.R.O. 1300 .—in exercise of the powers conferred by section 28 of the Indian Boilers, Act, 1923 (V of 1923), and in supersession of the Government of India Notification No. A. 470, dated Simlo, the 27th October 1923, the Central Boilers Board is pleased to make the following Regulations, the same having been previously published as required bv sub-section (I) of section 31 of the said Act, namely : REGULATIONS PRELIMINARY 1. Short Title, Extent and These Regulations may be called the In lian Boiler Regulations, 1950. (2) They extend to the whole of India, except Part B States. (3) They shall come into force at once

2. Definitions.—In these Regulations, unless the context otherwise requires,— (a) the ' 'Act" means the Indian Boilers Act, 1923 ; (b) "accident" means an explosion of a boiler or steam-pipe or any clamage -$0 a boiler or steam-pmpe which is calculated to weaken the strength thereof so as to render it liable to explode ; (c) • 'boiler" means any closed vessel exceeding five gallons in capacity which is used expressly for generating steam under pressure, and includes any apparatus

forming an integral part of a boiler, which is wholly or partly exposed to the action of the flue gases for purpose of recovery of waste heat, and also includes any mount- ings or other fittings attached to such vessel which is wholly or partly under pressure "ithstanding anything contained in section 2(b) when steam is shut-off but not of the Act does not include an econmuiser as defined in clause (cc) of section 2 there- of. (d) "Chief Inspector" and "Inspector" mean, respectively, a person appointed to ae a Chief Inspector and an Inspector under the Aet ; (e) "economiser" means any part of a feed-pipe that is wholly or partly exposed the action of flue gases for the purpose of recovery of waste heat ; [607] dog INDIA (f) "feed-pipe" (i) moom any pipe or connected fitting wholly or partly under preasure through which feed-water passes directly to boiler. (ii) every reference to a steam pipe or steam pipes shall be deemed to include also a feed-pipe or feed-pipes respectively ; (g) " Inspecting Authority " means on authority recognigccl by the Central Boilers Bourd us competent to grunt certif cate in Form J (h) "Inspecting Offcer" means— (i) in respect of muterial monufuctured 01' boilers m any Stote an omer appointed by the Tnspecting Authority in that State. (ii) in respect of moterial munufactured or boilers conetructed outside the States offccr acting on behalf of the Inepecting Authority ; (i) i 'owner" includes any pergon using a, boiler 8B agent of the owner thereof ancl any person using a, boilor hich he has hired or obtained on loan from the owner thereof; (3) "prescribed" means prescribed by regulations or rulee made under the Aot ; (k) "Steam-pipe" means any main pipe exceeding three inchee in internal dia- meter through which etoam passes dircctly from a boiler to o prime-mover or other first user, and includes any connected fitting of steam-pipe ; (l) "State" or "States" Inean 1--1 State or the Statea to which these regulations extend ; and (m) " Structural alteration, addition or renewal" shall not be deemed to include any onowal or replacement of petty nature when the part of fitting uscd for re- placement is not inferior in strength, emciency or otherwise to the replaced part of fitting. LI't of Inapertmg AuthorLtneg recogniBed by the Oentral Bollera Board. gee Appell(llh (J

CHAPTER 1 GENERAL REQUIREMENTS, APPLICATION OF STANDARD CONDITIONS AND EXCEPTIONS THERETO 3 (1) A boiler shall not bo rogietcrod undor sub-section (4) of Section 7 of the ActJ and eerfifieate Nha,ll not be issued under sub-ecdion (5) of that section with reference Io a boiler, u-n.lessa the '*tnudnrd conditions in respect of material, design and (onstruction, arc spec ific•cl in the subgequent Chapters of •Lhese Regu- Iai sat,iAficd in reapect of such a boiler. Notwithstanding anything contained in sub-regulation (l), thc Chief Ins- pact or may, nuhjeci, tho provisions of Rcgulation 7, register a boiler and order {ho iNBue of a certificate authorising the uso thereof, althougll the standard condition8 are not -fully *8tiyfied in respect of such boilcr : Provided that the Chief Inspector shall not register boiler or order the iE$uc Qi' such cortificatc, if a structural part of Hueh boilcr which iB subject to pressure is made of Bessemer prpcegs steel of cest 01 .tnnlleablc cast iron. STANDARD REQUIREMENTS 4. (n) Måtbriål.—Altl Platog, rivets and bEi,rs used iii the oonytrt10tion of boilbrE *hull bo tcsted and found to contorm with the hereinafter contained. t b') CoiBtruOtiöh.- boilers during construction shall be under the supervi' Sion of an 111Bpectiug OffceÉ. (o) Inspecäng Authority's certificate.—For boilers imported into the Stanes a. certificate from an Inspecting Authority in

Form 11 certifying that the material -ion sliilll be furnished to the was tested and the boiler built under their i rat ion. Together with such Chief Inspector before or with the application certificate the Inspecting furni,,h n of Inspection book M'l'ibed by Regula t ion 3b(i in respect of the ins. in Form I prepared in the nner pection of the boiler during construction and the hydraulic test applied on comple- tion. In the case of steel made and tested by well-known makers in India or other countries the eertificate of the makers in Form IV as prescribed in Regulation 26 may be accepted in lieu of a certificate from an Inspecting Authority. The Central Boilers Board shall decide whether for the purpose of this Regula- tion a maker is " well-known" or not. (d) Certificates, etc. under section 14(1) (c) of the Act. —In advance of or along with an application for registration of a boiler, the following certificates and draw- ings or specifications should be furnished to the Chief Inspector, namely:— (i) A certificate in Form Ill of manufacture and test signed by the maker or by a responsible representative of the maker of the boiler containing a description of the boiler, its principal dimensions. particulars of the kind of material used in its construction, the thickness of all plates, the diameter of and method of forming the rivet holes in the shell plates, particulars of any departure from ordinary practice in making the shell such as solid rolling or welding, the hydraulic test to Mhich the boiler was subjected, the intended M)rking pressure, the area of heating surface, the maximum continuous evaporative capacity, the year and place of make, and the works number of the boiler. There may be included in such certificate a further declaration that samples of the angle, stay or rivet bars and rivets used in the construction of the boiler have been certified by the makers to have been tested and found to comply with the re- quirements of Chapter 11; in which declaration the kind of material used and the limits of tensile breaking strength with which the teste comply shall be stated with suffcient Where such frrther precision to obviate the risk of confusion in mak ing a 110M declaration is included in such certificate, the d to in clause (iii) of this sub-regulation shall not be required. (ii) A drawing or print to a scale, in the case of large boilers of not, less than inch to the foot and, in the case of Fmall boilers, of not less than 1} inches to the foot, showing the principal dimensions and a longitudinal section and end iew of the boiler, and bearing the works number of the boiler and the maker's cffce stamp. The drawing shall show details of riveting of longitudinal and circumferential seams with pitch of rivets, cross spacing of rivet rows and diameters of rivet holes : the radii of curvature of dished end plates, fillets of flange ancl corners of bent plates, and where gusset stays are fitted, the number and diameter of rivet holes in each gusset stay•' Tn the case of water tube boilers, the foregoing scales shall apply to thc main boiler drums only, but in addition a general arrangement drawing of the boiler to a scale of not less than c ' to the foot shall be provided. (iii) A certificate from the steel maker and a certificate from the maker of the plates, rivets or bars, of the nature referred to in Regulations 26 and 27 The certificate from the maker of the plates, rivets or bars, shall show the charge numbers, the plate or bar numbers and the number and dimensions of the various plates, etc., tested, their ultimate tensile breaking strength in tons per square inch of section, th- number, kind elongation and the length on which measured, the or other tests made and the date of tests: Provided thot where an Inspecting Authority furnishes certificate in Form 11 together with a Menu of Inspection book in Form I in accordance with (c), the certificates proscribed, under clauses (i) and (iii) need not be furnished to the Chfef Inspector when application is made for registr ati011 of the boiler. But should ony question ariNe in respect of the fitncB8 of the boilers for thc working pressure approved by the Inspecting Authority within a period of three years from Lhe dato of their certificuto, tho owner shall, if requested by the Chief Inspector, obtain and furnish the original documents specified in the said 01811Neß. (e) Maker's stamp.—Tbe boiler shall have stamped upon its front plate in a oonspiouous position tho following purticularg :— Work 'B number Tented to lbs. lbs. Muker'ß nume Yeor of nnulce on Inapoctlng C)mcer'ä or Inspocting Authority'R Ht,mnp, 6. Modification of Under the Regulations for dotermining the working pressuro to be ollowed on various parts of boilerB, the material to which the formulae apply ghbll in the absoncc of express provision to the contrary be steel oomplying with Che requirement8 of Chapter 11. (ii) Whene no test certificates for shell plates and rivets are producod, the mate- rial may be Ireutecl iron, if the Chief Inspector is satisfied that tho material is of suitable boiler qdul_ity. If in such cngea the Chief Inspector is clearly 88tigfied that the material is of good quality, a higher strength than that ullowed for iron may be permittccl but tho strength of the shell plates Shall not, gavo for special reasons be assumed to be morc than 26 tong. In such cages S and Sl in equotiong 1, 3 and 4 of Chapter IV rnay be rogpoctivcly 26 and 21 for steel and 21 and 18 for iron. For Iron across tho grain S jnuy be 18. (iii) Where end plates, furnaces, flat, plates, girderg, gusaet and other Btayg, etc. are made of

Ft,oel or iron for which no tegt certificates are produced, the working progsure us found frorn the formulae in which S is to be taken at thc lowost, limit proscribed for the PR rt, reduced by 15 per cent, ghall, oxcepiJ where such material ig gpceifienlly provided for in R ny for rnuln, be thc working pressure pormitted. For flat platCN of copper, thc working prcNgure ns found from the formulae, reduced by 50 per cont. shon be the working prcggus•e permitted

6. Standard epeoifloations for materials.—.The gtnndnrd specifications for steel wrought iron and copper plbtes oud bury, und for caet steel Bholl be those prescribed in Chopter 11, but certificates or test* of Inuterial for wrought iron (except for special wrought iron for screw stbys) coppcr bnd CRIBt steel shall not be required unlegg special allovnnceg ure required. Suoh special allowances Bhull be in the discretion of the Chief Inspector

7. Boiler Shells not in nooordanoe with standard conditions.—Whon the standard conditions are not, complied with, bdditions to the appropriate coemcient as defined in Regulation 176 shall be made as followg : (R) When there no proofs of test* of ßteel, 15 per cent. of the Btondard co- 6m cient. (b) When b boiler has not been ingpected during construction by an Iæpeoting Offcer and certifiecl by him, IO per cent. of the standard coeffcient. (c) When the workmanship is in any way doubtful nnd the Inspector iB not ,.aatisfied that any of the foregoing additiong to the cocff&ent would be Buffcient. THE GAZETTE OF INDIA EXTRAORDINARY 611 to meet the circumstances, such Inspector deems fit. percentage of the standard co-effcient as the Chief Provided that nothing in this regulation shall apply to a hollow forged or a fusion welded drum if it is constructed under the supervision of an Inspecting Authority

8. Welding.—The use of welding in the construction of boilers shall be permitted only where specifically provided for in the standard conditions

CHAPTER 11 MATERIALS OF CONSTRUCTION STEEL PLATES, RIVETS AND BARS 9. Process of manufacture.—Structural steel for boilers shall be by the Open Hearth or an electric process, acid or basic. IO. Chemical Analysis. (a) The steel shall contain not more than 0 •05 per cent. of sulphur or of phosphorus. (b) A sulphur print test shall be taken fron the material of each charge used for rivet bars for the purpose of ensuring that sulphur segregates are not concentrated in the core. The stage in manufacture at which this test is made shall be at the option of the Steel Maker

11. Freedom from Defects, etc.—The finished material shall be sound and free from cracks, surface flaws and laminations. Hammer dressing, patching or welding is prohibited but this does not prevent the removal of slight scale or shell by the use of chisel, file or buff, providing the material is not reduced to under the specified thickness

12. Rolling Margin ----No plate or rolled section *hall be under the specified thickness at any part, nor more than 5 per cent.over the calculated weight, except that in the case of thin plates and wide plates the weight tolerances shall be as set out in the table below. Scheide of tolorances for boiler plates. Width In inches Thickness In. 1/4 to under 5/16 5/16 to under 3/8 3/8 to under 7/16 7/16 to under 1/2 1/2 to under 5/8 5/8 to under 3/4 3/4 to under I I to under 2 Under 1 48 60 to to to to 5 5 Eunder 5 5 5 5 5 I under lunder under under 5 5 5 5 5 6 5 5 9 6 6 6 5 108 12 10 8 6 5 5 5 to under 120 o 12 11 9 8 7 6 5 120 to under 11 9 9 8 7 6 132 and over 15 12 10 9 8 7 All the above margins will be taken over nett theoretical weight

18. Testing and following tests and impections shall be made at ule place of manufacture prior to despatch ; but, in the event of any of the material EXTRAORDINARY 11 proving un.s»tiA$+ot01'.y the oourß* being worked into boilers, such muteriBl shall be rejected, notwithstanding any previoua certificate of satißfactory testing, und such further tests of the material from the Bame charge shall bc made the T.iixpéct'ingl in lit,tbndåhre Imoy eonsider desirable, i4. Selection of test pieces.—AlI tæst pieces Bhall bo seleotod by tho Tngpeoting Officer and tested in his presence, and he shall satisfy himself that the conditions described are fulfilled. 15. (a) \'engile test pieces.—The tensile strength Bild ductility Bholl be deter- mined from standard test piccee (see App. B) cut lengthwise or croeawise from the rolled moterial. When material is annealed or otherwise treated before despatch, tho test pieces Shull be similarly end Bimultuneously tl eatod with the material. before testing. (b) (j) Plates, Teem—Wherever praotieahle the rolled gurfaoe *holl be retained on two oppoeite sides of thc test piece. Tho i engile stress and elongation khall bo de6ermined on standard tk.'-lt piece A (see App. B). (ii) Round Ban.- -Round barq may be tostad full Sizo ag rolled or they Inay be turned down to convenient size If tested I inch diameter or under, tegt piece B (see App. B) shall be used. The sectional area, of the piece shall not be less than square

Inch. Where the teet piece is over I inch diameter, test piece Bl (see App. B) may be used. Any struighteuing of the teet pieces which may be requircd shall bc done cold. The ultimate tensile gtresg and elongation of the various of not mopp 4 in leach closg of material Bhall be permitted. Should o tenßile test piece brenk out8ide the middle huff of the test, gauge length the test may be discarded und another test be mado of tho same plate or bar. Plut&l for AhaIIN butt Mt ropy, und gusset *tayy Plut0A for flanging or welding P Integ for ßtfiy angle and tee bars Rnvot burt.l hrnate teneu-le 'Ilong/sq .10 M lillinum elongation per cent. 'I'agt ploce A 23 for 26- 30 20 for 28 -32 20 for 32-- 3d 30 20 for 28 32 23 23 for 26— 30 20 foc 28—32 20 for 32—36 TOBI placo B 23 for 26—30 20 ror 28—32 20 for 32--86 25 for g 23 for 26—30 Test C 28 for 26- -30 24 for 32 24 for 32—36 30 for 24—29 28 for 30 17. Number Tæt.8. (a) mates—For plates, butt straps and gusset plates one tensile tost pieoo shall be cut from ooch end of every plato ag roll. ed. (b) For other plates such as end plates, furnace and flanging plates etc., tensile tost pieco shall bo cut from one ond of every plate rolled. (c) Angle, tee, rivet and stay barg.—Ono tengilo test shall bo made from oach 15 or part of 15 bars rolled of oa,ch section or diameter from tho same charge, but not legg than two tensile tests shall be made unless the total number of bars rolled from the Nåthe e iG 8 pr less thon 8 und the bors are of the samo section or diameter, in • 'Whfchi cåke Orlé tdhg\le test shall Nllffce. For round bara of 11 inches diameter nnd 1. . u INDIA under, the numberg 50 and 20 shall be substituted for 15 and 8 respectively for determining the numbnr of tests required

18. Dump Test8.—Short longths equal to twiao thoir dialnoter out fronm tho rivet bars shall, when cold, wiffNi and without fracture being compressed tc. half their length. A dump teNt shall be made for ench Tensile Teßt

19. Bend Cold Bends.—Test be sheared lengthwise or crosswise from plat9N or bnrg, and shall not be lees than l} inches wide, but for gmæll bors the whole soction (nay be used. For rivet bars bond tests oro not required. (b) In all cold bend teats, on samples O •5 inch in thickness and above, tho rough edge or arris oouaed by sheoring may be relnovecl by filing or grinding, and samples I inch in thioknegs and abovo may have the Odgea xnaoh_ined, but the test pieces shall receive no othor proporation. The test pieeos Bhall not be armoaled unless the material from which they are out iB similarly annealed in which cage tho test piece shall be girn_ilorly ond simultoneously treated with thc material beforo testing, (c) For cold bend tests the test piece shall withstand, without, fracture, being doubled over until tho internal radius iB aqual duo 11 times the thicknesN of the test piece and the sides are parallel, (d) For small sectional material these bend tests may be madc frorn the flatten. ed bar. (e) Bond t,ogts muy he mado either by pressure or by blows

20. Number Bend Platee.—A bend test Bhull bo taken from each plafo as rolled. For pla,teg exceeding 2} tons in weight, one bend test shall bo tokon from en,ch end. The bend t,estg from *hell p18tex, str ups and other pla,tee which have not, to be flunged or ork0(l in the fire ot hVhich when in use a,re not to be exposed to fl01ne shall be cold bend tegtH, (b) A.ngle Barg.—A cold bend (eBt shou be made from each angle bar (c) Stay Barge—A cold bend i est shall be made from every 15 Ftay bars as rollod from paoh charge

21. Manufactured Quality of Materibl.—Rivets *holl bo manufuo- tured from steel complying witli the aforementioned requirements of this ChBpt,er in reqpect of livct bans. (b) Tests. —(i) The rivet Shanks shall be bend eold, and hammered until two ports of the sha,nk fonch, without, fracture on he outsido of the bend. (ii) Tho rivet hcadg gha,ll be ßattencd while hot, without cra,cking at the edges, until their cliarncter 19 2} times the dia yneter of the Nhank. (c) Number of Tests. —I-jp to half por cont of rivets of oooh Nize shall bo selectod by the Inspector or Inspecting Officer fronl bulk for the above tests

22. Additional tests before rejection. Should tho test pieces ffrgt oelooted by the Inspector or Inspecting Othoer not fulfil the test requtranentx, Lwo further test* of the surno kind may be I-nacle, but, should either of these fill, the plat0B or barg from which test pieecs wore cut, be T eieoted. In all suc•h oases further testB shn,ll be made before any material from tho ome ch8,rge onn be accepted

28. Branding.—Every plate and bar *hall be olenrly and distinctly mnorked by the ma,kel' in two places with an a,pproved quality bland mdica,ting that, the motorial hos complied with the lequirecl ; oncl LI. wit,h thc number or identification marks by which Lhoy can be traeed to the charge from which the material was made

24. Defacing of rejected material.—ln the event of the Inutoriul failing in any oue to withstand the prescribed tests, the Inspector or Inspectiug Officer shall see that the quolity brand stamped on the ha,N becn defaced by punch mtbrks xtending bevond the brand in the form of a croc, denoting fhRt the materiul has teen rejected. GAZ* -LINDIA *NA

25. Facilities for iD. Bpeotion.—The maker Bhall adopt a system of marking tho ingotN, billet", qJabfi, pln,tcs, bars, etc., which will enable 011 finished material to be trn,cecl to the original charge, and the Inspector or Inspectincr Offccr shall be given every facility for tracing all plutcs and bars to their respective charges, und for witnessing the required tests. When he is sali with the n_1utorial and with the results of -the tests. he shebll be furnished with two copies of the advicc notes of the' material for his 'Aign»turr

28. Steel not produced where rolled.—Where steel is not produoed in the works at which it is rolled, n ecrtificnte in

Form IV shall be supplicd to the Inspecting Officcr dcputcd to witness the testing of the Tn u,terinl, stating the Open Hearth or Electric Procerqs by xvhieh it was [e, the natnerof the Steel Maker who supplied it, BINO the numbers of tho ('hargeg for rcferenee to the books of the Steel Maker. The number of tho chau•gre Bhull be murkcd on euch plate or bur for the purpose of identi- fication

27. Maker's certificate.— -Boforc tho :rnill sheets are signed, the maker Bhall furni8h the Ingpecting Officer with u certificule in

Form IV guaranteeing that Lho material has been nuode by the Open Hearth or un Electric Process acid or bngio and that it has been gubieoted to, and has u•ithstoocl satisfaeborily the test above described in the presence of the Inspecting ()ffLeet. WROUGT IRON STAV AND RIVET BARS 28. Rivet Baw.- —The tensile breaking strength shall bo botweon 21 and 25 tong with un of not lcsg than 25 per cent. measured on tho standard Tost Piece B (a,s rolled) or per cont . measured on the Tcst Pjeoc Bl (os rolled)

29. Manufactured Rivet8 Tests.— To comply with Regulation 21

30. Stay Bar8.—The tensile breakfrlg strengih shall be between 21 und 25 tons with elongation of not, less thun 22 per cent,, measured on the Standard Test Piece B or 27 per cent. Tnea,surecl on the Standard Test Piece Bl. 31 Stay Bend TegtB.— mo comply with Regulation 19 32. Special Iron for Screw Stays for Fireboxes and Combustion Chambers.—ln order t hart, iron gi n..ys may be H,pproved of the garne size ag would be required for mild steel, the Ilion ust withdlund the following tests:— (a) Tensile Tutg.— -The tensile breaking Btrength shall not bo less than 21 \ torw per square inch, with an elongation of not less than 25 per cent. measured on the Standard Test, Piece B 01' 30 por cent. Ineusured on the Standard Test Piece Bl. (b) Bend Testa. —Tosi, pioces (lither of tho bur as rolled, or turned down to I inch shall stand bending cold until the sides Ute parallel oncl thc space between the Lwo Bides iN not grcnt,er than thc climneter of the test piece. (c) Number of Tengile Tegu.—Thc burs as rollod shall bo placed in batches of twenty und one tensile test shall bc t &ken from ach batch. If this is unsutisfactory two other bars Bhall be gelectecl for fest, und should either of these fail tho batch Shull be rojectcd. (d) Number of Bend Teatg.— Onc ordinary bond tost Bhall be taken from eaoh batch, and a similar test piece fr•cnn eocb. batch Shull be lightly ond evenly nicked on one side with sharp cutting tool and bent buck ot this point through an nnglo of 180 dogrces by cgsure or by o succession of Light blows. The fraotuce must be clean, fibrous, free florn sing or dirt or ony coarse crystalline gtructure, If cither of those is unsa,tåBfactory, other bars shall be selected for test, and should either of thcse fail the batch shul-I be rejected. (e) In ull coscs the selection of tho test pieces Bhull be mudc bv the Inspector or the Inspecting Offcer. OF INDIA COPPER PLATES, STAY AND RIVET BARS AND TUBES 33. Proce88.—Tho copper Shall be fire.reßnod or clcotrolytio, and hoL-roIled from suitable cakes. (b) Chemical Composition.—The plates Bhall contain not legs than 99 per oent. of copper, and hctween •3 0/0 uncl •5 0 of arsenic. (o) Freedom from defect8.—The plntcs shall be clean, smooth and froe from defectg gand Bhull have o workmanlike finish They shall be thor oughly unneolcd. (d) Rolling Margin.—No plute *hull be under the specified thickness at any over thc ca Leulbted The scrop margin, partly part, nor more tham 50 sheured ancl left attached, Bhull bc nod ICEH than 3 inches at the ends and 1} inches ut ench side. (e) Tensile Tegt8. Ono tengilc test Shull bo taken from each plato us rolled. The tensilc breaking strength, Stunclßl'd Test Piece A, shall not be less than 14 tons per sq. in. •mth an elongai Ion of not less than 350/ (f) Hot and Cold Bend tests. —Ono hot (tornperature betwoon 12000F. and 14000 and one cold hend test, shall hr taken from eoeh as rolled. For either hoL or 001(1 bend i eg18 thc test piece shall withstand boing doublem ovel wii,hont fruci ure uni il the sides are touching uncl parallel

34. Stay and Rivet Procæ.—To comply with Regulation 33 (a). (b) Chemical Composition.—To comply Wii h Regulation 33 (b). (c) Freedom from Defect8.-—To comply with Regulation 33(0) (d) Roll.ing Margin. —The bars in any purt shall not be moro than 100 over or more than 1/2 00 under the specified diametel (e) Tensile Teøtg.—The tonsile breaking-sft engih Shull not bc less than 14 tone per sq. in. with an clongotnon of not ICSH thun 400/0 on the Standard Test Piece B. (f) Band Tegte. —To comply wil h Rogului ion 33(f). (g) Durnp Test8. -A piece of rod 1 in. long shall be placed on cnd and hammered or crushccl cold to a thickness of 3/8in. wit hout showing either erack or flow on tho cirournfcrence of the rosulting (h) Number of Teßt8.—- ()ne bar, from wlLioh the required test gpacimens shall be token, shall be sole(ted ut rnnc10111 from each batch of 50 (or purt thereof) bars of ea,ch size from cach mc•Jt. Frorn cael) bar geleetcd one i,ensile tegt,, onc cold bend test, ono hot, bend test, and one dump test Shull bc Ilibde

35. Tub08 eoppor shall be fire-refined or olootrolytio and Nholl be madc ini,o tubes eithel by the hol 'A'olling or cold dra,wmg process. The tubas shall be fifi1Nhed by cold awing. (b) Chemical Composivion.—To comply with Regulation 33(b). (c) Freedom from Defeot8—The f*ntghed ubo», both externally and internally shall be sound, (Ilea,n, smooth well (i rushed oncl :free frorn surface dcfccts und longi- tudinal grooving, and the end* ho cleon and square. (d) actual woight of oooh tube shall not be more

than 50/0 Bbove the calcula ted weight. Unless, otherwise specified, they shall bc Btruight cylindricol, of uniform kncss ancl external diamet,cr throughout. (e) Treatment of T08t Specimens..—All teat material, if not already in an annealed condition, Bhull bc unnea,lod before teqt,ing and Rhall comply with the mrehonicol tests without further heat or mechanical Lrcatment. 16 GAZETTE OF INDIA EXTRAORDINARY mLD DRAWN SEAMLESS STEEL BOILER AND TUBES FOR DESIGNED STEAM TEMPERATURE NOT 8500F (45400) 86. (g) Material.—Tho tubes Shall eean)lef4B ond made of BtA51 produoed by an Open Hoarth or Electric Process, ucid or basie, und Shull be certified as such by the makers of the steel ond tubes. Tho moterial of the tubeN Shull show on analysis not more than O • 045 por cent .of sulphur and O •04 per oent. phßphorug and the manufacturer shall supply certificotc of the anolysis when required to do go. Note.—Where the material is used for designed stoam temperature' above 7500 F (39900) and not exceeding (4540C) the steel shall be of non-xegregated of fully killed type. (b) tubes shall be carefully annealed throughout their length after the operation of drawing and the ends shall be eurefully unnealcd ofter the process of swelling or reducing the diometer. (o) Fwedom from Defeco.—'L'he tubes both internally and extornally Bhall be sound, Cleon, smooth, well ffnighccl ond free from surface defects, rust, longitudinal seaming and grooving. The ends Bhull bc clean and square. (d) Thiokne88.—Tho toleranee in thickness shall be 5 por oent. below and 10 por cent. obove the gpecified thickness. (ii) or Reduced Endg.—Where tho endy of tubes are swelled or reduoed, the thickness ut the ends may be reduced, 011 increased under or over, the actual thickness of the tubes by mnou-llt strictly in proportion to the percentage of such swelling or reducing and in addition to this allowance the tolerances specified in parograph (i) of this sub-regulation Bhall also u,pply. (iii) Diameter.—The extarnal diurnoter of the tubes, measured at nny point shall be not greater than thot specifiod, but moy be logs by not more than J per cent, (iv) longth.-—The longth of the tubos Nhull be not Ices than thot gpeoiflod und not more thon 1/8 inch greater

37. Selection Of Tubes for Tent—Two per oont. of the tubes of oooh thiokneeg and diameter ond only one for every or part thereof above 40() tubes of such •similar size shall be made a,vailnble to the Inspocting Offcer for teNting to the extent of such numbers

38. Tensile Test.—Tegt pieces eut frcnn the endg of the selected tubes shall comply with the following requirements Ultimate tent-Ille ßtret38. Tons por sq

111. Not Not Mirmnum olongatnon por cont.m. thick and OVOT 20 On 2 in. in. thiok L6Nß then and over thick. Strip out from tubee und tegted in their curved oondition.B. Tect lengths taken from finished tubes (endB to be plugged for than 20 20 than 28 28 LOBB thun thick. 18 23 go 28 31 THE GAZETTE OF INDTA fiXTRAÖRDINABY BIT 39. Flattening Tæt.—A ring not less than 2 inohu in length cut from one end of ea,eh selected tube aholl be flattened between two porollel flat yurfaoee, the width of which shall be not legs than 1 i times tho diameter of thc tube. When the preg- sure is releu,sed, the interior surfuc•eg of tho fest, piece (ot, the middle) shall remain at the following distances apart nnd the tcgt piece Bhall then show no Nign of crook or flaw. Tubes over IO S.W.O. thiQknDN8 Nof more twice thioknep,e ot the Tubog up to and includmg IO S. W.G. in thickneHg. Until the interior All_rfaoea maat at the 18 40. Expanding Teet8.—The tubes shall withstand expanding by a drift expander having total incllded R,nglc of between 400 and 600 (200 to 300 per Bide) to the following increa,ses in external (limneter without showing crock or flaw. Thickness of tube 6 S. W.G. and th-uxn.er Thinner than 5 S. W.G. upto ond including 3 S.W,G. Thicker than 3 s.w.a. Incroase in d.i»mater per cent. 16 12 9-5 41. Additional test before rejection.—(a) Should b tube Belected for testing purposes show defini(c signs of failure in a,ny one or moro of the testa specified in RegulaHJions 38, 39 amd 4(), two further teats of the gamo kind may be made at the option of the manufQcturer from two bdditionol tubeg selected from thc some batch. (b) If the ropea,t tests are sotiBfoetory the tubes shnl] bc ocoopted provided that in all other respcet,9 they fulfil the conditiona of this Standard. Should either of thc tubes fail in any test, {he bbtch of tubes represented muy be re-hcat-treated in accordoncc with. Rogulation 36(b) und then retested in accordunco with Regulations 38, 39 und 40 but ernploying twieo the munber of test pieces. If these second repeat testa ore B&tisfactory, the tuber/ Hhall be occepted provided that in all other respects they fillfil iJhc conditions of thig Standard; but if definite defécts ore again shown, thc buteh of tubes which f1ho fest pieces represent shall be rejocted

42. Hydraulic Te8t.—Each tube Shall be tosted at the makers works by hydrou- lic pressure in accordance with the following tuble governing the rolation between the test pressuro and tho doaign prosgure which the tube will bo subjected in service. Deqign preqau-re lb/sq. in. Up to ond inoludlng 500 Above 500 upto und including] 000 Abovo 1000 Hydraulio tost prose•u-re lb/sq. minimurn OOO Twice tho design Preki.aure: 1000 ubove the dßßlgn pressure. GAZETTE or INDIA EXTRAORDINAfiY [PART In 011 enses the tensile stress (S) on the moterial when under these tests shall DP not exceed IO tons. per sq. in. as doterrninccl by förmula S Where D =out8ido diometer of tho tube in inches P —test pressure in tons per sq. in. t =nominal thickness of tube wall in inches. HOT FINISHED SEAMLESS STEEL BOILER AND SUPERHEATFB TUBES FOR DESIGNED TEMPERATURES NOT EXCEEDING 850C'F (4540c) 43. (a) Material.--T0 comply with Regulation 366). (b) Annealing.—The of RII tub0N shall be carefully annealed to a length not less thon 0" if i,hey have been gubrnitted to a process of swelling or reducing the end climcnsions. (c) Freedom from defecL—To comply with Rogulation 36(c). (d) Tolerances. —The tubes shall be of the dimenaions spooifiod, straight, cylin- (Irical, of uniforrn thickness and cxl,erml. diomed er hroughout , subject to the working given in the table below : (i) Diameter.—The external dianißter of the tubes measured ot any point shall be with in the following tolerances of (limneter specified : ()ntR1de dtzl]noter of tubes. Up to IO. Over 24 in. (ii) Thioknæg. —The thickness tolerances • oc •tubee.. Up to and Including ID. Ovar 2} In. Tolerance. of the tubes Khull be within the following Tolerance 50 Whero the onds of thc tubes are swelled or reduced the thickness bt the endg may be deorcaged below or increased above the nominol thickness of the tubeg by an amount in proportion to the pereontoge of such swelling or reduction and, in addition to this allowance, the toleranceg relating to thicknegg Bhall algo apply. Wi) Ian.8th.—The tubos Shull be not lees than the nominal length but rnoy exceed it by the amount given below : Up to and ineluding 30 ft.. Over 30 ft. (e) Selection of tubes for test.—To comply with Regulation 37. 44. (a) Tensile Test—Tost pieces cut froin the efidB of the anneuled portions removed frorn tho endg of the selected tubes shall comply with iJhe föllo» ing require- i,menLs : Ultimate tensile Btr0ßH tons por Minirnurn elongation per cent. on 8 in. on 2 in. 1/4 LONR thun I Not than StriPß cut from tub6H uncl t6ßt8d in their curved condition. Teat If ngthg tBken from finished tubes (ends 01 (tub0H to be plugged from Not more thun and 28 28 o ver 20 25 Leas than thi('k 18 23 thiek and over 30 20 20 28 (b) E18ttening Test.-—A ring not, less thnn 2 inches in length cut from the unueol- ed portions retnoved from the ends of the sclected tubeH Hhnll be flattened between two parallel flat surfaceg, the width of which Bhall be not less thun] * tillies thc diarncter of the tube. W hc•n the pressure is released, the interior Burfoeeg of the teat piecc at the middle shall rernnill at, aport of not, more than three Lnnc•s tho thickness of the tube and hr test piece NhnlJ thcn Bhow no Nign of cruck or flaw. (c) Expanding Te8t8.- -The annealed {ube ends Shall Wii hstancl expanding by a, drift expander having a total included angle of between and ('200 300 er side) to i,hc following increase in ex tcrnul din,rneter without sh0M ing 1 ruek or of rlh]be d. und thinner Thinner than 5 ancl up to and Ineluding 3 S.W.G. Thicker t,hbn 3 s. MIT Inereb8e Diameter per cont. 15 12 45. (a) Additional teBts before rejection.— Should tube for t,eNting pur- poxes Show definite signs of failure in any one OJ more of the tests specified in Roga- lotions 44(a), 44(L)) and 44(c) further teatH of the game kind may be Inade at the option of the manufacturer t" o additiona,l tubeg selected fi om thc same batch. (b) If the repeat teste are satisfaclory the tubes be accepted thot in 011 other respeotg they fulfil the conditions of this Standard. Should eiiher of the tubes fail in any test, the boteh of tubee represented may be re.heat-treated in gooordance with Regulation 43(b) and then re-tegted in accordance with Rogu- lotions 446), "(b) and 44(c) but employing twice the number of test piecem. If these second repeg# tests are satisfactory, the tubes Bhull be accepted provided that in all other regpectB they fulfll the conditions of thig Stondard; but if definito defects ære again Bhown, the botch of tubes which the tests pieces ropregent Bhall be rejected

46. Hydraulic Test.—Each tube aholl be tested at tho makers' works by hydraulio pregeure in accordance with the following table governing the relation between the test preggure and the design pressure to which the tube will be subjected in Deign præuurø lb/eq. in. Up to and Inoluding 500 Above 500 up to gnd including IODO Above 1000 Mydrnu.hc test preggure lb./sq. it.L m-lrumum 1 ooo Twice the doxign pressure 1000 above the d8B1gn proeure. In oll eosos the tensile stress (S) on the material when under these tæt• 'halt not exceed IO tons per sq. in. deternnned by thc formula DP Whore D outside diameter of tubo in inches. P = test pressure in tons per sq. in. t Nominal thickne*N of tube wall in inches. SEAMLESS HALF-PER CENT. MOLYBDENUM STEEL BOILER AND SUPERHEATER TUBES

FOR DESIGN STEAM TEMPERATURES NOT EXCEEDING (51000) 47. GenenL—Those Regulations q. ovcr both hot finished and cold drown seam. leBB boiler ond superheater tubC8 Mthieh Shall conforrll ull respeetg with the require- mentN herein specified. 48. (o) Material.—The i ubos shall be Inanufactuted from steel produced by the Open Hearth ot Eloct,ric processes and shall conforrn to the following limits of chemical compositions ('arbon Wi"nganeso '311-ioon Sulphur Loephorug M QI ybdenum 15% maximum 0 0 40 to 700/ O, 10 O, 0/90 maxzmurn The steelmgker Shal-I supply certificate of the normality of the steel. (b) Neat tubes shall be normalised at a temperature between ld880F (9200 C) and F (9600 C). (o) Workmanship and toleruoe. 'L'he tub03 shall be well finished, •olean and free from harmful defects. They Bholl bc reosonobly straight, smooth, cylindrical* and aubject to the following tolerances before bending (i) Diameter.—The oxternnl diameter of the tubee measured at any point shall be within the following tolerances of the cliomcter specified : — 50 Type of Tube Hot finished (hld drawn anoes:— Ty-pa of Tube Hot, finished Cold drawn Outside Dlbmeter of Tube Up to Including In. Over 111. Tolerancz 1/(34 in. — 1/32 in. (ii) thicknesg of the Lubes *hall be within the following toler- OLIt8ido Diameter of Tuba Up to killd including in. All Tolerance O O O o 50/0 Where thc encls ot the (JILbes R,rc or reduced the ot, the ends may bc (Iccreased below or increased above the ncnnina,l f,hicknegs of the tubes by an onaountJ in proportion to i,hr ercontnge of sueh swelling or reduction and, in oddition to t,hiq i he relu,ting to thickness shall also apply. Swelling or reduction Bhu,ll 110 euried ont before the heut treotment, specified in Regulation 48(b). (iii) Length.—rllhe tubes shall bo not less thc nominal longth but may exceed it bv i,hc Olnount given below : Up to ineluchng 30 Ovpr fti. ot JNL)IA (d) Selection of tubes for testing.—After heat treatment, tho Cubop, fthall bo preentcct teHting in aeoorduncc• With RcgulR,tions 490), 49(b) and 49(c) in batches of not jnore thai 100 01' the same ncnninal diameter and thieknes*. The manufacturer shall provide Ot, liiN own expense ex Cru tubes at, the rat,e of 2 per cent. of each diazneter and thickness of tube Epeeified und the 1 nspceting Offcer Shull gclect, for t est guch of thc tubes us he Ina..y think proper to the extent of the percent,uge Inentioned, Should the ntunber of tubes or ed of any one nominal Sizo exceed 401) then, for evcry tubeg or part thereof ubove that nurnbcr, one additional tube *hau be provided. The sa.,tnplC8 for testing shall not bc heat-treated after golection. 49. (H) Tensile pieces cut, from the of tho selected Bhall comply tho following requirelnents : Ultimut4' 'INengile Stregs tone per sq. Not 188B than Not more Minimuln elongution per cont. on 8 inehe8 Strip8 rut from tubBB and t.108toc{ in their curved condition. Tegtg LongthH token :from eniBhocl tube8 (end* of tilb0H to be plugged for griPH). 27 25 thun 33 33 1/4* thick and over 23 LOHR than 1/4'* thick 17 21 (b) Elattening Test.—A ring not less than 2 inches in length cut from one ond of each sclceLed tube shall be flB,iJtenecl bctwecn two parallel flut surfoceg, the width of which shall be not less than times tho diameter of thc tube. When thc essure ig releu,sed, the interior surfaces of the test piece (ot the Inidcllc) shall renmin at a distance a,part of not more than three timos the spceified thickness of the tube and the Lest, piece shall then show no Bign of crack or HAM'. (e) Expanding fest8.—Tha tubes *hall wifh*i and expanding by u drift, expander having a total included u.nglc of between 400 and to 300 each side) to the following increases in external dimneter without ing cruck or flaw : 'DhickneHH of tuba] O S. W.G. ond thinner Thinner than 9 S. W.G. up to and inv]uding d • Thicker than 6 S.W.G. Inel'(in diurnetor per eent

50. Additional tests before rejeotion.—Should n tube, gelectcd for tosting purposes show definite signs of failure in any one or ntore of the tests specified in Regulations 49 (a), 49(b) and 49(c), two furthcr teats of tho same kind rnay be made ut the option of thc manufacturer from two additional tubes selected frorn the sorne botch. If the repeat tests ore Nbtisfactory the tubes Bhall be accepted provided that in 011 other regpects they fulfil the conditions of thig Standard. Should either of the tubeg fail in any test, the botch of tubes represented mtbY be rcuheat-trea,ted in accordance with Regulation 48 (b) and thon retested in a,oeordance with Regulations 49 49(b) ond 4É(c) but employing twieo the number of test pieces. If these geoond repeat tegt,a ore aotisfa,ctory, the tubeg Bhull bo accepted provided that in all other respects they fulfil the eondiLions of thig Standard ; but if definite defects are aguin shown, the batch of tubes which the test pieces represent shall bo rejected

51. Hydraulic Te8t.—Each tube shall bo to, ted at the moker'* worke by hydraulio pressure in accordoncc with the following table governing the rolatjon between the test pressure ond the degign pressure to which the tube will bc subjected in ervice. Design pressure lb 'sq. in. Up to and inoluding 500 Above 500 up to and includmg 1000 Above 1000 Hydraulic t,e8t pressure lb/Hq, in. minimum 1 ooo Tvfcc the dogign pressure. 1000 above the d0ßign pressure. In all cases the tonsile stress (S) onitho moteriol when under

these tests Bboll oot oxoæd 10 tons per sq. in. determined by the fonnula DP Whoro D —outside diometer of tube in inches. P —test pressure in tong per sq. in. t —nominal thickness of tube wall in inoheg, SEAMLESS CHROME-MOLYBDENUM STEEL BOILER AND SüPBR. HEATER TUBES FOR DESIGN STBAM TEMPERATURES NOT EXCEEDING (53800) 52. Be Rogulntiong covor both Hot _Hinished and Cold Drawn Sea,mlcgg Boiler and Superheater Tubos which Bhall conform in 811 respects with the requirem nts herein gpocißocl. 53. (o) Material.—-Th hall be manufactured from stool produced by the open Elea,rth o.' Electri and Bholl conform to the following limits of chemi• cal composition. - Carbon Munganeße Silicon Sulphur Phoaphoru.B Molybd onurn Chromium . 0 •12% maximum. o .35 to o •650/ O •050/ maximu-rn maximum 0150 to 0-700/ o .75 to 1 •25% The sholl su pply a, certificato of the normolity of the Btee]. (b) Heat tube3 shall bo fully annealed, nr normalined at B -temperbture between 16880 F (9200 C) and 17600 F (9d00C). (o) Workmanship and tolerance.—The tubes shall bo well finished, Olean and free from hor mful dcfcet*. They Bha,ll bc strangtlt, gnu-10th I cylin(lrieu.t ond qubject to Lhe follow-Ing i oleranec•s beforc bend! rjg : (i) Diameter. —Thc external diameter of tubcs rneuyured at any point 811011 be within the following tolorp,nces of the diameter specified : Typo of Tube Hot finished Cold drawn (ii) Thickness.- tolerances ; Typo of Tube Hot fln1Bhed Cold drawn Outside Diameter of Tube Up to and Ineludrng 2i in. Ovor 2} in. Ilho [hiekneys of tho tubes shall be Out81do Lhumotf-)T of ube Up to and including 2} in. Over 2} m All sizes Tolerance within the following Tolerance o 5 OX + 100/ Whr•re Lho encls of Lhe tubes lire swelled or rcdueed, the thickness at tho ends moy bo (leczea,Necl below or Increa,qed bovo Lhe nomina] thickneqs of the tubes by on n,rnonnL in proportion to tho per centage of such swelling or reduction bild, in addition to this allowmneo, the toler ü,nccg relating (go thiekncsq shul' algo apply. Swelling or reduction shall be carried out befote thc heut trcntrnent specified in (iii) Length.—tl'ho tubes shall be not than (he nominal length but may be 1/8 in. greater. (d) Selection o} tubes for teeting.—Aftor heat troatrnent, tho til b('N Shull be pro- sented mechanical testing accordance Willi Rcgulatiom•1 54(u), 540)) und 54(c) in of' noi rnore than the sn,rne (118tne(er awl thic 'l'he monufR,ei Bhall at own expense exi rn i ubeq nt t he a,te of 2 por ecnt. of each diamefor and LluekneN"A of' tube specified and d Ile Inspect,mg Officer shall select for. such ot thc tubo he Inay think proper to Lhe extent of thc poreent,uge mentioned. Should the number of specified of any one nominal size exceed 400 then, for every tuboy 01' vort t 11 51 eof above that n umbel, one additional tube shbll be provided. Thc somplcs for testing shall noi, be heat treated after Selection. 54. (a) Tensile Test.—Tcst pioc,0N cut from the ond8 of the selected .tubos shall comply with the following req unements : IT It Ton.ßlle Sl,re88 in Ions per 8(4. In. Mtnimum Elongation per coni,, on 8 Inches Not, than 27 25 Not moro bhan 33 Strips cut from tubes and tegted in thali' curved oondltwn Toet lengthH takan from fimshed tu bea (enda of tubag to bo plugged for griPB). 1" thick & over 23 than thick 17 21 (b) Flattening Test.—A rmg not loss 2 ineh0H in length eut from ono end of eBCh selcetcd tube shall be flattened between two parallel flat qurfacc•s, the width of which E4holl be not legs than 1} i,nnes the chametel of the Lube. When the presauco iN released, the intem ior surfaces of thc test pieces (at the mulclle) shall remmn at distance "part of not rnore {Jhan three tillitiB the Npeeified thi('knegs of the tubc and tho test, piece shall thcn Hli('w no Bign of crack 01 flaw. (c) Expanding Tests.- Tho tubcs shall with8tand oxpuncling by drift expander hoving b totbl Ineluderl angle OE bet,wcen and and per side) to the following in oxternul (Limneter without showing en aek or flaw : Thickness of Tubo .10 W.G. and thinner Thmnor Chon S.W.C. up to und including 6 S.W Thicker than d Increase Lhur.noter per cent. 9} 55. Additional tegts before rejection.- -Should a tube selected for sting purp08(4B show definite Nigns of flMlurc m nny onc or morc of Lhe tests specified 1{cgulHt10ng 54(a), 54(b) and 54(e), two further tests of the samo kund I-nay be made at the option of tho monufaot,ucer from. two addit,ionol selected tubes. If the ycpeut tcsts arc satis- factory Lhe Lubeg shall bo accopted proviclcd that in ail other respcj(tg they fulfil the conditions of thid Should cither of thc tubc fail in u ny test, Lhe hatch of tubeg represented Tnay bc re-hoat-i reui,ed in oceordn nee with Regulutlon 53(b) ond thon retested in accorda neo With Regulations 5401), 54(b) and 54(c), but employint' twice the nurnber• of i,cst pieces. If these second repeat t,0Nts are sat,1Bfiietory, tho tubes shall bc accepted provided that in all othor respects thoy fulfil the conditions of this standard but if definite defects are again shown, the butch of tubcg which the i]CBt piece* represent Shull be rejected. INDIA 56. Hydraudo Tgt.—ER0h tube phall bo tested at the maker'e workg by hydraulic pressure in accordance with thc following tablo governing the relation between the test progsure and the design pressure Io which the tubes will be subjected in service. ')08ign pf08aura lb. /HGI. m. 500 or Above 500

but not exceeding 1000 Above 1000 Hydraulic test pressure lb/gq. in. In-i-n.imur:n. 1000 Twice the design pressure, 1000 obove the design preegure. In 011 cages the tensile stress (S) on the material when under these tests shall not exceed IO tong per sq. in. ag determined by the formula :— Where D P t DP outside diameter of tube in inches. —teet pressure in tons per sq. in. —nominol thickness of tube wall in inches. ELECTRIC-RESISTANCE-WELDED STEEL BOILER TUBES FOR TEM- PERATURES UPTO 7500 F, AND PRESSURES UPTO 840 Lbg./SQ. IN. (FOR EXTERNAL PRESSURE)

57. Genoral.—These Rogu18tions cover eleotrio.resigtance-welded tubæ mode of steel and intonded for boiler tubes. 58. (a) Material —The rnateriol shall bo mode either or both of the following processes : Open-hearth or electric-furnace. (b) Manufacture.—Tub0B shall be made by olectrio-registano and shall be normalised ot a temperature above the upper critical temperature. (c) Chemical Composition.—Thß 8teel shall conform to tho roquircments as to chemical composition prescribed in Table below : TABLE — Chemical requirement'. Carbon, par rent ManganoHe, per cent Phosphorug, por conv. Sulphur, mox., par cent. Low Curbon Steol o .04 o •045 Medium Carbon Steel O •85 max. O •80 max. 59. (a) Flattening A sertnon ot the tube not than .21 in. in longth dhal-I be flattened cold between parallel plates until the opposite wollg of the tubo TEE GAZETTE or INDIA EXTRAORDINARY 627 meet. No oraokg or breaks in the metal Bhall occur until tho distance between the plates is less thon the colculbtod value of 'H' by the following formula : Where H diNtance betweci flattening inches, t nominal wall thicknesF of tube in inches, D actual outside diameter of tube in inches, and deformation per unit length (constant for u, given grado of steel, 0 •08 for types A, 0 •07 for type C). Evidence of laminations or burnt Jna,terinl, or incomplete penetration of the weld, 8haIL not develop during tho entire flattening process (ii) The weld gholl be placed 90 deg. from the line of direction of the applied force. (iii) Superficial ruptureH as o result of minor gurface imperfections •Nhall not bo couge for rejection. 7b) Flange Test. (i) A section of iho tubo not less than 4 in. in length shall be capable of having a, flange turned over at a right angle to the body of the tube without cracking or showing flaws This flange, as measured from the outside of the tube, sh811 not, be 168B than 1/8 in. nor rnoro than in. Within these limits, the width of the flange Bhall be not less thun the following Width of Flange Outeide Diameter of Tubo, in, Type A 15% of outside dibl.n ter Type C 2} and under Over 2} to 3-8/4 over 3-3/4 to 5. 75 per cont of that 3/8 in. 10% of outside diameter requirod for *type A. (ii) In making the flange test, it is recommended that thc flaring tool and die block shown in Fig. below be •eosiTf0t•.' AFTER usr•w f i-..ARING -roa- BC A..OD TUBE LESS i TUBE Itss Pt-US TOOL POSITION AFTER TUBE pws& (c) Orueh Test.—When requ irod bv tho Authority JFcrughingFt,e8t8 BhBll be mode on sections of tubo 2}in. in lengoh which shall stond crushing longi- tudinally, without cracking, splitting, or opening bt tho •weld, as follows thiokneæ of tubee, in. 0 •185 and under Over O •185 Height of Crushed Sect on. in. Type A Tub08 Type C Tubeg 3/4, or until outBide Crush teete not folds ore in contact required. Slight arf•æ cheokß Bhall not be cause for rejection. 628 THE GAZETTE OF INDIA EXTRAORDJNARY [PART 11 (d) Reverse Bend Test. in I ngih Bhull be taken every 1500 A 4 In . ft. of finishod welded tubing to bo split, longitudinally 180 deg. from Lhe weld and thc qnrnple opened u,nd flatl,oned with thc weld nt tho point of max. bend. 'l'here shall be no evidence of crucks or lack of penetration or overlaps rosulting from flas» removul in Lhe weld

60. Tensile C tubep S'hull conförn) Io the require ments as to tcnsile properties preecribed in Tablo below : Ten 8ile Requirements Tengila Htrength, Inin.. per sq. nn Yield point. nun., Elongation in 2 in. , min., per cent, For longitudinal Nt rip tests deductiou Cor ()RCh 1/32 in. decreaae in wall thicknesg below 5/1 f] m. from tho Jilin. elongation of the fi-)llow- ing porcentago. lbs. 37000 Ibe. 30 61. Hydraulic Te8t. —(u) Each tub? shall b* t at the mnkc r 'N works uncl shall with' tand för minirnurn of 10 seconds R hydraulic lest pressurc which Shull impose u minimnrn fibro coss of Ihs(sq. inch and not oxceoding lbs/sq. inch. for type A aud not exceeding lbs/gq• inch. for typo C 0B detorrnincd by thc [Ollowing for.' nula:— Where P S T Hydru ulic test prossure in lbs/sq. in. fibrc stress. Outside diameter of tubc in inches, und thioknoss of tube wall in inches. (b) Il'ube Nhall be struck neur both ends while under (Jlje toet pressure with o 2-1b. steel harnmcr or its equivalent

62. Test Specimens.- (a) 't spocivnfrllt•g required for tho flattening and flange tests spocified in Regul Lt,ions and 59(1)) Bhall bo fn.k-en from the cncls of finish- ecl tubes prior to up-setting, uging, expanding, or other förming operations, or be- ing cut, to length. rllhcy Afinll be on the ends and free frorn burrs u,nd flaws. (b) If dosirublc and practicable, tensiou tests n) uy be Inade on full scctions of the tubes up to tho of thc testing rnachine. For larger size tubes, the tension Let-it spoeirnen shall consist of u Strip cut

longitudinu Ily from the lube und not flattened botween gnrugc marks. 'J_'he sides of the specimen shall be pnrullck betwoon gauge marks ; -Lhe widl,h, irrespective of Lhe thickness, Shull be I in. , tho gougo length shall be 2 in. (c) All specimene Shull bc i,ested at room ternpcruturcg

63. Number Of Tests.— (a) For type A, one of tho tests specificd in Regulations 5901), 59(b) and sbull be rnade from ench lot of 25() tubes or fraction thereof and from each ft,. or fraction thereof safe end n) utcria]. For type C, one of euch of (Jhe tests specified in Regulations 59(u), 59(b), and 60 shall bc mado from each lot of 25() tubes or frnction thereof. A reverse bend test specified in Regula. Cion 59(d) 81.1011 be I-nado on each ft. of finished t,ubing. (b) any test spechnen shows dofcctivc machining or develops flaws, it may be discarded ond another specimen substituted, (c) If the poreentngo of elongation of ony tension tcsf specirnen is lees thun that specified in Regulation and uny purt of the fracture is rnore thau 3/4 in. from the contre of tho gouge longth, arH indicatcd by scribe scratchcs marked on Lhe spccitncn beforo tcsting, rc-l,est shall bc allowed. (d) Euch tube shall be subjected to tho hydraulic test specified in Regulation 61. SEC. 3] THE GAZETTE OF INDIA EXTRAORDINARY 629 LAPWELDED STEEL BOILER TUBES (FOR FIXTERNAL PRESSURE) 64, (a) Materials—The tubes shall be enade, from steel which shall show on ana lysis not more than 0 •05 per cent. of qull)hur or phosphorus. The manufacturer shall supply a certificate of the analysis required to do so. (b) Annealing.—The ends of all tubes shall be m,refully anneded . (c) Freedom from comply with Regulation 36(c). (d) Tolerances. — The t [bes *hall he of thc dimensions specified, straight, cylin drical, of uniform thickness and external diameter throughout, subject to the work ing margines given in table below . On diameter On thickness on length Outside diameLer of tube Under 2} inch 2} inch and over Inch 64 Per cent. 1 Minus Inch 1 Per cent. 1 Per cent. 10 Minus Per cent. 10 Plus Inch 1/8 Minus Inch (e) Selection of tubes for test.—To comply with Regulatiou 37. (a) To comply with Rog. 44(a)

65. Tensile test.(b) Flattening test.—To comply with Reg. 44(lJ), thc weld being placed 450 from the horizontal. «a) Expanding test.—.The selected tubes shall, when cold, withstand being ex- panded by a drift or a roller expander to the fol]0Töing increases in diameter with- out showing crack or flaw :— Thickness of tube S. M' .G-. Up to 10 Above 10 to 6 Above 6 Increa«o in diameter per cent. 9-5 5 66. Additional a tubQ relocted for testing purpose in accordance with Regulation 37 fail to satisfy the requirements of any one or more of the tests specified in Regulations 65(a) (b) (c), if so desired by the manufacturer, the tubes represented shall be re-annealed and then retested in accordance with these Regula- Cions and if the repeat tests are satisfactory, the tubes shall be accepted provided that in other respects, they fulfil the conditions of these Regulations, but if the tube again fails to satisfy the requirements, the tubes which the test pieces represent shall, be rejected

67. Hydraulic test.—Every tube shall be tested at the Maker's works by hydraulic pressure to not less than 1,000 lbs. per sq. in. Any tubes failing to withstand this test shall be rejected. --uéO -L He INDIA WROUGHT IRON LAPWELDED BOILER TUBES (FOR EXTERNAL PRESSURE) 68. O) Material.— The tubes shall be Inade from wrought iron which shall show on analysis not more than 0 • 100/0 manganese and 0 •03% sulphur. (b) Annealing.—The end of all tubes shall ba carefully annealed. (c) Freedom from defects.—To comply M ith Regulation 36(c). (d) Tolerance. Tho tubes shall be of tho dimensions specified subject to working margins given below. They shall be straight and cylindrical, of uniform thicknesse concentric and unless otherwise specified, of uniform external diameter through« out. The working margin shall be as follows : On thickness—plus or minus 10%. —plus 1/64" and minus 1/32". On external dia. for tubes under 21" for tubes 2" and larger—plus or n)inus 1 per cent. (e) Selection of tubes for test.--To comply with Rcgulation 37. 69. (a) Tensile Test.—Lengths or strips cut from the selected tubes shall comply with the following requirements : Ultimate Tensile Strength in tons/ sq. m. Not less Not moro Strips cut from tho tubes clear of the welds and tested in their curved condition Tested longths taken from finished tubes (ends of tubes to be plugged for grips) than 20 20 than 24 24 Elongation per cent. on 8 in. 10 12} (b) Flattening Test.—To comply with Regulation 39

70. Expanding Test.—The selected tubes shall. when cold, withstand being expanded by a drift or roller expander to the following increases in diameter without showing crack or flaw :— Thickness of Tube SW G Above 6 I Increase in Diamoter per cont

71. Crushing Teste—A ring 2 in. in length cut from one end of each selected tube shall withstand, without showing crack or flaw, being crushed on end by hammering or pressure when cold, until the length is reduced to 1-5/8 in

72. Hydraulic TBt.—Every tube shall be testcd by internal hydraulic pressure to not less than 1,000 lbs./sq. in. Any tube failing to withstand this test shall be rejected. STEEEL CASTINGS 73. Scope.—Steel castings shall be of the following grades, according to the purpose for which they are to be used and as may be specified :— Grade 1 . erade 11. 28 to 35 tons per sq. in. 35 to 40 AZ. .L . 1 LYDIA. .x. 74. (8) Process o! manufacture.—Steel for castings Bhall bo made by the Opon Hearth or an Electric Process, acid or bogie. (b) Ohemical Analygig.—Stool for grados I und 11 castingN ahull not show on analysis rnore than 0.06 per cent. of Bul-phur or phosphorus as determined from the test samples, ancl tho manufa,cturer Shull supply on onalysis of each oagt when requested. (c) Heat treatment.—All castings Nhall be heat treatod to refine the crystalline structuro throughout tho costing by heuting to a uniform temperature not than the normalising temperuturo and allowing to cool *lowly from Lhe maximum tcmpe- roture in a practically uniform I-nunner: or altornutivoly normoliscd by heating in a similar manner Olid ullowing to cool in still air. (d) Freedom from defect8.—All castings Bhall be free from twists, crooks. flows and Nimilor defects

75. Repairs to defective shall not bo repaired or weldod with ont the specific sanction of the Inspecting Officer, If required the castingg 2b all be suitably re-heattreatcd to retnovo internal stresses. Should o deféct impair the strength of the castings, ropuir by welding or otherwiso sholl not bc permitted, 76. Number of loast ono tensile and one bend teBt shall bd made from the casting from euch charge, and when more than one casting is mode from one charge, at least one tensile oncl one bend tost shall be modc from the castings run from ono common pouring head ; but geparate tests Nholl be mode from each cost. ing or set of costings run from each acparute pouring head. Test pieces Bholl not be c,ntJ off until Lhcy huve been stomped by {he Inspecting Officer after the unnealing has been completed

77. Tensile tests.-The ultirnnt," tonsil') strosg, yield point and elongation for grados I ond 11 costings shall bc not less (Iban shown in table below:—- Tensile Tests on Steet Ca8tings Grade 1 11 Minimum ultimate 'Lionailo Btrongth Tong per sq. in. 28 35 Minimum yif'ld point Jn tor-rny of 'Ilonelle strength per eent,. 50 50 Minimum Elongotion on teat picco 'C' (figure 5 to Appx, B) per cent. 20 15 Should b tensile test pieoe break outside the middle holf of its gauge length, the test moy at the manufucturer's option be discarded and another test be made of the earne outing

78. Bond tests.—Cold bend tests shall be made upon test pieoos having reot- angular sootion of one inch Wide by 3/4 inch thick. The test pieces Bhall be moohined and the edges rounded to o radius of 1/16 inch. The test pieoes shall be bent over the thinner geaqon. 632 THE GAZETTE OF EXQRAORDINARY [PART 11 Bond tests nxn y be nut(le by essnre 01 by blows, and thc test pieces shall without turo withstand being bent touncl r having n raclius of I inch through an angle not less than that given thc lollowing table . Grado 01' Ca.Httctg 1 Bond 79. Additional tejts before rejection. —Should a t+lt firgt bv the -lugpector not Itulfil the test roquiremonts, two odditiona] tests of the samo kind from thc ensting or group of eagl Ings Nhull bc mude. Should onc of tho additional test pieces filll to fu Ifil the specified test requircments, the eastings shall bc rcjocted

80. Waiving Ot te8ts.—No tests *hall be mudo from unituportunt steel custmg or from Hteol eastings which ure 118ed Tor articles usually rnadc• ot cust iron, if the geantJinge are not materially reduced below what would be required if cast iron were used. CARBON STEEL FORGINGS (OTHER DRUMS) 81. (a) Process of manufacture. —Carbon . feel ror forgings 'Ahull be mado by Open Hearth or an Eleci,ric Process, ucid or bagic. (b) Chemical analysis.—Tho steel shall (ontain nol. than per cent . ot sulphur or of phosphorus. (c) Freedom from detects. forgings *hall be froe fronl defect N ot any kind blld Nhall bc finished to thc prescribed (Innensions. Defé(ts In forgings shnll not, be repaired without, the previous sanction of thc Officer. (d) Heat treatment.— h forgill(f shall be efli('lentlv -treat ed u nless during the last stage of rnuuufacture it been finished Rt such telnpernturo as to ensure that the material of thc for gmg •w ill havc sntißfaetory mechanical proper- 82. Selection Of test pieoas.—Suffu iont material shall be left on h forging for test pieces. In the caye of a nurnbel' of forgings, not less than two per cent. of the total 01' not less Lhun 2 forgings frorn each cast. 83. (a) Tensile tests. —The ultirnuto tensile 'illd elongation Shull bo between thc lirnitN of 26 and 32 Tons per sq. in uncl 2800 und 2200 respectively dctcrrnincd on BlitlNh.

Standard Test, Piece C, or sul)HH1iary Standnu! -Rou nd Tegf Picce (See Appendix B.) In no eusc shull the sum of the ultimote tensile and esponding tion be loss than 54. broak outside tho Illi(ldl half of the test (b) Should tensile i..ost piece gouge length the test tnay, Rt f he nuaufucturot•'B option, bc urded and anothel test be made of tho forging

84. Bend tests.(R) Bond test pioees shall be rectangular section I in. wide by 3/4 in. thick. The edges shall be rounded to a rodius of 1/16 in. The test pieccs Bholl be bent over thc thinner section. THE GAZETTE OF INDIA EXTRAORDINARY 633 be en,pable of boing bent, without fracture (b) 'Fhe test pioces shall, v, hen (Old, through nn mngle of 180% the micrnal radlll* of the bend not greater thun Inch Bend tests may bc mudc by oresgure or l).y blows. tensile or a bend teut 85. Additional texts before rejection.- Should either fall, two further Leets of the type which falJe(l may be rnade on lost cut from retes1,8 1-Irc satisfactory, the the Blime forging. If the results obtained h (hose forgings shall bc ucccpted, providcd that in other rcspc ctg thcy fulfil the conditions if these letestN do not give satisfactory results loid down above for stoel forgings. the forgings reprcsentcd may IJC re-heat-treatcd togelher With the rcnuunder of the toet blocks und presented for further tcetmgs. retest* do not give satisfactory results, the forgings In all cage* where final rcpreHented by thc test peces which full Bhall bc rejected GENERAL GREY TRON CASI'INGS (GRADE A) 86. (u) Proces8 of manufacture.—Tho eustingq shall be east, from metal melted or refined in any metallurgical plant other thun an Iron ore smelting fnrnnce, for the use of which furnua•e perJniB'-jlon writing Inusl. bc Ived :from the Inspeeting Authority . (b) Chernical composition. The composition. of the iron cast shall be left to the (liserotlon of the manufacturer but the Ina,ximurn pereontugc of phosphorus may bc specified bv the Inspeetmg AllthQf It,y If he so (10911es. (e) Moulding.—(i) The crust Ing* Shall be Hecuraiel.y moulded in accordance with thc potteyn 01 working drawings supplied by the lnspccfing Authority, with tho uddition of sueh let!termg us mny bc Ilied. out of t M oncl ee fyorn blow ho!ee, (ii) The ng *11011 be sound, elca,n, digi,ortion nncl all suTfnec and other 'llhe.y shall be well dressed or fettled ond Shull be .tnach11iH,bIe by nonnol methods PROVISJON OF BARS 87. Ihe I nspectinr*' Authority shnll state ut thB t "no of cnqtury whother he requires tensile or tranyverse teqtfi, or both, n nd he rnny Olso specify cost-on barg where the design of he Ing and ei 1 unning pet tmt. When iJhc tesgt burs sopu,r H tely tho. be pour(d at i,hc t,lme uncl from {jhc supine ladle of tnptal ag Ihr r a Ai 'ing 01 cnrstingg they reprog(nt 'The number or tost spe( ]fied Regulation 92 shall be appllenb\e to HII ('Ftinga of cach melt. When the u -on, the Inonl(l For the en,Nting u nd the rnoul(l fol Lhe tost piece Bhull be joined together such u, rna,nneT that the liquid ln•etul fills both moulds bt the saane operut ion All tost bars shall be ea,qt in green sand or dry sand moulds according to whether the casting or castingg they lepregcnt ure moulded in green gand, or in loom or dry sand respect ivc]y. rl'he test bars Bhall not be subjected to any heut troa,tment ofter leaving the moulds. DIMENSIONS OF TEST BARS 88. (a) Transverse Test Bars.-—Tho trunsverge tost bars of the diameter specified by the Inspecting Authority according to the mn,in cross sectional thickness of the casting represcnted, shall conform to thc following dimensions Diumoter of toet Bor in. O •875± Limits on diamotor in. o •045 0 090 0-10 O verall Ian gth in. 10 15 21 21 27 Main crogg-eeetional thickness of caating repreacnted Not excoodi-ng 3/8 Over 3/8 and not exoeeding 3/4 Over 3/ # and not exceeding 1.1/8 Over, 1,118 und not excooding l. 6/8 Over 1,518 Bars cast to size in excesg of the limits given mbove may bc machined to 8 diameter within the specified limits. BOL'S cast within these lirnitg of dimneter may Olso bc machined beforc the transverso test is n) ado, providing thu,t thc finished diameter follB within those hinits. SCREPÆ Ddi AREA @RALLEL) SCREWED) TABLE ends Diarmtnr Gauge D. 875 1 596 Area pommel adlU_B length of plB1-n Approximate mi-nil:nuxn ovaall length Plain ands ends 2 B.S.F. Main thickn• of cest-mg Not exeædxng 31S Over 3/8 not 3/4 Over 3/4 and not oxemdin.g 1-1/8 Over l, 1/8 not exe.æiing 1-5/8 over 1-5/3. The b6N shall be as parallel bars of the dibrneta giva:r in Column and to the dime.nsi01* D ond P in the above t,abk. If thc diameter of u test va ries with in the limits specified I n Regulation 88 (B) IJhe equivalent along load for i he t bur dia- lth the factors given Appendix F. meter *holl be ed in o TENSELE TEST 91. A tensile test, bar to the dimensions Nhown in Regulation 88 (b) (b) Tensile Test Bars. 'Ilho tensile test bus of the diameter specified by the Impeoting Authority, according to thc rnnin cross-yectionarl thicknegs of the ousting represented, shall conform to Che (limcnslong shown ill thc following table. Borl-J may bc tested with either plann or screwed ends. (c) For costings over 2 Inches in thickness a tost bar of Ibrger diometer thon 2-1 inches mu,y be uged by agrecrncnt bet ween the manufacturer und the -Inspecting Authority. For diagram uncl table sce pp. 28 to 29 MECHANICAL TEST 89. rl'he casting

musl comply with the transvors') and tk-)nsile tests spcoifiod in Regulations 9() and 91. All test, ghnll he selected by the inspector nnd tested in hig presence und to hig sotiHfaction. TRANSVERSE TEST 90. A transverse test bar cast in accordance with Regulution 88(a) must, whon placed on supports get ot the distu nce dhow-n in eolurnn 2 of the following tbble sustain a loud applied ut the centre of less thBn that shown in column 3 and must show before 1 upture u deflect ion not less than thu,i ghown in column 4. The supports und the point or upplieai 1011 of the load shall bc rounded to of not, less thun 1/8 inch. 1-2 2-1 Diameter of test bar 1 Ili. o •875 1-2 2-1 Distunea betworn 2 In. 9 12 18 18 24 Mirumum breaking MI mmurn deflec- load—Grado A 3 1,050 6,660 4 in. 0-12 ond tested Wii h eid,her less than that, show-n I)iameter OL tost un. or screwed ends must show a, bleaking strength of not In the following table. bur NOTE]. —Self-aligning grips to enaure axial loading ultimato t0D8110 A 'Pons per 11 aro recommendod. NUMBER OF TRANSVERSE TENSTLE TESTS of required for cach batch of custings be iu 92. Tho num ac cot - the various ('lasses of (being divided dunce wilh the follow four representntive test, whethel taken ()ne test Shull refer to one tl•nnsverse a nd onc tensile or two fest bars at eaA. Group 1 2 3 of Up to 28 lb. Over 28 lb, nnd upto Over I cwt. ond upto tng• cwt. one Ion roquirelnentd Ono i eat for cach 30 cwt. of ragt,mgd or part 2 tong Of custings or Ono te8t for oaell part thereof. (_)ne t08t Lor each tons of castingB or part thoroof. tn (ho above Groups, I, 2 und 3, all cutfitingg repröyant,ecl by one teat mugt ho poured from tho same ludle or game heut the bnc or barg providod for the teat. Over I ion and Important ca8t1ngB One for euch 4 Cona of cust,ingg or 4 part (horeof or for each casting weighing whore rnutunlly agreed upon. 4 tom or l.nora

93. Additional Test8.—The additionol tests to be curricd out, bcfbre or botch of eastings is rejected Shidl be in accordance with thc following tem Io Te8t piero Evont If thi* failg If thiR pu,RHØH If this Condition8 The aocond t0Ht pleco Rhull be teetod. 'I'hc boteh or Fgoparnto ing reprascntrocl Bhall bo urcoptod. Fl'ho bul eh or separeto custmg ropregenLod be rejooted Provided i hat, ill the enge of failure of both d,est pieces if either show obvious (lefeei hil d test pic•ee .rna,y be aken frotn broken Q&8Ling or pieec may bc cut f't•orn u, usnble ing for fnrLher testing as follows : 3rd 94. welding If thig paggea If fnilH Tha batch or 8epu,rute easting reproeontecl shall bo accepted. The bnteh or N8pnra,to coating repreftentcd may be rejected. COVERED FOR METAL ARC (FOR TIAND (hERATION) Construction.— Tho motRl eleotTQ(lcs be provided with a flux eov ••ring externull.y by pointing, spruying, (I ippingr or other lncthod, covered 01, redes shall Application. -—The b) suitable for rnotal are of rnild si,cel having tensile Ntrcngih not cxceedig 33 tons per 1 HY', uAz. INDIA Au

96. Quality.—The elcotrodeg shall bo uniform in quality ond when uæd in 00- oocdonce with the appropriate instructions of the Manufacturer shall be capable of flowing freely and smoothly without producing nn undue umount of 't under cutting in the parent metol adjacent to t,he wcld

97. Covering—-(a) Strungth.—Tho (overing shall be guffciently robugt to with- stand without, clama,gc the normal conditions of transport, 8toroge, handling and use to which the electrodes ore to be subjectcd. (b) Uniformity.—The covering Nhall be substantially unifoyn in out, ido diameter throughout its length ond shnl] fusc evenly. (c) Stability.—Thc stability of the covering shall be such that if the electrodes are stored they gha,ll, after a period of thrco months, be capablc of giving results 8imilor to those ot the dote of despatch from the supplier. (d) 8torage.—The requiremonts of paragraph (c) obovo shall apply only if the electrodes have been kept in their original packages in on enclosed dry storeroom

98. Moohaniool properties of All-weld Metal test pieoes.—The mechanical pro- pertieg shbll be determined on olLwe]d-metBl test gpecimens followe : (o) Tensile Test.—The tensile test Bhall be made on a specimen having a gauge length of 3 •54 times the diomot,er of thc test, piece. The ultimote tensile stress, elongation ond reduction of areo of tho deposited metul BhB11 be not leB8 thon thc figures given In the iob]e. (b) Impact Test.—lmpaot tests shall be made on a three notoh epeoimen. At 1068t two of Lhe three values obLBined shBll be not less than that given in the tablo. Ultimate abregs (tong per eq. in.) min. 28 Elongation on 3 • 541) (per cent.) min. 20 Roduction of Area (per cent.) min. 35 Impact Value 30 ft. 1b

CHAPTER 11.1 CONSTRUCTION AND WORKMANSHIP GENERAL 99. Preparation ot Plates.—With (he exception of gussct plates, which may be eheorcd, thc edges of 011 platea ond buijL Straps sholl bc planned or machine gag cut to an angle of' opproxilna,toly 800 with (Jhe surface of the plate

100. Annealing after working in fire.—All steel plates which are welded, dished, dunged or locally hcatccl shall be ufterwordB efficicniJly gnneuled

101. Minimum thickness of boiler shall be than inch in thickness.SHELLS, ANGLE RINGS, BU'.I'T STRAPS, ETC

102. Cylindrical Shells.—Eaoh ring shall be bent while cold (o cylindrical forh to the extreme ends of thc plate. Tho bending shall bc done entirely by mgwhine and *heatm.g or hammering is prohibited.

108. Posidon of Longitudinal 8eamj.—Each ring of plata föü:nfn.g the Ehen, barrel or drum shell, where practicable, be in onc Picoe and have its longitudinal geom well out of line with those of thc adjoining ringN. In Lancashire, Cornish, ond ot,hcr typeg of boile:y, Lth of the are cxpoged to flame, the longi-tudmal qeam* shall, where LT in the steam e. arrn,ngcd on eaeh gicle of the crown ancl oleor of {Jhe brick work

104. Circumterential and End The strength of the joining the end plate• flat end Lancashi]e Cornish boilers With the cylind) leapi shells (enl„ of the strength of thc calculated Chieknc ss of the shad-I he not, than 38 per 'The 8tT engt,h of the inl ormcdißte *earns of flat fcnmd by Equal (l), ended boilers and all of dish ended boilers shul] be pcr cent of that oc the longttud_iJlRl sea my but in no cUs(less than 42 per (ent of the strength of the col- cnlaied thickness of the plate.(b) In boilers of other types thc strength of tho circumferenti&bl and transverse Beamti Bhbll be not less than 38 per cent. of of calculated thicknesg of the plate ag found bv Equation (l) and not lega than per cent of thot of the longitudinal gemns whichever ig the greater. (o) When (hc shell plbtc thicknega exceeds 11/16 inch the intermedil)te cir- cumfercntlal Neame, shall be double riveted. (d) In the cnse of thc electi ode bode] * where thc (I-lan_neteT of the shell doen not" expec d 18", the end p]atFN Inay be attached to the shell bv means of Electric Arc fillet I'll ng provi(lcd the welds n,re stress relieved and the cubicul copacity and worloug preqsure (Io not exceed 30 gallons B,nd 120 lbs. respectivcly

105. Angle Rings.—A-ngle rings for tho atta,chtuent of end pliites to 8h011 plutos and flue qectlons shall be rolled or machined so thot they fit ologel.y to the flat and surfaces to bc connected, ond Bhnll be machined or machine gag cut on thc ennlkmg edgeg

106. Thickness ot Shell Angle Rings.—Where shell plutcs and (nd :plaics are connected by ynea,ns of an external angle ring, thc ongle rings shnll be not le*S in th1Cknoqg i han ag followg (l) For *hell platcg up to and Including 5/8 inch in t,hlek-neptg (2) For Bhell platea exoacdlng 5/8 h thick. and upto and Inolndlng 1 Inch thitk• negg. (3) F 01 pln,teg over 1 ineh in thieknogg IO per cent In excegg of the thickneas of the ßhell plat". 90 por cent of the thicknegg but not t ban 11/16 Ilit*h. Mude from anglo bar having Nöction thickness of 1 Inch. (a) Exccpt ng provided for in Chapta V end in 107. Welded Shell Plates. Rogulotion 112, where longitudmbl scams orc welded dhe wold shall bc entirely cox erecl by u, buf,t strap or butt Htraps securely riveted to the shell. (b) For Bma,ll stcam dorncg when the welding is done by hnmmcr ancl the plates (Io not exceed inch in thickness butt strops may be omitted. (c) The strength of the weld covered by butt Htrapg Shull be osaumed to be 50 pet emit of thot of the solid plnte. The thickne88 of r-b single strap or combined thi(of double strap* ahull be not, loss thun tho thicknenr of the Bhell plate.

108. Seou.—The longitudinal Bhall be butt'.jointed with double straps when the diometer or Working Precure exoeedg the limits 8tbted below Type of Boiler Loco Vertical Other Type When diameter exceeds Feet. When Working Preasure oxceødB Lbs. 200 80 109. Butt Strapg.—Butt straps Bhall bo out from the Ehcll plafis or, ultcrna- tive]y, 81.1 the butt straps of euch required thickness shell be out from one plbte. The lengths of the strapd wherever practicable gholi be transverse to the dilcetion of rolling of the plate. Straps shall be pressed or bent in rolls to thc shell curvature. .110. Thinning of Butt StrapB.—Th-inning of tho (ndB of butt tuck under shol] rings, Bholl be done cold by machine ond not by heating or hammering. 'The shell plate shall be notched out to reccivo the thirmed end of the butt strop, so that thore shall be no undue thinning of the butt strap, 111. Alternative AFI an Io the tucking of buti - *trap ends under the Shell rings, the ends may be terminutcd at the edge cf the shell rings or cndB und electrically welded thereto

112. LOBI Welding Of Butt The ends of longitudinal butt soums of "hell rings ma,y be welded for length not exceeding three timos the overlap ot the oirctunferential geom, provided the butt etropa are run a8 closely as procticoble to the circumferential scum.(b) Only rnetal arc welding of the butt seams of shell rings shall be permitted

113. Flat F,nd The ond ploteB of boilers shall preferably bc in one piece made froyn one rollcd p ate. Alternatively, the end plates Shull be bunt up by butt-welding two pieces. In the latter case the line of

welding Bhall be parallel to the horizontal axis of the boiler and Bhull run through the centre line of furnace or furnaces of Lancashire boilers and between two rows of stays of murine type boilcrs. In the cusc of flat end pl&teg the fusion welding, shall comply with stress relieving requirements oncl in the cosc cf dished end plotes the fusion welding shall be sub- ieotcd to both strogs relieving and rodiogrophio exaniinbtion. (b) The peripherml flonging of end plutes gholl be donc by machine. Such flanging shall prefcrubly be clono in ono operation, but where th1S is im practicable seotional or creep •machine flanging may be perrnitted, pro\ ided that the plate iR worked at a suitbble tcmperat,urc, and the plate is hc&ted to un aclequu,te distance beyond the portion under immediate treatment. (c) mugt, be tilkcn to see thot the flanges orc circular und of good gurfa.cc, free from local irregularities, and thot they are parallel square with the ßRt port of the plot,e. For thc purpose of relieving internnl stresses, 011 which hove been flunged or locally heated Bhnll afterwords be efficiently on-nealed unless during the laet stage of manufacture they hove been uniformly heu,ted througb- out. (d) Flat portions of end plates, on completion of all flanging end machining operations, shall be flat and free from set or distortion.

114. Strengthening of Flat End Plate Lt In thé End Plated of Lonooshire Boiler type the mudhole in the lower part of the front end plate Bhall be fitted with B dunged riveted strengthening ring, the thickness of the flot portion of which shall be not, leu than (1 •5 TX 1/8 in.) where T equals the thicknegs of the end plate in inches. (b) In boilers 7 ft. 6 in. diameter ond obove, the mudhole frome Bhall be fitted Vith a, peak to reinforce the portion of tho end plate between a,nd below the furnaces, and this peak shall be securely riveted thereto with rivetN of similar pitch to the Temoinder of the franne. (o) In all cases; the front end plate gusset stays below tho furnoces shall be placod as closely possible to thc mudhole flibme. (d) Where flEbt, end plutey are flonged for eonæction to the shell, the Inside of flamging shall bc not, lesg than •75 times the plBte thicknesa, with minimum of 1} In

115. End Plates in steam spaces.—Whøn the end-plates of boilorg situated in thc steam spuee n,re liable to contact with hot goses Lhe end plotes shall be em- ciently ahielded from Nuch coni,bQt

116. Hemispherical All sogmentB *hall be pressed iu one hebt to qcorreet curvature.The acljoccnt pluteg Nhbll bed 010301y at the seams and wherever poygible at the junction of two seoms tho pla,tea *holl be mochined down to provide fair gurfbce to thc joint. [f the thimung is (lonc by hoo+ing oncl hammering -the plote *hall be subsequently annealed. (b) The cylindräcæl portion of the crown shall be tangential to the hemigphericol portion bnd filo truly to the shell. (c) Where henliqphericol shell crowns ore preaged from one plote they Shall be prcB*ed to form by mochine in progressive stbgeg without thinning and on eom- •pletlon shul-I be annaled

117. Dinhed End and Crown The inside radius to which a is dished shall not be greater than the externol diameter of the shell to which it ig attached, except In the case of Lancashire and CormBh boilers when the radius Bhall •not exceed times the cliometer of the ah 11.(b) Thc inside radius of curvature of the flanges tc the *hell or firebox Nhall not be loss than four times the thickness of the crown or end plute uncl in no cue lou -thbn 2å inches. (o) Thc inside rulius of ourvæture to uptBkeB *holl be not legs than twice the thickness of the crown plnte and in no coge less than I mch. (d) Bunged mouth-pieces may be welded on to end plbteg 111 place of the ortho- 'dox flimsnng for the ment of furnocc tubes. Sueh welding shall comply mith provisions of Regnlbtion 125. (e) M8,nholc frames rnoy be gimila,lly on the front end plotcs, and 'be subject to osnsiong of Regulation 125

118. Tube Plates.-—Smokebox tube plateg shall bs flanged for attachment to the ebarrcl or Bhull be flot und conueetecl thereto by external riveted ongle rmg

119. Parts the Smoke Tube Plates within the tube Where the total urea, of' all tho nbc ne-,tA exceeds 7 sq.ft . stn,,y tubes *11811 t)L3 fitted within the neqtg. her e 8tay tubes are not] thc-i of the tubes *11811 be beaded or boll mouthed. (b) 'Phe of tube plates which 110 outside the nests of tubes shall be stayed or Bupported wherever the Size of the arca, of ploto subject to stcam pre4sure neces- sit,liteg *toying or support, either by marginal stay tubes or other Ineong

120. Flanging End Plates.—All flanges shall bo good fit to the Nhell ond flues. Floggtng a,ndlor h unmering in the fitting of these purtB is prohibited. Tho •caulking edges of 011 flanged plates Shull be Imghined or machine guy cut. FURNACES 121. Furnaces in No furnaco or firebox top, whether plain or corrugated, Shull cxceed 7/8 inch in thickness, and all cixcular sectioned furnaces when new Bhall be near

the truly ej rcular form as the typo of joint will permit. (b) The use of Z angle rings for furnace foundation seams shall be prohibited

122. Furnaces Of Horizontal Thc sections (if' (he into nal flues 8ball ea,ch be in one plate and Bhall Le bent while cold to circular form and shall be welded longitudinally.(b) The maximum permissible variation in diameter ot any crogg section Nhol.l not exceed the thickness of the plate. (c) The wclds Shall be placcd at tho lower part of the flues, and Bhall break joint in successive sectione by ot least 12 inches. (d) Each flange for the circular geoms Bhall be formed at one heat by suitable mochinery. (e) The sections shall be allowed to cool gradually to ovoid internol stresses. (f) The caulking edges of all fluo flonges Bhull be machined or machine gag cut. (g) Thc circular seams shall be arranged so that they do not full in line with those of the adjacent flue or with the circumfcrentiul geoms of the shell and are least 6 incheB apart. (h) When flues are flanged for ottuchmcnt to both end plates tho total longth of each completed flue Shall not excecd the length of the shell measured from the inner eurface of thc back end plate to the in-nor surface of the front end plate, both ad. jocent to the shell. (i) Where the flues ore flanged for attachment to tho end plates, the end geo- tions shall be 1/16 inch {hicker than the remaining sections, except in cases where the calculotcd thickness is over 13/10 inch, when the end* sections shall be 7/8 inch in thickneBB. (j) Tho flanged portion of furnace rings shall hove a radius of curvotive Of not less than 1 inch on water Bide. (k) Seotl ona of corrugated flues may be fusion butt welded circumferentially and Oftcrwords stress relieved by hebt treatment

form in o similar man-nor to the shell plates.(b) Circular furna,ces shbll preferably be tappered, toper of 1} in. in diometer per 1 foot of height being recommended. The minimum water sparo at the bottom between the furnaecs and tho shell shall not be legs than 2 in. for boilers up to 2 ft. 6 in. in diameter and shall be not less than 2} in. for boilcrg over 2 ft. 6in. in diameter. (o) Where hemispherical furnace crowns ore pressed from one ploto they shall be pregscd to form by muchine in progressive stages without thinning and on com- pletion Bhall be unnealed. (d) Ogec flonging where integral with thc firebox or in o scparote ring shall prefcra,bly be formed at one heat by suitable machinery and Bhall be allowed to cool gradually to ovoid internal stresses. (o) Furnaces of vertical type boilers may be attached to the shell bt the fire- hole by solid rectongular section steel ring riveted together or by a, circular ring of substantial section fusion welded to shell and firebox. Where the latter cons. truction is employed the opening in the shell for fireholc Eholl bc substantially com- pensated by o ling welded on the outside of the shell plate. (f) At the firehole the firebox plate gnd the Bhell plate may be flanged und fusion wcl(lccl together. gøo. 8] THE OF INDIA EXTRAORDINABZ 640 124. Longitudinal Seamg.-—The longitudinal sea,mg of furnaces may be either : (o) Forge Lop Welded. (b) Fusion Butt Welded. (c) Riveted. Longitudinal seu,ms of furnoces exceeding 3/8' thiokneBB shall not be riveted

125. Fugion Welded Longitudinal Seams.—Where the longitudinal Neam is fudion welded tho following precoutiong shall be obscrvcd (b) Pliites over 5/8 in. m thicknesB shall be bevolled from both *ides of caoh Obutting edge, but the bevel need not nccesaarily be the same on eoch Nide (see Figs. 1 ond 2). Plbteæ less than 5/8 in. in Lhickneys moy be bevelled from ono Bide only of each abutting edge (goe Figs. 3 ond 4). The mcluded ongle of the bevel *holl be not, less thon 600 ,nnd Lhe 'nevelling may be any one of thc forms Bhown in Figs. 1—4. rig. 1. ir*d.ng mote t, n part of tube Odon o.} mg

5. Fusion Welding o! Cross Tubea o} Vertical Orog Tube Boilers.(b) In ordor to obtoin full penetration of the weld metol a gap be main- tained between the plates when they ore being welded. Joints Nholl be welded from both Bides, and the Alag Shull be removed after making each run. Before THE GAZETTE, OF INDIA EXTRAORDINARY [PART 13 the aocond side of the joint welded uny slag 01 defect at the bottom of the first run shall bc ed by grinding, chipping or machining, There shall be no appre- ciable undercutting of the plate. (c) For the purposc of relieving internall estrcsFe8 the plbtes adjocent to a fusion weld 8h&ll be em eic•ntly annealed after Mreldiug, and when the firebox forge,weldecl it should be allowed to cool gradually

126. Furnace Tho ful nace crown heum Bhull not full in line with ony Oiretnnférc•ntiol of the boiler shell.(b) the furna,ec crown n)H.y be riveted to the vertical portion of thc ebox, or el.y. the ioint muy bc fusion buit welded by the electric are proecss, pro. vided the conditions as to fusion welding in Regulation 125 are observed. Where the joint IS t.0 welded the edges of tho furnocc crown and thc firebox body shall accordancc with -Fig. 3 OT Fig. 4. Fl'hß depth of the flangc of the be bevelled in furnace ernwn plut(from the conunenoemcnt, of tho curvature of the fanging radius shall be not les> than four times thc plate thickncss M,ith minimum of inches. On corn pletion of M elding {he m cljox sholl be effectively stress relievcd by heat 128.) 127. Cross Tubes.—(a) Cross tubes shall br jnade from weldless stoel tube or from plate or strip rolled and forgo water gag welded. Where welded tubes are used the longitudinal welde ghall be so situated that they are not exposed to the direct impact of the flame. (b) The minimum thioknegg shall be 5/16 in, (c) Where croc tubes are flanged and riveted to the frrnaoe, the flanges Bhan be get to the curvature and toper of the furnace, and Bhall be a good fit before rivet- (d) Wherc welded comtruction iB employed the tubes shall be of sufficient length to enter the furnace plate and be flush with the wafer side all round or project not more than 5/8 in. into the water space at any part of the circumference. Where the tubes are fueion welded in position, the firebox plates shall be suitably ohamforod and the jointß shall be welded extornally and internally (Bee Fig. 5)

128. Thc upi shall be formed from weldless, forge wat+r gag welded or fusion butt welded steel tube and Bhall be securely riveted to the fur.nace crown plate and riveted to the Shell orown plate. (b) AB an alternative to riveting, the uptake may be fusion butt welded by the electric arc procegg to the upward flange of the opgnmg in the fire box crown plate provided the conditions ag to fugion welding in Regulation 125 are observed. The edges of the upward flange and the adjacent end of the uptake 8ball be bevelled in accordance with Fig. 3 or Fig

4. The depth of the crown plate opening from the oon:unencement of the curvature of tho flanging radius Bhall be not legs than twice the plate thickness with a minimum of 1 inch. On completion of welding tho uptake and crown plate Bhall be effectively streu relieved by heat treatment. Where the firebox crown plate is algo fusion welded to the body of the fire. box, the firebox complete with uptake shall be effectively gtregg relieved by heat on completion of the @) Welded uptakes gholl be go arranged that the weld iB directly facing the longitudinal centre line of the manhole

129. LOCO Type foundation htwm Bhall be of rivetl(l con- ztruction but all other seame may be welded subject to the depth of the flange being euch that the welded seams fall between the 18t and 2nd rowe Of screwed "ayg or between the flange and the adjacent row of gorewed stays.8ß0. 8] GAZETTE OF INDIA EXTRAORDINARY (b) The firehole mouthpieec may be Bimilarly welded when the firebox and 8hell aro flanged for the purpose. (o) The welding Bhall comply with Regulation 125. STAYS 130. Bar gtayg.—Bar stays shall not welded nt u ny part. gluall. pre. ferobly hove plus threads, tho ends of the stays being upset or the middle portion being reduced for this purpose. Stay bars v, hich have been worked in thc fire shan be subsequently annealed

131. Longitudinal Stays.(a) Longitudinal and sinnltll solid d stay shall be efficiently scoured with nutg ot each end and not Inere)y riveted over. Where they are over 12 feet in length, they shall be supported at intervals of 6 ft. along ite length. (b) Where the stay is screwcd through both plbtcs, the stay and holes ghan have a continuous thread and fitted 141ith nutg ancl ashers on the outside. Whort• the atuy paN,ses th rough clearing holes nn internal nut and Nhull also be fitted. Where the stay is not normal to the gurfucc of the plate the washers Bhall be shaped BO to form a truc surfuec for the nuts or a knucktc joint may be fitted. (c) In vertical boilers the stays shall cither be ecrewed into both crown plates or screwed into the fnrnoco crovvn plate and passed through clearing holes in tho shell crown plate

132. Nuts and Waghere for Stays.(a) 'l'he washers sludt ut (irnes the diometer of the threaded portion of the stay and not less than 1/4 in. in thick. ness. (b) Thc thicknces of the external nuts Bhull be at least equal to the diameter Of the threaded portion of the stay. Where bar stays pose through clearing holes in end plates, internal nuts of a thickneea not less than t," o-thirdg of the cli-umet.,er of the threaded portion of the stny Bhall be fitted 133. Jointed Stays. —WII'11'ft longitlldlflßl gta.) i hoy shall, where practicable, be fitted Mith pins having an effective sectional urea 25 per cent. in exoese of thot of the stay. If the pins ure slack in the holes, the total Bluoknese Bhall not be more than 1/10 inch. The pins shall be as close us possible to tho Shoulder of the eye forging. The shoulder of the forging shall be at least 1/2 inch wide ull round, i.e., the diameter ut the shoulder shall be not less than the diameter of the hole plug I inch

134. Diagonal bar or rod stays.— The sectional of diagonul rod or bar Ntay shall bear the same proportion to that of a direct Stoy as the lcngth of the dia- gonal Stoy beare to the length of the perpendicular line from the end of thc diagonal stay to the surface Bupportcd. Thc ends of diagonal stays, shall not be bent, but shall be attached to the plate vrith bevelled washers and nuts or with riveted tee, blockB or angles and shackle ping (see Rogulbtion 133 for eyes ond pins). SCRN.,VEI) STAYS 135. Screwed Screwed st.uyr•ö and the holes for these shall be screwed with o continuous thread. (b) The screwed threads of the stay Shull be Cleon, froe from checks or imper- feotions, 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. (o) The stays Bhall be Bcrewed with fine threadg of not less than 11 threade per inch. 646 THE GAZETTE OF INDIA EXTRAORDINARY (d) The ditmeter Of the stay over the threads shall not be legB thon 3/4 in. or twice the thickness of the firebox plate whichever the greoter. (e) The pitch of the stays at the furnace of vertical boilers shall not exceed 11 timos the thickness Of the furnace plate. (f) W hero tho stays orc not fitted with nutB, the ends Bhall be riveted over to form substantial heads. (g) Crow-n stays of Loco Type boilers shall either be fitted witb nuts or riveted over on the fire side

136. Axial drilling,—A)' ed Stays less than 14 in. long Should be drilled with a, tell-tole holo 3/16 in. diumeter to a depth of 112 in. beyond the in-nor face of tho plate. Stoys which are obgouro on one side should preferably be made from hollow Btaybor. 137, Stay nuts. (a) Nuts to serow stays in corn bugtion ('humbl and hreboxcs not bo less than 3/4 inch thick for 8t0YB up to l} inches diameter over threads, 7/8 inch thick for 1-5/8 inches ond l} inches gt0YB, I inch thick for 1-7/8 ond 2 inohea stays, and 1-1/8 inches thick for stays over 2 inches in diometer. (b) The nuts shall be made of solid mild steel or of iron which gholl be without weld if exposed to flame

138. Spacing of end gt8YB—Allowance for curves, etc.—Fol fireboxes ELIM-I cornbustion ohombors the distance between the rows of stays nearest to the tube plate or firehole plate or bock plate os the oase bo, and the oorumence- ment of curvature of theso plates at their flanges shall not be greater than the hori. zontol pitch of the stays. GIBBER STAYS 139. Girder Stays tor Firebox and combustion Chamber) h. R)ldfrr when of the normal type, fitted with Stuy bolts and nuts, shall be of the double plato interconnected type of snmcient strength to support its proportion of the load on tbe crown plutc independently of tho crown plate. (b) Tho clear waterway bctween the crown plate and the underside of the gfrdor bors Bhall be as Inrge as practicable but in no case less tha,n 1-1/2 inches ae (c) The ends of the girders shall not rest on the landing of the flat crown plate but shall be carefully fltted to bed directly on the bends of the corners of the vertical end or Bido plates. (d) 'I'he tocs of the girders shall bo solid with the girder plates and not separate pieces uttaehed thereto. (e) Girderg shall be properly attached to the crown plate by bolts or sorews. N0TE.—Æternative methods of staying may be used, or umtayed firebox, orowng of special or patented design of equivalent strength may be fitted. See Regulations 230, 2.31 and 232. (f) Where on ull welded firobox ig fitted, the girder stays may be welded to the firebox prior to stress relieving. The girder stays Bhall be recessed for waterways ag in paragraph (b) (Figs. 6 and 7). Such girders shall be securely welded by an approved method to the firebox crown. The method of welding ond the proportions of attachment Bhall be to the satisfaction of the Inspecting Authority. THE or INDIA EXTRAOM)INABE Not less than Fig. 6 Gü8sET STLYS 647 Gusset plntos hhnll bo flat, and perpandiculor to tho 140. Gusset Stays. mend plot,cs. The gusset anglos Bhall be fitted to bed closely to tho Shell end ond gusset plates. Cranking or setting of the plates is prohibited. (b) Gusset stays, where fitted, Bhall oornprise flat plates secured by double anglee to the Bhell and ond plato respectively, and shall be dosigned in oocordance with the following conditions 141. Breathing Space. (o) Gusset siu.yg shall be arrangod us i allow Buffoiont breathing space around furnace connections and tube nests. (b) For Lancashire boilers the proportione shown in the table below are ro- oommendcd for the portion of the end plates above the furnaces and flues Tbicknogg of end plates in. 13/16 Above 18110 9 10 11 12 10 11 12 18 1.3} THE GAZETTE OF INDIA EXTRAORDINAay Fig. 8 [PART 11 (c) Fig. 8 shows the breathing space rccoznruended for the following condi- tions : Flot end, furnace or flueg flanged for attachment to end Plato, furnaces and? flues formed with Adamson flanged geanjg, (d) Fig. 9 shows similar conditions to Fig. 8 except that the end plate is flanged outwards for tho furnace or flue ring connection, the breathing spaces allowed being 1 in. more than those for the same thicknegg of plate in Fig. 8. (e) Where a corrugated section not less than 6 feet long iB included in each internal flue of a, Lancashire boiler, the dimensions given in tho tablc above may be reduced by approximately in. throughout. (f) It is recommended that the breathing space below the furnaces and flues' Bhall be approxirnately one half the dimensions given in the table above. Where it iB desired to use any other urrangement which gives a greater or lens degree of exibility, the aanount of breathing gpnce shall be specially considered and modified 8.8 the necessity of the case requires. (g) For gusset stays above tube neEtN, as fitted in wasto heat boilers without internal furnaces, a breathing space of 8 ilichcs from the contre linc of the top tubes to the centre of the too rivets of thc gusset ungles is recommended (see Fig. 9)

142. Guoeet8 ngleB.—Thc gusqet nnglcs connect ing the hta,) s tho shell and end plates shall bc ut least 718ths of thc thickness of the-shell plate, but shall be not legs than 1/2 in. in thickness 148. Load on Guwet Stay.— -ERf\h_ gußset Ntny suppol'(the end plate of a boiler Bhall be designed to carry thc wholo loud due to pressure on the urea supported 144. Gusset Riveting.— (L) 'M. curing gusset *hull be not JeBB in diameter thon the thiokness of the cylindrical shell plate and the riveting Bhall be arranged 80 that the strength of the shell plate whero drilled for the gugget rivets Bhall not be lega than the strength of the longitudinal seams, (b) Not less than three rivets sholl be used to connect any gusset plate to any ongle or ony angle to the end plate or to the shell plate. BOILER TUBES SUBJECT TO EXTERNAL PRESSURE 145. steel and Wrought Iron Tubeg.— (a) Both plain und tubes may be made either of wrought iron or steel and may be either lapwelded or weldlegg. (b) Tubes may alB0 be fabricated by electric resistance welding from strip plate. Thig may be accepted for temperatures up to 7500 F and preæur€8 up to 840 lbg.(sq. in

146. Pitting Plain stay tubes arc not fitleci, tho end8 of tho tubes shall be beaded over at the fire box end and beaded or bell.mouthed at the other end. If bell-mouthed the tubes Bhal protrude not lees thun inch the tube plate. GAZETTE OF INDIA EXTRAORDINARY 147. Screw Threads ot stay tubes.— St ny

tub(N shall be scrÄwed ot both endg with oontinuous threads, and the holes in tho tubo plates shall be tapped with continuous threads. The pitch of the threads shall not be finer than 11 threadg• per inch. The stay tubes shalt be cxpnndcd by roller expanders and not mode tight by caulking only

148. Minimum thickneB8 of stay tubes.—The minimum thieknesH of tubes in the body or at the ends under threads shall not be legs than 5132nd* of an inch. If stay tubes are rcquircd to havo their 149. Thickened ends oi stay tubes. thickness increased at, the screwed ends BO that the thickness at the bottom Of the threu,cle iB approximately the snme 8s in the body of the tube tho thickening Bhan be attained by upsetting and not anv welding proeeas, and the tubes shall be an- neoled after the upsetting. (8) Stu.) tubt s shall be (IF eignc,cl to curl y t be whole 150. Load on stay tubes. Load due to pressure on the arca to be supported In each cage the areog to be cal. culoted as follows : (b) For a stay tube within thc tube nest the net oreo to be aupported shall be the product of the horizontal and vertical pitches of the stay tube legs the area of the tube holes embraced. Where the pitch of the stay tube is irregular tho oreo shall be taken as the square of the meun pitch of the stay tubes (i.e., one-quarter the gurn of four sideg of any quadrilateral bounded by four adjacent stay tubes) legs tho urea of the tube holes embraoed. (c) For a stav tube in the boundary row, thc net area to be gupported Bhull be the areo enclosed by lines passing midway between it ond the adjacent points of eupport less the aren Of any tubes embraced. Tho adjacent points of gupport may bc stay tubeg, or the connnencement of curvature of flanging of centre line of t he circlc of rivets securing the end plate tu thc 8bell angle, BOILER AND SUPER HEATER TUBES SUBJECT TO INTERNAL PRESSURE 151. Steel Tub". (a) All tubes which subjeet (o infi rnul pressure of wafor or steam shall bc cold drawn or hot finiBhed seamless in accordance with Regula- tiong 30 to 56. Except aa idecl for in sub-reg. (b) below they Bhall be without joint. (b) Tubes having an external diameter not exceeding 5 inches may be jointed and such joints may be flash welded, machine forge welded, aro or gaB welded. (c) Flush welding shall be undertaken on a welding machine of b type approved by the Inspecting Offcer and the external fin caused by vvelding shall be completely removcd. The internal fin caused by welding shall also be removed Nubjeot to maximum height of 20 per cent. of tho wall thickneag of the tube. (d) Aro welded butt joints 811011 be mado by the metallio abiolded aro• process. (e) When gas welding is employed the technique followed shall be opprovedd by on Ingpecting Offoer and all welds shall be suitably heat treated. (f) For design steam temperaturea over 8500 F the material to be used Bhall be fn accordance witli Rags. 48 & 53

152. Attachment Of steel TubeH be connected to the tubfh plates by one of the following methodB (l) Expanding.(2) Strength welding. (3) Mechanical bolted ball joint. 050 THE GAZETTE OF INDIA EXTRAORDINARY [PABT 11 (b) Drift or roller expanded tubee shall project through the neck or bearing •part in the holes by at least quarter of an inch ond shall be secured from drawing rout by being bell mouthed to the extent of 1/32 M for each inoh in diameter plus 2/32". (c) Tubes moy be geal welded into fittings or headers for both boilers and •uperheotere after they hove been expanded and flared provided the material in the fittingg or hooders doeg not contain carbon in excess Of 0 •35 per cent. (d) In the cage of drifted or roller expanded tubes, the tube holes in tho tubee plates of drums, pockets, or heuders shall be formed in Buch a woy that the tubes can be effectively tightened in thein. Where the tube ends are not normal to tube plate, there Shall be a neck or belt of parallel geoting of at least 1/2" in depth measured in a plunc normal to the n,xis of the tube at the holos. (e) Where the tubes ore strength welded direct to the tube plotee, the technique followed shall be approved hy the Inspecting Authority and all welds shall be suitably heat treated. (f) 'I'ube *pacers, supporting clips uncl lugs muy bo welded to the tubes. Flash welding of studs for supporting refractories, etc., is algo perrnissible. (g) The tubes shall be go arranged that they uro accessible for cleaning internally and externally

153. Copper tubes.—Cop1) tub(up to one inch in oxternu[ba used for small boilers ; *euoh tubes shnll be not less than 12 s.w.g. thiok. HEADERS, MUD BOXES, ETC., OF WATER TUBES BOILERS of water tube boilers rnay be of solid drown 154. (a) Headers, rnucl boxrch, r e. , Or wc[ded steel, or of cast stcel ccnuplying with thc requirements of Regula,tionß 73 to 80. (b) Each piece prior to being fitted in place Bhall be subjected to hydraulic test to double the working pressure of the boiler into which it is to be fitted. For pressures over 1000 lbs. per sq. inch, the hydraulio test pressuro Bhall be the permissible working pressure plus Ibe. per sq. inch. (c) (i) the sighting hole doors shall be gubstantial and capable Of being removed and replaced from ti-lno to time without loss of efficiency or safety. (ii) Tho bolts by which they are held in place shall be fitted to them in such B woy us to satisfy the above conditions. (iii) The

doors Bhall be so designed that they will not blow out in the event •Of breakage of the bolt. (iv) Circular holes also may be providcd in addition to elliptical holes, if pro- vision is made to prevent the door bolts from turning, while securing tho joint. (d) All flonges Bhall have o fillet with a radius Of curvature at least equal to the ,thicknegs of the neokB to which they ure attached. STAN) PIPES, PADS, ETC

155. Stznd Pipes and Pads.. -Stand pil)e8 and seatings for cerrylng mounting •ghall be made of wrought, east or fabricated steel. Where pipes are fabricated 'by welding they shall be stress relieved. These Shall tako the form of short stand pipes, pressed steel plate gaddles, forged pada or podg cut from round rolled may be most convenient ancl secured to the boiler by rivoting or welding. Where short stond pipes are used they shall be of solid forged, fabricated or cut steel. They •dhal-I be carefully bedded to the shell before ottachrnent and where riveted the rivets shall be so pitched to ensure tight joint. The jointing faceg to which aountingg are to be bolted shall be machined. Padg Bhall have gumcient thickne 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 pod Bhall be not legg thon the diameter of the stud

156. Design of Stand Pipes.—Whero short stand are used, the bolting flanges Bhall be forged solid with the bodi0B or attached by combined screwing and welding or by welding alone. The thick-negs of the gtand pipes Bhall comply with table below:— Maxi :rnurn porn-ÜR81b]e working prest3urt38 lbs. per eq. m. Upto 150 Flange adjoin* Thi ing B ody drum Stand pipeg bore Pressed saddleg 157. Plate Saddles. Above 150 & upto 250 Above & upto 350 lölFü,ge adjoin- drum Thu 1,- Bodv Flange adjoin- drum Thiok- negs Body Above 360 & upto 600 Flan$ Th Ok- ness Body —Where pressod ploto saddles are omployod they Bhall be formed to bed ologely to the boiler, and be machined on the face jointing the mounting and on the edges. The studs for the attachrnent of mountings, if' screwed through the saddle, Bhall each be fitted with o nut on the inside having o. •thiokneßß equal to the diameter of the Btud. Where the etud holeg do not penetrate 'through the gaddle, the length of the screwed portion Of the 8tud in the plate shall not be legs than the diameter of the stud

158. Seatings Mountingg.—For prcræsurorg not exoeeding] 25 lbs. par xq. in. mountings with Borewed endg not exceeding 1 in. B.S. P.T. may be used; the screwed portion of any such mounting being an integral part thereof and the thickness at ethe bottom of the thread being not lcss tbR)) 3/16". The mountings may be screwed : (a) Directly into the boiler 8hell plate, nuts being fitted on the waterside, or (b) Into steel distance picces the length of throad engaged being in no cage less than the bore of thc Tuounting plus 1/4 in

159. Atteohment 01 Mountings.(a) Mountings JnHiY be ad i achccl direct Io any •shell or end plate whero tho plate is of sufficient thickness to allow o suitable surfaoe to be obtained for the attachment of the boiler rnountings. (b) The minimum thickness at the holo in the shell or end plate eball be not ,legg than the thickness required for the maximum permiegible working preagure considering the plate 0B being unpierced. (c) Where the boiler mountings are secured by studs, the studs Bhall have a full •thread holding in the plate for at least one diameter. If the stud holes penetrate the whole thicknegg of the plate, thc 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 ure used for securing mountings they shall be screwed right through 'the plate with their headg inside the shell or end plate

180. Insumcient thickneBB oi End Plate8.(LI) In cases •whero the thicknet+ of the end plate is insumcient for this purpose the mountings Bhall be jointed to suitable Bteel seatings ug provided in Regulation 155. (b) The following congtructiong as to Btand pipes attached to end plateB shul-I be)permiegible:— (i) Where the internul cliR,rnetcr of thc stand pipe does not excecd 1 inch, the Ntandpipe may be screwed into the plate and fitted with a nut on the wutereide. (ii)' Where the internal diurneter of the standpipe exceeds I inch but does not exceed 2 incheB, it Inay be screwed in and seal-welded. , (iii) Where the dionaeter of the standpipe exceeds 2 inches, it mny bc welded to the end platc. The foregoing provisions us to the stnndpipe Bhall be regulated by the following conditions. (iv) When standpipes are screwed, the screwing Shall be British or Anierican Standard Pipe Thread. I (v) Where standpipes, saddles or other forms of seatings are fubrieatcd by fusion welding they Bhall be stress relieved by heat treotment before attachment to the boiler. (v;) Where the bore of the standpipe or seating ond the hole in the plate does not exceed 5 inches plus twice the thickness of the plate, the seating may be welded to the plate ithout

subsequent heat trcaånent of the weld so made. Where the hole in thc plate exceeds 5 inches plus twice the thickness of [he plate, (hc plate to which the seating iB attached Bhall be Btress relieved by heat treatment

161. Attachment of Water and Precure aouges.—Wliter gauges and pressure *auge syphons may be attached direct to the front end plates without the inter- vention of a pad or standpipe, provided they are flanged and secured by studs If the stude are eorewed through the plate, nut8 shall be fitted on the imido of the plate

162. Mountings on Flat Plateg.— -Where the flanged mountings are a,ttaohod 'direct to 8, flat plate, euoh mountings sholl be provided with substantial spigot, the full thickness of the boiler plate

163. Bolt8 and Nut8.—Bolts and nuts Bhall b mM-5hi-113d where thA.y oomo in contact with the flanges, ond all holeg in ßbddleg and pads 8holl be drilled. 011 cans where the boiler 18 lagged, the joint of tho mountings Bhull bo Clear of the lagging surface or the legging kept olecr of the flange BO that tho jount onn be impacted and, when neceæary, remade. MANHOLES, MUDHOLES, ETC. (b) Sumcient sight and cleaning holog Bhall bo providod to permit 164. Access. of emoient inspection and clenning. Such holes Rhall normolly be clliptical In forrq and not loss tha,n 3} in. X 2} in.* (b) At Ica,st one manhole or Bight hole shall be provided in the upper part of the oylindrical shell or in the Bhell crown, or end plute und this shall not be lesB than:— Boilers not excoeding 2 ft. 6 in. Boiløra over 2 ft. 6 in. diameter and not exceeding 3 ft. Boilorg over 3 ft. diameter and not exceeding 3ft. 6 in. Boilers over 3 ft. d in. diameter and not excoeding 4 ft. Boilen over 4 ft. . m. (c) Where the size or construction of the boiler does not pormit of entry for cleaning ond inspection suffcient oleoning holes Shull be provided in thc shell for -these purposes. (d) Where cross tubes orc fitted in Vertical boilers ono clcaning hole *118.11 be pro- vided opposite ot least one end of euch tube. At, the bottom of the norrow wot,er ceg at least three cleaning holes shall be provided. The cleaning holCB Shull be go arronged that thc circurnforcntial distance between then) does not exceed 3 ft. unless the foundot,ion ling is guffciently oooessible to pennill of clc•oning nnd ins. pection from the ingi(lc of the boiler. (e) Cleoning holes or mudholes in Loco Type boilers shall be providod at euch bottom corner of the outer firebox casing, above the fire hole ling and on coch side •of gaddle plate in line with bottom of barrel. (f) In the cuse of grnoll boilerg or where the foregoing provision* arc irnpruct,i- .coble the cleoning holos or mudholes shall bc n •urly us poeib13 in thc corner of the outer firobox casing and thc holes largo circunn perrn it

165. Compensating Ringg and Frames for 01)3nings in Compen- goting rmgs and frames for openings in Nhells DC of ought 01 cast stcel.'The compenyution provided shul] preferably be flan which be fitted in 011 cases where tho Bholl plato excoeclB 9/16in. th irk. Flanged frbrnes Ahti,ll be weldless ond shall be flanged QI' pressed to prcvicle u Lt for the ,oover. N0TE.—Wherevor practicable tho frames Nhonld bc secured to the ln.ßide of the shellB go d,hat, the Shortar bXi8 is parallel to the longitudinal contro Iino of the boiler. 'iæee of mudholes and Bighthole8 are 7" X 5", x and X 2} (b) All compenßbting rings and frames shall be formed to bed c]ogcly to the gur• fooeg to be connected. Where attached Io cylindrical shells ana ore 12 in. X 9 in. or larger they- shall be ut least double riveted. All caulking edges shall be machined or machine gas cut. (o) The flat jointing surfaces of all flanged (r progged frames and 011 doors or covers shall be mnehmed

166. Doors and Cross Bars.(u) All internally fittcd d001B of nmanholes, mud- holes and Rightholes Nhull be of wrought steel built up or essccl to shupe and anneal. ed or mado from onc thickness of place with a, rnachined receqs for he jointing IT) uteria,l or may be a, steel eosting. 'Their spigot part or the recess shn,ll not hn,ve a groater oleoronce than I/]6ih inch all round, i.e., the RXIS Shall noi be less than 1/8th inch smaller than the holes in which they arc fitted. The Btuds or bolt of lurge shall be scrcwcd through Lhe plates Bild riveted over. (o) Internal doors for openings not larger than 9 in. X 7 in. in size need only be fitted with one stud, which be ptovidod with an integr a I collar und screwed through the plate with o nut on the inside of the doo. Internal doors for openings not lorg«. than 5 in. X in. may hove thc stud forged solid With the door or if screwed he emciently riveted to the doors. (d) (_lross bars Bhbll be of subBtp.nt181 proportions ænd either solid steel forging or of cukåt steel

167. Raised Manhole frames and Cover plates.- (a) Raised circular manhole frames nn' xcee ding IO inches in diameter Bhall bc least, 3/4 Inchet-l thick in BII ports. 'Tho circular cover plates and joint flanges for such frames sha,ll be not lus thon : I inch for pressures not exceeding 12() lb. sq. Inch. 1-1/8 inc thick for prosaurcs over 120 lb. but not exceeding 200 lb. sq. Inch. 1.1/4 inch thick for pressures over lb. not

exceeding 250 lb. sq. inch. For pressures 250 lb. sq. inch and over ruiscd circular manhole frameH shall not be fitted. The cover plates shall be Necuuecl by nt least, *ixteen stcel bolts not legs than inch (limneter. (b) External raised ciroulor mouthpieces Bhall be : (I) formed in one piece without, welds, (2) formed ft om suitable rolled section and forge welded, or (3) fbbricgted by fusion welding provided they are stress relieved by heat treatment ofter weldill!t and before attaching to thc boiler. Wolds *Inould be positioned so that they ore located on the trousvorse centre line of the boiler. The jointing flanges of mouthpieces und covers shall be mochined on the fove ond edge and on the beut Ing *urfoce for the bolts. Bolts Rnd nutl-l *hull be much ined whcre in contact with thc flanges and thc joints *hould be formed inside ond outside thc bolts to preclude thc pogsibility of ßonge dißtortion. Cover plates shall bc dlHhed outwards to o depth of upproxilnatoly one-eight of the internal diameter of thc frame. All fromeg und mouthpieces gholl bed closely to the surfoces to which theyRare to be connected, and where riveted to cylindrical shells Shull be at least double dveted. All Coulking edges shall be rnoehined or machine gag cut. •SEO. B] GAZETTE OF INDIA EXTRAORDINA±Y 666 168. Position of Manhole in Shell.—Manh0108 in oylindrioml shells shall be placed fa,r as possible frorn any riveted sea,ms, pretorab]y town,rd8 (he book end of the boiler top

169. Compensation Rings to Manholes. Componsation shall pr. ovided' in every case for the part cut out or R, Bhcll for u Illu,nhole. The Ntrength the net qeetion of eornponsatjng rinc•• u,J1d of the rivels securing it to "hell pared with that Df the part Gf shell cul out shn]l not ho IONS than the sti ongth loogi-tudinal (b) Thc spacing of the rivets shbll be not to reduce the of the Shel! plate below that of the longitudinnl seams

170. Compensation for cutting large holes in shell Type Boilers.-- Where holes ore cut in the cylin(Irical Bholl for the purpo,ye of oti,uching R, seating, trauno or door, compemsati011 shotl be provided such that thc added Bectional n,rtb, including porte of the frame within 4 inches of the *hell ancl excluding rivet holes, sholl be not, lexe than the gect,iontbl toreu of the plate removed which Nhull be thc produci of the dio- meter of the opening ond tho calculated thickness of the phåc• found by Equa• tion l. Where holes a,re cut in tho cylindrica,l shell for the purpose of' fixing Ebt,ing for mountings und the diameter of the holed iH greater l,hun 2• 1/2 times thc thickness of thc shell plate plus '2' 3/4 inches, compensul,ion gha,ll bc provided. Where Ibrge opening is rut in a, cylindricul shell to reeeivo another port of the structure, the side* where cut uwoy Nh oll be efficiently cross staycd or Strengthened in qorne other effective 'nunner

171. Rivets gecuring compensating Rings and Stand Pipes. For nmrliholes or tot±hl effecLive shear strencth of the vets on Bide of the centre line shibll be not loss than the tensile streug(h of that pox tinn of the hhell Dound by Regulation 170, Thich is renlove(l und the rivets '4 •eurin',,f nny cmnpemat,ing ring or fr•n.ltle 8hB,ll bc so a-tanged thu,t JOtnt •effeiency ealeulatecl on any line parallel the axis of the boiler through any Pint of such ring or frame shall not be less thon i ho effciency of the Of the boiler. For Stu nd. pipes.—Whcrc the hole in the *hell to oceornmodote u Stundf)lpe (loes not exceed 8 inche* (liumeter, the total shca.r strength or t,hc rivets un en,eh ccntrc linc shall not bc Icqg thun 75 per cont. of thw tenqi Atrc•ngth nf the portion of the plate, as found by Rcgulai,ion 17(), w hieh hay been removed The strength of rivets in double Nhcnr shall bc ta,ken 0B I • 875 times the strength of rivet* in *ingle shear. RIVETING 172. Rivet Holes. (a) Rivet holes sholl be punched, but Bhall be drilled full Eize from the solid plate, und wherever possible rivet holes shall be drilled in plaoe with plutes, straps nnd ends bolted in position. After drilling, the plates aholl be separated, thc burrs and thc sharp edges of the holes shall be removed and the contact surfaces of the plates shall be elcnned. All tacking holes shall be drilled to a size which will ollow tho holes to be enlarged to the required rivet size by drilling or remnering. All rivet holes *holl be slightly countersunk under cach rivet head. (b) The diametel of the rivet hole shn.,ll be not, Inoro than 1/16 in. lorgor than Itho standard diameter of' the cold rivet us Innnufactured. (a) Where sizes of rivets ure mentioned the sizes refer to the diameters-of the rivet holes not to the diameters of the rivet* used beforc closing

173. Rivets shall be closed by hydrnulic machinery wherever the design of the boiler permits the rivets bc closed by hand or pneumatlø Lhammer in position where hydroulie riveting iB impracticable.GAZEÄTE OF INDIA EXTRAORDINARY [PART (b) Rivet,g shall be of xuffcient length to fill rivet holes and form sound ond aubNt,n.ntiA.l headR. Thc heads sha,ll be finished concentrically with the rivet . Rivets shall be heuted unifonrrly throughout their full lengtfi. (c) Drift piDN not be iVith such foceo as to diHtort the rivet holes. If the rivet holes me found not to bf' fa,ir when the

plates bolted up for riveting thc holey shR,II bc reamerecl fair befo re the vivel,ing iN eommeneed. (d) For hydraulic riveting the prc•Henre shall be the least necessary to onsm..ue a tight joint,, oncl only yufficicnt proNgurc shull be usccl to close the rivets properly and securoly without indenting, l) nckling or otherwise dumoging thc plate. 'The rivete Shall be 01 lowed to Nhrink while under pressu re frorn_ i,hc riveting machine

174. Fullering ond OauIking.—AIl seams Shall be fullered or caulked inside and outside nnd thix shall be (Iona in such o Inanner that thc platßN ure not sprung or damaged. CHAPTER rv REGULATIONS FOR DETERMINING WORKING PRESSURE TO BE ALLOWED ON VARIOUS PARTS OF BOLERS OTHER THAN FUSION WELDED AND SEAMLESS FORGED DRUMS. 175, The 1-nuxitnum prcssu_re which u, boiler may be used shall be deter- nnnerl in n eecn•clonee with thc provisions of this Chapter. The Regulations in this Chapter refer to Jillbi,erial subjected steam f,etnpernturc not exceeding 5000 P SHELLS 176. Formula for working pres.eure of Shell. (a) For cylindrical shells, barrels, Btea,ln and water and of boilcrg the moxirnurn working pressure per squnre to be nllowed shall be enleulai,ed from Che following formulb : [NOTIC. Where parts of drums of tubo boiler are perforated for tubes, the work- ing preesure Bhull be calculated by equation (53) under 'Tubs Platea'.] jN the working pressure in lbs. per square inch, t is Ohe thickness of Bhell plates in 32nds of on inch, Eqn. (1) S is thc minimum tensile breaking strength of the shell plates in tons per square• illa•h or wha,tever strength is allowed under Regulation 5, is the percentage of strength of the longitudinol geome of Shell or of line of hol('k in thc shell for stays, or rivets, or of an opening in the shell not fully compen- Bated, whichever ig least colculated bv the methods hereafter described, (n eo-effcicnt os follows 75 hen i,he longitudinld seams are mule -with doublc butt straps and when gmall sh are formed from solid rolled geetions ; 83 qrhen the longitudinal scamf-l aro made with lap joints and treble riveted hen I hc longitudinal seanns are madc with lop joint* and ore double riveted 2, '0 when i,he longitudinal seorng are welded ond ore fil ted with o single butt strap •3 when thc longitudinol seams are mgde with lop joints and are Bingle riveted. D IS tho inside diameter of the outer strake of plating of the cylindrical shell mnasured in inoheg. s.o. 8] OF INDIA (b) The Factor Of Safety shall in no oase be less than 4. The aot,unl Foetor of Sufety in each case moy be found from the eqnotion With the best form of joint ond leust eo-emcient (C) Safety for shell plbt,es, inch to 12 inches in thioknesa, varies from 5' 13 to 3 • 99. (o) An addition of IO per cent. 8ball be mado to the appropriate co-efficient for shells of boilers in which. the longitudinal sea,ms are la,p jointed and not urce*Bible to cloc visual ingpeotion bnd for shell pln,teg of externally fired boilers exposed to the direct inpoct of furnace flame ; provided that this addition shall not a,pply to the gteorn ond water dru_ms of water tube boilers where the drums are noi close to the fire-grate and there ore tubes between the fire-grate the drunu. (d) The obove co-emcient ore Btandardß and shall be used only for boilo opelk to unspection by an- Inspecting Offcer during the whole period of construct ion and which arc certified by him ha,ving been constructed in accordance with Lhe stowi- ord oondition.ß laid down in these Regulbtions

177. Methods of calculating the strength o} riveted joints.- The Ik3rcentag•e Of strength of riveted joint (J) ahull be found from the following formulæ (i) (ii), (iii) : (i) and (ii) are applicable to any ordinary •type of joint ; (iii) is applicable only to thot type of joint in which t,ijc number of rivets in thc inner coq is ble that of the outer row. The lowest value given by the application of these formula, ig to be taken as the percentage of strength of tho joint ith the solid Plate percentage LUO A' AxNxC Sl - Rivet percentage PxTxS IOO(P- 21)) IOOxAxCxS1 —Combincd plute Litcl rivet Eqn. (41 P ig the pitch of rivete at outer row in inches, D is the diameter of rivet holes in inches, A iB tho aectional area of one rivet hole in square in c hrs N is the nutnber of rivets per pitch, (P), 'P iB the thicknees of plate in inches, C --1 for rivets in single shear as in lup jointe, and 1 •875 for rivets in double shear us in double butt strappod joints, Sl is: the shearing strength of rivets, which Bholl be taken to be 23 tons per Bquare i-noh for Bteel and 18 tons per squnrc inch for iron, S is thc mi-nirnum tensile b] euking si,rength of shell plates in tons per sque re ineh, or whatever strength is allowed under Régulation 5 of Chapter I. In the fomnula (i) D is the diameter of the rivet holeg in the outer YOV, s and in the third formulu J) iB the (libineter of the livet holes in the next rows. {n the last A is the nrea of onc ri et hole in the outer row. (b) When the sectional urea of the rivet holes ig not the same in all rows, and when some of the rivets nre in double shear and others in single shear the rivet sections pcr pitch of euch sizc nr shear Nhall bo oomputed nud added together to fomn the total rivet section. 658 THE GAZETTE OF INDIA EXTRAORDINARY 11 178. When Pitch exceeds

maximum allowed.-—Shou1d the pitoh of tho rivets exceed the maximum pitch allowed, the permissible pitch shall be used in place of the actual pitch in determining the percentage of plate section. No greater percentage than 85 shall be allowed for any type of riveted joint

179. Butt Strops and gpacing of rivet8 below requirements.—Should the spacing of tho rOWB of rivets or the distance between edge of plate and rivet hole or the thick. ness of butt strops be less than is gpecified in Regulations 182 and 184 the percen- tage representing the strength of joint shall be m)difled ag prescribed in those regulationß

180. Percentage of Welded and Strapped Seams.—ln determining the percentage of strength ofa weldcd seam covered by a strap or Btrapg the formulæ and allowances in Regulations 177, 178 and 179 shall be applied, but 50 per cent. Bhall be added to the rivet percentago for the weld

181. Percentage to be allowed for Solid Rolled Shells.— When small shellg are rolled from the eolid, J. in equation (l) Bhall be token as 100 per cent

182. Thickness ot Butt Straps.—The minlmuyn thickness of butt straps för the longitudinal Beams of cylindrical shells Bhull be determined by the following formulæ but all Btraps should be of Buffcient thickness to permit of efficient caulking, and in any cage Bhall not be less than 3/8 inch in thickness. Single butt straps having ordinary riveting : 1-125T Tl Eqn. (5) Single butt Btraps having overy alternate rivet in the outer rows omitted 1 125Tx (P—2D) Double butt straps of equal width having ordinary riveting -625T T Eqn. (6) Eqn. (7) Double butt straps of equal width having every alternate rivet in the outer rows omitted • -625Tx Eqn. (8) Double butt strups of unequal width either having ordiuury riveting, or having every alternato rivet in the outer rows omitted. • 75T Tl (wide 'trap) • 625T Tl (narrow strap) . Eqn. (9) Eqn. (10) Tl is the thickness of the butt strops in inches. The other symbol* havo the sume significance os in Regulation 177. Single and wide butt Btraps shall, wherever prooticable, be on the inside of the shell. Should tho thickness Of butt strops be less than thut above described, the least percentage of joint as determined under Regulation 177 shall be reduced in the portion of the actual thiokneu to the proscribed thickness

183. Mbximum Pitch of Rivets in longitudinal joint8.—Tho maximum pitoh of the rivets in the longitudinal joints of boiler shells shall be OxT+1 • 025 maximum pitoh in inches . T iB the thickne of the mhell plate in inches, . Eqn. (11) Number Of Rivets per Pitch 3 4 5 THE on INDIA O is oo.emcient, as given in the following table :—- 1 .31 Co-emclents for Lap joints 3 .47 4-17 Co-amoient3 for Ningle Butt-dtrHpped join(1 .53 Co-eficiontg for double Butt- atrapped joints 5 52 184. Spacing ot rowe of rivets. Ln jointN, whether lopped or fitted with butt strops, in which there are more than one row of rivets and in which there ig on equal number of rivets in each row, the distance between the roM s of rivets shall be . not leg8 than— Zig.zag riveting. •93P+ • 67D distance between centre lines of rows (R) . Chain riveting, 2D = distonoe between centre lineg of rowg (R) . Eqn. (12) Eqn. (13) (b) In jointe in which the number of rivets in the outer rows is one half of the number in each of the inner rows, and in which the inner rows are chain riveted the distance between the outer rows nd tho next rows shall bo not less than as required by equations (12) ond (13) whi lever is the greater, and thc distanco between the rows in which there are the full number of rivetB shall bo not less than 2D(R1) . (o) In jointB in which the number Of rivets in the outer rows is ono half of tho number in each of the inner rows and in which the inner rows uro zig-zag, tho dig- Once between the outer rows and the noxt rowg shall bo not less than— -2P -F I 15D = di8tance between centre linea of outer and next rows (R) Eqn. (14) The distance between the rows in whiå there are the full number of rivet8 shall not leu than— • 165P+ • 67D=digtance between centre linee of inner rows (RI) Eqn. (15) P iB the pitch of the rivets in the outer rows, D ig the diameter of the tivot holes in inches or the mean of the diameters of rivet holeg when the distance to be deterrninecl is between two rows of rivets of different diameters. (d) Should the distance between rows Of rivets be legs than ag prescribed above the plate percentage determined by equation (2) shall be modifiecl thue— actual distance 100 prescribed distance modified plute percentage, Eqn. (16) (e) In all oases the oleor space between a rivet holo and the edge of o plate shall not be legs than the diameter of the rivet holes, i.e., the centro of the rivet hole Bhall be at least 1} diameterx distant from the edge of the plate (E)— Provided that, if thie condition be not observed, the strength value of the rivets affected shall be reduced in the proportion of the actual distance between the outer edge of the rivets and the edge of the plate to the prescribed distance. ox INDIA 185. Circumferential and End Seams of Water Tube Boilerg.—The suitabili of efroumferenti81 seams including

the Beams joining ends to Shel-18 shall be verffe by the following formula : is equal to or greater thon WP DxC K —2 150 for 26/30 tong tensile plateg. K 157 for 28/32 tons tensile plate8. Due to higher stresses, see Reg. 271 and 340. WP The working pressure fn lbs. per eq. in. Eqn. (17) D — The diometer of shell in inches, meagured inside the outer ring of plates. J Circumferential Joint emoienoy calculated by Eqns. 2 or 3. C 8 • 24 where the seams ure made with lop joints ond oro treble riveted -z 8 where the geamg ore made with lap joints and are double riveted - 9 •60 where the seams are made with lop jointe and are single riveted. t thickness of plate jn 32nds of an inch

186. Compensation for Manholeß and other openingg.—The percentage of pensating section shall be determined by the following formu-læ :— 200 (W—D) X Tr percentage strength of compensating section percentage strength of rivet section (J,+2D) xTs Eqn. (18) Eqn. (19) W iB the width of componsation ring in incheg measured in the direction of the longitudinal axis of the boiler, L ig the length of opening in shell in inoheg measured in the direction of the longitudinal axis of the boiler; D iB the diameter of rivet holes in inches, Tr iB the thickness of compensation ring in inches, TB ig the thickness of shell plate in incheB, A the area of one rivet hole in inches, N is the number of rivets on one side of the longitudinal line. When the rive" are in double shear 1 • 875 times tho single rivet section Bhall be allowed. Parts of raised manholo mouthpiooes within four inches of the shell Bhall, in addition to the ring, bo included in the compensating section

187. Uncompensated Holes in Water Tube Boiler8.—The maximum diameter of ony uncompenantcd opening in a shell Bhall be determined, subject to the condition that the minimum thickness nt the holo in the shell or end plute shall be not 1888 than the flhickness requ;rod for the maximum permiBBible working preggure, oongidering the plate as being unpierced, as follows : d -2 {XV(D+T) Eqn. (20) Where d=Maxim nm mean effective diameter of uncompensated hole in inches. N Thickness of drum Bhell in inches. Internal diameter of drum in inches, but not exceeding 60. 3 where does not exceed 0•50. in other oueg 0-50 Bqn. (21) The required thioknegg of b seamless unpierced Bhelll Where n — Eqn. (22) DISHED END PLATES 188. Complete hem.igphere without Btayg or other gupport made of one or more and eubieot to internal pressure.—The maximum working pressure yhall be by the following formula (t-2)xSxJ CxR W.P. is the working preegure in lbs. per square inch, t is the thiolmeg of the end plates in 32ndg of inch, , Eqn. (23) S iB the In-inimum tensile breaking strength of the end plates in tons per squam or whatever efrength ig allowed for them, J Is the least percentage of strength of the riveted joint8 of the plates

forming hemißphere or eeouring it to the cylindrical shell, R is the inner radfug of curvature in inoheg, C for single riveting iB 3 •3, C for double riveting iß 2 •9, C for treble riveting iB 2•83

189. DiBhed end8 subject to internal For unstayed endg of Btoam ud water drums, tops of vertical boilers, etc., when dighod to partial spherical form maximum working pressure 8ball be determined by the following formula 15 xsx W.P. W.P. 18 the working preegure in Ibe. per square inch, t is the thicknese of end plates in 32ndß of an inch, Eqn. (24) R iB the inner radius of curvature of the end in inches, which shall not exceed •e dia,meter of the shell to which it is attached, S i8 the minimum tensile breaking strength of plate in tone per gquore inch, or •hotever ig allowed for it. (b) The inside radiua of curvature at the flange shall be not less than 4 timeo the thick-negg of the end plate, and in no ooge legs than inches. {c) When the end has manhole in it (t-—5), 811811 be substituted for (t—l) in the ormulo. (d) In the case of the electrode boilerg where the attachment, of ende is perrnittød by fillet welding as per Regulotion 104(d), for oo.emcient 15, the eo.effcient IO ghan be gubgtituted. (e) The total depth of flange of manhole from the outer surface in Inches measured on the minor ox-iB Bhall be at leagt equal to— v/ nw=deptb of flange in inches Eqn. (25) •here T ig the thickneu of the plate in inohee ond W is the minor axig of the hole inches. Non.—The foregoing provisions shall not preoludo the of dished end' compliance with Rego. 275 to 278 whore not fltted with an upåake.

190. Dished endg subject to external pressure.—ln the cage of unstayed dished' ends, for the co-emcient 15 in equation (24) the co-emcient 12 ahall be gubstitutd, ond R shall be the outer radius of curvature of plate. For plates exposed to furnace name the co.emcient shall be 10•6. In no cage shall —exceed 2-75'. 191. Di8hed end* o! Lancashire and Cornish type For dished ends of Lancashire and Cornish boilers with external or internal flanges for furnaoe• formed in one piece, without stays and subject to internal pressure the maximum working pressure shall be deterrnined by the following formula 8) x 30 xs W.P. W.P. iB the working pressure in lbs. per square inch, t iB the thickness of the end plate in 32nd' of an inch, Eqn. (26) R ig the inner radius of curvature of the end in inches which shall not exoeed•• one and half times the internal diameter of the shell to which it is attached, B ig the mi-nirnu.m tensile breaking Btrength of the plate in tong per square inch or whatever ig allowed for it. (b) The inside radius of ourvature ot the flange Bhall be not less than 4 times the th]okne8B of the plate and in no cage less than 3} inch88

192. Dighed shell and ßrebox In determining the working preagure in accordance with Regulations 189 and 190 no account Bhall be token of the fluence of the uptake tube in vertical boilers. If diBhed crown plates having takes ore flt for higher pressures, when considered as flat plates, under Reg. 19T øuoh higher pressure shall be allowed. (b) The rediua R of the dished part may be found ag follows Eqn. (27) C ond are the lengths in inched of half the base line or chord on which measured ond the height of the dish or camber at the middle of the chord rose peotfvely. FLAT PLATES 193, Flat plates supported by solid screwed stays, marginal seams or flangeg.— (a) For planl flot p] aterq supported by solid screwed stays or rivctcd marginal seams 01' dances thc rnaximum working e€Rurc shall be as follows Eqn. (28) In i,hif4 fol mula and ill tho:qc following in the succeeding regulations relating to *'Fladi Plat+" unless otherwise specified. W. P, is the workmg presauro in lbs. per square inch, t IR i,he thicknc•8F4 of the fiat plate in 32nds of on inch, tl lhe thiekneßs of the wa,ßhcrg, strips, or doublings employed, m 32nd8 of on inch) A IS the horizontal pitch of stays in inches, B is thc vertical pitch of the staye in inches, C is a co.effcient which varies in voluo with the mcthod of fixing the stays ond nature of the support. Where the plates ore exposed to the direct impact of the flame the foUowing valueB of C sholl be reduced 12} per cent. — 60 for stays gcrewed into the plate with their ends riveted over. c BNO. 8] GAZETTE OF INDIA C 90 for stays scrcwed into the plote and fitted witb nutg on the outside, C 100 for stays puged through tho plotc and fitted with nuts ingide ond out• side, C = 110 for B riveted setun or flange, in the flbtJ plate *ecuring it to the shell eide ploto, end plate, furnace or uptJbke. W hero portions of plat,c ore supported by stays or riveted seams or flanges hoving various values of support, the value of C, Bhull be taken as the mean of the points of Bupport concerned. The support of rivetod seam shall bc assumed to be the line through the centres of rivets iD the nearest row and of flungc ot the commcncement of curvature. In tho lotter oose, if the inner radiua of curvature of the flange exceeds timeg the thickness of the plate, the support shall be bgsu_mecl to be ut distance of times the thickness of the plate from thc inner side of the flange. (b) Tor portions of ploce wherc the stays ore irregularly pitched DR shall be used instead of AN-FBB, D being the diameter in inches of the lorgegt circle which can be drawn passing through not less than three points of support, viz. , the centreg of stays, or rivets or the commencement of the curvature of flonging, whichever

is applical)le. (c) For the tops and sides of combustion chum bers and fireboxes thc distance between the rows of stays neatest to tho back tube late, or the back or firehole plBte respectively, and thc commencement of curvaLure of those plbteg ot their flangbs, shul-I not be greater thon the In a,xil.n nm pitch of the stays. (d) For the topa of combustion cha,mbers and fireboxes where they are joined to the sides by curved portions, if the outer radius of (Jho curved portion iq less than holf the (Lllowable distance between the girders, iJhe distance between the first girder ond tho inner surface of the side plotcs shall not excccd the ollowa,ble dig- tance between the girders. If the radius of cnrvoture is greoter than half the allow- bble distu,ncc between the girdorg, the width of the flot portion measured from the centre of the girder shall not be more thnn half the mllowoble distance between the girders. (e) Where Btuy tube8 are not fitted in nost of tubes, in tube platea of loco- type boilers, ond ports of plate outside the gpa,ce, occupied by tubes are supported, in accordance with Regulation 212 (b), by screwed stays cach stay in the row nooreat the tubes shall bc guffcient Btren4h to gupport the plate up to the edgea of the tube holes in oddition to ita shore of the, plate on thc opposite side of the line of staya. The working pressurc for the platc between n bog ond stays shall be dotermined by Eqn. (28), Ä being the horizontlil pitoh of 1 hc slays in the nearest row, B twice the distance between the centre line of *toys and a Iino touching thc tubes opposite them oud C the co-effcient appropriate to the kind of stay

104. Flat plates supported by stays and nuts and large washers or stripe or W hero the plates am supportod by stays passing through and aro fitted with nutB inside and washers ond nut8 outside, thc diameter of the w»• ghera being at least time* thot of the stay, ond thcil' thickness leogt two-thirds thot of the plate, but not greater thon that of the •plate, the maximum working pressure Bhall be : 100 Eqn.(29) (b) where the washers hove o diameter of at least two-thirds of the pitoh of the stmys and b thick-negg of ot least two-thirds of the thickness of the plate, but not .11- INDIA greater than that of the plate, and are riveted to the plate in arn moient manner, the maximum working pressure shall be 100 35t1ß] Eqn. (30) (o) Where the plate ix stiffened by strips at leost, two-thirds of the pitch of the stays in breadth which hove u thickness of ot lea.Bt two-third-H of thot of the plate but, not greater than that of the plate, and are riveted to the plate in an emoient manner, the moximurn working pressure Nha,ll be 100 55t1'] Eqn. (81) (d) Where the plates are flttod with doubling plates having b thickness of ot least two-thirds of that of the plote but not, greator thar» that of tho plate, ond are riveted to them in an emoient manner, the moxirnum working pregxu.re Bhall be : 100 Eqn. (82) 195. Flat tube For tho portions of tubo plate* i_n the neate of tubes where Stoy tubes ore required and where the minimum thickncss ond cross section of tube plate are not Lesa than ag prescribed in kegulation 211 the maximum work- ing pregaure shall be Eqn. (33) P ig the Inean pitch of the stay t ubcs supporting ony portion of the plote (being the sum of the four sides of tho quadrilotorol divided by four). C 70 for stay tubes scrowed and oxponded into the plate ond no nuts fitted, C 85 for stay tubes screwed and cxpnndcd into the plate nnd fitted with nuts. (b) No nuts shall be fitt,od to Atay tubes the combugtion chamber or firebox end. (c) Where the plates are exposed to the chreot impact of flame, the co.emoient O shall be reduced by 12} per cent. , und where the thioknees or orogs geotion o: tube ploto between tubes is less thon as prescribed in Regulation 211 the appropribte 00-omoient shall bo reduced in proportion to the dofioit. (d) For tho wide wuijcr Npaceq of tube pla,tes betwoen the nests of lubes and tho wing rows of tubes and the shell, thc maximum working pr08Nure ghBIl be :— c 55t1*] Eqn. (34) A ig the horizontol pitch of stay tubes in inohos measured aoroag the wide water space from centre to centre, B iB the vertical pitch of Stoy tubes in the bounding rows in inches measured from centre to centre, C 00 for stay tubes gorewed and expanded into the tube plates and no nuts are fitted, O = 80 for stay tuba screwed md expanded into the tube plates and fitted •With nutß, O 70 for 8tBY tubes screwed und expanded into the tube plates and nutg are fltt,ed only to alternate stay tube, t ig the thiekneas of tho flat, plaic 92nd* of an iueh, tl is the thickness of the washcl *trips doublingg employed in 32nds of on (e) Where the plbtes me exposml to the direct impoct of dame, the co-eßcient C shall be reduced 1 pet cent

196. Plates supported by gusset Fot the end plates of Lonotu3hire, Cornish, Vertical and locotype boilers, and other flat gurfooee supported by irregu18rLy pitched gusset the Inoximutn wotking preg*ure Nha.ll be :— Eqn. (35) D the diameter in Inches of the Ibl circle which oun be drawn passing through not leNE-; thon three points of support, •viz.. the centre lines of rivet* or the commencement of the curvoture of flanging, whichever iN applicable. C 100 for plotcs not exposed to flame. C 88 for plates exposed to flarne. (b) Where such plates ore Btiffcned by suitablo teo or angle bbl'S Neeurely riveted to

the platea within the circle D, the oppropriate co-emcient may be increogod thirty per cent. Such stiffening bars shall be placed ag to trmsmit their loorl in a direct rnnnner to the gusset Btu,.ya Nhell plate. (c) FOI the part of the end plate containing the manhole in I,anCONbire boilers the •rnnximum working pressure ghall be c Eqn. (36) D the diameter in Inches of Lhe IBrgegt on•cle which earn be drawn enclosing 6he monhole ond pugging thiough the centreg of the rivets in eud plates connecting the shell and gusset angles ond finnaces or to the cojnmonoement of curvature of flang- ing, whichever opplicable where the circle passes through only three of the posBible five pointf of support Jnentioned thc remaininæ two shall be embracecl within the circle. t is the thickneas of tho end pluteg m 32nd* of inch, tl iN the thicknesa of the bosc ot the mouthpiece or flat ring in 32ndg of an inch, C 90 where the manhole mouthpiece iq either of mild or cast steel, ond hag a turned-in qango of a depth, measured from inside of end plate, of not, les» thon 4 times the thickness of the end plot,e, ond thickness not legs than tho thickness of the end plate, C — 70 where only a fiat 'Atcel orn pensat,lng ling iB fitted, C iN to be taken thc mean of IJhe poinfa of support through which circle posses in accordan(c with Regulation 93 where there no mouthpiece or flat ting and the end plute flanged around the mnnholc to tho depth required in RegulBtion 201

197. Flat Crown plates vertical boilers. For the Ant cromn ?lBtee of vertical boilers either with or without bolt stays, Equotion (35) gholl be used rn deter- mining the WOT king pressure wil h C —80, when the ploteq ore not exposed to flame, and '70 when thoy are exposed to flame, In this cage D is the diometcr of tho IR,rgegt circle in inches that can be drown passing through thc centres of tho rivets or bolt stays when fitted, or tho commencement of the curvature of the flanging, whichever iB applicable. Where bolt gtays are fitted with washers of the same thick-negg the plate securely riveted thereto, the cirole shall poss through the centrcs of the washer rivets but where the washers are not riveted or where none are fitted the circlo shall pass through the contre of the gtoyg. In the cosc of electrode boilers where the attach- ment of ends ig permitted by fillet welding OH per Regulation I()4(d), t,he working pressure Bhall bo determined by Equation (35) with (b) Where the crown plate ig flanged tho ingide radius of cnrvnture ot the flange *hall not be legs than 4 times the- thickness of thc end plate, but in no coge leas than 2%"

198. Circular flat ends o} drums, etc., supported only at For those endg C in Equation (35) Bhall be ta,ken as 140 when the plates are not, exposed to flame, ond 122 •5 when they oro exposed to fl8T71e. In this case the circle D shall pass throu h the centres of rivets or bolts securing the ond to the Bhcll or, where the end anged, through the commencement of curvature. (b) Where flanged the inside radius of curvature the flange shall not be legg than 4 times the thickness of the end plate but in no case less than 2å'

199. Bar or bulb stiffened end plates and smokebox tube plates of locotype boiler8.-—Where such plate* instead of being gupported by stays are stiffened in tho steam space by substantial tec 01 angle bbl s securely riveted to the plate and tending across the plate to within the margin allowed by Equation (37) or where euch pln,tcg are formed with o deep bulb extending across the plate to well within the margin a]Jowed, for the support th us given, C shall be token as equal to 80 ond 7() for plates not oxposed, and exposed, to flome respeotivcly. The margin or pitch for guch stiffening shall bc measured from the centre line of rivets or commencemcnt of euzvaturc o? bulb provided it is not more than 2 ineheB from the centre line of bulb. For the flot pla,te above the stiffcne] or bulb, O Nhall bc token the Tneon of the values appropriate for the points of support

200. Flat plate margins.—The amount of Bupport in relief of stays which mW be credited to the sideg of shells, furnu,nces, upl bkeg, fireholes ond foundation rings to which flat plates are attached Shall noi exceed that found by the following formu)b Width or in inches t Thickness in 92nds of nn inch w.p. Working pressure in tb per inch C = 3 •47 for plutes exposed to flume — 3 • 70 for plates not exposed to fit-line. c Eqn. (37)' Where the plates are flongcd (lhe margin Shull be nieasured from the commen- cement, of eurvbt,ure or from a. line times the thickness of thc plate distant from tho eide of the flange next to the inncr radius of the corner whichever is the less. In other cases, the •ynargin shall be measured frcnu the centre line of rivets in the nearest row of the geom by which the fln,t plate iN ottached. Doubling plates shall cover the area supported between the stays and oxtend beyond the stays so tha,t the contre of the rivets securing the doubling plate to the end plbte shall be Ot, least half thc distance frotn the out,crrnost stays to the noareqt gubeta,ntial point of support. Where flat end pluteg are flanged for connection to the shell, the inside radius of flanging Bhall be not' less than I •75 times the plate thickness with a minimum of 1} inches. szo. 8] THE GAZETTE OF INDIA EXTRAORD11U3Y, 667 201.

Manholes and Mudholes in Flat Plates.—Where a flat ploto is flanged to 8tiffen it a, manhole or sightholo, to permit same wol'king pressure as would be allowed upon on unpierced pla,tc, the depth of the Bonge measured from the outer surface shall be ot least equal to— v/ T X W —depth of flange in inches Where T is thc thickness of the plate in inches, and W is the minor axis of the hole in inches. STAYS Eqn (38) 202. Solid screwed Bt8Y8.—For screw stays to combustion chambers und boxes and for longitudinal und cross Stu,ys, the rnaxirnurn working pressure for the Btays is to be calculated from the appropriate onc of tho following two formulæ c Eqn. (39) Eqn (40) W P. ig the working presgure m tbs. per square inch, D is the diameter of stoyg over threads in inches, DI is the diameter of body of stay ot its smallest part in inehca, N is the number of threads of stay per inch, A is the orca in gquare inches supported by one stay [for area, to bc suppocted by neur in liltcbox tube plates of locotype boilers, see Regulation 193(c)], for steel or gpeeia»l wrought iron screw stays to combustion ber or fireboxes för *tecl longil,udinal or croqs stays fitted with nutB, for eoppcr screw stays to fireboxes. Where Ntays orc made with cnlurged ends uncl the body of Che stay IN snibller in diameter thon nt the bottom of the thread the working pressuro Shull bc emloulatocl from thc second forrn 1110

203. Stresses in steel jointed stays.rl'he sect ion of least strength whether of Hiny, rivets, gbaeklc or Pin shall be used in calculating the working pressure for the stay. For parts in tension stress of 9,000 tbs. per squaro inch of net scction Bhull be ollowed, and for ports in Hheor n stress of lbs. per squu,rc• inch of net aection. (b) Part,g in double shear Bhull be a,llowed b section of 1 •875 times the single sect i on 204. Stay tubes.—For htax tubQ8, whoth01' of wrought iron or steel, seamless or lap-wel(lecl the Tim-xnn unn (Irking In oas,uze shlLll be eulculatod from i he follow- ing lomnula : W.P 5900 Eqn. (41) I) ig the dimneter 01' the I uhc ovel threads in Inclies, DI ig the internal diomet,er• or the tube under the thrcH,clB in inches, N is the number of threads of stay per inch. A is the oreo in squore inches eupported by one Stoy tube, measured from centre to centre of stay tube*. When the oreo contains tubes or ports of tubea their aggre- e H,reo, calculated from their smallest externgl diameter of body when in tenqino 668 THE GAZETTE OF INDIA EXTRAORDINARY [PART jr and internal M hen in eon) pregsion, *holl bc deducted from the crea of thc cont8 iuing figure ancl the nsed ag A in the fortuula, 205. Stays in tension and oompreggion.- (u) The same stresH shall be allowed' The '*t.rength of *hort stays in compression and not in conjvreAsioru in tension. koble to bending Nhol-l be calculated on the net gertlon the gtb.v at bottom of thread or in bonv, iH (b) r ['he *treys to be ed on n n \ ay 01' port, of a Bta,.y not provi(lcd Llor foregontg shall be (rhe satnc• as t,hRt, allowed for 8t,BYN or parts of stays of up proxi- mat.e!v like kind in condition*

206. Measurements of stayed areas in the end plates oi locotype and verticaF boilerg.—When the areas yupportocl stb.ys aro genii-circular as in the upper part* of the end platee ond smokebox tube plates of locotype boiler*, or annular oe in the crown ploteg of vertical type boilers, the area to be supported by stays, A in Eqng. 39 and 40 gholl, in the firgt case, bo the acea of the plate contained within the margins credited to caging or barrel Bides, screw stays, fire door ring or tube stays the cose may be, and in the second case be the area of the annulus between the margins credited to uptake and Shel], When bolt staying ig necessary, the stays Bhall be properly dietributed ; the aggregate stay seotion shall then be used in the forrnula for calculating the working pressure

207. Gusset stays.—-The working for gusset Ntays Nhall be calculated by i.Jhe following, : 9000 x c W.P. Eqn. (42) C, the co-effcient, is the number representing the least of the following (2) 1-875. (3) 1-875. (4) N,xm. (5) (G—NaDa) (t —2) (6) (GI—D8) (t—2) Nl, N z, N 9, N, , DI , D 3 , und A 2, are respectively the numbers, L'i vets in the joints of each gusset stay, only diameters and sectional areas of the rivets in the supported arca, to be (onsidered offectivc the order of the joints being shell ungles to gusset, and (l), angles to ond plate, (2) end plute n nuleg to gusset, (3) (4) onglee to shell, G iB the depth in inches of gusset plaic measured through the line of rivets attaching it to the end plate angles. GI is the depth in inches of gusset plate measurocl normol to the slant edge of plate through the rivet nearest to the end plate in the joint attaohing gusset plate to shell angles, t is tho %hioknega of the gusset plate in 32ndd of un inch, A iB the oreo in Bquare inches of flat plate supported by the gusset stay which, in the case of Loncashire nod (_h-n•niNh boilers, shall be determined ag followe : (L) The margins bllowed under flat plote regulations {Or ghell and furnace Bhall be morked on end plateg and the lengths of the centre lines of gussets between them measured, also the distance between each pair Of gusset lines from the middle of the smaller in o direction normal to the greater. If L and LI be the lengths of two adjacent or INDIA gu«et

liræ ond if the dißtanoe between them be W, the areo oontained by the guæet lines and the shell and furnooe margin linee may be apportioned between the stays W(8L+Li) Portion of area in square inohes, 8 opprtioned to L line gusset W (3 LI+L) Portion of area in square inohee 8 apportioned to LI line gusset . Eqn. (48) Eqn. (44) (b) The portion of the areo on the other side of each guuet line ebon, except when of triangular form, be found in like manner ond its amount added to that al- reedv found to form the total. For the triangular portionB in the wing spaces the area Bhall be taken oe half the product of the length of gugget line into the perpendicular distance between it and the intersecting point where the marginal ourveg meet. BOLTS AND STUDS 208. (a) Bolts and studs connectinrr parts of boilers such ag shell, end plates, tube plates, furnaces, uptakes, externfily fitted manhole coven, mountinge, eto., moy be mode either of steel or good quality wrought iron. (b) The maxi_murn working pressure for the bolt* Or 8tudß shall be oaloulated by the following formula : Eqn. (45) D is the diameter of bolt or stud over threads in inches, N is the number of bolte or studs securing the part, n 1B the number of threads of sorέw per inch, for steel boltB or studs of 28 tons/sq. in. minimum ultimate tengile 8tress where the diameter over throad is legg than 3/4 ineb. for steel bolts or studs of 30 tong/sq. in. minimum ultimate tenaile stress where the diameter over thread iB legg the 3/4 inch. for ateel bolts or studs of 35 tong/B . in. minimum ultimate tensile streee where the diameter over thread iB legg than 3 4 inch. for steel bolts or studs of 28 tong/sq. in. minimum ultimate l.aneile Strese where the diameter over thread ig not legg than 3/4 inch and not greater than 718 inch. for steel bolts for studs of 28 tons/sq. in. minimum ultimate tensile Btrees the diojneter over thread ie greater than 7/8 inch. When the material is iron, a reduction of 15 per cent ghbll be made in the work- ing pressure are calculated by the formula. A the areo in square inches of the surface supported by the bolts or studs. For jointed flanges the area shall be taken to extend to midway between the pitoh fine of thc bolts and t,he inner edge of the flange by which the part ig Recured, INDIA TUBE PLATES [PART u 209. Compression of tube p12teB.- (a) For fire-box or cornbugti011 lubo plates which ore subject to compression due to the pressure on the roof plate, the maximum working pressure shall be :— W.P. LxP t is the thickness of the tube plate in 32ndN of nn inch, Eqn. (46) P ig the pitch of the tubes in inches, measurod horizontally where the tubes are chain pitchod, and diagonally where the i ubos are zigzag pitched and the diagonbl pitch is less than the horizontal, D is the internal diameter of the plain tubes in inches, L is the internal length of the fire-box or cornbustion chamber in inches rneasured at top between tube plate and firehole plate or back plate, or between tube plates in doublo ended boilers with combustion charnbora cornmon to two opposite fur- maces, C= 875 for steel and 437 •5 for copper, Provided that the ubove formula shul-I not apply in the ooge of fire-boxes where -the girders do not rest on the tubo plate, or where the roof plate iB stayed direct to * tho outer shell or to girders supported by the shell. (b) where girders rest on the Bide plates or the root plate is so formed that the load ig carricd both by Bide and end plates, in no oase shall the compressive stresB on the plotcs exceed Its. per square inch for steel of 7,000 jijs. per square inch for copper

210. Parts to be Tho Ntiftnr of tubo platea oncl pitch OF stays within the nests of tubes where stay tubes n ro required and where marginal stay tubes are required in yupport of blank spnoos adjacent, to or between the nests shall be determined by flat plate rules under Regulation 195.(b) Tube plates within the nosta tubes whether fitted with stay tubes or not gholl comply with the requirements of -R,egulution 211 in regard to thickness and oroge section between i,nbeg

211. Minimum thickness and cr088 section.—To provide a socure attachment for plain tubes in the tube plates Lhe Illiekneqs and erogg section. of tho plate between Tthe tube holes shall not be less than • Steei tube plate, • 1251)+ • thickness in inches • 17D+ • 025 —minimum cross section in square inches Coppey tube Plato, . 21) + • 4—minimum thickness in inches • 527 D— •'263æminimu-m cross section in square inches Eqn. (47) (48) Eqn. (49) Eqn. (50) D the dicbtncter in inches of the tube at thc port of attachment to tube plfl,te. Where the thi and cross section of the tubo plates ame less than the Ininirnum the appropr iute co-cffcient jn Eqn. (51) shall bo reduced in proportion to the 212. Holding power of plain tubes. (o) W hero tube plates ore not specially Bta,yod in nests of t,ubcs, thc working pxessuce, bused on the holding power of the t,ubcs shall not, exceed that found by the following formula, CxD W.P. Eqn. (51) GAZETTE OF INDIA EXTRAORDINARY 671 D is tho cliom3ter of tube the part of ottachmcnt to tube plate in inches, A is the oreo in square inchoa ot the tubo plate supported by each tube, which generally ma,y be taken the product of Lhe horizontol and vertical pitohos of the tub) less the area of the tube itself, C 470 for Lubeg expanded into parallel holes in steel or irontubo Platea, C = 53() for tubes expanded into taper holes in steel or irontubc plates. For copper tube plates or copper or bross tubes the approprioto co-cmcient 8hould be reduced 20 per cent. (b) In thc unstayed tube photos of locotype boilers and in other tube plotog in which Stuy tubes arc not required the support bffordecl by the ploin Lubes shall not bc taken to extend beyond the lines enclosing the outer edged of the tubes. Port8 of flbt pliito outsido thia line shall cither lie in the plate margin or be separately supported. No o,ccount need be taken of tho stiffness of tubo plate jn the nests of tubes when tho a,bove conditions ame fulfilled. Ordinarily (.,hc requirement,8 of this clousc ore applicable only to expanded smoke and water tubes in flit, continuous tube plates containing moro than one row of tubes. (See Reg. 152 for n,ttochlncnt of tubcg in Water tube boiler.) 213. Tube plates, other than ends, of vertical boilerg torming parts 01 outer shell. @) When vertical boilers have a nest or nostg of horizontal tubcg so thot there is direct tension on the tube plut0B duo to thc vertical load on the boiler ende, or to their aci,ing os horizontal ties across the *hell, the thickness of the tube ploteg and the spacing of the tubes shall be such tha,t the section of metal toking the loa.d i.ß sufficient to keep the sbresg wit,hin that allowed on the Shell plates. (b) Each alternate tube in the outer vertical rows of tubes shall be b Stoy tube. The tube plates botwecn thc Stoy tubes ahl-l be in accordance with the rules for tube plates and in addition, considered 0B port of shell, the maximum working pressure,— Eqn. (52) RxP t i8 the thickness of thc tube plote in 32nds of an inch, P is the vertical piteh ot the tubes in inches, D is the dia,metcr of the tube holes in inches, S is the minimuT11 tensile breaking strength of the tube plutes in tons per square inch, or whatever is ollowed for them, R is tho radiol distance oc the centre of the outer row of tube hole from the axis of tho Sholt in inches, 214. Curved Tube plates of water-tube boilers.—For tube

forming part of cylindrical drums the maximum working pressure shall be xExS W.P. D t = thickness of tube plato in 32nds of inch, Equ. (53) *Effciency of the longitudinal joint or the ligoment between the tube holes, whichever is loss, S = Minimum Tensile Stress of the tube pl&to in tons per sq. in. or whatever iB allowed for it, D —Inside diomet,er of tho drum in inches. 672 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 216. Emciency of Whcn a, shell or drum ia drill(d for tubea in u Iino poral-lcl to the oxib of the shell or dru_m, the cmciency of the ligament botween the tube holos Shull be determined us follows (a) When b pitch of the tube holes on every row is equal (as in fig. I(h. Lhe for-- mula is : = emciency of ligament. P Where p = pitch of tube holes, incheg, d = diomoter of tube holes, inches. Eqn. (54)) The pitoh of tube holes shall be meosured either on the flot Dlatc before rolling or on tho media,n lino after rolling. Emmple.—Pitch of tube holcs in the drum as shown in Fig. r IO T 5} in. Dia. 3å". Diometcr of Lube holes — 3-9/32". meter of tube = 5, 25—3 •281 —0 •376, emciency of ligament, 5-25 Lime Fig

10. Example of Tube Spacing with Pitoh of Bol .8 equal In every Row. (b) When tho pitch of tube holes on any one row is unequal (as in FigB. 11 & 12) the formula ig p—nd Equ. (55) Where p d cflieiency of ligament. unit length of ligament, inches, number of Lube holes in length p, — diameter of tubc holes, inches. Example.—Spocing shown in Fig. I l. Diameter of tube holog = 3.9/32'. P—nd 12 —2 x — 0 •453, emcienoy ofligoment. 12 Luny f'.'Q Fig

11. Example of Tube Spacing with Pitch of Holes Unequal in every S3cond Row. Example.—Spneing Bhow-n in Fig

12. Diomcter of tube holeß = 29-25—5 X 3,281 0 • 4 r 9, 'fioienoy of ligament. 29•25 THE OF INDIA EXTRAORDtNÄhY Lon mivdrma' Fig. 12 Example Tuba Spacing with Pitoh of Holes varying in every Second and Third Row (c) The strength of (hose ligamontB botwoen tho tube holes which are subjected to longitudinal stress shall be at loogt one holf tho required strength of those ligaments which come between the tube holes which oro subjected to a circum- ferential etregg. (d) When a shell or drum is drilled for tube hole 30 og to

form diagonal ligaments ehown in Fig. 13, the efhoioncy of these ligamenta shall be that given by the dib-gram in Fig

14. In thig diagram the abscisses ore—and the ordinates Whero p d longitudinal pitoh of tubo holes, or distance between centreg of tubes in o longitudinal row, inches, diagonal pitch of tube holes, inches, diameter of tube holes, inches. Longzrudjna/ Fig

13. Example of Tube Spacing with Tube Holes on Diagonal Lines To use the diagram in Fig.14. the volucs of— and — d are computed and the effciency for the corresponding points is rood off from-the diagram. Should the point fall above the curvo of oqual emcioncy for the diagonal and longitudinal ligaments, the longitudinal ligaments will be the weaker, in which ooge the efficiency is computed from the following formula : P DxampZe.— (1) Diagonbl pitch of tube holes in (Itum ag shown {n Fig. 13 d 42 in. 674 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 Diameter of holes — in Longitudinal pitch of tube holeg 11 •5 4-031 6-42 o, 558. 11 The point corresponding to these values ig shown at A on the diagram in Fig. 14 and the corresponding efficiency is 35 •3 per cent. AB the point follß below the curve of equal emciency for the diagonal ond longitudinal ligaments, the diagonal I igament iB tho weaker. (2) Diagonal pitch of tube holes in drum Diameter of tube holes Longitudinal pitch of tubö holes 6-35/64 in. 4-1/04 in. 7 in. d 7 4-0156 p' 1 •743 6,547 o .935. The point corrosponding to these values is shown at B on the diagram in Fig. 14 and it will be Been thot it falk above the line of equal effciency for the diagonal and longitudinal ligaments, in which case the emeiency is computed from formula (l). Applying formula (I), wo have . 7--4,015d O •426, emcienoy of ligament, or 42 •d per cent. 7 For holes plooed longitudinolly along drum but which do not oome in B straight line, tho obovo rules for oaloulotlng emoienoy shall hold, exoopt that the equivalent longitudinal width of o diagonal ligamjnt shall b3 used. To obtain tho oquivalont width the longitudinal Pitoh of the two holes having B diagonal ligament shall be mult1p110d by tho eff(.nency of the diog mal ligement. Tho effoienoy to be ngod for tho diogonal ligaments iB given in Fig. 15. •0 30 •O 7.5 SO DIAGMM 'OR DETERMXNINO Eh FIC!ENCY OV DIAGONAL LIGAMEt OkDcp TO OBTAIN LONGITUDINAL EPFICJENCV BOILER AND SUPERHEATER TUBES SUBJECT TO INTERNAL PRESSURE 216. The rn working pressure for the tubo shall be detorminul by Equation No. 87. (See Regulation 338). The minimum thickness of the tubos shall comply with the table given fn Regulation 338(b). HEADERS AND SECTION BOXES OF WATER TUBE BOILERS 217. see Eqn. 88 Reg. (340) BOILER TUBES (SMOKE) SUBJECT TO EXTERNAL PRESSURE 218. Steel and Wrought Iron Tubes.— (a) The maximum working pressuro for the tubee Bhall be . 100 (t W.P. t ig the thioknogs of the tubes in 100th3 of on inch, D is the external diameter of the tubes in inches, Eqn. (56) (b) No tube shall be leu than 12 S. W. G. (•104') thick

219. Brags and Copper Tubes.—The thickness of tapered brass and copper smoke tubes for locomotive boilera BhBlI, in the cose of tubes of an external dia- meter of l} to inches inclusive, bo not less than 12 S. W. G. (• 104 inch) at the amoke-box ond ond 10 S. W.G. (128 inch) at the other and in the case of tubeB of an external diameter of 2 to 2} inches inolugive, the thickness at the gmoke„box end Bhall not be legs thun 11 S. W. G. (116 inch) and at the other end not leee than 9 S. W. G. (•144 inch). FURNACES 220. Plain Furnaces of Horizontal Boilers.—For ploin finnaccs or furnaces Btrengthened bv Adamson or other joints or stiffeners of suffcient strength and for the semi-cylindrical tops of fire-boxeN and bottoms of combustion chambers where the Bides ore securely stayed, the working pressure shall not exceed the gmaller of the val obt lined from the following formulæ W.P. W.P. c D (L +24) X [10 Eqn. (57) Eqn. (58) D ig the external diameter of the furnace or chamber top or bottom in inchæ t is the thickness of the furnace plate in 32nds of an inch, L is the length of the furnaco or other part in incheg measured between points of gubstantial support, i.ø., contres of rows of rivets in ond seams or commencement of curvature of flange, whichever is applicable, C = 1450 where tho longitudinal Beams of steel furnaces aro welded and 1300 where they are riveted, C = 725 where the longitudinal Beams of circular copper fire-boxeg or furnace are fitted with double butt Btrapg and 050 where they are lapped, Cl 50 where the longitudinal seams of steel furnaces are wolded where they riveted. Cl = 25 where the longitudinal seams of circular copper fire-boxes or furnaoe8 are fitted with double butt strops and 22 5 where thoy are lapped

221. Corrugated Furnaces oi Horizontal Boilen.—-Tho maxirntllü working preß8ure to be allowed on corrugated furnaceB Bhall be determined by the following formula— 1). . Eqn. (59) D ig the least, external diameter in inchoa measured at, the bottom of the corrugations on the water Bide, t ig the

thiokneu of the filrnooe plate in 32nds of an inch meoeured at the bottom Of the corrugation or chamber, C 480 for the Fox, Morrison, Deighton, Purves, ond other similar furnaceB and 510 for the Leede Forge Bulb Suspension Furnace

222. Plain Furnaces of Vertical Boilers.—The same formulæ ag for tho plain furnaces Of horizontal boilers Bhall be uged, but where the furnaces are tapered, the diameter to be taken for calculation purposes shall be the mean of that, ot the top and of that at the bottom where it meets the gubstanti81 support from flange or ring. The length for the game purpose shall be the distance from the centre of the row of rivets connecting the crown and the body of the furnace to the substantial support at the bottom of the furnace, or to a row of gorowed stays connecting the furnace to the shell, provided that the pitch of etayg at the furnace does not exceed 14 times the thicknegg of the furnace plate when the stays are riveted at their ends, or 16 times when the stays ore fitted with nuts. Such screwed Stoya shall be in djameter over the threads not less than twice the thickness of the furnace plate and in no case leu than i' '—diameter (sce Reg. 135(d).) 223. Homi8pheri081 Furnaces of Vertical Boilers.— Whcn furna«s are homi- m Brm anl subject to prJ3gure on tho convex side and are without support from stayg of any kind, the maximum •Working pressure Bhall be : 2750—1) W.P. Eqn. (60) t iB the thirknoBB of the top plate in 32ndB of on inch* R iB tho outer radius of curvaturo of the furnace in inch0B

224. Corrugated Fireboxes of Vertical Boilers—For the somi-spirally corrugated fireboxes of "Sentinol" standard motor wagon boilers the v•orking precure Bhall be determined by tho following formula : t is the thickness of the firebox plate in 32ndB of an inoh, Eqn.(ßl) I) iB tho nuean of the external diamoterg of firebox moagured over the plain part at earh end at commencement of curvature of flange

225. Foundations of Vertical Boiler Furnaces.—Whore circular furnacoB or fireboxes of vertical boilors ore not connected to tho shell crown by uptake tube, smoke tubes or bolt Bto.yg and the whole load on the firebox vertically iB borne by the bottom part of the firebox whero it ig connected to the shell the working pressure for the part, if firebox is joggled out to meet the shell or if on ogee ring is fitted, Bhall not exceed that found by tho following formulo DO—DI) . Eqn. (62) t is tho thickness of the joggled firebox plate or ogee ring in 32nds of on inch, D is the inside diomotcr of the boiler shell in inchog. Di is the outBide diameter of the joggled firebox ot the commencement of our- vatu-ro obovo joggled port or tho outside diometor of the firebox where it joins the ogee ring, 226. Foundations of Loco-type Boiler Fireboxes.—Whero tho fro-box roofin loco- type boilers is not stayed direct to the externul 00Bing crown Or to girders carried by tho casing or is not connectod to tho casing by slings in accordance with Regula- tion 229 (c) and the whole loud on the firebox vertically ig borne by the bottom ports of the firobox where connectod to tho external oosing the working pressure for the ports, if plates are joggled out to meet tho casing or if an ogeo ring iB fitted, shall not exceed that found by the following formula 70 (X (L+W) Eqn. (63) t is the thioknoss of the joggled firobox Sido plates or fire holo plate (wh iohever iM lesg), ogoo ring in 32nda of on inch, L iB the length of firebox oasing in inchos measured between tho water sideg of front ond plate and Bbddle plute ot the foundation seam, W ig the width of firobox oosing in inches moasured betweon the water sides casing Sido platog at the foundation seam, WI is the width of firebox in inches measured botwoen the water Bides of firo box Bido plates at the commoncornent of curvature above jogglod part or where it joins the ogee ring, Whero only o comparatively narrow strip of tho firebox roof is Btoyod directly to the casing crown the orea so stayed shall be doducted from the area roprosented by L X W in tho bottom line of tho formula thus, (L xW—A) (W—WI) and NO used in Equation (63) in determining the working pressure for the parts, ('A" being the oreo in square inches of the part of roof supportod by tho cosing crown

227. Crogg Tubes.—The working pressure of the tubes shall be determined by the following formula : D W. Working pressure in lbs. por sq. inch, t— minimum thicknosg in 32nd8 of an inch, D— the internal diameter in inchog of tho cross tube. Eqn. (64) 228, Uptakes Of Vertical Boilers.—The working pr€8ßure for uptako tub(s of vertical boilors Bholl bo determined by Eqns. 57 and 58 but only half the least pressure go found is to be allowed for uptake tubcB. SUPPORTS FOR COMBUSTION CHAMBER AND FIREBOX CROWN 229. Girder gtBY8 for firebox For girders supporting platCß Of rectangulor fireboxes, where the ends of the girders are supported by the vertical end or Bicieplates, their proportions shall be calculated from the following formula:— CST W.P. Where WP = Working pressure in lb. per sq. inch, Eqn. (65), s c Minimum tensile Bt,reNB of thc motoriol in tong per sq. inch, Total thickness of the

stay in thirty seconds of on inch, Depth of the girder Siay in incheq, Length of girder Atay in inches measured between the in.ßidc of t,hc tube plate ond the firehole plate, or between the inside of thc side platee, according to the method of support. Pitoh of girder stoyg in inchea, — 22 for steel plates or gtccJ. forgings 19 for steel costingg. (b) Where girders orc supported in any other way (han by the end or Hide p]bteg of the firebox or combustion chamber the calculations for In in-ing the working pressure shall be made in accordance with octuol conditions of support. In such cages the length of the strip of firebox or com bugtion chambcr top plate to be Bupportcd by the girder shall, Hubjcct to the limiiJ ilnposed on thc distance of the neoregt stay, bc token og egual to the produe{, of tho number of bolts curiod by thc girder into the pitch of the bolts. A maximum stress of 14,000 Ibe. per aquare inch on girder seoLion *hnll bc allowed for steel. (c) Slings, links, pins, rivets, and connectiong io shell of Blung girders *holl be guffcicnt to carry the whole load that would oLhcrwise be carried by the girder, ancl each girder must be eqnnlly slung or supported. For regges bllowed on thc sectiona see Regulation 209. (d) In the case of girders supported at {'he ends only by R,ngle bara riveted to the casing crown, the longth L Inay, when the girder extends over the full breadth' of thc angle face, be taken os the diBtance between the centres of the ongle focea. When this distoncc does not exceed thot of L in (Jhe formula, the pressure Bhall be determined in the ordinary way. The supporting angles ond rivets shall bc of sum. oient ion for thc intended puJ pose. For stresses allowed on the sections, sec Regulation 203. PATENT FIREBOX ROOFS OF LOCOTYPE BOILERS 230. Marshall Type.—For Me.BBrg. Marghall Sons and Company'g patent Btayle€s roof for fireboxes of locotypc boilers mode of stecl in which the cent,ro lines of thc corrugations meet thc centre lines cf the encl riveted seams at, points not foriher diBta,nee from thc Bide plates than ono hull' the inner radius of curvature of the oorncr formed by the roof and *ide plate, in order to ensure thot tho thickness and height of thc pregp.ecl diagonal corrugations of the camber oro *btisfnctory, the working pressure shall not execed the smaller of the values obtained from the follow- ing formulæ : 25000 (tr—.l) xH2 55 (W x W.P. Eqn. (66) Eqn. (07) t iB the thickness of the roof plate in 32nds of on inch, H iB the height of the corrugation 8t its highest port measured perpendicularly on one Sidc of the plate in inchos, W is the widhh of the roof plate between tho flot of Bido plates ot top less the inner radius of curvature of corner of roof and side plate in inches, i.e., W+radius — internal width of firebox at top, L iB the length of the roof plate between centre lines of rivets in inches

231. Garrett Type.--For NEBBrs. Richard Garrott and Son's corrugated stay. less roof for fireboxes of locotypo boilers mado of steel in which the Sidc corrugu- tions ore ports of true circles ond the radius of the middle corruga,tion not moro than a,bout of tho radius of Lhe oul er corrugations ond the corrugations ore cam. bercd longitudinally, the working pressure Bhull not exceed the smaller or the vulues obtained from the following formulæ (1,+24) W.P. t iB the thickness of the corrugated plate in 32nds of on inch, Eqn. (68) Eqn. (09) L is the lcngth of tho roof plate between centro lines of rivets in inches, R ig the ofternal radius of thc gicle corrugations ot the middle of the length in incheg, C = 363 wherc the roof and side plates arc in one piece and 325 when they are riveted, 12• 5 where the roof ond side platCN ore in one pieco ond 11 •25 where they are rivcted

232. Fowler For M 'ssrs. John Fowlor and Company's (Loed8) corruga- ted roof for fircboxes of Io •otype boilers made 01' stccl in which thc crown of the roof iB transversely curved and corruga,Lcd in the style of Fox's corrugated furnoce ond the roof plute, if not sol,d with the side plotes of the firebox, is securely riveted thereto and to the flunges of the tube plate and firehole plute and there is a, row of suitably sized and spaced screw stays Below thc commencement of corrugations on each side attaching the roof platc Lo the external casing, when the conditions hereunder ore oomplicd with, thc working pressure Bhall not exceed the smaller of the values obtain- ed from Lhe followmg formulæ : 1) W.P. Eqn. (70) Eqn. (71) t is thc thickness of roof plate before ore forrncd, in 32nd* of an 'inch. is the thickness of siclc plutes of firebox to which roof plate is attached in 32nds of on inch, R is tho radius of transverse curvoture or canibcr of middle part of corrugution measured from the bottoni of corruga,tion on water side, in inches, W ig the width of firebox in inches measured over water Bides of side plates at the sea,ms uttoching them to roof plate, 1 (b) Th' corrugotion,A measured from top to bottom on one Bide, 8hbll not be legs thun throc times the thickness of the finished plute in depth H,nd not more thon 12 times the i,hiQknegs of the finished plate upgrt, (c) The inner rodius of corner ot sides where corrugations merge into the flat Bides shall be not lege thon 4 timed the thickness of the finished ploto. (d) Tho length of the plain parts ot ends

of roof bctwecn tho centre lines of riveted seams ancl comrnenoemcnt curvnture of corrugations 811811 not exceed that allowed foc flat plbtc under Regulation 200

CHAPTER V FUSION WELDED AND SEAMLESS FORGED DRUMS FOR WATER TUBE BOILERS AND SUPERHEATERS GENERAL REQUIREMENTS 238. Where applicable tho genoral i,ormg of Choptor I relating to Cori ificutcs from Makers, Inspecting Authorities, etc., and of Chapter Ill concerning construc- tion should be followed. MATERIALS OF CONSTRUCTION 234. Material For Fusion Welded Boiler Tho of gulations 9 to 20 go fur 8B they relate to plates, Bhall apply to steel plates for fusion welded boiler drums excopting thot the ultimato tensile Btre8B and elongation of the materials Bhull be between the limits shown in table below and shall be specified for •each component part of the boilers. Degor, ption Ultimut,c tensile MI u in-nun elongation étreB' Tonq por *LI. in P18t(54 for drum dh ills w upper p!.Lt and 28-32 tube platog). Drum *tand or brts•nch on 1 808ting* I for Inountmgg. .1 per cont. 'J'egt pujre A or B 20 23 for 26—30 t por sq. in 2() for 28—32 tong per sq. in (b) Plates over 2' in thickness before being fabricated, shall be uniformly heat treatod to produce grain rofinernent. Heut treatment involving quenching in o liquid medium is not permitted. SEAMLESS FORGED DRUMS 235. Process of Manufacture.- —Carbon Bleol for souml(steol drums shall bo made by the open hearth or an electric process, acid or basic

236. Chemical AnalYBiB.—The steel ahall contain not more than 0 05 por oent- of gulphur or Of phosphorus

287. Freedom from defects.—Tho drum shall be freo from surface defects and Bhall be machined to the prescribed dimensions. Defeotg in forgings Bhall not be repaired without the previous sanction of the Inspecting Offoer

288. Heat treatment.—Each drum Bhull be effcient]y hcat freated : (a) At various stagea during manufacture, as required. (b) On oompletion of the forging procegg but prior to the hydraulic teet

239. Mechanical Tegtg.—MatßriuI shall cornply with the mechanical tests heroin specified. Sumcient material shall bo left on the open end or ends of each forging to enable tangential test pieces to be taken. These teste shall congi8t of not less than one tensile ond one bend tost from each open end. In tho case of drums with open end-B tho tost material shall not be parted off before heat treatment. If the drums are closed in at the ende the test rings Bhall be Flirtod off immcdiotely before this operation ; Bubsequcntly tho test rings and the forging shall bo similarly, and simultaneously heat treated in the some furnace

240. Selection Of Test All lest picoeg Bhall bo d Ly lhe guiho- rised Inspector and shall be tested in hig presence and he shall satisfy himself that, the conditions herein described are fulfilled.(b) Tengile resist—Tho ultimate tensilo str(. and elongation Bhull Le bc t ween the limits shown below. A range of not more than 4 tons per sqr in. for any one forging shall apply, such rango to be specified for each drum. (i) Ultimate tensile stress 28 to 38 tons per sq. in. (ii) Elongation 29 per ccnt. to 19 per cent. dotermined on British Standard Test Piece C, or o subsidiary standard round teat piece (see Appendix B). In no case Bhall the gurn of the ultimate tengile stress ond corresponding elonga- tion be less than 57. Should tensilo test piece broak outside the middle half of the test gouge length the test may be diBcardcd and another test be made of the same drum. (c) Bend Test Pieoeg.— -Bend test vieces shall bo of rectangular section 1 in wido by in. thick. The edges shall be rounded to a, radius of I (IO-in. The test pieces Bha be bent over the thin-nor section. (d) Bend Test8.—Tho test pieccs shall, when cold, be cupablc of being bont without fracture, through an angle of 1800, the internal radius of the bend being not greater than thot specified in table below. Ultimata tennile streaa, Tona por sq. in. Upto 32 Above 32 and upto 36 Above 8f.} uncl upto 38 Bend test may bo made by preggure or by blowg. Intornnl radinq of bend Inches 1/4 241. Additional teste before rejection.—Should oil her a tc,nsile or u bend teNt fail, two further tcsts of the type which failed may be made on test pieces cut from the game test ringg. If the results obtained from these re-testg are gatißfactory, the drum shall be accepted, provided that in other reepectg it fulfils tho conditione of this Chapter. If thege re-tegtg do not give satisfactory results the drum repregented THE GAZETTE OF INDIA EXTRAORDINARY 688 may be re-hebt-treated togother with tho romoindor of the test rings, and presented for further testings. In all case where final re-test8 do not give satisfactory results, the drum re. presented by the test pieces which fail gholl be rejected. 242. discard shu 11 from the i op oncl bot Lom of each ingot to ensure sound-nogg in thc portion for forging

243. Forging.—Th') forging ghnll be I-nn,de from u solid cost ingot, punched, bored or trepa,rmed, or alternatively, hollow cast ingote may be used. The resultant wall in the case of the solid cast ingot, or the wall of the hollow ingot as cast Bhall be reduced in thickness by ot least one half in the process of forging. (B) Tubt-hl shall of cold dcnwn woldloss or hot finiNhod weld10B3 244. Tubes. steol und shall comply with Regulations 36 to 56. Hoa,dors and similar pressure parts shall be of forged steel, seam- legs steel tube or of cost steel, to comply with tho appropriate Regulations in Chapter 11

245. Pipes.- -Pipes forming an integral part of the boilor unit shall oomply with the Regulations of Chapter V.LII

246. Steel Castings.-Steel castings for pressurc parts shall comply with Rcgu. lotions 73 to 80 (28 to 35 tong per sq. in.). FUSION WELDED DRUMS 247. Deflnition of term 'FuBion Weld'.— Fl'ho torm 'Fusion Wold' is, for the purpose of thig Chopter, applicable to all welded joints mode by tho rnetal oro pro- cess with covered electrodes or other electric ore process in which the orc stream and the deposited weld metal are shielded from atmospheric contamination. It is intended that this Chapter Shall apply to the single run or hcavy run welding process and that welded boiler drums manufactured by that process shall conform with all Regulations of this Chapter, excepting those in which divergence is necessary eolely because of special requirements essential for tho most omciont utilisation of that process. Thus all Regulations governing quality of material construction, workmanship and testing (both non-destructive and otherwise) aro applicable. When welded dcu.rns ordorcd to this Chapter are mode by the Bingle run or heavy run process it will bo understood that Rogulationg 252 ond 267 do not apply in their entirety

248. Equipment of The welding plant and quipmcnt are fo bo of good quality and ynaintainod in an omcient working condition. Tho welding oppa- ratus is to bo instal-lcd under cover and arranged so that the welding work may be carried out in positions freo from draughts ond adverse weather conditions. The procedure is to be such that thoro iB regular and Byeternotic supervision of the weld- ing work, and the welding operators are to be subjected by the works offcials to perio- dic tests for quality of workmanship, Records of these tests ore to be kept and are to be available to the Inspecting Offcerg for ecrutiny. (b) The Works should be equipped with on effcient testing laboratory which should include apparatus guitable for carrying out tensile, bend and impact tests, micro-cxamination of spccimons and X-ray examination of the aotuol jointß in pres. sure vessels. The Works should also be oquippod with a suitable heat treating fur. noce having gotisfactory Ineons for temperature control, but as an alternative, arrangements may be made whereby the drums oon be heat treated elsewhere. 684 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 249. Congtructional dctailg and preparation for welding.—The manufuciurcr shall supply tho Inspecting Authority with fully dimensioned sectional drawing showing in full detail the construction of the drum (8) for approval before putting the work in hand. A full sized dimensioned sketch of the weld grooveg for the longitudinal oirouxnferential seams shall be shown on the drawing. Full sized dimonsioned sketches sholl algo be shown of the details of the joints for stand pipcs, branch pipes and seating and the position of those joints relative to the longitudinal and circumferential scams and other openinge shall be indicated

250. Preparation oi platep.-. Thc cdgeg of 011 pluta Bhall bo prcpam d and sur- faced by machining or chipping, Before welding is commenced, the groovcs Shall be thoroughly cleaned of rust, oil or other foreign matter. Before welding of the joint ig commenced (apart from tack welding) the surfaces of the plates of tho longitudinal and circumferentiol seams shall 8t no part be out of alignment with one another by more than 10 per cent. of the plate thickness, but in no oase exceeding 1/8 in. for longitudinal joints or 3/16 in. for oircumferential joints

251. Cylindrical shells of drums.—Each drum Ehell plate Bhall be of cylindrical form to the extreme edges of the plate. The bending Bhall be done entirely by machine and local heating or hammering is prohibited. Where the plates are bent to a, diameter less thun 40 til.nes the plute thickness they Shall be effciently heat- treated ofter bending to relieve internal BtreBB08 unlegg during the last etage of bend- ing they hove been uniformly heated throughout

252. Method of making welded joints.—The seams Bhall be welded frcnn both aide of the plate. Before tho sooond side of the plate is welded, the metal at the bottom of the first Bide shall be removod by grinding, chipping or machining. Additional rung of motal shall bc dcposited at both surfaces of the welded seams go that the weld metal at the level of the surfaccg of the plate i.ß refined as far ag pos- gible.

The surfaces of the welds shall thcrcaftcr bc machined or ground so as to provide, smooth contours and to be flush with tho respective surfaces of the plate. There shall be no undercutting 8t tho junctions. The positions of the welds shall be marked permanently to facilitate their loco. tion. Not less than two runs of metal shall be deposited at, each wold fixing stand pipes, brunch pipes und seatings. Each run of weld melal shall bo thoroughly cleaned and freed from slag before the next run is deposited

253. Type of welded joint8.—The longif udi-nal and circumfacntial be made with but joints of the single or double U or Vee type

254. Number ot joint8.—-Where, having gard to Ihe approved design, the dimengiong ure 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 ringe Bhall not fall in line

255. Position ot tube holes.—Tube holes Hhblj not bc locat(d in a welded joint. The distance botwcon the edge of hole and the cdgc of a longitudinal or circum. ferential seam shall be not ICBB than I in. where the plate has o thickness less than 1 in. In plates 1 in. to 2 in. thickness the minimum distance shall be not lese thon the thickness of the plate. For plates of thickness greater than 2 in. the minimum distance shall be 2 in. N 0TE.—Tho edge of the wold shall be (onsidcr(. d ag the Edge of the weld groove 08 mochinod in the platc prior to welding. SEO. 31 THE GAZETTE OF INDIA EXTRAORDINARY 68b 256, Circularity of drums.—Tho difference betwocn the intcrnal dit metcr of the drum measured ot any orosg section and the norninol internal diameter of the drum should not exceed per cent. of the latter. Any departure of profile meagured on the outside of the drum with a gouge of the designed form of the exterior of the drum ond of length equal to L quarter of the internal diornetcr, shall not exceed the percentoge given in table below :— Nominal Lilternul charnetor oc drum I-nch8B Up to and including 3d Over 36 up to end Including 45 Over 45 Porccntago of nominal I-nt.ornel. charnotor 0 36 Flat* ot the welded Beams shall not be permitted and any local departure from circularity Bhall bo gradual

257. Mechmical tests and test plateg for fusion welded Fusion Weld- ed jointe shall comply with the mechanical tests herein specified. Not less than one get of test plates shall be provided to represent the welding of each longitudinal seam. The teet plates may be attached at each end of the longitudinal geom or the 806 may be located ot one end only. (b) Where the drum shell is forrned in two or more courseg, the staggered longi- tudinal soom shall be regarded as a continuous longitudinal seam, provided the welding be effectod in one reasonably continuous operation and by the game operator or operators. (c) Where there arc circumferential seams only or where tho mcthod of welding the circumferential geom differs from that employed for the longitudinal Beams, tho method of providing the test plates shall be decided by the Inspecting Authority. (d) The test plates Bhall be of a size suffcient for the preparation of the test pieces specified in Regulation 258 (o) and for any repeat tost pieces that may be re- quired. The material for each get of test plates shall be cut from the respective plate or plates forrni_ng tho appropriate seam, and before being cut Bhall be Btamped by the Inspecting Offcer. (e) W hon Lhe analysis of the plates iN approvcd by thc Inspecting Authority cnd iB considered sumcicntly similar, the test platea may be eut from one drum shell plato (f) In the cogc of imuffcient motorial being available on the shell plato to permit the cuffing of test picceg, these shall be neceptoblc if they aro •mado from another provided it is made from the same ca,Bt. (g) The weld groove in the test plot,0B Bhull bc similar to tha,t adopted for the corresponding Odgeg oc Lhe longitudinal Beam, b.nd the respective fusion faces BhBll be in continuous olignjncntl. The test plates Bhall be reinforced or supported during welding in order to prevent undue warping. The weld metal in thc test plotcs and the seam Bhbll be of tho same grode of electrode oncl sholl bc deposited continuously the game operation. . THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 (h) Thc weld in ony test plate shall not be repaired un-10BB agreed by the Inspect- ing Authority and tho repairB Nholl be done in guch a manner os will ensure that the repaired geom in the test plate is still rcprogcnLotive of the materiol in tho moin seam. (i) Whoro it iB desi-rod to stroighLen test, plates which hove warped during weld, ing they moy be straightened at B temperature below the temperature of heat trebt. ment of the drum to which they belong. Straightening shall toke placc before final heat treatment. (j) For hoat trootment see Regulation 267. (k) It ony defects in the weld mctbl of o test plute ore revebled by radiogrophi- Obl exomillibtion, the position of those Bhbll be clearly morked on (Jhe plato and test pieces sholl be BCIected from such parts of the test 83 moy bo decided by the Inspecting Authority. 258. S31eotion ot Test From the test plate or plot0B on each lon- gitudinal seam, toat picccs ghd,l-l be selected

for tho following tests, tho specimons being cut out shown in Figs. 16 and 17 a,nd stumped by the Inspecting Offcer for identification :— (i) Ono tensile test specimen for the welded joint. (ii) One all-weld metal tonsile test specimen. (iii) 11'wo bend test specimens. (iv) Two -Izod impact test Bpccimcns. (v) One specimen for micro 8,nd macro exominbtion. The remoinder of each Bot of tost plot,ey shall be retoined for any re-tegts re. quired. Any specimen for re-test shall be cut off from the some got of test plbtee the original specimen. (b) Surfaces of tcngilo, bend nnd Izod impoot specimend corresponding with the outsido or inside of the drums shall be only lightly dresged so thot the rolled surfa,cc of tho parent metal is not wholly removed, except that where the rolled eurfoccs of tho abutting plates are not levol with one another, one plute may be machined at ca,ch face of the weld, proviclcd the depth of metal removed does not exceed 1/32 in. to 2 3 o I. 3. 4

5. Fig.ld.—Detailå of tegt plBte8. Tensile for joint. Ten-Bild tost for bll.weld meta]. Bend outer ond innor gurfaca,y of plate (at weld). a. Izod impact togt, outer surface of Plato. b. Izod in- puct t3At, Inner surface of Plato. Micro and mocro specimen. Exampled showing approximate dispositions of the teat pie (50B in the test plates shown in Hgb. 16 ond 17, l. 3

5. Fig.17-—D9tai1s of platæ. te-,t, for joint. test for Bll-wold mota_L B tests, (Yiter and unner surfoe.es of plat • (at. Izod l_rnpa.rt outer surraca of plate b. Izod t, ft, inn-or surfan OF plat* . Micro and macro THE GAZETTE OF INDIA EXTRAORDINARY 11 259. TJ119ile Test Welded Joint.—The dimensions of tho epccimens shall be in accordanco with the sketch in Fig

18. Specimen 1, und the specirncn Bhall bc cut tronsversely to tho wel led seam. When the cupocity of thc available testing machine does not allow the full specimen to be teated, two nar•rower tengile specimens Bhall bc substituted. 'These specimens shall bc the full thickness of the plate ot the weldcd joint ond their breodth8 shall bc as great the testing machine will reasonably allow, provided the effective cross sectional area of the tegt pieco is not less than sq. in. (gee Fig. 18 Specimen Io). (b) All-weld Metal.—The dimengiom of the specimen Shull be in accordance with the sketch in Fig. 19, Spccimcn 2. The specimen ghnll cons;st entirely of depo- ßi%ed meta,l and sholl -be cut longitudinally frcm the geom. p Spooimcn l: Tensile test for jointB. Specimen la. 'I'ensilo toxt for joint* plates). Fig. 18.—Tensi1e test pieces. Thickne8i3 of plate. Broodth of test piere : Speoiznen 1. Not 108B than T n,nd In no than 14 in. Spgoimon lb. T x b not leu than l} . in. W = Width of wold groove. p c Parallel length, minimum= 3 x W. Rt shoulder, Iniilimurnc.• in. all-weld metal. R admus at Parallei length shoulder J ametcr 2 82 70 0-50 1-79 O • 45 Specimen 2 Fig. 19.—Tensi1e test pieces : Chuuge length gq• in. in. 798 0 O • 564 0 • 505 0•479 0-452 o, 437 • 424 0•399 o, 357 0•5000 O • 2500 0-20 o. 18 0-16 0-15 o. 1412 o. 1250 o. 1000 1-70 I •55 P mmimum in. 3•18 2•25 2•01 1•58 • 42 R minimum • 42 0-40 0-39 0•37 0-35 0•31 260. Tensile Welded Joint. Thc ultimate stress shall be not less than the lowe. nit, specific d tor the plate (see taig [e under Reg. 234). (b) All-weld Metal.—The ultim tensile stress shall be not less than the lower limit specified Plate O ce table under Rea. 234). The elongation shall not t,han 20 per cent. on a gauge length of four times the square root of the cross sectional at ea of the specimen, and the reduction in area not less than 35 per cent. (a) Two bend test specimens Shal] be made

261. Bend Test Pieces. The specimens shall be ectangulav section and shall be cut transverselv from the weld so as to have a width equal to onp-and-a,,half tirnes the thickness of the speci- mens. The corners of the speci01en shall bc rounded to a radius not exceeding 10 per cent. of the thickness of the •pecimpn. (b) Where plate thicknesses do not exceed, l, 1 14-in. the thickness of the specimen shall be equal to the full thickness of the test plate Where thp plate thickncss exceeds l, 1/4-in. the specimen shall in all cases have a uhickness of at least 1, 1 14-in. The specimen to be tesfed with the outer surface of the weld in tension shall be prepar- ed by cutting to waste the metal local to the inner surface of the weld so that the desired specimen thickness is obtained (see F]g. 20, Specimen A). The specimen to he tested with the inner surface in tension shall be prepared by cuttinø to waste the metal local to the outer of the weld so that the desired specimen thickness is obtained (see Fig. 20, Specimen B). Where thc thickness of the piate permits. both specimens may be cut from the same piece of plate, the specimen being located in the plate on • above {he other (see Fig. 20, Specimen C). Spec cei OUt« Normal spectrmn hmr Boeh sxcå—« C C0*Ms nunÖed Surface oi weld In Fig. 20.—Specimen 3 Bend Tot

262. Bend Tests.—Ono specirnon shall be tested with the surftl,eo corresponding to the outer of thr drum in t,engion ond thc other with he surfoce ponding with the inner surface or the drum in å,ension. The

speeimens to ber mounted on the of whieh ore by a distance not Illore t,tum 5'2 timos th of (he gpcc•ilnen, and NhRll be pushed through thc supportB by former boving a (linrncter equal to three times tho thick.ncsN of th specirncn. On cornl)tefion of f,he test no ot' defect on the outer su_rfneo off,he specimen 8h8kl bc | (1 6 in. measured thc specimen or 1/8 in. nu•agured along the leng of gpoc•ilncn. Premature failures at thc eorners of the specitnen not be considered ctl,uge for rejection

263. Izod Impact Testg.—The dimensions of the two gpecinums shall be in ao 01 dunce wittk Fig. 21, Spechncnr-, a nd 4b. Ono specimen shall have f,he notch eut at (he midcllo of outnr gnrfnrne of tho wold und the other thc middle of the inner gurru,ce of tho weld. The tCBts Bhall Bhow a minimunl Izod test-volue of 30 fk . lb. gpo. B] GAZETTE OF INDIA EXTRAORDINARY 22mm. 691 7Smm & m mer OF Fig

21. Specimens 4a and 4b Izod impact test piece8

284. Additional tests before rejection—(o) Should of the (est spocimene 257 to 263 to yncet specified requmcment8 taken in accordn,nce ith Rc•gg. one re-test, Nhbll be bllowccl for each specirnc•n that, fails, provided the following minimum fignrcs have been obf nined • (i) Reduction in urea PCI' cent, (ii) Any other test except, the bend and impa,et tests, 90 per cent. of the specified requiranents. (b) If cold bend speeilncn should fail to meet thc specified requirements, two re-test,8 Bhall be luken frorn the same test plate and these 8hbli comply with the T equirementg of Regulations 201 and 262. (c) If an Izod impact test fails to meet the specified requirement g, two re-tegt8 ehmll bo token from the tegt, plntc, one ea SICIc of the original specimen and -from it by not more thon 5 mm. Both rc-teNIJH sha,ll show o minirnum Izod impoct test volue of 30 ft. lb. (d) If it be found there iN insuffcicnt Inetjul to permit thc prepnraation of speoi- mens for re,,tcst from thc remainder of the test plate which the original gpeoi- men was taken, the specimen for re-te€t may be cut frmn the t,eHt plate relating to the opposite end of thc game longitudinal seam

265. Non-Degtrucfive Tests.- (u) Micro and Macro specimen, the full thickncBB of the plate and not Iesg than half-nn-inch vide l.nay be taken from each Net of plot,cs by the Inspect,ing Authority for thc purpose of micro and .ma,cro examination. (b) Examination.—Evor.y portion of thc longitudinal and Qi-r. ournferentibl welded joints of the Shull bc subjected to rndiographical exami- nation. Thc method crnployed in Obi a,ining the radiographs *hall be such as to show olca,rly defects having magnltude cqual to 2 per cent. of the thickness of the welded joint. To dctermine whcther hlß result ig being obtained nn indicator of approved form which includes portion equiva lent, to not rnore than 2 per cent. of the joint thickness, Shall be ploccd in the vicinity of the weld go to make record on each radiograph. Each section of every weld Bhall be h) urked so that the radiographs can be easily correlated to the porticulur part of the joint reproNentcd. 692 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 'like oxamina,tion shall be made from the original films and tho acceptability of tho welds shall be decided by the Tngpeoting Authority. The welds deemed un- satisfactory shall be rejectod or dealt with under Regulation 266 and be radiographed again. REPAIRS TO SEAMS 266. (o) General.—A-ny ropair io u wold carried aut by [he manufacttuer shall first be ogreed to by the Inspoeting• Authority. Where dofeet8 occur in diBtribut0(l •positions in a, seum, to the oxtent of 15 por cent. of the total longth of the ghall. he pennitted to replaco Che defoctive welding. Where Che defects aro lorut81i in Ningle pontinuoug longth, Che permissible extent of ropuir shall be decided by the Inspooting Authority. (b) Longitudinal Seam..8.—Where the wold metal in any woy fails to comply with tho requirements speoified, the whole of the weld metal may be removed and the Noam re-weldcd provi 3d that ; (i) the original test plutos are similarly treated, or (ii) new tost plates of tho thickness us the joint and of similar quality Of tnoterial Eire uttached to ond of the scajn and re-weldod with it. In oithell tho platea be tjegtad in oecordunce with Regulations 257 to 265 and the requiromonts for heat trcmLrnoniJ shall be in ocoordanco with Regulation 267. (c) Circumferential Seams.—-Wit h regnrd to tho extenl, of permissible repair ond when agreed by the Inspoeting a circ uruferential seam shall be treot• ed in the samo rnlinner o longi seam. 'Ilho rngpaet,lng Authority shall be entitled to ca,ll for reprosonüutive Lest8 for ro-welded seam. (d) Removal shall bo eut out by ohipping or machining only and not by burning Olit the defective port. (o) Examination before Re-welding.—Where a defective part has cut out, tho Ingpocting Authority Bhall bc ontitled Lo mako an oxarnina,tnon bofore re-welding. (f) Process used for Repairs. (hily metallic arc welding shall bo uN€cl for repairs. (g) Radiographica! ef.trt' Repaire.—A11 repaired aroas *hall be sub- jeoted to radiographical oxo ruinouo,l.

(h) Spnnämtü Representing Repairs.—The Inspecting Authority shall be on- titled to cali for Bl)e• imens representing any welded repair, for the purpose of exa- mimtion und test. (i) Diagram of Welded Repairs. (_)n completion of welded repairg the manu- facturors ghull, If roqnesLed, supply for rooord purposes a dotoilod diagrum Bhowmg the position, longth, depth ond width of all such repairs. HEAT 267. (a) Aftor thc cornple,tion of the welding of thc soams and the welding on of the stand pipes and includmg welding repairs but before the hydraulic test, each drum shall bo heat treated for sLresy rehev ing ; during this heat treatment the official test plates shall be lying inside the drum. (b) Where the shell it-I subjected to a prirnary 8tross relieving treatment identi* 001 to the final heut troatmont to bo given to the drum, the test plates may be plao ed inside the shell during the primary treatment and thereafter cut up and tegted with- out waiting for the finol treatment of the drum. '1. or INDIA (c) Where the shell is not guf)ieetcd to prima,rv rolieving treatment or iB subjoct, to B, stress relioving troutnnont which, iB not identical T9ith the final heut the tost plates muy be plueed inside anv oi,hor drum of comparable dimenNions which to be hoat treated in a,eoordun, e w It,h thig Chapter. The heat trebtmont iB to in the furnace in which the (Irurn relntincr to Lho test plateg will ovontumllv bo given , ts final heat ironi,melit•. (d) Totnporoturo Thurts bo submitted to indicato that tho test plates and cooling troatrnont. (e) For thig heat troatment Lho drum shall be placed in a, furnace guff(iently large Io to thc whole druJn. The furnace shall be slowly roiged to a temporaturo between (i000C. and and the drum 8hatl remain unt,ll it Jug, uni- forrnly vouched thiN telnperuture. Such tompern,turc ehRll bo Bustaincd for 75 to 90 minuteiä per I inch thiok ncFf-N of metal. Tho drum Jna,y bo allowed to cool in tho furnace, but, if withdrawn, Nhall be spreoned from draughts whilst cooling. (f) Alternativo proceduro for tho heut treatment of the drum may bc submit- ted to tho Inspecting Authority for approval. (g) In Npocial it rna,y bc permissible to heat troai, the togt plateg separate. ly from the drum, provided the Inspecting Authority Bbtigfiod with tho meanB adopt- ed to onsurc that the following factors will bo the game for the drurn RIB for the test plat08. Rate of heating. MaximuTn tennperature. Time held at Tnoximum temperature. Conditione of cooling. Hy DRAULIC AND TESTS 268. Euch drum on ion of all welding and after heal tread ment shall be subjected to a, hydraulic test pressure of ono-and-a-hblf Limes the boiler drum moxirnum permiN8iblo working pressuro, and whilo the pressure is applied the vold8 shall be given thorough IIR,mrncr test throughout their length, raro boing taken to ovoid darn ugg to tho surface of the platog. After thig Lho pressuro Bhull be rn,iged to tw ice boiler drum maximum permiseiblo working progsuro uncl bo maintained for R length of ilitno Bumcient to enable an in- gpoetion to be _t•nado of a,ll sea,mg and eonnecti011B, but for not leBß than half an hour. INSPECTION AND T p,srnnva 269. Inspection durinx construction.—-lngpoction shall be made bt least nt the following Ftogog of congtruotion : (i) When the tost platog ore readv for Btumping for identification and before they are ouL frorn the parent plato or plaies. flnngod, tho welding grooves ore rna,cllinod, and tho parts arc assembled readv for woldin(l. (iil) When wolfling is in progress. (iv) W hon wolding at the outside surfaco has been cornpleted. (v) W hon the inside Burfnoe hag been prepared for wolding and beforo the outside surface dre8sed. (vi) When the scams are dregsed . (vii) When the geoms are being radiographed. .LLL ux -INDIA Ad-i.- 11 (viii) When the openings are preparod for stand pipes and seatings, and these are being welded in place. (ix) Whon the drurn has boon heat treated, prior to the hydraulic test, (x) When the test plutes aro ready for Inarking off the test spoaimcns. (xi) When Lho test tspoelmens havo Leon machined and are rondy for testing. (xii) W hon the drurn iB ready for hydraulic test. (xiii) When the tube holeB ore bored and tho drum iN e omp1eLed. REGULATIONS FOR DETERMINING THE WORK-DIG PRESSURE OF WATER TUBE BOILERS WITH FUSION WELDED AND SEAMLESS FORGED DRUMS SHELLS 270. Shells of steam and water The working pressure shall be detennined by the following formula: 2fE (T— •03) D+T— •03 (Eqn. 72) T D WP E Thickness in inches. Maximum internal diamoter in inches. Working prossure in lb. per sq. inph. Permissible stress in lb. por sq. inoh at working metal tem- peroturo (Seo Rog, 27]). Effi"ienoy of Ligaments betwoen tube holos or other openingh in Bhel_l or of longitudinal jointB (expreseod ag u fraction) whichever applies. In the particular case of an unpierced wrapper ploto of fusion weldod drum and f=pormissible stress on butt weld from the table in Reg. 271, column B. (b) Irrespective of the thickness obtained by the use of the foregoing formula 'T" shall not be less than (i) For tube plotes (whero the tubes ore expanded therein) the thicknesB *holl be at least Buch 8B to allow a rninimum purallel bolt width of tube seat of 3/8 inch, this seating to be measured 0B explained below. (ii) All tubes shall be carefully expanded into the holcs in (Jhe tubo plateae The tubeg shul-I be belled of beacl to resist

withdrawul and if belled they shall project through tho t ube Nont at least å inch, (c) The Belling shall be shown in toblo below TABLE Outgide cuarneter of tube Upto und Including in. Over in. upto and includmg 2 in Over 2 in. upto and 11101uding 3å in. Over 3å in. upto uncl ineludmg 4, fn. Amount, of (hametet• of bell-mng ovor diameter 01 the tube hole BEO. 81 GAZETTE OF INDIA EXTRAORDINARY 695 (d) The tube holes tho tube plutcs of drunns, poc kots of headers Bhall be formed m such o wav t,lllit the tubes bc effec tnvcly tightenod m them. Where the tube onrls aro not/ normal to the fube plate, thero ahall be n,nglcs to tho of tho tube ot bolt of parallel goat Ing Ut right neck or (o ng Lhe of tho tube least rn In c13PLh m l. m n, at the holo. (e) Whore the tubes aro pral allv Inul to the tube plate or tho heudor less th nn jut Lil g Nh •01, over pro be 8 this p L!'R.IIBI m. 8 in dopth 271. Permissible workmg stresses for sh$lJs of Boiler and Integral Superheater hetbders shall be ag given In the Table bolow : Porm18A1bla fD" gt lxuv.ng LLlt1tn Lta to strt3*8 tons par qq nn. 01 , Workmg temperature 650014' 700QF 7500F 8000F 8500F 90DOF NV r pper 1" vetod forge drains 200 15 13 400 8 goo 300 BLitt weld* of fumon weldcd droms lb./gq 14 ooo 13 500 9 DOO 7 OOO 5 700 Tube plat28 I votocl. fusion welded forge-'d drums 10 8 500 heudf 15 13 (100 ooo 8 goo Snorn10BH forged and headorel lb /gq. zn 17 300 14 200 600 11 300 Intorm3Å1ato values Jnu,y bo Interpolated. The working motal temperature shall be taken as (a) For ßbturuted steatn, water and muddy-urns, tho saturation temperature corresponding to the presBure WP plus 500 F (b) For superh0bter drums, the designed inoximum steam temporbture for that drum plus 500 F Where tho drums are adequutely protocted from the gat-;es of combustion or swept by guoh the third or gubsoquont paBB of a b(D181, tho workmg metal temporature Bhall be t Iken the saturation or despgned Ilia,xlnnlrn 8toam tempera. ture ag defined above, whi0hovor a,ppheB A rovenng of or maulutmg material uhl('h Inay libblc to become dislodged shall not be deemed udequote protection. Note —W hero nro for *-3rvlee at t8A1.1P rat,nr,. -l Dt 70) F It *hall be 80 Bt,oted and the 811Lcon content ghBll be 0 10 per ent rnunmum, or Altern Ltlvely tho Inatornal must "Proof Test for Oreop Quality of Carbon *teal PIBta of Bollor P luti) Quality" In tha App. D. 696 THE GAZETTE OF INDIA EXTRAORDINARY [PART 272. nt ffieils noy- of drum shells Shull comply with g. 21 5, 273. Longitudinal Stress.—The Inakor of boiler and the Insp(eting Autho- rity concernerl shall he responsible for asoertaming that tho longitudinal strogs. resulting from the ion of atieing from IJIternal pregguro, tho gelf weight of tho n). Rnd (and ull oxtornu,lly applied load8, Bhall not oxeeed tho pornHt4F4iblo work mg *trogs corrosponding to tho working metul lempera- tures Included Rogulatlon 27]

274. Intermediate Ü0iler Drum Suppolts.— -M'"horc a r drum ig supported at interrned:ate point* its length at distanoe grater than ono mtornnl diameter from the end of (he parallftl of the drum shell, the sholl k4hnll bc thickenod 100811)' i,he so designed that when the stregg 80t up by tho sup- etca,zn presgure and supported loadN, the rnaximum resultant stress doos not exceed the permi8Fiblt• working Atte* at tho working rnotlil tornperuture. PT,ATEB 275. Shape ot Dished End Plate.—Where an oncl pluto is dishcd to NC mi Ilip- sodiul or partial spherical form, tho maximum radius of dishing shall not bo grobtor than the IJINide diamatar of (he shell (o which the end 1B tached and thc corner radius to tho thi(knosg shhll bo not loss thun four t,llnes the thiek- ness of tho ond plute or whiohovor 18 the greater

276. General.—Tllö IllickneNs Io be uscd in tho formulao ig (he thickness of tho Ploie after prnssyng and is applu able over the whole area of the end plate up to tho poini where th+ d' shing raclitu•l joins •the cornor radius. From thlf•d poll-it a, gradual thinnina upto H maximum of IGO of the thick net-IN T ut the point, TVhere tho ('01 ner lug joint* tho straight portion of the flanged end plate. This permiß8ib10 in thickli0H8 applies algo the flange for thc manhole oponing. In no ea,sfb, however, Bhull tho think ness of the edge of the flange for connection to the shell he loss t ILO thickncbB of an unpier(ed gcarnICS8 8holl of the same diamotor lind In ateribl. at,) When. an nd plate hns flun in manhole 277. End Plate with Manhole. or access opening thc thu k ness Bhall be Increaged by •noi let*B Lhan 1500 of the thH'k- Bhall th1B Inereage loss than (b) Tho clopth of thc Ilango Cot m the a.c cess opening measured from the outer surface of the plate at the ruinol axis of tho opcnlng shall be not loss (Eqn. 73). than of tho ond plate mchee ; when full compensation 1B pro- W = Longth of , n v Idec] for an ut Ill a, d shed ond Plato, no additional thickness IN 278. End plates gubject to pressure on the concave side. (q) Tho maxnnurn working preagure of unBtayed End Plateg aubJect to pregeure on the con- oavo Bido shall be doternunod by the followjng formula: WP WP f 2f (T—o .06) DFK Work ing Pressure In lb./sq. -PermBBlble BtreBN in lb./sq. table below). (Eqn. 74) in. bt workmg metal temperaturo (Sce SEO. 3] THE GAZETTE OF

INI)YA EXTPXORDINARY of end Dlate in tnenos. D=Mean Dianneter of end plate ;nche;-:. R 697 end b'aouÜ holes, o: sDaced -j_t• Q iameter no greater for olates a flan (complying witl: Eqn. Ro). he effective externa] Far •toye upon the ratio he If) frt»n lil (Eqn. 75) Mean raclius of dishing in inches. r—Mean e orner radius of flange. Outside diam+ter of Drum end in inches. DI 045 ot 698 THE GAZETTE OF INDIA EXTRAORDINARY (b) Macimurn permiY8bbZe 8tre88 of 8teel 'l'onsilc Strength of Plato in lbs. inch. Working metal temperaturo 11 24 28 tony 20—30 tong 32 32—36 tony 34—38 tons m r sq. in. per qq. in, 6500 T 7000 8000 8 500 13'40 11600 per in. 15700 13400 1 5200 9000 6300 18500 13900 9000 0300 h D Pig. 28 STAND PIPES OR BLOCKS 279. Compensations.- Exc for those cas3B where no cmponsotion iB necessary ag defined in Regulation 187 adequate comnpensation for tho hole cut for -gtand pipe Bhall be providod. Compensation Bhall bo considered adequate when the equivalent cross sectional areo provided is not loss than 1 25 times the cross sectional areo obtained by multiplying the diameter of the hole cut in the 8holl by tho thiok- negg required for on t-)quivulent unpierced drum Bhell. (b) The equivalent cross se 'tional area providod Shull. caloulutcd as follows (l) The crOBB sect ional arca of the wall of thc Btand pipe upto a point 4 in from the outside au rfaco of the drum 8he11, but proportionately roduced In tho ratio of the ultimate tenailo stresges of the motalB composing tho stand pipo and the drum shell. (2) The cross sectional arcu of the welding fillets external to the drum shell. (3) 'l.'he arou obtlilned by Inultiplying the difference botween tho actual drum shell thic•kncss and tho thickness of an equivalent geamlesg (See Fig. 25). unpierced drum shell a, lentrt,h 2 (3-1-T). (c) In oases where the total compensation obtained by tho aum of the areae i ven above is loss than the total cornpengation requ ired, u eompengoting plate 'hall bo fittod to the drum Shel] ot the si and pipe and socurod by fillet welds •B ghown in Fig. 26. N0TE.-—An rquivblent unporoed drum Bhøll Bhall mean seamless drum ehell of gimilar matcmal designed for the eomo conditionx of prcqut'0 and temperaturo tho drum *hell in queetton. (d) The minirnu13E of i,he fiangoa and of the body of stand pipes shall bo m oeeordance tho table under Reg. 156

280. Attachment Stand Blocks—(a) The mc(hcd of nt shall be in at cordanoe -mih (hut Nhown in Fig9. 24 25, 26 0} 27 und after tho wclding Ihe parts shall he heui, ireuted. holo drilled in the *holl plate for tho reception of the Ntand pipc bo in. greater in diameter than the outgido diamotor of the stand pipe where this if-I secured bv fillct welde only aB Figs. 24 and 2.1 Fig

24. Minimum weld attachment for stand pivs 2 im bore and under.(b) Bloc shall c•ornplv TV ith the of Regulations 94 to 98 (Covered Elcetrodeg for Matul Are Welding). (c) Where ono S'de of a, double Vee ueld hus boon c•oznpleted, the under gurfaeo of the originlll first run of' znotnl *hall be ('hipped hefore welding on the other side i8 commenced. (d) Thc final finish of f he shall bo Htu h thai or gor tion from 8heII to gradual and free frorn sharp (e) So far us f he att H'jnnen(of flungee to is concerned construc- tion shown in 28 & 29 shall be pennif4BJDe. Fig

25. Aru —Minimum weld attachment for stand pipog over 2 in. bore upto and including 4 in. bore. 'J. H L (JI IINLJIA Fig. 28. —Minimum weld attachment for stand pipe over 4 in. bore where compen- sating ring ig required and tor attachment 01 flange to stand pipe8 8-in. bore and over. (Alternative to flange bttachment ßhown in Fig. 27). 702 GAZETTE OF INDIA EXTRAORDINARY I PART 11 Fig. 27.—Minimu19 weld attachment stand pipes over 4 in. bore where a compen- sating ring is not requ•-red mirimum weld attachment of flange to stand pipes over 4 in. bore

CHAPTER VI VALVES, GAUGES AND SIMILAR FITTINGS 281. *Requisite Mountingg and Fittings.—Every boil(r shall fitti d at least with the following Two safety valves (Mtl)lnnnn 3 4") Two independent Inenns of ill(llcatmc.a the water level ; A steam pressme gaur A steam stop e A feed check valve ; Two n)eans of feedlnu• the boiler the heating sutfaco ceedb 200 sq. feet • A blow dowr cook or valve ; A fusible plug hen boiler has internal furnacf s. An attachment for Inspector's test ganee. A manhole, vvhere thn size and construction pot nut, and such nmdholes or sightholes as are nece-nary for effectively cleaning, the boi]et GENERAL Materials, Temperature and Pressure Limits Tlu xuaicrials in the IP,9hL1frcfure of I odi(of 282. (a) Materials. fittinos shall co the *NOTE. —It IS lerommended that Lanc ashzre and Cornish Boilers one of the safety s. alves should be of flyo•h steam and 10M irvpp In water tub• and horizontal Inult1tlLhtL• lar boilers a low a f A alarm should be fitted Ranisbottom tvpe safet' als,es of ! wo salves With lg an lei er rnnm m u be oon-ldpred as two safetv '•lxes the purpose of thlS Regulation In the case of man m• t. pe but!ens I 'w w, ter alarm mav he fitted rn Place of a fusihle OF

INDIA F,XTRAORDINARY 708 (i) *Steel mstings Bhßll comply with 28 tons grade 11. See Regulåtiong 73 to 80. (il) Stool forgings shall comply with Regulations 81 to 85. (m) Iron cu.stmgs Bhall comply With Reguliåiong 86 to 93. (iv) Bronze costings shall hove a, l,ensile breaking strength of not less than 16 tons per sq. in. With an elongation of not legs than per cont. meugurod (jn standard test, picoe C. (v) The scat* dises of volves Bhall be mode of non-corrodible metal. t (b) Limits of Oagt Iron.- Cust iron shall not be used for : (i) TcmperBtureg above (ii) Stcn,m presaureg exceeding 16() tbs. per sq. in. (gauge). (iii) Feed vulvea bncl scum valves directly Ott a,ehccl to boilers for pressuree above 160 tbs. per sq. in. (gauge). (iv) Blow-down fittings. (c) Limits of Bronze Fittings .—Bronze shall not be used for steam temperature 4250F. MTTHOD OF CONSTRUCTION 283. All castingE4 shall be smool h, sound and frcc from flows, crocks 01' other inj urious defects. - Varia,tions in thickness at, any sholl be gradual, ond substantlbl fillets Shall be provided. (b) Tho body of a boiler mounting Bhall be connected the boiler donge by B strong and Bbiff neck. In no shall the thickness of the neck of bronze mountings be less tha,n 3/16 inch for Bizes up to ond including 3/4 inch bore or 1/4 inch for Bizes over 3/4 inch bore

284. Packing of Cock8.—-The bodies of all oookB except those for pressure gouges Bhall be packed with asbestos or other heat resisting material and shall bo of substantial design, thoso over one inch bore shall havo special provision, other than the gland for seem ing the plug. Wu,tor gauge column cocks may be either asbestos pocked or Bolid plug type

285. Covers and Spindles.- Valves of I inch bore and over directly connoctod to boilera, and ot hor valves of Inch bore and over whoro fitted with b cover shall-I hove Buch cover socurod by boltB or 8t11ds and thc screwed portion of the spindlc shall bc outside the sl,nffing box. All valves for superheated stea,m Shull he fittcd with am externul screwed *pinclle. (b) Where thc covers Df valve* secured by gt,udg, the studs ghn,ll be screwed Inio the body With full thread fcn length of len,gt onc dmrneter. Tlhe stud holcg shall not penetr ate into the pressure spac•c of any casting. * No-mo.- Steel whu•h Will to tho eetlon of feed water shall bo modo of of which Lhe m l,ngoncga pontont doca not, oxeaeod • 8 per cent. T By nnetal Inoant motul gpoeuolly 1'0ßzstunE to corrosion and/or oroglon. 704 OF INDIA EXTRAORDINARY [PART 11 (c) Valves with screwed covers shall be fitted with a suitable locking device* to prevent rotation of the cover

286. 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 show clearly whether the valve is closed or open and all valves shall open by ante-clockwise rotation

287. Moving Parts.—The valves and spindles shall be effciently guided and means shall be provided in every case to prevent them leaving their guides. The working parts shall have suffcient clearance to ensure freedom of movement under all conditions of service

288. Flanges shall be in accordance with the tables for the appro- priate pressure.(App. E). (b) 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 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. (c) 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 the working pressure of the boiler. (d) All flanges shall be machined on the face, spot faced, or machined at the back, and the bolt holes shall be drilled

289. Valve Seatings.—Where separate seats are fitted thc y shall effciently secured. Means shall be provided in every case to prevent the valveq leaving their guides

290. Chests etc., in All chests and fittings I n coth, sound and free from flaws, cracks or other injurious defects. After compæt on they shall withstand satisfactorily a, hydraulic test to at least twice the pressure of the boiler for which they are intended. (b) Valves may be fabricated from seamless steel pipes fol vires not ex- ceeding 250 lbs. per sq. In. and temperatures not exceeding 8000 F The welding should conform to Regulation 125 and the valve chests shou after fabrication. The working pressure of the valves shall equation 91 where 2 Se shall be substituted by 1 •8 S. The wah be less than 3/8". They shall. withstand satisfactorily a hydn twice the working pressure of the boiler for which they are m (c) The working pressure and thickness of the chests shall E followmg formulae (Subject to the nnmmum thickness m R' W.P.— W.P.xD D is the internal diameter of the chest in incho t is the thickness of the chest in 32nd* of an li'l C is a co emcient from the follow ng table, ess relieved mined from ness shall not to at least uned by

the 283(b). X ig o provision for tolerance, etc., from the following table : Tablo of Values of C and X Motorial of Outing Caet iron, least IO tons ten-ule Rtrength Bronze, Bt least 16 tona 8trength Oost neel, 28/35 tons tensile 8trength— Por up to 5500 F. For temperature up to 6000 F. For temperature up to 6500F. For temperature up to 700 F. For temperature up to 7500F. For temperoture up to 80009. Por temperature up to 8500 F. Por temperoture up to 9000F. Intermediate values may be interpolated. SPECIAL REQUIREMENTS SAFETY VA-LVIDS 160 175 350 315 280 265 252 230 220 154 x 6 4 8 8 8 8 8 8 8 8 291. GeneraL—Sofety valves, ordinary, high lift and full lift, shall be go oonstruoted that breakage of any port will not obstruct the free and full discharge of steam from the boiler

292. An ordinary safety valve iB a, valve which liftN automa- tically ot least D/24, where D=diameter of valve sealing.(b) A high lift Sbfety valve ig B valve which lifts outomotically ot lea8t D/ 12, There D=diameter of valve seating. (c) A full lift Bbfety volve ig B valve which lifts automatically o distance a discharge orca round the edge of the valve Beoting equal to the oreo, through the volve orifice, when the volve ig fully lifted, after deducting the area of guides or other obstructions

293. Minimum Aggregate Saturated Steam.— The minimum aggregot& area of tho orifices through the seotings of the safety Vblvos on each boiler* (in. aluding high steam and low woter safety valves) gholl be found by the following formula Eqn. (78) Where A—for ordinary ond high lift NBfcty valves the oggregat,o oreo in square inches of the orifices through the geotings of the valves. for full lift safety valves the nett n,reu in square incheg through the seu,L8 after deducting the urea of guides or other obstructions when the valves ore fully lifted. E—total peak load evaporation in lbs. per hour (including evaporation from water WBIIB, steaming economiser, a,nd other heating gurfoce in direct communication, with the boiler), for which the boiler ig specified. In no cosc, however, shall the evapo a,Lion as calculated for thia purpoye,be based on loss than 6 tbs. per hour per sq. ft. of heating surfocc (cxclugive of superheater ond non-steaming economiser). *Subject to the Bppllcatton of Eqn. 79 tho tartn ' 'boiler" Bhull include uny supcn'hoauoc to tho boiler without on mtorverung 8top vulve. THE GAZETTE OF INDIA EXTRAORDINAJ& 11 pressure in tbs. per sq. in. to which tho safety valve is set. constant, us follows 'Llypt) of Vulvo ()rdnu-iry Valvog High Lilt Valves -Full Lift, Volves Spring loaded Valves, Dirac t and I-over c. 4 8 For water tube boilers of ovaporn,tivo oapaoity greater than water per hour C rnay bo inoreused os follows:— Type of Valve Ordinary VolveN High Lift Valvog Full Lift Vulvet* Spring Valves, Direct and I.*ver 9-6 20 Weight 10Bdod Dn•oct or Laver c. 16 10,000 lb*. of Weight loaded Valves, Direct or Lever c. 4-8 9-6 20 Whore two valves ore loaded by a single spring the bbove areas Bhall be increosed by 50 per cent. (b) Superheated Steam.—lf the valves have to POBB superheated steam the area shall be detormined in accordance with the following formula : Eqn. (79) 1000 W bere As=orea, in sq. inch for superheoted steam. A—Area in sq. inch for saturated eteom. 'Li—degree of superheat in deg. Fahr. 294 Over volvos shall be go degignod that the maximun peak loud evaporation for which the boiler is spccified will be oorupletely discharged with a iD preysure of not more than IO per cent. of the safety volve blow-off preuure. 295, Preuure Drop.—The valves Bhall Bhut down ot o prcssuro (b) not more than 5 pet cent. and (b) not less than per cent. below thc Nbfei,y valvo blow, off pressure. For valves loss lå inch diameter the limits shall bc increased to] C) and (b) 5 per cent. respectively. Valves for Bupcrheoted Steam and for water t,ubc boilcng of æn cvn,porutivo copaeity grea,ter thon tbs. or water per hour ghall be exempt from thc minimum requirements (b)

296. Attachment to All the safety valves of boiler ,may be fitted in onc chest but, with tho following exception, such ohest, shall bc sc•pnrute from any other valve chest. Tn t of boilers with overhead engines where tho cylinder costing iB mount- od directly on thc shell, the safety valves may be Offa,ohed to Che engine cylinder p ovidcd that the passage way to the volve complies with the above ruleg. GAZE,mE OF INDIA EXTRAORDINARY (b) The chest shall be connected to the goating by b strong und stiff neck, the passage through which Bhull hove a cross sectional areo at least equal to the gunt of tho areog of the valves. (o) Safety volves shall be mounted so that the axis of the valvo iB vertical. (d) Shut-offs or obstructions or any description shall not be placccl between the boiler ond the safety valve. (e) The inlet and outlet, flongcs shall be drilled in accordance wiiJh the oppro- priate table in App. E for the diometers of flangea adopted. 297. in Shell.—No accessories other than those integral with the Safety Valve shall obstruct the openings in the boiler shell. steam Sha,l.l have direct occeBB to the gofety valve without flowing through internal pipeg

298. Discharge Steam Safety V81ves.—Tho urea of the waste steam possoge both in the vulve itself in the oscape pipe, shall bc not lose than sq. in. for high lift valves, ond sq. in. for ordinor.y for full lift valves. Where E oncl P are definecl in Reg. 293

299. Drainue.—For each enclosed safety valve chest a means of drain- ing shall be provided. The drain pipe shell be loid with a, continuous (lownwordg gradient of the boiler duo a, place where the dischurge is v1Bit)lo and ennnot do Injury to any person

300. Moving Parts.—The volves and Npindleg shnll bo effoiently guided and meana Bhull be provided in every case to prevent their lifting out of tlü-•ir guideH. Thc working ports shall have sufficient ('learoneo to ensure frccdorn of rnovement under all conditions of service. The apindle shall not be fitted with a, Btumng box. r Phe bearings of tho levers of lever valves shul] bo 301. Bearings tor Levers. 60 designed to allow of freo working of the valve under all conditions of service. Where (Jhe lever is mounLod on pin bearinga, the holes in the lever shall bc bushed with non-corrodiblc metal, or tho pins shall be of metul

302. Attachments of Weights and In n levcr and weighi Nüfoty valve the weight shall be in one pieec and attached to the lover in such a way that i,he 88.fet,y valve cannot bo overloaded. (b) In the case of spring loaded safety valves, woghers or ferrules *hull bD fitted under thc adjusting scrcwe NO that the valves cannot bo overloaded when under steam. W horc springs are in tension, links or other suitable stopt* BhalJ bc fitted to I provenlJ the spring being extended a greater amount than that, corresponding to valve lift of D/4, where of valve seoting

303. Easing Gear.—Safety valves Shull be NO arranged thai thoy can be ('as-led off their Beats when under pressure and the easing lofen Shull positively lift the 804. Lift.—Safoty valves shall be capable of being lifted u diBtunco such that the oreo of the discharge edge sholl bc not le-s than the minivn urn aggregute urea, A in Reg. 293

305. High and Low Water Alarmg.—High and low wator a,larmg Nh}ill be a,djustcd so i,hat, the Alarm is sotuuled with the watcr level visible in the gauges

306. Final Setting.—Each SHIfoty valve shall, beforo loaving the mokor's works be adjusted to blow-off ot the specified pressure. 708 INDIA BX'1nAORDINAR± SPBINGB 307. The springs gholl be manufactured from 8tee1 made by the Acid or Open Hearth process and sholl show an analygiB the following oom• poeition :— Carbon Manganese Silicon Sulphur . Phosphorus . not less thon O •9 per oent and not more thon I *2 per oent. . not legg than O •45 per oent. and not more than O •75 per cent. . not more than O •30 per cent. . not more thgn O •05 per cent. . not more than •05 per cent. The manufacturer shall supply an analysis of eooh oa.Bt when required to do 80. Should independent unolysiB bo required, these Bhall be mode bt the rate of one per cast. (b) All springs shbLl be formed hot and Bhall be hordened in oil ond suitably tempered

808. Dimensions.—The compression or oxtenßion of safety valve springs to load the volves to ilhe set pressure shall not bo less than one quarter of the dio- meter of the valve, due conalderotion being paid in the coae of spring loaded lever safety valves to the ratio of leverage. The proportion of unloaded length to externa,l diameter of the spring shall not excced 4 to l

309. Determination of Working Preggure.—The maximum working pressure to be bllowcd for steel springs of round, square ot rectmgulor sec+ion shall be de- ternincd from tho following formulae : (o) Round section 10,000 d8 DACR (b) Squore section, 33,333 d8 W.P. DACK (o) Rectangular section. ¯DACK) Where (all dimensions in inches) Equ. (80) Eqn. (81) Eqn. (82) D 4 D 4 d 1 .615 d (In oaae of rectangular section gubgtitute B Eqn. (83) W.P.=Working pressure in lb. per square inoh (get pressure). orea of valve. d=diometer of round of Bide of square steel. B=Breadth of wire (radial to spring oxiß). H=Depth of wire (parallel to spring BXiß). D=Mean diameter of ooil. W Congtant= Eqn. (84) Ll=lnitial oompregaion Or extenßion of the spring to give the required loading. further compreg8ion or extension of the spring to give the lift defi- ned in Regg. 293, and 304. BcampZeg•.— where oompreesion or extenßion of spring to give the required looding is diameter of valve. • 5 where compre88ion or extension of spring to give the required loading iB diomøter of valve. C— I • 25 where compression or extengion of spring to give the required loading ig full diameter of valve. —The obove formulae are boeed on maximum allowable gofe strou on the aection of the springs of 80,000 lbs. per squBre inch

810. TestB.—CompreBBion springs shall not show any permanent get after being compressed coil to coil Bix times in o quick ooting scrag. Extengion spring shall not zhow permanent set bfter being tested to 25 per cent. in exoess the loud neces- Bory under working conditione to lift the vaalve, 311. Extension springs shall be made from round goetion wire

312. Number of Effective OoilB.—Tho number of effective or free coils in eom- preasion or extension spring Bholl bo determined from the following formulae (i) For Round or Square Wire KxCxd' sxry (ii) For Rectangular Wire Where N —Number of effeotive ooils. Ka: CompresBion or extension in inches at set pressure. 0=22 for round, 30 for square et,eel. d*diameter or side of square steel in 16ths of an inch. S=Load on spring in lb. ot 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. . Eqn. (85) Eqn. (86) 313. Spacing of OoiIB.—The space botween the coils, when tho volve is lifted one- fourth of ite diameter shall be not less than 1/16 in. INDIA IIAIHAUHDINA-t The springe shall be coiled in euoh a manner ae engureg the coils being uniforxnly opaoed and the Bided to be parallel to the axis of the spring

814. Finighing of Ends.—CompresBion springs shall have their (nds wound flat and gmooth and at right angles to the axig of the spring over the full circumferenæ go that when placed on end the springs will stand perpendicular. STOP V A1,ng 315. Lever Valve8.—Where the valve iB operutcd by means of a lever, whether hand or mechanically controlled, the lever Bhall be of ample strength and the bear. in.gg shall be go designed as to allow of free working of the vulve under all condi- Hong of service

816. Steam Stop A steam stop valve Bhall be fitted between the boiler ond the steam pipe and, except in the cage in which 8 superheater formg an integral port of tho boiler itself (e.g. in the Babcock and Wilcox water tube boiler) between the boiler and the guperheater. Where two or more boilers are connected with steam receiver or ony other vesgel, g steam stop valve ehnl-l be fitted between the boiler and Buch receiver or veggel. (b) Steam stop valves Bhall be attached direct to the boiler shell or to suitable pads or stand blocks riveted to the shell, ond the neck of the valve chest gholl be reasonably short and of strong construction : Provided that in the ooge of a larger baler in which it is proposed for the purpose of drainage or owing to obstruction, to oon-noct the steam pipes to the steam stop valve at higher level than would be 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 Bhall bc of strong congtruction, and of wrought iron, mild steel, or cast, steel. The flanges of wrought iron or mild steel pipes shall be riveted or welded to the pipes, and there shall be no branch on thc stand pipe for any other connection, Provided aJgo that in the cage of a largo boiler in which it is deaired to fit a tee piece for the purpose of providing bronch connection between the etop volve and the boiler, such a, tee piece may be 80 fitted. The tee piece shall be of strongr con- struotion, of wrought iron, mm steel, or cast steel ond shall not exceed diametere in height. A etop valve shall be fitted direct to each tee piece branch. (c) No stop valve of the wedge type shall be employed for Bt,eam service. BLOW-DOWN COOK OR VALVE AND PIEBs 817. General.—Thc blow,,down cock or volvo shall be of gubstantiul tion. Tho waste pipe attached to the cock or valve shall not be connected to o pipe to another boiler. The pipe Bhall not be bound fagt in earth or briok- work

318. Blow-down Mountings.—(a) Each b011cr Bhall be fitted with a suitable blowdown valve or cook placed ot, or ag near as practicable. to the lowest point Of the boiler. (b) For locomotive, vertical and marine type boilers, the valve or 000k Ahan be attached direct to the boiler or to suitable pad or stand pipe. For water tube boners the valve or cook Bholl be outside the brickwork with o substantial steel pipe between it and the mudbox. Bøo. L. . E On DLA unl.RAO. DI. IA- (o) For Cornish ond Lancashire boilers the cock or volve may be attaohod to a cast gteol elbow pipe of substantial section bolted to a suitable stand pipe or pad' riveted to the boiler. But céBt iron elbow pipes Bhall not be 819. Blow-down Valve or Cook.—- (a) Each valve or cock shall be fitted with b device which sholl indicate clearly its open and closed pjsitionB, and any key or Bhnilar device for operating the valve or cock shall be such thot it cannot be removed unless the valve or cock ie fully closed. (b) The locking feather shall be secured by welding. (c) Cookß fitted witli taper plugs shall bc Of the bolted cover type with separate packing glands. WATER GAUGBS 320. (u) Every boiler shall have two indopmdent• means of indicating the water level in it ond have marked on it, when applicable, in a, contiguous position easily seen, the level of the highcgt part of the furnaces, firobox or combustion chamber the oase may be. (b) All boilers 3 ft. dia. and over gholl be fitted with two glass water gougeB. Eor small boilers whcrc there is diffculty in fitting two gla,es water

gauges two test cocks may be fitted in place of the eecond glass water gauge. (c) The lowest viBibIe part of the gloss of the water gauge and lower, test cook Bhall be fixed at safe working level. For locomotive type ond vertical boilerg thiB shall not be less thon 2 inches above the highest part of the firebox roof plate. (d) Glasg watcr gauges Bhall be so placed os to be easily seen and reached by The fittings of glass water gouges and test cockg shall be the boiler of gub8tantial moke with lorge passage ways through them to facilitate cleaning. The gouge cocks when open aholl have their handles in 8, vertical direction ond each handle at its junction with the plug shall be plainly marked with cleop line to indi- cato the direction of the passago way through the plug. When detaohbble handles are provided orrangement shall be mude to prevent incorrect fitting of the hand-leg

321. Drains.- A d} ui_n eoek or vo Ive with u guitable (Ilhchnrgo pipe shall bo fitted to each water gouge

322. Protectors.-Whore tubul,ll water gauges fittcd, substantial protectors shall be provided. The glasg shall be suitably troated Lo prevent splin- tering

323. Glass Size.—Tt1bular er gaugo glasses shall be not It-'NS than inch and not rnorc thon } inch outside diameter

324. Safety er gaugo glu:4S mountings Shall be fitted with self.closing icc" in he bottom arnx,. and it is recommonded that a similar devioo should be fitted in the top arm

325. Gauge Columns.—Whoro the gauges arc mount ed on a column thero sholl be no connecting passage between the top und bottorn arms of the column unless valves or cocks are flited between Che column ond the boiler

326. Isolating Cockg.—MThero isolating cocks or valvos connecting water gauge i g top the boiler ore fitted, they Bhull be not leas than I inch bore and of the Vted cover type with separate packing gland. 712 awA7Ætrr-E OF INDIA EXATRAORDNARY GAUGES [Pia* 827. For pressures up to ond including 500 lbs. per sq. in. pregeu_re guage dialg Bhall be graduated in pounds per square inch from zero to twice the pressure, nearly as may be practicable. (b) For proggures exceeding 500 lbs. per sq. In. the ronge of graduation shall be from zero to one and o half tirneg the moxi_mum permissible working pressure, 88 nearly as may be practicable, but in no case Bhall be maximum graduation on the gnage be legg than 1,000 lbs. per sq. in. (o) The ecole on the diol Bhall be clearly ond permonently marked "Ibe. per sq. in.". (d) The diol of each preggure gauge shall have marked upon it in red the maxi. mum permissible working pressure. (e) Whoro the gauge ig compensated for o head of water between the gauge and the boiler connection, the amount of such compensation Bhall be marked on the dial. Pressure gauges shall be calibroted within an accuracy of 1 por cent. of the working pressure. Boiler pressure gauges Bhall be not legs than 6 inches in diameter except in the cose Of small boilers where a, guage not lees than 4 inchB8 in diameter may be used. (f) The travel of the pointer of dial gauges shall not exceed 3250

328. Oonneotions.—All pressuro gauges shall bo fitted with a syphon pipo and a cock or valve integral with, or adjacent to, the gauge in euch manner thot the gouge may be shut off and removed whilst the boiler is under steam

329. Gauge CockB.—Tho handles of i he gaugo cockg shall be purollel to the pipos in which they ore located when thc cocks are open and marks shall be out on the Bhank of the cock indicating open position. CONNn0T10NS 330. Inspector's Pressure Gauge Attachment.—Eve1T boiler shall be filttd with a valve or cock carrying in a, vertical position a receiving screw for the attachment of the inspector's pressure gauge. The receiving eoeket shall be tapped with in. British Standard Whitworth screw thread and shall be fitted with an easily re- movable oop. Fus1BLE PLUGS 331. General.—Fus1blo plugs Bhall be of sufficient height and fitted in such 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. In Lancashn•e BollorB tho fu81blo pluga 8h0LIId be 111 tho crowng of N0Tß .—For example : the furnuccg from I '2 mrheg to 18 Inches 1-n front of the brickwork firo bridge

332. Type.- -Fubiblo plugs shall consist of an outer body with a central conicol poasage, the smallest part to be not greater than inch for plugs suitable for preg- sures up to 100 lbs. per sq. in. and not greater than 3/8 inch for plugs for pressures exceeding 100 lbs. per sq. in. The passage shall be closed by o plug secured by on annular lining of fusible alloy so that the plug moy drop clear if the lining melts. The portion

of the body carrying tho fugible metal should preferably be detach- able from the base to ollow of easy replacement without removing the whole fitting from the boiler

333. Material.—-Tho non-fuslblo portions of tho plug shall. be of bronzo except where the nature of the boiler water precludes the UBC of a, non-ferrous material. The fusible metol shall be on alloy melting readily at o temperature not less than 1500 F in excess of the saturated steam temperature at the maximum permiggible working pressure of the boiler. OF INDIA EXTRAORDINARY 718 884. Att80hment to Boiler.—Wherevor practicable fusible plugs shall •garewed into the boiler plates from the waterside. The screwed portion shall hove -tbrøadß or Whitworth form not more than 11 per inch. VALVES 885. Feedcheck valves shall be of the non-roturn type. (b) Where the valve is not of 8crew-drown non-return type 8 geporote gorew. down valve shall be provided. (o) The discharge from the feed Cheok valve or from the internal feed pipe (if provided) eha,ll be above low water level and in the coae of Lancashire ond CorniAh boilers shall be at least 5ft. beyond the fire bridge

886. Operating position.—Feed chook valves or regulating volv08 shall be 80 orranged as to enable them to be gatisfootorily operated from the boiler floor

CHAPTER Vu SUPERHEATERS TUBES 337. and Construction—See Reg. 151. 388. (a) The Working Pressuro of tubes Bhall be determined by the following formula :— WP (Eqn. 87). Where T —Minimum thick:nesg of tube in inches. W.P.=Boiler drum working pressure in lb. per sq. in. D=Outside diameter of tube in incheB. f=PermiBBibIo working stress in lb. per sq. in. at working metol temperature See Toble below. C=Constant as follows :— Cold Dra•wm Tubes. For generating tubes and unprotocted furnace wall tubes CGO •06 The working metol tomperoture shall be taken ag : Hot Drown Tubes. @) For boiler tubes, the goturotion temperature corresponding to pressure W.P. plus 250 F. (b) For convoction superheater tubes, the maxi-inum steam temperature for which the tube is designed plus (c) For radiant superheotor tubes the designed maximum stoa,m tempera- turo plug more than 500 F, the amount depending upon the super. heater degign. GAZE'ITE OF INDIA EXTRAORDINARY Perm1881bIe Working Stresses for Tubes. [PART WorWng metal temperature Upto 6500F 700QF 7500F 8500F ØOOOF Ø600F 9750? 10000F 10250F 1050CF Tobie. Low carbon stoel tubeg to Reg. 36 and 43 10,000 lbs. lgq. in. 9,000 " 8,000 ' 6,800 ' 5,600 Molybedenum 10/0 chrome *0/0 8toeJ tubeg 12,000 J 1,600 8,400 6,100 4,500 molybdenum tubes 12,000 11,600 9.800 8,400 7.000 5,750 4,500 Intermediate values may be interpolated.— (b) In no cage, however, Bhall the (standard wire gouge) of tube ag supplied be leu than those given in the following table— [Subject to the tolerances Regs. 36 (d), 43 (d), 48 (c) and 53 (c).] Table. OutB1de diameter m inchcg Upto end including 2 Over 2, up to and mcludmg 3 Over 3, up to and including Over 3}, up to and including 4} Woldleas tubes Hot fini8hed SWG 10 10 10 9 Cold drawn SWG 13 12 10 9 (o) Where tubes are bent the rosulting thickness of the tubes 8t the thinnest part Shall be not lese than that required for plain tubeg. HEADERS AND SLMILAR PRESSURE PARTS 389. Material and Construction. Soe Regg. 154 & 244(b)

340. Rectangular Headers Symmetrical in Form.— (a) Thc Working Pressure Bhall be determincd by the following forrnula : W.P. eqn. (88) Where W.P.=The working pressure in lbs. per sq. in. t=The thiokne88 in 1/32 in. b—The breadth in inches between the gupporting Bides of the header leo one inside corner radius ' r ', this being the oorner radius of the rectangular box from 'hfch the header pressed or of the header caging, which Shall be not leu than 114 in. In no case, however, Bhall ' b ' be taken as leu than O •9 of tho breadth bet. the supporting Bides. THE GAZETTE OF INDIA EXTRAORDINARY 715' C=300 for wrought stool and 350 for *teel castings : where the Bides are corru- gated or otherwise reinforced by substant ial supports so that the length of the flat portion between thc corrugations or supports does not exceed ' b '. ' C ' shall be token 175 for wrought Steet und 200 for BLeel costings. f=The pormißsible stress bt working metal temperature lbs. pcr sq. in. gee table below. (b) If the faces of the headers are machined locally ut the tube holes or hand holos the thicknesa ut that part may be as much us 6/32 in. legs than given by Equa- tion 88 but irrespective of the thiokncsg obtained by the use of the formula, the thioknege of the headers at tho tubo holes in 1/32 in. shall be not less than : Eqn. (89). Where diameter of thc hole in inches, und in no oase Bhall the thiok- nega be less than 10/32 in. , except that in small patches not exceeding one-half a sq. in. in area, the tllick-ness may bc 50 per cent. of the thickness used in Equation 88. (c) The permissible stress at working metul temperature shall be ag given in the table below. Working metal ternpergture OOOOF äOOOF 8000F 8500F 9000F TABLE PcrmiBBibIc stress in lb/eq. in.

Wrought stæl having an ult,irnatø tensile etres8 in tons per sq. in. of 24-28 2300 12800 12300 1800 1 0000 9300 7800 26-30 13300 1.3300 13300 12800 IldOO 1 oooo 8300 6.900 28-32 14.300 14300 13800 12300 8500 0300 18,300 10300 15800 14000 11800 9200 6300 84-38 17800 17800 17300 16800 14800 12400 9000 6800 Cut Stool 28-85 tong 10000 9000 8000 7560 7200 6700 0300 4400 Intormodiato values may bo interpolated. The working metal ten) peroture shall bo taken as : (d) For saturated steam, Muter drums, rnud(lrums and hoaders, the saturation Cemperaturc corresponding to the pressure WP plus 500 F. (e) For superheater thc designed maximtun Steam temperature for thot header plus 500 F. (f) Where hgaders are adequateAy protected from the gases of combustion or swept by such gages in the third or subsequent poss of a boiler, the working metol temperature shall be taken as the saturation or designod maximum ateurn temper- aturo as defined obovo, whichever applies. A covering of refractory or insulating 716 GAZEi2Æ., OF INDIA EXTRAORDINARY material which may be liable to become dißlodged Bhall not be deemed bdequbtø• F0taotion

841. Irregular in Form.—ln where the headen are of i.rregular form ae to render improoticable the application of o formula for the determination of thickne88, the manufacturer Bhall Bhow the suitability of the hezderg for the working conditione by indicating practically the maximum internal hydraulio presgure which a header, made to the same degign and of Bimilar will withstand without perrnanent deforn:lation. The maximum working pressure for Bimilar headers may then be determined by the following formula :— Permisßible Btregs ot working metal temperature Eqn. (90). FxC Where W.P.=The working pregsure in lbs. per sq. in. pz=The maximum internal hydraulic preggure withBtood without permanent deformation. •75 for wrought steel and 2 for cast 8teel, 0=15 500 for wrought steel of 24 tons per sq. in. stress, —16 500 for wrought steel of 26 tons per sq. in. stress, = 18 000 for wrought steel of 28 tons per sq. in. Btress, —21 000 for wrought steel of 32 tons per sq. in. 'treg.8, —22 000 for wrought steel of 34 tong per sq. in. "cess, and minimum ultimate tensib minimu-rn ultixnate tensile minimum ultimate tensile minimum ultimate tensile :tninimum ultixnate tensile —15 500 for cast steel of 28 tons per Bq. in. rninimum ultimate tensile stress

342. Cylindrical Hebder8.— Whore cylindrical headers aro provided their working pressure shall be determined by Equation 72. CHAPTER vm STEAM PIPES AND F1m.NGS 343. Steorn pipes rnoy bo wrought iron, w-rought steel, east stoel and in gome cases of copper, Steel pipes may be solid drawn (cold or hoc finished) or lop welded. Wrought iron pipog may be lup welded. Copper pipes Bhall be solid drawn and no pipe made from the electrode position of copper on u mandril Bhall be used for steam delivery. MATERIAL 844. Steel Thesc pip 8 b4 medo by tho open hoarth or an eleotrio proceB3 ooid or bygio. Where the material is used for designed steam temperatures above the ,st• •1 shall be raf non-gegregetod or fully killed tvpe. (b) The material from which these pipes are made Bhall conform to the following requirements : gee Table 1. Ultimate ten.ßlle Btr€B8 in tons per gq. in, Min. elongation per cent. On 2 in. Kind of pipeg Not leg than Sulphur Mc.xim- mum Not more thon thiok 1.088 and then over th10k in. thiok over Piped 32 Pipee Lesa than thick 30 80 phortlß maxi. mum Cold draum WeldU88 steel trips cut from the pipes and tested in their curved condi- tion. TCBt longthB taken from finished pipes (ends of pipes to be plug- ged for gripg) trlpg Clit from the p pea and testod In their curved condition Test lengthe from flnixhed pipcs (end* of pipes to be plug. ged for grips). 8tripB cut t 0111 the pipes elonr of tho welds urad toted in t}" ir curved condi- Mon. Test lengths from R n ighed pipea (ondN or pipeR to he pluc- ged for grips) 23 23 30 30 20 25 18 23 Hot-fini8hed WeldJeeg Steel Row Lapu,elded steel Pipa '2 22 28 2B 20 25 32 23 •718 THE GAZETTE OF INDIA EXTRAORDINATL Hydraulic (water gas) Lapwe?ded Neel Pipea [PART 11 Sulphur LJ]t1rnute tenaile Htr('8R in tong per aq. N ot le€H Not morc tl n 22 Min. Elongation per ecnt. on 8 in. thun Selected gnmples cut transversely maxi- Tn o Phorus maxi • ant i" thick und not and over 23 than 4 18 845. Condition of pipes.—AII Pipos shall be commerciully Straight freo from Elongitudinol seaming, grooving, blistering or other Injurious Bilrface marks. The ends of the pipes Shull bc cut square. IVfrCHAN]OAL TEs'1t 346.- —Flattening test (Por pipes upto and including 4-in. nominal bore).— A ring not less than 2" in length cut from onc end of each selected pipe shall when cold withstand, without, showing cither cruck or flow , being flattened between two parallel flat surfaceB until when the pressure iN released the interior surfaces of the test piece remain at the middle a, distance apart equal to 4 times the thick. negg of the pipe

847. Cold bend test (For pipes over 4-in.nominal A strip wide out circumferentially from one end of each selected pipe *hall when cold withstand, without showing either crack or flaw, being doubled over in

the direction of original ourvature round a bar, the diameter of the bar being :— For pipes upto and including 3/8" thick . 3 times the thickness, For pipes over 3/8" thick 4 times the thickness. Bend Test on the Weld.—(b) A rip 1}" wide cut circumforentiully from one end of each selected pipe with the weld near the middle of the strip, shall when cold withstand, without shoving either crack or flaw, being doubled over in the direc- Mon of original curvoture round o bar, the diameter of the bor being equal to eight timee the thickness ot the test piece, the weld being placed at the point of maxi- mum bending. Additional Should a, pipe selected for testing fail in any one or more of the tests specified above, two further tegt8 of the same kind may be made from the same or other pipe. Should eithcr of thosc fail, the pipes represented nua,y be rehoot treated and Lhen retested. If the repeat test aro 8Btisfnct,ory, the pipeg Bhall bc accepted provided they comply with other requirements but if failure again occurs, the pipes which the tost pieces rcproeont shall be rejected. 348. (a) The process of welding] up jointed seams Shall be by hammering or rolling the joint. (b) On completion of any work which involves heating, whether for welding the joint, welding on flanges, hot bending the pipe or för any other purpose, the pipe Bhall be carefully annealed

349. The pressure and temperature limit* within which pipes, tee* , branches ato,, shall be used Bhall be in accordance with Toble 2.8] OF INDIA EXTBAORDINARY WORKING PRESSURE OF STEAM PIPES 719 850. gtæl and Wrought Iron Pipes.—The Inn,ximunu working pressure allowed on steel or wrought iron pipes Bhall be determined by the following formula 2Se. (t—9) W.P. — 100 D t=nlinimum thickness in hundredths of on inch. W.P.=Working pressure in lbs. per sq. inch. Outside diameter of pipes in inches. Eqn. (91) S=AllowabIe stress in lbs. per sq. inch 88 specified in Table 3. effcienoy factor I for weld-legg steel pipes, for welded steel or iron pipes for values of t up to and including 7/8', •85 for welded steel pipes for values of t over 7/8" and upto and in- cluding 1-1/8', -8 for welded steel pipes for values of t over 1-1/8"

351. Cut steel Pipes.(a) The material Shull comply with Rogulotionse 73 to 80, i.e., 28 tons mi-nirnum tensile Btreee. (b) The maximum working pressure allowed on caat steel pipes Bhall be deter• mined by the following formula : 2S(t-. •015 dl 25) t=minirnum thickness in inches. W.P. •Working pressure in lbs. per sq. in. d—internul diameter of pipe in inchee. dl diameter of pipe in inches. Eqn. (92) S = allowable working stress in lbs. per sq. in. ag specified in Table (4)

352. Copper Tho 10 nforinl shall oomply with Regula(ion 35.(b) Copper pipes may be uged for a working pressure not exceeding 180 lbs. The external diameter Shal] not exceed 5-in. (c) Copper pipes Bhall not be uged for superheated Bteam. (d) The maximurn working pressure on such pipes Bhull be determined by the follomng formula . W.P. D minimum thickness in hundredths of an inch. W. p. working preysnre in lbs. per sq in. D outside diumeter of pipe in inches. 720 GAZETTE* OF INDIA EXTRAORDINARY TABIN 2 (Maximum permi88ible W. P. and Temperature) Materl Bl Mild Wrough* Iron Oa.8t Steel Copper Mothod of manufacture Cold drawn weld-legg. Hot finished weldless. Hydraulic lap- welded. Roll lap-welded Roll lap-woldod Castings Solid drawn Mo-Ii.mü.r:n pormi8dbIe preg.gure in Ibo. No roatriotiong 300 250 No regtriotion Upto ond includ. ing 5'..180. Maximu-m permiMiblo temperature in OF. goo goo goo zoo 426 000 Doan Strdghta, bonds or iee•, eto. Do. Do. Straight', bends or tea, •to. Straight', bond' or toce, etc. Straighta Maximum!permigsible working Stress in lbs. (Values of S) PermiB81ble Working Strega in Ibe. per sq. in. for deaign Pipea Cold Weldless steel, Hot finished i Weld-leag Steel. Hydroubo (Watergaa) lap-welded Bteel• I-boll lap-welded Steel. La 4250 5000 11200 10000 10000 6009 temperature in e F. Over 6000 5500 7000 Up to and including 11200 10000 10000 9000 8000 7000 7560 7600 8000 7200 7500 6760 8000 8500 7000 6300 5800 5280 and 8750 '880 4400 7500 Not uged for thew Koi thee 4 Maximurn permissible working streu in lbß. for cagt steel (Values ot S) PermiB8ib1e working stre88 in lbs. per eq. in. for design temperature in OF O ver 10000 5500 6000 9000 600' 6500 8000 6500 7500 Up to and including 1560 7200 8000 6750 8000 8500 6300 8500 8750 5280 8760 4400 ATTACHMENT OF FLANGES 353. manges Of Iron and Steel Flanges of iron and i es may be made of caat steel wrought iron or wrought steel made without B we . They may be geoured to the pipes by gorewing, riveting or welding. (b) No flange or blank flange of oaat iron shall be attached directly to main steam pipee or form part Of main ßteam piping. (c) Blank flangeg Bhall be of mild steel or cast steel and shall be not leu in thickne88 than the flangee to which they are attoohed

854. Screwed on flanges.—The pipes may be screwed into flanges with B disappearing thread and expanded. Such sorewed and expanded flanges may be aged for steam for o maximtun pressure of 450 lbs.

per sq. in. and/or o maximurn temperature of 7500F and for feed pipes for pressures up to 600 lbs/eq. in. Sorewed and expanded flanges may in addition be seal welded

355. Loose Flanges.—Loogo flanges may be used whore the joints ore made by metBl to metal faceg integral with the endg of the pipog. Alternatively thege joints may be welded or Rc•al welded. The loose flange shall conform to the table given in Appondix E. Where the joint ig formed by integral flangeg, these after machining Bhall be noi lees in thickneßB thon the designed thickness of the pipe as calculated by Equ. otion (91)

356. Riveted on Riveted on flanges Bhall only be used for pfpøg of 7' bore and above and for b maximum pressure of 350 lbs.per sq. in. and/or o maximun:l temperature of 7500 F. (b) The shear Btregs in the rivets not exoeed 6000 lbs. per eq. in. when calculated by the following formula :— Sr Eqn. (94) NDIA EXTRAORDINARY Where Sr = the shear stross in the rivets in lbs. per sq. in. [PART' A, crogg sectional areo, calculated on outside diameter of pipe in sq. inches. working pressure in lbs. per sq. in. number of rivetg. Area of one rivet hole in sq. in. (c) The stress in the pipe shall not exceed that speoified iD Toble 3 when col. oulated by the following fornula: Sp xdxt) Where sp — the gtresg in the pipe in lb. per sq. in. , Ao, P and N hove the values given above, and Eqn. (95) d t crossg sectionol areo, calouloted on ingide diameter of pipe in sq. inohee. — diameter of rivet hole in inches. = minimum thicknegs of pipe in incheB. (d) The flange hub thiokneeg shall not be 1088 than 0 •2 in. thicker than the minimum thickness of the pipe. (e) The distance from tho edge of the hub to the centre line of the rivete shall be not less than one and a half times the dial neter of the rivet hole. (f) The pipes shall ffrgt be properly exponded i_nto the flanges or alternatively the flanges shrunk on to the pipes the rivet holos Bhall then be drilled through the pipe and hub, and the holes afterwards countersunk to remove barre. (g) After riveting the flango hub Bhall be fullerod at the back

357. Welded on flanges.— (a) Whoro flnnggs wolded on, the welding 8hal] be carried out by thc oxy-acctvlene or electric procese. (b) The proportions of the welds in the cage of metallic arc welding shall be ars indicated in Figs. 28-32, thc respecti ve working condition for each Gype being ag föllows . Figs. 28, 29 and 32: for all pressure and temperature conditions Fig. 30: for pressure condition ul) to 250 lbs. and temperature not exceeding 700QF. FKq 31 ; for pressure conditions up to 150 lbs. and temperature not exceed- ing 5000F. (c) (i) Electric Welds rnude in accordance with figure 32 shall be strew relieved. (ii) Similar welds mado in accordance with Fig. 28 or 29 shall be stress relieved when procticable. (i;i) Flangeg for use at telnperntureg over 7000 F. which ore welded by the oxy- acetylene process SYILII be normaliB0d. (d) For Bizes up to and including 12" bore bossed or hubbed flanges may be used in Figs. 30 & 31. (e) Welded on flangßB may be screwed on to the pipes Plior to welding. G OF Fig

28. For all pressure and temperature conditions.t but not legs than in and• not more than 9/4 in. t but not than 3/8 in, 1} t but not than 3/8 in. 1} t but not logs than 8/8 in. t but not logs than 9/8 in. nud not more than 3/4 in. t but not less than 1/4 in. OF INDIATXTRAORDNARY [Pin A e A B c D Q Fig

29. For all preware ud temperature conditions.112 but not legg than 3/16 in. 114 fn. Min. for Tubee up to and Including 5/16 in. th10k. t— 1/16 in. for Tubeg over 5 16 in. thick and up to and including 9/10 in. t— 11B in. for Tuben over 9/ 6 in. thick gnd up to ond including 7/8 in. t— 114 im for Tubee over 7/8 in. thick and up to and including I in. t but not lese than 8/8 in. t but not legg than 3/8 in. t but not 1088 than 3/8 in. t but not lese thon 8/8 In. and not more than 314 in. t but not legg than 114 in. I (Oz LUA - t but nnt legs thon 3/8 in, but not than B c 3/8 in. bui not 1088 than Fig. For condition(up to 250 lbs. and temperature not exceeding 7000 F. A D t but not Iosq than 1/16 in. t c Fig

81. For præa.re conditions upto 160 lbs. and temperature not exceeding 6000F•

1. DIA oxhÅo*bntA2Y An hterna' n.m O min A G Fig. 32. t-å•l/lf.} in, 1/16 in. 1/16 in. nun. For all precure and temperature conditions. t not greater thsu 1/2 in. Where t is greaif-ll* i han 1/2 inch. ' U ' ghapea groove as Shown may be used. h g B 150 min. 1/8 in. 1/8 in. 1/8 in. min. in. 1/16 in. mill

358. Flanges Of copper pipes.—Flanges of copper pipes may be made of brass or bronze. When flanges uro ottaohed to copper pipes by brozing they dholl be geoured in guoh additional way (e.g. by riveting the onds or

forming a conical end 80 as to fit into cornoal bore in the flonge that the resistance to withdrowal from the flonge doos not depend wholly on the brazing)

859. Standard Flanges.—Tho size ond thickness of flanges and the number and size Of their bolts should be us shown in Appendix E

860. Those RøguJations provide for ordinary bolted flange joints. Speoial types of joints ma,y be used, subjoct to tho approval of the Chief Inspector. (b? All steam pipes with butt welded circumferential joints having a Wall thick- ness 0 3/8' and above or oarrying a pressure of over 50 lbs. shall bo effectively 8tres8 relieve. (c) Such butt welded joint shall conform to standard specification. STEAM PIPE FITTINGS AND CONNECTIONS 861. Wrought 'Wherovor practicublg tho rudii of bends (on centre lino) shall be not less than those given below : Bore up to and including 6 in. ovor 6 in. up to and including 9" over 9 in. up to and including 12" over 12 in. up to nnd including 15" over 15 in up to and including over 18 in. up to and including 20" Where d=the bore of the pipe, R=Radius of bend to contre line of pipe. R.3xd R=5xd (b) The thioknoss of pil)0N from which such bends ure made shall be not logg than per cont. than the Ininilnum thicknogs requirod by Equation 91. Where srnn,ller rndii ore necossnrv further ollowances shall be made for thinning at of the bend. Alternatxvoly gome special form of rongtructnon Bhall be adoptod to provent undue thinning

362. Branches, Teeg., etc.—Ft 'hes, bc»qses und drain pockets shall be welded to the pipes. Whera a bronch i'l size to the mai I pipe an approved type of ro- inforcement Bhall bo employed. For progsureB over 350 lb./sq. In. and/or tomperotures of 7500 F or ovor, branehes of (i in. bore und largor shall bo welclud imide as well ag outgido. Ali,ornatively to tho woldlng on tho ing.cle of the pipe, an approved type or ro.inforceJnontJ or mochanieal look Tna,y be providod

363. Blow-down pipes.(a) Blow-down which can bo gubjooted to full boiler proggure sliR.ll be considorod saturLtorI Btoam pipes Rt that prosaure. (b) ' 'Blow-clown pipos whir•h cannot Lo subjected to fall boiler pressuro shall be considered ag saturatod Bloearn pil)0F4 at half the •working prossuro of tho boiler." 384. Valve Chests. -(a) (Jhegts of stop.valvos, isolating valves, reducing valves ßtoam traps etc., forJT1ing ports of wrought iron or rought steol main gtoam piping when for with Naturat,ecl Ntoum up to u gaugo sNuro of 160 Ibe. per square inch or tempsrature of 400010. may be modo of cast Iron, cost steel or wrought steel in aocordanoo with the roquiromenLB of Rogulation 290. (b) When superheatod stealin ia 11B0d abovo 4000 F. or WI-lon pressurog are above 160 lbs. per sq. in. gougo, ('hests shbll bo made of cast or wrought Bteol or other approved material in accordance With the requirernont of Regulation 290

365. Steam Receivers, separators, etc., for temperature exceeding If Buch vossels aro fusion weldod tho manufeue and tests shall conform to Chapter V- (b) The working •prossurc of all part* 8ha,ll be determined by the appropriato formulae givon in Chapter V. (c) All mountings for the above and for connectod steam pipe ranges shall be of cast stool or other approved matomal

866. Steam Receivers, separators, etc.for temperature not exceeding Tho shells of stoam receivers, steam separators, steam driers, catoh waters, drop legs, interceptors, etc. may be mode of steel plates or steel costings. .LNVIA , (b) (i) When fabricated of steel plates the geomg may be riveted or welded. (ii) When riveted the working pre8sure for the parts shbll be determined by the formulae pregoribed for corresponding parts of boilers and the hydraulic test pressure to Which the vesgel Bhall be subjected on com. pletion Bhall be that proscribed for boilers. (iii) Exoept •where such vessels are fusion welded in accordance with Chapter V the longitudinal •weld of vessels exceeding 15" internal diameter be covered by a butt strap. (iv) For Buch spelded seams tho standard oo-omcient C of Regulation 176 to be used in determining the working pressure shall be .3•0 for both, welded ond wolded and stroppod seams. The strength porcentoge to be allow. ed for the wold shall be 50 ond J, the strength peroentoge to be allowed for welded ond strapped soamg Bhall be determined in ocoordance with Regglation 180. (v) , Branches for attachment of steam piping shall be flanged and be either flanged and riveted or welded to the vessel. When welded this Bhall be done inside as well as outside where practicable. Alternatively to tho welding on the inside of the vessel an approved type of reinforcement or meohb,råcal lock may be provided, Where a brmoh iB of equal Bize to the vessel the opening Bhall be (vi) All welded vossels shall be strosg relieved. (c) (i) Where made of cast steel the shell shall comply with the requirementg of Rege. 73 to 80. (ii) The working pressure for flat end platos of cost steel shall be detemnined by the formulae for flat end plates wrought Bteel. (d) Suitable arrangements for drainage Bhaal oe fittcd to all vessels intonded for use

in the soporation of condensed stoam. Whore automatic drainoge iB not piovided a glass water gauge of Blibsta,ni iol :moke to indicato the watcr level in the vessel and substantial drain cook or valvo Bhall Lo fitted

867. Screwed ond 800ket6d Jointe.-- C.ouplings or sockets may bo us-ad on pipe up to 4 in. internal (hamot,cr veil h prossures up to 120 ILA. por square inch guugo and up to 5 in. diani(ter with pressur(-s up to 100 lbs, pcr yquare inch gouge. 011 other cagoE, flangos w.th bolts uncl nuts Bhall bo used. (a) Valvo rhosis of bronze for Biop valvos 368. Other fittings and Mountings. up to 3 In. diarneter of boro may bc uttuehcd directly to iron and steel steam pipea whcn pressurog do not excocd 120 111k". per eq.in. gouge and temporature not exceed- ing 425' F. Tho ottachmont may bc bv direct screwing to tho steam pipe or by meons of flanges. (b) Drain cocks and valves mu.y be attached to stoa,1Y1 pipes eithor by flange and bolts or be screwed into n boss formod on Cho pipe

369. Reducing Valve.- WII(rt rßducing valve is install, '(I in pipe linc, the pipe line gnd aecessori0N on the Iow preH,guro side of the reducing valvo shall be protected by u 8bfety valve or vulveg NQ adjusted as to perrnit tho steum to escope us Boon us the safo working pressure iB oxcoodcd or by u, suitable appliance for cutting off automotieal]y the Bu-pply of Bteom as soon as tho sufe working pressure ie exceeded

370. Tho use of sliding expansion joints is prohibit(d. The nooessory degree of floxibility Bhall bo obtained by the 1.160 of special oxpangion jointß, or tho pipes Bhall bo pre-scressed initially Whcn cold by loaving gaps at appropriate ointB und pulling these up when erecting the piping. ']'he amount of tho cold spring OF INDIA EXTRAORDINAÄ± shall bo not 168B than 500/0 of the total ox-pa,nßion of the length under congidorotion and may be groator than this in cases where it is necessary in order to koop within the permissiblo stress value shown in tables 3 and 4. (b) The ollowanoe for expansion per 100 ft. of piping at various tomperaturcs 911011. be baged on Table 5. TABLE 5 EXPANSION ALLOWANCE 3•35 5-31 5•83 Rango of temporalure Degreeq Fahronhoit 60-300 60-360 00-400 60-500 00-600 60-6.50 60-700 60-750 00-800 60-850 60-900 Expansion Inclxey por 100 ft. 7, 44 7•99 371. Pipe work supports.—All pipe work shall bo odoquotßly supported in ordor to permit froe Illovomeni, for expansion and contraction, and the amount of such movement shall bo proportioncd throughout tho wholo of any main by the provision of onohors ot suitable points. Whoro pipeg may be subject to vortical movement, spring support8 detAignod to corry tho load under all conditions shall be provided. It is des-iroble thot pointB of supportN should, far ag practicable, be arranged odjb- cent to the pipo joints. Slings arc in general preferable to roller supports, and these lbttor should bo used only whoro necessary. All pipo supports should, 0B far at' practicable, be of mild stool and pipe anchora cither of mild steel or cast steel

872. In tho caxe of steam mains, attention Should bo paid to the adequate provision of drainage points in the forrn of drain pockotB. Drainage pointe oonneotod to Stearn traps, Shull bo provided wherever water can collect under •work- ing condition'l. Hand drains Bhall be providod at all pointN at which water can oollff)t in uny portion of the Stearn main, by valve leakage or othor rueun-s, when Shut down, or when warming up prior to uge. (b) Where practicable o suitable gradiont Bhall be provided in the pipe work to onsure tho passage of condensed water in the direction of flow of Bteurn. towards the drainago point. (c) It iB recornmonded Lhat o by-pass should be fitted at eoch steam trap. (d) Whero the volume of M'btor deposited is likoly to be of serious proportione, separotorg should bo installed. Each separator shall be furnished with steam trap which Shall be connected to it by means of three-way cock ono ond of whieh ie connected to a, .manually operated drain

378. Freedom from rust and other foreign matter.—All pipes, valves and fittings Bhall be thoroughly cleaned as far us possiblo of rust ond other foreign matter bofore erection ond pipe linos shall be blown through with steam or bir before being put into sorvioe. *780' OF INDIA EXTRAOürDINARY 374. Test Each cornplotad pipo and fitting shall be tested by hydraulic pressure at the Manufacturer'H works to twice the maximum pormisgible working prossure. Jt is inadvisablo Lo 811 bunt a completed steam pipe installation to any hydraulic test. (b) Pipes and fittings with flanges for steam pressuros exceeding 100 lbs. per sq. in. shall be tosted with blunk flanges bolted or clampod on. All other pipoa, if straight may be tested botween the hoods of an ordinary hydraulic pipe teating moohine. (c) Special arrongoment8 shall bc mode, oooording to eireumstaneos, for testing bends ond other fittings where not flanged

CHAPTER IX REGULATIONS FOR REGISTRATION AND INSPECTION OF BOILERS 375. *Tho procedure to be followed in oonneotion with applications for the rogistrution of B boiler und with oxnminations of boilers under the Act shall be rcgu- lated in accordance with the provisiong of this Chnpter rcod with the relevant Sections of the Act

876. Preparation for Ingpection.—(a) At every oxamination of a boilor for the gront or renewal of a certificate, the boiler Shull be empty ond thoroughly Olean in all its ports. Exocpi, as providcd for in sub-rcgula,tion (f) 011 doors of monholes, hond- holes gnd sightholes and cleaning plagg and all cops in the heulers and mud drums of voter-tube boiler 9, all firebars, betM•ers, fioni, plates, bridge plates, firebridges, brick archce, oil Cuel burners and mechatueul stoker fittings shall be All valveg and cocks comprising the boiler mounting Bhull bc opened up and tbken apart and the volves or coekg ground, when neee,+ory, before the Inspector's visit. (b) Proviqion shall, if required by tho Inspector, be mado for the removal of lagging or brick-wotk or other concealing port and for the drilling of plates, and for verifying the pressu re gange and Bufet,y valve dirnengions and weights. (c) All smoke tubes, exterior of tubes, smoke boxeg, a,lld exLernal flues Bhall be swept clean. (d) ProviNion Shull be mado for thc effective disconnection of all Bt.eoz.n and hot wot,er communicat,ion wit,}' uny other boiler unclcr gleam prcgcribecl in Chaptot X of these Rogultbtion*, This shall be effected either by the rornova,l of o length of pipe from tho 8team and foed piping or by the insertion of substantial blank fla,ngeg. Where blank flanges employed, thoy Bhall be inqcrted between {he fla,nge of the chest and tho pipe ottochcd to it. (e) No blank flange Bhall be inserted between a, Bfl,foty volve chest the boiler. (f) At alternative unnual inspertions and subject to of i,hrc€h bottom rows or 011 tube* subjeot to the first of heot boing opened up for ingpel ion, the Inqpector moy at his discretion relax the preporation for inspection called for under (a) obovo in favour of boilers having an ovopora,tive capacity of 200,000 lbs. per hour ond over, and fed with vv'lÅjer trcnLed to the satisfaction of the Inspector

877. Hydraulic test of boilerg for registration.—Every boiler shall be hydrou- lically tested in the presence of an Inspector or Inspecting Offcer. accordance with 800tiong 7 and 8 of the Aot Inspeotorg ore roquir«l mecgnre and examine boilers for regißteetion, to examine boflere for renewal oertifl0Bteß, iO determine gubjeot to tho opproval of the Chief Inspector, the preggure ab whioil thoy may be allowed to work, to grant certiflcota therefor and generally to convey to the ownerg moh .ordorg ae the Chief Inspector may issue. OF INDIA 878. Preparation for hydraulic The cheetR of all mountinge subj(ct to steorn prosauro *holl be ill ploce :mcl shut fight or blank flanged. be renu-wed and tho chest opening (b) The safely valves invariably blank ßonued. (c) The for the Inspector's pressure gouge and tho nipple for con- neeting the oetot"s test, hose shall be in order. (d) All doors '-,hall bc vrooerly jointed and tightened up. Tho boiler Bholl bo cornplc•telv filled wilh water, cure being taken to ollow all air to csca,pe and, if pos- Bible, a -prc lilpinary fest, not cxeceding thc working pressure of the boiler Bhall bo token before thc Inspect or's viHit, to teet the tightncgg of the joints. (e) When u boiler iB hydraulically tested for the first time, it Bhall be entirely oleored of lagging or brickwork ; 1M, gnbßcquent tests the lagging or brickwork, or portions thereof, Shall bc removed if required by the Inspector

379. Procedure o} hydraulic tests.- (a) Subl(ct (o tho provisions of sub-regula- tion (e) of Regulation 381 every boiler Bhall be hydraulically testcd in the presence of an Inspector to not ICES thon the approved working pressure, when such working essure cloca not exceed 100 lbs. por squure inch; when the approved work- ing presgure iN obovc 10() lbs. pcr square inch, the hydraulic tegted pressure Bhall bc times the woyking pressure plug 50 lbs. per square inch. (b) The boiler Bhall withstand Fuch pressure without appreciable leakage or undue deflection or distort ion of its parts for ot least ten consecutive minutes, If the tcst iH got,i8faetory, the working pressure allowable by calcula- tion eh811 be snif,bbly reduced, unlCBF4 the owner clegires in make such. alterationp as will enable the boiler to wil hgtnnd the hvdra,ulio tesi ; in which ecofe the boiler *hull again be exomined, after thc alterui ions have been mode, the pressure if necessary, and the boiler tested •Lho *furtion of thc inspector, (c) *Ai i h" first hydenulie tost of boiler prior to the issue of an original certi- ficato deflection ynca,surementg shn]J he madc before, during ond after test of cach furnace length, fire-box and flat, end or other plates. (d) Aft the opplicuf,ion of the hydraulic tesL the Inspector shpol-l ('B,rcfully cxo- mine the boder inside and out.ßiclc and him8elf that it has sol,igfnctorily with- stood the teat. (e) In case in which thc Rafo working pressure to be ollowccl for a boiler cannot, owing to peculiar construction of ony of its ports, be determined by culou- lation in tho linnry wav, the Inspector Shull, under I,ho direction of the Chief Inspect0T , subject the Io hydraulic test

fou the purpose of det,ermining the fitness of sueh ptu't,B. The amount of the test preggure to be applied in Nuch n, casc ghn,ll not exceed the proqsu• e for thc loa,At working pressure found by calculation for ot hor part* of {be bmler or lhe intended working preFsure, whichever (f) Should any part of the hoilcr show undue deflection indiention of perma,- nent (Inving thc progress of thc tc•Nt, pressure shall be released hnynediatoly guch indico,tionq are observed. The working presgure for the part Bholl bc per cent. of the togt pressure applied when the point OE' pertnanent get was reached. ThiB ,hall apply i o nny boiler at, ony test. procedur' (g) H vdlnul-ie tests of boilers nt subsequent examination:4 hholl, cxccpL when tho Inspec{or ox pro•plv J equ I res otherwise, he mude after the inspection. The test pressure to be to bc ilorB at queh subsequent oxaminotiong Bhall be from one and quarter to one nnc1 a half times thc working prcs,qure of f,he boiler. 0TE.— TheHe deßertion meneurementæ Rhould be entored in the Momorandurn of Insppvtion Boo), before its submjßHion to the Chief' Ingpector. .1- GAZMTE or INDIA EXTRAORDINARY (h) When the internal construction of Bize of o boiler does not perznit of the Inspector getting inside it or of exomining cloyely all its parts, he shall gee it tested by hydra,ulic pressure to one and a half tirnes the working pressure at each inspoo- tion for the grant or renewal of a cgrt,ificale. (i) Wa,Cer tube, locomotive type and BII tubulur boilcrg shnll bo hydraulically tested at each inspection for the grunt or renewal of cortifr•ote, unless such test ig under thc orders of the Chief Inspector. (j) The Inspector may, if he considers it necessary, opply a, hydraulic test to any boiler ot ony inspcction. (k) Except in the cose of small, portablo and vehicular boilers which do not requiro re-erection or building in brickwork, the hydraulic test of all boilers shul-I be conducted only oftcr tho erection of the boiler in situ tblld 011 boilers shall after re- *erection in position different from that in which they were Inst examined bc hy- draulicolly tested. (l) A hydraulic test shall also bc tokon before granting on increased pressure certificote and after repairing o boiler, unless the Chief Inspector authorizes the Inspector to waive such test. (m) When carrying out hydraulic test, Inspectors Bhall use pressure gauges guppliod by the Chief In gpector. 380. *Steam Every newly rogistored boiler and every other boiler of which the working pressure has been altered shall, before the issue of an original or renewal certificate for such boiler, be tegted under steam to the satisfaction of the Inspector. (b) At the ti_rne of tegt the safety volves shall be left free and oopable Of being adjusted to the approved working pressure. (c) After adjustment of the valves to the correct blowing pregsuro the boiler shall be tried under full eteom and firing with the feed water Bhut off and the etop volve closed, during which time the Inapeotor shall note the accumulation of pres- sure end other detailß of the teet ag well ag the loading and adjustment of the Bbfety volvee. In the oase of water tube boilers, or boilers fitted with superheatere, the feed water connection and stop valve need not be ghut off, ond if the total gafoty valve areo and lift ore found to be adequote, the requirements of this clause may be assumed to have been gotißfied if the valves are 80 adjusted that each blowg at the approved pressure. (d) On completion of the safety valve test the Ingpootor Bhall satisfy himself that the water gauges are in working order and that the feed apparatus ig capable of supplying the boiler with suffoient water. (e) Where the State Govern-naent does not require a person-in-charge of a boiler to hold a certificate of competency, the Inspector may when he thinks fit gatißfy himself by questioning or by practical test whether the person-in-charge of the boiler understondg the use and purpose of the water gauges, the pressure gauge, tho safety valves, the feed water-supply and blowdown. Bteom test iB prim»rily intended for the purpoge of ogrertoining by cotual t.t whether the gafGty valves ore gumcient to relieve the boilor effectively of oxoeg.g Bteom and whether they operate at the time when the maximum working pressure is reaphod. Inspectore 8hould alwaye send to the owner due notice of the date fixed for the steam teeb. On completion of the teet the Inspector enter all details in the Memorandum Of plnepection Book. GAZETTE OF INDIA L%XTRAOBDINARY (f) When witnessing 80fety volve tests, Inspectors shall ugo the standard pres- sure gouges supplied bv the Chief Inspector unless the boilor pressure gauge h8B, •ince the time of inspection boen tested and found correct with an authorized testing machine, (g) NO steam gouge eh811 be used without u syphon filled with water between it gnd the boiler. (h) When the accumulation of pressure at steam test exceeds ten per cent. of the maximum working pressure, the areo Of the safety valves shall be considered imumcient, and certificate shall be refused until the safety valve areo is increas- ed. (i) An Inspector may, when visiting a factory for any purpose, verify the oor- reotnegs of the safety valves and pressure gnuge of ony boiler under steam by com- porieon with hig Btandard precure gauge

381. Procedure tor registration.— (a) On reeoipt of an application for registration under section 7(1) of the Act, the Inspector shall, when the boiler has been properly prepared for exornination, proceed to measure in complete detuil all its parts, aeoer- toin the working pressure allowed by the Regulotiong by making series of coloulo• tions of the Btrongth of the various parts, such calculations being based on hig mea- surernent and if he is Otisfied with the correctness of the maker's oertifloate, on the dimengiong and other particulars relating to the material and congtruction 'toted therein [vide Section 14(1) (c) of the Act and Regulation 4]. In making hiß calcula- tiong he shall after examination of the material, toke due account of the work:man• ship ond detailB of the construction of each part. In his examination the Inspector may, if he deems necessary, bore the plates or other parts to a,8certmn their thickness and in ma,Wng hig calculations he shall be guided by the requirements of Chopter8 IV and V of these Regulations. (b) If no formulae or oo-effcient applicable to any part is contained in Chapter TV or V of the RegulationA, the Chief Inspector Bhall in his discretion determine the dtnegg of guoh part. (c) The strength of the weakest part go calculated or determined, subject to any discretionary power exercised by the Chief Inspector, shall determine the por- missible working pressure of the boiler. After inspecting the boiler and asoertMning by the prescribed calculations the maximum pressure at which the boiler may be worked, the Inspector Bhall hydraulically test and steam-test it in accordance with requiremontB of Regulations 379 and 380 and ma,y issue provisional order under Section 9 of the Act in

Form V. (d) The Inspector shall enter the above particulars and dimensione of the boiler and calculations of strength of the various ports, together with detailB of the hy- drou_lio and of the steam tests, in "Memorandum of Inspection" Book (vide Re- gu18tion 386) which, together with all the maker's papere for the boiler, shall be gubmitted to tho Chief Inspector with the Inspector's report under sub-section (3) Of Section 7 of the Act in Form I. (e) Where o certificate in Form 11 and o memorandum of inspection book in Form I ore furnished by on Inspecting Authority in accordance with gub-regulation (o) of Regulation 4, the Inspector sholl, on receipt of an application for registration under Section 7 (I) of tho Act, proceed to moke such examination and measurement of the boiler will satisfy him that the boiler ig the one certified by the Inspecting Authority and that it hos sustained no damage in transit for which purpose he may, if he considers it necengory, subject the boiler to hydraulic test in ocoordanoe with Regu.lation 379. 'Ihe Inspector shall, if he ig gatißfied with the condition of the boiler, zoæpt the paricu.lug •nd approved working pressure entered iu Form T by the Inspecting GAZBTOTE or INDIA EXTRAORDINAflY Authority if they had been ascertained and entered by himself and shall inue provi8ional order to enable the boiler to be worked. He Bhall make euoh entries in respect of his examination of the boiler in the Memorandum of Inspection Book as may be required and 8holl submit the book and Inspecting Authority's certificate and drawing of the boiler with his report to tho Chief Inspector as prescribed under sub-reguloticn (d). 882. *Engraving of registry number. (a) Tho registry number of overy boilor shall, with-in o period of one rnonth nfte(' thc registration thereof, bc cut in the front plate thereof in Buch position ag shall bc pointed out by the Inspector. The device for each stote shall bc distinguished by the following letters : Aj Iner A8B.or:n Bhopal Bihar Bilaßpur Bomb BY Coorg Himuchul Prgd08h Kutch Madhya Pred88h. Mud roe Monipur Orissa PunjBb (India) Tripuro Uttar Prodeyh Vindhya Prr&desh West Bengal B.P.L. B.Y. C. D. K.U. M. M.A. o. T.R. V.P. The dist inguishing lotters gholl engrßved ubovc n nurnber and separated thore- from by a horivontnl lino two and half inches in length. The letters ancl figures' Shull be one inch in height and of quituble breadth, provided that in thc coae of small boilers the letters und ti(-nu ee of thc (Lnvice mav, in the discretion of thc Chief Inspec- wholo Bholl be enclosed in a rectongle, the tor, be reduced to 318" in height. upper und lower sidea of which- shall be incheg part ond orjo quarter inch clear of the of tho Ict,ters ond the boi torn of tho figures respectively as indicated below : The Bide lines shall bent, equal dist,unce Oleur from the figures. The engraving shu,ll not be than 1 164th inch in depth. (b) Tho engravirg sholl be complete ond ready for verification within thiriv duyg of thr in ion the boiler. (c) Boilers having registry device; differing from those proscribed herein Sha] I ulter ed or (4 ut in conformity with Lhoso pres- have such devices oblit,eruted, cribed above. The original ntlÜLbers ot' such bDilcrs shall he rct?ined in thc new device. A number once allotted to n, boiler Bhull not be used again for anol her boiler, lor traeing thib devices in the bailor will be yuppliod by the Chißf n * voctor tho shp Bli0Ldd be pugt,ed on tho pact of the boilor pointed out by the Inspector.

888. Meuurement of heating For the purpoee of regulating tho area of the sofety valves ond the brnount of registrRtion and inspection foes the heoting surface " of a, boiler *hall bc the total surfaec OL all plates und tubes exposed to heat on onc Bide and in contact with wutor on the other mengured on the water Bide or the fire side, whichever is larger.(b) For Luncoshirc and Cornish boilcrs the tot,ul heating surface Nhaill include the wetted surfR,cc of the furnaces between the end plates, the fire surf?bce of cross tubes where fitted, and the part of the externol shell. below the *idc flue covers. In estimoting the aroog furnuce,H shall bc considered ploin cylinders ; the areu of their wetted surface shall be token their meun externBl circumference X the length of the boiler between end plbtes. For the shell the width of thot of the circum- feroncc below the flue eovcrs shall. be tokon —'2 D, and Lhis width X the longt,h betwccn end plates shall bc taken the of shell heating surface. Tho part of surface ot the back-cnd plate exposed to heat 8ha,ll bc omitted frorn the col- culotion. formula, for tho tot,bl heuting Burface of La•noashire boiler having plain furnoces without cross tubes iB as follows H.S. in Nquure feet 2L (3 • 14d+D). L is the length of the boiler between end plu,tes in feet, (l i* the rnean externul diomctcr of the Ctrrna,ceg in feet and D ig the internal diometer of the largest, belt of shell in feet. (c) For stcom and woter drums of wut,er tubc boilers the heoting sul'fuce of the drum shH,ll bo ta,kon hblf t,he cxtcrnul melin circurnfccenoe multiplied by the 010br (length of drum between Lhe outer brick wollg or centres of cross boxes, the may bc. The heoting surfa,cc of the tubes Bhall be token tho externB,l surface of 'the tubes betwet)n the tube plbLes or headers. rt'hc heating surfoee of the heoders ghbll be omitted from the ct'lculotion. Integriil economi*erg *holl be deemed component heating surface. (d) For murine boilers of

the fire-tube type the heating surfuoe gholl include the wetted surfa,co of the furnaces between the tube plates (considered in the same woy for Lancashire boilers), the ivetted surface of the combustion chumbera (IOS' tho amog of the tube holes) and the wetted Burfoce of the tubos between tubo plot,ey. The ports of the front tube pla,tc oxpoged to hoat sholl be omittcql from the ealcula- tion. (e) For locotnotivo type boilers the heut,ing surface :-Jholl include the wetted surftwe of the fire,,box above thc foundation ring (109B the areu of the tube holes the fire-hole a,ncl ring) ond thc wetted aurfncc of the tubes between tube plates. Tho BTnoke box tube plate shall be mnittcd from €he colculation. (f) For vertical boilers of ordinary type tho heating surtoce BhBll include the wetted surfa,cc of the fire-box above the foundotion ring (less the ore:b of fire-hole noncl ring and tube holes, if u,ny) Imd the surfuet3 of ony ero-l* or other tubes und uptake below tho lowest wa,ter level shown in the gouge gloss. (g) For any other hcatingisurfnce not provided for in the forcgoing the sorne generol procedure shbll bc observed. (h) No deduction shall. be mode for stays, etc., in calculating the heoting sur- 884. Boiler rating.—Tho boiler rating shall be the number of square feet, (to the whole figure) in thc heating surfoce of tho boiler 0B determined under Regulu,tion 383

385. Registration fee.—Th6 fee requirorl to accompany application under gub-section (1) of geotion 7 of the Act Bhall be-_tw For Boilor Rating not exceeding I (JO For Boiler RaLing exceodtng 100 but not excooding 300 Peg. 50 For Boilor Rating oxcoedmg 300 but not exeooding BOO For -Boiler Rating exceeding but not oxceeding 700 For Boilor Hating exceeding but not oxceeding 900 For Boiler Ratmg exceeding 900 but not exceeding 1,100 . For Boiler Ruting oxceedmg 1,100 but not exceeding 2,000 For -1301181' Rating exec odi-ng 2,000 but not exeoeding For Boiler Rating exccochng but not excoodmg 6,000 For Bon-ler Ra,tjng• tng 6,000 but not ox coeding 8,000 :E'or Bollor Rating eoding 8.000 but not exeoedlng For Boiler Rating exceeding 10,000 70 80 200 Provided thot the Chief Inspector may direct that no fees shall be payable in respect of 8, fresh opplicution mudc in pursuancc of sub-section (2) of Section 14 of the ActE 886. *Memorandum of Inspection A Memorandum of Inspection Book shall be plcpared för cach boiler in

Form L In [his hook the Inspector shall enter in ink all punticulm•s and dimensions of (he bGiIer with the calculations for the vorious parts in detail, particulars of hydraulic test and steam tost and IliB Inspection noteB. (b) At subsequent inspections Inspectors shall enter the dates of the inspec- tions, hydrou]io tests and Stearn tests, whon such are made with their notcs there- on. (c) Jnspectors should Olso enter in the Memorandum of Inspection Book the general condition of the boiler and of rcpail s, to what extent boilers have been cleared of brick work, etc., a, report of all casuol visits, visits for inspection of rcpoirs, for inspection of main steam pipes, and reports on accidents, etc., in this woy the Memorandum of Inspection Book will IJIovide a useful record of the boiler's history for the inforrnut,ion and guidilllcc of Inspectors ot subsequel't inspec- tions. (d) On subrnission of i,he M('lnorandum Book to the Chief Inspector hc will in the ense of newly registered boilel*, check all particulars and calculations and a prove or tho working pressure that iB to be permitted. In the cage of old boilers, t e Chief Inspcctor• will exuumino lhe Inspector'* notes of inspection and proposals madc for repuil,g or reduction of pressure. A pregsurc once approvccl for the boiler should not be ultered without the NVTitten authority of the CA-lief Inspector

387. Registration Book.—(a) A Rogiß€ration Book or copy of Memorandum of Inspection Book contmin_ing all the particulars required for lcgistraiion shull be mointained in tho offco of Che Chief InepceLor In Forun I and any orders pugscd by bitn regurding the boiler shall be entered in the kegistraLion Book under his initials. (b) The Chief Impector should Olso sco thot the notes of subsequent impectiong entered in Lhe Mornora.ndutn of Inspection Book arc copied in the Registration Book

888. Transfer of Memorandum o! Inspection Ecok and Registraticn Ecck.— On b boiler passing frorn one State to another, thc Memorandum of Ins- pcction Book and tho Registration Book shall, on the request of the Chief Inspect or of the Stote to which the boiler has been traansferred, be forwor(led to that offeer who Bhall take over their custody and maintain them os hereinbefore pre- Boribed. 389. tarant of certifloate. (a) A certificate for the use of a boiler Shull be granted in

Form V L In t,he certificutc shall be entered the maximum pressure at which the boiler shall be worked, the load to be plneed on the safety volves or the * N0TB.—Tho Meroorendum of Tnapection Book 8hould ulwayß be kept Olean and up to (lute. Inspection Book8, except when actuolly required by the Tngpeotor, Hhould be filed in the ofriro of the ('Inef Inspec t or. Nom —The In8peotor'R remark should brief 13088ibIe. INDIA thickness of wushers or ferrules required os N&feguard against overloading, the (lato uncl pressure of the last hydraulic tost of thc boiler and, when applicable, of i he •rnnin Stearn pipes prescribed

390. Procedure for inspection of installed boilers.(o) Gencral Instructions.— is essential have every purt of a boiler, that is uceesyible, open and to properly prcpnred for exa,tninui ion, internally u,nd externally. All hollers havo openings thvough which au exalilinotion may be I-nude ancl Ilich foe opern(ion ore closed • all parts shall be opened wheth0f' for acc•cgs to wutor {Lees, or heut,er surfaces. Tn eooling n boiler down for inspection or repairs, thc should not be Wii unfil setting is sufficiently coolcd [o ovoid (larnnge Che boiler and when possible allowed to cool (low-n urully. It is not noecssnry, in ordel' to comply with ordinary prudence, to rclnove insulation material, intl.gonry, or fixed parts of thc boiler, unless (lcföetg or detetiD11Rtlon peculiar i o cel tain types or inmecesqiblc• pu r•t3 of boilers ore suspcctccl and where there moist ure or vapour showing t hrough the coveJ ing, thc' covet ing should be removed nt once and coin - plcte investigu.tion Particular attention should be paid to the external ports of' boilcrg in the way of senting blocks, cgpeeiul[y when the Bit110fJi(-n is clamp. and engine fittings ot locomotive type boilers should bc removed to facilitato the inspection of thc underneath the first inspection, und any reusonable period if t he Ingpertor cannot, otherwise satisfy himself us to the condition of (Jhoge ports. Wuter wolls, Bhall be bared at least once in every nnonthH. Upon visible cvidenee or suspic ion due to oge or ca,uscs, every effort Nhull bc Inade Lo discover the condition, even {o the rctnovnl Of insulal,lng matcrin,l, masonry or fixed parts of a, boilel. Sometimcs drilling 01' cutting own y of parts iB justifiable and to posit ively detern)inc this condition. Thc Ingpector should, whenever t,he *izc pcrrnit9, go inside it ond make in;gpection of a,ll Its internal parts. Beforc doing so, he should course, got,isfy himself proper provision hus been mode for disconnect ing the bouler from any other boiler under Should he find that, proper proviNion disconnection nob been or that the boiler huq not, been properly cle or sen,led, or thii(, is unreasonably hot, he should decline to pr oceecl with thc inspect]' and Bhou]d repon (,he to the, Chief Inspector for orders. When. boiler is ot' such size or ily construction is such that the Inspector cannot, go inside it, there should bo yu_mcient, sightholes or ha,ndholcs provided to enuble l)il-n to see thc l)lincipal internu,l parts ; if any irnpot't,nnt, part of n boiler is so eonstruet,ed that the Insgpoctor on.u-not exan)inc• it, he should report, the frets thc Chief Inspector for orders. (b) Scale, Oil, etc.—Upon eni,ering R, boiler, the shall examine all Hurfaecs 01' the exposed 01 to observe thc action caused by the use of wuLer, oil eca,le 801v enis, or other gubsf ances which may h uve intentionally or unintention- ally gone in with the Any cvidence of oil is dangerous and e Steps shall be taken prevent nny further of oil into the boiler. Oil or gcole in thc ijubf-+l of woLer-tubc boilers or on plates over the fire of ony boiler is pnrticulurly hlMI, often ct-1[1E4ing thern to rupture. (c) Corrosion, Grooving.-—A given amount Of corrosion along or imrnediotely adjacent to a seam is morc serious than a similar amount Of corrosion in the solid plate away from the seams. Grooving along longitudinal seomg is especially gig. nificont as grooving or cracks urc likely to occur when the motorial is highly strosged. Severe corrosion is likely to occur at points where the circulation of the water ig poor and such places should be exumined most carefully for evidences of corrosivo aotion. If the Inspector decideg that a boiler in one or more of its ports iB no longer for the pressure approved for it, he muBt without delay report hig proposal for re- ducing the pressure to the Chief Inspector and at the same time submit his calcula- tion för the wasted parts for check and approval of progeure. 738 THE OF INDIA I x ART With regard to the pitting and wasting Of shell plates; tho Inspector should boar in mind that shell plates may become reduced in thickness to an appreciable extent ond still be stronger than longitudinal seame. All flanging shall be thoroughly inapected and particularly the flanges of cir- culor end plates that are not stayed, Internal grooving in the fillet Of such heads and externul grooving in the outer Bu-rfaceg of - heade concave to presauro is very common since there is Blight movemcnt in the heads Of thig character which produces thig kind of defect. Some types of boilers have what iB known 88 the OG or reverecd flange construction in some of their parts that may be inaccessible to the eye, but the condition shall be deterrnined by the insertion of a mirror which at a proper anglo will reflect bock to thc eye the condition of such a place, or any other feasible manner. (d) Stays.—All stays, whether diogonnl or through, Bhall be examined to note that they are in cven tension. All fastened ends Bhull be examined to note whether cracks exist where the stays are punched or drilled for rivets or bolts and, if not found in proper tension, tho inspector should recommend their proper adjust- ment. (e) Manholeß and other Openings.—The manholo and other reinforcing plates, os well as nozzles or other connections flanged or ecrewed into a boiler, Bhall be exmnined internally as well as externally to soo that they are not crocked or de- forrned, and whercvor poseible observation shall be made from tho inside of the boiler us Io the thoroughness with which its pipe connections are made to the boiler. All

openings to external attachrnents, such as water column connections, open- ings in dry pipes and openings to gafety valves, Shull be noted to gee that they are free from obstructions. (f) Firo Surfaces—Bulglng, Blistering, Leaks .—Particulor attention shall be given fjo the plato or tubo Burfuoes exposed to the fire. The Inspector shan Obgervc whether any part Of the boiler has beconle deformcd during operation by bulging or blistering ; the former iB a distortion of thc entire thickness of the plute or tube where it takes pluce, vvhilc the lotter is B lamination or separation of the plate due to foreign Jnatcriol being embedded in the ingot before the plate ig rolled, If bulges or blisters are of such Bize 8B would seriously weaken the plate or tube, and egpecially when a Icakage is noted coming from those defects, the boiler shall be dis- oontinuecl frorn service until the defective part or parts have received propor reh C lureful observation Shall be madc to detect leakage from any portion of the pairs. boiler structures-b particularly in the vicinity of scams and tube cndg. Fire tubes gometimcs blister but rarely collapse ; the Inspector ghould look through the tubes for Auch defects ond if they are found with o sumcient degree of distortion they ahould be removed. (g) Lap Joints, Pire boilcrg are apt to crock where the plates lap in the longitudinal or straight seam ; if thero iB any evidence of loukuge or other Atress at this point, it Shull be thoroughly invogtigated and, if necessary rivets removed or the plate slottcd in order to determine whether cracks exist in the scam. Any cracks notecl in shell plates are usually dangerous except fire cracks thut run from the edge of the plute into the rivet holi of girth Bearng. A limited nurnber of such fire crucks is not usually very serious matter. (h) Testing StayboIts.—The Inspector shall test staybolts by tapping one end of each bolt with a hommor ond when practicable o hmmnor or other heavy tool ghould be held on the opposite end to muke the test more effective. (i) Tubas—Th3ir DöfectB etc.—(i) Tubes in horizontal fire-tube boilers do. teriomte more rapidly at the endg forward the fire, and they should be carefully ped {fh a hommer on their surface to ascertain whether there haa been THE GAZETTE OF INDIA EXTRAORDINARY 735 'Dhe tubes of vertical tubular boilers are more serious reduction in thickness. susceptible to deterioration at the upper ends when exposed to the products of combustion without water protection. They should be reached far as possible either through tho handholes, if any, or inspected at the ends. (ii) The surfaces should be curefully examined to detect bulges or cracks, or ony evidences of defective welds. Where thoro iB a strong draft tho tubes may bo- come thinned by corrosion produced by the impingernent of particles of fucl and ash, or the improper use of soot blowers. A leak from a tube frequont]y causes Berioug corrosivo action on R number of tubes in itB immediute vicinity. (iii) Whore short tubes or nipples ure in joining drurns or headers, therc is a tondoncy for wasto products of thc furnace to lodge in thc junction points and such deposits are likely to cn,uge corrosion if I-uoigture is present. All such places should be thoroughly cleaned and exnrn ined. (j) Ligaments bctween tube h0198.—The ligamonts bet" een tubo holes iu the headg of ull types of firc-tubc boilers and in shells of water-I ube boilers Nhould be examined. If leakuge is noted, it may denote a, broken ligament. (k) Steam Pockets.—SteRITn pockets on firo surfaces ore sometimes found in new or replacement work, and wherever this iB possible or likely Che Inspector should make observa(. ion and, if any ore found, recommend thc ncccssary changes, (I) Pipe conneotiong and Fittings.—'l'he steam and water pipes, including eon- nections to the water column, Bhall be examined for leaks, and if any arc found it Should be determined whether they are the result of execssivo strains due to ex- pansion and contraction, or other cauges. The general arrangement of the piping in regard to the provisions for expansion and (Irainuge, as well as adequate support at tKe propor points, shall be carefully noted. The locution of the various atop vulvcs Bhall be observed to BOO that water will not bc pocketed when the valves are closed and thereby establi8h cause for water-hanuner action. Tho arrangement of connections between individual boilers and the muin steam pipes Bhull be especially notod to gee that any change of position of the boiler, due to setting or other COUBCB, will not produce an undue Htroin on the piping. It Shull be ascertained whether all pipe connections to tho boiler possess thc proper strength in their fastenings, whether topped into the boiler, a fitting, or flange riveted to the boiler. The Inspector sholl determine whethcr there is proper provision for the ex- ponyion and contraction of such piping, and thot there is no undue vibration tending to crystallize the parts subjected to it. This includes all steam and watcr pipe , and especial attention should be given to the blowoff pipes with their connections and fittings, because the expansion and contraction duo to rapid chungos in tem- perature and water-hommor action create o great etrain upon thc entire blowoff system, which is more pronounced when o nurnber of blowoff pipes ore joined in one common discharge. "Ifhe freedom of the blowoff connection on each boiler Bhall be tested whenever possible by opening the valvo for b few geeond8, at which time it can be determined

whether there is exccssive vibration. Blowoff pipes should be free from extcrnal dampness to provent corrosion. (m) Water column.—The piping to the water oolumnlghall be carefuny noted to gee thot thore ig no chonces of woter being pocketed in the piping

forming he steam connection to the woter column. tl'he steam pipe shoulcl proforubly drain towards the water column. 'I'he water-pipe connection to he water column must drain toward the boiler. The relative position of thc water column to the flro gurfaceg of the boiler shall' be observed to determine whether the column iB placed in accordanco with tha 740 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 regulations. The attachments shall condition. bo examined to determine their operating (n) Baffng—Water-Tub3 Bollør8.—In •water-tube boilers, it should be noted, 88 far aB possible, whether or not the proper buffing ie in place. In many types of boilers tho obscnce of baffling often onusce high temperatures on portione of the boiler structure which are not intondcd to be exposed to such telnperaturey, from which dangerous condition may result. The locution of combustion arches with respect to tube surfuccg shall be carefully noted. rl'hese are sometimes arranged 80 as to cause the flmne to impinge on a particular part of a boiler and produces overheating of the material uncl comcquent danger of the rupture of the part. (o) Localization of Beat.—LooaIization of heat brought about by improper or defoctjve burner or stoker instal-lution or operation cremting o blowpipe effect upon the boiler, *hull be condemned. (p) Suspended Boilers—Freedom of Expansion.—Whore boilers are suspended the supports and getting shall be oarefülly examined espccially at points wherc the boiler structure comes neur tho setting wall-B or floor. Often accumulation of ash and soot will bind the boiler structure ut such points ond produce cxcessive ßtrainE-4 on tho structure owing to the expansion of thc parts under opocating condi- tions , (q) Safety Valves.—AB i,he safety vulvos arc the most important attach_mentN on tho boiler, thev shall be inspected with the utmost caution. There should be 110 accumulations of rust. , scale, or other foreign subgi ances locuted in the cusincys so ns to interfere with the frec operation of' the valves. rDhe Netting and freedom of the safety valves should be tested pterel obly by raising the steam prex9dure to the blow- ing-off point, ot if this can-not bc done, the valves shall be tested by Inen,ns of the trv levers to usccrtain if they are free. Whoro i,he stetun discharged :from a sufcty valve is led through Pipe the [tl*pector shall deterrnine ut thc tillie the vl-Llve is operating whether 01 not tho drain opening in the discharge pipo is free ancl in accordance with the Regulations. If the Inspector iL necessary, in ordor to determine the freedom of dis-charge frorn sufetv vnlvc, thc discharge connections should be removerl. Undet no cireurnstances should a stop valve bo perznitted between ft boiler ancl its safety (r) Steam Gauges.—'llhe steam cruuges on all boilers shul-I bc rotnoved and the Inspector shall test thern and cornpnre their readings with standard test gauge. The readings of the steam gauges shall be observed oncl compared when making an inspection with steam on tho boilor, where several boilers are in eervice con- nected to a Inon sten main. Thc location of the steam gauges Shull be noted to seé whether or not it is exposed to high temperaturo cither externally, as would be the case if ploced close to thc Blnok-e flue or other highly heated part of the boiler or setting, or ox posed to heut internally due to lack of protection of the gauge spring with proper syphon or trap to provent Nt,ontn frorn coming in contact with the epring. The [nspector Bhall see tllbt, provisions aro Inade for blowing out the pipe leading to tlle steam gauge

391. Cdculation o} Wasted When uny part is wasted and rngpootor is doubtful of Its fitn04s for the pressure, he shall one or more Bmn,l) holes to be borod and from them ascertain the overage thickness of the parts froin -which he can "tisfy hirnsolfb.y calculation in aeoordonoe with the formula opplienblc to the purt. Such gauging* nnd calculotionB he Nhall onter in the Memorandum of In-spcofron Book. •SAO. 8] THE GAZETTE OF TNDIA EXTRAORDINABY 741 (b) In making calculationg for o wbNted port of a boiler shell, e.g., along the lilW pof seating blocks of Lancashire boiler, the Inspector shall use the following for- mula: W.P. Dxb thicknt ßß of wasted plotc, where thinnost,. . .Eqn. (96) S—Injnimum tenNiIe strength of material of shell in lbs. por gq. in. D=intornal diomoter of ghcll in inohcs. Füfoct,or of safety, which shall not be less than 4

392. Repairs to Extonsive reopairy such ag, fusion weldod or riveted potcheB to gholls, fire boxes and ond plat,es of boilers ancl extensive building up of wasted parts of b011cra permit Lod under these Rogulationg, the renewal of furna,0D8 and end plates, pmrt,g of Shell, fire boxes, girders ote x, Bhull only bo ontrugted to o Repairer who can sai isfv the Chief Inspeetor regnrcling the quality of and other repair done by his Organigation. Welding (b) TIW' -Repairer Nhall satisfy tho Chief Inspector, (i) thal the electric oro or ox wolding sets and 011 ()t} xor tools and plant in his pogaosston for carrying out repairs are suitable for the work un (-161 tuken, (ii) that tho qualil,y of material used to the specification that ore prescribed, (iii) that the supervis0TY pund opera Lionnl staff employed by hirn poggesg thc neceygary training and exporience for tho work undertaken, (it) lill welding Operators by the

Repan•or shall be roqturod. to pogg the teats in regnrcl to vortical, horizontal, overhoud und 6110t welding Ijres-•riberl by Lhe Chief Inspootor, (c) standard of -work 'Ahould be of high order and cornply with ull the require. ments and Lost that may bo preseribcd by the Chief Inspector Riveting and other repair8 (c,) The Repairer Bhall Nbti8fy (Jhe Chief Inspector,- (i) that he po»sogseg the necessary equ lpmont and tools and engages trained ond oxperionced workmen and staff for tho work under (aken- (il) standard of work should be of a high order ond comply Witli ull the l'f)qture- mentg and test tha (J :rnay be proserihod by the Chicf Jngpcwtor, and all Inaterial used Nhull bo of boiler qualii,y Minor repairs. (d) Notwithstanding anything contained in (a) above, minor repairs as dotormin- ed ot the diacretion of the Chief I ngpector may bo cntrusted to uny Repairer. (e) The repairg Bhould be su jerviged, BO for his other duties perrmt by tho Inspector when the fibrobox+J un smoke tubes of locomotive tubo boilore are with- drom»n, the opportunity should be taken to inspoct the internal ports uhioh are other- wige inaccessible {o close inspection. (j) Repairs to boiler shells Bhull be effoctod either by patching or by removing o strip of worn or domaged plato and inserting the new strip with covering strops over the longitudinal butt endN, the strength of the revetod joints to be not lose than that of the longitudinal joints of tho shell. 742 GAZETTE OF INDIA EXTRAORDINARY [PART (g) Patches for fire-exposed platcs *holl be fitted metal to metal 'Æithout joint of any description. The anectod part shall bo eut out, leaving tho eornerg of the holo PatcheH shall be secured, wherever possible, by properly spaced rivets With a width of plate at least equal to tho diameter of rivet botu eon tho edge of the rivet hole and tho edge of tho platc. Whore rivoting is irnpracticable, tho plo:e shall be ecwu-red by well pountersunk headcd pine. (h) Tho thickness of a patch plute shall not be legg than the original (hicknese of tho plate which it is used to pateh. (i) Bulged or distorted furnacog of circular Nection :muy, if the bulgo or distor- tion is not too great, be pressed back to shape. (j) Circular furnaces of horizontal boilers thot haye become distorted, may be suitably roinforeod. (k) Anti-col]opse rings shall be of substantial section either of single or doublo anglos bolted back to back With Bta,yg not ICBB than 7/8th inch in diameter ond about 7 inches in pitoh pagsed through flat of angle and screwed into thc Furnace, the ends being her rounded or riveted over on the fire udo ond fitted With nute at tho other. Tho stay boltN Bhall be fitted With ferrules not lese than I moh in depth botueon furnaco und angle ring. (J) Welding Bhall not be accepted for tho repair of any part of b boiler for which welding is forbidden for a now boiler undor Chego regulations, Boiler Shells Bhall not be repairod by woldmg beyond tho filling up of a small Isolated corroded or pitted port or the making up of yagted edges of oponing». (m) Crocks or grooving in cli8hod or flat cnd plate8 of cylindrical shells or in the bends of furnare flanges in a circumferential direction nua,y be veed out and Butt welding of "moke tubes.—Smoke tub0f1 rnay Le butt welded either by fugion welding, flash welding or oxy-acetelyne welding, and theso should be t0Nted hydrauli- OBI-IY at tho discretion of the Chief Inspector. (n) Wust,ed parts of circular furnacce und fire-boxes and fire exposed fiat, plates in rectang ular fire-boxes and om buBtion chambors may be cut out and be rcplaced by now pieccg welded m or they mau\ be built up by •welding. Longitudinal cracks in circular and fire-boxes and c T uckß rectangular fire-boxes und combus- tion chambcrg may be wolded. (o) No Bta,y shall bo welded. (p) For the purp080N of i,hego legulations renewed ports shall be deemed to be parts of a now boilcr intended for uso at tho pressure at which the boiler under neqal used, 393. Submi88ion of plans of In the oase of land boile1N made in India or outside India for use In the States the Chief Inspector may, on receipt of b Treasury acknowledgment Qf the prescribed fee, receive for examination in advance tho plans and particulars of nuateria]N, deeign and construction of boilerN NO as to avoid quest ions arising at the examination of the finished boilers. (b) Tho fee required under sub-regulation (a) Bhall be half the feo which would be required to accompany an apphcation for the regißtrution of the boiler (vide Ragulation 385). (c) Tho Chief Inspector shall, after examination of the plans and particulars intirnute to the propogors whcther he iN satisfied with the design and fitnegs of the parts for the intonded prosBure and, If not, what modification is necessary thcrein. When plans and particulars of boilera have boen approved, the Inspector in making his examination Bhall sce that the designf4 as approved have been carefullv followed out and that tho material correyponds with the approved particulara. THE GAZETTE OF INDIA EXTRAORDINARY 743 (d) The above procodurc shall be followod in the case of extensive repbirB or atterations to boilers, but no fee bo loviable for tho exunination of euch plans and portic ulors. STEAM PIPES 394. Inspections of steam Steam pipe* Nhall bo inspected and by hydrauli- cally tested before erection in pluec, the test pressuro to bo that progeribod in tho Standard Conditions for gtoam pipes, A ccrtificate :from an Tngpecting Authority ot' u rocogniN0d

mokor stating that this been dono may bo accepCed. If tho Ingpoctor is stigfied with the tcst,, thc pipeB may be orectod in position , at, the Btoom teyt of the boiler ho Bhull examine thom under steam pressure. No separate certi- fieufe for the stoam pipes Bhall be nwued, nor Bhall o separato foe be charged for their ingpection. (b) At subsequent inspootiong of tho boiler or at any other time, tho Inspcctor may moke externul inspection of the steam pipes and for this purpoge may rcquire a part of the lagging at the flangcg to be removod, and the pipe Inodo bare. If as a result of this inBpection tho Inspector is of opinion that tho pipes or any portions of thorn are in on umatisfactory condition he Bhall report the matter to the Ch ief Impoctor, who may require the wholo of the logging to bo removed and may require any pipo or pipen to bo hydraulically td8tod. The tet-lt prossuro at such hydraulic tost shall be not legg thon twi(e the working pressuro of the boiler. (c) The dute ond hydraulic pressure to which stoam pipe8 were gub.iectcd Shalli be e ntcred in the eortificate for the boilor and such entrios shall be continued frorn time to time in the renewal certificute» for the boiler

395. Submi88ion of plans of 8team of steam pipes Bhull bo subniitted to the Chief Ingpoctor before construction or tho t)Jno of registration of the boiler for his dooi8ion whether thc pipes and their arrangement cornp]y with [he regula- tions.CHAPIQER X SAFETY op PERSONS mSIDBB01L.ERB 396. Safety of persons working inside boilers.— (a) No person shall bc compol- or allowed, by the owner or person in charge, to go inBide o steam boiler for any purpoH0 whatsover unlosg tho boi]cr is effectively diuonnected in the manner horo- inafter prescribed from any steam or hot water communication with any other boiler. (b) Effective dißcon-ncction Shall be mudfl either by the rcmoval of tho boiler 8top valve or of o longth of piping from *toom and hot water connections •with ony other boiler, vessel or pipe containing steam or hot water or by tho inaertion of subBtantial blunk flanges between the boiler stop valves und piping. The Shutting of b etop va,lvo, stop cock or automatic isolating vulvo alone Bhall not be dccmcd ti(» constitute compliance with thiN regulation. (c) Tho owner of o boilor to which tbi8 regulation iB applicable shall obtain the approval of the Chief Inspector in Wl'iting to the method of disconnection which he propose" to use and shall be responaible för enguring that the method BO approved is followed in pruotioe

CHAPTER X1 ccxmncns DE81GN ARD cc1EV1k1)vncN or ECONCMIEERS AID FEED PIFES. ECONOMISERS An economisor Bhall not be registerod under sub-sootion (4) of gection 7 of tho Aet und certificate Bhull not be issued under sub-section (5) of that section. 744 THE GAZETTE OF INDIA EXTRAORDINARY [PART 11 with reference to an economiser, unless the 8tundard conditions in respect of material, dosign and construetion, which aro specified in this Chapter aro gati#ficd in rospeot, of Buch economiser. Where the ocononniyor hooting surface iB designed to permit the generation of steam und there nre no valves interposed botwoen thiN heating gurfaoo and the boilor druxn, then the economiser Bhall be dosigned in oecordonce with Chapters I to VIII of the Regulations where thew apply: Provided that on economigor in at the tirne Chapter XI of theso oame into forco, may be so registered and Huch Certificate may be issued in respect thereof notwithstanding thul such standard conditiona ore not gn,tiNficd in respect of such oeonomisor. (b) Notwithstanding anything containod in sub-regulation (a) the Ctuef Ins- pector may, subject to tho provisions of Regulation 502, register un economiser and order tho issue of a certificute authoriging tho use thoreof, although the Ntandard conditions ore not fully sut]8fiod in respect of Buch eeonomiBer. G ENERAI, REQUIREMENTS lhe part8 used ill the assembly of 501.— (a) All east iron and headers and an econorniser eoufornj ith the requircrnentB of this Chupter in respect of moteli LI spe 'ification Olid test, worknutnship and Ntructu_ral requirement8. (b) All ecQnomiö61'B under construction Shull be under the supervision of an Inespeoinng Authority and must bo so tified by that Authority. (c) For eoonoullsorg impor led into tho States to which thoxe Rcgulation.ß extend, o certificate from thc Inspect ing Authorit in J/'orrn VIJ rortifying that thc rnuterial tegtcd and the econonlisor built unclor• its suporviBion shall bo furnished to tho Chief lnspector before or witll tho first application for rcgistJ ation. (d) In advance of 0K' along with an application for registration, the following shall be furnished : (i) a certificate in

Form VIII of manufacture und test signed by the Makor or by b responsible reprcsentutive of the Maker, containing the descrip- tion of the economiser, particulars of the material used in its construction, and the dimensions of the several parts with the declaration that thc limits of tensile breaking Btrength ond t0Bts comply with the stand urd conditions ; (ii) o certificate from the Maker of the material, stating the tensilo breaking strength and the elongation provided that if the Maker and Manufacturer bo the sumo, the Manufacturer's precise statement showing the above inforrnation shall be accepted. (e) To suit owmers convenienee where possible it is recommended thot econo. misers be installed in two oc more sections

502. Where no certificutos are produced, tho working pressure ag found by formula will be reduced by 1000 When the workmanship- is however in any way doubtful and (he Chief Inspector is not satisfied that any of the foregoing oonditiong would be sufficient to moct the circumstances, he may at hig discretion reduce the working pressure by such percentage as he cleans fit

503. Makers' certificates for steel economigerg.—The Mako shall furnish tho Inspecting Offcer with a certificate in the following form:— "We hereby certify that the material described below has been made by the Open Hearth or an Elcctrio process acid/basic and has been satisfactorily tested in the presence of {he Inspecting Offccr/our Test House Manager in accordance with thc Standard TestB. " f below : On components before bk.lsemb\.y Oost iron tnbøg, heoderg & BendN Steel tubes, & Bendd THE GAZETTE OY INDIA EXTRAORDINARY 504. For all now economisers tho hydranlic test mugt applied as shown 1, 20 0' 10 HydrBu110 tost prosgure Twirt' working prouure; MI n.mu-l-n 500 lb.(gq. in. working pre8ALtro: Mintrmnn preggura 1000 lb./Ejq. In. Max. 1000 lb./sq. in. pluH working preRRnre. "Workl " be the higheqt ot which the economi80L' re110f NOTJD. vblvga arc to Tha +ü)ove toyt Lull be held Lor xn-LilLJ(1Lun period of ten 1.mnub8d

505. Material of construction, worksmanship and material used in the construction of pressure purls Bhull be tested ond shall conform with the following requ-ircments .(a) The workmanship throughout shall be of the highest standard. All ca,Btinge Bhull be well finished, free from defects, porous places and blow holes, and true to dimensions without warping. W hero chaplets are used, there must, be satisfactory fusion with the metal. Chaplets must bo properly tinned with metal free from lead. (b) The screw threads of all bolts must be of British Standard Whitworth forms. (c) All component parts shul] whore necessary bo manufactured to limit gaugeB to secure interchangeability throughout. CAST IRON TUBES AND HEADERS 506. Process Of niinimu tensile Btrength be in accord- ance with the following tablo Main croqs or ('ß9t,Lt1g I Ln. Up to 5/8 Ovor 5/8 and not exceeding I • 1/8 Lha. of brit' (dia. of lest piece LEI. o, 504 o 708 Minimum tonsi strength tony {t•gq. In. ton* On anulysis, the sulphur ond phosphorus content of the iron shall not exceed the following percentageg - Component Tubes Hoaders SulphL1-r POI' cent mnx. -Phogphoruq per rent max. THE GAZETTE OF INDIA EXTRAORDINARY [PART 507. Test b81'8. (a) When tho test bars are cast separutcly,i hey shall be poured at the same tixne and from the game ladle of metal as the casting or castings they represent. Tho number Of test bars specified in Regulation 508 shall be opplicable to all oaatings of each melt. (b) When tho burs are cast on the mould for the casting und the mould for the teet picce shall be joined together in euch b man-ner that thc liq uid metal fills both moulds at tho same operation. (c) All test bars shall be cust in green sand or dry Band moulds according ag to whether the casting or castings they represent ore mouldcd in green sand, or in loam or dry gund respectively. (d) The test barg shall not be subjectcd to any heat treatment ofter leaving the moulds except where the castings are hoat treated. (a) EThe number of tests required for each batch 508. Number of tensile tests. of castings shall be in occodance with the following table the various clagges of cogt- ings being divided into 4 representative groups Group 2 Weight of cust.nngH Up to 28 lbB. ()ver 28 Ibe. unci up to I ewt. 3 1, C)vor J cwt. und up to 1 ton. 'Ilest requurdlngntt•l One test for euch 30 cwt8. of raytinge or part thereof. Ono t8Bt for each 2 tons of coet- inge-} or part thoreof. One t88t for each 4 tong of ingg or purt thereof. lu the above Groups 1, 2 and ull c.-LHtingH reprugonted by one must be poured frolD the game ludlo of heat the bar or bbl'S provided for the toyt. 4 Over ton and importkvnt ea»tlngs One test för each 4 tons of cast, ingg or part thereof or for eoeh coBting weighing 4 tons or mero. (b) The odditionol tests to be curried out before cu,Bting or butch of costings is rejected gha,ll be in accordancc with the following table: 1st toyt pioce 2nc[If thia fBiIß If this paBBf+ . If this fails The gecond teat piero Hh»ll be togted. Tho bot.oh or separato ea.sting ropregented Bhall ba oocepted. represented mey be (c) Provided ulways thot in the case of' fbilure of both test pieces if either show obviouN (lcfccts o third test, piecc niü,.y be taken frcnn H, broken casting oc 84 piece may be cut from u. usable casting for further testing as

followa•. 3rd best meco If this If thig failg The batch or separato costings repreNentacl Shall be aocepted. The betch or gepureto coeting represented may be rejectod

509. Studard te8t piece.—Tho tensile test bar Bhall conform to tho dimensions Bhown in the following. Bars may be tested with either plain or screwed ends. (SAU. SCREWED) Ddi AREA D 111. SCREWED) Main cross goc- tionul t,bieknoxg of casting repræentf%l. in. 0•875 11 in. 0•25 (NRALLEL) C m. in. 2 in. 3} 111, (BSW) ILL. in. 7-1/16 in. 4-13/18 Up to 5/8 Over 5/8 nnd not exceerltng 1-1/8 'I'he toyt burg Bhall be ag ryhnr]ricul bara of the d101noter,4 given in Col. B and 'to tha dnmeneuons Kivon in COIN. D & P in the above Toble. CONSTRUCTIONAL REQUIREMENTS CAST IRON ECONOMISERS 510. (a) The Manufacturer *hall, on the basis of design details, satisfy the Ins- speet,ing Authority regnrding the design and strength of all ports of Cagt Iron Econo- uniserg for whieh, under these Rcgulbtiong, specific design und stregs lirnitot,ion hove inot been imposed, subject to thé following muximum working pressures (1) (2) Mox. W.P. Ordinary Vertical Tube 250 lb./ aq. in. Ordinary Vertical 'l'ube with Strengthened tubes . 300 lb./ sq. in Ring Stay Vertical Tube 350 lb./ sq. in Gill rrube type of approved design . 450 lb./ sq. in. (b) A certificate from the Inspecting Authority regarding tho safe working pressure of such parts of Cast IT on Economisers for which design and Biress limita- tions have not becn imposed undel these Regulations, should bc furnished to the Chief Inspector. 511. "Joint bolts and studs for cagt iron economisers—- (a) The maximum working pressure fov the bolts and stud8 shall be calculated by Regulation 518. (b) The use of studs tapped into cust iron is permiNhibIe where:— (i) The studs and nuts ore not in the paih of the flue gases. (ii) The studs arc eurefullv throndcd to gougc und fittcd into tapped holes of omplo depth", 512. Üge Of ca8t iron.—Wherc i he water tomperature ig expected to exceed 4250 F. the use of cust iron for pressure parts is prohibited. STEEL ECONOMISERS WITH OR WITHOUT CAST IRON SLEEVES ON THE TUBES 513. Tubes, The tubes Bhall bc manufactured in accordance (b) Suitable provision shall bo madc for supporting horizontal with Regulation 151. tubes ot one or til ore intervals in their length to relievo bending silesses, and these BupportN as woll as thc ond connect]011B rnust permit free expansion

514. Tubes Working preoure.—The working pressure of tho tubes shall be calculated aeeorda,nce With Regulation 338

515. Heeders: The headers Bhull bc constructed in accordance with Rogulut ion 154.(b) Branches Bhall be secured by one of the following methods: (I) Expanded, belled and welded. (2) Strength welded with additional securing meuns. (3) Full depth. strengi,h weld. (4) Brunches leys than 2 inch Inuy be scrcM,ed and scal weldcd. (c) Open cnd8 of forged for seamlesr, 9tcol tuhc headers may be closed by for. ging, 011 the ends nmy bo secured hy bolting, scr ewing. or welding in an appzovect manner

516. Headers: Working pressure.(a) Rectangular headers. Tho working pres. •ure Bhall be calculated in accordance with Regulation 340, (b) Cylindrical 'I'he working pressurc shall be calculated in accol d- once with Regulationg 270 and 271

517. Attachment of tubeg to headers (u) Tub(S shall be eon-noctecl to thc tube plutey by one of the following methoc!g•.— (l) Expanding wilh bell Inouthing or Real welding. (2) Strength welding. (3) Mechanical bolted joint. (b) Roller cxpu,nded tubes shall project through the neck or beaning part inl the holes by ot, least n, quarter of an inch and shall be ed from clt•uwing out by being belhnouthed to the extent of 1132" for each inch in diameter plus 21.32M (c) Tubes expa,nded into headers Inay bo seal-welded inyide or outaicLe tho header. Where a, smal weld is provided inside the heudcr, the tube end projection) und bolitnouch specified (b) not required. (d) In the case of roller expanded tubes the tube holos in the headers shall be formed in such a, woy that the tubes cun be effectively tightened in them. There 8haLl bc a neck or belt 01 seati og oc least, inch. (e) W hero the tube* are stren.g#h welded dircot to thc hcti(lcnq, the technique f0110N4 ('d Shull be n,vprovcd by thc Inspecting and all welds BhR,ll bc. suit. ably heat treated. (f) Bolted joints Shull be designed in accordance with Rcgulation 518. (g) Tube Npocers supporting clipe•l u,nd lugs :may bc welded to the tubes. (h) Tho tubes shall bc so arranged that they are accessible for cleaning internally and externally. BOLTS AND STUDS 518. Joint boltB.—The rnuxil-nurn. •working # urc for i he bolts shall be determined by thc following fornmla: N XC D n 2 Eqn. (121). N n D C No. of bolts securing Lhe ports. No. oc screw threads per inch. Bolt diameter in inches measured over thc threads. the area exposed to pressure which is assumed to bc bounded by line midway between the pitch line of the bolts and tho inner edge of (Jho flongc here flut joints are used with joint rings. Where

conical joint fueeq lite used with joint ringg of curvilinear cross acction, the area exposed pressure Shull bo mesumed to extend to the root of the thread where thc i,ube end* ore screwed, or to bounclary if the flanges ore attached by other a, corresponding means. for steel bolts or stud-8 of 28 tons/sq. in. TT)ini ultimato Lensile stress where the diamctor over thrcnd is less t,hßn 3/4 inch. for steel bolls or soud* of 30 tons/" . in. Illinimum uli»imote tonsilc stress whore Lho diameter over thread is legs than 3/4 inch. for steel bolts or studs or ,'35 tons/sq. in. nrinimum ulti rnate tensile stre*8 where the thread iH legs thon 3/4 inch. for steel bolts 01' studs of 28 tons/sq. in, n)inimum ultimate tcnß]lc sLrcss where the dia,metor over thrcnd is not lcss than 3/4 inch ancl not greater 7/8 inch. 7,()0() for stccl bolts for lids of 28 Lons/sq. in. mill-in) unm. uli,imato tensile Btrcss Mhere the diameter over thrca,d is greater thun 7/8 VALVES AND MOUNTINGS 519. (a) Thermometers.- All economisers shall be providcd with Thermomoterg or measul ing 'BRLer telnper uture adjocent to the inlet and outlet connections. (b) Relief ullvo which shall prevent increase of pressuro beyond 8 predetcrrnincd liniit Bhall bc fitted to every economiser (exccpt where ceonomiuers are designed to permit Stean'l generation lind have open connections to the boiler drum) and the design 811011 provide agminat unauthorised interförence with tho loud-ing. Economisers with pressure parts of cast iron ond arranged in groups of tiers connected by circula,iincr piping Bhall have a relief valve fixod on each group or tier Relief volves should a miniynurn diameter of 2". (c) Pressure Gauge.—Moan8 for indicating the proB8ure in the economiBeÉ •Bhall be provided by u, Pressure Guugc constructed on the lines of Regulation 327. (d) Air releaee rnu8t be provided for tho release of air all point* where air accumulation mu,y occur. (e) Blow off drain valveß.—Means must be provided for draining the economiu•r roompletcly of water. (f) Non-return valveg.—Economiser8 provided with means for heating the -incorning feed b.' mixing it with hot water from the economiser outlet must hnve non-return valve in thc hot water return line. (g) Reserve Flues.—ln every cusc a, reserve flue shall be provided for by- paBBing the flue gasog when no water iN being fed to thc boiler through the economiser. (h) Explosion Doors.—To relicvg the economiser of excessivc pressure mulotion due Lo internal explosions doors prefcroblv of horizontally hinged "self- gealing' ttype Bhall be fitted. (i) Hydraulio Tagts.—AlI volves a,nd nt,ing8 shall bc tested by hydraulic preggure to not less thon twice the working prosgu re subject to o Inaximum of 1000 lb./ sq. in. thc working pressure. N0TB.—The working presanro shall be tho highegt preaeuro at whioh the economiser •relief volveg Hro to be set. FEED PIPES 520. General.—Feed pipes may be mado of cast, iron or copper but >00Bt iron pipes will not be accepted for working pregsure over 200 lbs per sq. in. or 4250 F. Copper feed pipes Bhall be solid draw-n and not exceed 8" external diameter . and rnay bo uscd for n working pressure not exceeding 350 lbs. or 3000 F. Design pressure for feed piping.—The degign pressure 8holl be the maxi- mum pressure generated in overcoming friction ond other losses in the feed piping unclor ordinary working conditions, or the mtoximum pressure which can he genero- ted by the boiler feed purnps unless special provision iB mB(Ie to prevent thBt preggure being communicated to the pipe linc

521. Steel feed pipes.—Steel food pipes shall bo in accordanoo with Chapter tvm

522. Cast iron teed The standard condil ions for material of construc• 'tion and tegt,s for cast iron pipes shall oornpl.y with Regulations 505 to 5()9. (b) Tho maximum working pressure Shull be clctcrrnined by tho following for- kmula:— 1.30 (t- 6) Eqn. (122) I,hicknesg in thirty-seconds of an inch. d the exterrul diameter of the pipe in inches

523. Copper teed The etandard conditions for materiol of conatruc- •tion ond LestJF4 for copper pipes shall cotnply with Regulation 35.(b) Tho rnaxilnum working pressure Shull be determined by the following -formulas: W.P. d Equ. (123) Ihickness in hundrcclLhN of un inch. external diomcter of the pipe in inches. REGULATIONS FOR REGISTRATION AND INSPECTION OF ECONOMISERS

524. Preparation for inspection.— (a) At each ingpection the economiser shall be (mptied ond thoroughly cleaned internally and externally ond in the flues. All mountings shall be opened up and cape removed to perrnit adequate inspection. (b) The owner of on economiser to which this Rcgulation iB applicable Bhall 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 thot the method 80 approved ig followed in practice

525. Procedure for registration.— (a) On receipt of an application for registra- &ion the Inspector, shall, after the economiser hars boen prepared for don, take full particulnrs of the design and agcertain the working presgure allowed by the Regulations. (b) If required under Regulation 510(a), certificate from the Inspecting Authority has not boen furnished, the Chief Inepoctor Shall determine the fltneu of such part! aa per the following formulae gubject to the lirnitotion prescribed under Reg. 510(a) :— (l) Economisers with pressed gocket joints not reiniorced,— Areo of Socket in contact, (width inside Header) (Pitch of tubes in Header) Friction Factor. W.P.=Working pressure in tbs. per sq in Friction Factor 300. (ii) Headers for above Economisers :-— 20 t Thickneps of flat sides in thirty second-B of an inch, (iii) Economisers with pressed socket joints roiniorced, Areo of Socket in contact, (width imide Header) (Pitch of tubes in Header) Eqn. (124) Eqn. (125) x . Eqn. (126) rriotion Factor 4k No. of stays per header Where k — No. of eocketß per header Where friction factor 300. and P—300 for approved design of reinforcing stay. be coneidered greoter than 150. (iv) Tubes for above Economisers : 200 (t—6) Where t Thickness in thirty seoondg Of an inch, d External diameter in inchcg. In no cage value of K shall (127) INDIA , (v) Headen for Economiserg with reinforced gookot loin" 1-— 200 (t—9) t thick-negg in thirty gecondg of on inch. d = External diameter in inches. (vi) Manifold Pipes for above Economiperg :— 200 (t—.7) D t — Thiokneeg in thirty geoondß of on inch, d External diameter f-n inches. Eqn. (128) (129) (vii) Cayt iron Economiser with gills or other extended surface Tubes 500 (t—C) t = Thicknegg in thirty seconds of an inch. C 8 for portion where gills act ag reinforcement ; inforced. d = External diameter in inches. (viii) Bends and Mauifold Pipes for above Economiser€ d t — Thickness in thirty seconds Of an inch. d — Extemal diameter in inches. Eqn. (130) IO for portion not re. Eqn. (131) (c) The Inspector Shall enter full particulars of the economiger together wlth the required calculations of various parts in a Memoranduxn of the Ingpection Book (

Form IX) and eubmft it to the Chief Inspector. (d) If no formula or co-emcient applicable to any part, other than what ig mentioned above, fg contained in the Regulations, the Chief Ingpeotor shall at h-ß digoretion deterrnine the fitnegg Of the part. (e) After Inspecting the Economißer and aacertafnlng, 8.8 pruoflbed, tho maxlmurn working pressure to which it may be worked, the Inspector Bhall witneß8 the hydroulio test in acoordonoe with Regulation No. 527 and may {uue a Provi. •ionol Order in Form X

526. Procedure at subsequent After tho economiser has been cleaned the Inspector shall make a thorough examination BO far ng ita congtruct-.tion permits. The external condition of tho tubes Should be oorefully noted for wag. ting eepecially at tho feed inlet end and all accessible tubes should be calipered. The internal gurfacee of caßt iron tubeg Should be cloæly observed for graphitic wagting 0B far it is possible and in the event of any tube failure these Should be broken up for scrutiny go that the general internal condition of the other tubu may be estimated. (b) Where tubes or other parte are wasted, the strength ghould be re-c•loulot. ed. (c) The scraper gear should be exnmincd to note if any parts are mi8.ging if the length of {rovel iB adequate und if tho scrapers are correctly adjugted. (d) All cap bolts are to be inspeoted, algo the condition and poeltion Of the dampen and baffeß. Ox_ I, .n.4A'i*IAO. (e) The record of each inspection und calculatfong will be entered in the Memo. rondum of Ingp30tion Book

527. Procedure for Hydraulic tøgt.—Every ooonomiser for rogistration shall be hydraulically tested fn the presence of an Ingpeotor to li times the working roes-ure- Subsequent budrau)ic test may be confed out after repairs or when the peotor oonsiderg ft ne$cary. During the test all parte oxternally and in the flueg •hall be noted for leakag es 528. Memorandum of inspection book.—ln this book the Inspootor Bhall enter •11 particulars and dimemione of the economlger wftb tho required ooloulutions for the various parte together with detailB of hydraulic test. At gubgequent inspeo. tlon the Inepoctor shall enter all notes pertaining to the condition of the variou parts

529. Registration Books will be maintained on tho lines of Regulation 387

Form XI

531. Casual Tho Inspector shall note if the economi*m is working uthfaotorily, and if the relief valves, are oorrectly bdjusted, ff the scraper gear operating and if the external brickwork ig froe from cracks.(b) He ghall LIBO ascertain that the makers' instructions for working are" being 5triotly followed by the owner. N0TB.—Tt, iB rerornmonded that the d inlet tcmporature to the should not be legg thon I ()OOF to prevont sweating nnd congeqncnt external oorrogion of tho tubo and bottom headere

532. Economiser rating.—Tho rating Khal] bo oquivu]cnt to the arca of , i he heating surfuco in square feet which Bhall be computed from the tubes and 533. Registration fee. —An application for registration 8holl be aocompanied by appropriate fee. For Economiger rating not excooding 500 For Economiger rating exceeding 500 For Economigor rating oxcooding 1 , 000 For Economiser rating exrooding 1,500 For Economiaer rating exceeding 2,000 For Economiaer rating exceeding 2,500 For Economigor rating excoeding 3,000 For Economiger rating exceed ing 3,600 For EconomiBer rating exceeding 4,000 For Eoonomigor rating orcooding 4.500 For Economiser rating exceeding 5,000 but not exoooding 1,000 but not exceeding 1,600 but not oxceeding 2,000 but not orceoding 2,500 b -Lt not exoooding 3,000 but not exceeding 3,500 but not oxcooding 4,000 but not oxcocding 4,500 but not exceeding 5,000 50 70 80 90 100 110 120 130 140 150 534. Engraving of Registry Number.— (a) E»ch ion, bronch pipo or detachable part gubject to the Gorkfng pregguro shall be marked for identification with Regigtry Number and also the appropriato device ag Bhown in Regulauon 882. (b) Jn the rage Of the ordinary vertical typo Of cast, iron eoonornixers, the devioe and number Bhall be stamped on the header flange connected to the top branch ipfpe. In each cage thc gtnmping shall be on some conspicuou• pact not affected by the gages or other corroding influence. The letter "F," Rh0111d be prefixed to f,h8 number iu the denorninoloz•. Exumnle : r.LHn.l Or -LINDIA

FORM 1 (Regulatione 386 and 887) INDIAN BOILERS ACT, 1923 BOILER INSPECTION DEPARTMENT BOILER REGISTRY NUMBER Memorandum of Inspection OR Registration Book 1.4 of Foctory, Nearest R.ßllway Station, ... mi-la Fultory is.. Work or Fbctory,. Working wason,. BOILER REGISTERED REGISTER BOOK No... . REGISTRY NUMBER, . APPROVED WORKINYG PRESSURE* . BOILER RATING, . REGISTRATION BOOR filed Remarks on transfers, etc.... .. fro-rn . on.... .. ...PAGE.... ...Verified on, . -NSPECTION FEE, PROVBIOKA-L ORDER AND RECORD Dote of payment Da±e of (>åficate No. And dBte Period of Certificate Working B oikr Rating Evaporati on Initiab D—iption of Pc*hon of . AND DIMENSIONS MAKER'S CERTIFICATES hydrudio . ...Ibs.,drawing No. . . of mzteiN. hydnolio ..... Pra3æ, ...l.md.ing . wo*in.g præ.lro..... . Müa.r's nuxnk»r..... ra:zived. .... PANZICULABS ARD D ONS—-eontd. Plates, ...„.. . Rivets, . G u.—t Steys Girders . End and Pire and . PIBt.æ.,.. MAKER'S CERTIFICATES—con.U. TEST RESULTS .... tons. E . * * tons. E ...tons. E .....tnns.E .... tcm.E.ß . . ..rec€va:l..... . Analysis ..... . ins. . AND DINASIOKS-.ntd. CYLINDRICAL SHELL (a) SIEII or Fire- box caÄ.ng or Mud Drax:n of parts . and material of eøc_h Length IEtween end plates do. do. s...æm Di81neter inside largest belt of plbteg. of belts of plating First or top t:At, inside or outside .Lonöudina.I seam*. (o'clock) Kind, L., S. B., D. B., W. Riveting, S., D., C., Z. He M. No. of rnvets pitch Pitch of rivets of holes, outar rows Do. do. r•OW8 Dig-tance rows, outer . do. Do. do. Do. rivet to edge Outer but* strap, width X . do. do. X do. Inner do. Cöwmfrerz*ü seams. No. of (end and Kind L., S. B.. D. B., W.,F & B. Riveting S.. D. T., C., Z., H., M. No. of rivets pitch Pitch of riveta Diar. of holes Dig:tznee rows Do. rivet edge Water Drucn or o FIB±, hemisph&iczl (in..... Nmeter front, . Radius of curvature do.,. ... . Do. do, u:rner of flange, .. Plate front... .....buk..... Attacht, to shell, crown or ... do-, back end,. ..... . Do. uptake or fur-rw:scrovnorfront,..... . fliE, kBck and..... Furnßco or riveting, pitoh circle,..... He-mL end ... Steam 8paæ dou-bLi.ng plate, front..... Do. do. stiffener or bulb, do.., AND D SHELL ENDPLATAS AND LONGITUDINAL STAYS ... riveting, S.. D., pitch riveti.ng S. .do on—- wntd. .... pieces), 11-ot gteyed, not flanged .....do.,... - plate F. , . . crown, ...back.... - -th;eaäe,..?..... .....mrcle,..... .....B,..... . -hoÄ ..... stays, No. F. E., Longtu #ays No. , . Do. DiagL do. pitch, V PABTICÜUES DIXENaONS-«mtd. MANHOI.&S. HAND AND SIGHT HOLES, DOORS AND STAND BLOCKS Pueand . No. md or plßto mner 0fdiing, kn.gtfi X Fr-une opzning, I.ength X irside, Fran:s wlid_, weld.:l, Frame sotion on Ion* . Door, tiF if inside, spigot ' Bolte, no. , diar. thr-æi.8 nr*.. B31t8, pitch oi:roL ring, width x I Riveting, S. D., T nn , rivet. O O No... .. Chan-ingplu.gx, no.. Height,. StandpiEE ... . •....•.....tnke., ...positicmg..... . . threads, ...diæ. (outaid.o). ... : thiekx:æ,..... Parte .... Length ovar ..... Height, foundn. •n to of plate,.. .. PARTICULARS AND D FIREBOX CASING do. do. .. .. Width ov«a.l-l., . Crown, Broha:l or flBt, cr 01B d.i&.,- .... $ PW thickn•, front,..... Radi-u.e of comer of front Riveting, front S.. D., pita:»... Do. %ddl.e 8. D.. No.... . .....crovn..... ...do, . threu:is.,... nutte:l, pitch,. .. ... RECTANGULAR VIREBOX. COMBUSMON OH.AMBER, GIRDERS SMOKE OR WATFR TUBAS AND SCREW STAYS Pere 0 I..ongth inside, Height, found-n., to Width in.skle, bottom, . I'. . . ...Rbdius of curve, chbr. tx:Étom,. . . ..rcnfg.ide,... Roof, flbt, to dL.oll or girders, ... Platz thickyæ., fir•e.hob eh.br. Do. tnttan,..... . to box tx:*tom,..... Found:n. ring, *Jtion. Fühob, .. -...gidß..... • .... Bidæ in .. riveting, pitch, ... above .... O 1.4 RECTANGULAR FIREBOX, COMBUSTION CEAHBBR, GIRDERS, SMOKE OR WATER TUBES AND SCREW apart, . . nutte:i, girder. Slings, nm..... Do. at-tocht. to ...Bolts, no.,.. ... distance apart, ... No. plains.... PIBi.n., diar., (out). ...Qlick:n—, . . , over F. .. length plat•,..... . . . . .F. Ek, expd., S. E., Expd-, bead, do., do. , nutted, S. E. , do. E., or.... .... straight ! Pitnh of pÄn tubes, V., m. stay TuEe Plata, no. of mvs-, V F. hok or back do., V Sids, do., L Bottom, Ordi_næy stays, diæ..... pitch, . pitch, . . rivete3., PARTICULARS AND D CIRCULAR FURNACE, CROWN AND UPTAKE .. I..ongtA-, NO. of No. of rings in tztwe•o 13 14 15 (Flau.gæ, ... I Caulking ring, FURNACE, CROWN AND .. riveting, püeh.,.. .....R8diusof ... .man.ge width, ... 8 s. Iongu No. each furn»æ,..... dir. ..... Attacht. to at Enü)m,... .... firel:wE.... . ...prtoh, V., ...H., ... weki.:l Flue. . ...thickræ,..... .. . do. Found.n. ring, wztion,.. do.., do.. Do. , ... Screw Stays, No. of rows,. . r met, Ysrni.spYEricnl, not stBYdi., not Ruizu.ß of curvatu-m . crown, . .mveting pitch,. do., do.. . of gb:me foundn. 1B.a.ræt mw found-n. . do. ryveted, c . . nua., (outäde), ... of flange, . ogæ rung Attøc-ht. furnace or .... Uptake ivefing, Pitch circle, ... o ..... . um.gtl. om . . Dir. (outside). top, ... bottom. Th-lch:æ., to mts±8Y ccolo, . not PARTICULABS AND DIMENSIONS—oontd. WATER TUBES, HEADERS, BOXB A-ND SUPERHEATER Puts and ... r MBin tul:«., f Diar, {outside),.. thickn—,- f Ends r Hæders,

no.... .... e)tion (otikide). .... 2 Staggared or straight, round, oval, s.quæo, b18i&, Boltz, . r ection (outä&) . no.... .....do.,..... . - -I.,ength or D, C. Z. Straighi, Lie, ... - I.an.gå . . ..,olid, welda:l. ....diu•. Straight, Lie.... Ends l:elkd of in . ...no. . thicklæ,. .....PcÄtion,..... . do. . in. in or Now Down . r Wate No. . Do. top of rover < f Do. Tæt cczks, H*tom i.e... Do. maker... o Tæter attachment type Do, Do.... : . Fu.sü)b plug, type. [Blow d0Fn eltÄ)V, . - &ppamtu.8..... Additi:mBl fistings - MOUNTmVGS AND .Tæt above. . ...no.... . .do... . r&dlina at... . cæk.ß No. - ins. to . _ . on right, loft Bide. . . ...IIR . waste inehæ above.... CAICUL.AMMS SMELL, BARREL, S. & W. DRUM, F.C. CROWN, M. DRUM, J0Äyrs Parts Plt.ch Innar Bowe Narow Stmp Plato % Working Jomt Fig. No. P...D...T.... 100 x AxN x cx (P—2D) ...J....C....D....W.P.— Fig. No. 100 (P—D) cxD P...D...T c. N. FLAT AND GUSH' STAYS PLAB Di—IN Do. FRONT RND Amund BACK V or Mid TV—v Mid 3-7 PRESSURE STAYS--.m.a. (A) Strnoxrn PILATE M.A.RGINB ERONT BACK END 8•-47 YLAT END AND SMYS (GI—DB) • Præ-are. SAFETY VALVES. No. æch ohæt Diameter Ditto 8maU ( ) DEAD VALVE. LEVER AND VA.LVN H.i@ end Iow Wate Tme Un.Y— IW.P V to ünb&æd [W.P.xA—Vl V F) L Round DACK CALCULAflONS----contd. SAFETY VALVES—41üd. SPRING IÆADED V AIRE. (.....inohæ. T.mrt compæion .... 33333 x d' D ACK REQUISITE AREA OF SAFETY VA-LVES. For NOTES ON WORKING OF BOILER DACK {3B+1 .8H) for Sal:mheated Boikr is fæ.... or ..... Is H:ik by long Pump ev•aÜabIe for f . Fæd water town we]] , ce Nata:æ of wgter..... . . Period b by Hæting . , by.... .... P—re, HYDRAULIC . of DÄ of . with. tat.... of tæi..... (RBATIOE) RIGHT HAND Af%r Tæt ZYDRAULIC Nos. T68t . Daring Tæt . After Test Parmi Gauge Poink Tæt During Afta Test . Pamnt. FRONT END LEFT HAND B XCR END of Approved ..... tot's precure gauge. .... Bo conne:tionB.... Fuel Safety lifted at (A) fining of Height water in glæ Presare by gauge . Do. Do. Accu.rnulation of) , ...Dßteoft88t* . - .. Tæt Boik gauge No. ... Condition of . . Draught . .1b3. (B) IO mil*. 15 n:rins. Difference. valvæ emciently relieve Condition of under Do. of mountings under . . . - Lcøding Of valves Bt blowing pæn.re (A) do. Do. do. Thicknes of *Behera or fa•eu.le€ pu:mp or worked Water B oüer attendant do. do. (C) Limit of load on safcty valves to in PLAN or BOILERS AND HAIN PIPES Situation. Ry. N'*. of boüers Main pil::— include P a, material . . . . {outmde) Do. Do. Do. thwknæ . attachrænt of • by . Pir cov&ing Provision for Main St«m . Auxy, do Bkrw down .. ... , W.P ammu-ßON8 RECX)RDS OF INSPECI'IONS AND First uld by . First hydraulic (to INSPEC!OB'S PARTICULARS OF Boz:r.EB ATTENDANTS Year of (hrtlficate Date of Employznsnt 784 THE GAZETTE OF INDIA EXTRAORDINARY FORM 11 INSPECTING AUTHORITY'S CERTIFICATE OF INSPECTION DURING CONSTRUCTION [REGOLAT10N 4 DESIGNATION OF INSPECTING AUTHORITY We hereby certify thot the type, boilør ; longth. \nnheg ; diarnetm)r, inches ; working presaum, feet, Merg. at fwt [PART 11 Ibe. built under Bhop wog constructed under ottr superviRlon and inqpeotßd Ot varioua stogea Number of by the Inspoctin.g Omoor and thot the construction and workmanship woro 80t18-factory and in with the Strmdard Conditions for tho d0Bign and construction of loud boilerß under the Inclicn Boilere Act, 1923* The boiler ig stamped of the front end plbte with our Stomp shown hereunder :-— Works num bor Tæt,ed to lbs. on lb3. Yo»r of Moke Inspecting OM certe or InAFotI.ng Authority 'B Omcial Stamp. The boiler on oompletion woe aubjectod t") pressure test of •quare inch in the prebence of the Inspecting Offoer on catißüwtorily withstood tho toxt. per and Samples of tho pl.Btß8. etuy, anglo and rivet, berg in tho construction of tho boilers were teeted In the progonoe of the Insper•ting Offoer "nd werg found to comply with the teet prescribed in Ohaptem 11 & V of the Raguiotiom relbting to Stonclard Conditions for the deBlgn end cong. truotion of boilam undor the Indian Bollore Art, 1923. We B.ati8Hed oursolvee thot tha construction and dimensinng of tho boiler ar3 shown Signod by u, and thut the purtioulara entored in tho makor'a in tho maker" drawing oertifloete Of manufacture in Form It I countergigned by us, uro correct to the best of our know- ledge ond belief. day Of Dignature o/ Dupeding Authority. 19 810. 8] GAZETTE OF INDIA EXTRAORDINARY FORM Worke Addre88 CONSTRUCTOR'S CERTIFICATE OF MANUFAOTURE AND TEST [REGULATION (d)) Des- orip Mon 2 1 Typo of boiler I-8ngth overall Intended working pressure lbs. Diameter in'!ide lorgoat Shop number of boiler eq. ft. Grote area sq. ft. Yeur of Mmufaoture Description of boilor. Totol Evoporotåon Boiler constructed under supervision of Boilor hydroulicolly tos+ed ond internally inspected ofter test by 8 Sheu Seanw.-—The longitudinal s.eom.s are and have rowa or rivet,ß in inside strop und inch diarnot,er and number rowø of rivete in out8ide gtrap. Rivot holog are inch08. per pitoh of Butt strop cut frorn plot.Q8 and bent to required curve in eirournferenti&l N8&rna joining ringA Of shell are inch diometer

md number Rivet holes ore and The riveted. per pitch of and riveted. Rivet holes ære inch diameter inches. The mhell and nro per pitch of mnd nu-rnber Detailg of gaung in drawing No. Furnace Seanw. —The longitudinal joining rings e Of type inches. The oroga seamg riveted. 8 rivet holes in shell and furnace flueg drilled in plat'S were bent, i plot3ß aftorwards tokon aput, burrg removed and rough edgeø of holo cleaned beforo rivoting. Riveting wherover practicable dono by moohine. All flro-worked platoe (moiently annealed aft8Y oompletion of operotionß. Welded portB of boiler are welding procesg. No part of boilor proper inoluding moutbpieoog and stend blocks, is made of iron or malleable COBt iron. Fuaion welded drums.—The construction is in aocordunca with Chopt,or V Of Indian Boiler RegulBtiou. Number of longitudinal goavns in oooh ring. Number of Dot8i18 of ropaird to soun3 during congtruotion, If my. Deüzila oj heal treatment GAZETTE OF INDIA EXTRAORDINARY 4 FORM Motorial oontd. Smelter Boiler parte ond attinge. Do. Rivet bors . Bota Tubes Glrd.erø Manhole frames . Manhole doom Manhole Compn. ring . Sighthole doon . Stand blookß Stop Valve Ohostß Valve Chests Fæd Volve Cheste Blow down Blow down elbow pl Water gaugo mount Make Inspooting Remarks ONoer N0TB.—Under ' 'Motorial" enter ogzinst appropriate Item Siemeg Martin, ope hearth acid (or basio) process" ; "Wrought Iron, Branch. ... , ... " ' '(Jogt Sta'l, Proce33. .. . " eto., oto., and under ag.. "Solid drown", Ibe. per gquaro inch, "Remarks" a briof explanation of proooge or x:nanufucturg where neoeB8B.fY' "Lop wolded"} "Solid preesed": Togt,od by maker€. .. ... etc. THICKNESS OF PLATES, ETC., A-ND TENSILE TEST rs 5 Pert of boilor Shall . Butt Btropg. Stoam and water drawn Barrel (Loco) Firebox Caging Crown , (Loco), Doma Mud drum Front End . Book End Sholl Crown Dome End . Mud Drum End • Soddlo (Loco) Firebox cæing Bideg (loco) Doubling Thick-n.8% of plotos in 82nd or Diameter in Incheo Tengile strength hmit8 to tone Elongation Gouge Brand and h.mitB to longth inB. number on plato eno. TIIICKNESS OF PLATES ETC. AND TENSILØ TEST LIMITS—00tud. 5 •u 8 8] oa_ INDIA FORM m.—concld. Tennilo Elongation Part of boiler Furnnce, Circular (plain) Furnaoe, Olroular (plain) Furnace, Circular (corrugated) Firobox, Crown. Firobox Sido. Firobor Front. Firebox Tube. Uptake. Smokebox tube. Tube,. Wator Tubog. Smoke Tubeg, (plbin) Synokø 'Itub6ß (atoy) Superheater. Crogg borog. Mud boxog. Gusset Stoy (plate B) Longitudinal. Scroy. Firebox Roof slinge. Firebox Roof Pins. Girder Bolts. Sholi Anglo Bolte. Uptake Anglo Bolt'. Manholß Bolts. Sightholo Bolt8. Firebox GirdeN. End plato Stiffenerg. Shell Anglo, Furnaoe An Io. Uptake An Manholo dompn. Ring. Manhole Frarne. Cover. Sightho]o Chmpn. Ring. Sightholø Doors. Stand Blocky. of plates in 32nd or Diameter in inchee strength limita to tons limits to Gauge length inm Brond and number on plate ox DIA LA 1 tsAOHDINA_kÖx [- xAB'R (6) Cortißod that the partloulan entered herein In monugoript by ug are oorroct and thai arts and fittinge in sections 4 ond 5, against tho nor:noe of whioh entries ore mode, havo u.eod in the oon.8truotion and fltbfnge of the boiler, Tho particulara shown agoinet tho various part ueed in aocordonce with tho maker" In our powewion. The dæign of boiler in section ond end view with principal ports fully dimongioned iB thßbl Bhow in drewing No. The boiler hog boan designed and constructed to oomply with tho Regulotiong undor the Ind-i% Boilen Act,, 1923, for a working proæum of Ibe. per square inch Bt our works obove namea aud 88ti8footorily withstood wetar teat of lbs. per gquare Inch on the day of 19 In tho of our rogpongible repromntativo whoso dignaturo oppended horounder. Makor. Signature of Engineer. Signature of Maker 01 who witneed test. Secrotary of Firm. Dated at Signature of Inspecting Authoråty. the doy of Nory.—'lho drawing of the boiler and maker" ærtifioate of manufacture and regultB of plate t«tß for tongile strength elongation and bending must cwcompany this and If boilof ha• built under the supervLion of an Authority their Form 11 mugt 01M) bo attaohed. FORM IV STEEL MA-KENS CERTIFICATE OF MANUFACTURE AND RESULTS OF TESTS [REGULATION 4 DESIGNATION OF ROLLING MILL We heeby ærtify that the n:raterigl described made by by the ocid, b-æ.ic and rolled by us and Las t—ted in the Of your Offcsr, or Test in Vith the tæts. Dag of Ceu O Niered by Boiler Nu.znk:zr Charge Num 19 Part of boiler Signbture or Initials, House Order Nurnber of of plate RESULTS OF TESTS SIZE or PLATE Length Tensile i:ng strength in tæ:ns squ aro Date in inches cent. B end Thickness in 32nds in. Counterfoil No. Bre hereby porr:nittad to tho Ratinz mule by numl»r lbs. of No. BoiLt (Registry at maximum Fr aquare hlCh pending issue or Nfuæl of a cørbißcrßte within six x:nonths from the date which Ch-is order will kHsome void. Doted In.81H3tor of H)ikrs. FORM V 381 (C) PROVISIONAL ORDER UNDER SECTION 9 OF THE INDIAN BOILERS ACT OF 1923. b..r•e hereby to the (RogiBt& No.) Boiler Rating by Bild tkbrxng Maker'* maximul:n of square inch i.sue or of a (Btiåo.a% within six 1:nonthB the date after which this order moome void. Dated r-n.sfB3t.or of Boi-læs.

N.B.—Thu order must on by any to Chief on of orders. FORM VI BOILER INSPECTION DEPARTMENT HOR or A BOLL-IGR (Regulation 389) RegiBtry Number of Boiler. Boiler Rating. Maximum Continuoue Evaporation. Nama of Owner. Situation of Boiler. Repairs. Remarks. Hydraulically Tested on to Type of Boiler. Place and yocr of manufacture. lb8. per eq. inch. I hereby certify that the above describcd boiler is permittcd by me/the Chief Ingpector under tho provisionß of Section 7/8 of the Indian 1301terej Act, No. V of 1923, to be worked at a maximum progsure of riod from The loading of tho exceed lbs. to the aquare inch for the Hafety valve ie not to I further certify that the main Bteam pfpe waa tested hydraulically to a pressure of Bqu.nro inch last on Fee Rs. Dated at paid on day of Countersigned. See Reverse for ' 19 Ingpeotor. Irwpeotæ. 'conditions" CONDITIONS (I) No structural alterut,lon, addition or renewal Bhall be mado to Lhe boiler otherwise thon 1-n occcrdanoe With Section 12 of the Act. (2) Under the prov1S10ng of Section 8 of the Act thw certifloate Bha)'ccaee to be In force:— (a) (b) (o) (d) (6) on the expiry of the period for which IL w ts grented or when ony accident occur" to the boiler , or when the boiler moved, the boiler not bemg verticol boiler the heatmg Burfocø of which 18 lees than two hundred •quam feet, or o portable or vehicular boiler ; or when any Btruoturøl alteration, addition or renewal iB made in or to the boiler ; or if the Chief Inspector an any particular case so direct8 when any structural alteration* addition or renewal made nn or to any 8teaan pipe attached to the boiler ; or on the communication to the owner of tho boder of an order of tho Chiof I-ngpector or Ingpeotor prohibiting [tg uae on tha ground thot It or any at..oom pipe attached thereto ie m a dungerou-ß condltåon. Under Section IO of the Act a boiler moy continue to be worked beyond the pomod of the oertlflcgte Issued for It provided the owner hae applied for o renewal of the certificate before the expiry date and none of the casea epeclßed In (b), (o), (d), (e) and (f) opply tothe boiler. (3) The boder Bhall not be used at pressure greater than the pressure entered In the certi- ßcot,e na the maxi-rnuzu prose-urc nor wuth the gafety volve get to a preuure xceedmg auch maxt- murn (4) The boiler Bhall not be used otherwise than in a condition which the owner reagonabJy behevoo to be compatible With working. N.B —Details regardmg th18 boiler are recorded In RegiBtrution Book No. which a copy may bo obtained on payrnent on apphcahon to tho Chief Inspector FORM vn of INSPECTING AUTHORITY'S CERTIFICATE OF INSPECTION I.FNDER CONSTRUCTION DESIGNATION OF INSPECTING AUTHORI'IY [Rag. 501 We hereby certify that Econon-nger, con.ßlßtmg of ted for o workm.g progeure of sections, and tubee to each Bectlon waa conBtruc. Ibe. by Megara under our eupervßlon and mgpcctod at various stages of eomtruotion by tho Inspecting Oßcer and that the congtructlon and workmanehlp were eatißfacLory and m accordance Witb the 'tandard conditione for the design and construction of Economiser IAId down In Chapter XI of the Indian Boder Regulations 1950. Identification muk on each section, Branch Pipe or othcr preuure part P0BILnon of same. 'IThe goctnone on completion were subaected to water pressure of for ten minutes m thc preacnce of the Ingpect,lng Offcer on Withstood the test lbs per gq in. and gatlBfactor11y Samples of the mnt.ennl used tn tho constructlon-ß of tho Eoononnger woro teßted in the pro• Benoe of the Inspecting Officer and were found to comply With the teetR prescribed in Chapter XI of tho Indian Boiler Reguli- Itione, 105(). We have sati8fied ourselves that thc condtl uctlon and dnmenBlon.ß of tho Economiser are Blgncd by ug and that the portlcu.-lma onteredin the 08 Bhown In the Makers' drawlng No. Makers' cert1fl0üta of manufacture In Form VIII countergngned by ua are correct to the beet of our knowledge and behef, Dated ut 19 Signature or Inspeotmg Authority. FORM VIII Works Addn BS CONSffHUOTOR'S CERI'IFICATE OF MA-NXTFACTUHL AND TEST [Reg 601 l. Desomptlon Typo of Economiser No. of Sections Intondod working presaure Year of manufactura Description. No. of tubeq lbs Total hooting aurfoce tubes

2. Inapecbing Authority . Economiser constructed under gupor• Sections hydraulically t0Bted for viB[on of inspootød after test by minutem and 2. Construction and work. DotoilB in Drawing No. manghip

4. Eoonomi.ß€r ond fittingn All castinge are well finished, free from external defectp, poroua placeg and blow-holes and true to d.imønsion.B without smrp{ng. Whoro chaplete aro used, thero is gatßfaotory fusion with tho Chaplets ore properly tinned with metal free from load. All acrow throodg are of Britißh Standtk.rd Whitworth forrn. All componont parts manufactured to limit gougoß to woure intorchangeobility throughout. Parts Material Tubes end or Valvo ohost3 Makor Inspecting P articularB of motorial THICKNESS OF PARTS AND TENSILE TEST LIMITS Remgrk* Brand and No

5. Part o Economisor Hoaderg Tuboe BoltB Thick-nose in 32ndß Tensile strength limits to tong Elongation limitß Gauge longth Cortifled thut tho particulorß ontored horoin are correct that tho parta ond ßttinge men• tioned obovo hove t:xxm ugod in tho construction and ßttingg of tho Economiß.or. The particulory Bhown ogaingt tho vurious aro fn accordance with tho Maker'a cerii. flcate3 m our poggeggion. Tho depign of the oconorn.igor in section ond ond view wH,h principol parts fully dimensioned is that shown in drowing No. Tho Economiser has been designed and oono- truct,ed to comply with the Indian Boiler Rogi-dations for a working of lbs. por sq. in. , at our Workfi abovemontionad and tho sections Jbtisfoctorlly with8tood 8 water text lbs. por sq. in. for of in the prosenco Of our Nignoture is appended horoundor. Signature of who witneyeed bho test. Dated at day of minutos on rosponsiblo repreænbe.tÅve who* Dosignotion of Mokor day of 19 Slgnature of the Inspecting Authority. Nom.—The drawing of tho Economiser and Mokor'8 oortificote of manuftM)ture ahowlng tegula of teste for strength ond elongation must accompany thie oortifioete and ff the economfger boon built undor tho supervigion of on I.n.gpoe ting Authority thoir in

Form VI-I must oocompany. FORM IX (REGULATION 528) INDIAN BOILERS ACT, 1923 BOILER INSPECTION DEPARTMENT ECON OMISER REGISTRY NUMBER Memorandum of Inspection OR Registration Book SEO. B] District Owners Address of Factory Nearegt Railway Station Eoonomåeer Regi8torod at Register Book No. Registry Nurnber Approved Working Pregure Economiser Rating RogFgtration book filed at Romarka on trangfer etc. OF INDIA EXTRAORDINARY THE GAZETTE MISCELLANEOUS on page verifled on lbB. Inspection fæ on PROVISIONAL ORDER AND CERTIFICATE RECORD Fee Dote of pagnent Date of Ingpec• Certifio tite No. and date Period of Working Certificato preaaure Econo. miser Rating 79b Remark g and I ingpector'8 ini tial Type of oconomigor Mokor . Intended Working Pressure .... Ploce ond year of Make... . . , . Makor'B No. Degcription of Economigor THE OF INDIA EXTRAORDINARY 196 No. of tub08. . , Longth. .....Dia. Thicknoga Internal dianen.ßions No. of Headers Thiokneaa of Headere . L.angth of Top Bronch Pipo..... . , Length of Bottom Branch Pipo Dimensions of cap opan-ing8 of cap boltx No. Relief valve Stop Valve . Blow Down Thermomotors Prweuro Gauge Additional Fittings Pogition 11 M bt,eriol Diameter cnm:r10ATB8 'r Type MAKERS, Nune of Maker Maker's Hydraulic Prossure, . , Maker's Drowing No.... , Name of Ingl:mting Authority Nome of Mokor of Matari . Prooeu Pipes Bolin Tub0B . Heodora . 0? Sulphur. % Phosphorug Tot Reeul•t8 r, Makon Idontiflgation Mbrks Position BEC . GAZETTE OF INDIA EXTRAORDINARY CALCULATIONS HEADERS TUBES BRANCH PIPE* B0LTß 197 798 GAZETTE OF INDIA EXTRAORDINARY SURFACE [PART n Total Heating Bur-face . Economiser Rating Calculationa made by Calculations checked by Leut prosgure, that for Approved working preuure Chief Inspector's remarka and signature INSPECÆOR'B oubmittod on on lbs, Ibe. NOTES SEO. 8] Counter foil No. GAZETTE OF INDIA EXTRAORDINARY FORM X [Regulation 525(e)] 079 Name of person or firrn to svhich provi8ionul order is granted. Description of Econonuger Makers No. Rating. Prcgsuro permittod Period Date Inspector PROVISIONAL ORDER UNDER THE INDIAN BOILERS ACT, 1923 are hereby permitted to use tho Economiser RY No. ond Economigor Rating by mado and boa,ring Makers' No. ot maximum pregsuro of lbs. per eq. in./moximum tomperature of OF. pending tho issue or rofugal of 8, certifioote SQithin six month8 from the dote hereof after which period this order will becomo void. Datcd FORM xr this day INSPECTOR. -Boiler Inspection Department. CERTIFICATE FOR THE USE OF AN ECONOMISER Regnstry Number of Economid0T No. of tubep. N ur:nber of Heoder8. Economiser Rating. (Regulation 530) Type. Place ond year of manufacture GAZETTE OF INDIA EXTRAORDINARY Name of Owner. Situation of Repafm. Remorb. I/We hereby oerti& that the •bovo described Economiser in permitted by me/Chief [PART under the providong of Setion worked at a maximum pæure of for the rmiod Gom The 10Bding of the relief Value is not to of the Indian boilerg A", 1028 (V of 1928) to be lb'. per aq. in. of Fee Dated ot pg{d on of msPECT0R REVERSE or FORM CONDITIONB CHIEF INSPECTOR (1) No Btructurzl alteration, addition or renewal •hall be made to the Economiær Kwithout a written permieøion from the Chief Innpector. (2) This certificate Bholl ceaee to be in force — (a) on the expiry of the period for which ft woe granted, or (b) when any acoldent occurø to the Economiser, or (c) when any 8tructural alteration, additlon or renewal made in or to the Economiger, or, (d) if the Chief Inßpector in any porticular so direotß when any etruoturol alteration, addition or renewal iB made in or to the Economiær, or (e) on the communåcation to tho owner of the Economißer of an order of the Chlef Inqeotor or Inspector prohibiting itø use on the ground that it ie in a dangeroug condition. (3) The Econorniær shell not be uged ot a pregu.re greater than the entered in the certificato maxi-rnu.rn pressure/tomperoture nor with the relief valve get to pregure temperature excæding Buch maxi-rnum prezuro/temporature. (4) The Economigcr Bhall not be uAed otherwiße than in a condition which the owner reann•- ably believeø to be compatible with safe working. N.B.—Detailß regarding this are recorded in a Book No. Of which copy may be obtained on poyment on appliantion to the Chief Inzpeotor. N. P. DUBE, Søcretrzrv , Central Boilen Board. THE GAZETTE OF INDIA EXTRAORDNARY 801 APPENDIX A DIAGRAMS OF RIVETED jonrrs WITH FORMULÆ RIVETED JONT8 LAP JOINT. ONE RIVET PER PITCH ONE RIVET PER PITCH Max. Pitch xT+1-625 100 (P—D) Plate 0/0 IOOxAxS1 Rivet 0/0 Eqn. (11) (2) (8) Rog. 184 SINGLE STRAP. ONE RIVET PER PITCH Max. Pitch O Rivet 0/0 —1-53xT+1-625 100 (P—D) IOOxAxS1 PxTxS Eqn. (11) (2) (3) Reg. 184 Eqn. (5) BUTT STRAP —1 •125 xT DOUBLE BUTT STRAP. Max. Pitch Plate 0/0 xT41 •025 100 (P—D) X AXI 875* Eqn. Reg. 625 xT BUTT STRAPS • (11) (2) (3) 184 (7) 802 GAZETTE OF INDIA EXTRAORDINARY DOUBLE RIVETED .T01NTs [PART 11 LAP JOINT. TWO RIVETS PER PITCH Max. Pitch Plate o

Rivet 0 • 625 100 (P—D) IOOxAx2XS1 PxTxS - .67D Eqn. (11) (2) (3) Reg. 184 LAP JOINT. TWO RIVETS PER PITCH Max. Pitch =2-62xT+1-625 100 (P—D) 100 x Ax2xSl Rivet 0 o Eqn. (11) (2) (3) Reg. 184 SINGLE BUTT STRAP. Two RIVETS PER PITCH Max. Pitch Plate 0/0 Rivet 0/0 Bum STRAP Eqn. (11) 100 (P—D) IOOxAx2xS1 — • 671) —1-125xT Roe. Eqn. (2) (3)] 84 (5) .11 DOUBLE RIVETED JOINTS SINGLE BUTT STRAP. TWO RIVETS PER PITCH P FIG. Mnx, Pitch Rivet BUTT STRAP —3-06XT+1-625 100 (P—D) IOOxAx2xS1 —1-125xT Enq. Reg. Eqn. (1) (2) (3) 184 (5} SINGLE BUTI' STRAP. THREE RIVETS PER PITCH Max. Pitoh Plate 0/0 Rivet 0/0 Combined 0 o —4-05 xT+1,625 100 IOOxAx3xS1 100 (P—2 D) IOOxAxS1 4 .2P+1-15D —1-125 Tx (P---2D) Eqn. (11) (2) (3) Reg. 184 STRAP DOUBLE Jonas SNGLE STRAP. THREE RIVETS PER PITCH Max. Pitch 100 (P—D) Plate % Rivet 9/0 100 (P—2D) IOOxAxS1 Combined 0/0 PxTxS = .33 P+.67D . or 2 x D whichever ig greater Bum STEAP 125Tx Eqn. Reg. Eqn. (11) (2) (3) (4) 184 (6) DOUBLE STRAPS. TWO RIVETS PER PITCH FIG. 10 Pitch Max. Plate 0/ Rivet 0/0 BUTI' STRAP 100 (P—D) IOOxAx2x1-875xSi PxTxS = .33P+.67D —1•5xD Equ. Reg. (11) (2) (3) 184 (7) grvrrn jomrs DOUBLE BUTI' STRAPS. TWO mvms PER PITCH FIG. 11 FIG. 12 Max. Pitch Plate 0/0 BUTT STRA2B • x • 625 100 (P—D) 100xAx2x1•875xS1 PxTxS —•625XT Eqn. Rog. Eqn. (11) (2) (3) (184) (7) DOUBLE BUTT STRAPS. THREE RIVETS PER PITCH Max. Pitch Plate % Rivet 0/0 Combined 0/0 BUTT S 100 (ED) PxTxS Eqnp (11) (2) (3) loo (P—2D) 100xAx1•875xS1 PxTxS —•2P+1•15D. Reg. 184 Eqn.' (8) (PAD) DOUBLE RIVETED Jonas DOUBLE BUTT STRAPS. THREE RIVETS PER PITCH FIG. 13 14 Mux. Pitoh Plato o Rivet o Combined 0/0 BUTT STRAPS DOUB LE Max. Pitch Plate o Rivet 0 o BUTT STRAP (WIDE) BüTT STRA;p (NARROW) 100 (P—D) IOOYAx3x1•875XS1 PxTxS 100 (P—2D) Eqn. (11) (2) (3) (4) or 2 X D whichevor is greater 625TX TWO RIVETS PER PITCH 100 (P—D) 100xAx1•875xS1 PxTxS •33 67 D —1 •5xD = •625 T Reg. 184 Eqn. (8) Eqn. (11) Reg. Eqn. (2) (3) 184 (9) FIG. 15 DOOLE RIVE'ID jonns DOUBLE BLITT STRAPS OF UNEQUAL WIDTH TWO RIVETS PER PITCH Max , Pitch Plate o BUTT STRAP (WIDE) BUTT STRAP (NARROW) 100 (P-—D) 100 PxTxS — •625 T Eqn. Eqn. FIG. 18 DOUBLE BUTT STRAPS OF UNEQUAL WIDTH THREE RIVETS PER PITCH 01) (3) 184 (9) (11) (2) Max. Pitch Plate 00 Pulvot 0 Combinod 0 BUTT STRAP (wrnn) B (JTT STRAP (NARROW) Eqn. 100 (P--D) PxTxS 100 (P •625T 100 x A x Sl PxTxS 1 •15D Reg. Eqn. (3) (4) 184 (9) FIG. 17 BIVEÆD Jomn DOUBLE BUTT STRAPS OF UNEQUAL WIDTH THREE RIVETS PER PITCH Max. Pitch Plate % Rivet Q/'ø Combined % Bore STEAP (WIDB) Bumm STBA-P (NARROW) —4 •63 xT+1 •625 100 (P—D) IOOxAx4-75xS1 PxTxS IOOxAxS1 PxTxS or 2 x D whichever i' greater Eqn. (11) (2) (3) (4) =1-5xD —625 T . Rtvmo JOIN'N Rag. Eqn. Ere. 18 LAP JOINT. THREE RIVETS PER PITCH Max. Pitoh Plato 0/0 Rivet 0/0 100 (P—D) PxTxS —33Px•67D Eqn. Reg. (13) 184 (9) (11) (2) (3) 184 Blv•rrmD jomz LAP JOINT. THREE RIVETS PER PITCH FIG. 19 FIG. 20 Max. Pitoh Platz % Rivet y, —3,47xT+1-625 100 (P—D) IOOxAx3xS1 PxTxS Eqn. . Reg. LAP JOINT. FOUR RIVETS PER PITCH Max. Pitch Plato 0/0 Rivet % Combined 14 x ' 625 100 (P—D) IOOxAx4XS1 PxTxS Eqn. 100 (P—2 D) IOOxAxS1 PxTxS Reg. (11) (2) (3) 184 (11) (2) (3) (4) 184 TREBLE RIVETED ronvrs FIG. 21 LAP JOINT. FOUR RIVETS PER PITCH! Mux Pitoh Eqn. (11) 1 Plute o Combined 0 o tot) x A x 4 x Sl 100 (P 21)) IOOxAxSl or 2 D whichever ig grebter Rog. (2) (3) (4) 184 FIG. 22 DOUBLE BUTT STRAPS. THREE RIVETS Max. Platc o O Rivet, 0 o BUTT STRAPS PER PITCH. •625 100 (P D) 100 x A rxTxS .67 D. Reg. (2) 184 SEO 8] THE GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED JOINTS DOUBLE PS. THREE RIVETS PER PITCH. Max. Pitch R ivet BOTT STRAPS - 4 6.3 (T+l . 100 (P—f)) —2xD . Eqn. Reg. Eqn. 811 (11) (2) (3) 184 (7) DOUBLE BUTT STRAPS. FOUR RIVETS PER Mux. Pitch Plate RI vot Combined 0/0 BUTT STRAPS —5,52xT+1-625. Eqn. (11) IOOxAx4x1,875xS1 (3) 100 xS1 • 2P+1•15D PxTxS Reg. Eqn (4) 184 (7) 812 FJG. 26 GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED JOINTS DOUBLE STRAPS. TOUR RIVETS PER PITCH [PART n Max. Pitch Plate 0/0 Rivet 0/0 (hmbined 0/0 BUTT STRAPS Eqn. (11) (2) (3) 100xAx4x1•875xS1 PxTxS 100xAx1-875xS2 PxTxS (4) — .33P+.67D •r 2 D whichever greater Eqn. (7) DOUBLE BUTT STRAYS. FIVE RIVETS PER PITCH Max. Pitch . Eqn. (11) (2) Plate 0/0 IOOxAx5x1•875xS1 Rivet % (3) 100 x Axl Combined 0/0 RI BETT STRAPS = = •671) .625 Tx (P—2D) PxTxS R". 184 Eqn. (8) GAZETTE OF INDIA EXTRAOÉDINA-R± TREBLE RIVETED Jonrrs DOUBLE Bum STRAPS. rrvn RIVETS PER PITCH FIG. 27 Max. Pitch X T + l. • 626 (P—2D) 818 Eqn. (11) (2) (3) o Rivet 0/0 Combined 0/0 RI 100xAx5x1-875xS1 PxTxS 100xAx1-875xS, PxTxS (4) or 2 D whichever greater BUTI' STRAYS — •625T X R eg. 184 Eqn.(8) RIO. 28 DOUBLE STRAPS OF

UNEQUAL WIDTH THREE RIVETS PER PITCH Max. Pitch o Rivet 0/0* STRAP (WIDB) BUTI' STRAP (NARROW) =4i63xT+1-625 . IOOxAx4.75xS1 = .625 T Eqn. (11) (2) (3) Reg. 184 Eqn. (9) (10) GAZETTE OF INDIA EXTRAORDINARY TREBLE RIVETED Jonrrs DOUBLE BUTT STRAPS OF UNEQUAL WIDTH FIG. 29 THREE RIVETS PER PITCH Reg. 184 Max. Pitch —4-63 xT+1-625 . 1 1 Plate 0/0 Rivct o R IOOxAx4-75xS1 =2xD Eqn. (11) (3) Eqn. (9) BUTT STRAP (WIDE) BUTT STRAP (NARROW) 625T. DOUBLE BUTT STRAPS OF UNEQUAL WIDTH FIVE RIVETS PER PITCH Max. Pitch Plate o Combined 0/0 BUTT STRAP (WIDE) BIJTT STEAP (NARROW) IOOXAX8•5XS1 Eqn. (11) (2) (3) IOOxAxSi • 165 P+ D •625T. Reg. 184 Eqn. (9) Nominal thiQkne•n oc tent picco Width Gauge length Pbmllol length (minimum) at ßhouldor (minirnum) Approximate total length ('61 Not' 8) Up 'o but not, Including 818 in. 8/8 in. •nd t hicker m. 8 111. 1 12 m. 1i (mex.) I I(max.) 9 18 9 1 18 When the width of the material to bo tested IS insufficient to permit of (he pre- paration of the Ntandard tensile test piece, a piece of the full width of the material may be ueød. Nori'". l. For some matoriolg it convenu-mt to use straight parallol t'8t paoeoa

2. For certam non-forrou• nnettd* it is sometimes convenient to use the scandal'd tent picee that, hoa a width of i m.and a gouge length of 2 in. for thickness exceeding in

3. A t0Nt piece of the dimensione given Col, (jiz) for material under 318 in, nmnmal thick- ia intended for ferrous metelg only. Piece A1 2. In tensile tests on special shoot and strip materialg (e.g., steel uBed for deep pressing operations) the follöwing alternativo tegt piece may be used. nn Nd in 9in mn length t5it,, BRITISH STANDARD ROUND TEST PIECES Piece B ined rods and noi exceeding 1 in. diuneter (exclud- Ing rnet u Is), P Length G=8D between gr•pg P to be not than 9 D All pieces of form B ore tly nnlar and for the same material give the eomo percentage elongat •on. They give elongation figures nearlv tho same as those ot' dtandard flat, test ex 8 in gange lengi)), in. Wide and iu. thick. N0TE. —When tensile toyts n re on unmachuzod square 't,nrl hexagonal bat'S (oxrludlnx caat metals) the g»uge length *hall he 8 tnnca the distan(e between the flatg and the lengt bo,lwcen the gl'1Æ»-J Nhall bc not thnn times tho dLBtnuce botween the flats. Test Piece Bl 4. For rods -l]ld bars over I in. clm,lncter (exclud)ng cost metals). Ga.nge• 102111th (A Lcngth between gr P to be 110t lcss thnn 4 •5 Piece C 5. Round TeNt G u uge longth G-='2 ID. Purallel lengQ1 P to be not 1649 than in Diameter 504 In. Cross-8tÅ'fiona,] oreo square Radius at nuntmurn for wrought meta]B and In. nnnimum for cast metals. Subsidiary Standard Round Test Pieces d. Machined Test Pieces for general purpogos (excluding cast iron). V] teel couforming tn the above d I u re snnilar to Standard Teat Piece (7 With e orre91)011ding shoulder rud ; us, and the sanie pereontlbge elongation 'Tt-*t Piece C for the same lna,tcriul. Reeonnnendcd diinenBions for Suhsl(liar.x, Standard '1108t Pieces are tabu• lot ad below. Standard Piece (() •.3ß4 in (limneter) 1B [Il'•luded for comparison. Any t08t pieec, however, in which the (lillinct01' noi lew thun • 125 in. , und the di,nengions of which conform to the Ht andurd fornn , is recouniN0d us sub- Mdilll',v standard test c. ot, Bhoul R (nunnnu-l.n) Ie,igtll P metol THE GAZETTI$u OF EXTRAORDINARY Cross. *ectlonal Arc•u A 4 Gauge length G •54K). --3 •9S D nuninnun. Parallel xth P=9J8 G In 14 (Millijnuyn. Radius ut shoulder for wroug,,rht Illeta18- •88 1) 'nint tn). 4.30 18 .85 1.75 0•35 1.55 O • 14 Radius at Hhou[der for eaHt — Ininirnum. 4 (4 •40 1) milli Ilium). 111. O, 70b 10. o, 7,100 2500 o, 012' Ill. 1.25 1.00 818 THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX C List of Inspecting Authorities recognised uy cornpetent under Rcgulation 2 (h) of the Indian Boiler Regulations, 1950. No. 1. 2. a. 4. 5. U. 7. 8. 9. 10. 11. 14. 15. 16. 17. 19. 20. 20 23. 24. 25. 26. 27. '8. 30, 31. 32. 33. 84. 35. 86. 37 r, 38 Name' Lloyd's Regietør of Shipping, .Londou. The ()cøan Accident ond Guarantoe Corporation Ltd., London, *I'he Authorized Boiler 'I'egting and Inspect ion -iggociation, (Czecho. alovüia). Dhe ScottiBh Boiler and Genoral -Lnsuru,nce Co., Glasgow. Magarg. Kennedy and Donkin. Consulting Engrn., London. The Notional Boiler and (-kneral Lnsuranc,ü Co., Monohegter. 1'h8 Vulcan Boiler and Genc rol Lnsuronce Co., Ltd., Monchester. Tho British Engine Boilor uncl Electrical Insuranc»e (NO. , Ltd,, MnnehßAter. Megrß. Preece Cardew & Hider, London. Messrß, Eagle Star Inguranco Co., Ltd., London. Bureau Veritas, Internetionol Registor of Shippmg, Paris. Inßurance Engineers, Ltd., London. 'I'he (Accident and Guerantoa Corporation, 14td., U.S.A., New York. India Store l)ept., London. MGB81'ß. Merz and Mclellan, Consulting Engmeerg, Englund. Messrs. Rendel Palmer and 'Ilritton. Consulting EngintRTN, England. "L'118 London Lancashire Co., Ltd., England. Chief Inspector Chief Inspector Chief Inspector Chiof Inspector Chief Inspector Chief Chief' IMVeetor Chief -Inspector Chief I napector of Boilers, Asgarn. of Boilers, Wogt Bengt•l. of Boilere, Bihar and (of S teenm B011erg, Bombay. of Boilers,

MadhyeL P rB(ltHh. of Boi101'N, Delhi md A.J1ner. of Stemn Boderg, and Coorg. of Boilers, (I) ot' Boilers, Uttar T'ru,d08h. Chisf Inspector or Boilerg, Department of I,obonr, Sydney, New South W 8168, A ustralia. Chief Inspector of Boilers, Mineg Department, Melbourne, Victori», Auetralia. Chief Inapector of Machinery, Brisbano, Queen51and, Augtr•lia. Chief Jn8pector of Machinery, Mines Department, Perth we8t Austrelia. Chief Inapeetor of Machinery, Hobart, Tasmanib, Chief IrwpocLor for Foetorios & Boilers Department, Adelaide, South Australia. American Employers Insurance Company, Mass. Employerg Liability AqsurH,nee Corporation Limited, M&8B. Mutual Boiler Ineurnnee Company of Bogton, Mau. Colum bia Oagualty Company, New York. London Guaranteø and Arrident OompB,ny Limited, New York. T)hanix Indemnity Compbny, New York. THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX D 819 Proof Test for Creep Quality of Carbon Steel plate of Boiler Plate Qaality SPECIFICATION NATURE or TE5T l. The test shall consiBt of a, tensile creep tost carried out over period of at least 48 hours Ut, a, temperat,urc of 4500C. und with Stress of 8 tong per eq. in. Under these conditiona the slope of the ohord to the creep curve between the 24th and 48th hour shall not excecd 5() X 10-8 strain por hour. CONDITION or MATERIAL 2. Thc tegi, shall bc modc on the material in the normalised conclition. The normalismg temperature shall be bewteen 8750C.—9250C., and thc plate sample shall be Binta,inod the normalising temperoturc for one hour per inch of thickneNN ænd cooled freely in still a,ir. TDMPØRATURB or Tswr 3. (b) Temperature measurement.—The temperature of the apecimen Bhall be measured by thermocouples suitable for the temperature xpecificd. Two thermo-couples situated one at ea,eh end of the gouge length shall be used in the cusc of test pieces having gouge lengths up to 2 in. , and for longer gouge length* on add itional thermocouplc sit,uutcd at the middle of the gauge length 8holl be used. Thermocou ples shall make good thermol contact with thc test piece oncl be protected from the direct heat of the furnace by being covered with asbestos tape or equivnlent insulu,tion. 'Ilhc cold junction shul-I be Ina,intoined a known tempermture which *hall bc regl*tcrecl by a mercury thermometer. Alternatively, a suitbb)e means shall be provided for correcting biltomuticolly error* in reading duo to chongeH m tempern- ture of the ool(l junction. (b) Temperature control—The two (or three) thermocouples speeliied in elausc 3 (a) Bhall ogrce with one Bnot,hcr within 30 C. a,nd the overage of thesc readings 8ball be taken the test temperu ture which shall not vory from by more 20C. throughout the test. Either u eont,inuoues record or gumcicnt, readings of thc temperature shall bc made indicate that the temperature cona !tions have been gutisfuctory. (c) Heating reriod before Loading specimen Bhall be ynaintained at the specified tempernttue for ot least an hour prior to the applieat ion of the load, STRn,SS 4. The load required to produce the ypecified stres» ghall be gradually applicd hout shook during a period not exce(ding five rninutes and thc Hi rcss Shull be occur te per cent. SENSITIVITY or STRAIN-MEARURING 5. 'l'ho sensitivity of the extensometer must bc such that struins can bc mea- gurecl to the nearest READLNas 6. A guffcient nurnbcr of st,rnin readings shall be tukcn cleurly to define thc creep eurve up to 48 hourg, and [he chörd slope Bhall be ed from u, chord drown between points on the curve ot the 24th ond 48th hours. THE GAZETTE OF INDIA EXTRAORDINARY REPEAT [PART 7. if thc Inatterial fail* to the test, but (ho chor d slope does not excecd 10.8 dt,ruin per hour, shall be n,ceepted if satißfuctory, or ot the Inspector't* (ltgctetlon u, puss tog(ut a, stress o per cent less thun that Fpeeified may be accepted. APPENDIX E STANDARD PIPE FLANGES. Pipe FlangeB (For La•nd ugr) TABLE WORKING STEAM PRESSURES UP TO LBS. (Thig tablo does not apply to boilcr feed I)' pes, 01 to ot nel er pipes subject to exceptional shocks.) TABLE E.—For WORKING STEAM PRESSURE ABOVE 50 LBS. UP TO IOO LBS. PER SQUARIO INCH. Number and 1 hameter Normnal of Diameter Diameter of Flange Did. of 100 lb. of Bolt Up to lb. 100 1b. Bolt' (()ff contre Up to [q lunge . Cugt St '81 aud Bronze Up to Sturm or Forge I or Iron or Steel Notes) 50 1b. 4—5/8 4 5/8 *See Notes ut end of T blos regard-mg thege, algo for other partnenlarg. Pip. (Land use) FOR W0RKING STEAM ABOVE 100 LBS. AND UP '10 150 LBS. INCH, TARI-E -FOR WORRI STEAM ABOVE 15() AND UP TO 25() LBS. PER SQUARE, INCH. Diameter I Nnmber and Diblnetpr 'l'hicknoßß of' F longe (must COBI. Steel und Bronze N01ninal Inll. 150 lb. only 25() lb. only of FNInnge 04 Boll 1b. o? BoltB (off eent re 150 lb, Up to 260 lb. Up to 150 lb. Støel (Btnmpocl or forged) (See Noten) Up to Up to 160 lb. 250 1b. *Soo Note* end of YINuhleH regurding thQNe, o]go for flonges for pipe lines •nd other parti• TABLE J Pipe Plangeø (For Land —F0R WORKING STHAM ABOVE 250 LBS. AND UP TO 350 LB8. SQUARE IN0M. 'I'hickne•sa of Flange Diameter of Diurnetor of Nt-unbor ond CBBt Steel end Bron- Nominol Intl. Act Extl. Dia. of Pipe Dia. of W rot, 1-29/32 Flange Bolt (hrcle Diameter of Bolts (off centre lines) ze,• Stoel

(stamped or forged) (See Notøs) *See Notes end of Tbb10ß regarding thcae, algo for flanges for Pipe linog and other parti- The actual oxternl'l diameters of wrought pipeq given ebove apply equally to all tables, TABLE K. Nominel Intl. Dia. of Pipo GAZETTE OF INDIA Pipe (For Land FOR WORKING STEAM PRßSSURE8 ABOVE 350 LBS. AND UP TO 450 LBS. PER SQUARE Thiok.neBß of flulge DiblDBter of Dizrnater of Numtm and Steel and Flange Bolt Circle Dibmeter Of Bronze Steel (ßt&mpad Bolts (off oentre Ifnøe) or forged) (Seo Notes.) iy recommended i,hAt Che urge of rn»rkod * should be ovoid&l. 'T'he of Hunge givon m tho include I'lbised faro Df not more than 1/16 in. high if guoh be used. E'or Fin. 5/8 in. bolt,g tho diumotorg of tho h010R to bo l/ ld in. Itsrger thBNh tho diameterg the bolts, and for Inrgor of boltH 1 18 in. Iron or Stf-Bl flougeg (gturnped or förgod) may bo grrewod or riveted on with bogs, or welded with flllot, tho 11 ».ngos boing of Ht•eol för prouuros "bove 15() lb. inch. Speciol {I»ngos (atamped or Ibrged) For pipe linos 2-i-n. nominal diametor of pipo and upward* (without valveg or fittmgs) oro made stated below, the flange 381eot6d in all being thot givon for the noxt arnal.ler Bize of pipo in the corrosponding table Btotedt— table F modified "bovo. .—For Working Stoun obove 150 lb. up 250 lb. por moh. Tobie M gorre»pond.ß with Tub19 mcx:lifiod above. Toble P.- -For Working *tenm P roBsu1'(N 25() lb. and 1 up to 850 lb. per qquare inch, corre»pond8 with 'I"ublo J modiflod ag above. THE GAZETTE OF INDIA EXTRAORDINARY APPENDIX Tronsverse rupture Btress (Modulus oi Rupture). 11 The t,tansverse strength of cast iron may be cxprcssed by a figure known as the Transverse Rupture Stress; this figure IS obtoined by dividing the maximum bending moment at failurc by thc modulus 01' tho soe€ion. Thus, the Transverso Rupture Stresa is the maximum stress which would huve exigted if the materibl hod behaved in ocoordanee with the assumptiong Inade in the ordinary theory of bonding, ond in that event it would be independent of the size and shupc of 1,110 aection. Bars fractured in transverse, however, urc stressed boyond the elastic limit, and under those conditions the theory of bending no longer holds good. Furthermore, the influence of rote of cooling in cast metal* is such that the Transverse Rupture Stress of thick bar is less thon that, of u thinner bur of tho sa,me metol. Thc Rupturo Scress, therefore, i I not Atriotly independent of the size and shape of the section, but nevertheless forms u eonveniont way of expressing the results of trane- verse tests without the nerossit.y for giving full details of bar dimensron.B. The formula required is obtained follows : A bar supported at both ends und centrally loodcd with a loud W is subject to bending moment WL L being the cliqtanc•c• between supports. The resistance offered by tho bar bc, expressed fZ f bemg tho stross und Z the modulus of the sectior. At brea,kinu stress or Trane•verse Rupture in tons and L m inches, f is in tong S tresg, and 4z per square inch. For a round bar, where d— diometey in inches. is fixed, Since for Standard f onnrl L and Z are constant, the va,luo and hence [Ile Trang verse Rnpfurc• St f -.E K W, where k a conBtant. The fnotors k for converting actuol breaking loads into Transverge Rupture Stresses orc givon in the follow inu both for the Stnndard test barg n,nd test bbl'S varying within tbe lunit* of Regulation 88. In the game table arc given hpea,king into equivalent, break in" load* on the factors for converting borg of Stunda,rd Factors X fck Actual Breaking Log.dg into Equivalent Breakina Loads on Bare of Standard (Equivoknt Bre&ing uoad on Bæ of Standard Did-meter = X X Actual Breaking load,) æ:id Factors K for converting Actual Loads into T-rønsvaræ Rupture Stræs. (Trumgver* Ruptnæ in tons in.=K Aetnal BTB8king Load in lb.) o •6 Tet 1 .12 .81 1 .13 0-82 o .83 1-17 o .58 o .59 I .20 2-10 0•61 0-62 Bar o •0582 0 0552 o •0524 o 0429 0 •875 in. Bar x 1 Test Bar x 1 .6 Bar 2 2 .02 2 .04 2-05 2 07 2-09 2-11 2-12 2-13 2-14 2-15 2-17 2-18 •l in. .86 o .87 o •875 o 0 0-91 92 0 93 0 94 o *0146 o •0142 o •0138 o .0135 0 0128 0 10113 o .0110 •0095 Dia. in. .52 I •56 1 .59 1 .61 1 .63 1 .66 I •68 .69 1 .70 x • 214 1 1 •144 1 1 .079 1 1 •946 o .929 o • 895 o *00606 o *00594 o .0058..3 o .00519 o .005Ü9 0 00490 o .00405 0 00447 o .00424 in. Test Bar x 1 .124 1 .075 •059 029 o *00336 o .0-0331 o •00317 0 0312 O O o o .56 • 63 64 x 1 •166 1 1 •107 0•952 o •864 .S24 1 •261 1 •215 1 •172 1 091 •053 •000 0 983 o *950 919 889 o o .833 o •0257 o •0247 o -0239 o •0230 o *0222 o •0214 o o•-07 o .0204 o .0193 O .018fi 0-0175 0-0170 .21 .22 i .23 1-24 t .25 .27 1 .28 1-29 1 •052 o .902 •929 o o •885 o 884 •844 O o 824 • S05 1 0-906 0-894 o -882 0 0)295 0 0290 O .(D282 o *00274 [No. E 1-11/304(40).] N. P, DBEJ Dy. PRINTED m INDIA BY THE MANAGER GOVT. or INDIA PREBS, NEW DELHI AND PUBLISHED BY THE MANAGER OF PUBLICATIONO DELHI 1950