CHAPTER XIII

QUALIFICATION TESTS FOR WELDERS ENGAGED IN WELDING OF BOILERS AND STEAM-PIPES UNDER CONSTRUCTION, ERECTION AND FABRICATION AT SITE IN INDIA

* **602. Scope.**—These Regulations shall apply to testing of welders engaged in India in the manufacture and site welding connected with the erection and fabrication of boilers and steam-pipes of ferrous material.

603. Definition.—In this Chapter "Welder" means a person engaged in manual welding (gas or electric).

* **604. Engaging of certified welders.**—No welder shall be engaged on welding of boilers or steam-pipes under construction, erection or fabrication at site unless he possesses the certificate as required under the Regulations hereinafter contained.

605. Initial qualification test and issue of certificate.—Every welder shall be duly tested and qualified to the satisfaction of the Competent Authority who shall assess his performance for qualifying for the certificate. The Competent Authority may, thereafter, issue a certificate in the Form XIII/Form XII indicating the class and type of welding in which he has qualified.

* **606. Production of certificate.**—The holder of such certificate shall be bound to produce it when called upon to do so by the Inspecting Authority or an Inspecting Officer.

607. (*a*) **Validity of certificate.**—A certificate issued to a welder under these regulations shall remain valid for a maximum period of *twenty-four months* from the date of issue, provided that the holder thereof has, subsequent to the test, been employed with reasonable continuity on the class and type of work for which he is qualified.

(*b*) **Re-validation of certificate.**—The certificate may be extended from time to time for a period not exceeding *twenty-four months* at a time on completion of a requalification test (*See* Regulation 610) to the satisfaction of the Competent Authority.

(*c*) Notwithstanding anything contained in clauses (*a*) and (*b*) above, a welder shall appear for a requalification test consequent upon any of the following conditions, namely :—

(*i*) An omission of backing strip in arc welding single welded butt joint or the addition of the backing strip in gas welding.

(*ii*) A change in class of electrode (Carbon or Alloy steel).

(*iii*) A change in the base metal to be welded.

(*iv*) If during the preceding three months or more the welder has not been engaged in welding of the type or class for which he is qualified.

(*v*) If there is some specific reason to question the welder's ability.

(*vi*) A change from one welding process to any other process.

(*vii*) A change from direct current to alternating current, and *vice versa*.

608. Age and experience.—A candidate who wishes to qualify for a certificate under these Regulations shall not be below the age of 21 years, and shall satisfy the Competent Authority that he had been employed as a welder in a Workshop or Firm for a period of not less than two years.

***609. Tests for initial qualification of a welder.**—(A) Theoretical Examination—A welder shall be required to answer questions on the following subjects, orally or otherwise :—

1. Electric Welder :—

(*i*) Weld preparation.

(*ii*) Elementary knowledge of the working of welding equipment.

(*iii*) Properties of material to be welded—cold and hot working, thermal conductivity, fusion point, oxidation (for welders engaged in alloy steel welding).

(*iv*) Elementary knowledge of electro-technical principles,—kinds of current, striking arc voltage, welding-arc voltage.

(*v*) Welding defects and their prevention—influence ofdength of electric arc, effect of excessive or too low amperage, slag inclusions, porosity finishing the surface of welding bead.

(*vi*) Electrodes for different types of welds and steels and joints in different positions.

2. Gas Welder :—

(*i*) Weld preparation.

(*ii*) Working of welding equipment.

(*iii*) Elementary knowledge of properties of materials to be welded—cold and hot working, thermal conductivity, fusion point, oxidation (for welders enagaged in alloy steel welding).

(*iv*) Elementary knowledge of fuel gas and flame adjustments for favourable welding condition.

(*v*) Kinds of welds, welding defects and their prevention, welding technique (right-ward and left-ward), welding with two torches on vertical surface, excess of gas or oxidation, preheating of base material and subsequent heat treatment.

(*vi*) Filler metals.

(B) A welder shall be required to undergo and pass the following practical tests.

1. Material for tests.—The material of plates, tubes, pipes and electrodes used for these tests shall conform to the requirements of appropriate Regulations as may be applicable in each case.

2. Test welds for initial qualification (Electric or Gas):—

(*a*) *Plate Welding.*—

(*i*) One groove welded joint of two pieces of plates with double Vee or Double U grooves on boiler quality plates over a length of 381 mm.

*NOTE.—Every welded test piece for the examination of welders shall be stamped with an identification mark on either side of the weld.

(15 inches) in the following positions (size of plates to be welded being not less than 229 mm.×381 mm.×16 mm. (9×15×5/8" each) :—

(1) *Flat position XIII*/6.—Plate in a horizontal plane with the weld metal deposited from above.

(2) *Horizontal Position XIII*/7.—Plate in a vertical plane with the axis of the weld horizontal.

(3) *Vertical Position XIII*/8.—Plate in a vertical plane with the axis of the weld vertical.

(4) *Overhead Position XIII*/9.—Plate in a horizontal plane with the weld metal deposited from underneath.

Qualification in position XIII/7 or XIII/8 shall qualify also for position XIII/6.

Qualification in position XIII/9 shall qualify for positions XIII/6, XIII/7 and XIII/8 also.

(*ii*) One fillet welded joint over a length of 381 mm. (15 inches) using plates of not less than 16 mm. (5/8 inches) in the following positions:—

(1) *Flat Position XIII*/10.—Plates so placed that the weld is deposited with its axis horizontal and its throat vertical.

(2) *Horizontal Position XIII*/11.—Plates so placed that the weld is deposited with its axis horizontal on the upper side of the horizontal surface and against the vertical surface.

(3) *Vertical Position XIII*/12.—Plates so placed that the weld is deposited with its axis vertical.

4) *Overhead Position XIII*/13.—Plates so placed that the weld is deposited with its axis horizontal on the under side of the horizontal surface and against the vertical surface.

Qualification in positions XIII/11 or XIII/12 shall qualify for position XIII/10.

Qualification in position XIII/12 shall qualify for position XIII/10, XIII/11 and XIII/12.

(*b*) *For Pipe Welding.*—

(1) One test on groove weld joint for each of the following welding positions:—

(*i*) *Horizontal Rolled.*—Pipe with its axis horizontal and rolled during welding so that the weld metal is deposited from above with the axis of the weld horizontal.

(*ii*) *Horizontal Turned.*—Pipe with its axishorizontal the upper half welded first, the pipe then being turned through 180 degree and the other half then welded.

(*iii*) *Vertically fixed.*—One test of groove welded joint with the axis of the pipe in a vertical position and the seam welded circumferentially in a horizontal position.

(*iv*) *Horizontal fixed.*—One test of groove welded joint with the axis of the pipe in a horizontal position and the seam welded without rotating the pipe.

Qualification in positions (ii) or (iii) shall qualify also for position (i). qualification in position (iv) shall qualify for position (i) or (ii).

(2) One weld of a branch to a pipe.

The size of pipe to be welded shall be not less than 127 mm. (5 inches) in external diameter and 10 mm. (3/8 inch) thick, and a branch pipe shall not be less than 89 mm. (3-1/2 inches) outside diameter and 6 mm. (1/4 inch) thick.

* (*c*) *For Tube Welding.*—

A butt welded joint of two pieces of boiler tubes with the axis in a vertical position and tubes of same size fixed in adjoining positions.

The welding should be carried out from one side of the tube only.

610. Tests for Requalification.—At a requalification test a welder need not be examined in theoretical subjects, but he shall be required to qualify in the following practical tests:—

(*a*) *Plate Welding.*—

A groove welded joint of two pieces of plates not less than 16 mm. (5/8 inch) thick over a length of 152 mm. (6 inches) in a position 45 degree to vertical, size of plates to be welded being 229 mm. × 152 mm. (9 inches × 6 inches). The main welding is to be carried from the underside only.

(*b*) *Pipe Welding.*—

(*i*) A groove welded joint with the axis of the pipe in a horizontal position and without rotating the pipe.

(*ii*) One weld of a branch to a pipe, as prescribed in Regulation 609.

* (*c*) *Tube Welding.*—

A butt welded joint of two boiler tubes with the axis in a vertical position, and tubes of same size fixed in adjoining positions. The welding should be carried out from one side of the tube only.

(*d*) When a welder is continuously engaged on production Weld, tests on the work in actual production to the satisfaction of the Competent Authority may be accepted as an alternative to the tests prescribed as above under clauses (a), (b) and (c).

* **611. Examination of test specimens for initial qualification tests.**—(*a*) Groove welded plate specimens—The Groove welded plate specimens after welding may be lightly pressed cold to remove any distortion due to welding. No heat treatment shall be carried out after completion of the welding.

After visual examination, the welded specimen shall be subjected to X-ray examination in the manner as provided in Regulation 265(b), provided that this requirement may he waived when the welder is to be engaged on production work where radiographic examination is not required under these Regulations.

Thereafter test pieces shall be marked and cut out in the order shown in Figure XIII/1.

* The bend test specimens (B1 & B2) shall be prepared and tested as per Regulations 261 & 262.

Two each specimens (E1 & E2) shall be prepared, one for micro and the other for macro examination as per Regulations 265(a).

(*b*) **Fillet welded plate specimens.**—The dimensions and preparation of the fillet-weld test specimen shall conform to Figure XIII/2. The test specimen shall not contain any visible cracks. It shall be cut transversely to provide a centre section (254 mm.) (10 in.) long and two end sections each approximately (25 mm.) (1 in.) long.

The stem of the (254 mm.) (10 in.) centre section shall be loaded laterally in such a way that the root of the weld is in tension. Thedoad shall be steadily increased until the specimen fractures or bends flat upon itself. In order to pass the test.—

(1) The specimen shall not fracture, or

(2) If it fractures, the fractured surface shall show no evidence of cracks or incomplete root penetration, and the sum of the lengths of inclusions and gas pockets visible on the fractured surface shall not exceed (50 mm.) (2 in.).

The cut end of one of the end sections shall be polished and etched with a suitable reagent to give a clear definition of the structure of the weld.

In order to pass the test:—

(*i*) Visual examination of the cross section of the weld shall show complete fusion at the root and freedom from cracks.

(*ii*) The weld shall not have a concavity or convexity greater than (1·6 mm.) (1/16 in.); and

(*iii*) There shall be not more than (1·6 mm.) (1/16 in.) difference in the lengths of the legs of the fillet.

(*c*) **Groove and fillet welded pipe and tube specimens.**—The groove welded pipe and tubes specimens shall be marked and test pieces cut out as in Figure XIII/3. The test pieces shall be prepared for face bend, root bend and etch test.

The pieces shall not be flattened, but tested in their curved conditions. The penetration bead may be removed to 0·8 mm. (1/32") proudoof the surface of the material.

Fillet welded branches shall be tested for:—

(*i*) **Visual examination.**—The test welds so obtained shall be visually examined for root penetration, freedom from undercut, disposition of runs, uniformity of surface, shape of profile, smoothness of joint, freedom from cavities and slag, dimensions of weld deposit, quality of weld metal (overheating, surface cracks, spongy surface, etc.). Any piece showing serious defect shall be rejected.

(*ii*) **Macro examination.**—Each branch weld test piece shall be sawn as shown in Figure XIII/4 and each portion so produced shall be prepared and etched. The sections shall then be examined for degree of fusion, degree of root penetration, absence of non-metalic (slag) inclusions and quality of weld metal. The joint should show good root fusion, complete freedom from basal cracking, and the absence of any but very minor defects.

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(*d*) **Welded Tube Joints.**—A test length approximately 203 mm. (8 inches) long shall be cut from the tube with the welded joint disposed approximately at the Centre. After visual examination one test piece not exceeding 13 mm. (1/2 inch) for tubes 6 mm. (1/4 inch) in thickness and below and thrice the thickness of the tube for thickness of over 6 mm. (1/4 inch) shall be cut longitudinally. The test piece shall not be less than 76 mm. (3 inches) in length on either side of the weld. The slight excess of internal bead may be filed until it is not more than 0·8 mm. (1/32 inch) proud of the general surface. The test piece shall then be bent back with the root in tension through 90 degree round a former of diameter equal to three times the thickness of the tubes. The bending may be carried out by blows or by pressure. Care shall be taken to ensure that the former is so positioned that the weld is maintained at the crown of the bend. The test specimen shall be capable of being bent through 90 degree without signs of failure, although slight premature failure at the edges of a specimen need not be considered a cause for rejection. The opening out of a slight defect due to incomplete root penetration or lack of root fusion need not be considered a cause for rejection, providing the defect has sound metal at the back, and on either side of it.

* (*e*) **Additional tests before rejection.**—Should any of the test pieces tested in accordance with the above sub-regulations fail to meet the specified requirements, one further strip may be cut from the specimen and subjected to the same test.

612. Examination of Test Specimens for Requalification Tests.—(*a*) **Groove welded plate specimens.**—The welded joint shall first be examined under X-ray and thereafter cut to appropriate dimensions for conducting the following tests:

Provided that the radiographic examination of the weld, may be waived when the welder is to be engaged on production work where radiographic examination is not required under these regulations:—

One forward bend test, one reverse bend test, and two macro examinations.

The test piece shall be marked and cut out in the order shown in Figure XIII/5 and tested in accordance with the provisions of Regulation 611.

(*b*) **Fillet welded plate specimen.**—They shall be conducted as detailed in Regulation 611(*b*).

* (*c*) **Pipe and Tube welding.**—Specimens shall be prepared and tested as prescribed in Regulation 611(*c*).

* (*d*)

* **613. Awarding of Marks.**—Marks shall be awarded in accordance with the Form XII. Candidates obtaining marks not less than 60 per cent in the oral or written examination and not less than 75 per cent in the practical tests, shall be deemed to have qualified for a certificate provided that the bend tests are found to be satisfactory.

The Form shall be attested by the Competent Authority and filed in this office for future reference.

614. Award of Certificate.—On successful completion of tests prescribed in Regulation 609(A) any of those prescribed in Regulation 609(B) the welder may be awarded a Certificate in Form XIII to the extent of the tests passed by him.

* Welder who pass the tests for groove welds in plates shall be considered as having qualified for making filled welds in plates. Welders who pass the tests for fillet welds, shall be qualified to make fillet welds only.

* **615. Maintenance of Records.**—Every boiler manufacturing works shall maintain a record of all welding personnel engaged on welding of boilers and steam-pipes, particulars of each welder in the certificate and the work handled by each welder. Such records shall be produced to the Inspecting Authority on demand.

In the case of welders who undertake welding under their own responsibility, the records as aforesaid shall be maintained by themselves.

616. All costs connected with these tests shall be borne by the applicant.

617. Penalty.—(1) Whoever employs a person in welding a boiler or steam-pipe in contravention of these Regulations shall be punishable with fine which may extend to Rs. 100.

(2) Any employer or welder who fails to maintain the records as required under Regulation 615 shall be punishable with fine which may extend to Rs. 100.

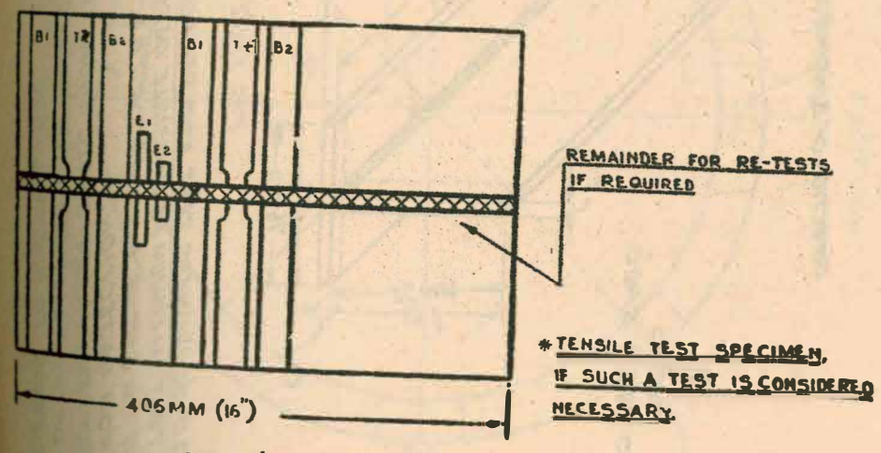


FIG. XIII/1
ORDER OF REMOVAL OF TEST SPECIMEN FROM TEST PLATE FOR INITIAL QUALIFICATION TEST

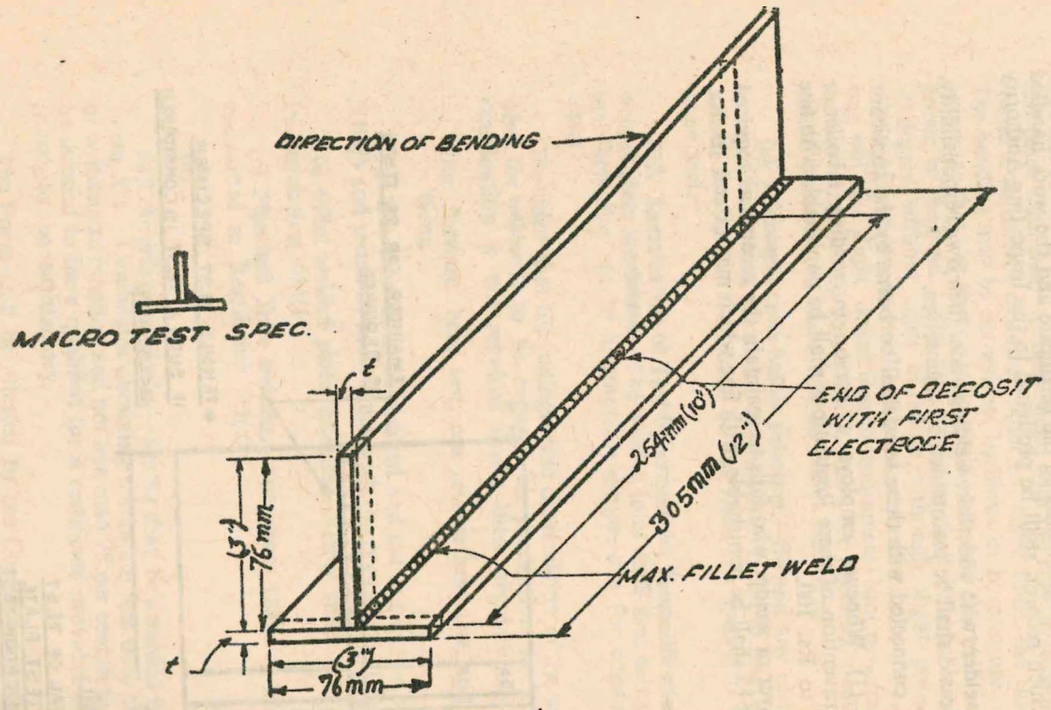


FIG. XIII/2

FILLET WELD SOUNDNESS TEST FOR PERFORMANCE QUALIFICATION OF WELDERS

FRACTURE TEST: MAXIMUM PERMISSIBLE DEFECTS SUCH AS SLAG, NON-FUSION, ETC.- 20 PERCENT OR 2 INCHS. EVIDENCE OF CRACKING OF FILLET SHALL CONSTITUTE GROUNDS FOR REJECTION.

MACRO TEST: THE FILLET SHALL SHOW FUSION TO THE ROOT. CONVEXITY AND/OR CONCAVITY OF THE FILLET SHALL NOT EXCEED 1/8 INCH. BOTH LEGS OF THE FILLET SHALL BE EQUAL TO WITHIN 1/16 INCH.

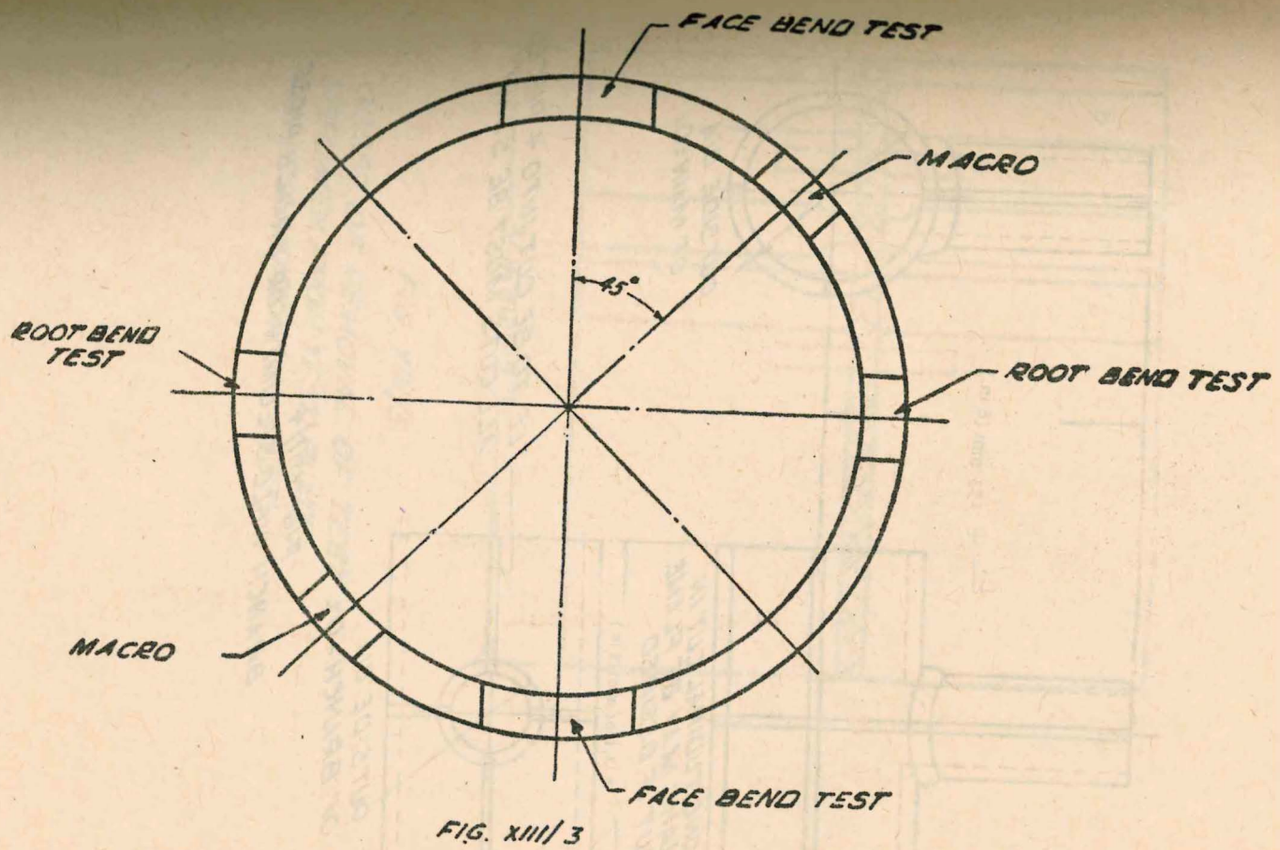


FIG. XIII/3

ORDER OF REMOVAL OF TEST SPECIMENS FROM WELDED PIPE

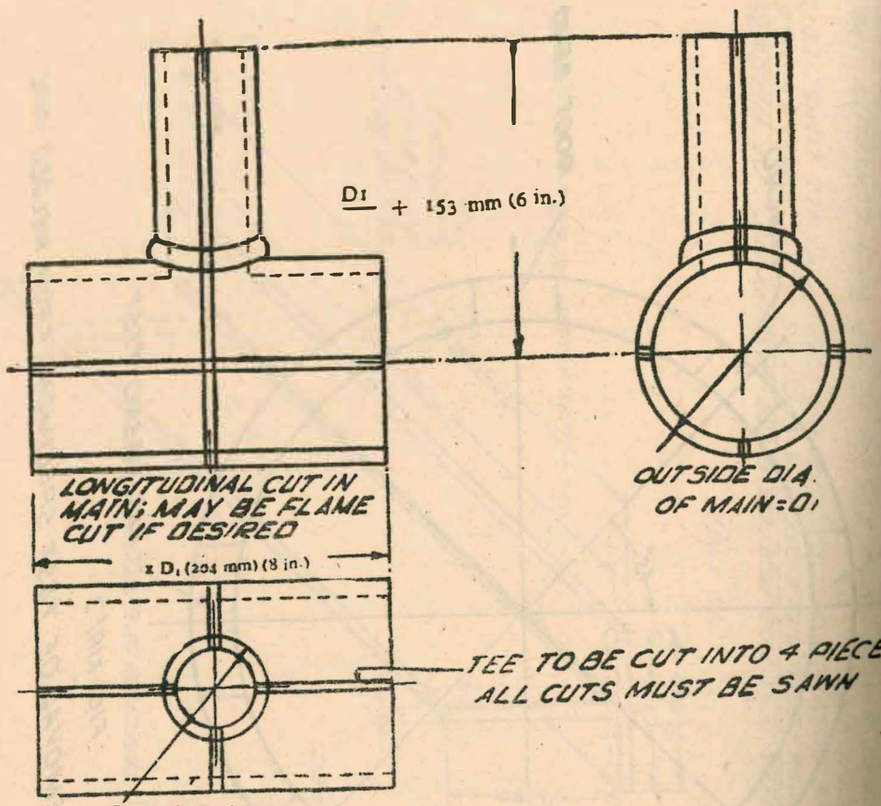


FIG. XIII/4
BRANCH WELD SPECIMEN FOR BRANCH PIPES

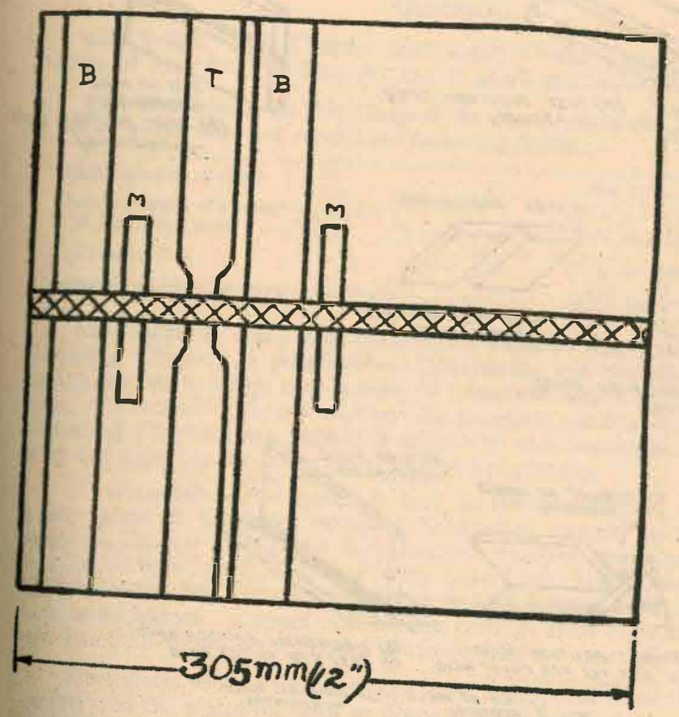
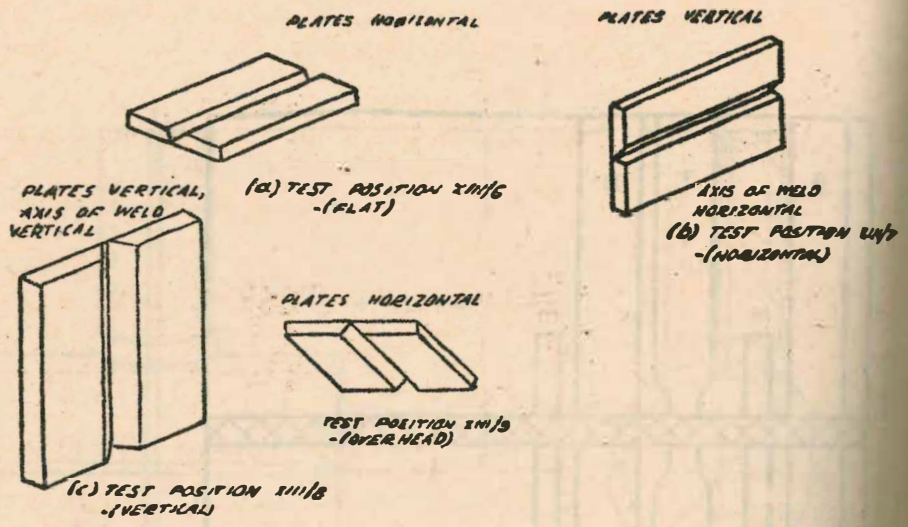
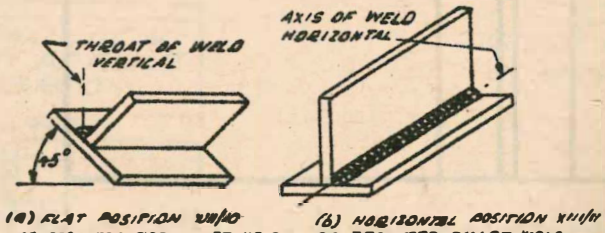
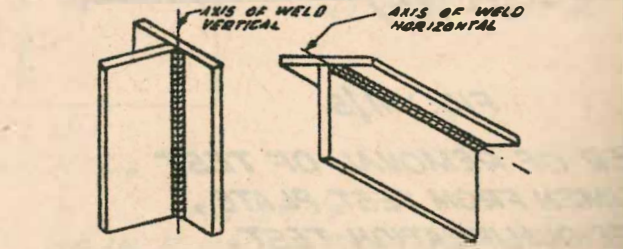


FIG. XIII/5
ORDER OF REMOVAL OF TEST SPECIMEN FROM TEST PLATE, FOR RE-QUALIFICATION TEST.


PLATES HORIZONTAL
PLATES VERTICAL
(a) TEST POSITION XIII/6 -(FLAT)
PLATES VERTICAL, AXIS OF WELD VERTICAL
AXIS OF WELD HORIZONTAL
(b) TEST POSITION VI/7 -(HORIZONTAL)
PLATES HORIZONTAL
TEST POSITION XIII/9 -(OVERHEAD)
(c) TEST POSITION XIII/8 -(VERTICAL)


THROAT OF WELD VERTICAL
45°
AXIS OF WELD HORIZONTAL
(a) FLAT POSITION VII/10 OF TEST TEE FOR FILLET WELD
(b) HORIZONTAL POSITION XII/11 OF TEST TEE FILLET WELD


AXIS OF WELD VERTICAL
AXIS OF WELD HORIZONTAL
(c) VERTICAL POSITION XIII/12 OF TEST TEE FOR FILLET WELD
(d) OVERHEAD POSITION XII/1 OF TEST TEE FOR FILLET WELD