

<p style="text-align: center;">NEW ZEALAND GOVERNMENT RAILWAYS MECHANICAL BRANCH</p>	<p style="text-align: center;"><b>PRACTICAL TRAINING AND TESTING OF MANUAL ARC WELDERS</b></p>	<p style="text-align: center;"><b>CODE No. 65</b> Page No. 1 of 6 Issue No 5      Date Issued 1/9/69</p>
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**1. GENERAL:**

This Code is to be brought to the attention of all staff trained and being trained in manual electric arc welding and a copy must always be available for their perusal.

All welding shall comply with the latest issue of B.S. 1856.

**2. ELECTRODES:**

All electrodes shall comply with the latest issue of B.S. 639.

Electrodes over twelve months old from the date of manufacture shall be retested to the requirements of the latest issue of B.S. 639. These tests shall be repeated at six-monthly intervals to check that the electrodes are suitable for continued use on test welds.

**3. WELDING PLANT AND EQUIPMENT:**

All welding plant, equipment and personnel protection shall comply with the latest issue of B.S. 638.

**4. QUALIFICATION TESTS:**

Before being employed on welding work at Workshops or Depots, all welders shall pass qualification tests for manual arc welders, using the type of electrode and steel specified in Appendix "A".

All welders shall undergo a requalification test within twelve months of the date of their previous test.

Qualification and requalification tests shall be carried out and assessed in accordance with the requirements of Appendix "A".

**5. TRAINING : NON-TRADESMEN TRAINEE WELDERS:**

Selected members shall be trained only at Workshops.

Training shall be carried out on low carbon steel to B.S. 4360 or similar with general purpose mild steel electrodes.

At East Town and small Workshops, training is to be similar to and of the same duration as at the large Workshops and under the supervision of the Sub Foreman Boilermaker or the Sub Foreman Fitter where there is no Sub Foreman Boilermaker. Each trainee shall be placed with a fully qualified welder and receive instruction for the first two weeks of training in each of the downhand, vertical and overhead welding positions. At the conclusion of the twenty-four week training period for each position of welding, the Welding Supervisor and Inspector shall decide if the trainee is suitable to undertake the relevant test.

At large Workshops except East Town, trainee welders will be under the supervision of the Sub Foreman Welder and will be trained as follows:—

- (a) Two continuous weeks of tuition in welding procedure and in single and multiple-run downhand welding.
- (b) During the following twenty-two continuous weeks, tuition will be given in single and multiple-run downhand welding consisting mainly of building up worn parts. Load carrying welds are not to be included.
- (c) Upon completion of training in (a) and (b) to the satisfaction of the Sub Foreman Welder, a downhand welding test as set out in Clauses (3) and (4) of Appendix "A" shall be undertaken. Upon passing this test the trainee shall be considered competent to carry out general downhand welding work.
- (d) During the twenty-four continuous weeks following passing the downhand welding test, tuition will be given in single and multiple-run vertical welding and as much practice as possible in vertical welding is to be carried out.
- (e) Upon completion of training in (d) to the satisfaction of the Sub Foreman Welder, a vertical welding test as set out in Clauses (3) and (4) of Appendix "A" shall be undertaken. Upon passing this test the trainee shall be considered competent to carry out general vertical welding work. He may then be recommended for classification as an Acting Welder. Classification to commence from the date of undertaking the vertical welding test. Unless authorised to carry out restricted welding work at Depots and isolated localities (see Clause 7), Acting Welders must proceed with the overhead welding training and test.
- (f) During the twenty-four continuous weeks following passing the vertical welding test, tuition will be given in single and multiple-run overhead welding and as much practice as possible in overhead welding is to be carried out.
- (g) Upon completion of training in (f) to the satisfaction of the Sub Foreman Welder, an overhead welding test as set out in Clauses (3) and (4) of Appendix "A" shall be undertaken. Upon passing this test the Acting Welder shall be designated as a fully qualified Electric Welder from the date of undertaking the overhead welding test.
- [(h) At the time of completing the overhead welding test in (g) a further downhand and vertical test plate shall be undertaken. Upon passing these two test plates the Welder will be deemed to have requalified under Clause 2.4.1 and shall there after be tested annually as set out in Clause 8 Page 3.]

[24/563 of 27/9/71]

NEW ZEALAND GOVERNMENT RAILWAYS	<b>PRACTICAL TRAINING AND TESTING OF MANUAL ARC WELDERS</b>	<b>CODE No. 65</b>
<b>MECHANICAL BRANCH</b>		Page No. 2 of 6 Issue No 5      Date Issued 1/9/69

## 6. TRAINING: SELECTED ENGINEERING TRADESMEN AND APPRENTICES

For selected engineering tradesmen and apprentices, training and testing in welding shall be as described in Clause 5 with the following exceptions:—

- (a) The training period for each welding position shall be reduced to twelve continuous weeks.
- (b) Training in downhand, vertical and overhead welding positions need not follow consecutively but may be arranged to suit a training programme.

## 7. WELDING WORK IN WORKSHOPS AND DEPOTS:

Only trainee, acting, or fully qualified electric welders trained as described in Clauses 5 and 6 may carry out welding work at Workshops.

Welding work at Depots, and isolated localities nominated by the Chief Mechanical Engineer, may be carried out by acting or fully qualified welders but acting welders may carry out such welding work only in the positions in which they are qualified.

Welding of pressure vessels must be carried out by fully qualified and experienced welders.

## 8. ANNUAL TESTING OF ELECTRIC WELDERS:

Testing at Workshops and Depots will be carried out to the following schedule:—

<b>Workshop:</b>	<b>Month of Test:</b>	<b>Test Supervised By:</b>
Otahuhu.	February.	Sub Foreman Welder.
East Town.	April.	Sub Foreman Boilermaker.
Hutt.	June.	Sub Foreman Welder.
Napier.	July.	Welding Supervisor and Inspector.
Hillside.	August.	Sub Foreman Welder.
Addington.	October.	Sub Foreman Welder.
Greymouth.    )		
Westport.       )	May.	Welding Supervisor and Inspector.
Invercargill.	March.	Welding Supervisor and Inspector.
<b>Depot:</b>		
Westfield Diesel.    )		
Auckland Car and Wagon.   )	February.	Sub Foreman Welder, Otahuhu Workshops.
Wanganui Diesel and Car and Wagon.	April.	Sub Foreman Boilermaker, East Town Workshops.
Wellington Diesel, Car and Wagon,    )		
Multiple Unit and Electric Traction.    )	June	Sub Foreman Welder, Hutt Workshops.
Christchurch Diesel & Car and Wagon.	October.	Sub Foreman Welder, Addington Workshops.
Dunedin Diesel & Car and Wagon.	August.	Sub Foreman Welder, Hillside Workshops.
Kawerau, Taumarunui, Te Rapa.	February.	Welding Supervisor and Inspector.

If a welder desires, he may carry out the requalifying test welds with the machine he is accustomed to operating and he may also be permitted a short period of practice beforehand if he has done little recent work in all positions. Test plates may be preheated if desired in conformity with recognised practice, as prescribed in B.S. 2645, Part 1, page 8.

Completed test plates shall be safeguarded, strongly cased and conspicuously labelled "Welding Test Plates" and forwarded to the Physical Testing Laboratory, c/o Works Manager, Hutt Workshops, for testing and visual assessment at the Laboratory. Test plates are to be covered by a test data sheet and Loco. 43 forms forwarded separately.

Works Manager, Hutt, will arrange for the radiographic examination and assessment of test specimens in accordance with Clauses 4.9 and 4.10 in Appendix "A".

## 9. TEST RESULTS:

The results of the physical tests and radiographic examination of each weld, must be entered on the covering test data sheet and forwarded to the Chief Mechanical Engineer who will retain the original and send copies to the District Mechanical Engineer or Works Manager and the welder concerned.

The Welding Supervisor and Inspector will counter-sign completed test data sheets and shall personally examine all test specimens that fail to pass the tests.

NEW ZEALAND GOVERNMENT RAILWAYS MECHANICAL BRANCH	APPENDIX "A" * QUALIFICATION TESTS FOR MANUAL ARC WELDERS	CODE No. 65 Page No. 3 of 6 Issue No 3      Date Issued 1/9/69
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## 1. GENERAL

1.1 This specification defines the tests and the procedures to be followed in qualifying manual arc welders, and the criteria by which the results are assessed.

### 1.2 Definitions:

1.2.1 The supervisor is the Welding Supervisor and Inspector, Sub Foreman Welder or Sub Foreman Boilermaker, who will supervise the welding of all test specimens, and who will assess the performance of the welding operator, the quality of the weld, and the results of the tests.

1.2.2 Hydrogen Controlled Electrodes are those complying with clause 9 (b) of NZS 1249 (BS 1719). They also comply with the requirements of NZS 1292 (BS 639).

1.2.3 Mild Steel Electrodes are defined as all those electrodes except hydrogen controlled electrodes complying with NZS 1292 (BS 639).

1.2.4 Mild Steel is any steel complying with NZS 309 (BS 15) or steel having physical and welding qualities similar to this steel.

1.2.5 Medium Tensile Welding Quality Steel is defined as a low alloy steel complying with NZS 1579 (BS 968) or steel having physical and welding qualities similar to this steel.

## 2. TEST PROCEDURE:

2.1 **General:** The tests for Manual Arc Welders Qualification consist of a fillet weld test followed by a butt weld test in each of the welding positions for each basic type of electrode and steel.

### 2.2 Extent of Qualification:

2.2.1 The following conditions define the extent of qualification:

		Symbol
(a) Position	Downhand .....	D
	Vertical .....	V
	Overhead .....	O
(b) Electrode	Normal .....	N
	Hydrogen Controlled .....	H
(c) Steel	Mild steel .....	M
	Medium tensile welding quality steel .....	T

2.2.2 An operator who passes tests in only some of the positions attempted may be granted a restricted qualification in those categories in which his tests were satisfactory.

2.2.3 An operator who fails to qualify in the downhand position will not be granted qualification in any other position even though his other tests may have been satisfactory.

### 2.3 Test Procedure

2.3.1 Each test weld shall be prepared, welded in the presence of the Supervisor, tested and assessed in accordance with the provisions of the following clauses.

2.3.2 Test plates in accordance with figures 1 and 2 may be prepared in advance, but where medium high tensile welding quality steel is used the Supervisor must be satisfied as to the identity of the steel by means of mill certificates and plate identification marks otherwise the steel will be considered to be mild steel.

2.3.3 The fillet weld test shall be carried out in each case for initial qualification. On the basis of this test the Supervisor will decide whether the operator may proceed with the butt weld tests or whether to fail the operator without further testing. [A replacement test piece shall only be allowed if, during the course of the test, it becomes apparent that (a) the test piece is faulty (for example, laminated) or (b) the welding equipment is unsatisfactory.]

[C.M.E.'s file 24/563 of 26.7.1974]

2.3.4 Each part of the welded test piece to be used in each subsequent test shall be hard stamped by the Supervisor with his own mark and that of the operator together with the symbol (clause 2.2) identifying the particular test. In the case of butt weld tests the stamp marks shall be on the first side welded.

### 2.4 Requalification:

2.4.1 An operator's qualification is valid for a period of 12 months, after which he must requalify.

The Supervisor, if he is satisfied as to the capabilities of the operator, may elect to omit the fillet weld tests when an operator is seeking requalification.

2.4.2 An operator who requalifies by passing tests on medium tensile welding quality steel also qualifies without further testing for mild steel in the same position/s and for the same type of electrode.

2.4.3 An operator who requalifies by passing tests using hydrogen controlled electrodes also qualifies without further testing for mild steel electrodes in the same position/s and for the same type of steel.

NEW ZEALAND GOVERNMENT RAILWAYS MECHANICAL BRANCH	APPENDIX "A" * QUALIFICATION TESTS FOR MANUAL ARC WELDERS	<b>CODE No. 65</b> Page No. 4 of 6 Issue No 3      Date Issued 1/9/69
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## 2.5 Retests:

2.5.1 When a manual arc welding operator fails to qualify or requalify he can elect to present himself for retesting immediately or wait for a period of three months. If he elects to retest immediately he shall complete two sets of tests both of which must be to the satisfaction of the Supervisor before he can qualify. If he waits for three months he shall complete the qualification test in the normal way.

## 3. FILLET WELD BREAK OVER TEST:

3.1 Separate tests shall be done in each position (horizontal, vertical, overhead) for which qualification is sought.

### 3.2 Assembly and Welding:

3.2.1 The test piece shall be shaped as detailed in figure 1. Tack welds shall be on the side to be welded and in the line of the weld. No other method of restraint shall be used.

3.2.2 The test weld shall be of between  $\frac{1}{4}$ " and  $\frac{5}{16}$ " leg length deposited in a single run. Each weld shall be stopped and restarted with a fresh electrode within the central 2" of the test piece.

### 3.3 Visual Assessment:

3.3.1 **Dimension and profile:**— The size of the weld shall be within the limits specified and its profile shall be uniform, of approximately equal leg length and free from overlap at the toe of the weld.

3.3.2 **Uniformity of surface:**— The weld shall be uniform in appearance throughout its length. Where the weld is recommenced the join shall be as smooth as practicable and shall show no pronounced hump or crater in the weld surface.

3.3.3 **Undercut:**— The welded joint shall be free from undercut except that minor occurrences (to a depth less than 0.030 inches and of a combined length of less than 1 inch in the entire test piece) will be acceptable.

3.3.4 **Surface defects:**— The surface of the weld shall be free from cracks, porosity, cavities and trapped slag.

### 3.4 Break Over Test:

The central 4 inch length shall be cut from the test piece. This piece shall be fractured through the weld by applying a load in the direction shown in figure 1. A central saw cut  $\frac{1}{16}$  inch deep may be made centrally along the weld face to ensure fracture.

### 3.5 Assessment of the Break Over Test:

3.5.1 **Degree of penetration:**— The fracture shall show that there is penetration to the root of the joint.

3.5.2 **Soundness of weld metal:**— The fracture shall have a clean appearance, the weld metal shall be free from oxide films, and any voids or slag inclusions shall be within the permissible limits defined under clause 4.10 (radiographic assessment).

## 4. BUTT WELD TEST:

4.1 Separate tests shall be done in each position (downhand, vertical, overhead) for which qualification is sought.

### 4.2 Assembly and Welding:

4.2.1 The test piece shall be prepared as detailed in figure 2. Tack welds shall be on the open side of the weld and in the line of the weld. Distortion or misalignment caused by tack welding may be corrected before the test weld is deposited.

4.2.2 The test piece shall be supported in such a manner that contact with the bench or other material does not provide a backing bar for the joint.

4.2.3 Number eight gauge electrodes shall be used for both the root and sealing runs. Large electrodes may be used for other runs.

4.2.4 Each weld run shall be stopped and restarted at the locations shown on figure 2.

4.2.5 The operator may back gouge or grind out the back side of the first root run to a maximum depth of  $\frac{3}{16}$ " below the face of the adjacent plate before the sealing run is placed.

### 4.3 Visual Assessment:

4.3.1 If the Supervisor is convinced by inspection of the weld both during and after the welding operation that the operator has not achieved the required standard, he may fail the operator without proceeding with the physical tests. Lack of competence during welding will be assessed on the following grounds:

- (a) Lack of control of the molten pool.
- (b) Excessive peaking on intermediate runs.
- (c) Excessive undercut on any run.
- (d) Excessive back gouging to reach solid metal.
- (e) The need for excessive cleaning after each run.

4.3.2 **Shape of profile:**— The profile of the finished weld shall be uniform, slightly convex and blending in smoothly with the parent metal without overlap and without abrupt changes in profile at the edge of the weld. The amount of reinforcement shall not exceed  $\frac{1}{8}$  inch.

NEW ZEALAND GOVERNMENT RAILWAYS MECHANICAL BRANCH	APPENDIX "A" * QUALIFICATION TESTS FOR MANUAL ARC WELDERS	<b>CODE No. 65</b> Page No. 5 of 6 Issue No 3      Date Issued 1/9/69
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**4.3.3 Uniformity of surface:**— The weld shall be uniform in appearance throughout its length. Where the weld is recommenced the joint shall be as smooth as practicable and shall show no pronounced hump or crater in the weld surface.

**4.3.4 Undercut:**— The finished weld shall be free from undercut except that minor occurrences (to a depth of less than 0.010 inches and of a combined length of less than 1 inch in the entire test piece) will be acceptable.

**4.3.5 Surface Defects:**— The surface of the weld shall be free from cracks, porosity, cavities and trapped slag.

#### **4.4 Preparation of Test Specimens:**

**4.4.1** The Department shall arrange for the preparation of all test specimens as detailed below in clauses 4.4.2 to 4.4.5. Testing will be undertaken or arranged by the Supervisor.

**4.4.2** The test plate shall be sectioned as detailed on figure 2. Thermal gas cutting, cold sawing or milling may be used at the discretion of the operator. After cutting, the edges of each specimen shall have all notches and tool marks removed over a minimum distance of 2 inches on each side of the weld. The corners shall be radiused to 0.05". The finished width of each specimen shall be within  $\frac{1}{8}$  inch of the dimension given on figure 2.

**4.4.3** For Bend Test specimens the weld shall be ground flush with the plate surface and grinding marks shall be parallel to the length of the specimen.

**4.4.4** For Nick Break specimens the weld need not be ground flush. Two  $\frac{1}{8}$  inch deep saw cuts shall be made centrally through the depth of the weld as shown on figure 4.

**4.4.5** For the radiographic specimen the weld need not be ground flush with the surface of the plate.

#### **4.5 Bend Test**

**4.5.1** Two bend tests shall be made; one with the first side welded in tension (face bend) and the other with the second side welded in tension (root bend).

**4.5.2** Each test piece shall be bent through 180° using a former and supports as detailed in figure 3.

#### **4.6 Assessment of Bend Test:**

The bend test is satisfactory if there is no crack or defect, at the outer surface of the test specimen greater than  $\frac{1}{8}$ " when measured across the test specimen or  $\frac{1}{16}$ " when measured along the length of the test specimen. Slight cracking at the corners of the test specimen shall not be considered cause for rejection.

#### **4.7 Nick Break Test:**

Each of the two test specimens shall be notched, broken open along the weld as shown in figure 4 and the fracture surfaces visually examined.

#### **4.8 Assessment of Nick Break Test:**

The fracture shall have a clean appearance and the weld metal shall be free from oxide films, and any voids or slag inclusions shall be within the permissible limits defined under clause 4.10 (radiographic assessment). There shall be no lack of penetration or lack of fusion.

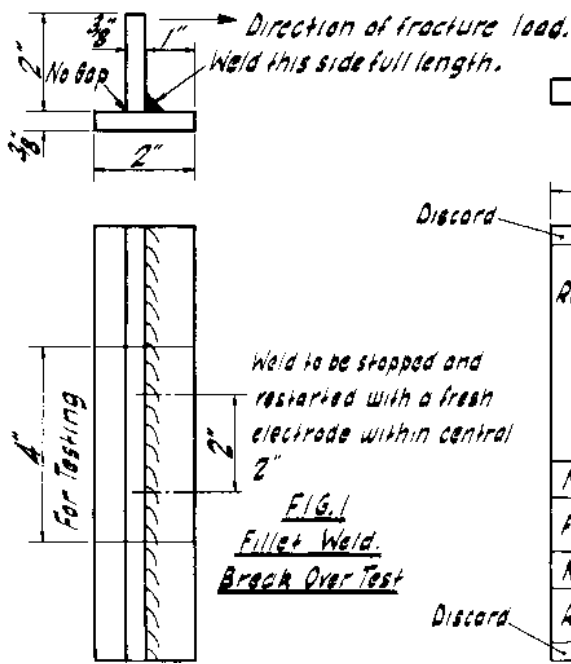
#### **4.9 Radiographic Examination:**

**4.9** The 6" wide test piece shall be radiographed in the as welded condition using methods in accordance with NZCP 13 (BS 2600) to achieve a radiographic sensitivity of 2% or better. Image Quality Indicators (penetrameters) shall be used in each case to demonstrate the sensitivity achieved.

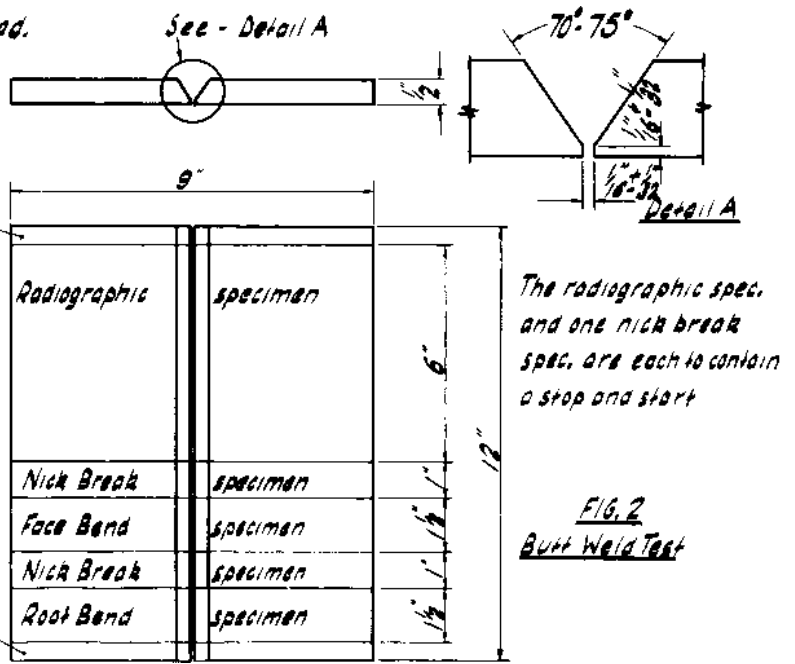
#### **4.10 Radiographic Assessment:**

In the interpretation of the radiographs the weld shall be acceptable if:—

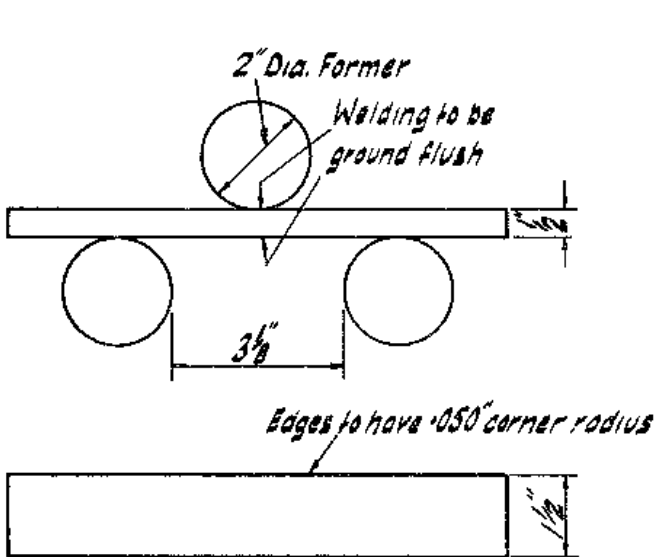
- (a) There are no cracks or zones of incomplete fusion or penetration.
- (b) There is no elongated defect which has a length greater than  $\frac{1}{4}$ ".
- (c) In any group of defects in line, either the aggregate length of defects is less than  $\frac{1}{2}$ " in the length of 6" or the distance between successive defects is at least six times the length of the largest defect in the group.
- (d) There is no porosity in excess of 0.03 square inches in the six inch length of the weld. If the weld is less than six inches long the total area of porosity will be reduced in proportion. The porosity charts of the American Society of Mechanical Engineers Code for Unfired Pressure Vessels may be used as a guide for the application of the requirements of this clause.



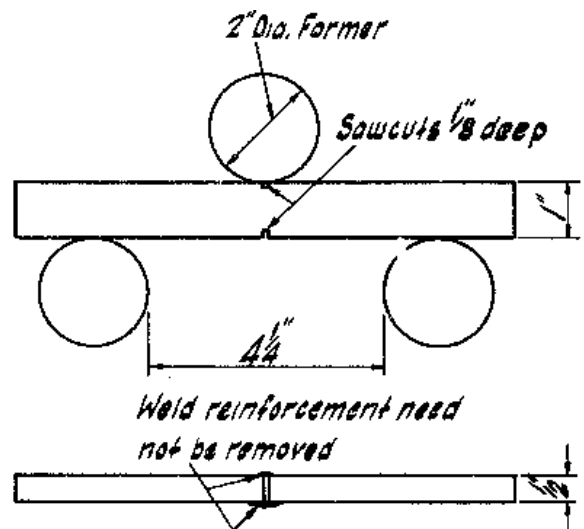
**FIG. 1**  
Fillet Weld  
Break Over Test



**FIG. 2**  
Butt Weld Test



**FIG. 3**  
Method of Testing Transverse  
Bend Test Specimen



**FIG. 4**  
Method of Fracturing Nick  
Break Specimen

NOTE ON CODE 65

Welders trained and certified to the current issue of Code 65 or NZ S 4711: 1984 are acceptable for work on steam locomotives