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**TECHNOLOGY MANAGEMENT**  
**STANDARD OPERATING PROCEDURE**

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**ULTRASONIC TESTING OF THE RAIL FLANGE, FLASH BUTT WELD FOR QUALITY ASSURANCE.**

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## 1.0 SCOPE

- 1.1 This procedure covers the ultrasonic testing technique of the foot of the flash butt welded rail joints by using pulse-echo, a scan examination method, utilised to detect weld discontinuities.
- 1.2 This practice utilizes one shear wave probe of a 70 degree refracted angle in steel, for the testing of the flange of the flash butt welded joint.

## 2.0 PURPOSE

The purpose of this document is to provide Ultrasonic testing personnel with guiding principle of how to test the foot of a flash butt welded rail joint by using the pulse echo system.

## 3.0 DEFINITIONS

- 3.1 **Probe:** A piezo-electric transducer responsible for generating sound, transmitting it to the specimen and receiving it.
- 3.2 **Specimen:** The test piece being tested
- 3.3 **Discontinuity:** An interruption or change in the physical structure or characteristics of a material.
- 3.4 **Flaw:** A material discontinuity whose size, shape, orientation or location may make it detrimental to the useful service of the test object.
- 3.5 **Back wall echo:** A signal reflecting sound energy at the end of the screen, it signifies the bottom of the tested specimen.
- 3.6 **Couplant:** A substance (usually liquid) used between the transducer and the test surface to permit or improve transmission of ultrasonic energy into the test object.

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## 4.0 SIGNIFICANCE

### 4.1 Personnel qualification:

It is highly essential that evaluation be performed by personnel who is qualified and certified in accordance with ASNT Documents SNT-TC-1A to a minimum level I for technician; supervised by a level II U.T, from an internationally recognised Non-destructive testing institution.

## 5.0 REQUIREMENTS OF THE ULTRASONIC TESTING PROCEDURE

### 5.1 Equipments and accessories

5.1.1 Pulse-echo type ultrasonic flaw detector.

5.1.2 One double crystal 70 degree (steel), shear wave, 2Mhz probe.

5.1.3 Battery with and battery charger.

5.1.4 Standard rail piece of 400mm length having standard simulated defects at standard locations.

5.1.5 Reference block 50mm x 30mm x 72mm of Class IV steel and International Institute of Welding calibration block; V1 or V2 block.

5.1.6 Steel measuring tape or ruler.

### 5.2 Pre-requisites

#### 5.2.1 Battery Power:

Before undertaking testing, check the power of the battery to ensure that it is fully charged.

#### 5.2.2 Functioning of the Machine

Check the correct functioning of the ultrasonic flaw detector and all angular probes on the International Institute of Welding calibration block; V1 or V2 block.

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### 5.2.3 Coupling condition/surface preparation:

The protruding upset metal around the welded joint shall be removed by any suitable mechanical means in such a way that the remaining protruded metal does not produce sharp corners and the finished surface of the protruded metal if any left should merge smoothly into the surfaces of the adjacent base metal.

The scanning surfaces must be free from weld spatter, scale, and dirt, rust and extreme roughness on each side of the weld for a distance equal to 200mm.

### 5.2.4 Couplant:

The couplant should wet the surface for the probes and the scanning surfaces it should also eliminate any air space between the two. Depending upon availability and feasibility of the testing, water, oil or grease can be used as couplant.

### 5.2.5 Calibration

Calibrate the depth range of ultrasonic flaw detector with the help of a Reference block 50mm x 30mm x 72mm of Class IV steel.

## 6.0 CALIBRATION STEPS

6.1 The ultrasonic flaw detector shall be calibrated for 100mm range with the aid of a 70 degree angle probe.

6.2 Calibration using a 70 degree angle probe must be accomplished by using a V1 block. Scanning limits should be calculated and adhered to during probing, refer to 6.3, and Figure 1 and Appendix A, for scanning limits.

### 6.3 Scanning limits.

Limits are calculated and marked on the specimen to be tested so as to ensure that the full body of the weld is adequately scanned

6.3.1 For testing the flange towards the centre at thickness = 22mm with probe angle = 70°.

The  $\frac{1}{2}$  skip = 60.44mm and the Beam path length to  $\frac{1}{2}$  skip = 64.33mm.

The full skip = 120.88mm and the beam path length to full skip = 128.66mm.

6.3.2 For testing the flange edge of thickness = 13mm with probe angle = 70°.

The  $\frac{1}{2}$  skip = 35.72mm and the Beam path length to  $\frac{1}{2}$  skip = 38.01mm.

The full skip = 71.44mm and the beam path length to full skip = 76.02mm.

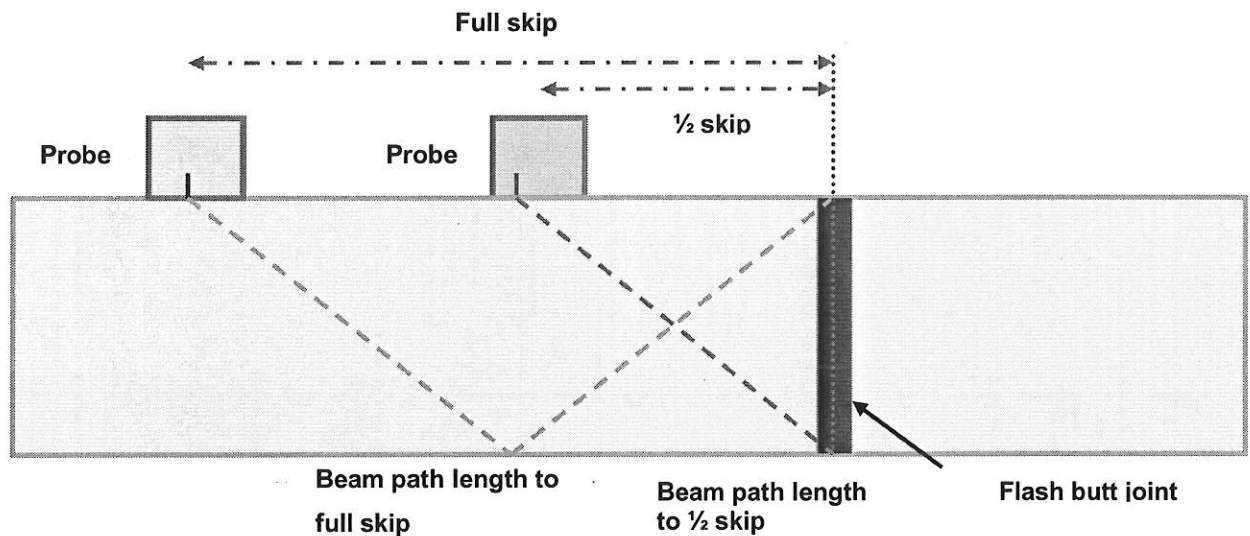


Figure 1. Schematic presentation of scanning limits and probe placement for testing the flange of a flash butt welded rail.

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## 7.0 EXAMINATION OF FLASH BUTT WELDED RAIL JOINT AT THE FLANGE:

Testing of flash butt welded joints is performed on the flange of the rail.

A 70 degree angle, double crystal probe of 2 MHz frequency shall be employed for examining the welds at the foot. The above probe has an index mark on its housing to denote the point at which the central beam emerges.

### 7.1 Testing procedure for the flange of the butt welded rails with the use of a 70 degree angle double crystal probe.

- 7.1.1 For examining the flange of the flash butt welded rail joints the detector's setting requires setting the machine to T + R mode in which case the probe works both as a transmitter as well as receiver.

The 70 degree angle probe shall be connected to the transmitting socket of the instrument and the sensitivity setting of the system shall remain unchanged.

- 7.1.2 A couplant must be applied along the right and left hand side faces of the rail web, up to 100mm away from the joint on both sides of the weld.

- 7.1.3 The probe shall be positioned 100mm away from the weld and navigated in a zigzag manner towards the weld. The probing should be done on the flange so that the entire width is scanned, (See Appendix A, fig. 1).

- 7.1.4 To detect flaws in the web, the probe must be twisted slightly in the direction of the web. No flaw signal will appear on the screen if the rail foot and web are sound.

If there are discontinuities in the weld, moving flaw signals will appear on the screen.

When the flaw signal is at its maximum height, the distance of the probe from the weld joint shall be measured, so as to determine the location of the flaw.

Any welded joint when tested with normal gain setting showing any moving signal shall be considered as defective.

## **8.0 REJECTION CRITERIA**

Any defect size detected in the flash butt weld by the use of an Ultrasonic testing method is deemed an immediate reject.

## **9.0 SUPPORTING DOCUMENTS**

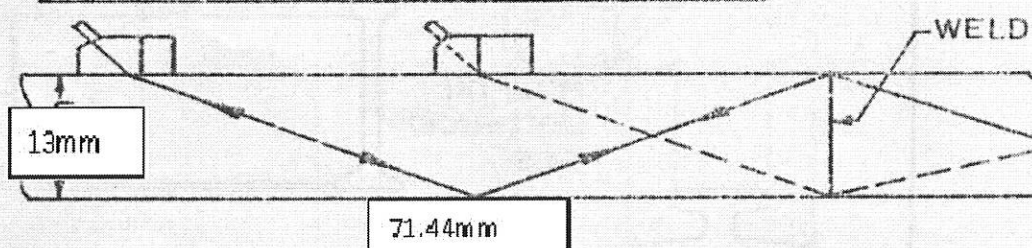
- 9.1 Flash butt welding of new and second hand flat bottom rails, specification S170, (2012).
- 9.2 Track Welding manual, BBB8341, Version 5, (2011).
- 9.3 Government of India, Ministry of railways, Manual for flash butt welding of rails (1996).



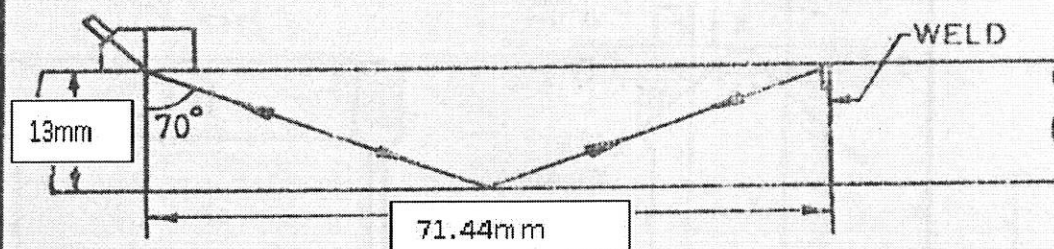
## 10.0 APPENDIX A

POSITION OF  $70^\circ$  ANGLE PROBE AND  
BEAM PATH FOR VARIOUS FLAW LOCATION  
WHEN EXAMINING THE FOOT  
OF BUTT WELDED RAILS.

WELD: FREE FROM FLAWS, NO FLAW SIGNAL



FLAW AT TOP (PROBE SIDE)



FLAW IN MIDDLE :



FLAW AT BOTTOM (OPPOSITE SIDE TO PROBE)

