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GOVERNMENT OF INDIA – MINISTRY OF RAILWAYS

2025

# BASIC KNOWLEDGE OF ULTASONIC TESTING OF RAILS






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# “BASIC KNOWLEDGE OF ULTRASONIC TESTING OF RAILS”

## Foreword

**U**ltra **S**onic **F**law **D**etection (**USFD**) technique is widely used on Indian Railways for detecting flaws in rails/welds for safety consideration of the track. This booklet gives correct knowledge for detecting flaws in Rails .

This booklet mainly focuses on testing procedure, calibration & sensitivity setting of machine, defect classification and action to be taken during USFD testing of Rails (need-based concept), for ensuring reliable testing and optimum output of machines.

Civil Engineering branch of CAMTECH has made excellent effort to bring out this booklet. I am sure that this booklet would be useful as reference book for inspecting official & field staff of open line in engineering branch.

***CAMTECH, Gwalior***
***February, 2025***

***Dinesh Shukla***
***Principal Executive Director***

## Preface

Detection of flaws in rails & welds and their timely replacement is an ongoing process to avoid fracture in track, which at times can have dangerous consequences. The Ultrasonic testing of rails is one of the Non Destructing Tests used for detecting any flaws in the rails. Engineering Officers and supervisors of Open Line organization are expected to spend some time with USFD teams and test check the quality of the ultrasonic testing being carried out at the field. The objective of this booklet is to provide basic and technical details regarding ultrasonic testing of Rails (Need based concept) for the guidance of inspecting official. It covers frequency of testing, calibration and sensitivity setting of machine, procedure of testing, defect classification, and action to be taken.

*This booklet is not statutory & contents are for the purpose of guidance only.* It also does not supersede any existing instructions from Railway Board, RDSO, Zonal Railways and provisions of IRPWM & USFD manual (CS upto 2) on the subject.

We welcome valuable suggestions from our readers for further improvements.

***CAMTECH, Gwalior***
***February, 2025***

***Deepak Mehra***
***Director/Civil***

**CONTENTS**


| | | |
|---|---|---|
| **1.0** | **Introduction** | **1** |
| **2.0** | **Basic Principles of USFD Testing of Rails** | **1** |
| | 2.1 Probes or Transducers<br>2.1.1 Normal Probe<br>2.1.2 Angular Probe<br>2.1.3 Types of Probes used for USFD Testing of Rails<br>2.2 Use of Couplant for Ultrasonic Testing | 1-3 |
| **3.0** | **Apparatus required for UT of Rails** | **4** |
| | 3.1 Equipments<br>3.1.1 Single rail tester<br>3.1.2 Double Rail tester<br>3.2 Test rig for wheel burnt/scabbed rails<br>3.3 Couplant | 4-7 |
| **4.0** | **Competency for Testing** | **7** |
| **5.0** | **Data presentation of ultrasonic testing** | **7** |
| | 5.1 A-Scan Display<br>5.2 B-Scan Display | 7-8 |
| **6.0** | **Frequency of testing of rails** | **8** |
| **7.0** | **Action to be taken after Detection of defects** | **9** |
| **8.0** | **Steps involved in USFD Testing Procedure** | **10** |
| | 8.1 Visual inspection of Equipments and accessories<br>8.2 Calibration of equipment<br>8.3 Sensitivity setting of the equipment and probes<br>8.4 Checking of the equipment characteristics<br>8.5 Testing and Interpretation | 10-11 |
| **9.0** | **Standard test Pieces for Sensitivity setting & Calibration** | **11** |
| | 9.1 Standard rail piece<br>9.2 IIW (V1) Block for Calibration | 11-12 |
| **10.0** | **0°/4 MHz, Double crystal Normal Probe** | **13** |
| | 10.1 Calibration<br>10.2 Sensitivity setting<br>10.3 Adjustment in sensitivity setting on account of variation in rail temperature<br>10.4 Test Procedure<br>10.5 Defect classification | 13-15 |
| **11.0** | **70°/2 MHz, Single crystal Probe (Center forward & Center backward)** | **16** |
| | 11.1 Calibration<br>11.2 Sensitivity setting<br>11.3 Adjustment in sensitivity setting on account of variation in rail temperature | 16-19 |

| | | |
|---|---|---|
| | 11.4 Defect Classification | |
| **12.0** | **12.0 70°/2 MHz, Single crystal Probe (Gauge Face and Non-gauge Face probe) (Forward and backward)** | **20** |
| | 12.1 Calibration<br>12.2 Sensitivity setting<br>12.3 Adjustment in sensitivity setting on account of variation in rail temperature<br>12.4 Defect classification | 20-21 |
| **13.0** | **37°/2 MHz, Single crystal Probe (Center forward & Center backward)** | **22** |
| | 13.1 Calibration<br>13.2 Sensitivity setting<br>13.3 Adjustment in sensitivity setting on account of variation in rail temperature<br>13.4 Defect Classification | 22-23 |
| **14.0** | **Test Rig for wheel burnt/scabbed rails** | **24** |
| | 14.1 Calibration<br>14.2 Sensitivity Setting<br>14.3 Adjustment in sensitivity setting on account of variation in rail temperature<br>14.4 Test Procedure<br>14.5 Defect Classification | 24 |
| **15.0** | **Precautions to be taken by the Operator for Testing** | **25** |
| **16.0** | **Limitations of Ultrasonic Flaw Detection of Rails** | **26** |
| **17.0** | **Guidelines for USFD testing of tongue rail of point & crossing in service** | **27** |

## 1.0 Introduction

Any defect in the rail which may lead to fracture or breakage of rail is called a flaw or a defect. The imperfections present in the material (defects generated during the manufacturing process, residual stresses induced during manufacturing), dynamic stresses caused by vertical and lateral loads due to passage of traffic (Fatigue of rail), incorrect handling and excessive thermal stresses due to variation in rail temperature beyond specified limits are the causes of defects in rails.

With the increase in the axle loads and the speeds of the trains, the rail stresses are increasing which in turn is likely to result in high defect generation rates in the rail. It is, therefore, essential that detection of flaws be carried out well in advance so that preventive action can be taken on time to avoid any disastrous condition due to rail fracture.

Ultrasonic testing of Rails and Welds is an effective tool for timely detection of defects due to its high sensitivity, accuracy, good penetration power and fast response time.

Since one of the most important inspection duties of engineering officers and supervisors is to ensure quality of USFD testing being carried out by USFD team. It is therefore very important that they are well conversant in basic knowledge of USFD testing.

## 2.0 Basic Principles of USFD Testing of Rails

Ultrasonic testing of rails is a non-destructive inspection method that uses ultrasonic waves (high frequency sound waves having frequency more than 20,000 Hz) for flaw detection in rails. The basic principle of Ultrasonic Testing is that the ultrasonic waves travelling in a medium will get reflected after hitting a flaw. The reflected energy is picked up by the probe and flaw gets detected. Refer Figure-1.

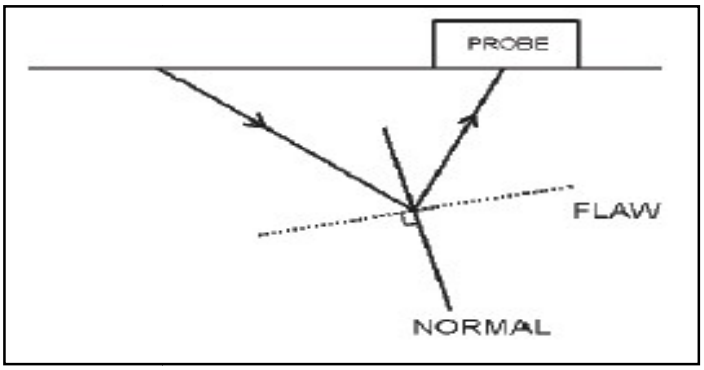



*Figure*-1

On the Indian railway, the most common technique used in ultrasonic testing is the “pulse echo technique”, which is more useful since it requires one-sided access to the object being inspected.

### 2.1 Probes or Transducers *(Ref: Para 4.3 of USFD testing of rails and welds issued by IRICEN)*

There are certain crystal in nature called Piezo Electric crystals which converts electric energy into mechanical energy and vice versa. Thus we give some potential difference

(electric energy) to the crystal and measure the potential difference (electric energy) on return. The vibrations of the crystals (mechanical energy) are directly transmitted to the medium in the form of ultrasonic waves. These crystals are mounted in housing with suitable damping material and this entire assembly with metallic housing is known as a PROBE or a TRANSDUCER. The crystal can transmit the ultrasonic waves and receive them back.

Quartz and Tourmaline are the examples of natural piezo-electric crystals while Barium Titanate, Lead Ziroconate Titanate (PZT), etc are the example of artificial piezo electric crystals. PZT is generally used in the transducers for Ultrasonic Testing.

Probes can be single crystal or double crystal. In single crystal probe, same crystal is used as transmitter as well as receiver while in double crystal probe; there are two crystals one works as a transmitter and the other as a receiver. Both the crystals in double crystal probes are exactly identical and any one of them can be used as a transmitter or a receiver. O° probe is double crystal probe while all other angular probes used in testing of welds are single crystal probes.

Depending upon the angle at which the waves are transmitted into the test specimen, the probes are classified as below.

**2.1.1 Normal Probe:** This probe generates longitudinal waves and transmits them into the specimen at zero angle of incidence, i.e. normal to the plane of application. The frequency of this probe is 4MHz for rail testing. This probe is double crystal probe. Refer Figure-2 & 3.

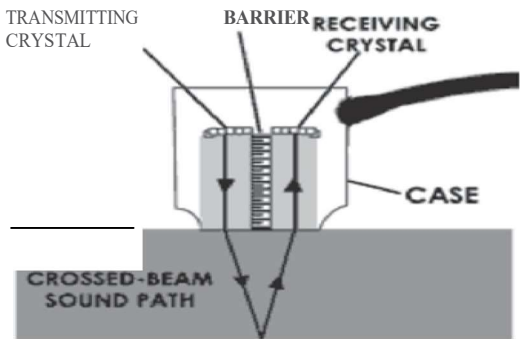



*Figure 2*



*Figure 3*

**2.1.2 Angular Probe:** These Probes transmit waves in the specimen, at a pre-decided angle. The angle of incidence is so designed so as to cause the transmitted wave in steel to travel at a particular angle. For that purpose the Perspex Wedge is used and the crystal is glued to the wedge, so that it generates waves to fall on the foot of the wedge at an angle. All angular probes used for rail testing are 2 MHz. Refer Figure-4, 5 & 6.

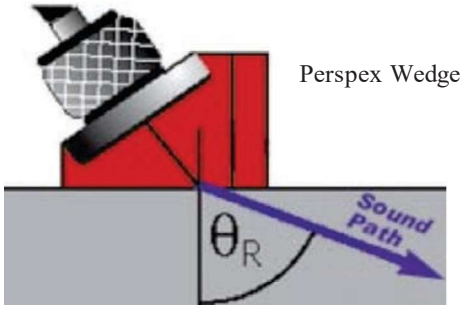



Figure 4



Figure 5

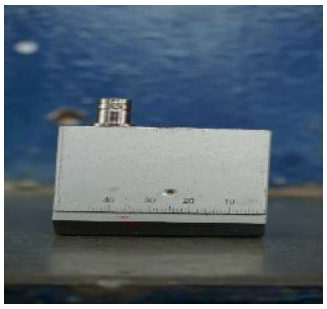


Figure 6

**2.1.3 Types of Probes used for USFD Testing of Rails** *(Ref: Para 3.2, 3.6 & 4.1 of USFD Manual-2022)*

Following types of probes are used for USFD testing of rails-

| **Type of Probe** | **No. of probes** | | | **Purpose** |
|---|---|---|---|---|
| | **Single Rail Tester** | **Double Rail Tester** | **Rig** | |
| Normal/$0^0$ | One | One for each rail | - | For detecting horizontal defects situated in head, web or foot. |
| $70^0$ (Center) | Two(F+B) | Two (F+B) for each rail. | - | for detecting defects in the rail head, the most typical of which is the transverse fissure or kidney fracture |
| $70^0$ (Gauge Face) | Two(F+B) | Two (F+B) for each rail. | - | |
| $70^0$ (Non gauge Face) | Two(F+B) | Two (F+B) for each rail. | - | |
| $45^0$ (Rig testing) | - | - | Two | For detection of transverse flaws in rail head in wheel burnt/ scabbed rails |
| $37^0$ (Center) | Two(F+B) | Two (F+B) for each rail. | - | to find out defects originating from the bolt hole (star cracks). |

**2.2 Use of Couplant for Ultrasonic Testing** *(Ref: Para 3.7 & Annexure 'C' of USFD testing of rails and welds issued by IRICEN, 2019)*

A liquid or semi-solid medium is interposed between the probe and the object under examination to enhance the transmission of ultrasonic energy between them. Synonymous terms are Coupling Film and Coupling medium.

When we keep the probe on the surface of the testing material say rail, there will be a thin film of air between the probe and the rail top surface which will act as a third medium. No ultrasonic energy will enter into the rail (through air) and the testing will not be possible. It is therefore necessary to expel the air film between the probe and the rail by the use of couplant. If we do not use a couplant, testing will not be possible. Refer Figure-7.

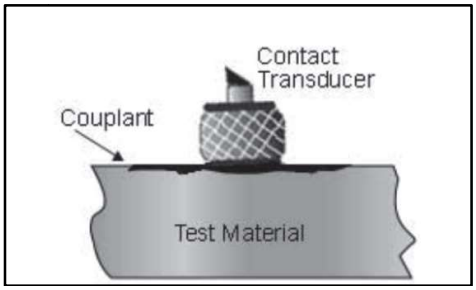



Figure 7. Use of Couplant between Probe and Test Piece

**3.0 Apparatus required for UT of Rails:** *(Ref: Chapter 3 & Para 6.7 of USFD Manual-2022)*

RDSO approved rail testing equipment & other apparatus shall be employed for conducting ultrasonic examination.

**3.1 Equipment:** On Indian Railways, flaw detection by ultrasonics is carried out with the help of two different types of equipments viz. Single rail tester and double rail tester.

**3.1.1 Single rail tester:** Refer Figure-8. Single rail tester is capable of testing only one of the rails at a time and is provided with following nine probes-

(i) Normal probe (0°),
(ii) 70° Center Forward (CF),
(iii) 70° Center Backward (CB),
(iv) 70° Gauge Face Forward (GF),
(v) 70° Gauge Face Backward (GB),
(vi) 70° Non-gauge face Forward (NGF),
(vii) 70° Non-gauge Face Backward (NGB),
(viii) 37° Center Forward (CF) and
(ix) 37°Center Backward (CB).



Figure 8: Single Rail Tester

- The normal probe (0°) is utilised for the purpose of detecting horizontal defects situated in head, web or foot.
- The 70° probe has been specifically provided for detecting defects in the rail head, the most typical of which is the transverse fissure or kidney fracture.
- 37° probes have been provided to find out defects originating from the bolt hole (star cracks).

The signal received from the defects by any of the above probes is indicated on the screen. In order to find out the origin of detection i.e. which probe has picked up the defect, provision for displaying the individual probe operation along with audio alarm/LED display has been made in the equipment.

**3.1.2 Double Rail tester:** Refer Figure-9. The double rail tester is capable of testing both the rails at a time. For each rail, following nine probes have been provided-

(i) Normal probe (0°),
(ii) 70° Center Forward (CF),
(iii) 70° Center Backward (CB),
(iv) 70° Gauge Face Forward (GF),
(v) 70° Gauge Face Backward (GB),
(vi) 70° Non-gauge face Forward (NGF),
(vii) 70° Non-gauge Face Backward (NGB),
(viii) 37° Center Forward (CF) and
(ix) 37°Center Backward (CB).




Figure 9: Double Rail Tester

The signal received from the defects by any of the probes is indicated on the screen. In order to find out the origin of detection i.e. which probe has picked up the defect, provision for displaying the individual probe operation along with audio alarm/LED display has been made in the equipment.

**3.1.3** The introduction of double rail tester has been specifically made for enhancing the productivity of testing and as well as improving the quality and accuracy of flaw detection.

**3.1.4** It is desirable to deploy only the 'single rail tester' ultrasonic testing machine for testing of sections other than LWR/CWR and double rail testers on LWR/CWR sections.

**3.2 Test rig for wheel burnt/scabbed rails** *(Ref: Para 3.6 of USFD Manual-2022)*

For detection of transverse flaws in rail head when rail top surface is having wheel burns/scabs, a test rig with two $45^0$ probes sending beam inward shall be used as shown in Fig. 10. The distance between probe index marks in the rig shall be adjustable and kept as 134 mm and 145 mm for 52Kg and 60Kg rails respectively while testing.

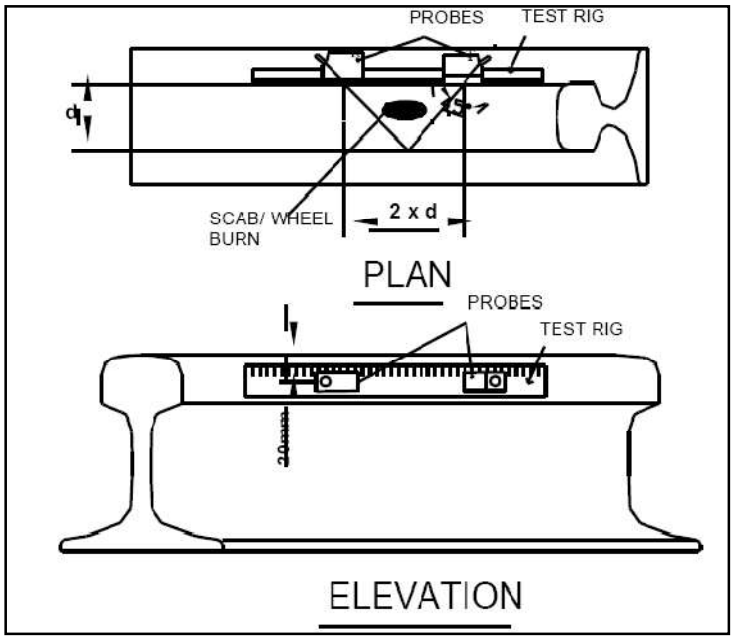



Figure 10 Test rig for wheel burnt/scabbed rails

### 3.3 Couplant *(Ref: Para 4.1 of USFD Manual-2022)*

Water is used as couplant while testing with Single Rail Testers/Double Rail Testers. This is supplied through a water container attached with the trolley. Soft grease to RDSO Specification No.WD-17-MISC.-92 or WD-24 Misc.-2004/ any thick oil of high viscosity grade (having viscosity grade of 150 cst or more) is to be used as couplant while deploying $45^0$ probes with test rig for testing rail at scabbed/ wheel burnt locations.

### 4.0 Competency for testing *(Ref: Para 3.0 of USFD Manual-2022)*

Inspectors carrying out the ultrasonic testing of rails shall be RDSO trained, in the techniques of USFD testing.

### 5.0 Data presentation of ultrasonic testing

- Ultrasonic data can be collected and displayed in format of A-scan, B-scan and C-scan.
- Each presentation mode provide different way of looking at and evaluating the region of material being inspected.

### 5.1 A-Scan Display

On Indian railway, till recent times all the rails were manually scanned through single rail tester (SRT) or double rail tester (DRT), using A- scan, in which the operator detects any rail defect by viewing ultrasonic image on the screen and can Record the data. In this method, there is no automatic recording of data.

## 5.2 B-Scan Display

In B- scan system, the scan is continuously recorded and kept safe for future viewing. Considering this advantage RDSO has issued equipment specification.
Rly.Bd.Lr.No.Track/21/2004/0902/7Vol.III Date:15.02.2023

## 6.0 Frequency of testing of rails *(Ref: Para 6.6 of USFD Manual-2022)*

In view of the revised criteria of defect, the testing frequency of 8 GMT has been prescribed. Based on the same, testing schedule of rails/welds as laid down in Para 6.1.1 shall be followed.

**6.1** After the initial USFD testing of rails in rail manufacturing plant, the subsequent USFD testing needs to be carried out at reduced frequency until the rails have undergone 15% of the service life in GMT as given below

For rails rolled in April 1999 and later, the reduced frequency testing period shall be 25% instead of 15%.

| Gauge | Rail Section | Assessed GMT service life for T-12 72 UTS rails | Assessed GMT service life for T-12 90 UTS rails |
|---|---|---|---|
| B.G. | 60Kg* | 550 | 800 (1000 for routes covered by rail grinding) |
| | 52Kg | 350 | 525 |
| | 90 R | 250 | 375 |
| M.G. | 75 R | 150 | - |
| | 60 R | 125 | - |

*For reduced frequency testing period, 800 GMT service life shall be considered for 60 kg (90 UTS) and 60 kg (R260) grade rails.

**Rail testing during reduced frequency testing period is to be done using all probes as is being done during normal testing frequency period on passage of every 40 GMT traffic or Eight (08) years, whichever is earlier.**

Whenever, rails are not tested in rail manufacturing plant, the reduced frequency testing period shall not be applicable and the rail testing shall be done immediately after its laying in field and thereafter at the periodicity given in table under Para 6.1.1.

**6.1.1** Frequency of testing for all Main line BG (rail head center and gauge face /non-gauge face corner) and Main Line MG routes is given as under:

For other sections Principal Chief Engineer of the Railway may adopt a frequency at his discretion.

Digital double Rail Tester is to be used for testing of 'D' marked rails at reduced interval to be decided by Chief Track Engineer of Zonal Railway.

| Route | Routes having GMT | Testing frequency Once in |
|---|---|---|
| All MG routes | < 2.5 | 5 years |
| | 2.5 – 5.0 | 3 years |
| | > 5 | 2 years |
| All BG routes(rail head centre and gauge face corner/non gauge face corner testing) | < 5 | 2 years |
| | > 5 < 8 | 12 months |
| | > 8 < 12 | 9 months |
| | > 12 < 16 | 6 months |
| | > 16 < 24 | 4 months |
| | > 24 < 40 | 3 months |
| | > 40 < 60 | 2 months |
| | >60< 80 | 1½ months |
| | >80 | 1 months |

**6.1.2 Frequency of USFD testing for all CC+8+2t routes on 52 kg rails (Irrespective of temperature Zone)** *(Ref: Para 6.6.1.2 of of USFD Manual-2022)*

| Routes | GMT | Testing frequency Once in |
|---|---|---|
| CC+8+2t routes | ≤10 | 4 months |
| | >10≤20 | 2months |
| | >20 | 1month |

**7.0 Action to be taken after Detection of defects** *(Ref: Para 6.4 of USFD Manual-2022)*

Following action shall be taken in respect of defective rails & welds:

| SN | Classification | Painting on both faces of web | Action to be taken | Interim action |
|---|---|---|---|---|
| 1. | IMR/ IMRW | Three cross with red paint | The flawed portion should be replaced by a sound tested rail piece of not less than 5.5 m length (in case of fish plated track) & 4 m (in case of welded track) within 3 days of detection | SE/JE (P.Way)/USFD shall impose speed restriction of 30 Kmph or stricter immediately and to be continued till flawed rail/weld is replaced. He should communicate to sectional SE/JE (P.Way) about the flaw location who shall ensure that clamped joggled fish plate is provided within 24 hrs. |
| 2. | OBS/ OBSW | One cross with red paint | Rail/weld to be provided with clamped joggled | SE/JE (P.Way)/USFD to advise sectional SE/JE (P.Way) within 24 hrs |

| | | | | |
|---|---|---|---|---|
| | | | fish plate within 3 days. SE/JE (P.Way)/USFD to specifically record the observations of the location in his register in subsequent rounds of testing. | about the flaw location. Keyman to watch during daily patrolling till it is joggled fish plated. |

**8.0 Steps involved in USFD Testing Procedure:** *(Ref: Para 4.1.1 of USFD Manual-2022)*

**8.1 Visual inspection of Equipments and accessories** *(Ref: Para 5.1.1 of USFD Manual-2022)*

Ultrasonic equipment is to be inspected daily before start of work for proper functioning of all controls of electronic units i.e depth range, gain, reject etc. Check the battery condition before start of work. Only fully charged battery is to be used during testing. Check proper functioning of trolley and probes, junction box, water outlet, probe cable contact and ensure smooth movement of trolley wheels. Maintain proper gap between probing face and probe shoe (0.2 mm). Check with the help of a feeler gauge. Also check probe alignment by keeping the rail tester on the rail.

**8.2 Calibration of equipment** *(Ref: Para 5.1.1(vii) of USFD Manual-2022)*

- Calibrate the instrument weekly.



Figure 11



Figure 12

**8.3 Sensitivity setting of the equipment and probes** *(Ref: Para 4.1.1(c) of USFD Manual-2022)*

– Check sensitivity setting once in every 3 days.

## 8.4 Checking of the equipment characteristics *(Ref: Para 4.1.1(d) of USFD Manual-2022)*

The characteristics of the equipment shall be checked at least once in a month according to IS:12666 – 88.

The following characteristics shall be checked:

i) Linearity of time base of flaw detector
ii) Linearity of Amplification of flaw detector
iii) Penetrative power
iv) Resolving power
v) Probe Index
vi) Beam angle

In a month all parameters shall be checked with 0° /2-2.5 MHz single crystal probe, as per IS:12666-88 or its latest version.

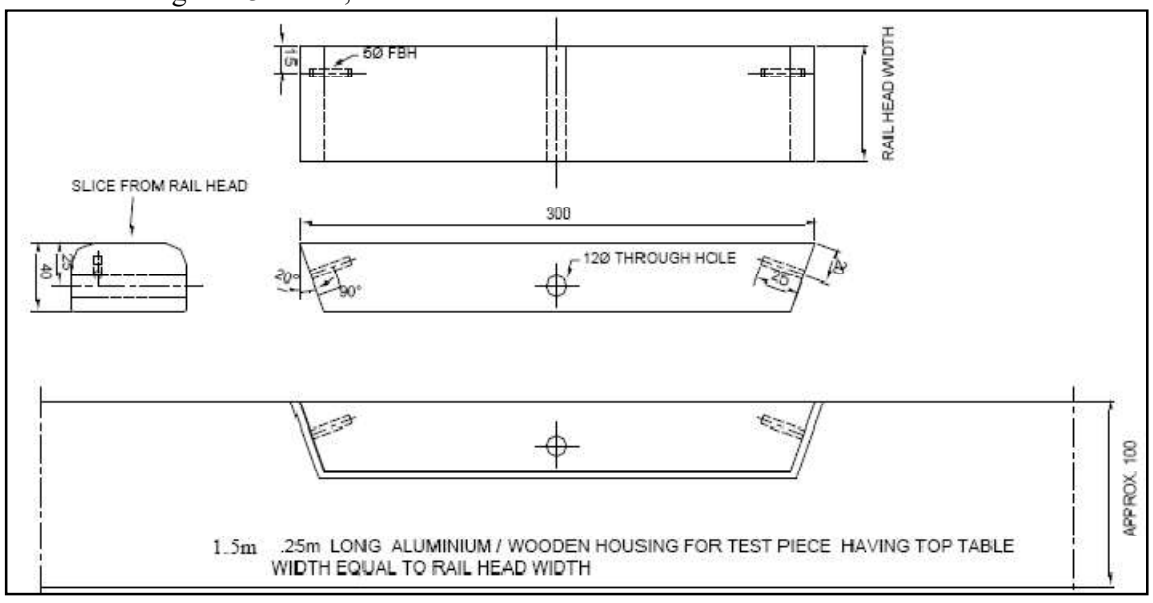
## 8.5 Testing and Interpretation

After sensitivity setting, actual testing of rails/welds is to be carried out and interpreted for follow up actions.

## 9.0 Standard test Pieces for Sensitivity setting & Calibration

### 9.1 Standard rail piece: *(Ref: Para 4.1.1(c) of USFD Manual-2022)*

For sensitivity setting of $0^o$ probe and $70^o$ probe, the standard rail piece having artificial flaws as shown in figure 13 below, is used.




1. The slice from rail head for sensitivity setting shall be from rail of same sectional weight which is to be tested(i.e.for testing on 60Kg/52Kg,90R rail setc. The sensitivity testing piece shall be from 60Kg,52Kg,90R rails respectively).

2. In case of machines having provision of variable shift of gauge face probes following shall be ensured:
   a) Maximum shift of probe shall be limited to the extant upto which there is no loss of acoustic coupling depending on rail top profile.
   b) The sensitivity setting shall be done at the shift level with which actual testing is to be carried out.
   c) The shift of probe shall not be altered during testing without fresh setting at altered shift.

*Figure 13 Sensitivity Setting Block For 70° 2Mhz (Centre, Gauge Face And Non-Gauge Face ) Probes (Ref: figure 3 of USFD Manual-2022)*

For sensitivity setting of 37° probe, the standard rail piece having artificial flaws as shown in Figure 14 is used.

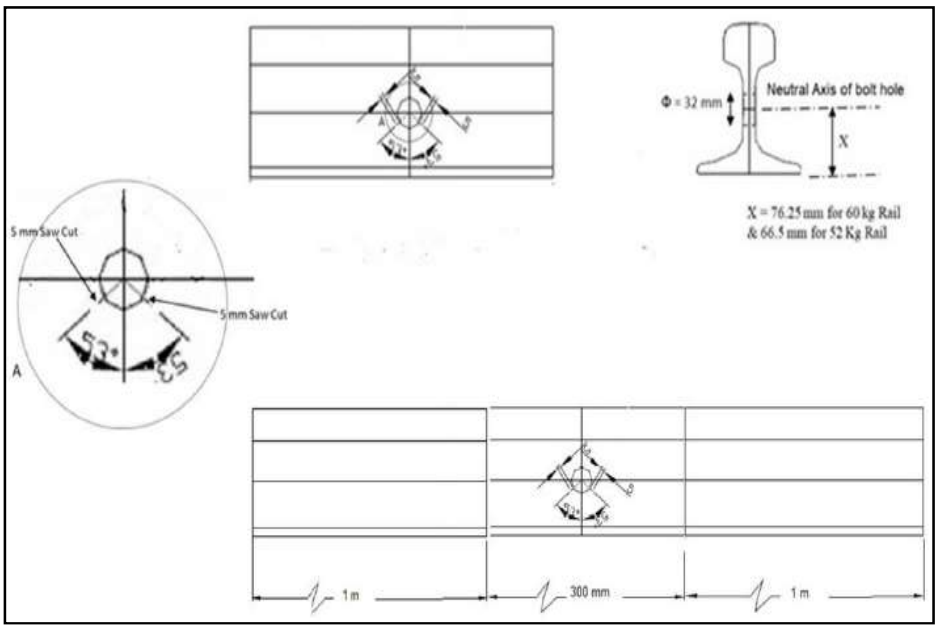



Figure14. Rails having artificial defect for sensitivity setting by 37° Probes *(Ref: figure 2I of USFD Manual-2022)*

### 9.2 IIW (V1) Block for Calibration

This is a standard steel block as shown in Fig. below. This block is used for calibration of digital rail tester and for checking the characteristics of USFD equipment.

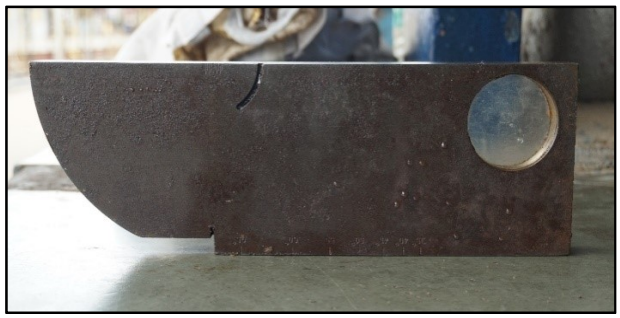


Figure 15

## 10.0 0°/4 MHz, Double crystal Normal Probe

The normal probe (0°) is utilised for the purpose of detecting horizontal defects situated in head, web or foot.

### 10.1 Calibration: *(Ref: Para 4.1.1 of USFD Manual-2022)*

Following procedure shall be adopted for calibration of 0°/ 4 MHz double crystal probe.

(i) Connect the 0˚ / 4 MHz Double Crystal probe to requisite channel given in multiplexure or in the unit itself.
(ii) Select Mode T-R i.e. Double Crystal/ Multichannel mode in Rail Tester having multiplexure. For multichannel unit, select the calibration set which is required to calibrate.
(iii) Feed the required range i.e 300 mm for rail tester having multiplexure/ 200 mm for multichannel rail tester.
(iv) Put 0˚ Double Crystal probe on IIW (V1) Block after applying couplant at 100 mm width side.
(v) Set Delay and Probe Zero (in unit having multiplexure) as per operational manual.
(vi) Set first reflected peak at 3.3 div ( if range is selected 300 mm ) or at 5.0 ( if range is selected 200 mm ) using delay key provided in multiplexure or DELAY parameter provided in multichannel unit. Place Gate over it. Press measure 0 (in unit having multiplexure ) and read the beam path, depth shall be 100 mm.
(vii) Second reflected peak will appear at 6.7 & third peak at 10.0 ( if range is selected 300 mm ) or second peak at 10.0 ( if range is selected 200 mm ) .
(viii) If last peak is not at 10.0, velocity may be adjusted to set the last peak at 10.0 ( if velocity control available) or by delay key on multiplexure.
(ix) The equipment is calibrated for 300 /200 mm longitudinal wave for 0˚ Double Crystal probe.
(x) To verify the calibration put probe on top of rail head, the back peak position will be at 5.2 for 52 Kg. rail & at 5.7 for 60 Kg. rail ( if range is selected 300 mm ) or at 7.8 for 52 Kg. rail & at 8.6 for 60 Kg. rail ( if range is selected 200 mm ).

**10.2 Sensitivity setting:** *(Ref: Para 4.1.1(c) & 4.1.2 of USFD Manual-2022)*

Sensitivity (gain) setting: For the sensitivity setting of ultrasonic equipment and the probes, the following sequence is to be maintained:

a) For sensitivity setting of $0^o$ probe, place the testing trolley on the standard rail piece having artificial flaws as shown in Fig. 13. Check the alignment of probes to make sure that $0^o$ probe travel centrally in line with the axis of the rail head & web.

b) Set the acoustic barrier of the normal probe at right angle to the longitudinal direction of rail.

c) Open the water nozzle and regulate water flow on the probes at an optimum speed.

d) While testing on single line section and 'D' marked rails on double / multiple line section, additional gain of 10db is to be employed.

e) The back wall echo will be adjusted by gain control of USFD tester to 100% of full screen height and the same shall be taken as reference echo.

**10.3 Adjustment in sensitivity setting on account of variation in rail temperature** *(Ref: 4.1.2 of USFD Manual-2022)*

Following procedure shall be used for adjustments in sensitivity setting of Ultrasonic Rail tester on account of variation in rail temperature before starting the testing of rails.

a) Switch on the Ultrasonic rail tester and keep the equipment for two minutes for thermal acclimatization of the component of the equipment before starting the adjustment in sensitivity setting operation.

b) In the Morning at 8.00 hrs, set the sensitivity of the equipment as per Para 10.2 and note the gain required to setup the amplitude of the signal to 60% of full screen height. Also Note the rail temperature.

c) After setting the sensitivity of the probes, the ultrasonic rail tester shall be retained on the standard rail test piece in ON condition and the signal amplitude of individual probe set as per above procedure, shall be checked on hourly basis. If the drop in the signal is observed then the drop shall be compensated by applying extra gain with use of gain control (dB). The height of signal amplitude is maintained to 60% of full screen height. Note the change in rail temperature from rail temperature at 8.00 Hrs. and corresponding extra gain used.

d) Actual Testing:
During actual testing on the track, the gain set by the above procedure shall be maintained depending upon the time and rail temperature during testing. Any variation in the signal amplitude shall be compensated by giving measured extra gain (dB) as per step (c) above to carry out ultrasonic testing.

e) Periodicity of setting the sensitivity:
The above procedure for sensitivity calibration against temperature variation shall be carried out at least once in a month. The adjustments in sensitivity setting of ultrasonic equipment in respect of gain (dB) shall be employed accordingly.

## 10.4 Test Procedure

The probe shall be placed on the head of the AT welded joint ensuring proper acoustic coupling. The probe shall be moved on the weld centre to scan the weld area.

## 10.5 Defect classification

*(Ref: Annexure-II A of USFD Manual 2022)*

| S. No | Probe used | Nature of defect | Oscillogram pattern | Classification |
|---|---|---|---|---|
| 1. | Normal probe 4MHz (sensitivity set with respect to 100% back wall signal height from rail bottom) | **A) Within fishplated area -**<br>(i) Any horizontal defect in head web or foot of length equal to distance between rail end and first bolt hole and connected with the rail head. | No back echo before or after appearance of bolt hole echo with Flaw echo with or without multiples<br>**OR**<br>Drop in back echo before or after appearance of bolt hole echo with flaw echo with or without multiple | IMR |
| | | (ii) Any horizontal defect connecting both bolt holes | No back echo between bolt hole echo. Flaw echo with or without multiples. | IMR |
| | | (iii) Any defect originating from bolt holes and progressing at an angle towards head-web junction or web-foot junction. | No back echo before or after appearance of bolt hole echo with or without flaw echo | IMR |
| | | **B) Outside fish plated area**<br>a) Any horizontal defect progressing at an angle in vertical plane in the rail at the following locations in the track:<br>i) In tunnel & on tunnel approaches (100m either side)<br>ii) On major bridges & bridge approaches (100m either side)<br>iii) In the vicinity of holes near the weld (50 mm for old AT weld and 75mm for new AT weld from the centre of weld on either side of weld) | No back echo with flaw echo (shifting/without shifting) for any horizontal length<br>OR<br>No back echo and no flaw echo | IMR |
| | | b) Any horizontal defect progressing at an angle in vertical plane in the rail at track locations other than (a) above. | No back echo with flaw echo (shifting/without shifting) for horizontal length ≥ 20mm | IMR |
| | | | No back echo with or without shifting flaw echo for horizontal length< 20 mm | OBS |

| | | | | |
|---|---|---|---|---|
| | | **C) Vertical longitudinal split (piping)** | In case of partial/complete loss of back echo, side probing shall be carried out with $0^o$ probe, if any flaw echo with/ without multiples is observed (in any length) | IMR |

**Note:**

**i.** Defect at any location which is detected by two or more probes and are considered to be classified as OBS/OBSW based on peak pattern of individual probe, should be classified as IMR/IMRW and action shall be taken accordingly.

**ii.** In case of any two or more defects (rail/weld) lies within a distance of 4.0 metre, it shall be classified as IMR/IMRW and action shall be taken accordingly.
*(Ref: Para 6.3.2 of USFD Manual – 2022)*

## 11.0 70°/2 MHz, Single crystal Probe (Center forward & Center backward)

The 70° probe has been specifically provided for detecting defects in the rail head, the most typical of which is the transverse fissure or kidney fracture.

### 11.1 Calibration: *(Ref: Para 4.1.1 of USFD Manual-2022)*

**(165 mm Direct Shear wave calibration for 70˚ / 2 MHz single Crystal Probe)**

(i) Connect the 70˚ / 2 MHz Single Crystal probe to requisite channel given in multiplexure or in the multichannel unit itself.
(ii) Select Mode T-R i.e. Double Crystal mode for rail tester having multiplexure. For multichannel equipment, select the calibration set and channel required to calibrate.
(iii) Feed range 300 mm for rail tester having multiplexure or 165 mm SW for multichannel unit.
(iv) Set Delay and Probe Zero ( in unit having multiplexure ) as per operational manual
(v) Put 70˚/2 MHz Single Crystal probe on IIW (V1) Block after applying couplant and direct the beam towards 100 mm curvature.
(vi) Move the probe slightly to and fro to get maximize signal.
(vii) Adjust the peak at 6.0 using delay key provided in multiplexure or DELAY parameter provided in multichannel unit.
(viii) Place the gate over this peak, press measure 70 (in unit having multiplexure ) and read the beam path it shall be 100 mm.
(ix) To verify the calibration, direct the probe towards 25 mm curvature and maximize the peak.
(x) Put the gate on this peak, the beam path shall be 25 mm.
(xi) The equipment is calibrated for 165 mm shear wave.

### 11.2 Sensitivity setting: *(Ref: Para 4.1.1(c) & 4.1.2 of USFD Manual-2022)*

Sensitivity (gain) setting: For the sensitivity setting of ultrasonic equipment and the probes, the following sequence is to be maintained:

a) For sensitivity setting of $70^o$ probe, place the testing trolley on the standard rail piece having artificial flaws as shown in Fig. 13. Check the alignment of probes to make sure that $70^o$ Central probe travel centrally in line with the axis of the rail head & web.

b) Open the water nozzle and regulate water flow on the probes at an optimum speed.
c) The equipment shall be able to detect 12 mm dia. hole for need based criteria in the head portion of the standard rail as shown in Fig. 10 by both forward and backward probes.
d) The amplitude of the flaw shall be set to 60% of screen height. This adjustment shall be done by individual potentiometer provided in the junction box.
e) While testing on single line and 'D' marked rails on double/multiple line section, additional gain of 10dB is to be employed.

**11.3 Adjustment in sensitivity setting on account of variation in rail temperature** *(Ref: 4.1.2 of USFD Manual-2022)*

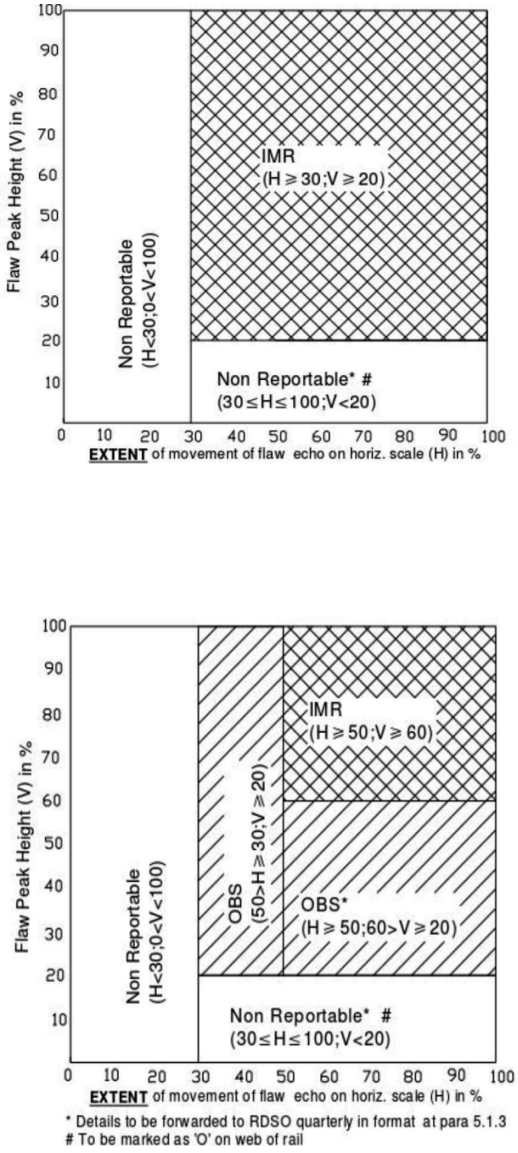
Following procedure shall be used for adjustments in sensitivity setting of Ultrasonic Rail tester on account of variation in rail temperature before starting the testing of rails.

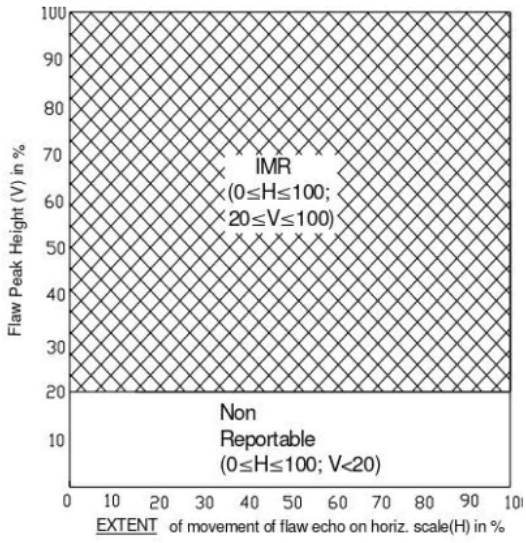
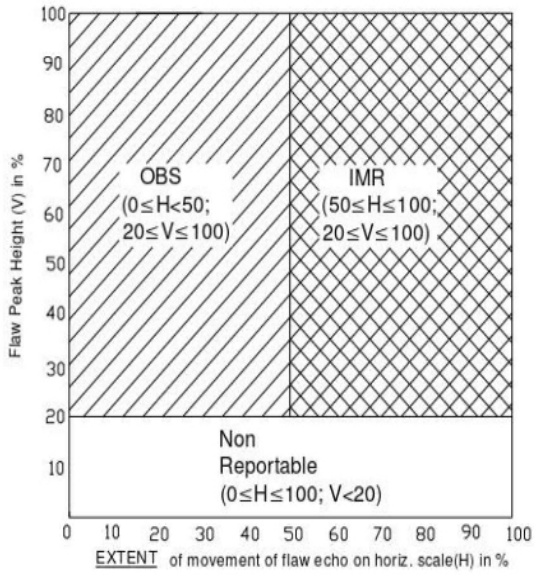
a) Switch on the Ultrasonic rail tester and keep the equipment for two minutes for thermal acclimatization of the component of the equipment before starting the adjustment in sensitivity setting operation.
b) In the Morning at 8.00 hrs, Set the sensitivity of the equipment as per Para 11.2 and note the gain required to set up the amplitude of the signal to 60% of full screen height. Also Note the rail temperature.
c) After setting the sensitivity of the probes, the ultrasonic rail tester shall be retained on the standard rail test piece in ON condition and the signal amplitude of individual probe set as per above procedure, shall be checked on hourly basis. If the drop in the signal is observed then the drop shall be compensated by applying extra gain with use of gain control (dB). The height of signal amplitude is maintained to 60% of full screen height. Note the change in rail temperature from rail temperature at 8.00 Hrs. and corresponding extra gain used.
d) Actual Testing:
During actual testing on the track, the gain set by the above procedure shall be maintained depending upon the time and rail temperature during testing. Any variation in the signal amplitude shall be compensated by giving measured extra gain (dB) as per step (c) above to carry out ultrasonic testing.
e) Periodicity of setting the sensitivity:

The above procedure for sensitivity calibration against temperature variation shall be carried out at least once in a month. The adjustments in sensitivity setting of ultrasonic equipment in respect of gain (dB) shall be employed accordingly.

**11.4 Defect Classification**
*(Ref: Annexure-IIA of USFD Manual-2022)*

Note: "Any sweeping signal on horizontal baseline that does not extend beyond 2.5 divisions from the left edge of the screen or vice versa shall be recorded as Gauge Corner Cracking (GCC) and not as OBS".

| SN | Probe used | Nature of defect | Oscillogram pattern | Classification |
|---|---|---|---|---|
| **1.** | 70° 2MHz Centre Probe (Sensitivity set with 12mm dia. Standard hole in rail head 25mm from rail top) For non 'D' marked rails on double/multiple line sections | A) Any transverse defect in the rail head at the following locations in the track<br>i) In tunnel & on tunnel approaches (100m either side)<br>ii) On major bridges & bridge approaches (100m either side)<br>iii) In the vicinity of holes near the weld (50 mm for old AT weld and 75mm for new AT weld from the centre of weld on either side of weld)<br><br>B) Any transverse defect in the rail head at track locations other than A) above |  | |

| | | | |
|---|---|---|---|
| **2.** | 70° 2MHz (Centre) Probe (sensitivity set with 12mm dia. Standard hole at rail head 25mm from rail top and with additional gain of 10dB thereon).<br>For all single line sections and 'D' marked rails on double /multiple line sections | A) Any transverse defect in the rail head at the following locations in the track<br>i) In tunnel & on tunnel approaches (100m either side)<br>ii) On major bridges & bridge approaches (100m either side)<br>iii) In the vicinity of holes near the weld (50 mm for old AT weld and 75mm for new AT weld from the centre of weld on either side of weld)<br><br>B) Any transverse defect in the rail head at track locations other than A) above | <br> |

**Note:**

**i.** Defect at any location which is detected by two or more probes and are considered to be classified as OBS/OBSW based on peak pattern of individual probe, should be classified as IMR/IMRW and action shall be taken accordingly.

**ii.** In case of any two or more defects (rail/weld) lies within a distance of 4.0 metre, it shall be classified as IMR/IMRW and action shall be taken accordingly.

(Para 6.3.2 of USFD Manual – 2022)

## 12.0 70°/2 MHz, Single crystal Probe (Gauge Face and Non-gauge Face probe) (Forward and backward)

The 70° probe has been specifically provided for detecting defects in the rail head, the most typical of which is the transverse fissure or kidney fracture.

### 12.1 Calibration: *(Ref: Para 4.1.1 of USFD Manual-2022)*

The equipment will be calibrated for 165 mm Direct Shear wave calibration for 70˚ / 2 MHz single Crystal Probe same as discussed in para 11.1 above.

### 12.2 Sensitivity setting: *(Ref: Para 4.1.1(c)& 4.1.2 of USFD Manual-2022)*

Sensitivity (gain) setting: For the sensitivity setting of ultrasonic equipment and the probes, the following sequence is to be maintained:

a) For sensitivity setting of 70˚ probe, place the testing trolley on the standard rail piece having artificial flaws as shown in Fig. 13. 70˚ GF & 70˚ NGF probes shall be aligned towards GF & NGF respectively at appropriate positions.
b) Open the water nozzle and regulate water flow on the probes at an optimum speed.
c) The trolley is moved on the standard test piece having 5 mm Flat Bottom Hole (FBH) as shown in Fig. 10.
d) The beam of 70˚ forward gauge face and non-gauge face corner probe is directed to 5 mm FBH in rail head. Signals from rail end surface and 5 mm FBH will appear on the screen.
e) Move the trolley forward and backward very slowly to get the maximum signal amplitude from the 5 mm FBH and adjust the gain to get 60% of full height.
f) Same procedure shall be adopted for 70˚ backward gauge face and non-gauge face corner probe also.
g) While testing on single line and 'D' marked rails on double/multiple line section, additional gain of 10dB is to be employed.

### 12.3 Adjustment in sensitivity setting on account of variation in rail temperature *(Ref: 4.1.2 of USFD Manual-2022)*

Following procedure shall be used for adjustments in sensitivity setting of Ultrasonic Rail tester on account of variation in rail temperature before starting the testing of rails.

a) Switch on the Ultrasonic rail tester and keep the equipment for two minutes for thermal acclimatization of the component of the equipment before starting the adjustment in sensitivity setting operation.
b) In the Morning at 8.00 hrs, Set the sensitivity of the equipment as per Para 12.2 and note the gain required to set up the amplitude of the signal to 60% of full screen height. Also Note the rail temperature.
c) After setting the sensitivity of the probes, the ultrasonic rail tester shall be retained on the standard rail test piece in ON condition and the signal amplitude of individual probe set as per above procedure, shall be checked on hourly basis. If the drop in the signal is observed then the drop shall be compensated by applying extra gain with use of gain control (dB). The height of signal amplitude is maintained to 60% of full

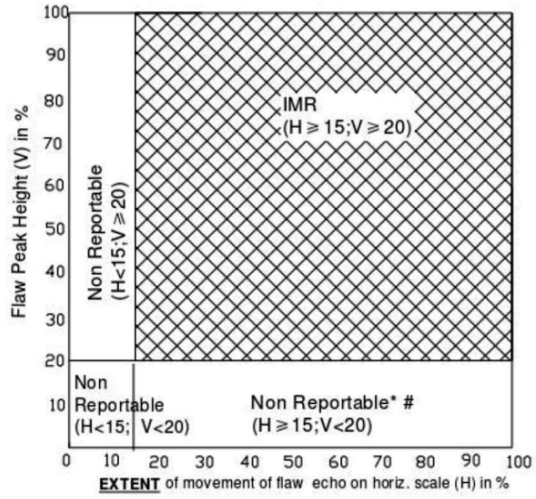
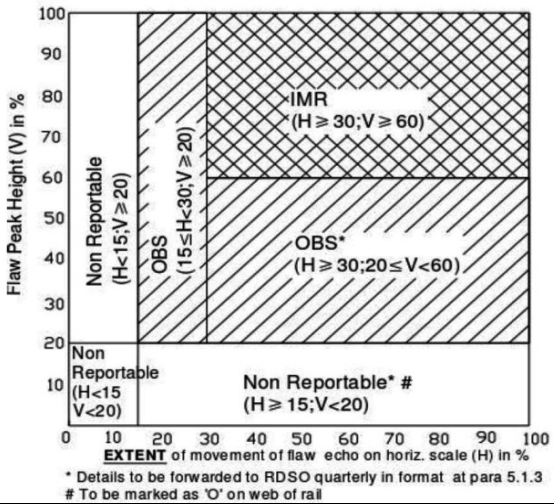
screen height. Note the change in rail temperature from rail temperature at 8.00 Hrs. and corresponding extra gain used.

d) Actual Testing:
During actual testing on the track, the gain set by the above procedure shall be maintained depending upon the time and rail temperature during testing. Any variation in the signal amplitude shall be compensated by giving measured extra gain (dB) as per step (c) above to carry out ultrasonic testing.

e) Periodicity of setting the sensitivity:
The above procedure for sensitivity calibration against temperature variation shall be carried out at least once in a month. The adjustments in sensitivity setting of ultrasonic equipment in respect of gain (dB) shall be employed accordingly.

### 12.4 Defect Classification *(Ref: Annexure-IIA of USFD Manual-2022)*

Note: "Any sweeping signal on horizontal baseline that does not extend beyond 2.5 divisions from the left edge of the screen or vice versa shall be recorded as Gauge Corner Cracking (GCC) and not as OBS".

| SN | Probe used | Nature of defect | Oscillogram pattern | Classification |
|---|---|---|---|---|
| **1.** | 70° probes Gauge Face & Non-gauge Face side (Sensitivity set on 5mm FBH) | A) Any transverse defect in the rail head on gauge face side/ Non-gauge Face at the following locations in the track<br>i) In tunnel & on tunnel approaches (100m either side)<br>ii) On major bridges & bridge approaches (100m either side)<br>iii) In the vicinity of holes near the weld (50 mm for old AT weld and 75mm for new AT weld from the centre of weld on either side of weld)<br><br>B) Any transverse defect in the rail head on gauge face/ Non-gauge Face side at track locations other than A) above | <br><br>* Details to be forwarded to RDSO quarterly in format at para 5.1.3<br># To be marked as 'O' on web of rail | |

**Note:** *(Ref: Para 6.3.2 of USFD Manual – 2022)*

**i.** Defect at any location which is detected by two or more probes and are considered to be classified as OBS/OBSW based on peak pattern of individual probe, should be classified as IMR/IMRW and action shall be taken accordingly.

**ii.** In case of any two or more defects (rail/weld) lies within a distance of 4.0 metre, it shall be classified as IMR/IMRW and action shall be taken accordingly.

## 13.0 37°/2 MHz, Single crystal Probe (Center forward & Center backward)

37° probes have been provided to find out defects originating from the bolt hole (star cracks).

### 13.1 Calibration: *(Ref: Para 4.1.1 of USFD Manual-2022)*

(i) Connect the 37° /2 MHz Single Crystal probe to requisite channel given in the USFD equipment.
(ii) Select the calibration set and channel required to calibrate. Feed range 275 mm Shear wave in USFD equipment.
(iii) Put 37°/2 MHz Single Crystal probe on IIW (V1) Block after applying couplant and direct the beam towards 100 mm curvature.
(iv) Move the probe slightly to and fro to get maximize signal.
(v) Adjust the peak at 3.6 div. using delay or probe zero parameter provided in USFD equipment.
(vi) Place the gate over this peak and measure the beam path it shall be 100 mm. Slight adjustments can be also done for correct measurement by gate.
(vii) To verify the calibration, direct the probe towards 25 mm curvature and maximize the peak.
(viii) Put the gate on this peak, the beam path shall be 25 mm.
(ix) The equipment is calibrated for 275 mm shear wave.

### 13.2 Sensitivity setting: *(Ref: Para 4.1.1(c)& 4.1.2 of USFD Manual-2022)*

Sensitivity (gain) setting: For the sensitivity setting of ultrasonic equipment and the probes, the following sequence is to be maintained:

a) For sensitivity setting of 37° probe, place the testing trolley on the standard rail piece having artificial flaws as shown in figure 11. Check the alignment of probes to make sure that 37° Central probe travel centrally in line with the axis of the rail head & web
b) Open the water nozzle and regulate water flow on the probes at an optimum speed.
c) Move the trolley on Standard Rail piece with bolt hole and 5 mm saw cut as shown in figure 11.
d) Two signals will appear, one from bolt hole and another from 5 mm saw cut.
e) The signals of bolt hole with maximum amplitude will appear at 4.0 Div. & 3.6 Div. (approx. on Horizontal scale) for 60 Kg & 52 Kg Rail sections respectively.
f) The signals of 5 mm saw cut, with maximum amplitude, will appear at 5.0 Div. & 4.6 Div. (approx. on Horizontal scale) for 60 Kg & 52 Kg Rail sections respectively.
g) The gain level has to be adjusted to get 60% of full screen height (Vertical scale) from 5 mm saw cut.
h) The same sensitivity setting method shall be done for both channels of 37° probes (C/F & C/B) .

i) While testing on single line and 'D' marked rails on double/multiple line section, additional gain of 10dB is to be employed.

### 13.3 Adjustment in sensitivity setting on account of variation in rail temperature *(Ref: 4.1.2 of USFD Manual-2022)*

Following procedure shall be used for adjustments in sensitivity setting of Ultrasonic Rail tester on account of variation in rail temperature before starting the testing of rails.

a) Switch on the Ultrasonic rail tester and keep the equipment for two minutes for thermal acclimatization of the component of the equipment before starting the adjustment in sensitivity setting operation.

b) In the Morning at 8.00 hrs, Set the sensitivity of the equipment as per Para 13.2 and note the gain required to set up the amplitude of the signal to 60% of full screen height. Also Note the rail temperature.

c) After setting the sensitivity of the probes, the ultrasonic rail tester shall be retained on the standard rail test piece in ON condition and the signal amplitude of individual probe set as per above procedure, shall be checked on hourly basis. If the drop in the signal is observed then the drop shall be compensated by applying extra gain with use of gain control (dB). The height of signal amplitude is maintained to 60% of full screen height. Note the change in rail temperature from rail temperature at 8.00 Hrs. and corresponding extra gain used.

d) Actual Testing:
During actual testing on the track, the gain set by the above procedure shall be maintained depending upon the time and rail temperature during testing. Any variation in the signal amplitude shall be compensated by giving measured extra gain (dB) as per step (c) above to carry out ultrasonic testing.

e) Periodicity of setting the sensitivity:
The above procedure for sensitivity calibration against temperature variation shall be carried out at least once in a month. The adjustments in sensitivity setting of ultrasonic equipment in respect of gain (dB) shall be employed accordingly.

### 13.4 Defect Classification
*(Ref: Annexure-IIA of USFD Manual-2022)*

| SN | Probe used | Nature of defect | Oscillogram pattern | Classification |
|---|---|---|---|---|
| **1.** | 37° 2MHz Centre Probe (Sensitivity set on 5mm saw cut on bolt hole) | Any defect originating from bolt holes and progressing at an angle towards head-web junction or web-foot junction. | During testing any moving signal observed by 37° in web region (i.e. beyond 2.3 div in horizontal scale) other than standard peak from bolt hole, bond wire hole etc. | IMR |

**Note:** *(Para 6.3.2 of USFD Manual – 2022)*

**i.** Defect at any location which is detected by two or more probes and are considered to be classified as OBS/OBSW based on peak pattern of individual probe, should be classified as IMR/IMRW and action shall be taken accordingly.

**ii.** In case of any two or more defects (rail/weld) lies within a distance of 4.0 metre, it shall be classified as IMR/IMRW and action shall be taken accordingly.

## 14.0 Test rig for wheel burnt/scabbed rails *(Para 4.1.2(d) & 3.6 of USFD Manual-2022)*

For detection of transverse flaws in rail head when rail top surface is having wheel burns/scabs, a test rig with two 45° probes sending beam inward shall be used.

## 14.1 Calibration *(Para 4.1.2(d) & 4.1.1(b)II of USFD Manual-2022)*

The machine shall be calibrated for 165 mm Direct Shear wave calibration for 45˚ / 2 MHz single Crystal Probe same as discussed in Para 11.1 above.

## 14.2 Test Procedure

*(Ref: 4.1.2(d) of USFD Manual-2022)*

a) The test rig shall be placed at 20 mm below rail table on the side of rail head.
b) The transmitter and receiver probe in the test rig shall be in opposite direction and shall be apart twice the rail head width.
c) Peak obtained in receiver probe shall be adjusted to full scale height by gain setting.
d) Testing of rails shall be done by keeping index mark of probe 20 mm below rail table.

**Note:**

**i.** For 52Kg and 60Kg rails the peak of received signal shall 16 appear at approximately 95 mm (shear wave) and approximately 103 mm (shear wave) respectively.

**ii.** Testing with test rig comprising of 45° probes is effective when the sides of rail head are nearly vertical.

## 14.3 Defect Classification

*(Ref: Annexure-IIA of USFD Manual-2022)*

| SN | Probe Used | Nature of Defect | Oscillogram Pattern | Classification |
|---|---|---|---|---|
| **1.** | 45° probes mounted in test rig (sensitivity set to 100% with respect to reflection signal received from opposite face of rail head) | A) Any transverse defect in the rail head, with scabs/wheel burn on top surface, at the following locations in the track<br>i) In tunnel & on tunnel approaches (100m either side)<br>ii) On major bridges & bridge approaches (100m either side)<br>iii) In the vicinity of holes near the weld (50 mm for old AT weld and 75mm for new AT weld from the centre of weld on either side of weld) | Loss of signal height equal to or more than 20% of full scale height. | IMR |

| | | | | |
|---|---|---|---|---|
| | | B) Any transverse defect in the rail head with scabs/wheel burn on top surface at track locations other than A) above. | Loss of signal height equal to or more than 80% of full scale height.<br><br>Loss of signal height equal to or more than 20% but less than 80% of full scale height | IMR<br><br>OBS |

**Note:** *(Para 6.3.2 of USFD Manual – 2022)*

**i.** Defect at any location which is detected by two or more probes and are considered to be classified as OBS/OBSW based on peak pattern of individual probe, should be classified as IMR/IMRW and action shall be taken accordingly.

**ii.** In case of any two or more defects (rail/weld) lies within a distance of 4.0 metre, it shall be classified as IMR/IMRW and action shall be taken accordingly.

## 15.0 Precautions to be taken by the Operator for Testing

*(Ref: 5.1 of USFD Manual-2022)*

Before undertaking the testing of the rails and welds, the operator has to ensure that the equipment is in good fettle and properly calibrated. He has to take the necessary precautions so as to get the reliable testing results. The operator has to carry-out visual inspection of the machine and ensure its calibration and sensitivity setting as per the provisions of the manual. The precautions to be taken by the operator are elaborated below.

**BEFORE TESTING**

1. 1. Check the battery condition as indicated by the voltage needle of USFD equipment (or ascertain the voltage with the help of a Voltmeter). Only fully charged batteries are to be used during testing.
2. Check proper functioning of all controls of electronic unit i.e. depth range, gain, reject etc.
3. Check proper functioning of trolley and probes.
4. Check junction box, water outlet, probe cable contact and ensure smooth movement of trolley wheels.
5. Maintain proper gap between probing face and probe shoe (0.2mm).Check with the help of a feeler gauge.
6. Check probe alignment by keeping the rail tester on the rail.
7. Calibrate the instrument weekly as per the procedure.
8. Set the equipment for proper sensitivity once in three days.
9. The ultrasonic equipment shall be checked for its characteristics at least once in a month. The characteristics of ultrasonic equipment are checked as per IS:12666-1988.

**DURING TESTING**

1. Conduct test as given in USFD manual issued by RDSO.
2. Maintain proper alignment of all the probes during testing, otherwise false echoes may appear.
3. Ensure adequate supply of water for coupling.
4. Check proper functioning of 70°probes by touching the probe bottom with fingers

Noise pattern i.e. random flickering of the signal should appear on the screen.

5. Look out for the back echo corresponding to normal probe throughout the testing since back echo shall generally be present for full screen height if there is no defect in rail.
6. Lift your machine at crossings/change of rail table height at joints to protect the probes.
7. Mark the location found defective as per classification.

**AFTER TESTING**

1. Maintain proper record of testing, observation, echo pattern, amplitude whenever a defect is noticed.
2. Keep the battery for charging after day's work.

## 16.0 Limitations of Ultrasonic Flaw Detection of Rails

*(Para 7.1 of USFD Manual-2022)*

(i) To detect the defect efficiently, ultrasonic beam is to be directed towards the flaw perpendicularly, otherwise, the reflected beam may not be received by the receiver crystal, resulting in absence/reduction in amplitude of flaw signal in the CRT. Cracks normally have facets and hence even under misorientation provide reflecting surfaces leading to flaw indication.

(ii) For detection of defects in rails, probes having incidence angle 0°, 70° (F), 70° (B), 37° (F), and 37° (B) have been provided in the USFD trolley. The angles have been chosen in a manner so as to detect defects which are generally observed during service and have been the cause of rail fractures.

(iii) Severe pipe in the rail may give indication of flaw echo by 0o probe, But in case of hairline or fine central shrinkage (pipe), negligible drop occurring in bottom signal may remain unnoticed by the USFD operator.

(iv) For detection of bolt hole cracks, 37° probes have been provided. This is because the cracks emanating from bolt holes are generally oblique and propagate in the zig zag manner. 37° probes have been provided both in forward and backward direction. At fish plated joint, if the cracks are not favourably oriented detection may not be possible. Similarly, if the cracks are propagating vertically downwards or upwards, detection is not possible.

If the cracks are so located that they are unable to be scanned by 0 probes due to smaller size or orientation, such cracks may not be detected in initial stages of their development.

(v) If sensitivity of the machine is poor or battery gets discharged the operator may miss the flaw signal. Hence, it is essential to ensure full charging of the battery.

(vi) The ultrasonic probes used in the rail testers have a frequency of 4 MHz (longitudinal wave) and 2 MHz (transverse waves). Therefore, cracks lesser than 0.8mm size cannot be detected by the present arrangement

(vii) Rails having rust, pitting, hogging, battering of rail end, misalignment of joints, scabs, wheel burns and other surface imperfections restrict proper acoustic coupling between probe and rail table and may not permit detection of flaws.

Whenever such defects are encountered, loss of back wall echo or an alarm signal is obtained. This indicates that defects if any below these patches may remain undetected. Under such circumstances hand probing may be done.

## 17.0 Testing on sharp curves, gradients, slack gauge etc.

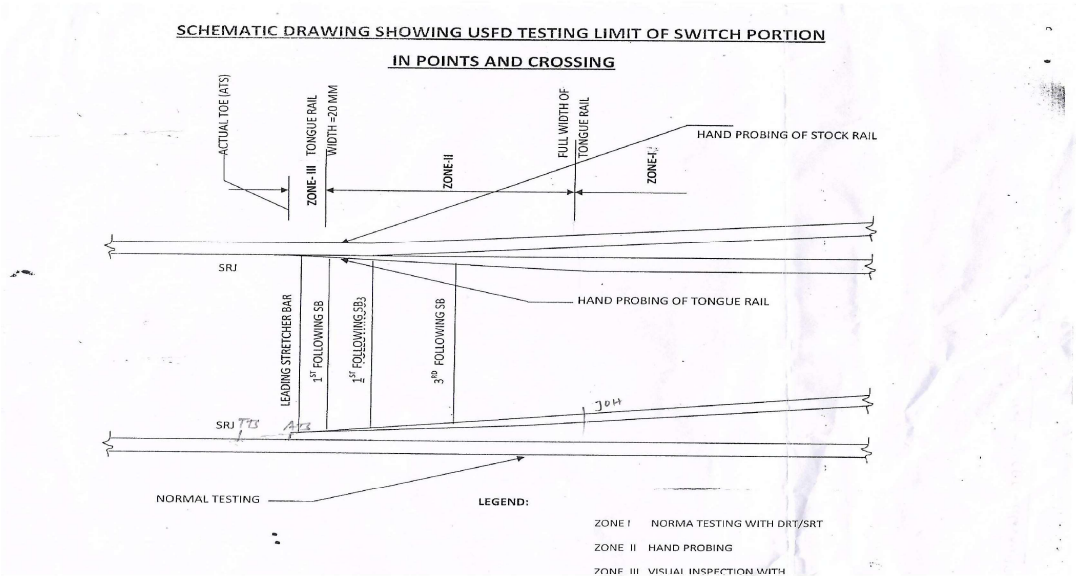
The USFD trolley has been designed to operate under normal conditions of gauge. In the event of dimensional variations in the gauge and also at sharp curves it is possible that the probes are not properly contacting the rail surface. This is indicated by loss of backwall echo or also by alarm provided in DRTs for backwall drop. Wherever it is not possible to ensure proper acoustic coupling due to these reasons, testing by hand probing or by single rail tester may be resorted to. Acoustic coupling needs to be ensured under all circumstances to detect the flaws.

## 18.0 Guidelines for USFD testing of tongue rail of point & crossing in service

*(Ref: Para 10.6 of USFD Manual-2022)*

**18.1** For purpose of USFD testing of tongue rails of points and crossings, the tongue rail can be demarcated in three zones as under:

a) Zone-1: Where full width of Rail head is available.
b) Zone-2: Region where scanning by 70° probe is easily feasible i.e. up to width of rail head of points and crossings, where 70° probe of 20 mm crystal size can be suitably placed over it.
c) Zone-3: Rest portion of tongue rail of points and crossing.




Ref. PCE Circular No. 42, SECR

**18.2** The USFD testing of tongue rails of points and crossings, shall be done as given below.

The sensitivity setting for the probes shall remain same as used for through periodic rail testing. The frequency of USFD testing in Zone-1 and Zone-2 of tongue rails of points and crossings shall be same as that of periodic rail testing as specified in Para 6.1 of this booklet.

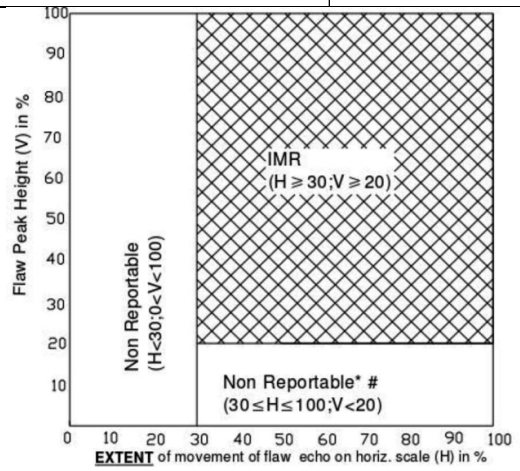
a) Zone-1: This part of tongue rail of point & crossings where full width of rail head is available, shall be covered in normal rail testing using double rail tester or single rail tester. In some of the switches in which guide roller of double rail tester hinder the

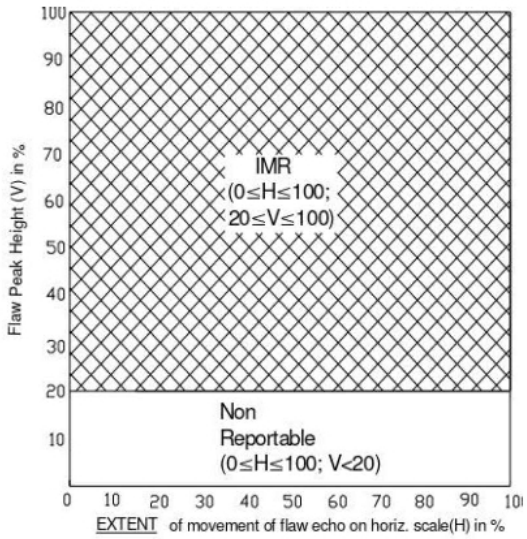
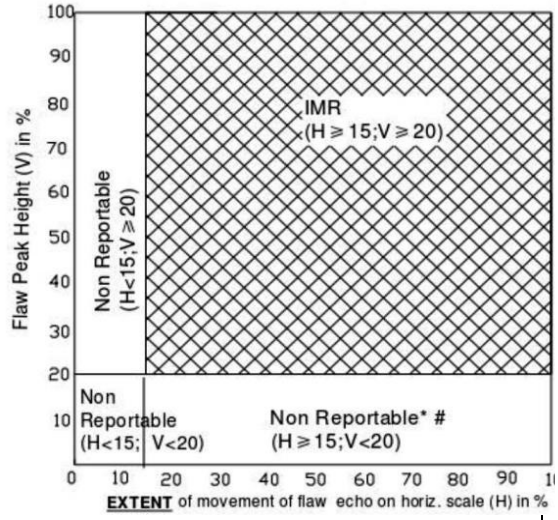
movement of trolley up to full width of rail head part, lower dia of guide roller shall be used.

b) Zone-2: This part of tongue rail shall be tested manually using 70˚/2 MHz, Single crystal probe having crystal size 20 dia. or 20x20 mm square crystal.

c) Zone-3: This part of the tongue rail shall be examined visually by P. Way officials during their scheduled inspections of Points & Crossings as prescribed in IRPWM.

**18.3 Classification of defects:** The defect classification for Zone 1 shall be made as per provisions given in the table below. The defect classification for Zone 2 shall be made as per provisions given in the SN-2& 3 of table below.

| S. No | Probe used | Nature of defect | Oscillogram pattern | Classification |
|---|---|---|---|---|
| 1. | Normal probe 4MHz (sensitivity set with respect to 100% back wall signal height from rail bottom) | (i) Any horizontal defect in head web or foot of length equal to distance between rail end and first bolt hole and connected with the rail head. | No back echo before or after appearance of bolt hole echo with Flaw echo with or without multiples **OR** Drop in back echo before or after appearance of bolt hole echo with flaw echo with or without multiple | IMR |
| | | (ii) Any horizontal defect connecting both bolt holes | No back echo between bolt hole echo. Flaw echo with or without multiples. | IMR |
| | | (iii) Any defect originating from bolt holes and progressing at an angle towards head-web junction or web-foot junction. | No back echo before or after appearance of bolt hole echo with or without flaw echo | IMR |
| 2. | 70° 2MHz Centre Probe (Sensitivity set with 12mm dia. Standard hole in rail head 25mm from rail top) <u>For non 'D' marked rails on double/multiple line sections</u> | Any transverse defect in the rail head |   | |

| | | | |
|---|---|---|---|
| 3. | 70° 2MHz (Centre) Probe (sensitivity set with 12mm dia. Standard hole at rail head 25mm from rail top and with additional gain of 10dB thereon).<br><u>For all single line sections and 'D' marked rails on double /multiple line sections</u> | Any transverse defect in the rail head |  |
| 4. | 70° probes Gauge Face & Non-gauge Face side (Sensitivity set on 5mm FBH) | Any transverse defect in the rail head on gauge face side/ Non-gauge Face |  |

18.4 **Action to be taken after detection of defects**: SE/JE (P.Way)/USFD shall impose speed restriction of 30 Kmph or stricter immediately and to be continued till flawed tongue rail is replaced which should be done within 3 days of detection.

***

# REFERENCES

| S.N. | Description |
|---|---|
| *1.* | ***USFD Manual-2022 upto ACS No-2*** |
| *2.* | ***USFD testing of rails and welds issued by IRICEN-August 2019*** |
| *3.* | ***PCE Circular No. 42, SECR*** |

## ✍NOTES✍

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CAMTECH is continuing its efforts in the documentation and up-gradation of information on maintenance practices of civil engineering assets. Over the years a large number of publications on civil engineering have been prepared in the form of handbooks, pockets books, pamphlets and video films, etc. These publications have been uploaded on the internet as well as on railnet.

# OUR OBJECTIVE

**To upgrade Maintenance Technologies and Methodologies and achieve improvement in productivity and performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability, and Utilisation.**

## *Disclaimer*

The contents of this booklet are for guidance only & are **not statutory**. It also does not supersede any existing instructions from Railway Board, RDSO and zonal Railways & the provisions of IRPWM, USFD Manual on the subject.

If at any point contradiction is observed, then Indian Standards, regulations issued by Government bodies, Railway Board/RDSO guidelines shall be referred.

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