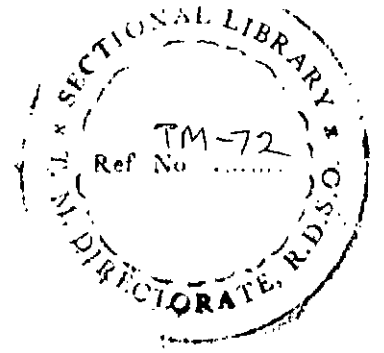


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2



**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**

**STUDY OF ULTRASONIC TESTING OF RAILS  
BY  
SPURT CAR**



**SELF PROPELLED ULTRASONIC RAIL TESTING CAR**

REPORT NO. TM-72  
SEPTEMBER 2004

**RESEARCH DESIGNS & STANDARDS ORGANISATION  
LUCKNOW -226011**

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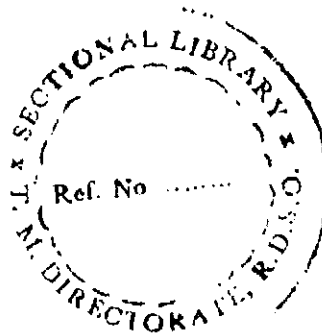
## **PREFACE**

In this report, study has been done on Ultrasonic testing of rails by SPURT CAR. The report is based on the sample analysis of testing data recorded between April, 2003 and Feb,2004. The purpose of the study is to judge the reliability and the efficiency of SPURT Car in the field. Although, every care has been taken for incorporating all the relevant data, it is subject to revision from time to time in the light of experience gained in future.

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**(A.K. Pandey)**  
**Director/TM-V**

**(Surendra Kumar)**  
**Executive Director/ TM**



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## 1. INTRODUCTION

Self propelled Ultrasonic Rail Testing (SPURT) Car was supplied by M/s. Matix, France in 1987 and commissioned in Feb,1988. The car is capable of testing the rails at a speed of 30 Kmph. The maximum speed with its own power in non-testing mode is 55 Kmph. Ultrasonic testing trolley in the car is housed and mounted on a special bogie having a wheel base of 3.05 metre. The car has driving cabins on both ends and can be driven in either direction. The car is powered by a diesel engine of 470 BHP capacity. A generator of 40 KVA has also been installed for power supply to ultrasonic equipment, recording system and air-conditioning.

The ultrasonic equipment of the car is housed in the central cabinet consisting of different electronic modules, analogue recorder and a digital computer. There is a measuring trolley on which separate sets of probes are mounted for each rail. There are two probes of  $70^{\circ}$  for transverse cracks, two probes of  $35^{\circ}$  for bolt hole cracks and one probe of  $0^{\circ}$  for horizontal cracks. These probes are utilised for identification of defects in the rail. The arrangement of these probes has been shown in figure-A at Annexure-I. The complete trolley can be lifted and lowered with pneumatic system provided in the car.

For guiding the probe and maintain it centrally on the rail axis, the car has been provided with hydraulic control system.

The purpose of the present study is to judge the reliability and efficiency of the SPURT Car in the field. The testing done by SPURT Car between April, 2003 and Feb,2004 has been taken for sample analysis of the results of SPURT Car. Test section has been picked up for confirmation of the defects detected on the selected stretches of Eastern Railway, North Central Railway and Western Railway. The identified sections were subsequently manually tested by zonal railways with SRT/DRT as per provisions of need based concept of USFD testing and the results were communicated to RDSO by concerned zonal railways.

## **2. WORKING OF SPURT CAR**

SPURT car is given a daily schedule check before the start of actual testing. All the probes housed in testing trolley are calibrated on standard defective rail piece as shown in figure –B at Annexure-I. Detection capability of 0<sup>0</sup> probe, 35<sup>0</sup> probe and 70<sup>0</sup> probe have been shown in Annexure-II,III & IV respectively. The condition of probes including their springs, holders and electric connections are checked. Visual inspection is done thoroughly and guide wheels are checked for skid marks. Before the test run, pneumatic system is

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checked for prescribed air pressure for lifting and lowering of measuring trolley. There should be adequate hydraulic pressure for movement of probe beam and water flow is also checked for adequate nozzle pressure. The working of paint system along with circuitary is also checked. Centring of probe beam is done to avoid abnormal probe wear and tear during testing. Cables and wires are checked for proper insulation cover. Guide wheels, movement of skids , carrying wheels and probe lifting and lowering movements are checked. The trolley is lifted in non-testing mode and must remain in locked position as a safety measure. The central spacer beam is checked for proper connection with drive pivot via link joint. The drive pivot with its flange should be tightly fastened to the bogie. All the four hinges of double seating trolley lifting device should be in working order. The guide wheel roller should prevent the rotation of drive pivot. During testing mode, the trolley is lowered by opening the lock with pneumatic pressure of 1.5 to 2.0 bars. The rails are tested with probe holder beam assembly touching the rails both sides at 5 bar pressure and continuous water coupling is maintained. Confirmation of flaw give rise to reflection of energy and multiple peaks are generated on CRT. This logic is used for detection of the flaws. Real time event wise print out is given with details of different sections, track features, lifting /lowering of probes along with starting /end of testing. A copy of the

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digital printout is placed at Annexure-V. Real time analogue record is maintained in the form of three blocks of 20 lines each giving information about defect events, paint marks and distance blocks . Editing and finalization of the report is done at the end of the day's work. The final defect report is given as per Annexure-VI.

### 3. SUMMARY OF SPURT VS. FOLLOW UP TESTING

| S. N. | Testing by SPURT Car |      |                  |                    |           |      | Follow up testing by PWI/USFD |                            |                        |                      |
|-------|----------------------|------|------------------|--------------------|-----------|------|-------------------------------|----------------------------|------------------------|----------------------|
|       | Rly.                 | Dir. | Section          | Month of recording | Kilometre |      | No. of flaws                  | Month of follow up testing | No. of flaws confirmed | % of flaws confirmed |
| From  | To                   |      |                  |                    |           |      |                               |                            |                        |                      |
| 1.    | ER                   | Up   | Howrah Division  | April,03           | 23 Kms.   |      | 211                           | May,03                     | 25                     | 11.85%               |
|       | ER                   | Dn   | Howrah Division  | April,03           | 41 Kms    |      | 476                           | May,03                     | 63                     | 13.23%               |
| 2.    | ER                   | Up   | Asansol Division | April,03           | 23 Kms.   |      | 186                           | May,03                     | 15                     | 8.06%                |
|       | ER                   | Dn   | Asansol Division | April,03           | 115 Kms.  |      | 1049                          | May,03                     | 75                     | 7.15%                |
| 3.    | NCR                  | Up   | ALD -GZB         | June,03            | 825       | 1428 | 3998                          | July,03                    | 186                    | 14.65%               |
|       | NCR                  | Dn   | GZB- ALD         | June,03            | 1428      | 825  | 3402                          | July,03                    | 178                    | 5.23%                |
| 4.    | WR                   | Up   | NAD-GDA          | July,03            | 698       | 471  | 1803                          | Aug,03                     | 28                     | 1.55%                |
|       | WR                   | Dn   | GDA-NAD          | Aug,03             | 471       | 698  | 404                           | Sept,03                    | 09                     | 2.22%                |
| 5.    | WR                   | Up   | MCT-BL           | Feb,04             | 165       | 197  | 417                           | Mar,04                     | 21                     | 5.03%                |
|       | WR                   | Dn   | BL-MCT           | Feb.04             | 197       | 165  | 418                           | Mar,04                     | 25                     | 5.98%                |

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**The first section in Howrah Division of Eastern Railway on Up line was tested by SPURT Car in April, 2003. Total 211 flaws were detected in 23 Km section tested by SPURT Car. The follow up testing was done immediately within two months and 25 flaws were confirmed manually. The confirmation percentage comes to 11.85% . In the Down line, a total 476 flaws were marked by SPURT Car in 41 Km section, out of which 63 flaws were confirmed in follow up testing done in May, 2003. The confirmation percentage comes to 13.23 %.**

**The second section was tested in Asansol Division on Up line in April, 2003 and a total of 186 nos. of flaws were detected by SPURT Car in 23 Km section. By follow up testing, 15 nos. of flaws were confirmed manually in May, 2003. The confirmation percentage comes to 8.06 %. On Down line 1049 nos. of flaws were detected by SPURT Car in 115 Km section. Whereas in manual follow up testing 75 nos. flaws were confirmed. The confirmation percentage comes to 7.15 %.**

**The third section was tested over NC Railway from Allahabad to Gaziabad on Up line in the month of June, 2003. A total of 603 Km track was tested and 3998 nos. of flaws were detected by SPURT**

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**Car. By manual follow up testing, 186 nos. flaws were confirmed. The confirmation percentage comes to 4.65 %.**

**On Down line testing was done by SPURT Car from Ghaziabad to Allahabad in the month of June-July, 2003. Out of total 603 Km of track tested, 3402 nos. of flaws were detected by SPURT Car. During follow up testing, 178 defects were confirmed. The confirmation percentage comes to 5.23 %.**

**The fourth section was tested in Western Railway from Nagda to Godhra on Up line in the month of July, 2003. A total of 227 Km track was tested by SPURT Car and 1803 nos. of flaws were marked. In the follow up testing, 28 no. of flaws were confirmed in the month of August-Sept,2003, resulting a confirmation percentage of 1.55%. On Down line, SPURT Car tested from Godhra to Nagda in the month of August, 2003 and 404 defects were marked. In the follow up testing, 09 defects were confirmed. The Confirmation percentage of defects comes to 2.22 %.**

**The fifth section was tested in Mumbai Central Division on Up line in Feb, 2004 and a total of 417 nos. of flaws were detected by SPURT Car in 32 Km section. By follow up testing, 21 nos. of flaws were confirmed manually in Mar, 2004. The confirmation**

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percentage comes to 5.03 %. On Down line 418 nos. of flaws were detected by SPURT Car in 32 Km section. Whereas in manual follow up testing 25 nos. flaws were confirmed. The confirmation percentage comes to 5.98 %.

#### 4-0 PROGRESS MADE SO FAR BY SPURT CAR

Till date SPURT Car has crossed 1.20 lakh run km mark very recently since inception in June, 1988. The tabulation is given as below :

| SNO.  | FROM   | TO     | RUN KM   | TESTED KM |
|-------|--------|--------|----------|-----------|
| 1.    | JUN'88 | MAR'89 | 8,415    | 6,812     |
| 2.    | APR'89 | MAR'90 | 16,948   | 11,582    |
| 3.    | APR'90 | MAR'91 | 9,559    | 5,572     |
| 4.    | APR'91 | MAR'92 | 5,496    | 3,443     |
| 5.    | APR'92 | MAR'93 | 1,456    | 930       |
| 6.    | APR'93 | MAR'94 | 1,829    | 1,661     |
| 7.    | APR'94 | MAR'95 | 13,678   | 6,849     |
| 8.    | APR'95 | MAR'96 | 4,158    | 2,031     |
| 9.    | APR'96 | MAR'97 | 10,946   | 4,627     |
| 10.   | APR'97 | MAR'98 | 4,428    | 2,040     |
| 11.   | APR'98 | MAR'99 | 3,941    | 1,991     |
| 12.   | APR'99 | MAR'00 | 1,322    | 723       |
| 13.   | MAR'00 | MAR'01 | 13,736   | 8,745     |
| 14.   | APR'01 | MAR'02 | 10,040   | 6,702     |
| 15.   | APR'02 | MAR'03 | 4,059    | 3,218     |
| 16.   | APR'03 | MAR'04 | 10,071   | 6,901     |
| 17.   | APR'04 | AUG'05 | 412      | 359       |
| TOTAL |        |        | 1,20,494 | 74,186    |

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## **5. PROBLEMS OF EXISTING SPURT CAR**

**SPURT Car contains very sophisticated electronic system for USFD testing. The availability of spares has always been a problem as these were required to be imported from abroad. With the passage of time, the electronic system i.e. data acquisition system, processing system, analogue recorder etc. became obsolete and even their OEM failed to keep the supply continued. Thus, due to irregular supply of spares, the SPURT car remained under-utilised. The responsibility of operation and maintenance of existing SPURT Car was given to RDSO. Due to under- utilisation and few key functions not being in working order, the team of officials in RDSO could get limited experience in operation and maintenance of the present SPURT Car.**

**The target of utilisation for the SPURT Car was stated to be about 10,000 Km per year. Initially for the first three years, the SPURT Car progress was satisfactory. After that major failures occurred and progress in the year 1991-92, 1992-93,1993-94,1995-96,1997-98,1998-99,1999-2000 and 2002-03 was not satisfactory. The major failures in different years are summarised below :**

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| S.No | Year/ Duration of failure | Type of failure                                                                                                           |
|------|---------------------------|---------------------------------------------------------------------------------------------------------------------------|
| 1.   | 1990                      | Rotatory type AC system of SPURT Car failed. However testing continued.                                                   |
| 2.   | 1991-92                   | (a)Duetz engine of the SPURT failed and replaced by new one.<br>(b)Alternator supplied by M/s Bosche failed and repaired. |
| 3.   | 1993-94                   | ZF gear box of the Car failed in June,1993. This was got repaired from M/s Plasser in March, 1994.                        |
| 4.   | June,95 to Nov,95         | The SPURT Car was sent to CPOH Allahabad for maintenance.                                                                 |
| 5.   | Aug,97 to Aug,98          | Analogue recorder and toner pump failed.                                                                                  |
| 6.   | April,99 to Feb,2000      | ZF gear box failed and got repaired in CPOH, Allahabad.                                                                   |
| 7.   | Feb, 02 to July,02        | SPURT Car under repair due to various pneumatic and hydraulics problem and staff coach under repair.                      |
| 8.   | Sept'02 to Nov'02         | Generator failure.                                                                                                        |
| 9.   | Dec'02 to June'03         | Fly wheel coupling failure.                                                                                               |
| 10.  | Feb'04 to 20th Aug'04     | Testing trolley failure which involved heavy repairs to skids, turning of wheels and bogie pivot checking/overhauling.    |

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The wheel diameter of the SPURT Car is nearing its condemnation limits. The testing system has become quite old. The breakdowns are quite frequent and of long durations due to non-availability of spares. The SPURT Car is likely to test the track for another three to four months. Afterwards, the process for condemnation of the SPURT Car will be started. Purchase Order for acquisition of two new high speed SPURT Cars has already been placed. The new SPURT Cars are expected to be supplied by Jan,2005.

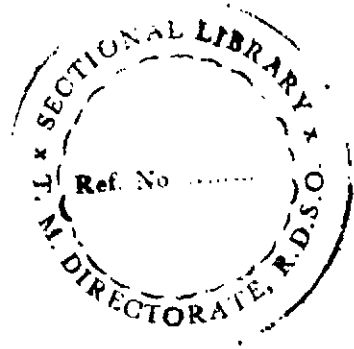
## **6. CONCLUSION**

The SPURT Car has been in service on Indian Railways since 1988. The follow-up testing is being done manually by single rail testers & double rail tester and final decision to remove the particular rail is taken on the basis of confirmation by the Permanent Way supervisors in the field. The analysis in the present study shows that :

- i) The percentage of confirmation is varying from 1.55% to 13.23% in the 8 stretches selected for the study.
- ii) The variation in the percentage may be on account of variation in size of defects present in different sections and then appreciation by the supervisor in manual tests.

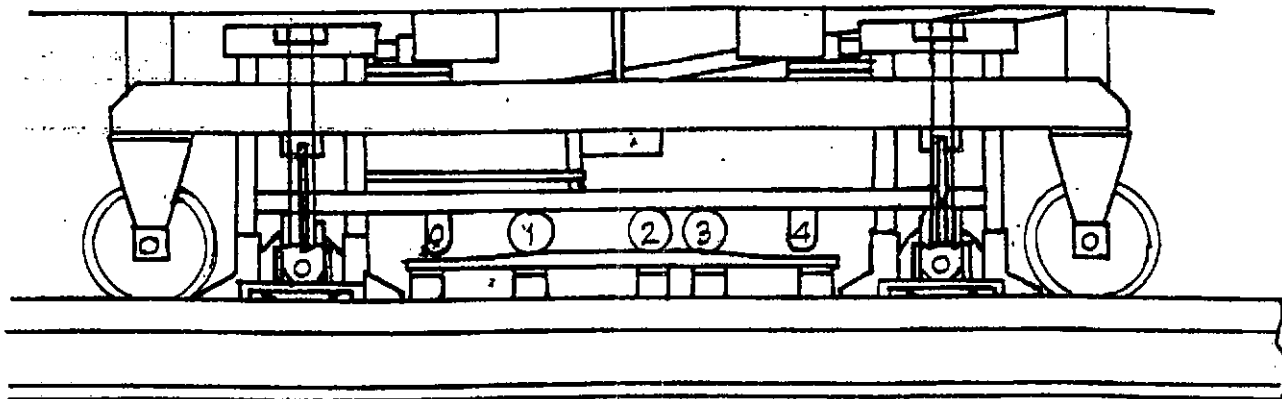
iii) As the car is about 16 years old, the sensitivity of the electronic modules have been reduced. Continuous efforts are required to sustain/improve its reliability and efficacy.

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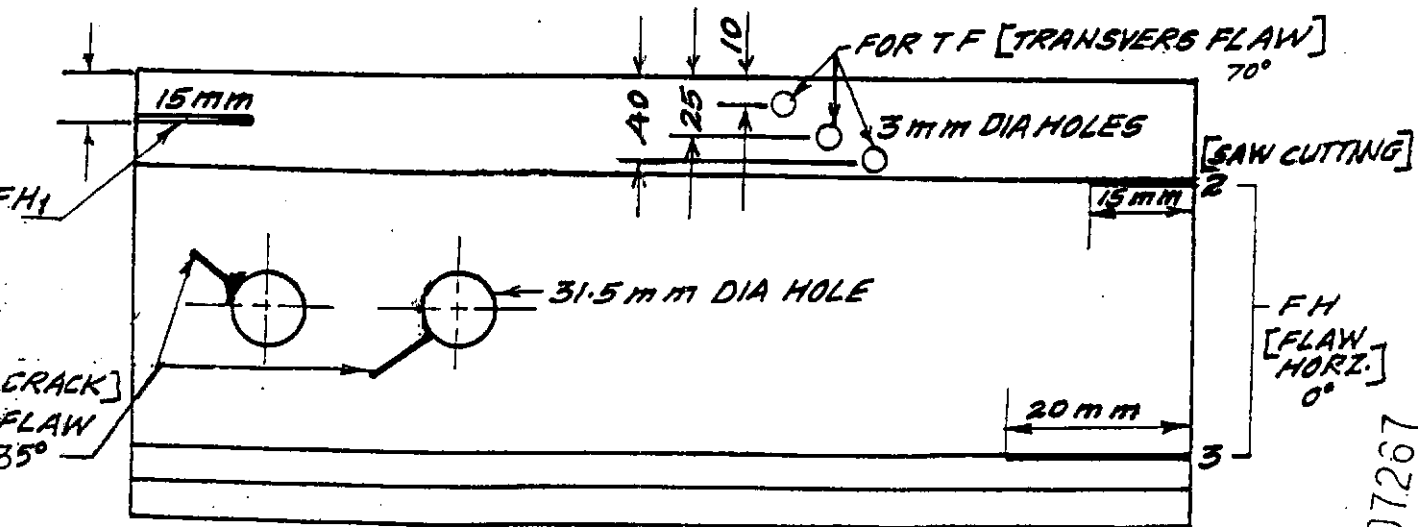
07266

# TESTING TROLLEY OF SPURT CAR



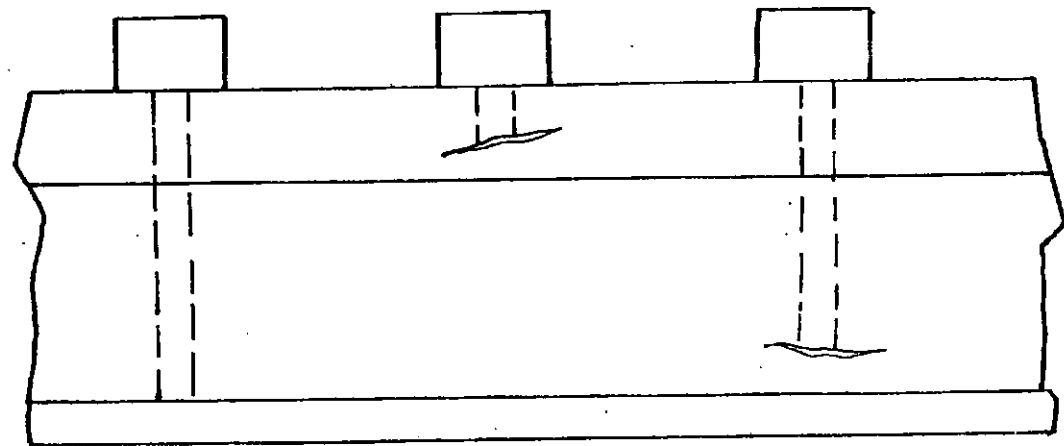
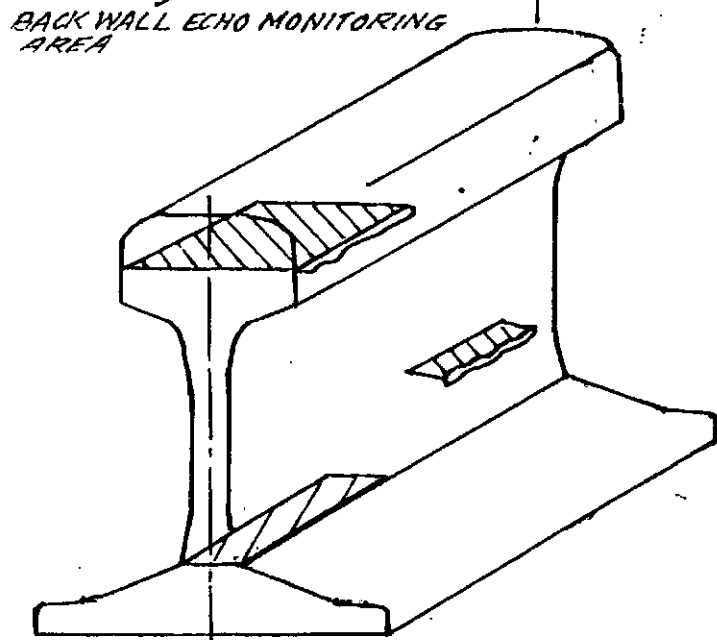
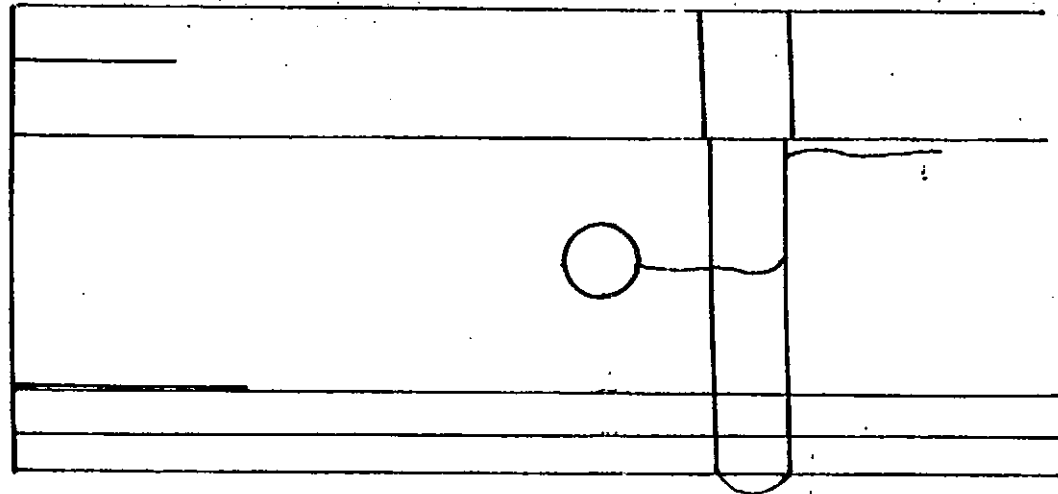
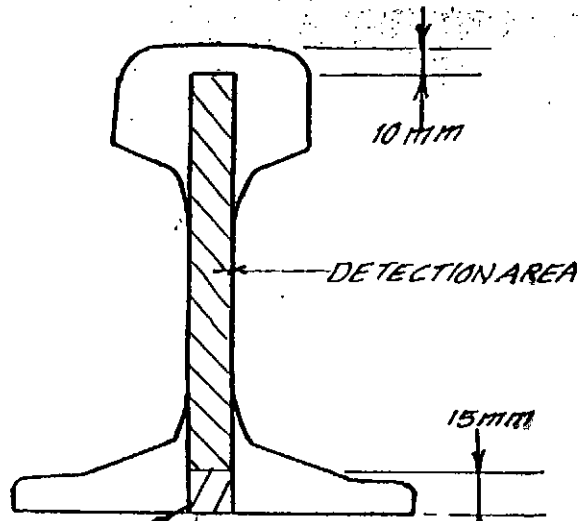
POSITION OF 70° PROBE 0 & 4  
 POSITION OF 35° PROBE 2 & 3  
 POSITION OF 0° PROBE 1

ARRANGEMENT OF PROBES ON TESTING TROLLEY OF SPURT  
 FIG. A



DEFECTIVE RAIL PIECE FOR CALIBRATION OF PROBES IN SPURT  
 FIG. B

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0° PROBE DETECTION CAPABILITY

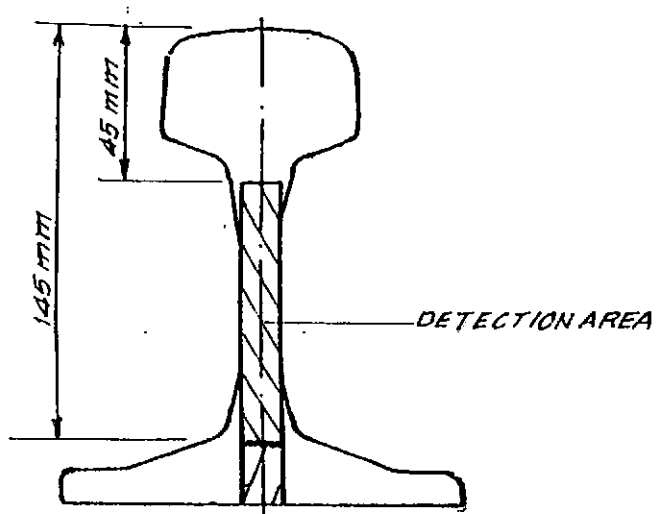
DETECTION CAPABILITY BY 0° PROBE OF SPURT CAR

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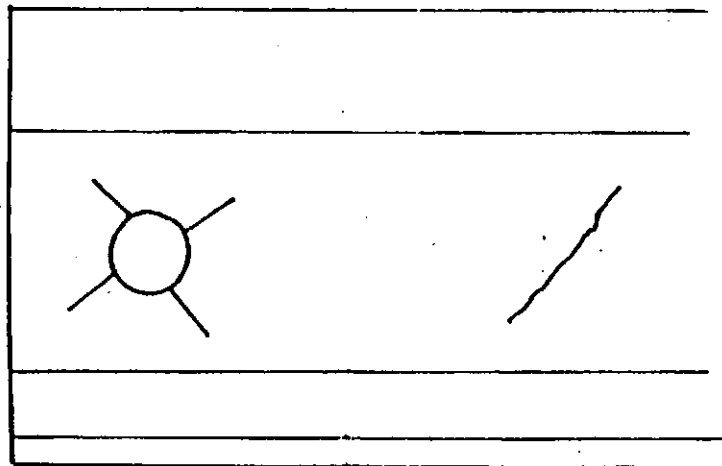
PNN-II



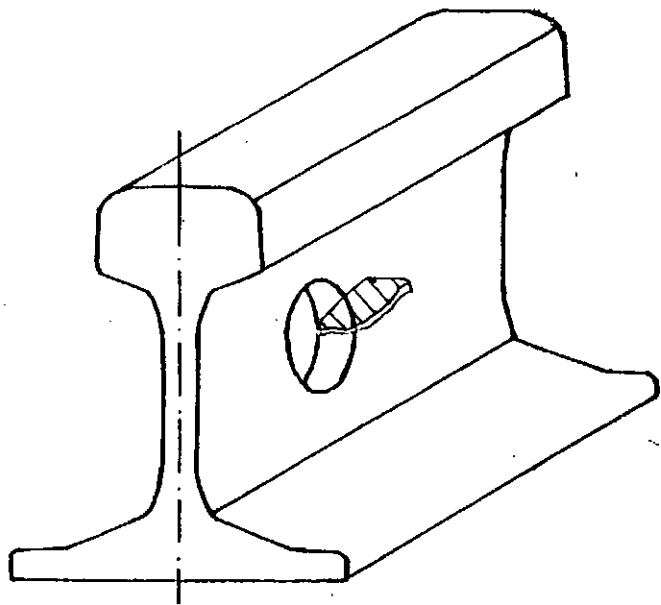
DETECTION CAPABILITY BY 35° PROBE OF SPURT CAR



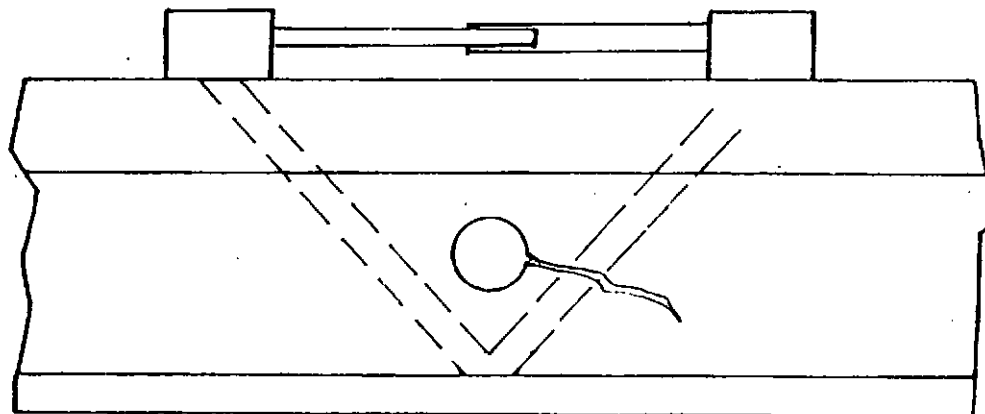
TRANSMISSION ECHO MONITORING



DETECTED DEFECT BY 35° PROBE



CROSS SECTION COVERED BY 35° PROBE

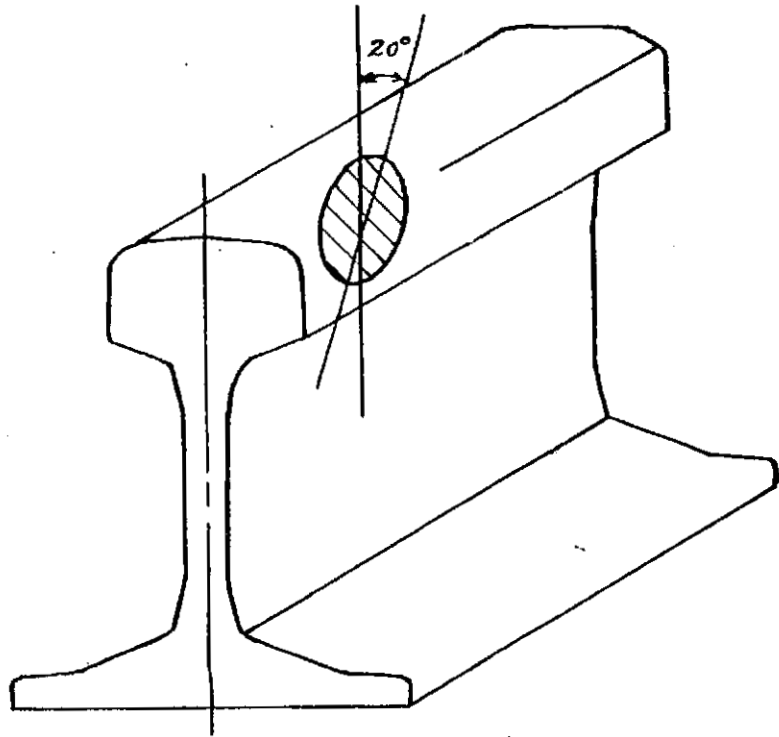
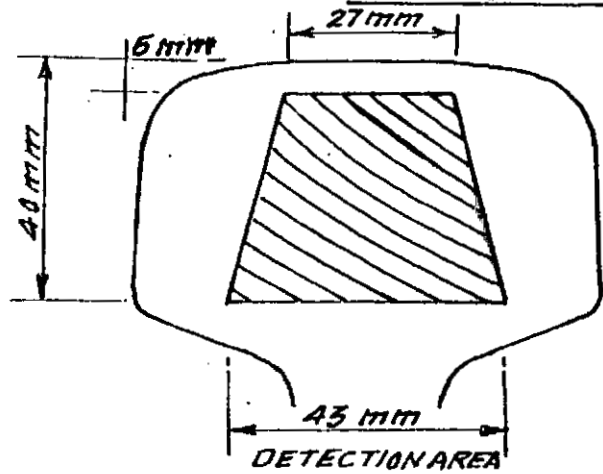


DETECTED DEFECT BY 35° PROBE

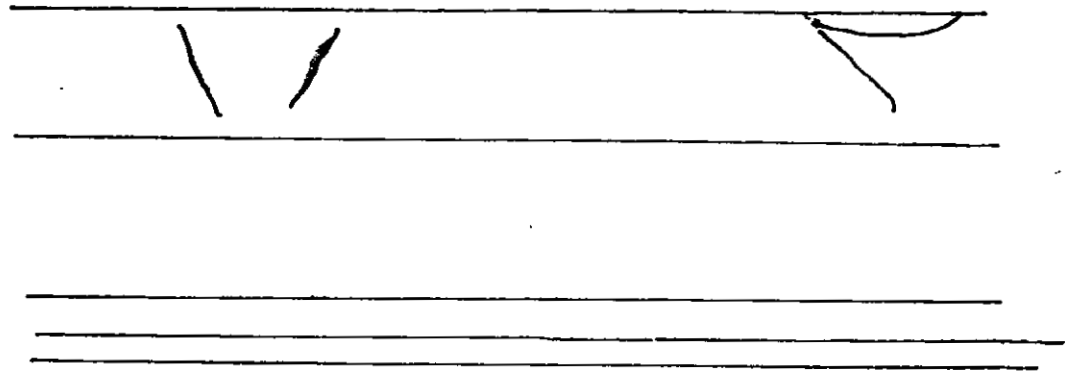
35° PROBE DETECTION CAPABILITY

DETECTION CAPABILITY BY 35° PROBE OF SPURT CAR

DETECTION CAPABILITY BY 70° PROBE OF SPURT CAR



CROSS SECTION COVERED BY 70° PROBE



DETECTED DEFECT BY 70° PROBE

70° PROBE DETECTION CAPABILITY

07275 DETECTION CAPABILITY BY 70° PROBE OF SPURT CAR

User information entry form for the present recording session.  
 Section No. : 36

Interregional Ultrasonic rail Inspection.

Inspection Car : URT-100  
 Inspection Supervisor : KCS, SK  
 Date : 11 / 4 / 2001 ( Format - dd / mm / cccc )

Location and Orientation.

Region : CR  
 Line No. : UP  
 Track : AGC-GWL  
 Group : GT RT  
 PK Local : 1343 Kms, 0 Mts.  
 Counting Trend : Decreasing  
 Checking Desk on duty : 0  
 Left Hand rail electronic ( 1 / 2 ) : 2  
 Right Hand rail electronic ( 1 / 2 ) : 1

Technical Checks >>    Electronic : 0                      Water Supply : 0  
 (O/N)                      Computer : 0                      Carriage Ready : 0

>> Defect Report - Eventwise.                      File Name : Data\11042001.A\_D

| PK<br>Kms | M   | Remarks      | N<br>REM | Left Rail Head |    |    | N<br>WF | Rem | Right Rail Head |    |      |
|-----------|-----|--------------|----------|----------------|----|----|---------|-----|-----------------|----|------|
|           |     |              |          | LUF            | TF | HF |         |     | LUF             | TF | HF   |
| 341       | 055 | START        |          |                |    |    |         |     |                 |    |      |
| 340       | 999 |              |          |                |    |    |         |     |                 |    |      |
| 340       | 981 | E.UN.LE.UN.R |          |                |    |    |         |     |                 |    |      |
| 340       | 974 | 13           | 1        | 7              | 3  | 24 |         |     |                 |    |      |
| 340       | 972 | 13           | 2        | 1              | 5  | 24 |         |     |                 |    |      |
| 340       | 964 | 13           | 1        | 2              | 1  | 6  |         |     |                 |    |      |
| 340       | 942 | 13           | 1        | 11             | 1  | 60 |         |     |                 |    |      |
| 340       | 940 | 13           | 1        | 9              | 1  | 48 |         |     |                 |    |      |
| 340       | 917 | 13           |          |                |    |    |         |     |                 |    |      |
| 340       | 881 | 13           | 1        | 2              | 1  | 6  | 1       |     | 11              | 2  | 54   |
| 340       | 853 | 13           |          |                |    |    |         |     |                 |    |      |
| 340       | 849 | 13           |          |                |    |    | 1       |     | 11              | 13 | 12   |
| 340       | 741 | 13           | 1        | 2              | 1  | 6  | 1       |     | 13              | 2  | 66   |
| 340       | 713 | 11           |          |                |    |    |         |     |                 |    |      |
| 340       | 672 | 11           |          |                |    |    | 1       |     |                 |    | R 88 |
| 340       | 670 | 13           |          |                |    |    | 1       |     |                 |    | R 16 |
| 340       | 624 | 13           |          |                |    |    | 1       |     | 1               | 2  | 6    |
| 340       | 530 | 13           | 1        | 3              | 2  | 6  | 1       |     | 1               | 2  | 6    |
| 340       | 524 | 13           | 1        | 3              | 3  | 0  |         |     |                 |    |      |
| 340       | 522 | 5            | 2        | 1              | 2  | 6  |         |     |                 |    |      |
| 340       | 405 | 13           |          |                |    |    |         |     |                 |    |      |
| 340       | 403 | 13           |          |                |    |    | 1       |     | 1               | 2  | 6    |
| 340       | 356 | 13           |          |                |    |    | 1       |     | 1               | 2  | 6    |
| 340       | 321 | 13           | 1        | 1              | 2  | 6  | 1       |     | 1               | 2  | 6    |
| 340       | 261 | 13           | 1        | 1              | 2  | 6  |         |     |                 |    |      |
| 340       | 259 | 13           | 1        | 1              | 2  | 6  |         |     |                 |    |      |
| 340       | 256 | 11           |          |                |    |    |         |     |                 |    |      |
| 340       | 244 | 11           |          |                |    |    | 1       |     |                 |    | A 12 |
| 340       | 241 | 11           |          |                |    |    | 1       |     |                 |    | C 28 |
| 340       | 237 | 13           | 1        | 2              | 1  | 6  | 1       |     |                 |    | P 17 |
| 340       | 224 | 11           |          |                |    |    |         |     |                 |    |      |
| 340       | 221 | 13           |          |                |    |    | 1       |     |                 |    | P 12 |
| 340       | 217 | 11           |          |                |    |    | 1       |     | 12              | 6  | 36   |
| 340       | 213 | 11           |          |                |    |    | 1       |     |                 |    | R 12 |
| 340       | 211 | 11           |          |                |    |    | 1       |     |                 |    | R 12 |
| 340       | 206 | 11           |          |                |    |    | 1       |     |                 |    | R 12 |
| 340       | 170 | 13           | 1        | 4              | 2  | 12 | 1       |     |                 |    | P 12 |

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» Final Defect Report «

Inspection Car : URT-100  
 Inspection Supervisor : D.KU,L.S.R  
 Date : 19 / 6 / 2001 (Format - dd / mm / cccc)

| P | Location |           |         |        | Automatic Measures |     |     | Spot Inspection |           |             |       |                           |
|---|----------|-----------|---------|--------|--------------------|-----|-----|-----------------|-----------|-------------|-------|---------------------------|
|   | N        | NUM L. D. | P K     | BN CWR | R L                | R R | DEF | VALUE           | CODE ASS. | CODE DEFECT | CLASS | Makes of Rails<br>Remarks |
| 1 | 1        |           | 745 920 |        |                    |     |     | START           |           |             |       |                           |
|   | 1        |           | 746 799 |        |                    |     |     | RUN             |           |             |       |                           |
|   | 1        |           | 746 757 |        |                    |     |     | E.UN.L          |           |             |       |                           |
|   | 1        |           | 746 757 |        |                    |     |     | E.UN.R          |           |             |       |                           |
|   | 1        | 2         | 746 757 |        |                    | *   | FT  | 24 %            | 13        |             |       |                           |
|   | 1        | 3         | 747 133 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 1        | 5         | 747 257 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 1        | 7         | 747 534 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 1        |           | 747 743 |        |                    |     |     | S.UN.L          |           |             |       |                           |
|   | 1        |           | 747 743 |        |                    |     |     | S.UN.R          |           |             |       |                           |
|   | 2        |           | 747 743 |        |                    |     |     | S & C           |           |             |       |                           |
|   | 2        |           | 747 789 |        |                    |     |     | E.UN.L          |           |             |       |                           |
|   | 2        |           | 747 789 |        |                    |     |     | E.UN.R          |           |             |       |                           |
|   | 2        | 2         | 747 791 |        |                    | *   | HF  | 16 mm           | 11        |             |       |                           |
|   | 2        | 3         | 747 824 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 748 001 |        |                    |     |     | TOPQ            |           |             |       |                           |
|   | 2        | 1         | 748 349 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        | 3         | 748 959 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 749 001 |        |                    |     |     | TOPQ            |           |             |       |                           |
|   | 2        | 1         | 749 518 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        | 3         | 749 886 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 750 001 |        |                    |     |     | TOPQ            |           |             |       |                           |
|   | 2        |           | 750 019 |        |                    |     |     | S.UN.L          |           |             |       |                           |
|   | 2        |           | 750 019 |        |                    |     |     | S.UN.R          |           |             |       |                           |
|   | 2        |           | 750 036 |        |                    |     |     | S & C           |           |             |       |                           |
|   | 2        |           | 750 063 |        |                    |     |     | E.UN.L          |           |             |       |                           |
|   | 2        |           | 750 063 |        |                    |     |     | E.UN.R          |           |             |       |                           |
|   | 2        | 1         | 750 802 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 751 007 |        |                    |     |     | S.UN.L          |           |             |       |                           |
|   | 2        |           | 751 007 |        |                    |     |     | S.UN.R          |           |             |       |                           |
|   | 2        |           | 751 007 |        |                    |     |     | S & C           |           |             |       |                           |
|   | 2        |           | 751 001 |        |                    |     |     | TOPQ            |           |             |       |                           |
|   | 2        |           | 751 032 |        |                    |     |     | E.UN.L          |           |             |       |                           |
|   | 2        |           | 751 032 |        |                    |     |     | E.UN.R          |           |             |       |                           |
|   | 2        | 2         | 751 399 |        |                    | *   | FT  | 6 %             | 13        |             |       |                           |
|   | 2        | 3         | 751 463 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 751 631 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        |           | 752 001 |        |                    |     |     | TOPQ            |           |             |       |                           |
|   | 2        |           | 752 027 |        |                    |     |     | S.UN.L          |           |             |       |                           |
|   | 2        |           | 752 027 |        |                    |     |     | S.UN.R          |           |             |       |                           |
|   | 2        |           | 752 027 |        |                    |     |     | S & C           |           |             |       |                           |
|   | 2        |           | 752 004 |        |                    |     |     | E.UN.L          |           |             |       |                           |
|   | 2        |           | 752 084 |        |                    |     |     | E.UN.R          |           |             |       |                           |
|   | 2        | 2         | 752 086 |        |                    | *   | FT  | 30 %            | 15        |             |       |                           |
|   | 2        | 4         | 752 139 |        |                    | *   | FT  | 0 %             | 13        |             |       |                           |
|   | 2        | 6         | 752 167 |        |                    | *   | ET  | 19 mm           | 7         |             |       |                           |
|   | 2        | 7         | 752 183 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        | 8         | 752 217 |        | *                  |     | FT  | 18 %            | 13        |             |       |                           |
|   | 2        | 10        | 752 231 |        | *                  |     | FT  | 12 %            | 13        |             |       |                           |
|   | 2        | 12        | 752 259 |        | *                  |     | FT  | 0 %             | 13        |             |       |                           |
|   | 2        | 14        | 752 296 |        | *                  |     | FT  | 6 %             | 13        |             |       |                           |
|   | 2        | 16        | 752 426 |        | *                  |     | FT  | 12 %            | 13        |             |       |                           |
|   | 2        | 17        | 752 538 |        | *                  |     | FT  | 6 %             | 13        |             |       |                           |
|   | 2        | 18        | 752 588 |        | *                  |     | HF  | 84 mm           | 0         |             |       |                           |

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## LEGENDS FOR ANNEXURE-V

|                  |                              |
|------------------|------------------------------|
| PK               | : POST KILOMETER             |
| N <sub>REM</sub> | : No. OF DEFECTS PER METER   |
| LVF              | : LONGITUDINAL VERTICAL FLAW |
| TF               | : TRANSVERSE FLAW            |
| HF               | : HORIZONTAL FLAW            |
| WF               | : WEB FLAW                   |
| E.UN.L           | : END UNTESTED LEFT          |
| E.UN.R           | : END UNTESTED RIGHT         |
| S&C              | : SWITCH & CROSSING          |
| S.UN.L           | : START UNTESTED LEFT        |
| S.UN.R           | : START UNTESTED RIGHT       |

## CODES

| CODE No. | ITEM                   |
|----------|------------------------|
| 13       | : TRANSVERSE FLAW (TF) |
| 11       | : HORIZONTAL FLAW (HF) |
| 7        | : WEB FLAW (WF)        |
| OTHERS   | : ERRATIC RESULT       |

## EVENT OF FLAWS IN RAIL

|     |                              |
|-----|------------------------------|
| R   | : RUNNING SURFACE            |
| C   | : HEAD                       |
| A   | : WEB                        |
| P   | : FOOT                       |
| N   | : NUMBER                     |
| FHT | : HORIZONTAL TRANSVERSE FLAW |
| DEF | : DEFECTS (MISCELLANEOUS)    |

## LEGENDS FOR ANNEXURE-VI

|        |                                                                                                            |
|--------|------------------------------------------------------------------------------------------------------------|
| P      | : RUN                                                                                                      |
| N      | : NUMBER                                                                                                   |
| L      | : INDICATION OF GROUND FEATURE CHANGE EVENT LIKE S&C, BRIDGE ETC.                                          |
| D      | : DEFECTS INDICATION. ODD No. INDICATES DEFECTS IN LEFT RAIL<br>& EVEN No. INDICATES DEFECTS IN RIGHT RAIL |
| PK     | : POST KILOMETER                                                                                           |
| RL     | : RAIL LEFT                                                                                                |
| RR     | : RAIL RIGHT                                                                                               |
| DEF    | : DEFECTS                                                                                                  |
| E.UN.L | : END UNTESTED LEFT                                                                                        |
| E.UN.R | : END UNTESTED RIGHT                                                                                       |
| FT     | : FLAW TRANSVERSE                                                                                          |
| S.UN.L | : START UNTESTED LEFT                                                                                      |
| S.UN.R | : START UNTESTED RIGHT                                                                                     |
| S&C    | : SWITCH & CROSSING                                                                                        |
| HF     | : HORIZONTAL FLAW                                                                                          |
| ET     | : WEB FLAW                                                                                                 |
| TOPO   | : CHANGE IN KILOMETER                                                                                      |
| *      | : CORRESPONDING DEFECTS                                                                                    |



## CODES

| CODE No. | ITEM                   |
|----------|------------------------|
| 13       | : TRANSVERSE FLAW (TF) |
| 11       | : HORIZONTAL FLAW (HF) |
| 7        | : WEB FLAW (WF)        |
| OTHERS   | : ERRATIC RESULT       |

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