#131560

ERL MAINTENANCE SUPPORT SDN BHD

(Company No. 498574-T)

E-MAS

Effective Railway Operations; Reliable System Maintenance

ROLLING STOCK DEPARTMENT

IN-HOUSE TECHNICAL INSTRUCTION

TRAIN LEVELLING GUIDELINE

R00.OMR.M91125.BT.1001.B

Release

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	Name	**Department**	**Date**	**Signature**

Amendments or additions to this procedure must be indicated with a vertical black line in the adjacent left margin.

Change Record and Configuration Control

B	14-Dec-16	Revision of the SOP according to the Levelling Training on 22.08.2016 until 05.09.2016	Muhammad Azizi
A	16-Jun-16	New	Siti Masitah
Revision	**Date**	**Modification**	**Name**

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1 Purpose

The purpose of this document is to provide guideline for RST staff to carry out Train Levelling work. This guideline covers all aspect including tool, method and safety precaution that should be used and applied while performing this job. This act as evidence to achieve a systematic way and to ensure all the safety precautions are complied.

2 Scope, Distribution & Access

This document is applicable to all RST personnel. The distribution and access shall be available for all RST and could be viewed and retrieved via EDMS and RST Portal [http://express50/ E-MAS_Portal/RST.html]. The hardcopy of this procedure is available in RST foreman room for reference. The full access for editing this document is only granted to RST MGT.

3 Train Levelling Activity

The levelling activity is consisting of two components which are:

a. Measurement without air in secondary suspension.

b. Measurement with air in secondary suspension.

Note: Please ensure that only the same person to do the measurement (e.g.: Z1) before and after the adjustment

3.1 Preparation for Train Levelling

3.1.1 Checklist for Train Levelling

Printout checklist for train levelling. Checklist are as below:

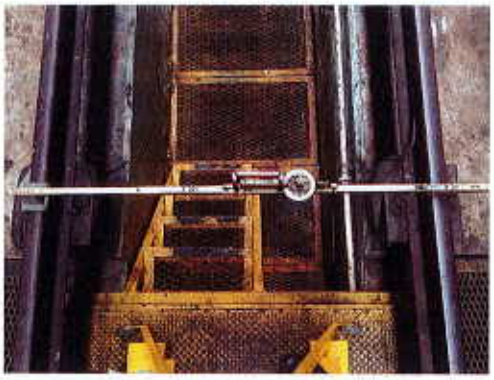
1. Train Levelling Checklist, in RST Heavy Maintenance Checklist, [R00.OMR.M14100.PT.1007. *]
2. Levelling Measuring Table, in RST Heavy Maintenance Checklist, [R00.OMR.M14100.PT.1007. *]
3. Primary and Secondary Shimming Record, in RST Heavy Maintenance Checklist. [R00.OMR.M14100.PT.1007. *]

3.1.2 Condition of Track, Tools and Equipment

- Ensure that the levelling track to be in good condition
  1. Height and level of the both side of the track are within the tolerance (difference +-1mm)
  2. Width (back to back) of the track are within the tolerance (1435mm +-1mm)

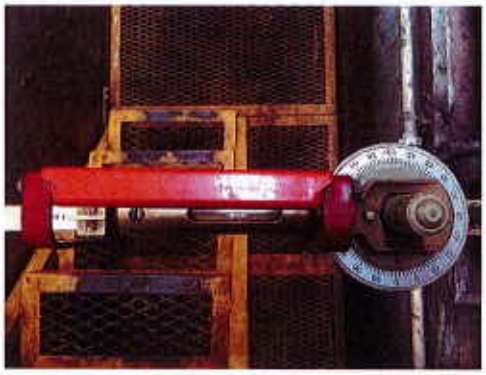
1. Measuring the height difference and width of the levelling track

2. Measuring the width and height of the track using water level



3. Measuring of the width of the track (1435mm +-1mm)

4. Measuring the height difference of the track (side 1 and side 2)



- Ensure that all the tools and the equipment for levelling are in good condition and fully functional and reliable

Note: If the track is out of the tolerance, please inform RST HOD.

Note: Ensure the train is with air (in secondary suspension) and had travelled at least 3km before entering the levelling track. This is to ensure that the train car body is centered.

Standby the train for 8-12 hours without air before start levelling.

3.1.3 Shunting of The Train & Safety Procedure

1. Park the train on the levelling track e.g. Track 9-North

2. Fix the orange flag

3. Choke the wheels

4. Put signage on the train driver's panel

5. Isolate the EP Panel

6. Isolate cock on each bogie and vent the air

4 Measurement

4.1 Calculation Preparation

Z1 and Z7 heights depend on the average wheel diameter of the bogie.

The difference of wheel diameters in one bogie should be **<=3mm**.

4.1.1 Height should be for Z1

Calculation of height should be, Z1 for both side.

x = Average wheel diameter for each bogie.

$Z1 = 715 - (850 - x)/2$

Note: If the wheels are worn out about 50% (Wheel diameter<=815mm), add (+) 18 mm shimming on the secondary suspension. Calculate using average wheel diameter including +18mm shimming.

4.1.2 Height should be for Z7

Calculation of height should be, Z7 for both side.

x = Average wheel diameter for each axle.

$Z7 = 740 - (850 - x)/2$

Note: If the wheels are worn out about 50% (Wheel diameter<=815mm), add (+) 18 mm shimming on the secondary suspension. Calculate using average wheel diameter including +18mm shimming.

4.2 Take Measurement

4.2.1 Measurement for Y1

Free lateral clearance between bogie and car body (underframe).

Note: Prior measurement please check the rubber stop has no damages or wear sign

- Mean value of the right and left side. (Side 1 and Side 2)
- 28 mm, max. tolerance +0 mm, min. tolerance -3 mm (for all bogies)
- Measure using Dial Caliper Gauge.

Note: This measurement is to make sure the car body sits on the center of the bogie.

For example :

Side 1 = 29 mm
Side 2 = 27 mm

(Side 1 + Side 2) / 2 = Y1

(29 mm + 27 mm) = 56 mm
(56) / 2 = 28 mm (**in tolerance**).

Note: The difference between Y1 on both side cannot be more than 6mm.

Note: If Y1 is out of tolerance, please inform your Supervisor

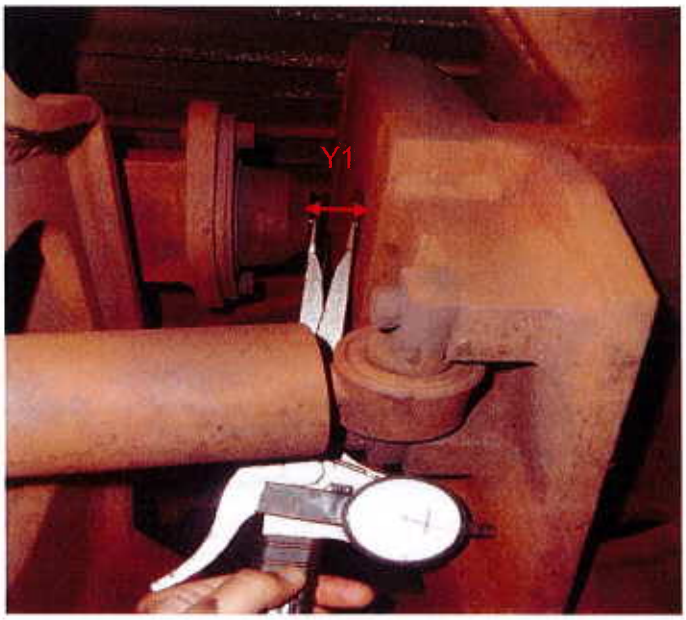


Figure 1 - Measuring of Y1

4.2.2 Measurement for Y3

Distance between the stops for curve-depend lateral clearance between bogie and car body.

- Mean value of the right and left side. (Side 1 and Side 2)
- 55 mm, max. tolerance +2 mm, min. tolerance -3 mm. (for end bogie)
- 58 mm, max. tolerance +3 mm and min. tolerance -5 mm. (for Jacob bogie)
- Measure using Dial Caliper Gauge

Note: This measurement is to make sure the car body sits on the center of the bogie.

For example:
Side 1 = 58 mm
Side 2 = 59 mm

(Side 1 + Side 2) / 2 = Y3

(58 mm + 59 mm) = 117 mm
(117 mm) / 2 = 58.5 mm (**in tolerance**).

Note: The difference between Y3 on both side cannot be more than 3mm.

Note: If Y3 is out of tolerance, please inform your Supervisor. Also to inspect the surface to ensure no unrecorded wear sign

Figure 2 - Measuring of Y3

4.2.3 Measurement for Z4

Distance between the axle box case and the stop at the bogie frame

Bogie	EMB5		JMB4		JTB3		JMB2		EMB1	
New Primary Springs	39mm		38mm		38mm		38mm		39mm	
	+1mm	-2mm	+1mm	-2mm	+1mm	-2mm	+1mm	-2mm	+1mm	-2mm
Used Primary Springs	35mm		35mm		35mm		35mm		35mm	
	+2mm	-3mm	+2mm	-3mm	+2mm	-3mm	+2mm	-3mm	+2mm	-3mm

- Measure using Dial Caliper Gauge.

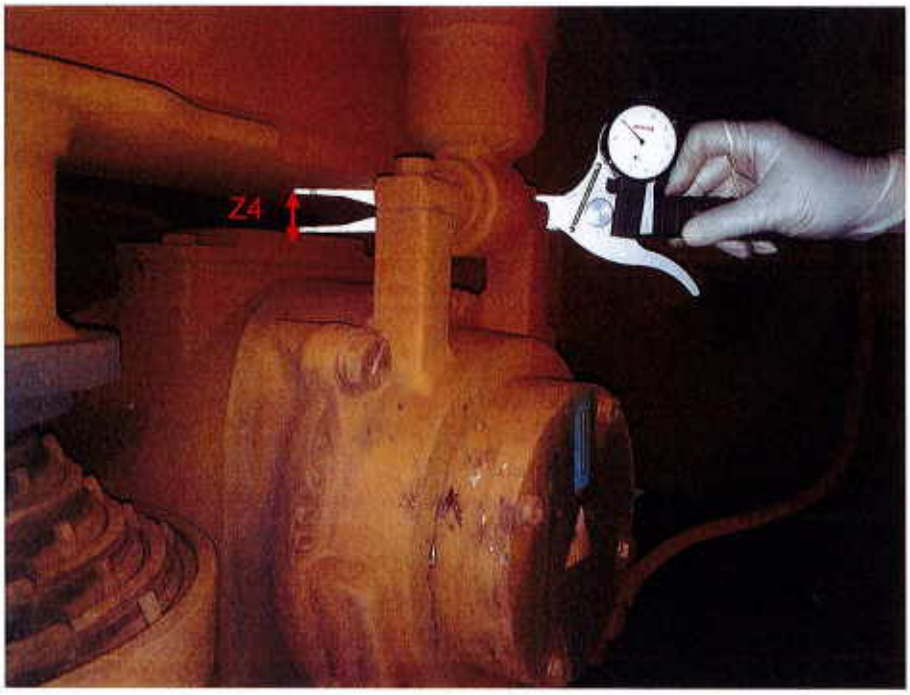


Figure 3 - Measuring of Z4

4.2.4 Measurement for Z1

Distance between measuring holes and top of rail (without air)

- Z1 (refer 4.1.1), max. tolerance +7 mm, min. tolerance -2 mm. (Side 1 & Side 2)
- Difference of Z1 between Side 1 and Side 2 should be <=4mm
- Measure using measuring tape or steel ruler.

  Note: This measurement is to check the car body without air. The **715mm** values is valid for new wheel and after shimming 18 mm secondary shims at wheel worn by 50%. All other new value has to be calculated considering the wheel diameter. (Refer to 4.1.1 for other wheel diameters)

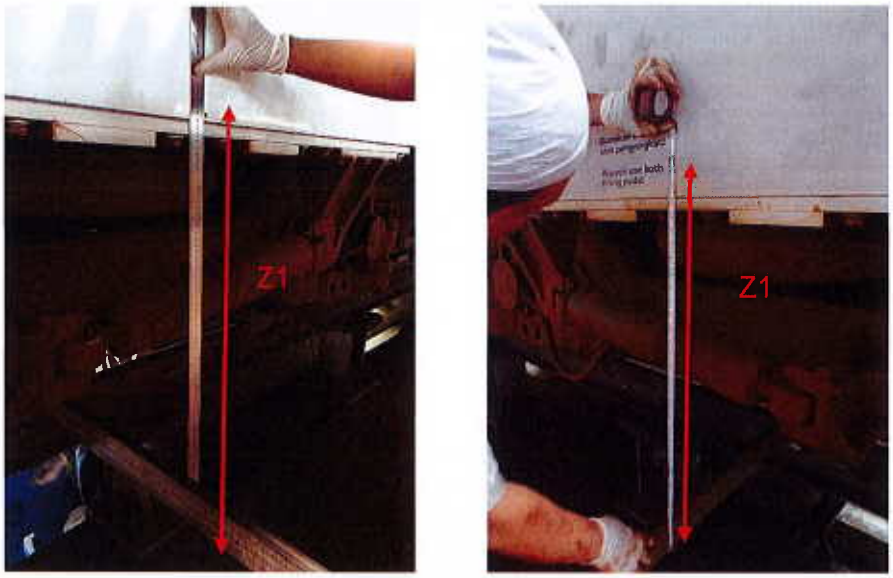


Figure 4 - Measuring of Z1 (using measuring tape or steel ruler)

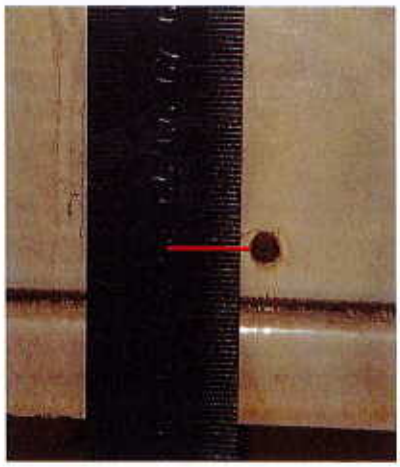


Figure 5 - Location of the center of the measuring hole

4.2.5 Measurement for Z7

Distance between measuring holes and top of rail (with air)

- Z7 (refer 4.1.2), max. tolerance +3 mm, min. tolerance -3 mm. (Side 1 & Side 2)
- Difference of Z7 between Side 1 and Side 2 must be =<4m
- Measure using measuring tape or steel ruler.

Note: This measurement is to check the car body with air. The **740mm** value is valid for new wheel and after shimming 18 mm secondary shims at wheel worn by 50%. All other new value has to be calculated considering the wheel diameter. (Refer to 4.1.2 for other wheel diameters)

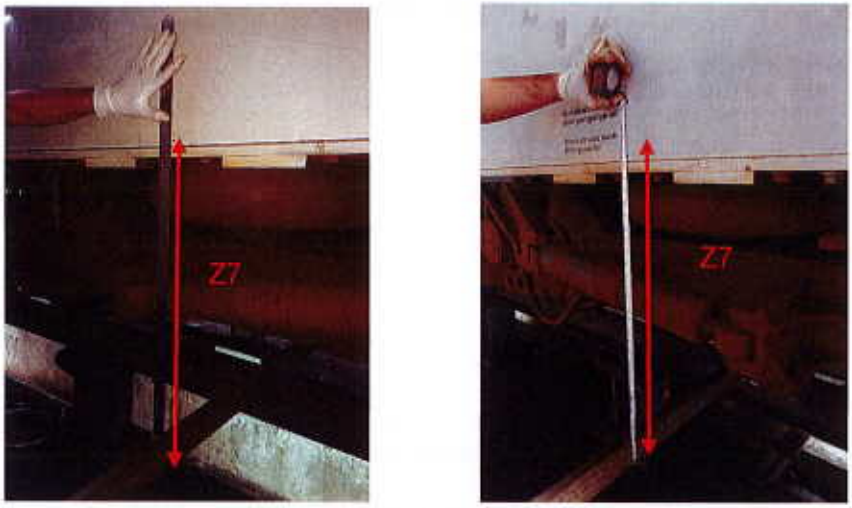


Figure 6 - Measuring of Z7 (using measuring tape or steel ruler)

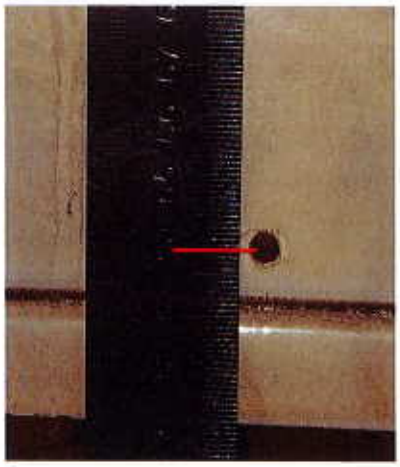


Figure 7 - Location of the center of the measuring hole

The difference of Z1 and Z7 between side 1 and side should be <=4mm. Example:

∧Z1 <= 4mm (Difference between side 1 and side 2)
∧Z7 <= 4mm (Difference between side 1 and side 2)
For example:

Z_7 Side 1 = 729 mm
Z_7 Side 2 = 730 mm

(Side 1 - Side 2) = (729 mm - 730 mm)
= - 1
= $|-1|$

$\Delta Z7$ = 1 mm (Within the tolerance)

4.2.6 Measurement for Z8

Distance between the bottom side of magnetic aerial and top of rail.

- 213 mm, max. tolerance +5 mm, min. tolerance -3 mm. (for EMB1 & EMB5)
- Measure using measuring tape.

Figure 8 - Measuring of Z8

4.2.7 Measurement for Z5

Height of Magnet Receiver

- 135 mm, max tolerance +6 mm, min tolerance -6 mm (for JTB3)
- Measure using measuring tape.

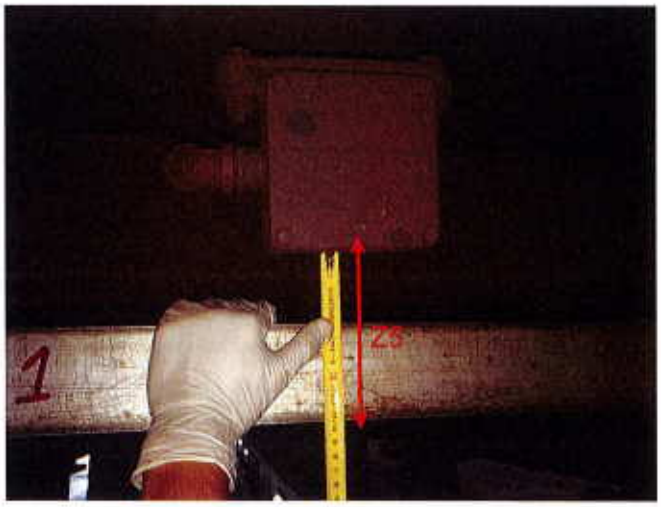


Figure 9 - Measuring of Z5

4.2.8 Measurement for Z9

Distance between the coupling center and top of rail

Note: Ensure that the coupler is at the center of the car

- 1030 mm, max. tolerance +12 mm, min. tolerance -15 mm. (for EMB1 & EMB5)
- Measure using measuring tape or steel ruler.
- Adjust the auto coupler if necessary.

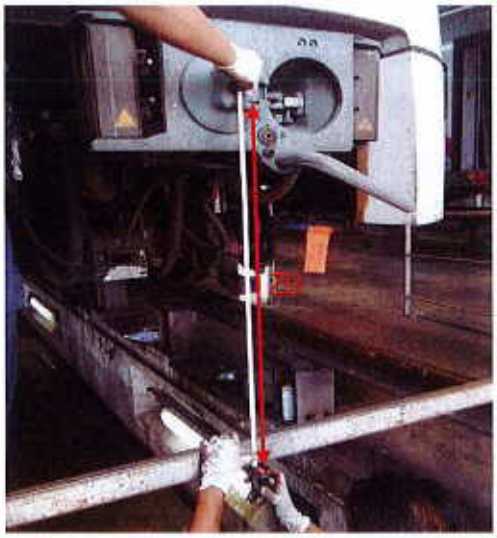


Figure 10 - Measuring of Z9

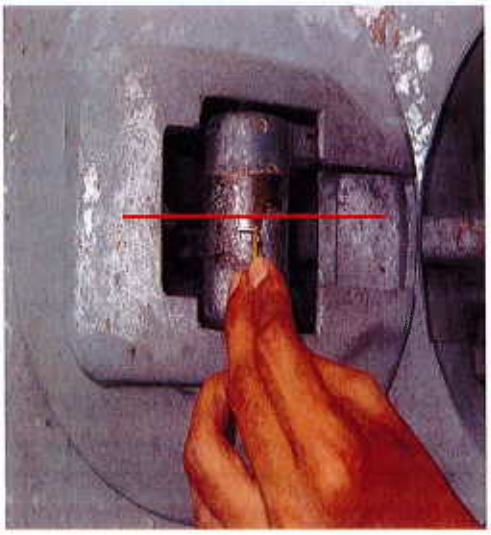


Figure 11 - Centre of the coupler

4.2.9 Measurement for Z3

Height of the pilot bar

- 80 mm, max. tolerance +1 mm, min. tolerance -1 mm. (for EMB1 & EMB5)
- Measure using measuring tape.

  Note: The pilot bar is provided to help minimizing dangers caused by obstacles that may lie on the rail, which could lead to wheel damaged or even derailment.

Figure 12 - Measuring of Z3

4.2.10 Check & realign KELSAN Wheel Flange Lubricator

- Clearance from mouth of applicator to wheel at closest point within 10mm to 15mm

Figure 13 - Measuring the clearance of KELSAN Wheel Flange Lubricators

5 Adjustment

5.1 Adjustment for Z4

a) Shimming on top of axle box

- Before remove or add on shim on Z4, please check height for z7 *(refer to z7 in bogie press)* and make sure it is within the tolerance.
- **Note**: In case of z7 (bogie press) is out of tolerance, adjustment of the primary suspension is necessary, do the adjustment of primary suspension as in b) first

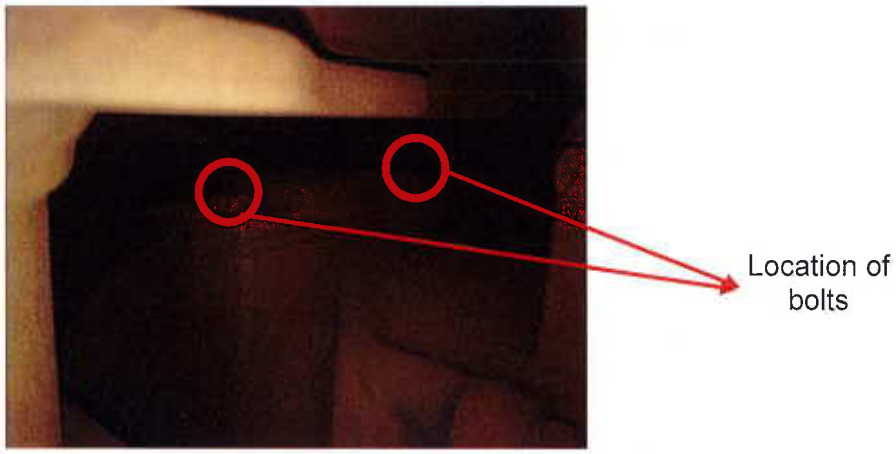


Figure 14 - Adjustment for Z4

- Loosen the two bolts as shown in Figure 22 (in red circles) and add or remove shim until it is within the tolerance (35mm, min. tolerance -3mm, max. tolerance +2mm)

Figure 15 - Adding or removing shim accordingly

b) Primary Suspension/Maggie spring - Adjustment of z7 (refer to z7 in bogie press)

- Set up the hydraulic jack and the special tools below the Maggie spring.
- Switch ON the hydraulic jack and align the special tools to the holes below the Maggie spring.
- Let the Maggie spring lift upward for few second until it is suitable for re-shimming. Make sure do no lift to much until the wheel being lifted.
- If the Maggie spring is stuck at its place, use WD-40 and copper hammer to force it out from its position.

Figure 16 - Lift up the primary spring using hydraulic jack (1)

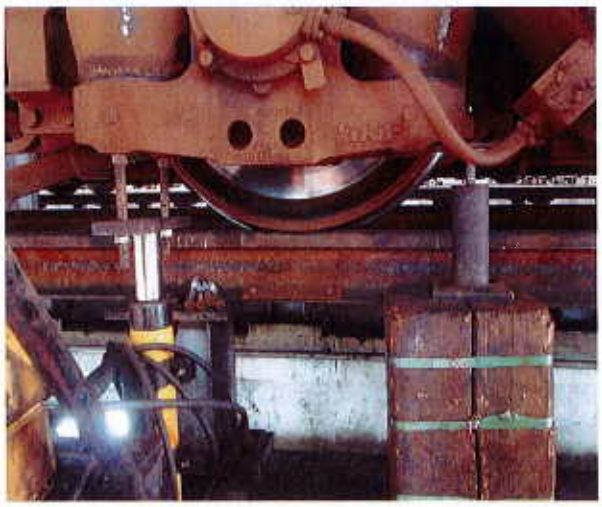


Figure 17 - Lift up the primary spring using hydraulic jack (2)

- The purpose of the primary suspension system is to cushion the force, which act on the bogie, namely all static forces, and all dynamic vertical forces that occur during service. It also provides horizontal guidance for the wheel sets relative to the bogie frame.
- Primary suspension shims are inserted between the primary spring element and the axle bearing housing for the correct height adjustment of the primary suspension system to the deviation centre of gravity the car body.

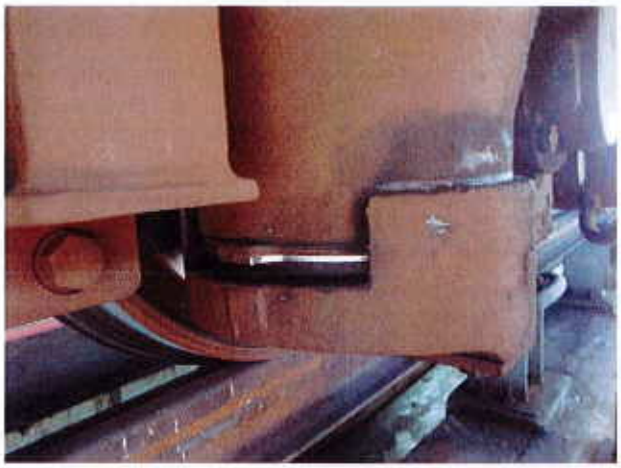


Figure 18 - Visual check on the primary spring shimming

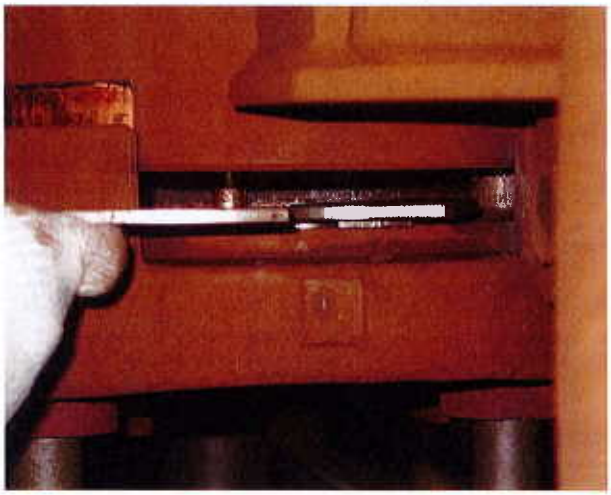


Figure 19 - Remove or add on shimming on the primary spring

Caution: Do not put your hand under the primary spring while jack lifting and shimming

5.2 Adjustment for Z1

a) Secondary Suspension/Airbag

- Set up the hydraulic jack and the round bar below the air suspension.
- Switch ON the hydraulic jack and align the round bar to the holes below the air suspension.
- Let the air suspension lift upward for few second until it is suitable for re-shimming. Make sure do no lift to much until the car body being lifted.
- The car body need to be levelled first before adjusting the height by removing shims on one side and adding shims on one side with the same number. This is done for one bogie.

  Example:

  Measurement before correction:

  Z1 on side 1 = 708mm

  Z1 on side 2 = 712mm **(Difference between S1 and S2 = 4mm)**

  Add 2mm of shim at side 1 and remove 2mm of shim at side 2.

  Measurement after correction (should be):

  Z1 on side 1 = 710mm

  Z1 on side 2 = 710mm

- After the car body is levelled, add or remove shim until the measurement for Z1 is within the tolerance.

Figure 20 - Lift up the secondary spring using hydraulic jack

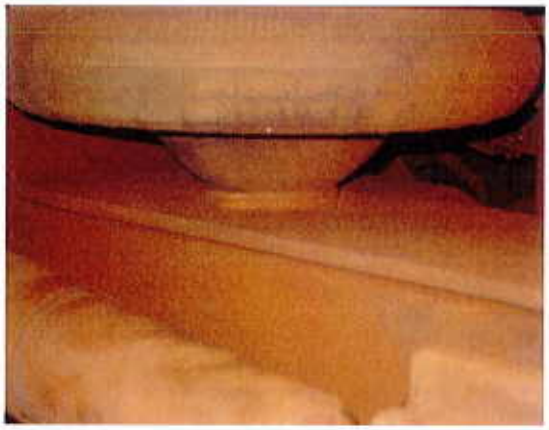


Figure 21 - Remove or add shim on secondary spring

- The secondary suspension system cushions the car body and buffers shock between it and the bogie. This system is supplied from the vehicles compressed air system. The secondary suspension system is actuated and controlled by the levelling valves. In case if compressed air failed, the car body comes to rest on additional spring.

5.3 Adjustment for Z7

a) Car height adjustment and over height cable

- The Levelling valve compensates for the different load conditions. It maintains a constant car body floor height irrespective of the passenger loading.
- They fulfil this function by inflating and deflating the air springs as necessary.
- A stud bolt to actuating the lever of the levelling valve conveys the vertical relative movements between the bogie and car body, caused by passengers entering and leaving the vehicle.
- When passengers enter the vehicle the car body initially sinks as the air springs are compressed by the increase in load.
- The control rod responds to the change and actuates the levelling valve. The inlet valve opens and delivers air from the compressed air system to the air springs.
- When passengers leave the vehicle, the car body initially rises as the air springs are relieved by the decrease in load. The outlet valve opens and expels the excess air to the atmosphere.

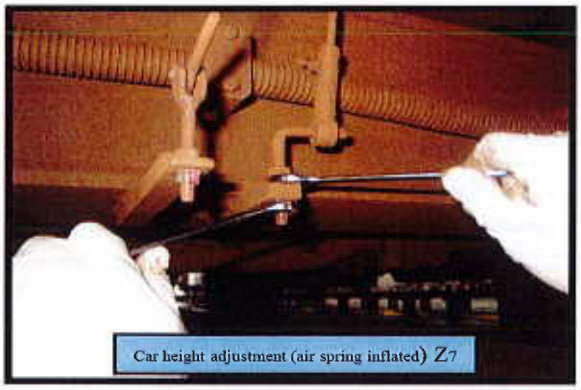


Figure 22 - Car Height Adjustment (Air Spring Inflated) Z7

b) Tilting Rod

- If the difference of Z7 between Side 1 and Side 2 is out of tolerance (Delta<=4mm), adjust the **used** tilting rod by using Swedish pipe wrench or **new** tilting with hand.
- Before adjusting the tilting rod, de-stress one of the tilting rod in one car by loosening the screws/bolts located at that tilting rod.

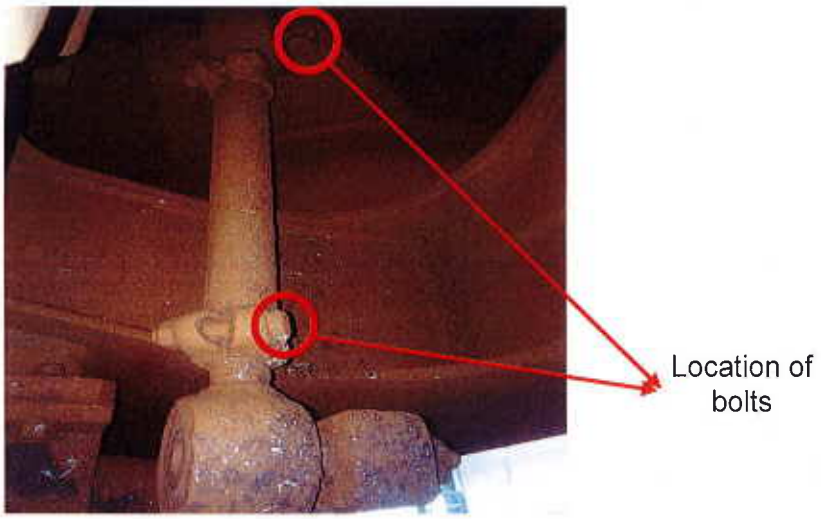


Figure 23 - Location of screws/bolts at tilting rod

Note: The initial setting for tilting rod for EMB1 and EMB5 is 488mm. The initial setting for tilting rod for JMB2, JTB3 and JMB4 is 440mm.

(Refer drawing R00-RSE-91120-XL-3029-A for EMB and R00-RSE-91120-XL-3028-A for JMB and JTB)

Figure 24 - Adjustment of the tilting rod using Swedish pipe wrench

5.4 Adjustment for Z8

- If Z8 is out of tolerance, loosen the bolts & nuts in Figure 32 (in red circles) then add or remove washer according to the height (tolerance)

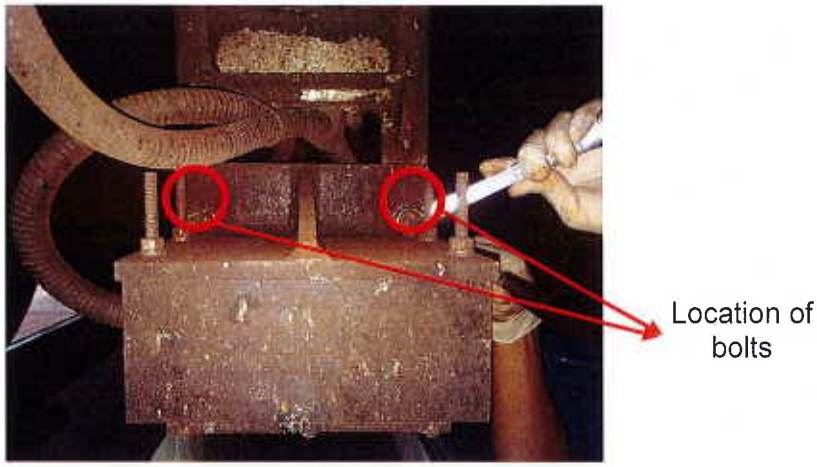


Figure 25 - Adjustment for Z8

5.5 Adjustment for Z5

- If Z5 is out of tolerance, loosen the bolts & nuts in Figure 33 (in red circles) then add or remove washer according to the height (tolerance)

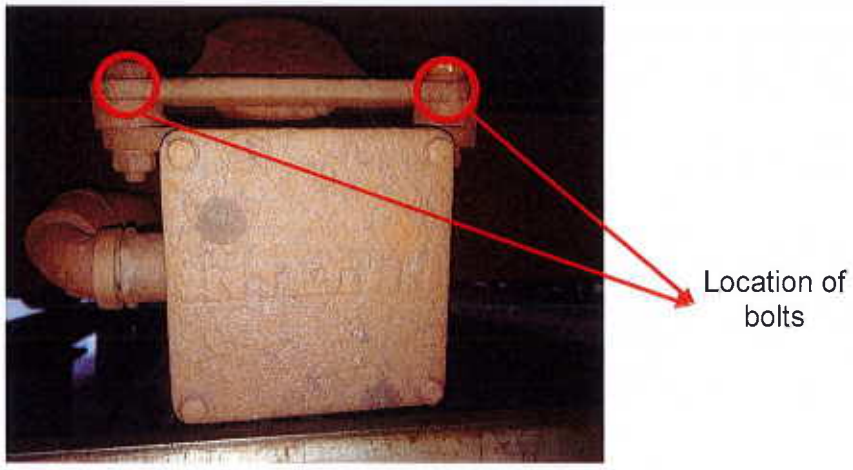


Figure 26 - Adjustment for Z5

5.6 Adjustment for Z9

- If Z9 is out of tolerance, loosen or tighten the bolt/screw in Figure 34 (red circles) then adjust according to the height (tolerance)

Note: If the coupler is not centered, adjust the damper located at the back of the coupler

Figure 27 - Screw/bolt to adjust the Z9

5.7 Adjustment for Z3

- If Z3 is out of tolerance, release the bolt & nut in Figure 35 (refer arrow) then adjust according to the height (tolerance)

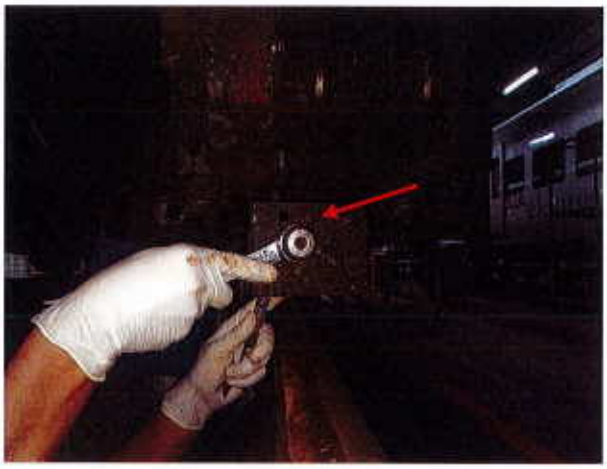


Figure 28 - Adjustment for Z3

6 Type of Shim

6.1 Shim for Axle Box Bearing

- Shim for axle box bearing has 2mm in size

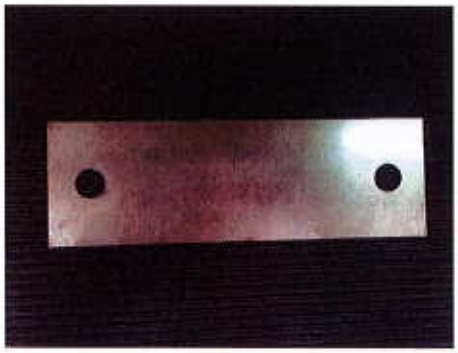


Figure 29 - Shim for Z4

6.2 Shim for Primary Spring

- Shim for primary spring has 4mm, 2mm and 1mm in size

Note: Shim for primary spring is to have an even distribution of wheel loads and to adjust height of primary suspended parts of the bogie above tolerance.

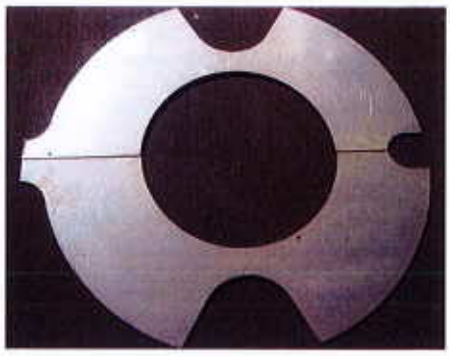


Figure 30 - Shim for Primary Spring

6.3 Shim for Secondary Spring

- Shim for secondary spring has 8mm, 4mm, 2mm and 1mm.

Note: Shimming of secondary spring is to adjust height of secondary suspended parts of bogie and car body above tolerance (include same height on right and left side with a maximum difference of 1mm).

Figure 31 - Shim for Secondary Spring

7 List of tools and Equipment and Special Tools

7.1 Tools and Equipment

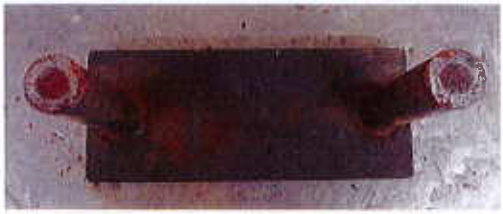
No.	Tools and Equipment	Picture
1.	Dial Calliper Gauge	
2.	Steel / Copper hammer	
3.	Flat screwdriver	
4.	Ratchet	

5.	Extension ratchet	
6.	Ratchet's socket (size : 17mm, 18mm, 19mm, 22mm)	
7.	Open-end spanar (size : 36mm, 19mm, 17mm, 13mm, 10mm)	
8.	Swedish pipe wrench	
9.	Measuring tape	

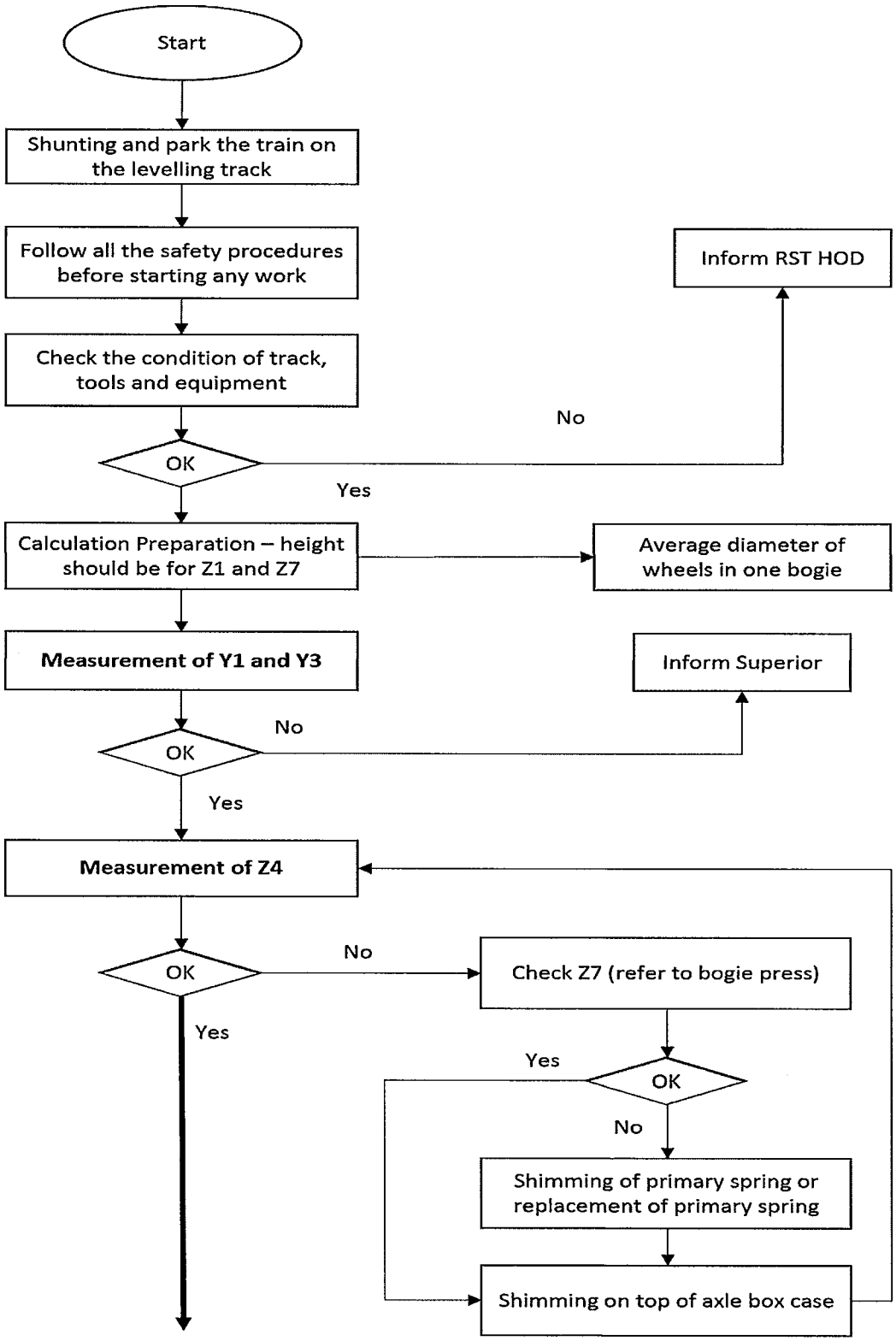
10.	Torque wrench 20 – 100 Nm	
14.	Torque wrench 70 – 350 Nm	
15.	Air tool	
16.	Levelling bar	
17.	Paint marker	

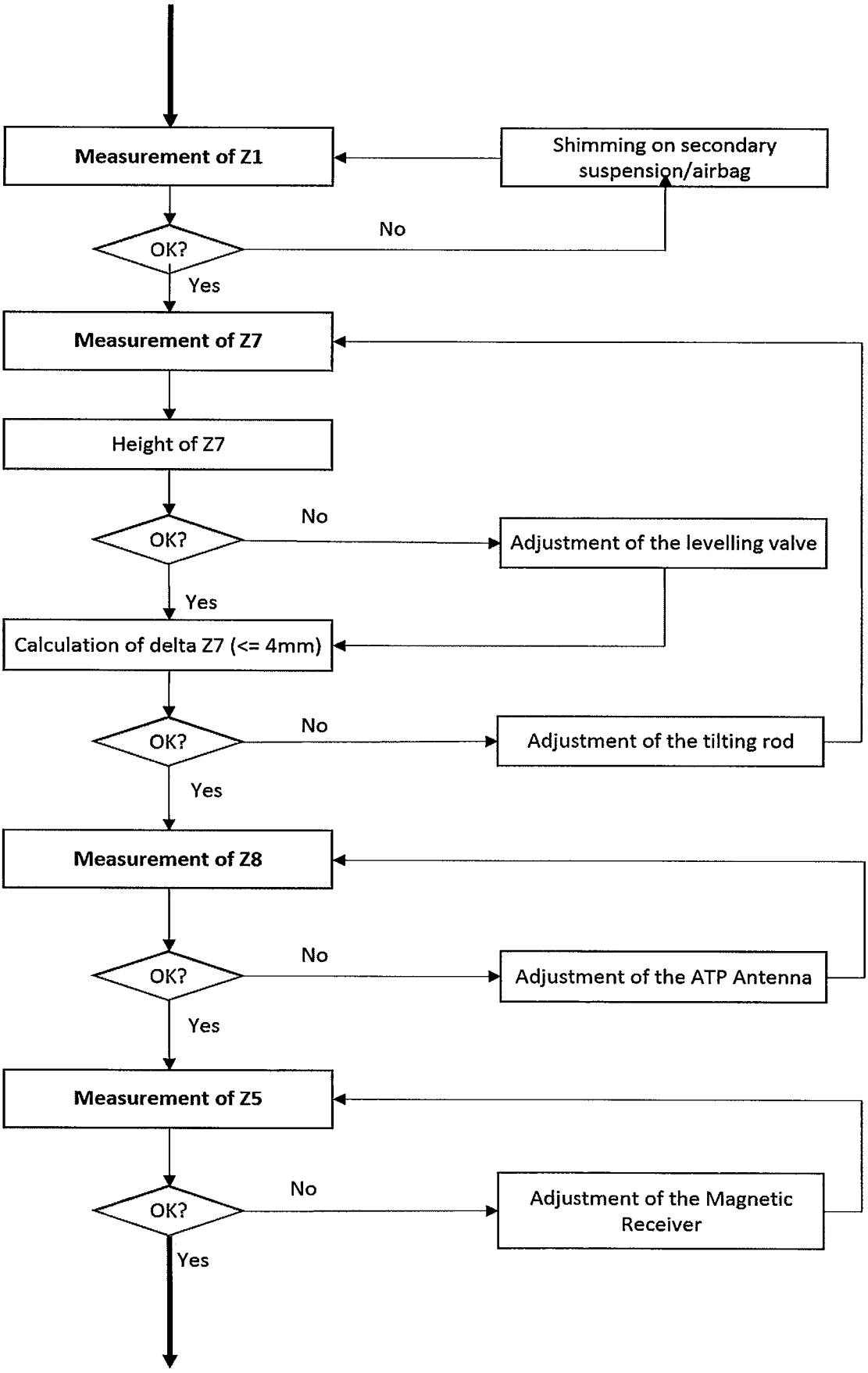
18.	Hydraulic jack pump	
19.	Steel Ruler	
20.	Water Level	

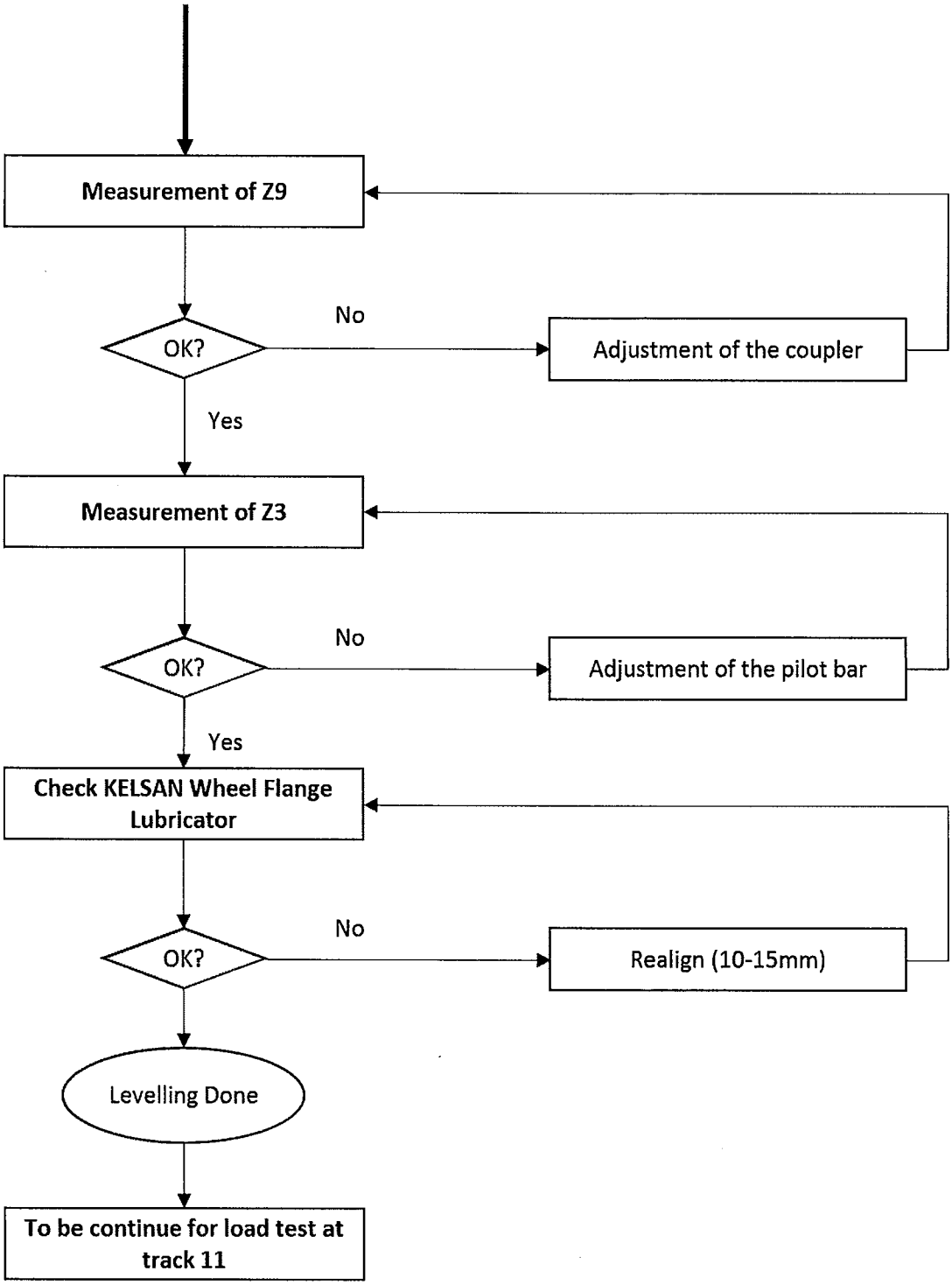
7.2 Tools and Equipment

No.	Special Tools	Picture
1.	Axle bearing stand	
2.	Air bag air venter - To vent air from the airbag	
3.	Primary suspension jack's tool - To add or removed shim from primary suspension.	
4.	Secondary suspension round bar (Ø ~ 55mm) - To add or remove shim from secondary suspension.	

8 Flow Chart for Levelling




Measurement of Z1
Shimming on secondary suspension/airbag
OK?
No
Yes
Measurement of Z7
Height of Z7
OK?
No
Adjustment of the levelling valve
Yes
Calculation of delta Z7 (<= 4mm)
OK?
No
Adjustment of the tilting rod
Yes
Measurement of Z8
OK?
No
Adjustment of the ATP Antenna
Yes
Measurement of Z5
OK?
No
Adjustment of the Magnetic Receiver
Yes


Measurement of Z9
OK?
No
Adjustment of the coupler
Yes
Measurement of Z3
OK?
No
Adjustment of the pilot bar
Yes
Check KELSAN Wheel Flange Lubricator
OK?
No
Realign (10-15mm)
Levelling Done
To be continue for load test at track 11

Appendices

1. Train Levelling Checklist, in RST Heavy Maintenance Checklist, [R00.OMR.M14100.PT.1007.*]
2. Levelling Measuring Table, in RST Heavy Maintenance Checklist, [R00.OMR.M14100.PT.1007.*]
3. Primary and Secondary Shimming Record, in RST Heavy Maintenance Checklist. [R00.OMR.M14100.PT.1007.*]