/3109675/2024

भारतसरकार (GOVERNMENT OF INDIA)
रेलमंत्रालय(MINISTRY OF RAILWAYS)
रेलवेबोर्ड (RAILWAY BOARD)

No.2021/Track-III/TK/12 New Delhi, dated 14.11.2024.

Addressed to:
As per list attached.

Sub:- Correction Slip No.5 to Indian Railway Track Machine Manual (IRTMM-2019).

The Ministry of Railways (Railway Board) have decided to make correction/addition/ deletion as indicated in the enclosed Correction Slip No.5 to relevant para/annexures of Indian Railway Track Machine Manual, 2019.

This has the approval of Additional Member (Civil Engineering), Railway Board.

Encl: As above

Vijay
14/11/2024

(Vijay Singh)
Executive Director Track (M&MC)
Railway Board

/3109675/2024.2021/Track-III/TK/12 New Delhi, dated .11.2024.

List

The General Managers (Engg.)- CR, ER, ECR, ECoR, NR, NCR, NER, NFR, NWR, SR, SCR, SECR, SER,SWR, WCR, WR and Metro Railway/Kolkata.
The General Manager (Const.), N.F. Railway, Guwahati.

The CAO/Const. All Indian Railways.
PFA All Indian Railways.
The General Managers (Engg.) – ICF/Chenai, RCF/Kapurthala, DLW/Varanasi, CLW/Chittranjan, W&AP/Yelahanka, Bangalore & DMW/Patiala,MCF/Rae Bareli, CORE/PRYJ.

The Director General (Track), RDSO/Alambagh, Lucknow.
Chief Commissioner of Railways Safety, Lucknow.

Managing Director, IRCON, New Delhi.
Managing Director, RITES, New Delhi.
Managing Director, DMRC, Metro Bhawan, Barakhamba Lane, New Delhi.
Managing Director, CONCOR, New Delhi.
Managing Director, RVNL, August Kranti Bhawan, Bhikaji Cama Place, New Delhi.
Managing Director, DFCCIL, Pragati Maidan, Metro Station, New Delhi.
Managing Director, PIPAVAV Railway Corp. Ltd., 1st Floor Jeevan Tara Building, Gate No. 4, Parliament Street, New Delhi.
Managing Director, MRVC, Church Gate, Station Building 2nd Floor, Mumbai - 400020
Managing Director, RLDA, IRCON Office Compound, Next to Safdarjang Rly. Station, Motibagh-I, New Delhi.
Managing Director, Konkan Railway Corporation Ltd., Belapur Bhawan, Sector-11, CBD Belapur, Mumbai, Pin- 400614.
The Chief Project Officer, DMRC, Pragati Vihar, New Delhi.

Director General, IRICEN, Pune.
Director General, IRIEEN, Nasik.
Director General, IRISET, Secunderabad.
Director General, IRIMEE, Jamalpur.
Director General, IRITM, Vill. Kanausi, Hardoi, Manik Nagar, Lucknow.
Director General, Railway Staff College, Vadodara.
Genl. Secretaries, AIRF, NFIR, IRPOF, FROA, AIRPFA, DAI (Railways) Rail Bhawan, New Delhi.

Copy to:-

PPS to, Chairman & CEO, Member (Fin), Member (Infra), Member (T&RS), Member (O&BD) and Secretary.

PPS/PS to AM(CE), AM (Works), AM (PL), AM (F), AM (T), AM(Staff).
AM(L&A), PED (Infra), PED(Bridge), PED(Vig).

PEDTK (M&MC), EDCE (G), EDCE (P), EDCE (B&S), ED (W), ED(Plg), ED(WP), ED(INF), ED(L&A), ED(PSU), EDVE.

Indian Railway Track Machine Manual, September-2019

Correction Slip No.5, Dated 09.11.2024.

A. A new para 116 to be added after para 115 of Chapter 1 as under:

116 Operation & Maintenance of Machine –

(a) Outsourcing of operation and maintenance for all type of machines except RBMV, UTV, MPT &PCCM, may be followed in following manner.

(i) During the currency of existing contract in which operation and maintenance is with OEM/sub-contractor, initial/refresher course of the staff of OEM / sub-contractor to be done as per G&SR from ZRTI.

(ii) Competency certificate is to be issued in favour of operation and maintenance staff who are designated for operation after duly completion of G&SR training and medical fitness examination.

(iii) Operation and maintenance contractor should arrange spares as per contract conditions for effective working of machines.

(iv) In order to operate the machine in a safe and responsible manner, authorized Railway's supervisor having route learning of the particular section should be deputed where the machine is working. Machine shall not be moved without authorized Railway's supervisor (JE/SSE).

(v) Operation and maintenance staff of OEM/sub-contractor should report to authorized Railway's supervisor (JE/SSE).

(vi) Authorized Railway's supervisor (JE/SSE) shall have overall responsibility for safe operation of machine.

(b) Operation and maintenance of RBMV, UTV, MPT & PCCM machines will be done by Departmental staff.

B. The Existing Para 304 shall be replaced by new para 304 as under:

304 Types of Ballast Cleaning Machines- Four types of ballast cleaning machines are presently available on Indian Railways:-

(1) Plain Track Ballast Cleaning Machine (RM80) (Plasser India) - This machine is capable of deep screening of plain track only and is not capable of working on turnouts. Scraper blades of excavating chain are fitted with 5 scraping fingers. The important dimensions of the machine are shown in sketch at **Annexure-3.1.**

(2) Points and Crossing Ballast Cleaning Machine (RM76) (Plasser India) - This is capable of deep screening of plain track as well as points and crossings without dismantling any component of points and crossing. For screening of points and crossing, which have longer sleepers, there is provision for extension of cutter bar by using 8 units of extension pieces, each 500 mm long; thereby providing for the maximum excavation width of 7.72 m.

Blades of cutting chain of this BCM are fixed with 2 scraping fingers. The important dimensions of machine are shown at **Annexure 3.2.**

(3) Plain Track and Points & Crossing Ballast Cleaning Machine (RM80 92U) (Plasser India) - This machine is similar to RM76 model except that it can handle heavier track structure with ease. The total excavation width of the cutter chain is 7.78 m, achieved by 7 extension pieces. Scraper blades are having 5 scraping fingers, in place of 2 in case of RM76. The important dimensions of machine are shown at **Annexure 3.2.**

(4) High output Ballast cleaning Machine - The machine consists of Ballast cleaning Machine and a stabilization unit. The machine gives increased output in traffic blocks (900 cum/hour or more). The screening followed by controlled consolidation of track by stabilization will also lead to longer retention of maintenance work. Two ballast containers of capacity 1.8 cum & 3.0 cum have been provided to store ballast and to utilize these as and when required. Presently, separate stabilizing machine is used behind the tamping machines for this purpose. The important dimensions of machine are shown at **Annexure 3.10.**

The main functions of HOBCM are:

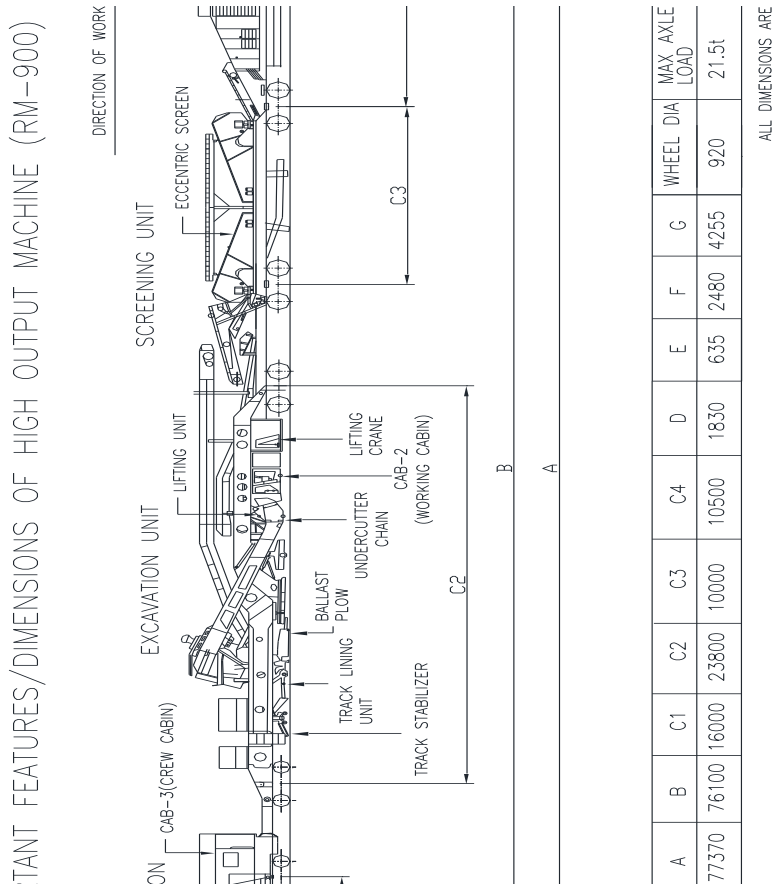
a. Screening of fouled ballast and disposal of muck away from track with higher output.
b. Restore clean ballast cushion, thereby improving the elasticity (resilience) of ballast bed.
c. Provide cross slope of formation.
d. Improve drainage of track.
e. Profiling of ballast.
f. Stabilization of track.

Some of the expected advantage of having combined machine for this purpose instead of two separate machines is:

(a) Operation of shunting is reduced and time lost in entry/exit to and from yard to block section is also reduced.
(b) A combined machine improves safety in movement vis-à-vis two machines following each other.
(c) Track occupancy is utilized optimally.
(d) Reduces number of operating staffs and also saves on fuel consumption thus lowering operational cost.

C. A new annexure, annexure 3.10 shall be added after annexure 3.9 as under:

Annexure-3.10



A	B	C1	C2	C3	C4	D	E	F	G	WHEEL DIA	MAX AXLE LOAD
77370	76100	16000	23800	10000	10500	1830	635	2480	4255	920	21.5t

D. The Existing Para 501 to 512 shall be replaced by new paras 501 to 512 respectively as under:

501 Rail Grinding Machine (RGM72 &96 stone) - Rail Grinding is done to re-profile the railhead taking into consideration the profile of the wheel for optimisation of the rail wheel contact band and thereby making rail wheel interaction favorable. This is expected to increase the life of the rail and the wheel, apart from reducing the rate of generation of defects in the rails. Indian Railway is using 72 & 96 stone grinder of RGI Series of Loram, USA Make machine.

(1) Purpose of Rail Grinding

(a) Rail grinding reduces the contact stresses and maintains favorable steering of the wheels. This will result in reduction in wear & tear and damage to the rail and wheel surfaces.

(b) Rail grinding shifts the contact of majority of the wheels from the area with surface defects on the rail, thus avoiding further growth of defects.

(c) Rail grinding avoids the contact of tread of wheel on misaligned welds, thus resulting in reduction in hunting on straight track and avoiding consequent damage.

(d) Rail grinding helps to control the damage due to rolling contact fatigue and removes the cracks in the initial stages of their development, thus avoiding their further growth deeper in the rail; thereby reducing rail/weld failures. The cracks will not be allowed to reach the stage of high growth and will be ground in initial stages when their growth is slow.

(e) Rail grinding removes the corrugations and other irregularities from the rail top resulting in better riding quality.

(f) Wheel radius is flatter than the rail radius of new rails. With the passage of traffic, the rail radius tends target flattened increasing the width of the contact band, which is not desirable. This causes hunting and damage to the rail surface. Rail grinding will restore the rail crown radius, thus reducing this damage.

(g) Rail grinding removes the white martens tic layer on rail top, which is the cause for development of cracks due to its brittle nature.

(h) Due to difference in hardness of rail and heat affected zone (HAZ) near welds, dip formation starts in the vicinity of the weld due to differential wear. This weld dip also promotes rolling contact fatigue (RCF) in various forms and also causes squat formation. This dip formation will be avoided by regular rail grinding.

(i) Rail grinding helps in reduction of wear due to reduced contact stresses by adoption of engineered rail profiles.

(j) Where other surface defects such as wheel burns, scabs, low or high welds etc. exist on rail, rail grinding helps to taper down the defects after each grinding pass so as to reduce the damage due to these defects.

(2) Advantages of Rail Grinding - The advantages that will accrue by rail grinding can be summarized as given below:

(a) Increased life of rail and wheel: There is appreciable increase in life of the rails afterrailgrinding.Thelifeofthewheelsisalsoreportedtoincreasebygrinding of rails.

(b) Improved reliability of assets: The defect generation rate of rails is reported to reduce to one-fourth on some of the railway systems. Reduction in failures will lead to increased safety and reliability of train operations.

(c) Less tractive resistance due to lesser impact & therefore be saving in fuel consumption.

(d) Improved reliability of USFD testing: Due to smooth and cleaner rail surface, the reliability of USFD testing will improve.

(e) Reduced track geometry deterioration: The track geometry will retain for longer period and the requirement of tamping of the track should come down.

(f) Reduced degradation of ballast: Due to lesser impact, the degradation rate of ballast will come down. This should result in reduction in the frequency of deep screening of track.

(g) Less noise: The noise level goes down after rail grinding.

(h) Reduced derailment proneness: The overall improvement in rail wheel interaction will result in better safety performance.

502 Important Assemblies of RGM

(1) Components of RGM 72 Stone-RGM consists of a formation of 6 vehicles, which moves as a train composition and is shown in Fig 5.1. The major components of RGM-72 are explained below:

(a) Front Control car(FCC)-1 No.

(b) Grind cars – 3Nos.

(c) Waterwagon-1No.

(d) Camp coach cum Rear control car(RCC)–1No.

Fig.5.1 (RGM-72 Stone)

Components of RGM 96 Stone-RGM consists of a formation of 8 vehicles, which moves as a train composition and is shown in Fig 5.1a. The major components of RGM-96 are explained below:

(a) Front Control car (FCC)-1 No.

(b) Grind cars – 4Nos.

(c) Water wagon-1No.

(d) Camp coach cum Rear control car (RCC) – 1 no. & Additional Camp coach - 1no.

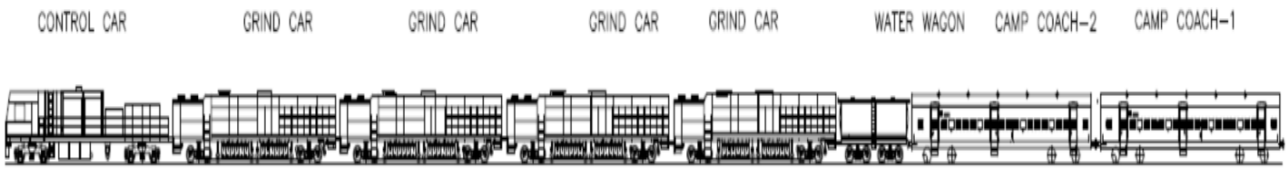


Fig. 5.1a (RGM-96Stone)

(a) Front Control Car (FCC) – This is air-conditioned cab provided for both driving and grinding operations. For all grinding operations, the machine is having 2 touch screen consoles known as HMI (Human Machine Interface) consoles. These consoles are used for various settings, selection of patterns, viewing machine working etc. Hydraulic and pneumatic system diagnostic mode is also available. There are two CCD cameras with one monitoring FCC showing the view of the track in front as well as the in rear of RGM formation. All driving and braking levers, gauges and switches are available on the front desk. The dimensions of Front Control Car of RGM-72 stone & RGM-96 stone are given in Annexure 5.1. The Front Control Car components in the RGM 72 and 96 Stone machines as that Fig 5.2 & 5.2a respectively:

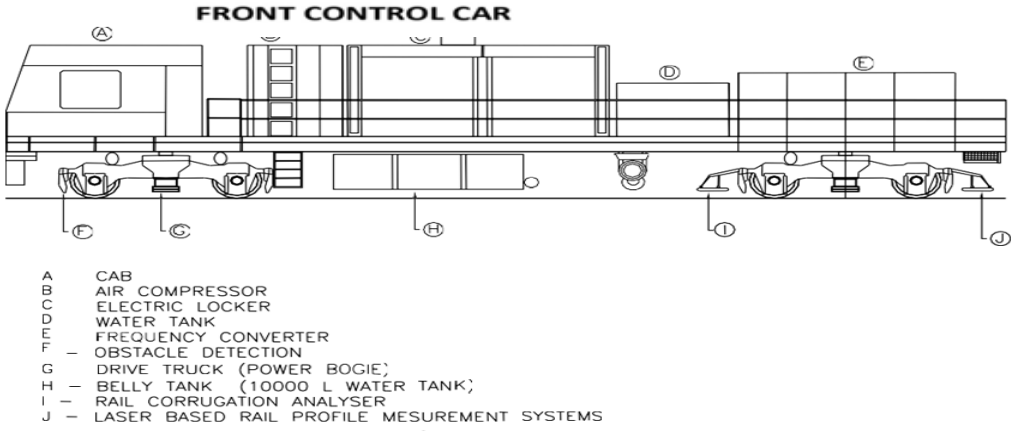


Fig. 5.2 (RGM-72Stone)

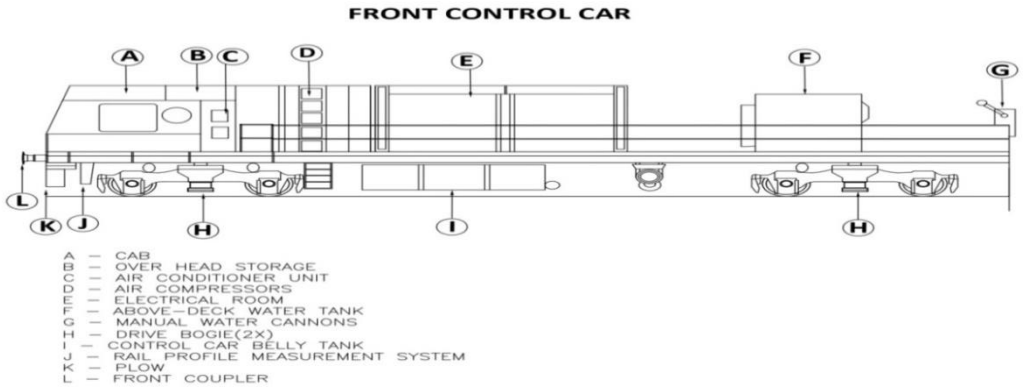


Fig.5.2a (RGM-96Stone)

(b) GrindCar–The components of grind car of RGM-72 Stone & RGM-96 Stone are given in Fig 5.3 & 5.3 a respectively:

The dimensions of grind car of RGM-72 stone & RGM-96 stone are given in Annexure 5.1(A) respectively.

(i) RGM-72 Stone Machine has three grind cars and each grinding car consists of two grind carriages and each carriage is having 12 grinding motors – six on each side.

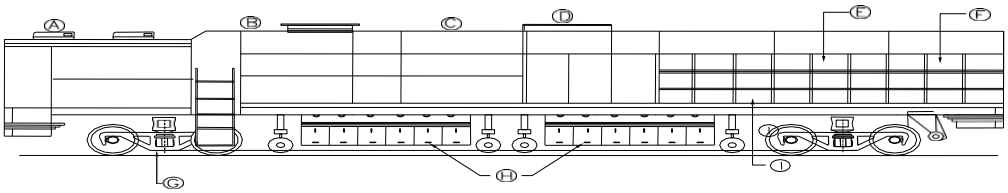
RGM-96 Stone Machine has four grind cars and each grinding car consists of two grind carriages and each carriage is having 12 grinding motors – six on each side.

(ii) The grind carriages known as buggies are provided with separate wheels and the buggies are kept in raised and locked position during idle running of the machine.

(iii) The grinding motors can be positioned in up or down condition when the buggies are down and running on the track.

(iv) During the working mode, the grinding motors are raised only in case of obstruction while the buggies keep running on track.

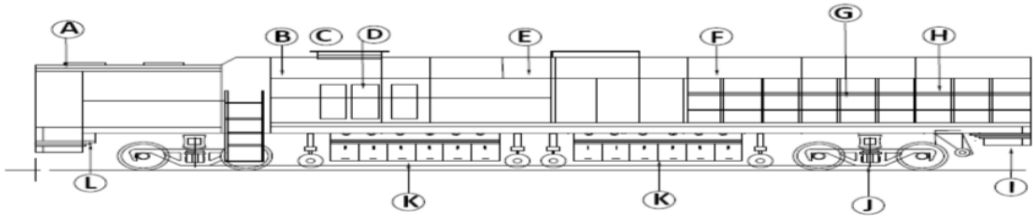
GRIND CAR



A – CAB
B – HYDRAULIC POWER
C – GENERATOR
D – ENGINE
E – DUST COLLECTOR
F – AIR COMPRESSOR
G – POWER BOGIE
H – CARRIAGE
I – FUEL TANK

Fig.5.3 (RGM-72 Stone)

GRIND CAR



A – WORK ROOM
B – BREAKER BOX
C – HYDRAULIC POWER UNIT
D – AUXILIARY FUEL TANK
E – GENERATOR/ENGINE
F – MAIN FUEL TANK
G – DUST BLOWER
H – DUST COLLECTOR
I – STORAGE CONTAINER
J – IDLER BOGIE(2X)
K – GRIND BUGGIES(2X)
L – TIE AND DITCH SPRAYS(GC1/GC4)

Fig.5.3a (RGM-96 Stone)

(c) Water Tank Wagon

(i) Water tank wagon is attached to Rail Grinding Machine to ensure sufficient availability of water to take care of fire hazards. Wooden sleepers in track, dry grasses in track/on cess are susceptible to catch fire due to heavy sparks generated during grinding operation. Water is sprinkled through 'Tie (sleeper area) Sprays' and 'Ditch (cess area) Sprays' provided on both front and rear of extreme grinding cars. Water sprinkling is done using the spray in advance of the grinding operation to wet the sleepers and cess to prevent fire.

(ii) The machine is equipped with 30 HP pump, water cannons, fire hoses, fire extinguishers and fire detection system to take care of fire hazards. Total water storage available on RGM-72 Stone machine is 75,000 litres (FCC – 20,000 litres + Water wagon – 55,000 litres)

Total water storage available on RGM-96 Stone machine is 75,198 litres (Water wagon 54000 litres, Belly Water tank 15520 litres, and above deck water tank 5678 litres).

(d) Camp coach cum rear control car (RCC) – The camp coach is having driving controls and is also known as Rear Control Car or RCC. Cameras are mounted on RCC over looking the

track in the rear and this image is also displayed on a monitor in FCC. This helps in sequencing the motors up and down as well as looking for any obstructions on the rear side of the train while carrying out grinding in reverse direction.

The RGM 96 equipped with two camp Coach. One of the camp coaches used for driving as well as for accommodation of staff and the other one will be used for accommodation of staff only.

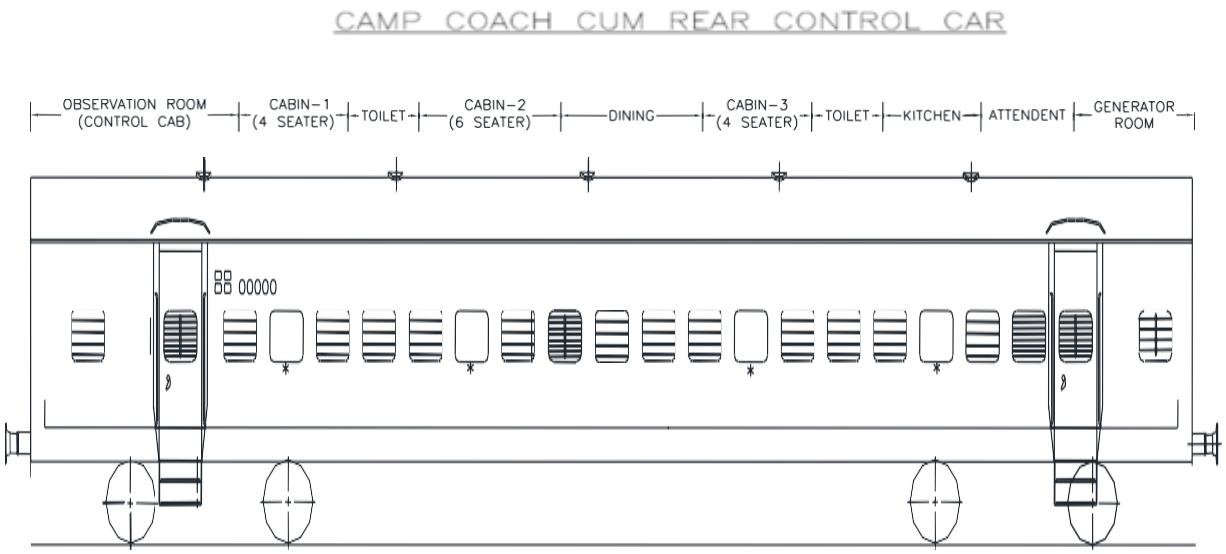


Fig.5.4

(2) Rail Corrugation Analyzer (RCA) –In RGM-72 stone**,** it is mounted on front axle of rear bogie of FCC. This measures the rail corrugation during running of the machine and gives an idea of the level of corrugations present in the track to facilitate the decision of depth of cut. It is not available in RGM 96 stone.

(3) Obstacle Detection System – It gives a warning to the SSE/JE/TM in case of any obstruction found in the track. The SSE/JE/TM can take appropriate action on getting a signal.

(4) Rail Profile Measurement System (Optical) – The machine is having two laser based rail profile measurement systems to measure the railhead profile before and after the grinding. These measuring systems are mounted at appropriate locations in FCC and water wagon.

(5) Dust Collection System – It is provided in the machine to suck the iron particles generated during grinding and to store them in a chamber so that the iron filings are not scattered along the track and also do not foul the environment. Iron filings are harmful for human beings and are also likely to cause damage to eyes. The dust collection chambers can be emptied as per convenience after the grinding run.

(6) Brake System- Following brake systems are provided on RGM Machines:-

(a) Indirect Brake – This brake is applied on machine with coupled camping coach/wagon automatically when air pressure of BP line releases through valve A9 or drops.

(b) Direct Brake – This brake is directly applied on all rolling stock attached with this machine. It is used for low speed braking.

(c) Emergency/Dump Brake – This is applied directly on the each rolling stock of the machine in the case of emergency for immediate stopping.

(d) Parking Brake – Hand operated brake systems are provided on each of the grinding cars for stabling.

(7) <u>Salient Features of RGMs</u>

(a) RGM-72 Stone

(i) Machine Dimensions: Length – 120.1 m, Width – 2746mm &Height – 3928mm.

(ii) Engine Make - Cummins, Model: QST30 G5 NR2, 1350 BHP, 1800 RPM on each grind car.

(iii) Generator Make Marathon - 900 kW, 480 VAC/60 Hz on each grind car.

(iv) Drive System: Diesel DC electric traction.

(v) Machine is capable of traveling and grinding in both directions.

(vi) Number of Modules: 72 HMI Computer controlled hydraulic powered (Automatic Tilt and Lift).

(vii) Type of Brake: Indirect brakes, Direct brakes, Emergency brakes, Parking brake.

(viii) Fuel Tank Capacity - 4542 Litre, Auxiliary fuel tank-3028 Litre on each grind car and Water Tank Capacity - 75,000 Litre.

(b) RGM-96 Stone

(i) Machine Dimensions: Length – 161.950 m, Width - 3250 mm & Height - 4344 mm.

(ix) Engine Make - Cummins, Model: QST30 G5 ATAC Tier II,1350B HP, 1800 RPM on each grind car.

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(ii) Generator Make Marathon - 900 kW, 480 VAC/60 Hz on each grind car.

(iii) Drive System: Diesel AC electric traction.

(iv) Machine is capable of traveling and grinding in both directions.

(v) Number of Modules: 96 HMI Computer controlled hydraulic powered (Automatic Tilt and Lift).

(vi) Type of Brake: Indirect brakes, Direct brakes, Emergency brakes, Parking brake.

(vii) Fuel Tank Capacity - 4542 Litre, Auxiliary fuel tank- 3028 Litre on each grind car and Water Tank Capacity - 75,000 Litre

503 Grinding Strategy

(1) **Strategy –** The metal removal during the process of grinding and the frequency of grinding is decided with a purpose to control Rolling Contact Fatigue.

(2) **Corrective Grinding –** Grinding done for complete removal of corrugations and surface defects in one cycle (with required number of passes in same or continuous blocks) to achieve the engineered rail profile is called corrective grinding.

(3) **Preventive Grinding –** Grinding done in the initial stages of defect generation is called preventive grinding. In preventive grinding, the grinding is done more frequently but the amount of metal removed during each cycle is much less as compared to corrective grinding. Preventive grinding is considered to be a better approach since the grinding can be done in a single pass at higher speed and the head hardened layer on the rail top is not removed.

(4) **Preventive-Gradual Grinding –** On Indian railway the surface defects, in the sections identified for rail grinding have passed the stage of preventive grinding. Corrective grinding on IR is not desirable on account of issue of blocks and likelihood of removal of head hardened layer. Thus, the strategy of Preventive –Gradual grinding has been adopted where in metal removal to be done more than that is required in case of preventive grinding but less than that required for corrective grinding. The stage of preventive grinding is expected to be achieved on IR, after 3 to 4 cycles of grinding.

(5) **Target Rail Profiles –**Target rail profiles are the rail profiles to be achieved after rail grinding and are designed to produce minimum contact stresses during rail wheel interaction. Nature of Rail Wheel interaction is different on straight track as compared to curved track. It is different on mild curves and on sharp curves, for high rail and for low rail of a curve. The target rail profiles to be achieved by grinding are therefore different for each of these locations and are designed to produce least stresses during rail wheel interaction.

(6) **Patterns–**Grinding stones are positioned across the rail head to achieve a particular pattern for removal of metal. The position of a stone is characterized by the angle of the rotation axis of the stone from the vertical. Thus, depending upon the angle, the location of the grinding by each of the stone on the railhead will vary. Power of grinding also be controlled. A pattern will be defined by angle and power of each of the motors working on the railhead. For grinding at different locations, it is required to select one of the designed grinding patterns to achieve the target rail profile in one or more passes. Different patterns may be used for left and right rail of the same track. Metal removal from the railhead will depend upon the following factors:

(a) The number of grinding stones working on a rail.

(b) The power of the motors.

(c) Speed of grinding.

(d) Number of passes.

(e) Hardness of the rail.

(f) Characteristics of grinding stones (depending on specifications of the manufacturer).

(g) Position of the grinding stones (angle of axis of rotation of the stone).

(7) Grind Data Management System (GDMS/RailPro™) –In RGM-72 stone Grind Data

Management System is an integrated automatic data acquisition, data management, quality control, reporting, and planning tool for Rail Grinding. GDMS is software-based system, which is fed with track data, different pre-decided patterns and proposed target profiles for different track geometry and structure. It uses these details to suggest patterns to be followed for grinding at different locations. It uses laser based rail profile management system available in the front as well as on the rear of the grinding machine to record the pre and post grinding rail profile. By taking a measuring run in advance, GDMS is having the facility of recommending one of the pre-fed patterns to get target rail profile from the existing rail profile. After measuring the existing rail profile and choosing the target rail profile, GDMS recommends patterns and speed to get the most efficient results.

In newly introduced 96 stone RGM, GDMS System is replaced by RailPro™ Suite. RailPro™ is an improved rail grinding management system which includes modules for data collection, rail profile inspection, grind performance monitoring, data management, analysis and generation of reports.

(8) **Grind Quality Index (GQI) –** The post grinding profile achieved is compared with the target rail profile by GDMS/RailPro™ and an index known as GQI (Grind Quality Index) is displayed during the run. GQI gives an idea about variation from the target rail profile. GQI value of 100 means that we have achieved the target profile within the specified tolerances. A lower value indicates the deviation. GQI value of 80 or above can be considered acceptable.

504 Capability of RGM

(1) RGM-72 Stone grinding machine consisting of 72 stones, i.e. 36stones each for the left rail as well as right rail and RGM 96 Stone grinding machine consisting of 96 stones i.e. 48 stones each for the left rail as well as right rail.

(2) Rotation of each is done by an independent electric motor of 30 HP. The speed of rotation is 3600 RPM. Each motor can be independently tilted at a desired angle from $+70^{o}$ (towards gauge face side) to -30^{o} (towards field side) in RGM-72 Stone and from $+70^{o}$ (towards gauge face side) to -20^{o} (towards field side) in RGM-96 Stone. This angle is measured from the vertical.

(3) The machine is capable of grinding of plain as well curved track, track in tunnels, track on bridges, glued joints and fish plated joints. Machine can work on curves up to 10^{o} and for track with gradients up to 3%. Check rails provided on curves, if any, are required to be removed, prior to the grinding. There is no need to remove the bridge guard rails. Level crossings, points & crossings, SEJs and axle counters create obstructions and are to be skipped by raising the grinding stones, while these features are encountered. It has also been observed that joggled fish plates provided on outer rail of sharp curves also create an obstruction and should be removed before grinding, as far as possible, to avoid grinding of the fish plate and resultant excessive wear to the grinding stone.

(4) The machine works in traffic block. However, no power block is required. Grinding can be done in either direction without the need for reversing the machine.

(5) The machine is capable of running while grinding, at a speed ranging from 2.4 kmph to

25 kmph, depending upon the quantity of metal to be removed. Generally, the speed is kept between 8 and 25 kmph during grinding.

(6) InRGM-72 stone, maximum cutting depth in each pass is around 0.13 mm at the working speed of 18 Kmph and around 0.20mm at the working speed of 15kmph.

In RGM-96 stone, the maximum cutting depth in each pass is around 0.13mm at the working speed of 22 Kmph and around 0.20 mm at the working speed of 18 kmph.

505 Working Parameters of RGM

(1) **General –** Indian Railways is initially doing preventive gradual grinding on the basis of target profile to be achieved, grind patterns and grinding frequency suggested by Loram in consultation with National Research Council, Centre for Surface Transportation Technology, Canada (NRC). After gaining experience, Indian railway should decide to shift to preventive grinding and modify target profile, patterns and grinding frequency accordingly, as required.

(2) **Target Profile –** NRC has designed four target rail profiles for Indian Railways as shown in fig 5.5 below. These are namely:-

(a) Contact Point Central (CPC).

(b) Contact Point Field (CPF).

(c) High Rail Sharp (HRS).

(d) High Rail Mild (HRM).

Loram has designed two new target rail profiles based on field experience for curved tracks in Indian Railways. These are namely:

(e) High Rail Sharp 2(HRS2).

(f) High Rail Mild 2(HRM2).

These two new profiles (HRS2 & HRM2) will be used for RGM-96 stone grinding machine instead of HRS and HRM.

(3) **Rail Wheel Contact Points –** CPC and CPF are one-point contact and HRS and HRM are two-point contacts on railhead as shown in the figure below. In CPF profile, the contact of the wheel on the rail will shift towards the field side (cess side) while in CPC the wheel will make the contact with the rail in the centre. In HRS2 and HRM2 gauge corner relief has been reduced from HRS and HRM profile due to which more steering was provided by gauge corner and shoulder, alleviating wheel flange contact and reducing gauge face wear.

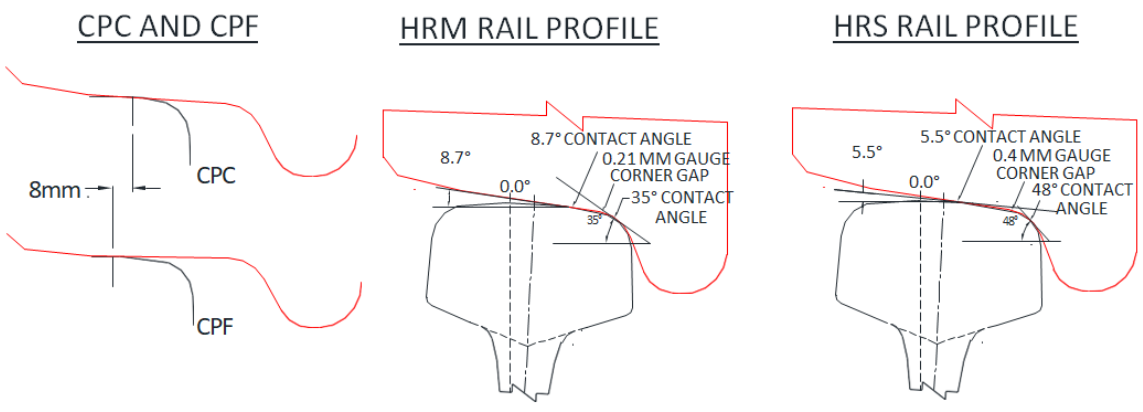


Fig.5.5

(4) **Selection of Target Profile–**For selecting the target rail profile, a curve more than 1.25 degree is called a sharp curve. The suggested profile for different track locations is tabulated below:

Table5.1 (Target Rail Profile-for RGM 72 stone)			
Location	**Line/Curve**	**RailSection**	**Grinding Template/Profiles**
Tangent(straight track)	UP	60Kg	CPF
Tangent(straight track)	DN	60Kg	CPC
Tangent(with hunting)	UP/DN	60Kg	CPF
Tangent(single line)	Single	60Kg	CPF/CPC (alternate CPC and CPF)
High sharp	> 1.25°	60Kg/52Kg	HRS
High mild	≤1.25°	60Kg/52Kg	HRM
Low sharp	> 1.25°	60Kg	CPF
Low mild	≤1.25°	60Kg	CPC
Tangent	UP/DN	52Kg	CPC
Low sharp and mild	UP/DN	52Kg	CPC

For the straight track, two profiles have been designed. CPC would be used on 'Down' track and CPF will be used for 'UP' track. The idea is to have half of the straight track with CPC and the balance with CPF. In case of long stretches of single line track, half of it will be demarcated for CPC and the other half for CPF.

Table 5.1 a (Target Rail Profile-for RGM 96 stone)			
Location	**Line/Curve**	**Rail Section**	**Grinding Template/Profiles**
Tangent(straight)	UP	60/52Kg	CPF
Tangent(straight)	DN/Single	60/52Kg	CPC
High sharp	> 1.25°	60/52Kg	HRS2
High mild	≤1.25°	60/52Kg	HRM2
Low sharp	> 1.25°	60/52Kg	CPF
Low mild	≤1.25°	60/52Kg	CPC

(5) **Grind Patterns –**Loram in consultation with NRC Canada has designed 50 patterns for grinding by RGM-72 Stone machine and at present 100 patterns (50 patterns in Group 0-normal patterns & 50 patterns in Group 1- additional pattern) for grinding by RGM-96

stone machine for Indian Railways. Since the target rail profile changes from straight to a curved track and will also be different for the high rail and the low rail of curved track, the pattern to be selected will also be different for all such situations. The patterns of RGM-72 stone & RGM-96 stone are shown in Annexure 5.2 & Annexure 5.2 a respectively.

Only one pass is generally done for straight track and 3 passes are done for curved track. 3 passes on curved track are done in the same block by stopping the machine after first pass, doing second pass by running the machine in reverse direction, again stopping the machine after second pass on curve followed by third pass in normal direction. For the first pass on curves, pattern suggested by Loram is used. The pattern for second and third grinding passes on curves is suggested by GDMS/RailPro^{TM} from the list of patterns on the basis of profile achieved after first grinding pass and known target profile. Target profile is known to machine on the basis of track data with detail of tangent, curve, starting and end of curve etc. fed in GDMS/ RailPro^{TM} in advance. The patterns suggested in Annexure 5.2 & 5.2 a are only for first cycle of grinding on the section. For subsequent cycles of grinding, the patterns are required to be revised.

(6) **Grind Cycle –** The grind cycle suggested by M/s Loram for preventive-gradual grinding for RGM-72 stone Machine is as below:-

Table5.2

Cumulative GMT in the section from start of grinding	**Cycle#**	**Track Classification**			
		Tangent (Straight) Track	**Mild Curves**	**Sharp Curves**	**Test Sites**
0	Grind1	SinglePassat 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile
25 (Approx)	Grind2	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF
75 (Approx)	Grind3	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF
125 & soon (Approx)	Grind4 &soon	Single Pass at 15 kmph	3 passes at 18 kmph	3 passes at 18 kmph	Monitor Profile and RCF

The grind cycle may vary for some special sections like KK line for which separate guidelines will be issued by RDSO. Where more than one passes is required (generally on curves), speeds and patterns for the second and the third pass will be as suggested by GDMS software.

The grind cycle suggested by M/s Loram for preventive-gradual grinding for RGM-96 stone machine is as below:-

Table 5.2 (a)						
Cumulative GMT in the section from start of grinding	**Cycle#**	**Track Classification**				
		Tangent (Straight) Track	**Mild Curves**	**Sharp Curves**	**Test Sites**	**Remarks**
0	Grind1	Single Passes at 22 kmph	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	Monitor Profile	Curve track - For full coverage of the rail head 96-Stone RGM will execute 1 (one) pass. However, for the preventive gradual strategy, existing surface conditions and thereafter for each round of grinding, the Rail Popup tool will provide guidance on sub sequent passes to be done by the machine in such sections if required.
25 (Approx)	Grind 2	Single Pass at 22 kmph	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	Monitor Profile and RCF	
75 (Approx)	Grind 3	Single Pass at 22 kmph	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	Monitor Profile and RCF	
125 & so on (Approx)	Grind 4	Single Pass at 22 kmph	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	1 pass at 22 kmph & Subsequent Passes (2^{nd} & 3^{rd}) would be called by RailPro popup tool.	Monitor Profile and RCF	

Note-(i) First preventive grinding for newly laid track is to be done as soon as possible after laying but within passing of 5 GMT or 6 month whichever is earlier.

(ii) Each Zonal Railway a block section (preferably higher annual GMT) in every rail grinding cycle shall be left unground so that comparison of various parameters between ground & unground track can be done. The block section selected should contain straight and curve (mild & sharp) track.

It shall be distinctly marked by providing the boards on both ends. In this unground block section test sites for tangent as well as curve (mild & sharp) to be marked & readings of track in pre prescribed format as per grinding frequency is to be taken and data to filled up in TMS so that it can be compared with data of ground section for analysis.

506 Monitoring Equipment for Grind Quality

(1) **Rail Profile Measuring Equipment –** It is an equipment for measuring the profile of rail head to the accuracy of 0.011 mm. This is contact type rail profile measuring system. The

measured data is useful for knowing the wear of rail due to traffic and wear of the rail due to grinding. It is also used to compare the post grind profile to the target profile to assess the appropriateness of the grinding parameters.

(2) **Bar Gauge –** This is a hand held instrument used for measuring of profile of the railhead. Fourtem plates are attached to this gauge for 6 target profiles, namely CPC, CPF, HRS/HRS2and HRM/HRM2. Deviation of existing profile from target profile is quickly known by putting one of the templates over the railhead and then using taper gauge to measure the gaps. The tolerances to the template are given in table 5.3.

Table5.3

Tolerances to Templates

Template	Gauge Corner (+65^0 to +16^0) in mm	Mid Gauge/shoulder (+16^0 to +6^0) in mm	Crown (+6^{o}to -4 ^{o}) mm	Far Field> -4^{o}mm
HS/HS2	+0 to -0.6	+0 to -0.6	+0.3 to -0.3	+0.3 to -0.3
HM/HM2	+0 to -0.6	+0 to -0.6	+0.3 to -0.3	+0.3 to -0.3
LS-CPF	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3
LM-CPC	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3
T-CPC	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3
T-CPF	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3	+0.3 to -0.3

(3) **Star Gauge –** This gauge is in the form of template having five different rail top radii. This instrument is used to make a quick check to compare the actual radius of the rail top, before and after grinding operation.

(4) **Digital Inclinometer –**This is used to know the angle of grinding stone at a particular point on the rail surface. By simply keeping the instrument at a particular location, the angle will be known in digital form.

(5) **Surface Roughness Measuring Gauge –** Roughness after grinding is high. This gauge measures the roughness of rail. Roughness after grinding should be within acceptable limits (less than 12 micron).

(6) **Rail Hardness –** The grinding should not cut the head hardened layer from rail top completely. This will increase wear rate after grinding. This instrument is used to measure hardness before and after grinding.

507 Working of RGM

(1) Feeding of Track Data-

(a) The track, prior to grinding, is surveyed and track data fed in an excel sheet, as per proforma enclosed of RGM-72 stone & RGM-96 stone at Annexure 5.3 & 5.3 a respectively and e-mailed to RDSO.

(b) The formatting of field data to GDMS/**RailPro^{TM}** format for use in RGM is done by RDSO/Railway.

(2) Patterns and target profiles are pre-fed in the machine. These can be modified, if required.

(3) Pattern for first pass is as recommended by Loram. Curves require 3 passes during the

same block. The pattern for second and third pass on curves is suggested by GDMS/**RailPro^{TM}**on the basis of Rail profile achieved after previous pass and final target rail profile (CPC/CPF/HRS/HRS2/HRM/HRM2) desired for the track geometry at that location.

(4) RGM can work in either direction. Therefore, direction of machine is not required to be changed for second and third pass in curves.

(5) Since lot of sparks are generated during grinding and there is fire hazard associated with grinding, due precautions should be taken in this regard.

508 Quality Inspection of Grinding - It is essential to monitor quality of grinding. Following methods are used for assessing the benefit of grinding and grind quality achieved.

(1) Test Site Monitoring – A typical test site is represented in the Fig 5.6 below. It consists of stretch of track covering three sleeper spacing divided into three parts – first for measuring rail profile by Rail profile measuring equipment (Marked as MP), second for taking surface photographs and the third for doing Dye Penetration Test and taking DPT photographs.

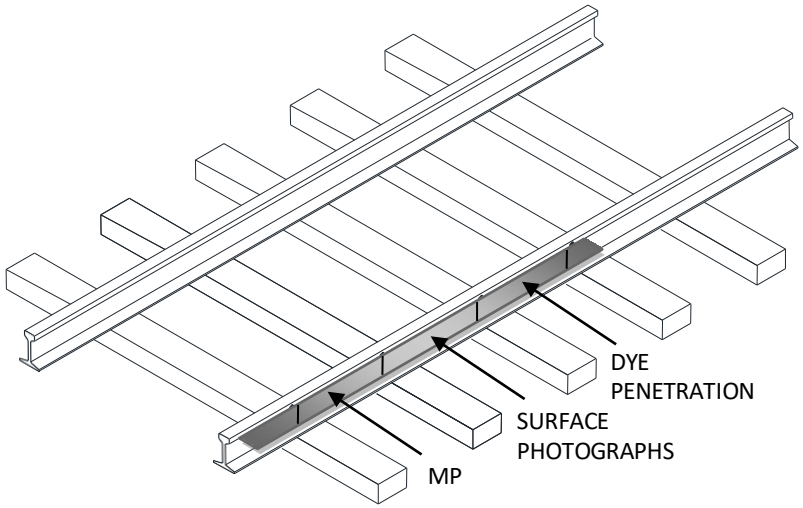


Fig.5.6

(a) Test Site– Test sites to be created in TMS sections as per deployment priority of Rail grinding machine given in para 613 (6) of IRPWM.

(i) One Test site shall be preferably is created/located in each TMS sections. During creation of test site in TMS "location" of test site should be the full length (starting & end point) of TMS section. However TMS sections less than 10 km may be left for creation of test sites.

(ii) Test site shall be planned where track renewal not planned in near future. Rail should have preferably 50 % of GMT life remaining and are expected to remain in service for at least 3-4 years period.

(iii) In each Zonal railways preferably equal number of test sites shall be created in Tangents, mild Curve (<1.25 degree) & sharp curve (>1.25 degree).

(iv) Test sites shall be chosen in such a way that these are away from signals ,defective/damaged rail , weld , glued joints , way side lubricators etc where train achieved its maximum sectional speed. Ease of access by road will facilitate movement to site for measurement/ inspection without dependence on trolley/train.

(v) Each Test Site consists of 3 test spots at the interval of 80-100 m apart. A typical test spot consist of 3 sleeper spacing- one for rail profile data, second for taking surface photographs and third for dye penetration test. 3 test spots are created to ensure true representation of the TMS section even if rail in one or two test spots have been changed. If all 3 test spots are disturbed due to rail change for any reason (Rail/weld fracture, defective rail etc.), new test site has to be created.

(vi) Wear (Vertical, lateral & angular) shall be taken at all 3 test spots of each test site. However DPT testing and measurement of contact band (Passenger as well as Goods train) can be done at any one test spot out of 3 test spots of test sites. If any test spot is disturbed due to rail change, wear to be measured in balance spots; DPT Testing & contact band measurement is taken on any one spot of the balance spots and so on.

(b) Measurement by Rail profile measuring equipment –The first portion of the test site is marked as 'MP' (Measured Profile) and an arrow is painted here. This is the location where rail profile will be measured every time before and after the grinding. The closer is the achieved profile of the rail to the target profile after grinding; the more will be the benefits accruing from it. It is essential to monitor the deviation of the post grinding profile with the target profile. This will also help in making a decision on the choice of the pattern for the future grindings. The measurement made by rail profile measuring equipment should also be used for calculating depth of grinding to ascertain the efficiency of rail grinding machine.

(c) Monitoring Contact Band – The location of contact of the wheel on the rail should change after the grinding. The rail-wheel contact band indicates this. Most of the wheels should make a contact on rail in a desired width on the railhead. Therefore, a clear change in contact band location and size should be visible after the grinding. The contact band is to be monitored in curve and on straight track before and after grinding. Identification of contact band on railhead is done by spraying paint or making chalk marks on rail surface and allow a freight train pass over it. This will manifest in a form of erasing of the paint or chalk covered area in a band like formation. Details of location, date, width of contact band, distance from gauge face etc. should be written and a photograph showing contact band and details written on rail foot is taken for record.

(d) Dye Penetration Test – At the second portion of the test site, dye penetration test is done, so that the damage on the rail surface including the cracks will become prominent. Dye penetration test is carried out before and after grinding. Extent of reduction in number and length of cracks indicates the efficacy of the grinding.

(2) Other Quality Checks

(a) Monitoring Rail Surface Finish – The condition of the rail top after grinding gives a lot of clues about the quality of grinding. A good finish should have regular grind marks of the grinding stones (these are known as facets) with silver finish. A bad finish will have irregular marks or skipped grinding at regular interval or blue colour on rails at certain locations (known as blueing defect) or irregular facet width etc. The facet width (the width of the marks left by grinding wheels) should be about 10 mm in the centre of the rail and4 mm at the corners.

(b) Surface Roughness after Grinding – The rail surface should not become too rough after the grinding. The surface roughness level should not go beyond 12 microns after grinding.

(c) GQI before & after Grinding – GQI stands for Grind Quality Index, which is a measure of the efficacy of the grinding with respect to the target rail profile. The GQI value 100 indicates that the target profile has been achieved fully. The lower the value, the more is the deviation from the target profile. During the run, GDMS/**RailPro^{TM}** screen displays GQI for both the rails before and after grinding separately. GQI of 80 and above is considered acceptable.

(d) Crown radius – Crown radius of the railhead is measured before and after grinding by star gauge. The crown radius should be closer to 250 mm at centre of railhead after grinding.

(e) Monitoring by RDSO–The revised Performa enclosed as Annexure 5.4 **i**s to be filled by field units and data feeding in TMS every time before and after grinding. RDSO shall study the data received from different railways and decide on appropriate grinding parameters and grinding cycle. The proforma may be revised by RDSO, based on the experience gained.

509 Preparatory Works for Introduction of RGM

(1) Arrange for proper stabling facilities for the machine at about every 30-50 km distance.

(2) Identify the Railway Consumer Depots (RCDs) and plan for timely supply of diesel to the machine.

(3) Make the arrangements for supply of water(75000litres) to the machine.

(4) Plan for the adequate traffic blocks for the working of the machine.

(5) Arrange for all the equipment for taking the required measurements.

(6) Collect the track data for feeding in GDMS/RailPro^{TM}software installed in the machine.

(7) Note down chainages of the level crossings, SEJs, Points & Xings, Axle Counters, start and end of curves. Direction of track measurements for collecting details should be considered in the direction of increasing km, irrespective of direction of movement of traffic on that line.

(8) Find out history of the rail wear, surface damage on the rail, USFD defects, rail/weld failures etc. in the section where grinding is being done and study the changes in these

parameters as the grinding is done.

(9) Identify the stretches of the track which will be skipped during grinding like rails planned for renewal in next two years, e.g. rails having severe corrosion and liner bite corrosion etc.

(10) Establish a test sites.

(11) Open a separate file for each test site in your section.

510 Pre-Block Activity before Deploying RGM

(1) Paint the sleeper prominently on either side of the SEJs, axle counter, points and crossings, level crossings and at the start and end of the curve for easy identification by the SSE/JE/TM while grinding.

(2) Ensure effective communication between FCC, RCC and staff on the ground.

(3) Counsel the staff and gatemen to keep everyone away from the machine during its working to avoid injury from flying sparks and iron dust.

(4) Counsel the staff working on track as well as the RGM to use safety gadgets such as helmet, goggles, reflective jackets, shoes etc. during RGM working.

(5) Measure the rail profile by equipment, carry out DPT and take surface photographs at each test site before grinding (say around 7 days prior). Keep these details in the file chronological.

(6) While filling diesel, ensure that diesel does not spill onto the rubberized spark guards, which may cause fire during grinding.

511 Operation during RGM Block

(1) On the Track

(a) Follow on a motor trolley behind the grinding machine and lookout for the fire in track or on cess and take necessary action.

(b) Check for the quality of surface finish visually for any irregular grinding, blueing of the rail, skipped grinding etc.

(c) See the facet (grinding marks band) width is about 4 mm at the corners and about 10 mm at the centre of the rail.

(d) Check the surface roughness at bad locations and see that it is not exceeding 12 microns.

(e) Check the profile at few places on straight and in curves after grinding with bar gauge and check how close or away are these from the target profile. See whether the profiles are within prescribed tolerances or not.

(f) Check the rail crown radius with the star gauge, the desirable radius being about 250 mm.

(g) Check the contact band in straight and curve track at test sites before and after grinding using paint/chalk in every block in addition to test site. Take a photograph and keep for record.

(h) See that the dust collection system is working properly.

(i) Inform any irregularity noticed to the SSE/JE/TM, and get it rectified.

(j) Ensure that a train with inflammable material is not allowed on adjacent track during the grinding operation, in case of double/multiple lines.

(2) On the Machine (SSE/JE/TM)

(a) Check whether the angles of motor, calibration of tachometer and calibration of Optical rail profile measuring device (KLD) has been done by the SSE/JE/TM as per the schedule.

(b) Check the proper functioning of the water pump and water cannons etc.

(c) Check that all the motors are working properly through the indication on HMI panel.

(d) Make a chart in advance for the pattern to be selected during the first pass of the grinding.

(e) Synchronize the chainage of the track on the machine before starting and during the working, as required.

(f) Check that the patterns being selected by the SSE/JE/TM are correct.

(g) See that the grinding speed is correct.

(h) Check that the SSE/JE/TM sequences the motors up and down correctly and promptly at the location of obstructions.

(i) Check whether the direction of the curve in GDMS/ RailPro^{TM} software is same as existing on the ground. Do not use GDMS/RailPro^{TM} suggested patterns for the second and the third pass on the curve in case the direction is wrong as it may spoil the surface profile. Choose the pattern manually.

(j) Make sure to remember to get the GDMS/RailPro^{TM} data corrected if the direction of curve is found to be wrong, so that the similar problem is not repeated during the next cycle.

(k) See that the patterns are changed promptly by the SSE/JE/TM on entry and exit of the curves.

(l) Check the GQI before and after grinding to check that there is improvement in GQI after grinding.

(m) Learn the working of GDMS/RailPro^{TM} software including recommendation for the pattern and speed for the second and third pass on curves.

(n) Check the pattern in use on the monitor, in real time.

(o) Look for any alarm on HMI of the machine and see that the SSE/JE/TM takes corrective action promptly.

(p) While starting the grinding, the buggies should be lowered on straight track only to ensure that the buggy wheels sit properly on rails .In case of curve, due to different wheel base of the buggy as compared to the wagon, the wheels may go off the rail on lowering. For the same reason, the raising of the buggies is also done on straight

track only.

512 Post Grinding Operation

(a) Take rail profile after grinding not later than7 days at the test sites.

(b) Carryout DPT test at test site within 7 days after grinding and take a photograph. Keep in file.

(c) Take a surface photo at test site within 7 days after grinding and keep in file.

(d) Preserve the soft copies of rail profile measurements and photographs.

(e) Superimpose the rail profiles before grinding and after grinding taken by profile measuring equipment on target rail profiles and analyze the results to calculate the metal cut and deviation from target profile.

(f) After taking all the test site measurements (before and after grinding) soft copy of the results should be uploaded in TMS (RGM).

(g) Ensure safe disposal of the grind dust in a yard.

512 A Lubrication of outer rail of curve

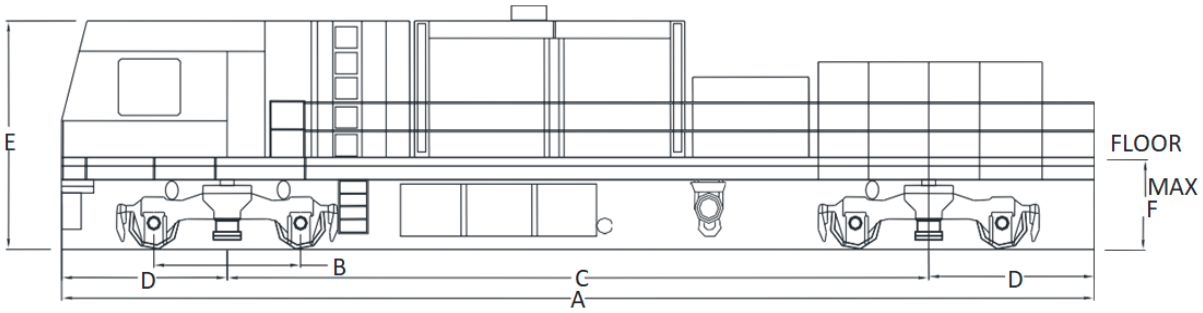
Lubrication of outer rail of curves where RGM's are working is to be done as per IRPWM para 424 (2).

E. The Existing Annexures 5.1, 5.2 &5.4 to be replaced by new Annexures 5.1, 5.2 & 5.4 respectively as under:

Annexure-5.1

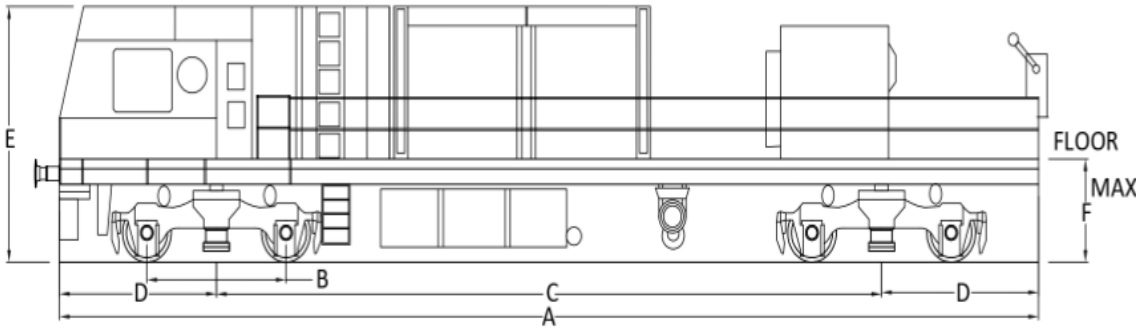
Features/Dimensions of RGM Control Car

RGM CONTROL CAR (RGM72 Stone)



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RGI CONTROL CAR	19304	2743	13114	3095	4104	1683		1000	22.75t	

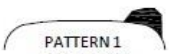
RGM CONTROLCAR (RGM96 Stone)



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RGI CONTROL CAR	19304	2500	13106	3099	4229	1636	-	920	21.40t	3022

Annexure-5.2

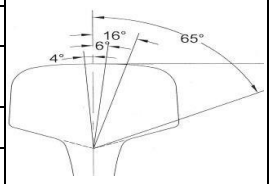
Pattern Sheet for RGM-72 stone

 PATTERN 1 +12 TO +60	 PATTERN 11 +4 TO +60	 PATTERN 21 +3 TO +25	 PATTERN 31 -5 TO +20	 PATTERN 41 -4.5 TO +45
 PATTERN 2 +1.5 TO +50	 PATTERN 12 +13 TO +60	 PATTERN 22 -3 TO +11.5	 PATTERN 32 -10 TO +20	 PATTERN 42 -10 TO +25
 PATTERN 3 +3 TO +20.5	 PATTERN 13 -2 TO +12.5	 PATTERN 23 -1 TO +20	 PATTERN 33 +2 TO +25	 PATTERN 43 -2 TO +20
 PATTERN 4 +3.5 TO +60	 PATTERN 14 +13 TO +60	 PATTERN 24 +1.5 TO +40	 PATTERN 34 +3 TO +30	 PATTERN 44 -10 TO +10
 PATTERN 5 -7 TO +7	 PATTERN 15 +1 TO +10.5	 PATTERN 25 +2 TO +31	 PATTERN 35 -4 TO +30	 PATTERN 45 -6 TO +50
 PATTERN 6 +9 TO +60	 PATTERN 16 +2 TO +25	 PATTERN 26 +4 TO +18	 PATTERN 36 -5 TO +21	 PATTERN 46 -6 TO +35
 PATTERN 7 +1 TO +25	 PATTERN 17 +2 TO +33	 PATTERN 27 -4 TO +7.5	 PATTERN 37 -5 TO +27	 PATTERN 47 -6 TO +45
 PATTERN 8 +6 TO +60	 PATTERN 18 +1 TO +25	 PATTERN 28 -8 TO +10.5	 PATTERN 38 -5 TO +32	 PATTERN 48 -6 TO +45
PATTERN9+3.5 +19 TO +60	PATTERN 19 -5 TO +5.5	PATTERN 29 -8 TO +21	PATTERN 39 -8 TO +45	PATTERN 49 -6 TO +50
PATTERN10 +14 TO +60	PATTERN 20 +6 TO +37	PATTERN 30 -10 TO +20	PATTERN 40 -1 TO +60	PATTERN 50 0 TO 0

Annexure- 5.4

Rail Grinding Monitoring Proforma
(A) For Site Identified for Monitoring
(Details of Test locations)

Rly……..	Divn……..	Route……..	Section…… Km/TP……
Rail Section/UTS……..	Type of sleeper……..	Sleeper density……..	Ballast cushion…
Tangent/Curved track……	Degree of curve……..	Line (UP/DN)……..	Axle load……
Total GMT carried……..	GMT (Current)……..	Date of Last Grinding……	Gauge (in mm)….
Engineered rail profile Template used……..		Rolling mark of rails……..	

S.No.	Item Description	Observations on Left Rail **		Observations on Right Rail**		Remarks
		Before Grinding	After Grinding	Before Grinding	After Grinding	
A	Visual Inspection (severity be indicated)*					
	1. Gauge corner chipping (Y/N)					
	2 .Metal Flow of rail top / Burring (Y/N)					
	3. Rolling Contact Fatigue (Visual inspection & Dye Penetration test)					For a)to c)
	a) Gauge Corner (65 to 16 deg.) (Y/N)					
	b) Shoulder/Mid Gauge of Rail (16 to 6 deg.) (Y/N)					
	c) Crown of Rail (6 to – 4 deg.) (Y/N)					
	d) Pitch of fatigue cracks (mm)(Range)					
	a) Max. length of fatigue crack (mm)					Field Gauge
	4. Wheel burns and Scabbing (Y/N)					
	5. Any other defect observed					
B	Corrugation (Y/N)					
C	Hunting (Cyclic Wear) (Y/N)					
D	Track Geometry parameters					Parameters of the concerned blocks (SD & worst peak) of test site location should be taken from the records of TRC run just before grinding.
	1. Gauge					
	2. Twist					
	3. Unevenness (9.0 m chord)					
	4. Alignment (9.0 m chord)					

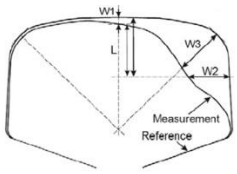
* Hard & soft copies of Photographs of the test locations before and after grinding, after Dye penetration test indicating condition of rail (size of defect, location in Km, Line, indication of gauge face, direction of traffic) be sent.

**Indicate Low or High Rail incase of curve. Left and Right rails shall be marked w.r.t direction of increasing kilometers in the section.

NOTE:1. Details for each Tangent, Mild Curve ($\leq 1.25^0$) and Sharp curve ($>1.25^0$) test locations shall be submitted separately in the proforma.

2. Corrugation and Hunting should be observed in the block section containing the test sites (few kms on either side of test site).

Date: (Signature of Inspecting official with Name/Designation)

S.No.	Item Description	Observations on Left Rail		Observations on Right Rail		Remarks
		Before Grinding	After Grinding	Before Grinding	After Grinding	
E	Type of contact of wheel on Rail (One/Two/Multiple point contact)					
	1. One point contact					
	a) Contact Band Width (mm)					
	b) Distance from gauge face side* (mm)					
	c) Gauge Corner contact (Y/N)					
	2. Two point contact					
	a) Contact Band Width (mm)					
	(i)					
	(ii)					
	b) Distance from gauge face side (mm)					
	(i)					
	(ii)					
	3. Multiple point contact					
	a) Contact Band Width (mm)					
	(i)					
	(ii)					
	(iii)					
	b) Distance from gauge face side (mm)					
	(i)					
	(ii)					
	(iii)					
F	Wear o frail** (in mm) Top Table (W1) Gauge Face (W2) Gauge Face Corner (W3)					 W1- To be measured at center of Rail W2- To be measured at 14.3 mm from top of Rail W3- To be measured at 45 degree from vertical
G	Weld dip at nearby location (Same weld to be measure every time)					
H	Post Grinding Roughness*** (Microns)					

*Distance measured upto center of contact band width.
**Measured by Rail Profile Measuring Equipment and soft copies of rail profiles be sent.
*** To be measured with equipment available at RGM, otherwise general observation to be recorded.

Date:

(Signature of Inspecting official with Name/Designation)

Rail Grinding Monitoring Proforma

(B) Route Specific

Railway……Divn…… Route……Section……. From Km/TP…… To Km/TP…… Line (UP/DN/Single)…….

Rail section and UTS……..Type of sleeper……. Sleeper density……Ballast cushion……Annual GMT…….. Cumulative GMT…….. Axle Load……..Start Date of grinding cycle for major section……..Date of last TRC run…….

Completion Date of Grinding cycle for major section……..

S. No.	Item Description		Straight Track		Mild Curve Track		Sharp Curve Track		Remarks
			Left Rail	Right Rail	High Rail	Low Rail	High Rail	Low Rail	
A	*Full details of locations **before grinding***								
	1.Rolling Contact Fatigue (Head checks) (Y/N)								
	2.Corrugation (Y/N)								
	3.Hunting (cyclic wear) (Y/N)								
	4.Other defects (gauge corner chipping, flow of rail top, corrosion, wheel burns etc., specify type of any other defect)								
B	Effectiveness of Lubrication in sharp curves (Y/N)								
C	Track Geometry (TQI Value) – before grinding*	Composite							
		Short Chord							
		Long Chord							

*Details to be given for specific locations wherever significant defect is noticed.

Note: The above details shall be recorded every time before grinding.

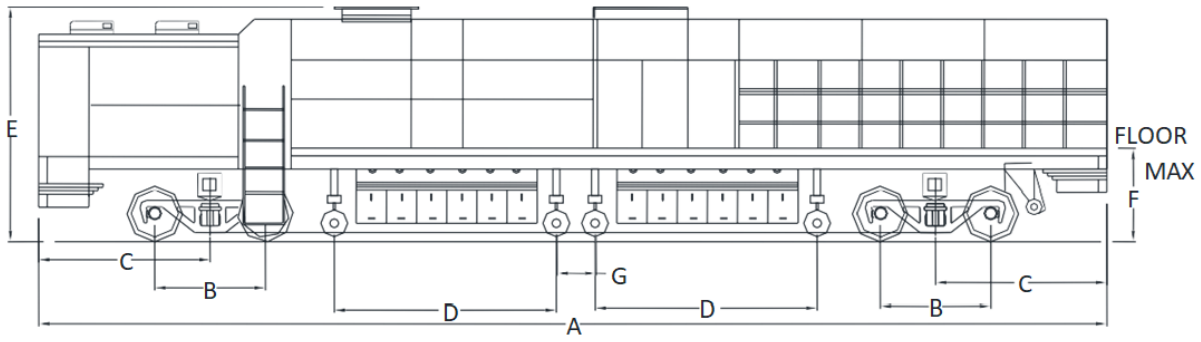
Date:

(Signature of Inspecting official with Name/Designation)

F. New annexures 5.1(A), 5.2(A) and 5.3(A) to be added after annexures 5.1, 5.2 & 5.3 respectively as under:

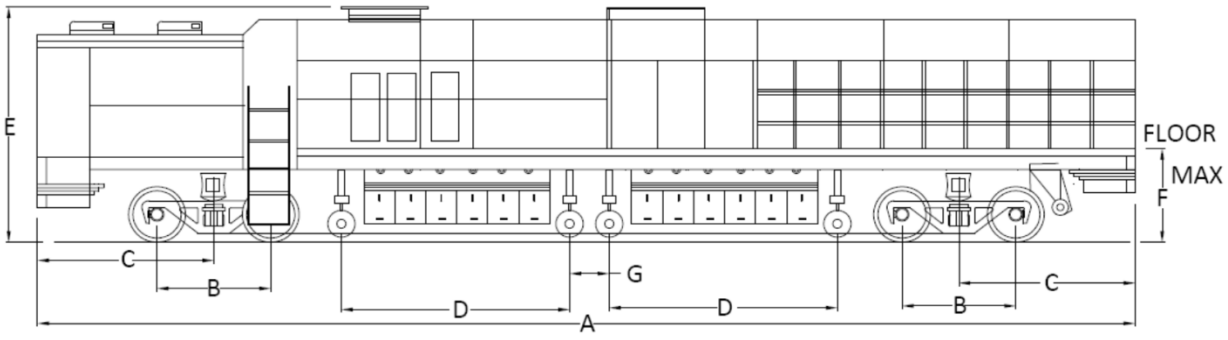
Annexure 5.1(A)

RGM GRIND CAR (RGM 72 Stone)



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RGI GRIND CAR	19304	2000	3099	4013	4231	1683		1000	20.0t	

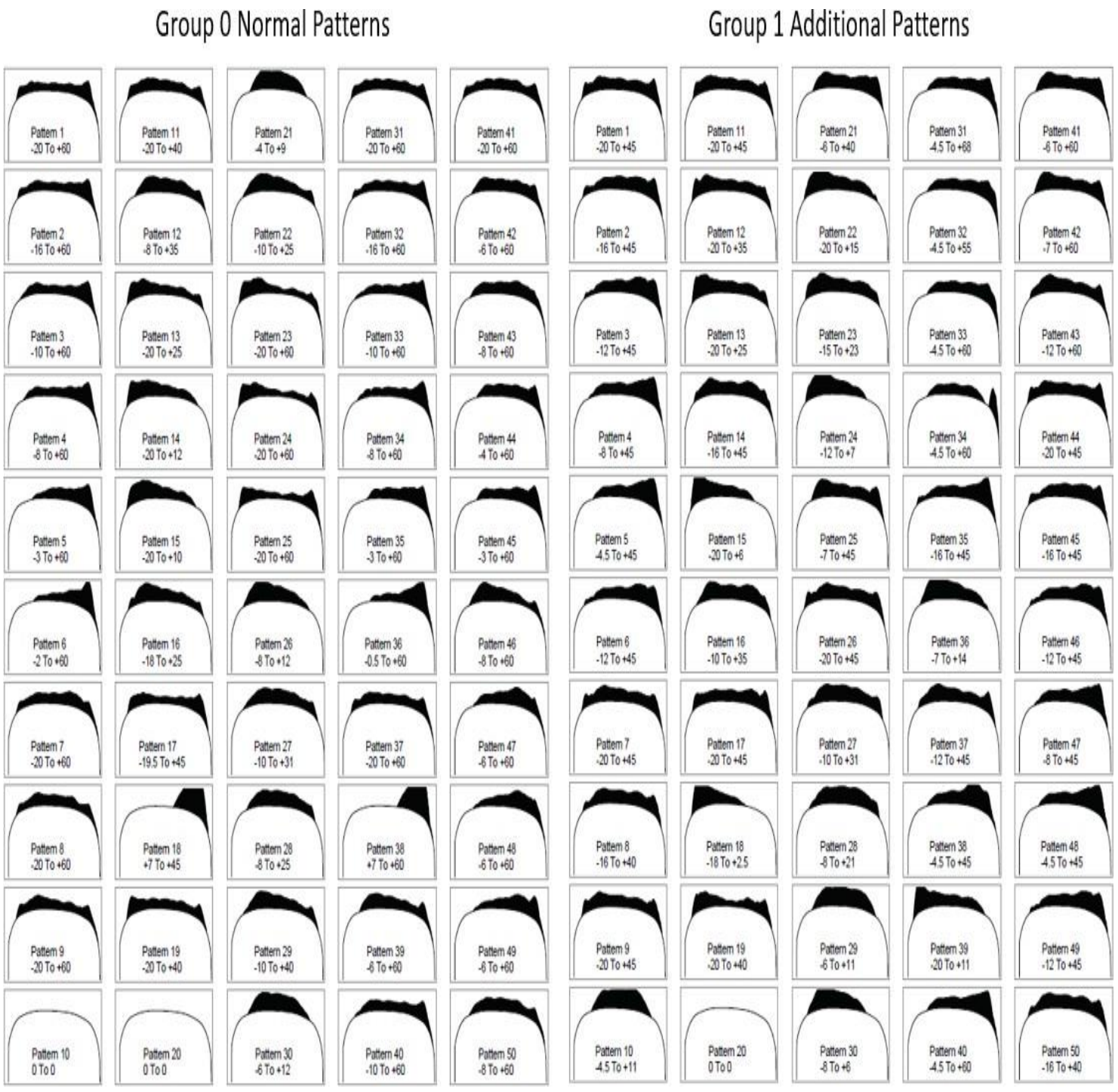
RGM GRIND CAR (RGM 96 Stone)



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RGI GRIND CAR	19304	2000	3099	4013	4232	1681	–	1000	21.16t	3153

Annexure 5.2(A)

Pattern Sheet for RGM-96 stone



Annexure5.3(A)

Performa for data feed in RailPro™

Note: Consider following Steps:

Id	Line	Region	Division	SubDiviisi	Track	TrackLeve	Km	Length	CurveNa	SPStart	CVStart	CVEnd	SPEnd	Degree	CurveDir	FeatType	FeatDesc	FeatLoc	EndFeatL	SwDir	SwTo	SwIsXO	Lat	Lon	52 Kg/60
1																									
2																									

- **Curve details in km point in meter format up to 3 digits**
- **In compound curve both curve bifurcate by at least 1 m.**
- **For UP and DN Track complete details in increasing km only.**

Complete RailPro™ Data in sample of 26 column format general formatting rules are given below.

General Data Formatting Rules

Column	Data Column	Data Type	Importance	
1	Id	Text	Recommended	The row number in the file.
2	Line	Text	Required	Name of the track line segment. Section details / block section.
3	Region	Text	Required	Railroad Region means Zone
4	Division	Text	Required	Railroad Division means Division
5	Sub Division	Text	Required	Railroad Subdivision means Subdivision
6	Track	Text	Required	Name of the track and used for location selection. UP , DN and SL etc.
7	Track Level	Numeric	Required	Track Level usually(0- SL & UP) (1-DN) ,(2-Others)
8	Km	Int	Required	An integer value specifying the kilometer location.
9	Length	Float	Required	The length in meters of the specified kilometer.
10	CurveName	Text	Optional	Curves are named by the program based on the curve start point.
11	SPStart	Int	Required	Starting point of the opening spiral. (Transition start location)
12	CVStart	Int	Required	Start of Curve body (Circular start)
13	CVEnd	Int	Required	End of Curve body (Circular end)
14	SPEnd	Int	Required	Ending point of the closing spiral (Transition end location)
15	Degree	Float	Required	The degree of the curvature of the

				curve.
16	Curve Dir	Text	Required	Either RH or LH indicating the direction of the curve in terms of increasing kilometer.
17	FeatType	Text	Required	Type of feature(Br , LC , Crossing , SEJ etc)
18	FeatDesc	Optional	Optional	Description of the Feature (Name and number)
19	FeatLoc	Int	Required	Start of feature location
20	EndFeatLoc	Int	Not Required	End of the feature location (only for Bridge , tunnel , Level crossing)
21	SwDir	Text	Not Required	Switch Direction namely LEFT or RIGHT(Increasing kilometer)
22	SwToTrack	Text	Optional	Switch is merging into the track UP or DN. Not filled up in IR left blank.
23	SwIsXO	Text	Optional	Switch leads to Crossover Typically N or Y. Not filled up in IR left blank.
24	Lat	Int/Float	Optional	GPS Latitude coordinates system. Not filled up in IR left blank.
25	Long	Int/Float	Optional	GPS Longitudinal coordinates system. Not filled up in IR left blank.
26	52 kg/60 kg	Int	Required	Indicate if the rail 52 kg or 60 kg

GUIDELINES

Feature types that data should be collected for:

- Track start and end points
- Kilometer posts
- Curves
- Switches
- Point features- list point features desired for database
- Length features-list length features desired for database

For the kilometer posts:

- Kilometer and distance in meters to next consecutive kilometer post.
- For lines/tracks that begin in the middle of a kilometer, include the previous kilometer post with the length to first kilometer post in the line/track.
- For line/tracks that end in the middle of a kilometer, include length to next consecutive kilometer post if it exists.

For the curves:

- Curve name, if not using decimal start locations as names
- 4 location points:
  Tangent to spiral point

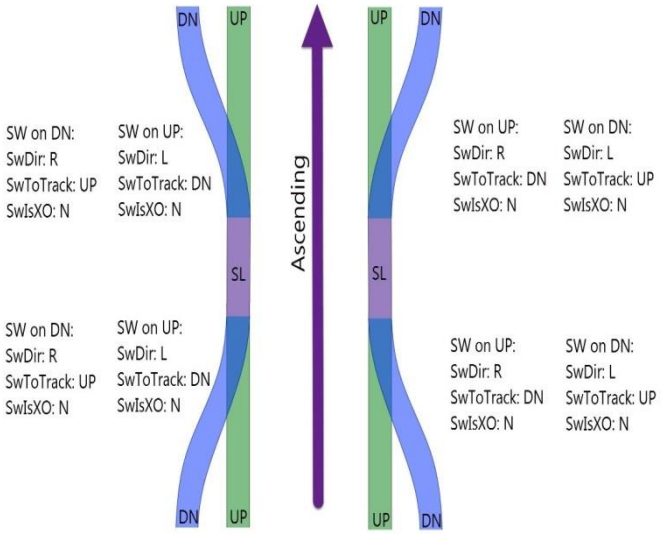
Start of curve body
End of curve body
Spiral to tangent point

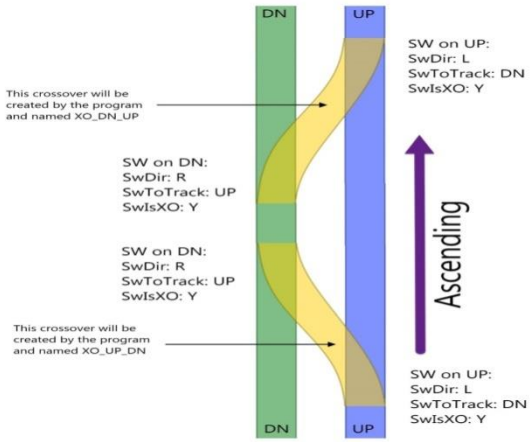
- All these points formatted as KM+offset
- The curve body should constitute at least 50% of the total curve, even if the radius is not completely uniform 20 meters minimum.
- Degree of curve
- Direction of curve in increasing kilometer.

For the switches (collect this information on each track the switch connects):

- Switch name(optional)
- Location of switch point as KM+offset
- Location of crossing body as KM+offset (can list with point features, but be sure to collect)
- Direction of the switch (side the crossing body is on when looking facing the higher kilometer post on that track.

See the diagrams below for help in filling column 21, 22 & 23 above with how to collect switch information.





For point features:

- Type of feature
- Location of feature as KM+offset (use midpoint if feature has length but can't be recorded as a length feature)
- Description (optional)
- GPS (optional)

For length features (crossings, bridges and tunnels):

- Type of features
- Location of feature start as KM+offset
- Location of feature end as KM+offset
- Description (optional)
- GPS (optional)

G. New para 516, 517, 518 & 519 to be added as under:

516 Switch Rail Grinding Machine (SRGM- Loram)

(1) General

RGI-20 (SRGM) Rail grinder is a machine designed to re-profile the rail cross section and to remove or reduce rail corrugations, corrosion, joint mismatches and other railhead surface irregularities. The 20Stone Switch Rail Grinding Machine (SRGM) is a typical "gap" grinder. The purpose of this machine is to specially cover sections that are left ungrounded by a large conventional mainline grinder. The machine can also be effectively used to grind sections of track near stations including the turnout portions& LC gates.

(2) Important Assemblies of SRGM

(i) Components of SRGM

SRGM consists of formation of 2 vehicles which moves as a train formation as shown in Fig 5.9

(a) Grind Car: It consist of Rail grinding equipment, dust collection, operator controls, power generation, hydraulics, hydrostatic traction, tie and ditch sprays and rail inspection.

(b) Camp Car: It consist of Operator controls, water pump and storage, rail inspection and convenience room

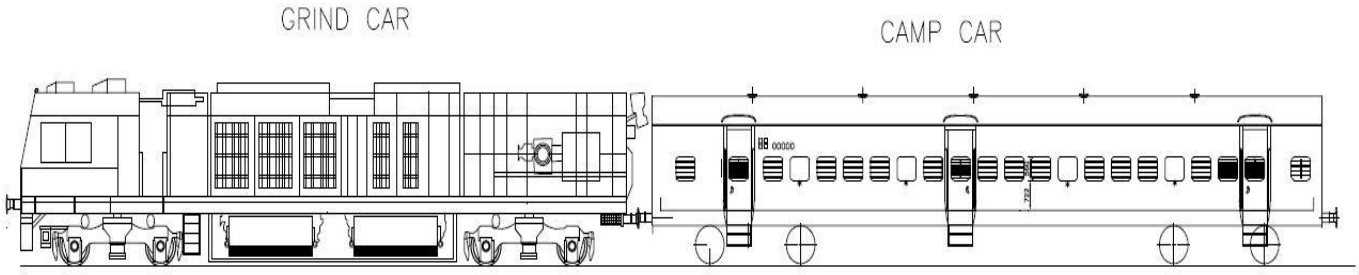


Fig.5.9

Grind Car - The operator controls and rail grinding components are located on the grind car (GC). The grind car has buggies, a hydraulic system that supplies fluid power to the grind buggies and grind modules and a dust collection system. The Dimensions of grind car is shown in **Annexure 5.6.** The grind car also contains:

(a) The operator control cab

(b) A Genset and fuel tank

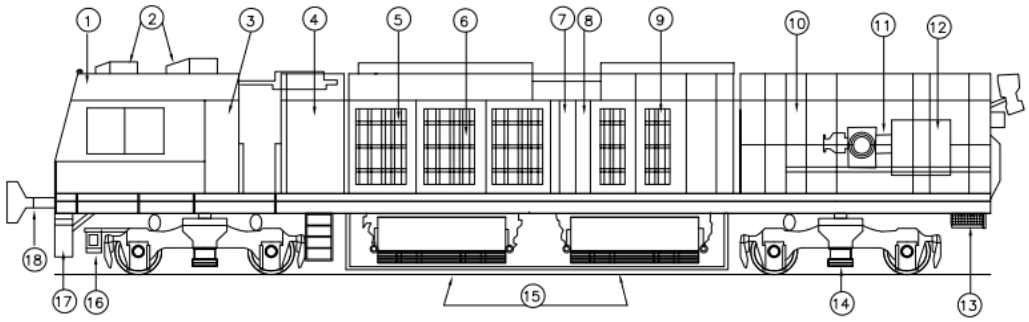
(c) A hydrostatic traction system

(d) An air compressor

(e) Rail inspection equipment

(f) A water spray assembly

Components of Grind car is shown in Fig 5.10



1–CONTROL CAB
2–AIR CONDITIONER UNITS
3–ELECTRICAL ENCLOSURES
4–AIR COMPRESSOR
5–HYDRAULIC POWER UNIT
6–HYDROSTATIC TANK STAND
7–HYDROSTATIC PUMP
8–GENERATOR
9–ENGINE
10–FUEL TANK
11–DUST BLOWER
12–DUST COLLECTOR
13–BELOW FRAME STORAGE
14–DRIVE BOGIE
15–GRIND BUGGIES(2X)
16–RAIL PROFILE MANAGEMENT SYSTEM
17–PLOW
18–FRONT COUPLER

Fig.5.10

Camp car- Camp car is having travel controls which drive the machine from rear side. Cameras are mounted on this cabin overlooking the track in rear and this image is also displayed on monitor in grind car. Components of camp car is shown in Fig 5.11

The camp car also contains

(a) A water tank and pump

(b) A convenience room

(c) Rail inspection equipment

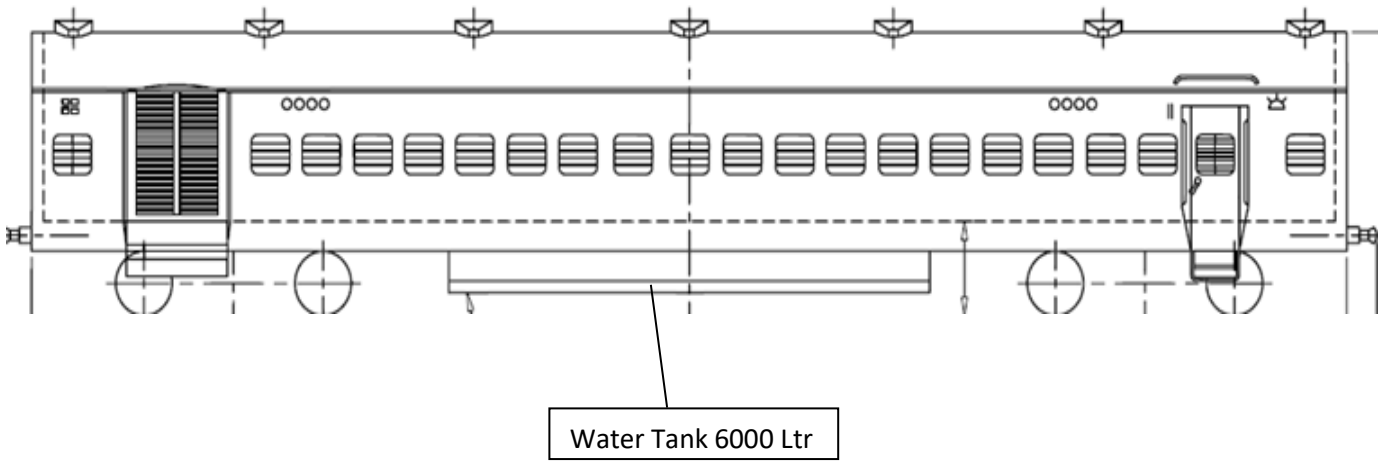


Fig 5.11

(ii) Rail corrugation analyzer (RCA)–

It is mounted on right side of front bogie of grind car. It measures the rail corrugation during running of the machine and gives an idea of the level of corrugation present in the track to facilitate the decision of depth of cut.

(iii) Rail Profile Measurement System (Optical)

The machine is having two laser based rail profile measurement systems to measure the railhead profile before and after the grinding. This measuring system is mounted in between the front bogie and plow of grind car.

(iv)Dust Collection system

It is similar to RGM's kindly refer point no 5 of Para 502.

(v)Brake System

Following brake systems are provided on RGM Machines

(a) Indirect Brake- This brake is applied on machine with coupled camping coach automatically when air pressure of BP line releases. This brake is operated by the automatic brake (A-9) valve in control cabs.

(b) Direct brake- This brake is directly applied on rolling stock attached with the machine. It is used for low speed braking. This brake is operated by the independent brake (H2FX) valve in control cab.

(c) Emergency/Dump Brake- This is applied directly on all rolling stock of the machine in case of emergency of immediate stopping.

(d) Parking brake- Hand operated brake system prevents inadvertent movement when machine is parked. Make all hand brakes are released prior to machine movement.

(e) Automatic penalty braking- The automatic braking application system restricts the speed of the machine beyond a predetermined set point to ensure safe operation.

(3)Salient Features of SRGM

(a) Machine Dimensions: Length - 43.36 m, Width - 3.30 m & Height - 4.45 m

(b) Engine Make - Cummins, Model: QST30-Tier II, 1350 BHP, 1800 RPM

(c) Generator Make Marathon - 900 kW, 480 VAC/60 Hz

(d) Drive System: Hydrostatic traction

(e) Machine is capable of traveling and grinding in both directions

(f) Number of Modules: 20 HMI Computer controlled hydraulic powered (Automatic Tilt, Shift and Lift)

(g) Type of Brake: Independent, Emergency brakes, Automatic brakes, Mechanically Parking brake.

(h) Machine is having automatic penalty braking system

(i) SRGM normally needs 3 passes on Points and crossing to complete the sequence.

(j) Fuel Tank Capacity - 5000 Liters and Water Tank Capacity - 6000 Liters

(4)Capabilities of SRGM

(a) The machine is capable of grinding following

(i) Plain track and curves

(ii) Track in tunnels

(iii) Track on bridges with or without guard rail (Without removing guard rails)

(iv) Track on platform lines

(v) Switches, crossings/diamond crossings (with or without removing check rails/guard rails)

(vi) Level crossings (with or without removing check rails)

(vii) Curves (with or without removing check rails)

(b) This machine works in traffic block, however no power block is required. Grinding can be done in either direction without the need of reversing the machine.

(c) The machine is capable of grinding turnout of any sizes of 1:8.5, 1:12 and 1:16.

(d) The machine is capable of running while grinding at a speed ranging from 8 kmph to 15 kmph, depending upon the quantity of metal to be removed.

(e) The cutting depth of SRGM in each pass ranges from 0.13 mm to 0.2 mm. Depth of cut per pass shall not be less than 0.13mm at speed 15 kmph and 0.2mm at speed 10 kmph respectively.

(5) Working Parameters of SRGM

Indian Railway is initially doing preventive gradual grinding in order to remove the defect present in the rail and to stop generation of new defects after that railways may shift towards preventive grinding.

(a) Target profile- Target Rail Profile template is finalized based on the rail and wheel profile collected. Till such time the development of these target rail templates, rail grinding is to be done as per CPC (contact point center) target rail profile template in turnouts and for other locations existing target rail profile templates as followed for RGMs. For CPC profile kindly refer Fig 5.5 of point no 3 of Para 505.

(b) Grind patterns- Pattern will depend upon the position of the specialty asset on track as well as the existing transverse profile shape and severity of rolling contact fatigue defects. For the 1st pass on a point & crossing recommend Pattern would be based on the Table 5.4.

Daily (Routine) Grinding on worn rail	Pattern 1 is recommended for initial grinding work. This pattern is optimized to arrive at the CPC rail template based on commonly measured rail profiles.
Gauge face wear	The best initial pattern for special assets with gauge face wear would be pattern 8.
Grinding new rail	The best initial pattern for new rail would be pattern 4.

Table 5.4

The patterns are shown in **Annexure 5.7**

(c) RailPro™- It is an improved rail grinding management system designed for Data collection and analysis, automated control and adjustment, integration with maintenance system, grind performance monitoring etc. the same software is also used in RGM 96 stone.

(d) Deployment of SRGM- Grind cycle shall be the same for the Turnouts as in case of existing RGMs sinceSRGM are planning to be used as a 'gap' grinder. Kindly refer point no 9 of Para 503.

(6) Monitoring Equipment for Grind Quality

Monitoring equipment will be same as used for RGM's Kindly refer Para 506 of RGM.

(7) Working of SRGM

(a) Progress of SRGM machine will be recorded in number of switches (points & crossings) grinded.

(b) For main line track progress will be recorded in linear track Km.

(c) The working speed of SRGM shall be 10-15 Kmph.

(d) Rail grinding with SRGM is to be done as per CPC (contact point center) target rail profile template in turnouts and for other locations existing target rail profile templates is to be followed similar to RGM grinders.

(e) Turnouts at test sites selection should be a mix of both new and old in a reasonable state of repair. Old Turnouts should have at least 50 percent of GMT life remained.

(f) The machine has a fuel tank of 5000 liters.

(g) The machine has a capacity to hold 6000 liters of water. This would be needed for grinding operations.

(h) Based on the actual usage of the machine between 3000- 6000 liters of water would be used daily.

(8) Quality Inspection of Grinding

Following methods are used for assessing the benefits of grinding and grind quality achieved.

(a) Test site monitoring- A test site is prepared as shown in Fig 5.12 and It has four spots, where rail profile measurement readings, surface photographs and dye penetration tests are to be done in each spot as we do for RGMs Kindly refer Sub point (b), (c) &(d) of point 1 of Para 508.

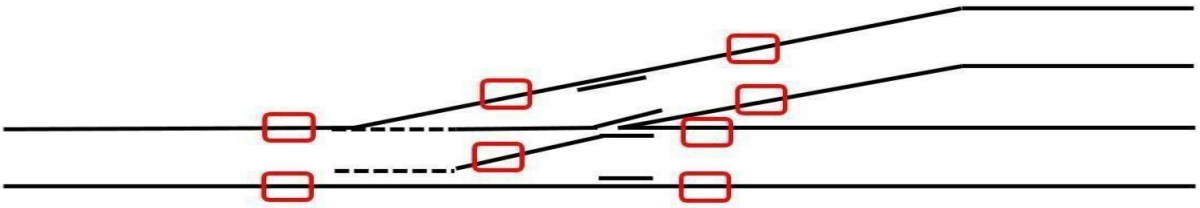


Fig: 5.12

(i) SRGM test sites should be made with 12 representative turnouts, preferably 4 turnouts each of the sizes 1:8.5, 1:12 and 1:16.

(ii) Turnout at test sites should be in main line. Preferably at least 1 turnout per type should be from railway lines of maximum annual tonnage/year.

(iii) At the time of establishment of these 12 test sites the following information should be collected as a baseline at each of the red boxed locations (shown in Fig 5.12) during each grind cycle. Indication of left and right rail shall be marked with respect to direction of traffic.

(a) Location (Zone, Line, division, track, Station/Section, KM, GPS, Latitude, Longitude, etc.)

(b) Turnout Size (either 1:8.5, 1:12 or 1:16)

(c) Rail Manufacturer and Rail Chemistry
(d) Rail Size/Rail Profile
(e) Rail-Year of laying
(f) Annual tonnage (GMT)

(iv) Rail Profile is measured with rail profile measuring equipment at the exact location on the rail to perform measurement in each grind cycle on the rail between two sleepers and at least 3meters from a joint or weld.

(v) Clear well-lit and labeled photographs of the rail surface looking from above.

(vi) Perform a dye penetrant or magnetic particle test directly adjacent to the location where rail profile measurement was taken.

(vii) Corrugation and hunting to be observed in the point and crossings containing the test sites (within 50 m either side of test site)

(b) Other Quality checks

It is similar to RGMs kindly refer sub point (a),(b),(c) &(d) of point 2 of Para 508

(c) Monitoring by RDSO-Performa enclosed as **Annexure 5.8** is to be filled by field units and data to be kept for feeding in TMS every time before and after grinding, SRGM module is under generation. RDSO shall study the data received from different railways and decide on appropriate grinding patterns and grinding cycle.

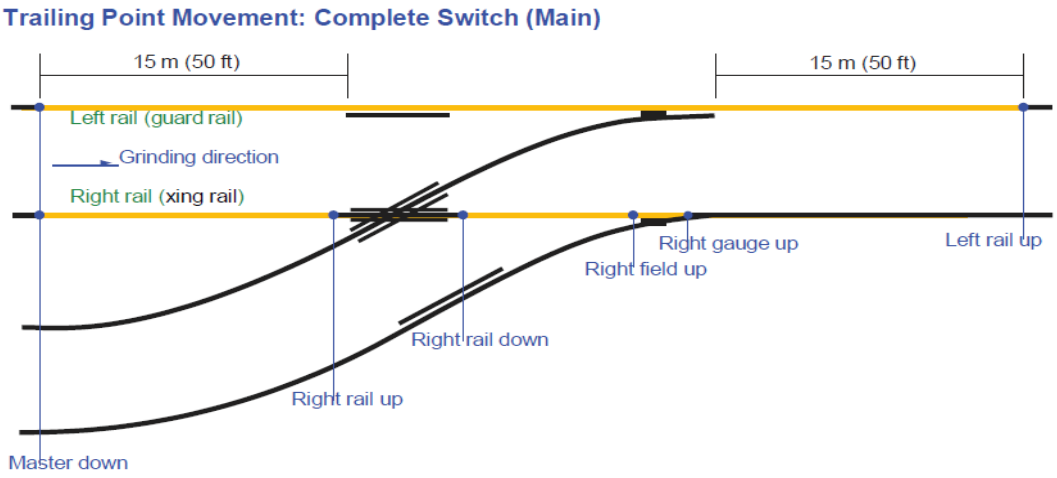
(9) Preparatory Works for Introduction of SRGM

Preparatory work of SRGM is similar to RGM's kindly refer Para 509.

(10) Grinding procedure by SRGM

a) Turnout

(i) While grinding turnouts with SRGM, machine operator should monitor the grind sequence set down and pick up point after each pass to make sure that the sequence point is at the desired location and that the machine is operating properly. If the sequence point is not at the desired location, clear the sequence memory and re-sequence. There is no difference for the purpose of grinding for turnout with thick web switch vis-à-vis conventional switch.



Trailing Point Movement: Complete Switch (Main)

Fig 5.13: Diagram showing the grinding of turnout from Trailing direction

(ii) Machine operator should be aware that during crossover side working grind sequence set down and pick up point drift may occur while grinding. This drift is the result of a grind cart wheel slip due to curving initiated by flange steering. The curvature of the crossover track, the travel distance, and the number of passes are all factors in a wheel slip.

(iii) Observe the stored footage on the Machine Overview Screen and the sequence line on the sequence monitor while grinding to determine whether a wheel slip has affected the location of the grind sequence set down and pick up point on the rail. The stored footage should be zero when the sequence line on the sequence monitor reaches the operator input stored sequence point. If the sequence point is not at the desired location, clear the sequence memory and re-sequence.

(iv) During Turnout grinding at start of work with SRGM when the sequence line on the sequence monitor is 15 m (50 ft) before the crossings, move the Master Sequence switch down. All grind modules lower on to the rails at the selected point.

(v) When the sequence line on the sequence monitor is approximately 0.3 m (1 ft) before the crossing, move the Right Rail sequence switch up. All grind modules on the right side (Crossing side) of the machine raise at the selected point & left rail grinding will be continued.

(vi) When the sequence line on the sequence monitor is approximately 0.3 m (1 ft) after the crossing, move the Right Rail sequence switch down so that right rail grinding will be resumed. All grind modules on the right (Crossing side) of the machine lower onto the rail at the selected point.

(vii) When the sequence line on the sequence monitor is at the switch point heel block, move the Right side Field sequence switch up. All grind modules on the right side of the machine that are set to field raise at the selected point& field side grinding of right rail will took place beyond this point, left rail full width

grinding will took place.

(viii) When the sequence line on the sequence monitor is at a point where the rail width decreases to approximately half the width of the rail, move the Right Gauge sequence switch up. All grind modules on the right of the machine that are set to gauge raise at the selected point & No grinding will take place in right rail beyond this point.

(ix) When the sequence line on the sequence monitor is 0.3 m (1ft) after the switch point, move the Right Rail sequence switch down. All grind modules on the right side of the machine are lowered onto the rail at the selected point.

(x) When the sequence line on the sequence monitor is 15 m (50ft) after the switch point, move the Master sequence switch up. All grind modules raise at the selected point.

(xi) When all grind modules have lifted and the last stored footage has cleared from the machine overview screen, press the right increase setting and left increase setting buttons on the pattern control screen to increase the settings.

(xii) Turn the travel direction switch to the opposite direction. The machine will slow down, stop, reverse direction and gain speed until it reaches the GSP set point. Depending on the rail condition, grade, speed and other variables, the use of the service brake may be necessary.

Facing Point Movement: Main Only

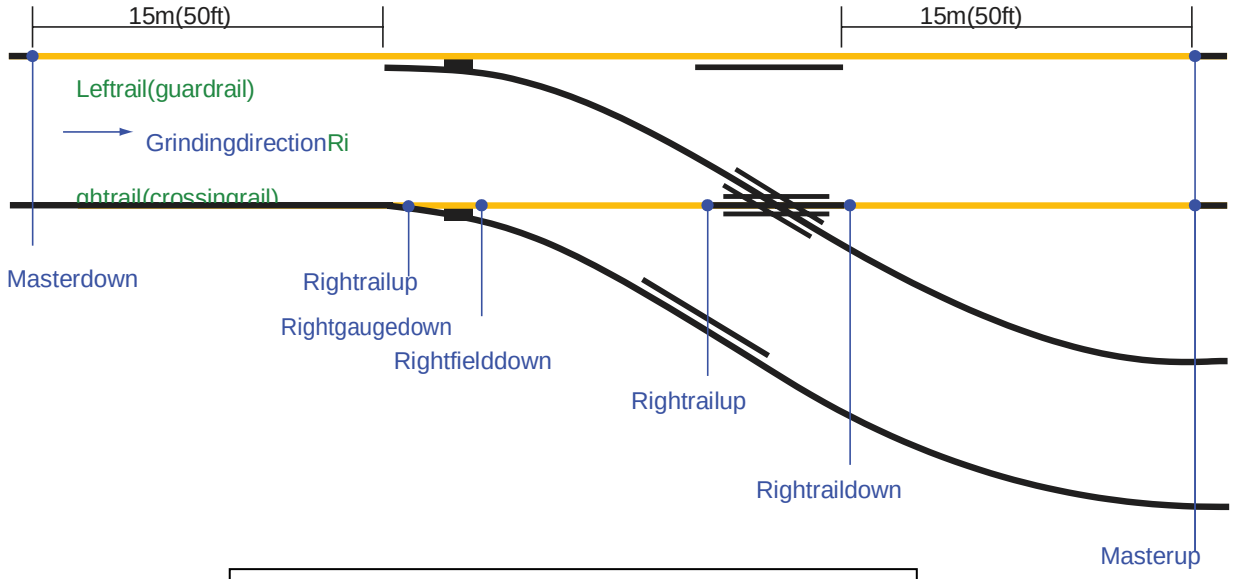


Fig 5.14: Diagram showing the grinding of turnout from facing direction

(i) When the sequence line on the sequence monitor is 15 m (50 ft) before the switch point, move the Master sequence switch down. All grind modules are lowered onto the rails at the selected point.

(ii) When the sequence line on the sequence monitor is approximately 0.3 m (1ft) before the switch point, move the Right Rail sequence switch up. All grind modules on the right side of the machine raise at the selected point.

(iii) When the sequence line on the sequence monitor is at a point where the rail width increases to approximately half the width of the rail, move the Right Gauge sequence switch down. All grind modules on the right side of the machine that are set to gauge lower onto the rail at the selected point.

(iv) When the sequence line on the sequence monitor is after the switch point heel block, move the Right Field sequence switch down. All grind modules on the right side of the machine that are set to field lower onto the rail at the selected point.

(v) When the sequence line on the sequence monitor is approximately 0.3 m (1 ft) before the crossing, move the Right Rail sequence switch up. All grind modules on the right side of the machine raise at the selected point.

(vi) When the sequence line on the sequence monitor is approximately 0.3 m (1 ft) after the crossing, move the Right Rail sequence switch down. All grind modules on the right side of the machine lower onto the rail at the selected point.

(vii) When the sequence line on the sequence monitor is 15 m (50 ft) after the switch point, move the Master sequence switch up. All grind modules raise at the selected point.

(viii) When all grind modules have lifted and the last stored footage has cleared from the machine Overview Screen, press the Right Increase Setting and Left Increase Setting buttons on the Pattern Control Screen to increase the settings.

(ix) Turn the Travel Direction switch to the opposite direction. The machine will slow down, stop, reverse direction and gain speed until it reaches the GSP set point. Depending on the rail condition, grade, speed and other variables, the use of the service brake may be necessary.

b) Level Crossing : gate

(i) Template: - It shall be same as used in RGM's in operation in section.

(ii) Speed of SRGM: -Working speed of SRGM is to be maintained between 8 to 10 kmph for normal grinding operations. In case the specialty asset is being exclusively ground as a separate section, then it is recommended that grinding upto 50mts before and up to 50mtr after the specialty asset.

(iii) Pattern will depend upon the position of specialty asset for the first pass of level crossing, Pattern 21 is recommended for the first pass.

(iv) GQI/pass: -GQI after each pass is not generated after each pass as full coverage of the railhead requires 3 passes and GQI is generated after the full rail head is ground. At the start of the grinding program, the minimum value of GQI to be achieved should be 80 and above.

In a similar manner, grinding of plain track which may be left during grinding by RGM due to constraint or otherwise, can also be grinded.

c) Diamond Crossing

(i) SRGM working with Diamond crossing Pattern will depend upon the position of the specialty asset on track for the 1st pass on Diamond crossings, Pattern 1 is recommended for the first pass.

(ii) Template: -Diamond Crossings should generally use the CPC on both rails.

(iii) Number of Passes:-For full coverage of the railhead there will be 3 passes requirement.

(iv) Speed of SRGM:- Working speed of SRGM is to be maintained between 8 to 10 kmph for normal grinding operations. In case the specialty asset is being exclusively ground as a separate section, then it is recommended that grinding up to 100 meter before and up to 100 meter after the specialty asset.

(v) GQI/pass:-GQI after each pass is not generated after each pass as full coverage of the railhead requires 3 passes and GQI is generated after the full rail head is ground. At the start of the grinding program, the minimum value of GQI to be achieved should be 80 and above.

(11) Pre-Block Activities before Deploying SRGM

Pre- Block activity of SRGM is similar to RGM's kindly refer Para 510

(12) Operations during SRGM Block

It is similar to RGM kindly refer Para 511

(13) Post Grinding Operations

It is similar to RGM kindly refer Para 512

(14) Operational problem and remedies during working of SRGM

During working, SRGM machine will encounter following obstructions during block.

(i) **SEJ's:** When SEJs encountered while grinding, SRGM machine will skip one meter length of expansion joint and remaining portion will be grinded.

(ii) **Earth bonds:** For working of SRGM, all the earth bonds need to be maintained below the rail level as these may infringe the KLD cameras (Laser camera) and grinding motors. If requires it needs to be dismantled

(iii) **Axle counters:** When axle counters encountered while grinding, axle counters have to be dismantled for complete rail grinding. For removing and fixing of axle counters will take approximately 2-3 hours, so it is not feasible due to traffic limitations. Practically for compete grinding of Axle counters' portion is not possible. Although SRGM can grind Axle counters by lifting gauge facing modules and continue grinding but grinding of rail top at field side can only be done.

(iv) SRGM Machine while working on points and crossings needed3 passes to complete the sequence. For each pass we need to cross the signals at ON position during working to complete the pass for which suitable authority to be given by ASM/SM.

(v) Fire detection & Extinguishing System: Machine is equipped with Fire detection system a UV Sensor is provided in engine compartment. Whenever it detects any fire, it gives alarm and engine get shutdown immediately. Eventually all systems will be stopped. RTD sensors are provided in buggies, continuously detect the temperature whenever temperature more than the set value. It gives alarms and the concerned buggy will be lifted and locked automatically.

(vi) During course of grinding sparks will be ejected; to suppress these sparks SRGM equipped with Tie Sprays, Ditch Sprays and Water Canon System. Water hose is provided to

extinguish fires up to length of 50 meters in Grind car and camp coach.

(vii) Engine failure in mid-section: Whenever Engine fails brakes automatically gets applied. During working the buggies are provided with manual emergency lifting provision for locking. Machine is to be towed with light engine if engine fails since machine is provided one engine only.

517. Rail Milling Machine (SF-06 IN-LINSINGER)

1. **GENERAL -** Milling is a machining process that involves the use of a milling machine to remove material from a work piece. Milling machines feature cutting blades that rotate while they press against the work piece. Important dimensions of RMM machine are shown in Annexure 5.9.

   (a) Purpose of Rail Milling Machine - The Purpose achieved by rail milling are summarized below

   (i) Removal of the rolling skin.
   (ii) Re-profiling of longitudinal and transverse profiles.
   (iii) Preventive maintenance of the rail head.
   (iv) Elimination of runway errors on the rail head (e.g., head checks, squats, slingshots, etc.)
   (v) Recognition of driving surface errors by the eddy current tester (e.g., head checks)
   (vi) Measuring the longitudinal and transverse profile.

   (b) Advantages of Rail Milling- The advantages that will accrue by rail Milling can be summarized as given below :-

   (i) Increased life of rail and wheel: There is appreciable increase in life of the rails after rail Milling. The life of the wheels is also reported to increase by Milling of rails.
   (ii) Less tractive resistance due to lesser impact & therefore be saving in fuel consumption.
   (iii) Improved reliability of USFD testing: Due to smooth and cleaner rail surface, the reliability of USFD testing will improve.
   (iv) Reduced track geometry deterioration: The track geometry will retain for longer period and the requirement of tamping of the track should come down.
   (v) Reduced degradation of ballast: Due to lesser impact, the degradation rate of ballast will come down. This should result in reduction in the frequency of deep screening of track.
   (vi) Less noise: The noise level goes down after rail grinding.
   (vii) Reduced derailment proneness: The overall improvement in rail wheel interaction will result in better safety performance.

2. **Important Assemblies of RMM**

   Components of RMM – RMM consists of a formation of 2 vehicles, which moves as a train composition. The major components of RMM are explained below:
   Carrier Vehicle - 1 No.
   Trailer Vehicle - 1 No.

   (a) Carrier Vehicle - The carrier vehicle features 4 milling stations, 2 for each rail and 2

grinding stations, one for each rail and is shown in Fig 5.15.

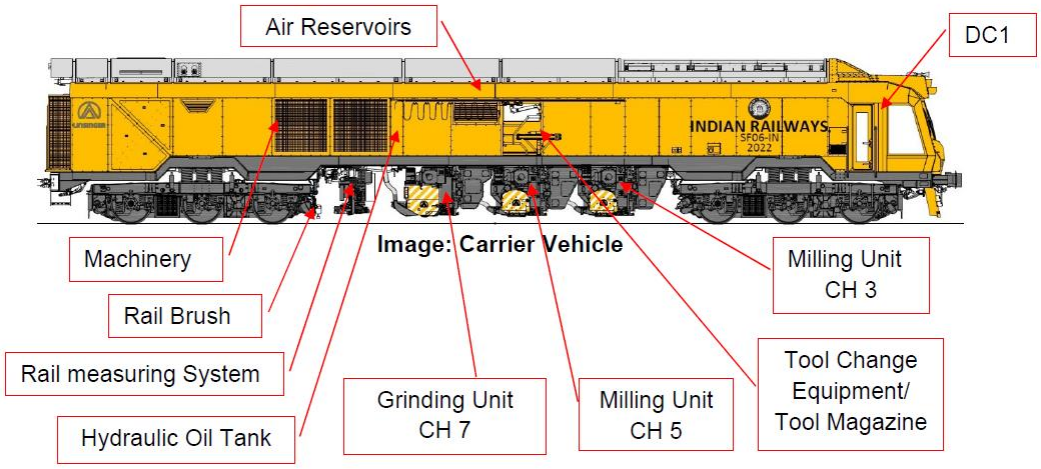


Fig 5.15

(b) Trailer Vehicle -The Trailer vehicle is equipped with Auxiliary Diesel Engine, Chip Bunker and Grinding Dust container .There is a chip suction system located on the leading vehicle that will transfer metal chips produced from the milling process to the trailer vehicle, where they will be collected in two chip containers)one for each rail operation (with a combined gross capacity of approximately 13 m^3 .The grinding process, a dust suction system will be used with a capacity of approximately 150 litres and is shown in Fig 5.16.

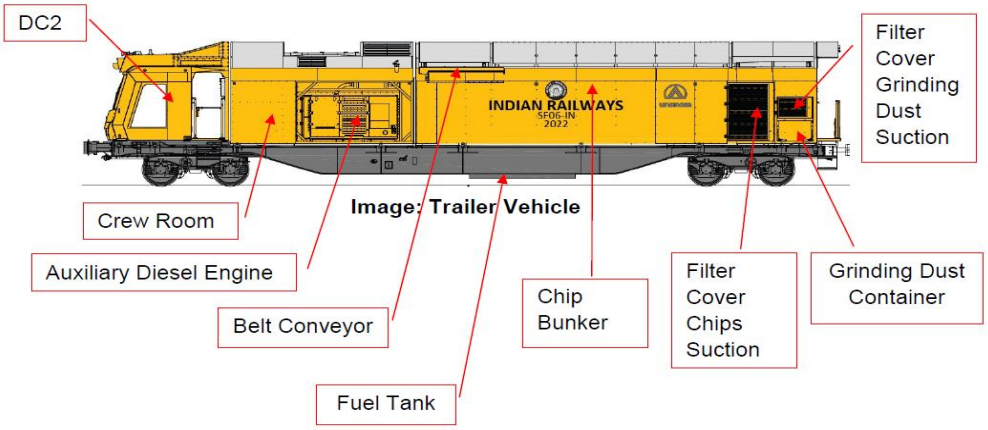


Fig 5.16

(c) Vehicle design

(i) The SF06-IN consists of two semi-permanently coupled vehicles formed of a carrier/leading vehicle and a trailer vehicle (with separation only possible in the maintenance mode).

(ii) The 23.3-metre-long carrier vehicle of the SF06-IN is mounted on two three-axle bogies and the machine will feature secondary suspension. The 19.7-metre-long trailer vehicle of the SF06-IN is mounted on two Y25 bogies. The overall length of the SF06-IN is 43.3 metre.

(iii) A full driving cab is provided at each end of the machine for bi-directional travel, with the direction of working unidirectional. Numbered from the front end of the machine, axles 1, 3, 4 and 6 is powered, with the remaining axles non-powered.

(d) Trailing profile measurement system (TPMU)

The trailing profile measurement system (TPMU) verifies the quality of the milling and grinding process according to (EN 13231-3:2012-01, Railway applications - Track - Acceptance of works - Part 3: Acceptance of re profiling rails in track, 2012) and is capable of measuring the longitudinal and transversal rail profile.

(e) Material removal

Material removed during rail processing (chips and grinding dust) is mechanically picked up and stored separately (dust and chips). The machining areas (cutter head and grinding disc) are equipped with housings. Emergence of chips, grinding dust and sparks are thereby largely prevented. Chips are sucked into a chip container. Emptying the chip container is carried out by conveyor belts mounted in the roof. Grinding dust is sucked off into a separate grinding dust container. The grinding dust container is emptied manually.

(f) Operation and performance

Material removed during rail processing (chips and grinding dust) is mechanically picked up and stored separately (dust and chips). The machining areas (cutter head and grinding disc) are equipped with housings. Emergence of chips, grinding dust and sparks are thereby largely prevented. Chips are sucked into a chip container. Emptying the chip container is carried out by conveyor belts mounted in the roof. Grinding dust is sucked off into a separate grinding dust container. The grinding dust container is emptied manually.

(g) Brake System:

Proposed rolling stock is equipped Air Brake arrangement (Twin Pipe braking system, which comprises of following-

(i) **Indirect Brake** –This brake is applied on machine with coupled camping coach/wagon automatically when air pressure of BP line releases through A9 valve or due to drop in air pressure due to leakage in the system.

(ii) **Direct Brake** – Direct Brake is applied when machine works individually.

(iii) **Emergency/Dump Brake** – This is applied directly on the each rolling stock of the machine in the case of emergency for immediate stopping.

(iv) **Parking Brake –** Hand operated brake systems are provided on each of the grinding cars for stabling.

3. PROCESSING COMPONENTS

(a) Milling unit with copy function

(i) Arranged on the underside of the carrier vehicle frame

(ii) Total maximum of 4 milling units in SF06 version

(iii) Milling units arranged in parallel for both rails

(iv) Per rail 2 successive milling units

(v) Milling unit hydraulically raised and lowered as well as electrically adjustable horizontally

(vi) The tool spindle is mounted in preloaded roller bearings
(vii) Tool spindle drive by means of a controllable main spindle motor in the range of the milling machining speed.
(viii) Hardened and ground, mounting flange for the milling tool
(ix) Milling area covered by protective cover
(x) Copy function via leading feeler lever (Copy finger) for each milling unit
(xi) Mounting of the copy shoe in round guides
(xii) Regulation of the cutting depth via copy ruler height adjustment by means of AC servomotor
(xiii) Horizontal positioning of the milling unit to the rail via laser sensor positioning system
(xiv) Side copy function by means of a feeler lever (Copy finger).

(b) Grinding unit with copy function

(i) Arranged on the underside of the carrier vehicle frame.
(ii) Total 2 grinding units, 1 unit per side centred on the trailer.
(iii) Grinding unit hydraulically raised and lowered as well as electrically adjustable horizontally.
(iv) The tool spindle is mounted in preloaded roller bearings.
(v) Tool spindle drive by means of a controllable main spindle motor in the range of the grinding machining speed.
(vi) Hardened and ground, mounting flange for the grinding wheel.
(vii) Grinding area covered by protective cover.
(viii) Side-copy functions via leading feeler lever for each grinding unit.
(ix) Mounting of the feeler lever in round guides.
(x) Horizontal positioning of the grinding unit to the rail via laser sensor positioning system.

(c) Chip brushes

(i) Mounted on bogie 2.
(ii) Total 2 chip brushes, arranged 1 unit per side.
(iii) Chip brush arranged in parallel for both rails.
(iv) Lift and lower chip brush pneumatically.
(v) Drive of the tool spindle electric motor.

(d) Chips suction

Consisting of the following components :-

(i) Suction pipes from the processing units to the suction device.
(ii) Suction device with hydraulic driven fan and air filter.
(iii) Chip extraction (conveyor belts).
(iv) There is a chip suction system located on the leading vehicle that will transfer metal chips produced from the milling process to the trailer vehicle, where they will be collected in two chip containers (one for each

rail operation) with a combined gross capacity of approximately 13 m^3.

(v) Easy emptying of the chip container at suitable places into an external container (height of chips extraction is approx. 3000 mm above top of rail).

(e) Grinding dust suction

Consisting of the following components:

(i) Suction pipes from the processing units to the suction device.

(ii) Suction device with hydraulic driven fan and air filter.

(iii) The grinding process, a dust suction system will be used with a capacity of approximately 150 litres.

(iv) The grinding dust container must be emptied manually and is located on the trailer. Vehicle, on the APU-Side (Auxiliary Power Unit) right at the transition.

(f) Tool changing system

Consisting of :

(i) One exterior overhead chain hoist per side with electrical lifting device for moving the tool from the tool magazine to the processing unit.

(ii) Interior tool magazines.

Load limits:

(i) Exterior chain hoist: 500kg

(ii) Interior chain hoist: 500kg

(g) Tool adjusting device

Consisting of :

(i) Loosely supplied precision tool setting device with hardened and ground tool holder can be mounted separately on a suitable substructure (work bench, etc.).

(ii) Magnetic stand with dial gauge.

(iii) Torque wrench with Torque inserts.

4. Target rail profile/milling head :- There are three type of milling head use in RMM machine

a.	New Rail Profile UIC 60 kg	Standard New Rail Profile is recommended for Tangent Track , Mild Curves up to 0.5° & inner rails for curves sharper than 0.5°
b.	Anti Head Check (AHC)UIC 60 kg	Anti Head Check Rail Profile is recommended for sharper than 0.5° for outer rails.
c.	New Rail Profile IR 52 kg	Standard New Rail Profile is recommended for Tangent Track and Curves for 52 kg rail.

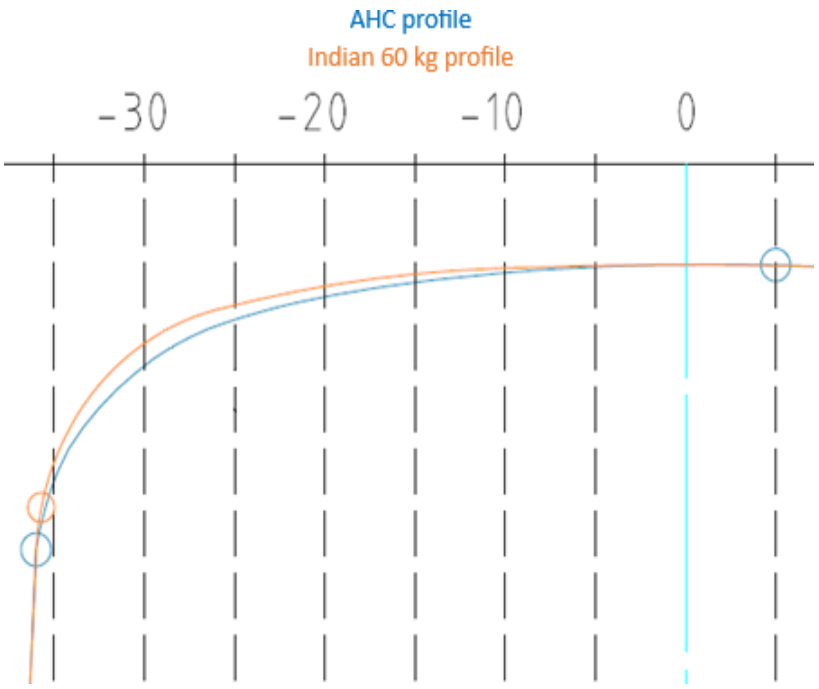


Fig 5.17

5. Capability of RMM

(a) Rail Milling Machine is high productivity Milling machine consisting of 4 milling stations, 2 for each rail, and 2 grinding stations, one for each rail.

(b) The machine is capable of Milling of plain as well curved track, track in tunnels, track on bridges, glued joints and fish plated joints. Machine can work on curves up to 10^0 and for track with gradients up to 3%.

(c) The machine works in traffic block. However, no power block is required. Grinding can be done in either direction without the need for reversing the machine.

(d) The machine shall be capable of cutting excessive material from each rail of section 60 kg UIC (90 UTS) and 52 kg (90 & 72 UTS) having hardness of 315 to 380 BHN in one pass to achieve target profile.

Capability of machine to cut depth of material on various speed in a single pass shall be as below:-

(i) Work Speed: 1.5 kmph up to 1.0 mm
(ii) Work Speed: 1.0 kmph up to 1.5 mm
(iii) Work Speed: 0.7 kmph up to 3.0 mm

6. Working Parameters of RMM

(a) Data processing: The process is controlled by the software Rail Viewer. When the measurement is started, an industrial PC IPC627D ("measuring-PC") receives and handles the incoming data flow from the transducers and the software displays the results in real time.

(b) Longitudinal profile: The longitudinal profile is recorded by a chord-based measurement system and consists of 3 triangulation laser sensors for each wavelength.

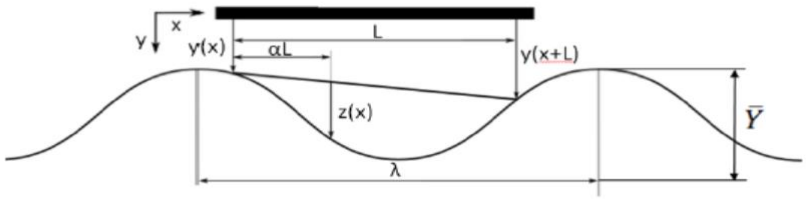
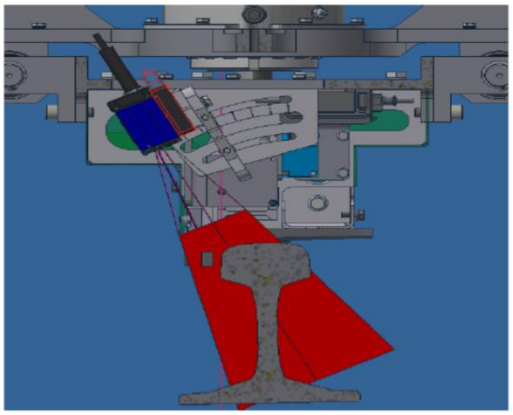


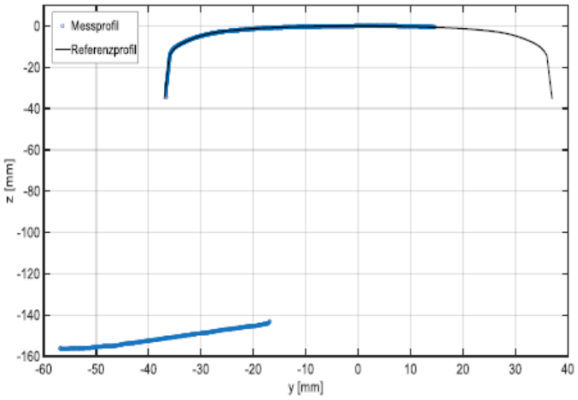
Fig 5.18

Digital filters isolate each wavelength. The relevant wavelengths are composed of 10-30mm, 30-100mm, 100-300mm and 300-1000mm.

(c) Transverse profile: The installed 2D laser sensors measure the rail head and send the data via Ethernet to the measuring PC. The measured profile then is aligned to a pre-selected target (or reference) profile. The distance between 2 subsequent measurements is 1m.



2D Laser Sensor



Measured profile aligned with a target profile;

blue … measured profile; black … target profile

Fig 5.19

After aligning the profiles, the deviation of the measured profile to the target profile is measured perpendicular from the target profile at 6 defined control points. The deviation is considered positive when the measured profile is above the target profile.

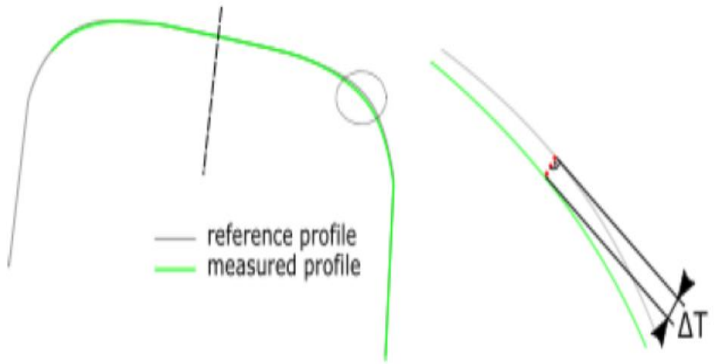


Fig 5.20

For the alignment of the profiles, 2 “reference points” on the target profile are defined. Naturally, the deviations between the profiles at those reference points are 0.

The control points (where the deviation is calculated) and the reference points (where the profiles are aligned) are shown in table 5.5& Fig. 5.21 respectively.

Point	Location on target profile
Reference point A	Y+5
Reference point A	Z-14
Control point Y1	Y-35
Control point Y2	Y-30
Control point Y3	Y-25
Control point Y4	Y+14

Table 5.5 (Significant points on target profile)

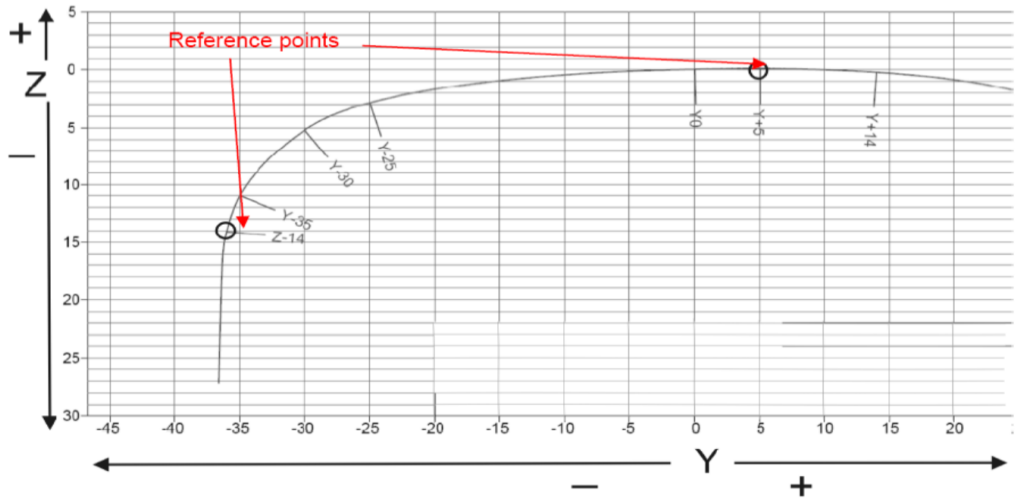


Fig 5.21

(d) Acceptance criteria for longitudinal profile

Wavelength range (mm)	10to 30	30to 100	100 to 300	300 to 1000
peak-to-peak limit (mm)	±0.010	±0.010	±0.015	±0.075

Table5.6—Peak-to-peaklimits

Table5.6 gives peak-to-peak limits to be fulfilled to a certain percentage that is given in Table 5.7. Table 5.6 and Table 5.7 together form the acceptance criteria.

The primary or traced profile shall be processed to provide a filtered profile within each of the wavelength ranges given in Table 5.6.

Wavelength range (mm)	10-30	30-100	100-300	300-1000
Class 1	95%	95%	95%	95%
Class 2	No requirement	90%	90%	No requirement

Table5.7

The percentage of any reprofiling site in which the amplitude of the filtered profile is

within the value specified in Table 5.6 shall be calculated on its total length and shall not be less than the values given in Table 5.7 for the class specified.
DB classifies Class 2 Track as Non-High Speed track with trains speeds of less than 200 Kmph. So IR track will come under Class 2 tack.
In plain line, the classification concerns the total length of each reprofiling section.

(e) Acceptance criteria for transverse profile

The percentage of measured values in any reprofiling site in which the range of deviation is less than 0.4 mm, 0.6 mm, 1.0 mm and 1.7 mm, shall be calculated on the total length of the reprofiling site and shall not be less than the values given in Table 5.8 for the class specified.

	Max. range of deviation (mm)	Min. proportion of measured values within specified deviation range
Class P	0.4	95%
Class Q	0.6	90%
Class R	1.0	85%
Class S	1.7	75%

Table5.8 (Minimum proportion of measurements within The specified range)

(As per DB Railway report : DB RIL 824.8310 T.TZF 61)

Maximum Permissible Speed	Standard value of acceptance
V<160	+0.5 , -0.5
160 < v<280	+0.3 , -0.3
v>280	+0.2 , -0.3

Table5.9

Maximum Permissible Speed (km/h)	Standard value of Acceptance (mm)		
	+/- 0.2	+/- 0.3	+/- 0.5
V<160	-	-	15 %
160 < v<280	-	10 %	5%
v>280	10%	5%	0%

Table5.10

For Speed< 160 kmph, These tolerances conform to Rail **Class R** according to EN Standard EN-13231- 2006, hence IR track will confirm class R track .

(f) Software (Rail Viewer): The software Rail Viewer is used to control the measuring process and to record longitudinal and transverse profiles. It is also used for displaying and analyzing historic data. Please see the screenshot of the Rail Viewer program in Figure below Fig 5.22.

Section	Description
1	Input of measuring information
2	User buttons
3	Transverse profile left

4	Transverse profile right
5	Longitudinal profile left
6	Longitudinal profile right

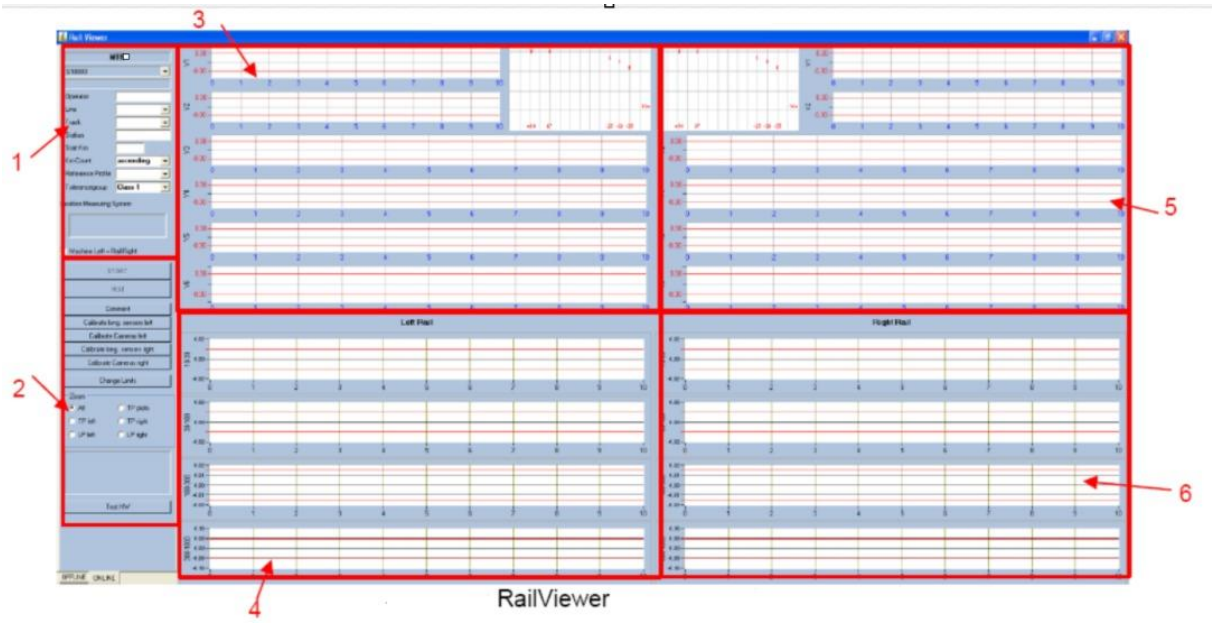


Fig 5.22

518. Rail Inspection Vehicle (RIV-Harsco)

1) General

Rail Inspection Vehicle (RIV) is a self-propelled bi-directional bogie type (2 bogies/4 axles) vehicle for use on Indian Railways tracks. The Self-Propelled Rail Inspection Vehicle (RIV) is fitted with Rail Head Profile Inspection and Analysis System to facilitate advance digital inspection of the rails for selection of optimum rail grinding programmed.

It is installed with rail head profile measuring system, Corrugation system and High-Resolution Optical imaging system.

The RIV is meant for collecting digitized image of the transverse profile of rail head for detailed analysis and for generating Grinding plans to be used on Rail Grinding Machines.

2) IMPORTANT ASSEMBLIES OF RIV

The important assemblies of Rail Inspection Vehicle (RIV) are shown below Fig 5.23

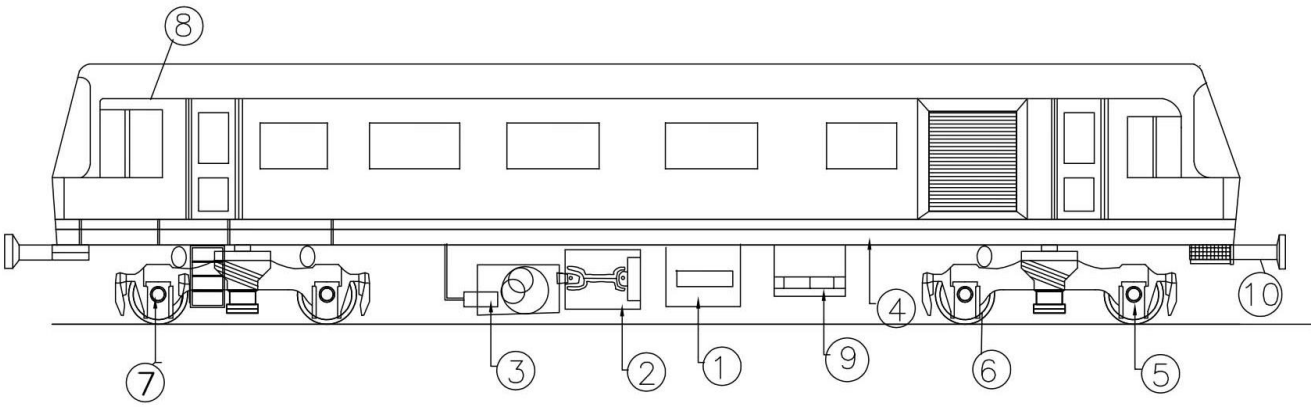


Fig 5.23

1 ENGINE
2 RADIATOR
3 TRANSMISSION
4 UNDER FRAME
5 BOGIE ASSEMBLY
6 POWERED WHEEL AXLE ASSEMBLY
7 NON POWERED WHEEL AXLE ASSEMBLY
8 CABIN
9 FUEL TANK
10 BUFFER ASSEMBLY

3) BRAKES

Following brake system is provided on RIV Machine-

(a) Indirect Brake– This brake is applied on machine with coupled camping coach/wagon automatically when air pressure of BP line releases through valve A9 or drops.

(b) Direct Brake – Direct Brake is applied when machine works individually.

(c) Emergency/Dump Brake – This is applied directly on the each rolling stock of the machine in the case of emergency for immediate stopping.

(d) Parking Brake – Hand operated brake system provided on each of the grinding cars for stabling.

(e) Automatic Penalty Braking– The automatic penalty braking application system restricts the speed of the machine beyond a predetermined set point to ensure safe operation.

4) SALIENT FEATURES OF RIV

(i) Machine dimensions: length over buffer – 15000mm, width – 3000mm & height – 3680mm

(ii) Diesel engine- c 9.3b, caterpillar

(iii) Weight of locomotive- weight of locomotive

(iv) Maximum axle load- 10 tonne±3%

(v) Track gauge- 1676 mm

(vi) Number of axle- 1- powered axle, 3- non powered axle

(vii) Engine horse power- 400hp at 2100 rpm

(viii) Design speed w/o load (maximum): 80 kmph.

(ix) Type of brake: emergency brakes, parking brake, service brake

(x) Transmission- CRT 5633, Avtec limited

5) Main objectives

The RIV is meant for collecting digitized image of the transverse profile of rail head for detailed analysis and for generating Grinding plans to be used on Rail Grinding Machines (RGMs, SRGMs, and RGM-10 Stones etc.) - The main objectives are:

(a) Recording digital image of the rail head profiles for selection of optimum grinding pattern, number of grind passes required and grinding speed per pass for any section of track.

(b) Assessing the grinding requirements due to surface defects on rail top after recording visuals of the rail top.

6) Working mechanism

Working mechanism can be divided in three systems which are:

(a) Optical Rail head Inspection & Analysis System based on LASER System:

(i) The rail head profile measuring system is capable of measuring the head profile of a rail with an accuracy of 0.15mm or better and its output format is acceptable on Rail Grinding Machines (RGMs, SRGMs, and RGM-10 Stones etc.).

(ii) The cameras on the system are mounted so that they can record from 70 degrees at the gauge side to 45 degrees at the field side of the rail head profile.

(iii) The system consists of two optical units that are mounted on the vehicle frame.

(iv) Each unit contains two lasers and two 3D-cameras that allow providing full rail profile.

(v) Advanced software algorithms provide calculation of multiple parameters, including rail wear as well as equivalent conicity in accordance with EN13231 and EN15302 standards.

(vi) Additional lasers provide a single line of illumination with the main lasers, which allows to increase the power and intensity of their radiation on the surface of the rails and successfully deal with possible flashes in the sun, get high-quality data at any time of the year in any weather conditions, and allows to maintain the reliability of operation with "shiny" (wet, polished) rails.

(b) Image Acquisition System

Image Acquisition System to collect and display top of rail (rail head) Images:

(i) It is able to capture at least one snap every 1 meter of track while moving at a speed of 50 kilometers per hour.

(ii) Broad parameters of the system are as under:

(i) Camera Resolution: Min 5MP
(ii) Sampling Rate: 30 Hz or more
(iii) Operating Speed: Up to (50 km/h)
(iv) Environmental Range: -5°C to 55°C

(iii) The system is using the same format as is being used on IR's SRGM and RGM to synchronize the data transfer with their chain.

(iv) The camera has optical image stabilization feature and vibration reduction as well as continuous auto focus to get reasonably sharp pictures.

(v) During the run, dust and other particles may accumulate on the camera which may degrade the image quality. The image Acquisition System has a self-cleaning system for continuous recording.

(vi) The design of Image Acquisition System allows to capture blur free images of the rail surface in real time, concurrent with rail profile with sufficient resolution to detail pitting and various surface defects on the top of rail surface.

(vii) It has high resolution cameras installed with high power LED lights.

(viii) GPS and encoder system provides high-accuracy location.

(ix) The Track Inspection Systems of Rail Inspection Vehicle (RIV) are shown below Fig 5.24.

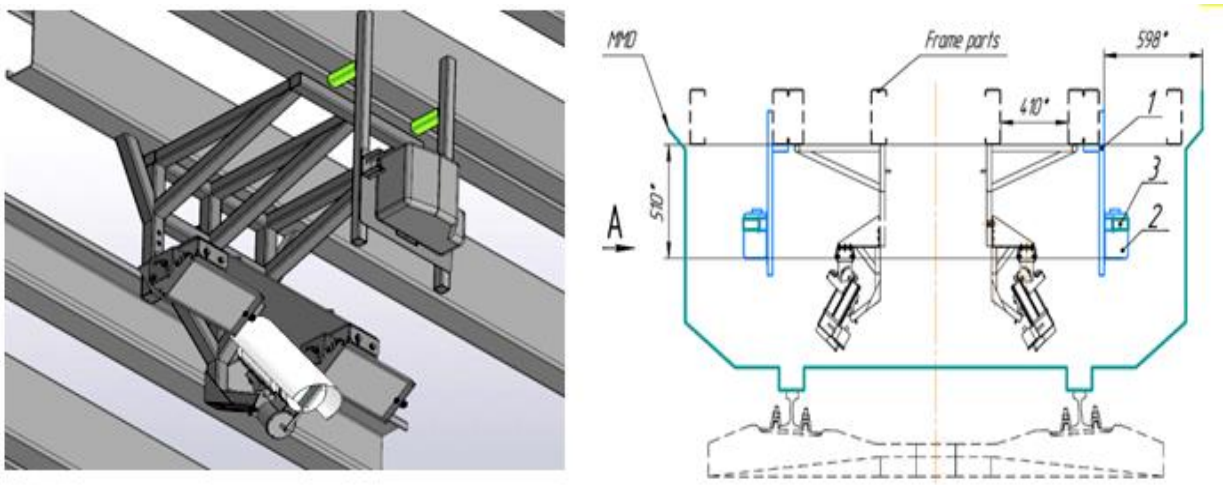


Fig 5.24

(c) Corrugation System

(i) The system consists of the acceleration sensors, which are installed on the axles of the rail-bound RIV. The accelerometers are used to monitor the vertical movements and to provide the signal data, sufficient for the assessment of the surface condition as it pertains to corrugation.

(ii) Installation of sensors on all 4 axles provides improved detection accuracy, and evaluation of interaction data in the "wheel-rail" system allows detecting rail surface defects at an early stage of their development.

(iii) The calculation of the parameters is performed in online mode at the computer, which is installed in the cabin of the vehicle.

(iv) Smart Grind software is used to record, localize and store the measurement data, and the configurable filters and processing patterns allow maximizing corrugation detection process.

(v) Corrugation Severity Index (scale of 0-5) is established.

7) DATA DISPLAY

Total 6 monitors are provided in the cabin of RIV machine. Data from each measurement system can be shown on separate monitors or all combined on one.

8) RIV: Communicating Grind Plan to other Grinders

(a) RIV measures Rail Profile.

(b) Smart Grind converts the Rail Profile into a .BAN file

(c) BAN file exported to other Grinders.

519.RGM - 10 stone (RGH10 C2-67) Harsco

1. GENERAL

The RGH10 Series C2 Rail Grinder consists of a single rail grinding car. The car is designed to grind the top and sides of both rails in main line, switch and crossing railroad track structure. The car is equipped with dual cabs, one on each end, and is also equipped with a rail profile measurement system, a rail corrugation detection system, Smart Grind analysis package and Compass telematics. Important dimensions of RGM - 10 stone machine are shown in Annexure 5.11.

It is currently being utilized in Kolkata Metro Railway Corporation (KMRC).

2. Important Assemblies of RGM-10 Stone-The components of RGM-10 Stone is shown in Fig**.** 5.25.

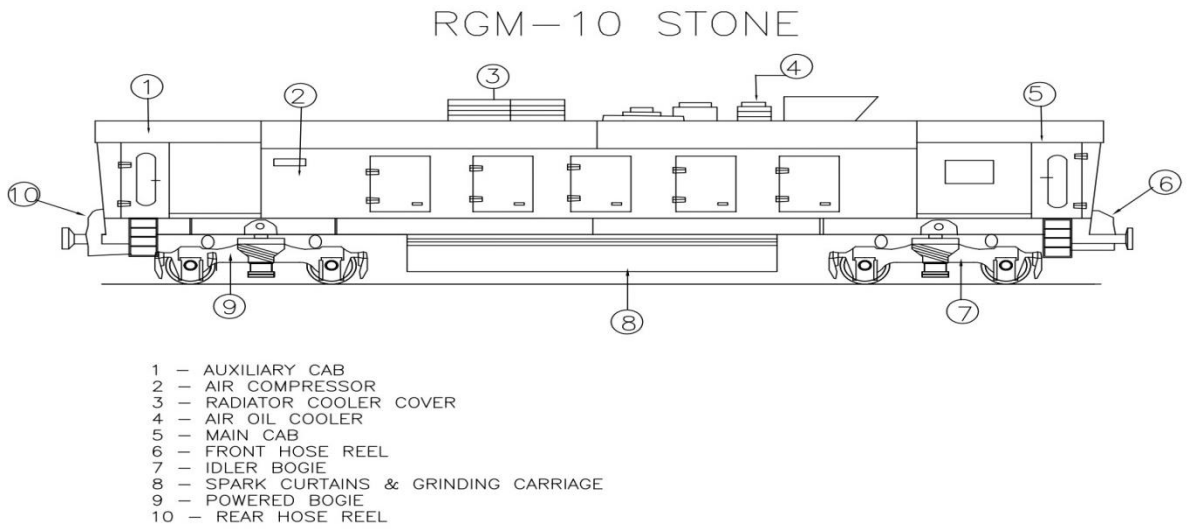


Fig**.** 5.25

a) Engine -

(i) 10-stone machine has a caterpillar® C13 tier III 6 cylinder 4 stroke - cycle diesel engine 388 KW (520 HP) @ 2,100 RPM.

(ii) Engine control system is designed to automatically shut down the engine in case of high engine coolant temperature, high compressor coolant temperature, low engine oil pressure, low coolant level, low hydraulic oil level, engine over speed, fire suppression system activation.

(iii) Engine can also be shut down manually through emergency stop switches inside both cabins and outside at opposite corners of the vehicle.

(iv) Engine cooling system is designed for use in ambient temperatures of up to 60° C.

b) Fuel System -

(i) The car is equipped with a fuel tank with capacity of 840 litres

(ii) Fuel level is shown on the control monitors in the cabins.

c) Brake System -

(i) Brake System - Standard train system with JZ-7 brake valves One composite brake shoe brake per wheel Each bogie is fitted with two air brake actuators Through brake linkage, actuators apply pressure to the brake shoe on each wheel.

(ii) Service Brakes - Air applied / Spring released Hand operated control valve.

(iii) Parking Brakes - Spring applied / Air released Hand operated control valve.

d) Water System -

(i) The grinding car is equipped with a water tank, water pump, track spray nozzles, and fire hose.

(ii) The stainless-steel water tank capacity of 428.3 gallons (2000 liters). The water tank level is viewed on the control monitor, and the operator is alerted when water level gets low and again when it is empty.

(iii) A fire hose is also located on the cab end of each machine. The reels each contain 50 ft (15.2 m) of hose. The switch is located outside next to the fire hose itself. The fire hose operates any time that the switch is turned on regardless of whether the machine is moving or not.

e) Dust Collector -

(i) The grinding car is equipped with integral dust collector units, which use a squirrel cage fan to draw roughly 4700 cfm (8,000 m3/hr) of air through a set of eight high-efficiency cartridge-type fire-resistant air filters.

(ii) Filters are capable of filtering 99.99% of airborne particles greater than 0.5 microns from the air that is drawn into the collector.

(iii) One pair of filters is purged every 10 seconds in a revolving pattern so that every 40 seconds each filter receives a momentary pulse of air in the direction opposite to normal flow to dislodge the dust from the filter media. The dust falls into a set of four dust collection trays, which can be pulled out by hand to be emptied. After grinding, a 15 minute clean up cycle can be started manually. The cleanup cycle allows the purge system to operate while the main fan is not running. The cleanup cycle can be interrupted at any time.

(iv) A temperature sensor inside the dust collector housing alerts the operator if the temperature gets above 107° C.

f) Video Camera and Monitor -

The low-light, high-resolution CCTV system provides a view of the track on both ends of the machine allowing bi-directional operation from either cab. Video cameras are mounted in environmentally protected enclosures and are tilted up and down with air cylinders. A color LCD monitor is mounted in each cab. The image is automatically switched from one camera to the other when the direction of the machine changes. The monitors automatically revert the image from the rear camera to preserve proper left/right orientation.

g) Communication Systems -

(i) The cabs are equipped with an intercom and public address system.

(ii) Space is available for the mounting of a railroad radio.

h) Rail Corrugation Analyzer (RCA) -

Accelerometers on front bogie axels provide corrugation detection of left and right rails in real-time with separate monitor. The Rail Corrugation Main Screen on the Jupiter monitor on the Car displays.

i) Salient Features of RGM-10 Stone-

(i) Machine Dimensions: Length –15.1 m, Width –2.6289 m & Height - 3.7139 m.
(ii) Engine Make - Caterpillar, Model: C13 Tier III 6 Cylinder 4 Stroke, 388KW (520HP) Idle/Full 900/1800 RPM.
(iii) Grinding Motor – Ten 152mm (6 inch) grinding heads 2.5-17KW (3-23 HP) hydraulic motors single speed 6,000 RPM, hydraulic load control.
(iv) Drive System: Hydrostatic Traction Drive, Gear Ratio 5.013:1 with variable speed hydraulic motor.
(v) Machine is capable of traveling and grinding in both directions.
(vi) Number of Modules: 10Jupiter Computer controlled hydraulic powered (Automatic Tilt, Lift and shift).
(vii)Type of Brake: Independent (service), Indirect brake, Emergency brakes, Automatic penalty brakes, Spring loaded and Mechanical Parking brake.
(viii) Fuel Tank Capacity - 840Liters, Hydraulic oil tank capacity-651 Litre and Water Tank Capacity - 2000Liters.
(ix) Fire Suppression System- Two 23kg dry chemical tanks.

3. Grinding Strategy-

a) Strategy- Grinding strategy will be same as apply for RGM's kindly refer para 503 of 1, 2, 3 & 4.

b) Target Rail Profile- There are five target rail profiles used in the RGM 10 Stone , one for tangent track, 02 for moderate/mild (high/low rail) curve and 2 for sharp (high/low rail) curves.

c) Patterns-RGM 10 Stone is currently stored with 50 patterns; however machine has capability to store 99 patterns in library. The patterns of RGM-10 stones are different from RGM-72 and RGM-96. Pattern number 38, 35, 34, 9, 8 & 5 are suggested for corrugation removal.

d) Smart Grind system-The Smart Grind system can generate dynamic grind plans in real-time after a measurement pass is made. This is achieved by comparing the measured current state of the track profile with the standard profile of the track. A quantitative assessment related to the rail improvement can be determined through the comparison of data collected before and after grinding. The system recommends the best patterns which are needed for the next pass after passing through track. In addition, the system also displays the information pertaining to the location, track layout, and profile. All relevant information is saved to a database for data collation and analysis. The system provides the user with immediate feedback of grinding requirements based on the measured profile of the rail.

e) Grind Quality Index (GQI) - GQI value of 85 or above can be considered acceptable.

f) Tangents and curves for metro railways are differentiated into the following categories.

Track	Minimum Degree	Maximum Degree
Tangent	0	2
Mild/Moderate	2	8
Sharp	8	---

4. Capability Of RGM-10 Stone -

a) RGM-10 Stone grinding machine consisting of 10 stone, i.e. 5 stones each for the left rail as well as right rail.

b) Rotation of each is done by hydraulic motor of about 23 HP. The speed of rotation is 6000 RPM. Each motor can be tilted at a desired angle from $+70^0$ (towards gauge face side) to -45^0 (towards field side). This angle is measured from the vertical.

c) Grinding speed of RGM-10 Stone 2–16 kmph. Corrective grinding (defect removal), maximum grinding speed is 8 Kmph.

d) The machine is capable of grinding of tangent as well curved track, track in tunnels, track on Bridges, LC and Turnout.

e) The Jupiter Control System is used to control the grinding functions on the machine. All grinding functions are displayed on the touch screen monitor and are controlled by the Jupiter computer, either manually or automatically. The Jupiter computer system is capable of storing up to 99 different rail grinding patterns.

f) The maximum cutting depth in each pass is around 0.2 mm at the working speed of 10 Kmph and around 0.13 mm at working speed of 12 kmph.

g) The machine is capable of broad gauge (1676 mm) and standard track (1435 mm).

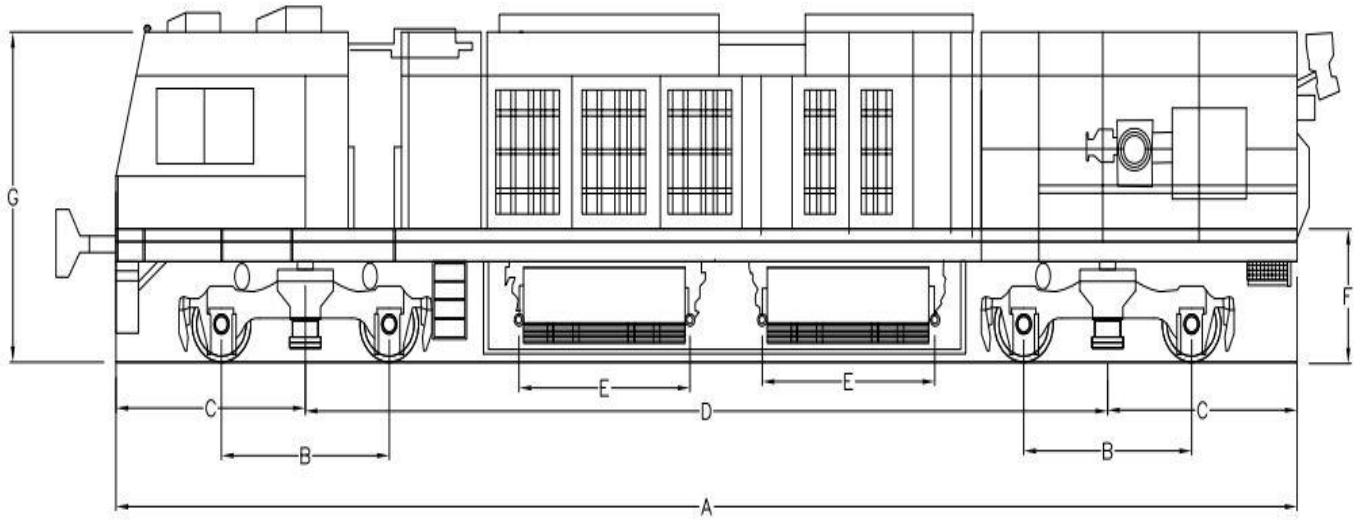
h) The machine is maximum permissible speed own power/in train formation 50 kmph.

i) Rail surface roughness after grinding 12 microns or less.

H. New annexures 5.6, 5.7, 5.8, 5.9,5.10& 5.11 to be added after annexure 5.5 as under:

Annexure 5.6

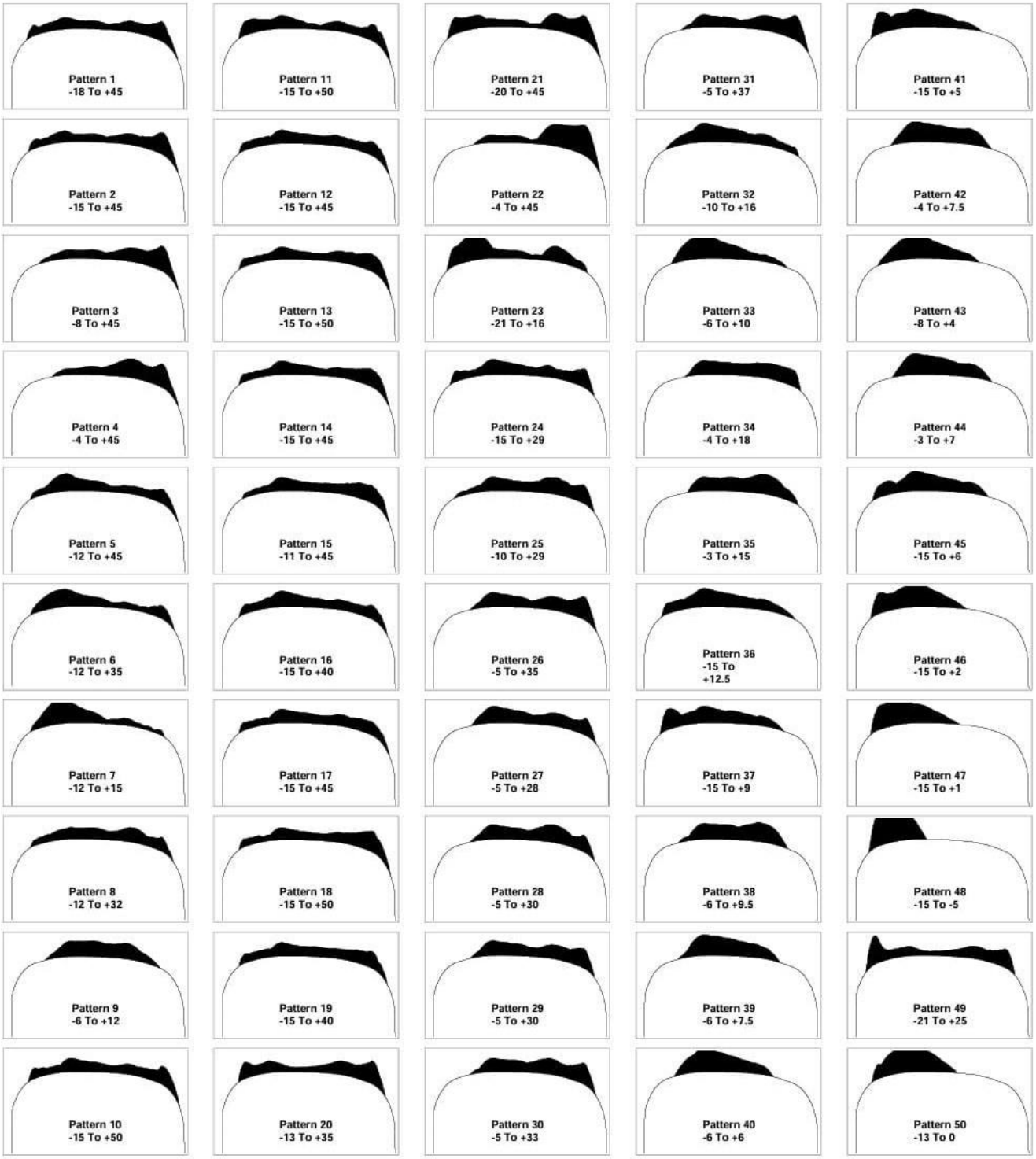
SRGM GRIND CAR



NAME OF MACHINE	A	B	C	D	E	F	G	WHEEL DAI.	AXLE LOAD
SRGM GRIND CAR	19304	2000	3099	13106	3454	1676	3927	1000	21.66t

Annexure 5.7

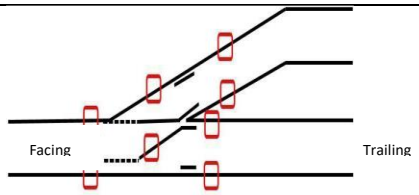
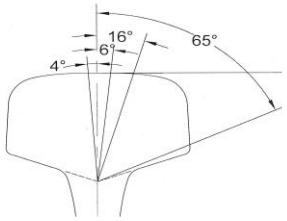
Pattern Sheet for SRGM



Annexure 5.8

SWITCH RAIL GRINDING MONITORING PROFORMA
(Details of Test locations)

Rly…….Div…….Route……Section……Rail Section/UTS……Typeof sleeper……Sleeper density……
Ballast cushion……Tangent/Curved track……Degree of curve……Line (UP/DN)…… Axle Load……Total GMT carried……GMT (Current)…… Date of Last Grinding……Grinding Cycle……Gauge (in mm)……Rolling mark of rails……Engineered rail profile Template used ……Turnout No…… Test Site No…… From Km/TP…… To Km/TP…… Crossing Angle …… Trailing/ Facing Direction (Direction of traffic)……
Position of spots on Turnouts (Choose any one as per requirement) (a) Ahead of SRJ…… (b) T/O Lead Rail ……
(c) Behind back leg of Crossing Main Line …… (d) Behind back leg of crossing turnout side……

S.No.	Item Description	Observations on Left Rail * *		Observations on Right Rail * *		Remarks
		Before Grinding	After Grinding	Before Grinding	After Grinding	
A	Visual Inspection (severity be indicated)*					
	1.Gauge corner chipping (Y/N)					
	2.Metal Flow of rail top / Burring (Y/N)					
	3.Rolling Contact Fatigue (Visual inspection & Dye Penetration test)					 For a) to c) FieldGauge
	a) Gauge corner (65 to 16 deg.) (Y/N)					
	b) Shoulder / mid Guage of Rail (16 to 6 deg.) (Y/N)					
	c) Crown of Rail (6 to -4 deg.) (Y/N)					
	d) Pitch of fatigue cracks (mm)(Range)					
	e) Max. length of fatigue crack(mm)					
	4.Wheel burns and Scabbing (Y/N)					
	5.Any other defect observed					
B	Corrugation (Y/N)					
C	Hunting (Cyclic Wear) (Y/N)					
D	Track Geometry parameters					Parameters of the concerned blocks (SD & worst peak) of test site location should be taken from the records of TRC run just before grinding.
	1. Gauge					
	2. Twist					
	3. Unevenness (9.0 m chord)					
	4. Alignment (9.0 m chord)					

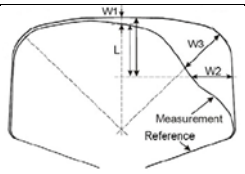
* Soft copies of Photographs of the test locations before and after grinding, after Dye penetration test indicating condition of rail (size of defect, location in Km, Line, indication of gauge face, direction of traffic) should be uploaded.

**** Indicate Low or High Rail in case of curve. Left and Right rails shall be marked w.r.t to direction of traffic.**

NOTE: 1. Details for each turnout 1 in 8.5, 1 in 12and1 in 16 test locations shall be submitted separately in the proforma.

2.Corrugation and Hunting to be observed in the point &crossing containing the test sites(within 50 m either side of test site).

Date: (Signature of Inspecting official with Name/Designation)

S. No.	Item Description	Observations on Left Rail		Observations on Right Rail		Remarks
		Before Grinding	After Grinding	Before Grinding	After Grinding	
E	Type of contact of wheel on Rail (One /Two/Multiple point contact)					
	1.One point contact					
	a) Contact Band Width (mm)					
	b) Distance from gauge face side* (mm)					
	c) Gauge Corner contact (Y/N)					
	2.Two point contact					
	a) Contact Band Width (mm)					
	(i)					
	(ii)					
	b) Distance from gauge face side (mm)					
	(i)					
	(ii)					
	3. Multiple point contact					
	a) Contact Band Width (mm)					
	(i)					
	(ii)					
	(iii)					
	b) Distance from gauge face side (mm)					
	(i)					
	(ii)					
	(iii)					
F	Wear of rail** (in mm) 1. Top Table (W1) 2. Gauge Face (W2) 3. Gauge Face Corner (W3)					 W1- To be measured at centre of Rail W2- To be measured at 14.3 mm from top of Rail W3- To be measured at 45 degree from vertical
G	Weld dip at nearby location (Same weld to be measure every time)					
H	Post Grinding Roughness*** (Microns)					
I	Depth of Cut (Metal Removal)					

*Distance measured up to center of contact band width.
** Measured by Rail Profile Measuring Equipment and soft copies of rail profiles to be uploaded.
*** To be measured with equipment available at RGM, otherwise general observation to be recorded.

Date:

(Signature of Inspecting official with Name/Designation)

SWITCH RAIL GRINDING MONITORING PROFORMA
(Section Specific details)

Railway…….. Div…… Route……..Section……..From Km/TP…… To ……Km/TP…… Line (UP/DN/ Single)…….Rail section and UTS…… Type of sleeper…… Sleeper density…… Ballast cushion…… Annual GMT…… Cumulative GMT …….. Axle Load……..Start Date of grinding cycle for major section…… Date of last TRC run…… Completion Date of Grinding cycle for major section……..Test Site No. …… Turnout No…… Crossing Angle …… Trailing/ Facing Direction (Direction of traffic)…….

S. No.	Item Description		1 in 8.5		1 in 12		1 in 16		Remarks
			Left Rail	Right Rail	Left Rail	Right Rail	Left Rail	Right Rail	
A	Full details of locations before grinding*								
	1. Rolling Contact Fatigue (Head checks) (Y/N)								
	2. Corrugation (Y/N)								
	3. Hunting (cyclic wear) (Y/N)								
	4. Other defects (gauge corner chipping, flow of rail top, corrosion, wheel burns etc., specify type of any other defect)								
B	Effectiveness of Lubrication (Y/N)								
C	Track Geometry (TQI Value) - before grinding*	Composite							
		Short Chord							
		Long Chord							

* Details to be given for specific locations wherever significant defect is noticed.

Note: The above details shall be recorded every time before grinding.

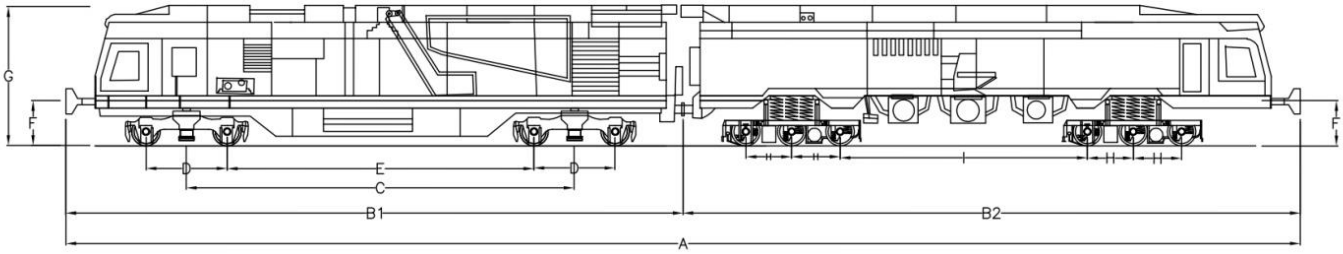
Date:

(Signature of Inspecting official with Name/Designation)

Annexure-5.9

Important Features/Dimensions of RMM

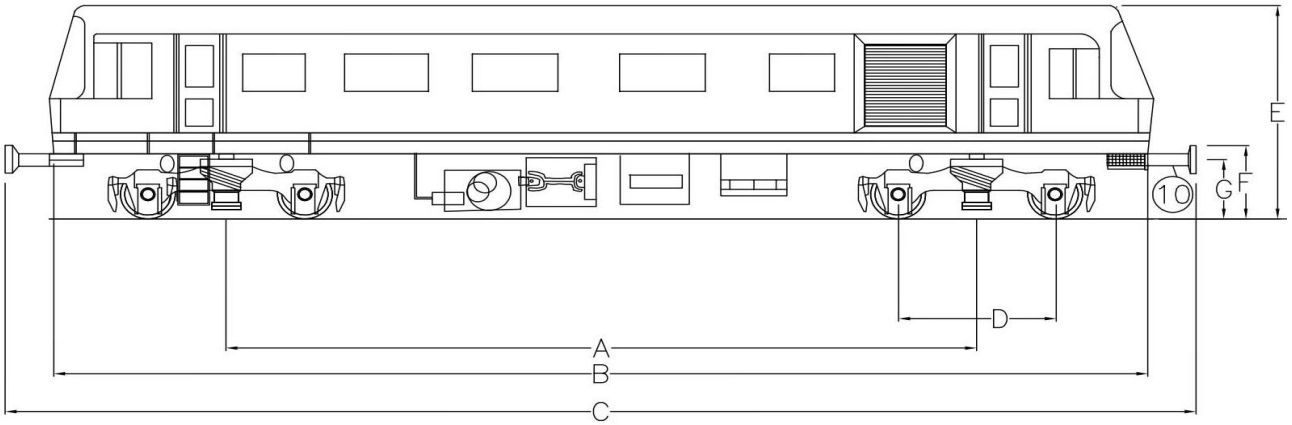
RAIL MILLING MACHINE



NAME OF MACHINE	A	B1	B2	C	D	E	F	G	H	I	WHEEL DIA.		AXLE LOAD		WIDTH	
											CARRIER	TRAILER	CARRIER	TRAILER	CARRIER	TRAILER
RAIL MILLING MACHINE	43336	19825	23511	14145	1800	12345	1105	4185	1800	11299	1000	920	19.2t	17.3t	2940	3061

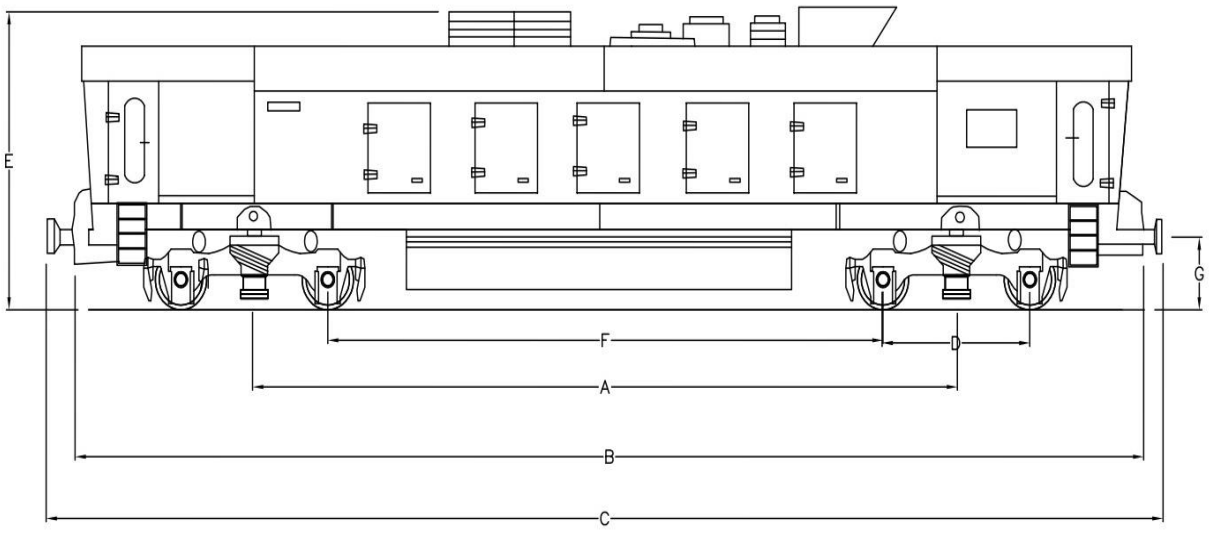
ANNEXURE-5.10

Important Features/Dimensions of RIV



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RIV	9000	15000	16270	2896	3700	1350	1105	915	10t	3000

RGM–10 STONE



NAME OF MACHINE	A	B	C	D	E	F	G	WHEELDIA	AXLE LOAD	WIDTH
RGM-10 STONE	7620	13506.5	15082	1800	3713.9	5820	790	832	13.05t	2628.9

I. Para 606 (1) shall be replaced by new para 606 (1) as under:

(1) Track machines are deployed for variety of track works and their proper utilization has to be ensured by making available minimum duration of blocks for smooth, safe and effective working. Minimum duration of block is fixed based on setting up/winding up time, ineffective time and progress per effective hour. Minimum block duration etc. for different types of machines is given in Table below.

M/c Type	Minimum Block (hr.) (min)	Ineffective time (hr.) (min)	Output / eff. Hr.
DUO	2.50 (150 min)	0.50 (30 min)	800 m
CSM	2.50 (150 min)	0.50 (30 min)	1200 m
TEX/ DYNAMIC	2.50 (150 min)	0.50 (30 min)	1600 m
UNIMAT	2.50* (150 min)	0.50 (30 min)	1 turnout
MPT	2.50* (150 min)	0.50 (30 min)	1000 PRC/ 1 turnout
DTS	2.50* (150 min)	0.50 (30 min)	2500 m
PCCM	3.00 (180 min)	1.25(75 min)	1 turnout per 1.75 Hr.
BCM(Plain)	3.00 (180 min)	1.00 (60 min)	200 m
BCM (P&C)	4.50 (270 min)	3.00 (180 min) #	One turnout =750 m track
HOBCM	4.00 (240 min)	1.33 (80 min)	350 m
SBCM	2.50 (150 min)	0.50 (30 min)	400 m
TLE	3.00 (180 min)	0.75 (45 min)	200 m
TRT	4.00 (240 min)	1.25 (75 min)	400 m
RGM (72 stone)	4.00 (240 min)$^{\$\$}$	0.75 (45 min)	12-15** km
RGM(96 stone)	4.00 (240 min)$^{\$\$}$	0.75 (45 min)	15-18** km
SRGM	4.00 (240 min)$^{\$\$}$	0.75 (45 min)	2 Turnout/3 km
RIV	2.50 (150 min)	0.50 (30 min)	40-50 km
RMM	4.00 (240 min)$^{\$\$}$	0.75 (45 min)	0.7-1.5 km

- **Time for turnout is for main line & turnout side and connection and disconnection time required for S&T.*
- ***Depending on the length on curves in the section.*
- *# For deep screening of P&C, ineffective time includes movement, preparatory works and S&T works.*
- *$\$$ If one block of 4 hrs block is not possible then two blocks of 2.5 hrs / fourblocks of 1.5 hrs to be provided.*
- *Output may vary depending upon the age of the machine and track features.*
- *For output less than 90% of the normal output, the reason should be analyzed and corrective action taken if any.*
- *MPT is used for spot attention of both plain track & points & crossing; hence requirement will vary depending on work to be performed.*

J. Para (1) of annexure 9.1 shall be replaced by new para (1) as under:

(1) Weightage Factors (Units) for Track Machines

S .No	Type of Machine	Weightage Factor
1	Tamper WST/DUO, CSM, TEX, Unimat/MPT, Dynamic Track Stabilizer, Points & Crossing Laying Machine (set of 2), Track Laying Equipment (set of 2)	1.0
2	Tamping Express Dynamic	1.5
2	Ballast Regulator/ Utility Vehicle (Self Propelled), RBMV	0.8
3	Ballast Cleaning Machine and Shoulder Ballast Cleaning Machine.	1.5
4	HOBCM(RM900), HOSBCM	1.75
5	Track Relaying Train	3.0
6	Muck Disposal Unit/ Tie Crane/ Rail threader Unit /Rail Lifting Units, Rail-Cum-Road Vehicles.	0.5
7	Rail Inspection Vehicle	0.8
8	Rail Grinding Machine (10 stone)	1.0
9	Switch Rail Grinding Machine	1.0
10	Rail Grinding Machine (72 stones)	4.5
11	Rail Grinding Machine (96 stones)	4.75
12	Rail Milling Machine	1.0