SUGGESTION FOR INTRODUCTION OF RACK ON GENERATION (ROG) IN MAIN LINE EXPRESS TRAINS WITH LHB FORMATION

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1. PROLOGUE

a. **Capacity augmentation, increase in earnings, energy efficiency, less pollution, etc are some of the key areas where continuous improvement is being pursued by Indian Railways both in passenger & freight services.**

b. **Any capacity addition in a train formation without increasing the number/weight of coaches will results in substantial improvement in above mentioned areas.**

c. **Introduction of Rack on Generation (ROG) system instead of EOG & HOG in LHB train formations will results in increased passenger carrying capacity. This will save precious fuel cost & less pollution effect. Railway earnings will also increase without any addition to the infrastructure.**

2. POWER SUPPLY SYSTEMS FOR COACHES FOLLOWED IN INDIAN RAILWAYS

a. **Self Generating (SG)**

2×25 KW alternators for AC coach and 1×4.5 KW for non-AC coach is mounted on Bogie, driven by a pulley-'V' belt arrangement, driving pulley is mounted on coach axle. Output is rectified and charges 110V DC battery for continuous power supply to AC and non-AC coaches. AC load of roof mounted packaged units is supplied by converting DC into 2×25 KVA inverters.

b. **End-on-Generation (EOG)**

Two power cars each equipped with 2×500 KVA DG sets, one at each end of the train, supplies 3 phase power at 750 V AC power to each electrically interconnected coach. The voltage is stepped down to 3 phase 415 V and supplied to standard voltage equipment on each coach.

c. **Head-on-Generation (HOG)**

HOG scheme consists of 3 phase electric loco with IGBT technology having minimum 2x500 KVA hotel load converters on loco. Power is supplied from the locomotive at the head of the train. Locomotives take power from OHE through pantograph to traction transformer. Traction transformer of WAP5 and WAP7 is provided with a hotel load winding to cater power supply to coaches for lights, fans and air conditioning, pantry etc. referred as "Hotel Load".

d. **Comparison between SG, EOG & HOG**

i. **Advantages & Limitations of EOG over SG**

EOG will be preferred over SG for all reasons, except two i.e. the carrying / earning capacity of the power car and limitation in flexibility & inter-changeability.

ii. **Reduction in carrying/earning capacity due to EOG**

Advantages of LHB coaches are lighter in weight, run in high speed, high passenger capacity, more safe due to centre buffer coupler instead of screw coupling in old design, more life, less maintenance, less noise, energy efficient because of end on generation and improved riding index.

Platforms of Indian Railways are designed to accommodate 24 coaches train formation of ICF designed coaches with total length of 512 meter. Total length of 22 LHB coaches train formation is 528 metres, out of these 22 coaches 2 will be generator cars which will not carry any

passenger. Effectively 20 coaches are used to carry passengers in LHB train formation. As a net effect it brings down the passenger carrying capacity of train formation.

For example a train formation with old 24 ICF design coaches (2 SLR + 2 GS + 1 FAC + 1 AC COMP + 2 AC 2tier + 4 AC 3 tier + 12 SL) had passenger capacity of 1492 and freight capacity of 16 tonne with 1200 tonne gross weight of train formation. New 22 LHB coaches train formation (2 EOG + 2 GS + 1 FAC + 1 AC COMP + 2 AC 2tier + 4 AC 3 tier + 10 SL) is having the passenger capacity of 1458 and freight capacity of 8 tonne with 1110 tonne gross weight of train formation. WAP-7 AC electric loco can haul 1430 tonne passenger train at a speed of 130 kmph. Dispite of the fact that LHB coach formation is lighter by 15.75%, passenger capacity is reduced by 2.3% and freight by 50% as illustrated in the table below,

	LHB DESIGNED COACHES FORMATION (EOG)				ICF DESIGND COACHES FORMATION (SG)				% difference in passenger carrying capacity of LHB over ICF	Weight reduction of LHB formation over ICF formation in %
	No of coaches	Gross weight Tonne	Length over buffer mm	Passenger capacity numbers	No of coaches	Gross weight Tonne	Length over buffer mm	Passenger capacity numbers		
EOG	2	113.56	48000							
SLR					2	108.72	42672	48	-100.0 %	
GS	2	100.98	48000	200	2	98.2	42672	180	11.1 %	
1st AC	1	43.34	24000	24	1	55.5	21336	22	9.1 %	
AC Comp	1	43.34	24000	38	1	53.13	21336	30	26.7 %	
AC 2 tier	2	93.44	48000	108	2	112.2	42672	92	17.4 %	
AC 3 tier	4	195.2	96000	288	4	229.6	85344	256	12.5 %	
Sleeper	10	421.9	240000	800	12	543.6	256032	864	-7.4 %	
Total	22	1011.76	528000	1458	24	1200.95	512064	1492	-2.3 %	15.75%
Freight Capacity				8 Tonne				16 Tonne	-50 %	

iii. **Advantages & Limitations of HOG**

HOG system is considered to be the most economical for the reasons,

a. Cost of generation is minimum.

b. Free from air pollution since burning of high speed diesel is eliminated.

c. Free from noise pollution of DG sets.

d. Low maintenance is required due to less number of generating equipments hence better reliability.

e. Reduced dead weight.

But, the head on locomotive is not permanently connected to the train formation. If for some reason, it is detached, there is no source of power; therefore, one power car has to remain in the rake. If the power car become mechanically sick en-route and detached, entire rake will have the risk of no power.

3. SUGGESTION FOR INTRODUCTION OF RAKE ON GENERATION (ROG)

a. **HOG system was introduced in Indian Railways in the year 2011. Even though this system has many inherent advantages as briefed in earlier para, still Indian Railways is not in a position to use this system in mass scale due to its limitations briefed earlier, to overcome this limitation introduction of Rack on generation (ROG) is suggested.**

b. **Existing DG sets in the power car can be eliminated, instead pantograph & other electrical equipments shall be provided in the Power Car.**

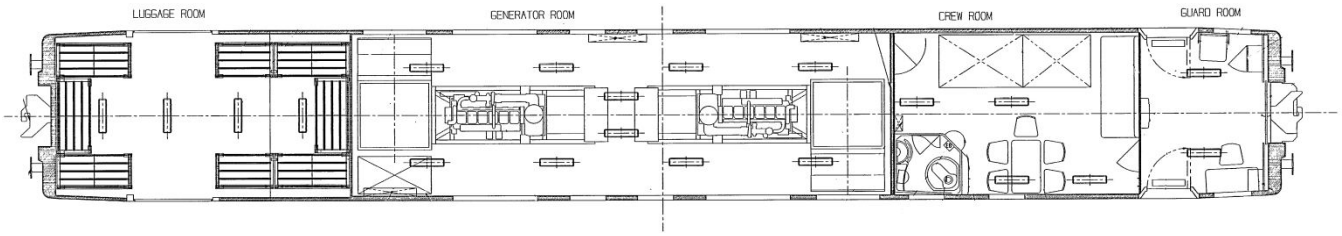
c. **Electrical equipments required to cater hotel load shall be provided in Power Car itself, ie, pantograph, transformer, converter, etc shall be provided in 2 Power Cars at both end of the train formation to supply power for the hotel load of the train formation.**

d. **Part of these equipments can be provided in under slung (in place of diesel tank) to get more on board space to accommodate more passengers.**

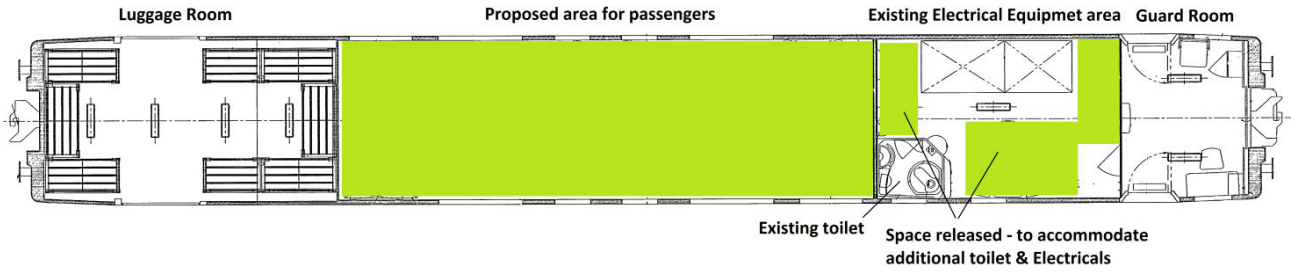
e. **Loco & one of the Power Car can draw power from OHE simultaneously for the purpose of traction & for feeding the hotel load respectively. Another Power Car can be used as standby.**

f. **This Power Car with pantograph shall be used as SLR to accommodate passenger, luggage & guard as given in the proposed layout below.**

Existing Layout



Proposed Layout



4. ADVANTAGES OF RAKE ON GENERATION (ROG)

a. **Advantage of ROG over HOG**

i. **Power supply independent of Loco**: This will ensure power supply to the train formation without Loco attached to it.

ii. **No need have DG set**: Even if one SLR coach needs to be detached enroute for mechanical failure, supply can be ensured through another SLR and hence no need to have DG set.

iii. **More flexibility**: Train formation can be hauled with any suitable loco, instead of restricting it to WAP-5 & WAP-7.

b. **Advantages of ROG over EOG**

i. **More carrying capacity**:

a. Engine room of EOG coach occupies 10,230 mm length. Size of one bay in passenger coach is 1702 mm, so effectively 6 passenger bays will be released if DG set is eliminated.

b. Already one toilet is provided in the existing power car. Additional toilet shall be provided in the available floor space opposite to existing toilet.

c. Hence, 60 passengers per SLR coach, 120 passengers per train formation can be accommodated additionally if it is utilized as general second class. 96 passengers per train can be accommodated additionally if it is utilized as 3 tier sleeper/3 tier AC sleeper.

ii. **Less weight of train formation**: Nearly 7.5 tone of weight can be reduced by eliminating engine, radiator, fuel tank, etc.

iii. **Less fuel cost**: Full cost of diesel can be eliminated

iv. **No air pollution & noise pollution**: Since DG set is not used, noise & air pollution generated by DG set is completely eliminated.

v. **Less maintenance**: Since DG set & its related moving parts are eliminated.

vi. **Energy saving:** Regenerative break system can also be introduced to save the electrical energy.

c. Projected additional earnings per rake per year

A train formation having two proposed ROG can earn additionally per year

i.	If the additional seating capacity is used for second class mail/express, additional earning per train in a year will be, Avg lead km 347.4 km X earning/passenger km 27.9 paise X 120 seats X 365 days	=	Rs. 42,50,000
ii.	If the additional seating capacity is used for sleeper class, additional earning per train in a year will be, Avg lead km 878.4 km X Avg lead km 45.6 paise X 96 berths X 365 days	=	Rs.1,40, 50,000
iii.	If the additional seating capacity is used for AC 3-tier, additional earning per train in a year will be, Avg lead km 823.3 km X earning/passenger km 125.6 paise X 96 berths X 365 days	=	Rs.3,62, 50,000

Thank you