ORGANISATION OF TRACK MAINTENANCE OF MOSCOW–KAZAN HSR

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ABSTRACT

The article contains recommendations on the track maintenance facilities organization on the pilot section of Moscow–Kazan high speed railway. Particularly, the authors suggest organization structure of current track maintenance, substantiate approaches to provision of track sections and local repair shops with track machinery, equipment and tools, arrangement of the number and locations of repair shops responsible for maintenance and repairing of track machinery and locomotives, of other technical equipment.

Keywords: railway, high speed railway, track section, technical maintenance, current maintenance, organization structure, management, control system.

Background. *The development of the project of construction of the Moscow–Kazan HSR requires number of economic and technical studies regarding its different aspects, comprising the track facilities and their future maintenance.*

Objective. *The task of the study was to substantiate recommendations on the organization of track maintenance facilities for Moscow–Kazan HSR.*

Methods. *The authors use technical, economic analysis, tools of project management.*

Results.

Calculations of the required number of daily maintenance personnel for HSR-2 Moscow–Kazan [ed. note: the HSR-2 is the short name of that section according to general project of construction of HSR in Russia] indicate that routine (current) maintenance of the operational 770–790 km of the main tracks and 35–45 km of zones regarded as approaches to the megalopolises can be provided by a contingent numbering from 211 to 420 persons. The smaller number corresponds to the initial parameters of the railway infrastructure. The greater number will be required at the latest stages of the railway infrastructure's service life [1].

The primary types of maintenance performed on a ballasted track include [2]:

– preventive local adjustment and replacement of defective fasteners and other elements of the track superstructure;

– local adjustment of the gauge;

– correction of local sagging or twisting;

– grinding of rails and metal elements of turnouts;

– removal of snow and rainwater during autumn, spring, and winter;

– other related operations (vegetation management, trackside land and treebelt management, etc.).

Same but primarily for the off-station main running tracks:

– local gauge adjustment, replacement of defective fasteners and other elements of the track superstructure;

– grinding of rails and metal elements of turnouts;

– removal of snow and rainwater during autumn, spring, and winter seasons;

– replacement of turnout elements;

– replacement of individual rails and turnout elements, normally involves replacement of all fasteners and pads;

– on-site rail welding (flash butt welding and aluminothermic welding);

– geodetic verification and preparation of tracks for the operation of track machinery; may be performed either during the day (if possible) or at night (during train-free «maintenance windows»);

– other incidental operations (vegetation management, trackside land and treebelt management, etc.).

Current (routine) maintenance includes the following activities: oversight, verification, monitoring, appraisal of condition, correction of minor defects incidental to normal operation (e.g. stuck turnouts, rail fractures, etc.).

Operations involved in the replacement of turnouts or rails and in rail welding are performed by Team 2 personnel of the corresponding track section. After replacements, old rails, fasteners, and pads are used elsewhere in the track as appropriate.

Ballasted track alignment and surfacing is performed with cycle machines.

Snow protection devices installed on operational railway sections must guard the track from blizzard snow accumulation and be economically viable.

Snow is removed from the track with snow plows or snow blowers, with pneumatic units blowing snow out of turnout elements, and with wind deflectors on turnout electric heaters.

Snow melting facilities may be used at stations. Snow melting can be economically justified if two conditions are met:

– waste heat is available (in the form of hot or warm water discharged into water reservoirs or the sewage system);

– a rainwater drainage system is available at the station.

Snow melting methods that rely on superheated steam, solid fuel or petroleum products are several times as expensive as methods based on collecting snow and removing it from the station with motor vehicles. For this reason, such methods of snow melting can only be recommended in special circumstances requiring a feasibility study and economic justification in each individual case [4, 5].

Selecting a tree planting system and a tree-belt construction is an important element of the track design process. A tree planting system is construed as the number and arrangement of tree belts and gaps between the belts on trackside land. By the number of tree belts, the planting systems are referred to as single-belt, double-belt, triple-belt, and multi-belt.

To support current (routine) maintenance of ballasted tracks on approaches to a megalopolis, or ballasted station tracks or other types of ballasted track, it is recommended that mechanized multipurpose units be formed [6] equipped with machines from the list provided in Table 1.

To provide current maintenance to the sections' main tracks (ballastless configuration), it is recommended that sets of mechanized equipment and machines from the list provided in Table 2 be used.

It merits additional clarification, especially with regard to the Tables, that the PCM maintenance units are workshops servicing the railway's divisions. They are infrastructural

Table 1

A suggested list of track machines and devices to be used on HSR-2; the number of units required to maintain megalopolis approaches, ballasted station and other tracks included in HSR-2

Type of machine (modern variety example)	HSR-2 structural unit			Base location
	HSR as a whole	Per division	Suggested crew per machine	
Self-propelled snow removal train (similar to the existing PSS model)*	16	8 (as many as there are stations)	3 persons (including 2 machinists)	At stations
Snow removal vehicle (similar to the existing SDPM model)	16	8 (as many as there are stations)	2 persons (including 2 machinists)	At stations
Rail cleaning vehicle (similar to the existing ROM model) *	2	1	2 persons (including 1 machinist)	PCM maintenance unit
Lining-tamping-finishing machine (similar to DUOMATIC)	2	1	3 persons (including 2 machinists)	PCM maintenance unit
Turnout lining-tamping-finishing machine (similar to UNIMAT)	2	1	4 persons (including 2 machinists)	PCM maintenance unit
Fastener tightening machine (similar to PMG)*	12	6 (as many as there are sections)	3 persons (including 1 machinist)	PCM maintenance unit
Track-laying crane with flatbeds fitted with USO standardized removable equipment, and flatbeds for turnout transportation (similar to UK-25/28 SP)	2	1	8 persons (including 2 machinists)	PCM maintenance unit
Multipurpose track maintenance machine (similar to PUMA-2000) *	2	1	4 persons (including 2 machinists)	PCM maintenance unit
Ballast leveler (similar to PB)	2	1	2 persons (including 1 machinist)	PCM maintenance unit
Dynamic track stabilizer (similar to DSP)	2	1	3 persons (including 1 machinist)	PCM maintenance unit
Multipurpose cleaning machine (similar to FATRA)	18	9 (as many as there are stations + one for the division)	2 persons (including 1 machinist)	At stations
Hopper batcher (similar to VPM-770)	16	8 (as many as there are stations)	4 persons	PCM maintenance unit
Track maintenance car (rail motor car) (similar to ASG-30P)*	12	6 (as many as there are sections)	2 persons (including 1 machinist)	На станциях
Rail grinding machine (similar to RSP-48)*	2	1	5 persons (including 2 machinists)	PCM maintenance unit
Combination vehicles with a set of detachable equipment	4	2	6 persons (including 2 machinists)	PCM maintenance unit
Ballast cutting machine (similar to MVB-150)	2	1	4 persons (including 2 machinists)	PCM maintenance unit
Mechanized finishing combination unit (similar to MOK-1)	2	1	4 persons (including 2 machinists)	PCM maintenance unit
Multipurpose vegetation management/sleeper replacement machine (similar to MKS[U])	2	1	4 persons (including 2 machinists)	PCM maintenance unit
Mobile power plant (similar to ZES) *	12	6 (as many as there are sections)	2 persons	At the section
AOU lighting units (similar to the «inflatable torch» used by the Emergency Management Ministry)*	100	50 (as many as there are stations + two for the division)	2 persons	At stations
A set of mechanized manual tools and accessories to be used by station maintenance teams	16	8 (as many as there are stations)	Depending on the number of tools available	At the section
* Machines of this type are used on both ballastless and ballasted tracks.				
TOTAL: the estimated total number of maintenance personnel is 386 persons. Of that number, 152 are machinists and their assistants.				

organizational units of the HSR-2 railway. Their mission is to perform scheduled maintenance, primarily intermediate maintenance, that involves deep cleaning of the ballast layer, and maintenance that involves lifting and replacing all the rails, replacing turnouts, continuous grinding and profiling of rails and turnouts with mechanized multipurpose equipment, etc. The other, and no less important, mission of the PCM maintenance units is the upkeep and repair of the track equipment and locomotives that are assigned to them [6].

By their organizational structure, PCM maintenance units are divided into two shops:

1) a track maintenance shop; and

2) a shop responsible for maintenance and repair of track machinery, track equipment, and assigned diesel locomotives.

The total numerical strength of a PCM maintenance unit is 380–400 persons, with the field contingent of about 200–230 persons.

The track maintenance shop is responsible for performing maintenance work and removing snow and rainwater within the division's area of responsibility. The shop employs 20–30 permanent maintenance workers and 20–30 seasonal workers (used as such can be employees of teams No. 2 of those sections where maintenance work is performed).

The track machinery/diesel locomotive maintenance shop will number no more than 100–120 persons.

The track machinery repair unit (based in the OPTZ, the Combined Process Building) will also perform current maintenance of railcars (both passenger and freight) and railway cranes.

PCM maintenance units are planned to be based at locations that support quick deployment of the

Table 2

A suggested list of track machines and devices, and their numbers, to be used for the maintenance of main track sections (ballastless configuration) on HSR-2

Type of machine	HSR-2 structural unit				
	HSR-2 as a whole *	Per division*	Section*	Station*	Subsection*
	Approximate number of staff members, persons				
PSS self-propelled snow removal train	16	8	-	1	-
Rail cleaning machine (similar to ROM)	2	1	-	-	-
Fastener tightening machine (similar to PMG)	12	6	1	-	-
Multipurpose track maintenance machine (similar to PUMA-2000)	2	1	-	-	-
Rail grinding machine (similar to RSP-48)	2	1	-	-	-
Track maintenance car (rail motor car) ASG-30P (and draisine)	14	6	1	-	1
Mobile power plant (similar to ZES)	12	6	1	-	1
AOU lighting units (similar to the «inflatable torch» used by the Emergency Management Ministry)	100	50	8	-	2
* No additional machinery is intended for the sections' main tracks. Maintenance is provided with the same equipment as serves megalopolis approaches, station tracks, and other tracks.					

workforce, machinery, equipment, and tools to any worksite on HSR-2, and easy return to the home base.

Another variety of track workshop operating on HSR-2 is known as the PDM, an organizational unit of the railway's division intended to provide the support function. Its key responsibilities include: current maintenance of industrial machinery, equipment, and tools. PDMs employ the following skills: track machinery and equipment technicians (including technicians servicing pneumatic blowers at turnouts), 2 persons; carpenters, 2 persons; blacksmiths, 2 persons; lathe operators, 1 person; track measurement equipment technicians (in the diagnostics unit), 2 persons; manual power tools and accessory repair workers, 2–4 persons; tractor drivers, 2–3 persons; drivers of maintenance motor vehicles: their number corresponds to the number of maintenance vehicles at each section of the division, and the number of station teams, plus 2–3 persons on 24-hour duty to support duty maintenance teams; janitorial staff for industrial and office space, 1–2 persons.

Thus, the total number of the PDM support unit employees sums up to 30–38 persons.

The PDM needs indoor space for a draisine (rail motor car), 2–3 service motor vehicles, metalwork, carpentry, and turning lathe shops, a blacksmith shop, a manual power tool and station team gear repair shop.

Conclusions. *A set of service units and subdivisions dedicated to providing maintenance and repair to the tracks on HSR-2 is designed in accordance with the spirit of the times, i.e. to be rational and efficient, with the functions, responsibilities, and requirements to the upkeep and operation of the railway's facilities being closely and systemically interrelated in their design configurations.*

This approach is understood and shared by the parties involved: engineers, designers, economists, and marketing experts. Thus, the picture presented in this article is a real starting point for making executive decisions that, once made, define the degree of the innovation project's maturity.

The availability of a conceptual road map for the project at hand provides, in our view, sufficient grounds to move on and start organizing and structuring activities.

REFERENCES

1. Strategy of the development of the holding company Russian Railways till the year 2030 (abstract) [*Strategiya razvitiya kholdinga «RZD» na period do 2030 goda (osnovnye polozheniya)*]. [Electronic resource]: http://doc.rzd.ru/doc/public/ru? STRUCTURE_ID=704&layer_id=5104&referLayerId=5101&id=6396. Last accessed 26.06.2017.

2. Instructions on current railway track maintenance, approved by JSC Russian Railways document 2791r of 29.12.2012 [*Instruktsiya po tekushhemu soderzhaniyu zheleznodorozhnogo puti. Utverzhdena rasporyazheniem OAO «RZD» № 2791r ot 29.12.2012 goda*].

3. Decree of the President of Russian Federation of 16.03.2010 No. 321 «On the measures of organization of high speed rail traffic in Russian Federation» [*Ukaz Prezidenta Rossijskoy Federatsii ot 16 marta 2010 g. № 321 «O merakh po organizatsii dvizheniya vysokoskorostnogo zheleznodorozhnogo transporta v Rossijskoj Federatsii»*].

4. Investment substantiation regarding construction of high speed railway Moscow–Kazan. Decision of the Board of directors of JSC Russian Railways of 21.12.2012 (protocol No. 21) [*Obosnovanie investitsij v stroitel'stvo vysokoskorostnoy zheleznodorozhnoy magistrali «Moskva–Kazan'». Reshenie Soveta direktorov OAO «RZD» ot 21 dekabrya 2012 g. (protokol № 21)*].

5. Technically substantiated rules of time spent on current track maintenance. Approved by JSC Russian Railways on 30.03.2009 [*Tekhnicheskie obosnovannye normy vremeni na raboty po tekushhemu soderzhaniyu puti (TNK). Utverzhdeny TSP OAO «RZD» 30 marta 2009 goda*].

6. Kovalenko, N. I., Suhorukov, V. E., Zastavnoy, A. P., Kascheev, A. V. Practices of work of Volgograd mechanized subdivision of track maintenance PChM-10 [*Opyt raboty Volgogradskoj mekhanizirovannoj distantsii puti PCHM-10*]. *Zheleznodorozhnyj transport. Seriya: Put' i putevoe khozyajstvo*, 1999, Iss. 4, pp. 22–31. ●

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