PRAHA a.s.

DYNAMIC TRACK STABILIZER

VKL 404 IN

OPERATION AND MAINTENANCE

MANUAL

NkOU 320 05

M T H Praha a. s.
Kandertova 1a/1131, 180 00 Praha 8

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CONTENTS

1. INTRODUCTION

This Operation and Maintenance Manual is valid for the special track vehicle called the **Dynamic Track Stabilizer VKL 404 IN** which was designed and manufactured by the **MTH Praha a.s.** company in cooperation with the **BHEL Jhansi** company.

Fig. 1 Dynamic track stabilizer VKL 404 IN

2. TERMINOLOGY OF THE VEHICLE

Vehicle front part	- the headstock opposite to the DG set cover
Vehicle rear part	- the headstock close to the DG set cover
Working Mode	- the main mode of the vehicle use due to its technologic purpose
Travel Mode	- secondary mode of the vehicle use for its transport
Working position	- the position of all the working mechanisms in the Working Mode
Travel position	- the position of all the working mechanisms in the Travel Mode
Stabilizing aggregate	- working aggregate with 2 bogies and the mutual vibration exciter

3. GENERAL DATA

3. 1. Brief Vehicle Description

The Dynamic Track Stabilizer VKL 404 IN hereinafter DTS is the four-axle double bogie special track vehicle with its own drive of two axles (nose hung traction motors) in one bogie. Power transmission is electric AC / DC. The vehicle has two cabins with the drivers desk each for the travel and the brake control of the vehicle and the connected vehicles. The vehicle is equipped with the railway type draw and buffer gear, brakes, the outer illumination

and signal elements used by IR. The front cabin (the bigger one) is equipped with the working desk. Both the cabins are connected by the cover. The DG set with the compressor, the air brake reservoirs, the hydraulic aggregate etc. are located under it. The vacant spaces of the underframe are equipped with the walkways which enable an entry to the aggregates and walking between the cabins. The energy supply (DG set) is created of the Diesel engine and three-phase synchronous alternator and is used both for the travel and for the working machinery drive or for both the purposes. The stabilization aggregate and its drive, synchromesh gearbox, thrust hydraulic cylinders are located in the middle of the vehicle. The thrust hydraulic cylinders are also used for the stabilizing aggregate displacing to and from the working position. The suspension hooks fix the stabilizing aggregate in the Travel Mode and help to set it onto the track in a curve.

The vehicle works in two modes. In the Travel Mode the whole electric power output is supplied across the traction rectifier to the DC traction motors. The alternator is controlled by the combined power output governor. In the Working Mode the 3x400 V, 50 Hz electric network is controlled by the automatic voltage regulator. The network supplies the asynchronous motors, the Working Mode travel is provided by the controlled rectifier.

The vehicle is equipped with the digital measuring and control system MS 404 In which enables to keep the set constant thrust or the constant drop by means of the proportional hydraulic valves which control the thrust. The pressure oil is supplied by the hydraulic aggregate.

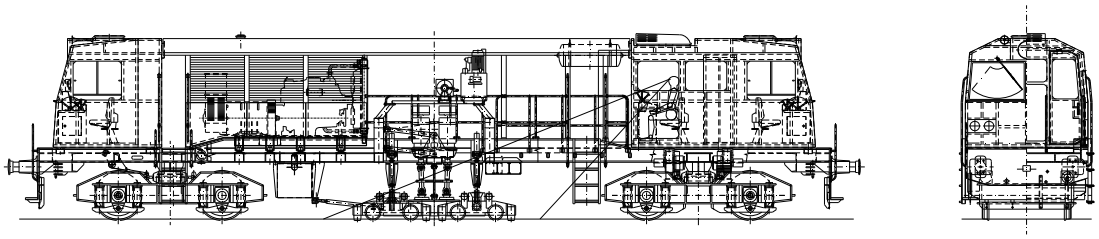

Fig. 2 DTS Type sheet

3. 2. Vehicle Operational Purpose

3. 2. 1. Working Mode

The DTS vehicle is determined for the ballast bed stabilization by means of the vibration consolidating on the tracks and turnouts especially on the high speed tracks.
The vehicle is a machine consolidating the track ballast bed in its whole section uniformly after the tamping machine work which creates appropriate conditions for the long-lasting required correct track geometry set by a tamping machine and for the demanded high transversal resistance of the track (especially on the continuously welded rail). This mode is being used notably on the new built tracks but also after the track geometry reset by a tamping machine during the track maintenance. The ballast consolidation after the dynamic stabilization is equal to the traffic load of 100 000 tonnes.
The DTS is not able to provide some track geometry adjustments possibly required because it is not equipped with the appropriate working members nor with the appropriate measuring and controlling appliance. The track geometry adjustments are done by a tamping machine.

The DTS, actually the stabilizing aggregate which effects the rail heads by means of the directional transversal vibrations, the sleepers through the rail fastenings. This vibration is transmitted by the friction forces between the sleepers and the ballast to the track ballast bed in the combination of the vertical thrust. The individual ballast grains are mutually wedged in, **the volume mass is being increased – the ballast homogeneity gets more uniformal in the whole section of the ballast bed, below and among sleepers as well.** It significantly participates in ensuring the long-lasting required track geometry including the high transversal track resistance.

The **constant thrust** working mode provides to reach the maximum homogeneity. The **constant drop** working mode due to the controlled thrust does not spoil the track geometry set by a tamping machine. Maximum working speed is of 2,5 kmph.

3. 2. 2. Travel Mode

The vehicle also enables the transport of the other vehicle up to the weight of 60 tonnes under its own power to the maximum speed of 75 kmph acc. to the DTS Performance curve (*see NC 05 05 , Enclosure 12. 7.)* including the air brake pipe connection. It can be transported in a train formation maximum speed of 80 kmph, without a crew, with a restriction not to be loose shunted, but always in accordance with the IR regulations. Minimum curve radius is 150 m when travelling the track speed.

CAUTION: **It is forbidden to use the DTS vehicle for the other purpose i.e. as a shunting locomotive, for persons and material transport etc.**

3. 3. Climatic and Geographic Conditions of the Vehicle Operation

The vehicle design enables Travel Mode in a train formation in the ambient temperature interval - 30° C up to + 50° C, the Travel Mode under own power - 10° C up to + 50° C and Working Mode + 5° C up to + 50°.
The items used in the electric equipment can work in the minimal ambient temperature of + 10°C. The items which need the higher operational temperature than - 10° C have been located in the electrical cabinet in which the temperature does not decrease below 0° C during the operation.

4. BASIC TECHNICAL DATA

4. 1. Basic data

Gauge	1 676 mm
Max. speed under own power	75 kmph
Max. speed in a train formation	80 kmph
Vehicle weight	approx. 64,5 tonnes
Axle arrangement	B´o 2´
Axle load	max. 18 t
Vehicle gauge	IR (1973)
Travel in a train formation	No restriction
Operational restrictions	Not to be loose shunted
	Max. connected load 60 tonnes

Minimum curve radius	150 m
Superelevation (cant)	185 mm
Max. gradient	1 in 33

4. 2. Dimensions

Max. width	2 850 mm
Max. height	3 925 mm
Length over the buffers	18 070 mm
Length over the headstocks	16 800 mm
Pivot pins distance	11 200 mm
Bogie axle base	2 200 mm
Headstock overhangs	
- to the front plate	2 800 mm
- to the buffer ends	3 435 mm
Wheel dia.	1 000 mm

4. 3. Vehicle strength data

longitudinal force on the buffers	2 x 600 kN
longitudinal diagonal force on the buffers	400 kN
longitudinal tractive force on the draw gear	1 000 kN
longitudinal inertial acceleration on the underframe parts	30 $m.s^{-2}$

Draw gear	General arrangement Sketch - 99003
Buffers	IR part No. WA/BD – 198

4. 4. Power output data

Diesel engine power output:	continuous	283 kW / 1 900 RPM
	intermittent	333 kW / 1 900 RPM

4. 5. Power transmission

Type		electric AC / DC
Gear ratio (axle gearbox)		92 / 19
Power output on the wheels:	- continuous	206 kW
	- intermittent power	234,6 kW
Speed :	- at the continuous power	18 kmph
	- at intermittent power	20,5 kmph
Tractive effort on the wheels:	- rated	41,2 kN
	- maximum	64 kN
Rated current		420 Amps DC
Max. current in acceleration		600 Amps DC

5. TECHNICAL DATA OF THE MAIN COMPONENTS

5. 1. Diesel Engine

Type	NTA-855-L 4 Cycle, In-Line 6-Cylinder Diesel
Aspiration	Turbocharged and Aftercooled
Manufacturer	CUMMINS India Ltd.
No. of pcs.	1
Rated power output	278 kW
Rated speed	1 800 RPM
Idle speed	750 RPM (min. 650 RPM)
Maximum speed	2 100 RPM
Maximum overspeed	2 700 RPM
Bore	140 mm
Stroke	152 mm
Displacement	14,01 litre
Compression ratio	14,0 : 1
Fuel	HSD (High Speed Diesel)
Max. fuel consumption at max. rated power output and speed	74 kg/hr
Oil pressure	276 – 345 kPa
Maximum oil consumption	0,24 l/hr
Type of engine cooling	water cooling
Type of starting	starter
Dry weight	1 330 kg
Minimum ambient temperature for unaided cold start	2°C

5. 2. Traction Alternator

Type	TA3560
Manufacturer	KEL Co. Ltd., India
Class	synchronous
Rated power output	220 kVA
Max. voltage at the rated power output	815 V AC / 1 800 RPM 415 V AC / 1 500 RPM
Rated current	270 A DC at 1 800 RPM 300 A DC at 1 500 RPM
Rated speed	1 800 RPM
Maximum excitation voltage	24 V (1 900 RPM)
Maximum excitation current	7 Amps
Exciting: Working mode	AVR
Travel Mode	LCC
Cooling	own air cooling
Weight	1 750 kg

5. 3. Traction Rectifier (Travel Mode)

Type	UID-45
Manufacturer	ČKD Elektrotechnika, Cz. Rep.
Class	uncontrolled, bridge, three-phase
Rated voltage	3 x 415 V AC
Rated current	420 Amps DC
Cooling	external forced-air cooling
Weight	45 kg

5. 4. Traction Rectifier (Working Mode)

Type	Mentor II M420
Manufacturer	Control Techniques
Class	controlled, bridge, three-phase
Rated voltage	3 x 400 V AC
Rated current	420 Amps
Cooling	external forced-air cooling
Weight	22 kg

5. 5. Frequency Converter

Type	Commander GPD4401
Manufacturer	Control Techniques
Class	controlled, three-phase frequency converter
Rated voltage	3 x 400 V AC
Rated current	96 Amps
Cooling	external forced-air cooling
Weight	70 kg

5. 6. Traction Motor

Type	TM4501AZ
Manufacturer	BHEL Bhopal, India
Class	series DC nose-hung motor
Rated power output	111 kW
Rated voltage	395 Volts DC
Rated current	320 Amps
Rated speed	748 RPM
Cooling	excternal forced-air cooling
Weight	2 035 kg
No. of pcs	2
Power transmission to the wheel set	gear drive, rate 19/92
Protection	fuses at the AC circuits

5. 7. Charging Alternator a part of the Diesel engine

5. 8. Auxiliary Charging Alternator

Type	9518 893X
Manufacturer	Magneton, Cz. Rep.
Class	three-phase with the rectifier
Rated power output	3,92 kW
Rated voltage	28 V DC
Rated current	140 Amps
Rated speed	6 000 RPM
Cooling	own air cooling
Weight	12,2 kg
No. of pcs	1

5. 9. Electric Motors of the Auxiliary Appliances Drives

5. 9. 1. Stabilizing Aggregate Gearbox Drive

Type	1AY 160M-4

Manufacturer	EM Brno, Cz. Rep.
Class	three-phase
Rated power output	22 kW
Rated voltage	3x400 / 230 V AC
Rated current	42 Amps
Rated speed	1 465 RPM
Cooling	external forced-air cooling
Weight	150 kg
No. of pcs.	2
Protection	100 Amps fuses ahead of the converter

5. 9. 2. Hydraulic Aggregate Drive

Type	MA – AL 132S - 4
Manufacturer	Elektro Precizia Bra**š**ov, Romania
Class	three-phase
Rated power output	5 ,5 kW
Rated voltage	3x400 / 230 V AC
Rated current	11,4 Amps
Rated speed	1 445 RPM
Cooling	own air cooling
Weight	42,5 kg
No. of pcs.	1
Protection	motor starter 9 – 14 Amps

5. 9. 3. Hydraulic Aggregate Cooling Fan Drive

Type	IMB34
Manufacturer	Oiltech
Class	three-phase
Rated power output	0,75 kW
Rated voltage	3x400 / 230 V AC
Rated current	1,86 Amps
Rated speed	1 395 RPM
Cooling	own air cooling
Weight	5,5 kg
No. of pcs.	2
Protection	motor starter 1,6 – 2, 5 Amps

5. 9. 4. Emergency Hydraulic Aggregate Drive

Type	36808
Manufacturer	Efel
Class	DC
Rated power output	2 kW
Rated voltage	24 V DC
Rated current	150 Amps (S2)
Rated speed	1 700 RPM
Cooling	own air cooling
Weight	11 kg
No. of pcs.	1
Protection	150 Amps fuse

5. 9. 5. Air-Conditioning Unit Drive

Type	1LA7130-2AA10

Manufacturer	Siemens
Class	three-phase
Rated power output	4 kW
Rated voltage	3x400 / 230 V AC
Rated current	13,6 Amps
Rated speed	2 905 RPM
Cooling	own air cooling
Weight	29 kg
No. of pcs.	1
Protection	motor starter 13 – 18 Amps

5. 9. 6. Traction Motor Cooling Drive

Type	P2Zx525
Manufacturer	ATAS Náchod, Cz. Rep.
Class	DC with pemanent magnets
Rated power output	750 W (1100 W S2)
Rated voltage	24 V DC
Rated current	38 A
Rated speed	2 800 RPM
Cooling	own air cooling
Weight	7,9 kg
No. of pcs.	2
Protection	40 Amps circuit breaker

5. 10. Hydraulic pump

Type	PV6 2R1 DF02
Manufacturer	Denison
Geometric volume	14,4 ccm
Maximum rate of flow	19,8 litre p.m.
Maximum pressure	15,5 MPa

5. 11. Accumulator Battery

Type	Traction battery
Manufacturer	Kirloskar
Class	lead-acid
Capacity	290 Ah
Rated voltage	8 V
No. of pcs.	3

5. 12. Speedometer

Type	LAX2000 D3
Manufacturer	Laxven Systems
Measurement range	0 – 120 kmph
Feeding voltage	24 V DC

5. 13. Compressor

a part of the Diesel engine

5. 14. Stabilizing Aggregate

Outer roller base	2 600 mm
Roller base	800 mm
Roller dia.	280 mm

Centrifugal force of vibrations	0 – 400 kN
Vibration frequency	0 – 45 Hz
Vertical thrust	50 – 240 kN
Drive	2 x 22 kW
Working speed	0 – 2,5 kmph
Weight	5 000 kg

6. VEHICLE DESCRIPTION

6. 1. Description of the Vehicle Basic Parts

6. 1. 1. Bogies

The bogies are of the BHEL manufacture, one of them is driving (below the front cabin) and the second one is trailing. The driving bogie is equipped with two traction motors, the sand boxes and the sand ejectors. Both the bogies are equipped with the mechanical brake including 2 duplex brake cylinders. The underframe is mounted on the bogies by means of the pivot pin arrangement.
Two numbers of GEL pulse generators are fixed on the axle bearing cover, R.H.:
the 2nd (driving) axle – generator for the travel control
the 3rd (trailing) axle – generator for the measuring system control
The speedometer drive is mounted on the L.H. bearing cover of the 2nd driving axle.

6. 1. 2. Underframe

The main underframe parts are two longitudinal beams of I section made of plates. They are connected at the both ends by means of headstocks for mounting the buffers and the draw gears. The headstocks are made of a thick plate and connected to the beams by the ribs. Two diagonal braces are inserted between the headstock and the pivot pin transversal beam to transverse the diagonal forces across the buffers. The fixing bases are welded to the main longitudinal beams to carry cabins on the silentblocks mounted.

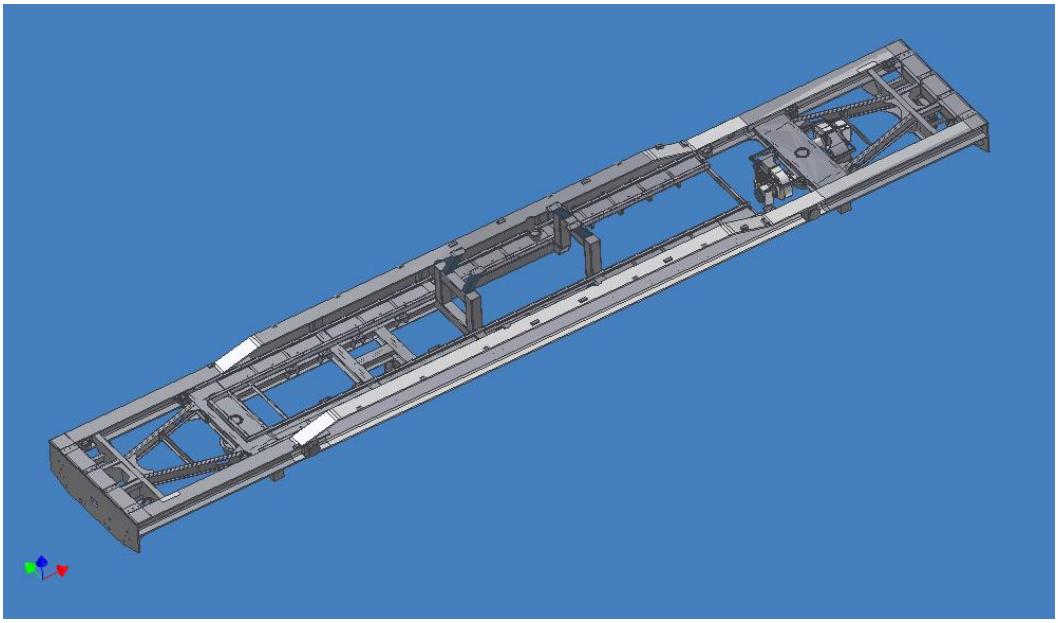

Fig. 3 DTS Underframe model

6. 1. 3. DG Set

The Diesel aggregate composed of the Diesel engine CUMMINS NTA855L type with the cooling system and the synchronous traction alternator KEL TA3560 type is located in front of the rear cabin. It has its own frame mounted to two longitudinal beams by means of the silentblocks. The DG set fastening must resist the longitudinal acceleration of 3 g.

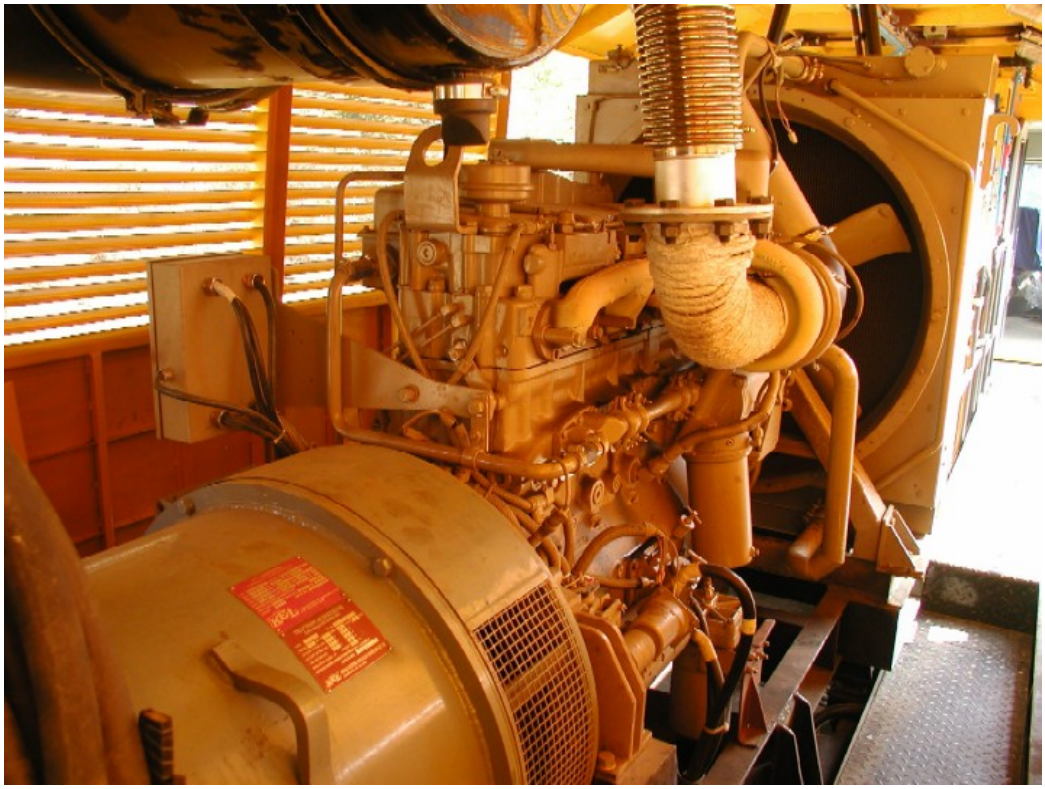

Fig. 4 DG set

6. 1. 4. Front Cabin

The front cabin is situated on the opposite vehicle end of the DG set location. It consists of two parts connected to one unit:

- the front part is identical to the rear cabin
- the rear part contains the working desk

The front part is equipped with the drivers desk with the driver´s brake valves on the left hand side and a table for the chief guard on the right hand side. In front of them three identical spring-cushioned seats with the foot rest are situated. The front window glazing is made of the safety triple ply glass thickness of 12 mm. The RM3 electrical cabinet together with the lockable box for the crew props, small spare parts and instruments is placed in the cabin centre, the lockable box towards the drivers desk. The other two tilting seats and the fire extinguisher are mounted on the sidewalls. All the doors of both the cabins can be locked with one key.

Fig. 5 Front cabin

6. 1. 5. Rear Cabin

The rear cabin is identical to the front part of the front cabin but only one entry door is situated in the centre of the rear wall which is created of RM1 and RM2 electrical cabinets. The hand brake gearbox is fixed on the middle support beside the drivers desk, the fire extinguisher on the sidewall.

Fig. 6 Rear cabin

6. 1. 6. Cover

The cover is inserted between the cabins and its shape has been created as per the IR gauge. It is removable mounted to the posts. The connection to the cabins enables longitudinal dilatation but being water-resistant because of the labyrinth joint.

6. 1. 7. Ladders, Walkways, Railing and Foot Boards

To reach the cabins and the walkways the side ladders are situated behind the rear walls of the cabins. The side walkways are equipped with the railing. The front walkways with hand rails equipped are used for the front windows cleaning, the head lights and position lights maintenance. The foot boards for a shunter are located at the both sides of the underframe headstocks.

6. 1. 8. Hydraulic Aggregate, Hydraulic System

The hydraulic aggregate is a supply of the pressure hydraulic oil for the control of all the DTS hydraulic cylinders. It is situated on the removable auxiliary frame above the stabilizing aggregate. The basic part is the welded oil tank with the hydraulic generator situated in the tank and the electric motor mounted on the tank cover. The necessary distributors, the temperature and the pressure transmitter sensors, the hydraulic accumulator, the pressure gauge, the drain and pressure filters are placed on the cover as well. The filters are equipped with the clogging signalization on the JSP working desk. The 24 V DC emergency hydraulic generator, the sightglass with thermometer and the clean-out port are mounted on the tank side wall. A part of the aggregate is the hydraulic oil cooler with the fan and the pump electrically driven. It is located beside the oil tank and connected to the aggregate by means of the hoses. The oil cooling is automatically controlled by the thermostat without any crew intervention.

The hydraulic system has been created of the hydraulic blocks with the hydraulic distributors the control and regulating elements. The proportional (relief) valves are used for the stabilization aggregate control, voltage of 24 V DC. The hydraulic installation is composed of the pipes and hoses.

Fig. 7, 8 Hydraulic aggregate

Fig. 9, 10 Hydraulic system

6. 1. 9. Fuel System

The basic part of the fuel system is the fuel tank. It is underslung mounted by means of the brackets below the DG set. The tanking inlet is situated on the both sides. They are high enough to prevent the fuel overflows on the superelevation. The fuel tank is equipped with the fuel level transmitter sensor and the gauges are situated on the both drivers desks. The sight glasses are additionally arranged on the tank side walls.

6. 1. 10. Electric Equipment

The Basic Wiring Diagram of the power, control and auxiliary circuits is shown in the drawing No. 3-320-26.1C *see Enclosure 11. 4.* All the functional connections and the circuits operations are evident in the diagram.

The Diesel engine drives the three-phase synchronous alternator.
In the **Travel Mode** the aggregate supplies the DC traction motors in cooperation with the uncontrolled rectifier and the power output and the speed governor. The travel speed control is being done through the stepwise speed variation of the Diesel engine. Its speed range of 750 - 1 900 RPM is spread to 8 notches. To reach the required travel speed the vehicle is equipped with the two-step resistor shunting which works on 5. – 8. notch only. The shunting is automatically switched on without any crew intervention at the speed of 30 and 40 kmph. To get over the steep gradients the short-time power output increase of the Diesel engine could be used. It is permitted to be switched-on in the drivers desk when the travel speed is minimum **10 kmph**, the 8th notch on and it can be used **once in 60 minutes.** The function is automatically finished either after 15 minutes or the coolant temperature exceeds the permitted value or the 8th notch is shifted out.

In the **Working mode** the aggregate runs on a constant speed of 1 500 RPM. The output voltage is kept on a constant value of 3 x 400 V, 50 Hz by means of the Automatic Voltage Regulator. This electric network supplies the technologic drives.

The DC traction motors are supplied through the controlled rectifier which is supplied the half voltage value of the traction alternator. That rectifier also controls the working speed.

The stabilization aggregate frequency is controlled of the static frequency converter which supplies two asynchronous motors. These motors are equipped with the external cooling, the thermistor protection and indication in the working desk.

The traction motors are ventilated by the 24 V DC motors driven fans which are supplied of the auxiliary charging alternator the Diesel engine mechanically driven. The traction motor cooling is switched on after the travel direction is selected.

Control and signalling circuits are the 24 V DC battery supplied. Its charging is the charging alternator (a part of the Diesel engine) provided.

Fig. 11, 12 Battery arrangment and charging alternators

The vehicle is equipped with the Bender type watcher of the traction circuit insulation condition, the AC network overvoltage protection, the Diesel engine electronic control panel (ECP2), the speedometer set (LAX2000 D3) and with the other common items of the track vehicles (illumination, wipers, glass blowing, sanding, emergency shut-down etc.).
Electric instruments, devices and items are located in RM1 and RM2 electrical cabinets in the rear cabin and RM3 electrical cabinet in the front cabin. The circuits breakers are situated on the RM2 and RM3 cabinets covers to enable the fast detection of the possible failures.

6. 1. 11. Air Brake System

*)

6. 1. 12. Stabilizing Aggregate

The working mechanism is composed of the directed vibrations exciter, two working bogies and their drive, the thrust (lifting) cylinders and the suspension hooks. It is situated beneath the underframe in the vehicle centre. Stabilizing aggregate runs with the vehicle on the track in the Working Mode and it is hung on the suspension hooks in the Travel Mode. The hooks are also used for the aggregate seating on a track curve.

The stabilizing aggregate base is made of a rigid steel plate with the vibrators drive housing welded on. Two spherical bearings for fastening the stabilizing aggregate transversal arms and transmitting the vibrating forces are also fixed to this plate. Each transversal arm has a swinging and sliding part and carries a pair of the rollers (in a balancer mounted) at the both ends for transmitting the transversal vibrations and the vertical thrust. The roller design enables the work in the turnouts. The roller balancers are equipped with the blades which

guide the rollers travelling through the crossings. The blades are made of the HTS and are mounted to the balancer plate by the screws.
Each transversal arm swivelling around a vertical axis enables that the rollers are radially placed in a curve. One roller pair is transversally moving along the horizontal pin for adjusting to the gauge and taking up the transversal plays. It is also swivelling round the horizontal transversal pin which enables the sliding. The pin and the rollers shift out is done by a pair of the expanding hydraulic cylinders.

Fig. 13 Stabilizing aggregate

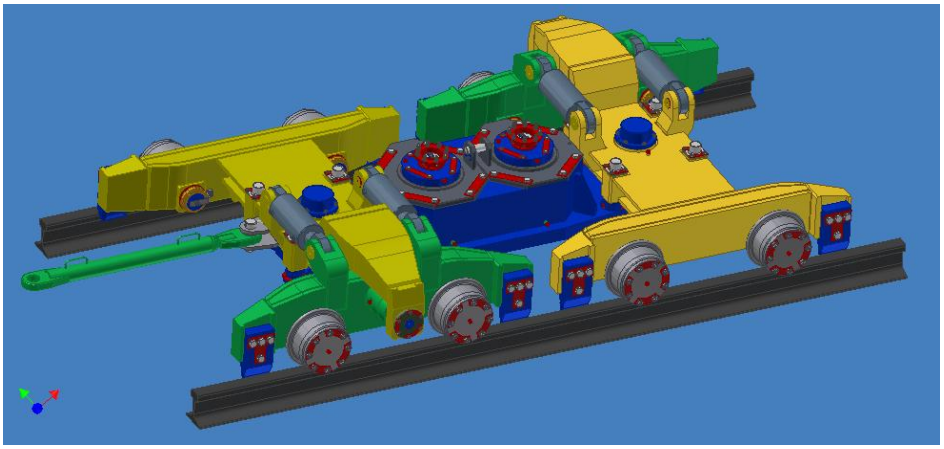

Fig. 14 Stabilizing aggregate - Scheme

Two vibrators (dynamic exciters – rotating unbalanced weights) with the vertical axis are the source of the vibrations which effect the track. Owing to the fact that both the dynamic exciters are mechanically synchromeshed they rotate opposite one another and their

unbalanced parts are in the positions exactly connected and they effect the direct harmonic vibrations – straight oscillation.

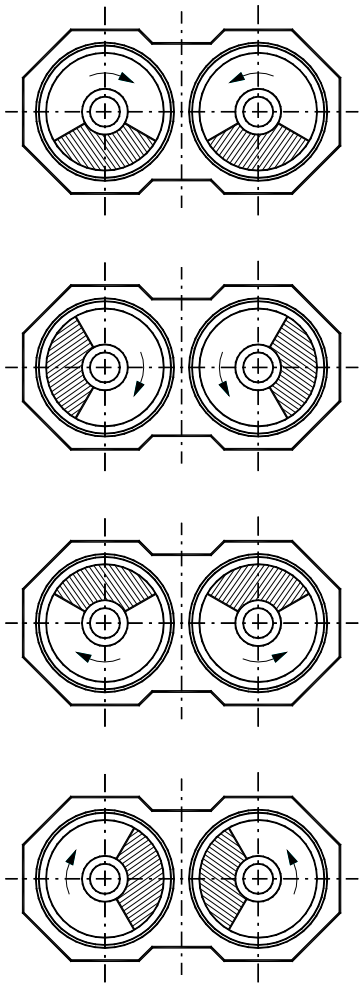

Fig. 15 Principle of vibrations source

As both the exciters are located close to the bottom bearings the centrifugal force acts close above the top of the rails. It prevents from the rollers rebounding of the rail tread and so the rails are not being damaged. Except for and regarding the fact that the vibration is carried through four rollers at any moment in co-operation with the vertical thrust the available conditions are created for the adhesive vibration transmission by the roller flanges without any other additional holding-down rollers even in a turnout where the holding-down rollers cannot act. The massive expanding hydraulic cylinders with the uncontrolled throttle valves which guarantee a high dynamic resistance to enable the vibrations transmission to the rails without any play and the rollers adapting to the variyng track gauge.

The vibrators are driven by two electric motors placed on the synchromesh gearbox and two Cardan shafts. The gearbox only keeps the correct permanent mutual position of the dynamic exciters unbalanced parts *(see Fig. 15)*. The lubrication of the gear wheels and shaft bearings is provided by the gear-wheel pump situated on one of the idle gear shaft inside the gearbox.

WARNING: In any case of the Cardan shafts disassembly or in a case of the entry exciter flanges disassembly from the splined shafts it is essential to set the mutual unbalanced parts position correctly and carefully during reassembly:

a) when mounting the entry flange on the splined shaft the previous mutual position of the splined shaft and the flange must be kept. The position is marked on the shaft and the flange faces.

b) when mounting the Cardan shafts the entry exciter flanges must be turned the way that the marks on their peripheries must point the same direction perpendiculary to the longitudinal vehicle centre line.

It is also important to keep the right sense of the shafts rotation (as per the arrows on the gearbox cover) to ensure the proper gear-wheel pump performance.

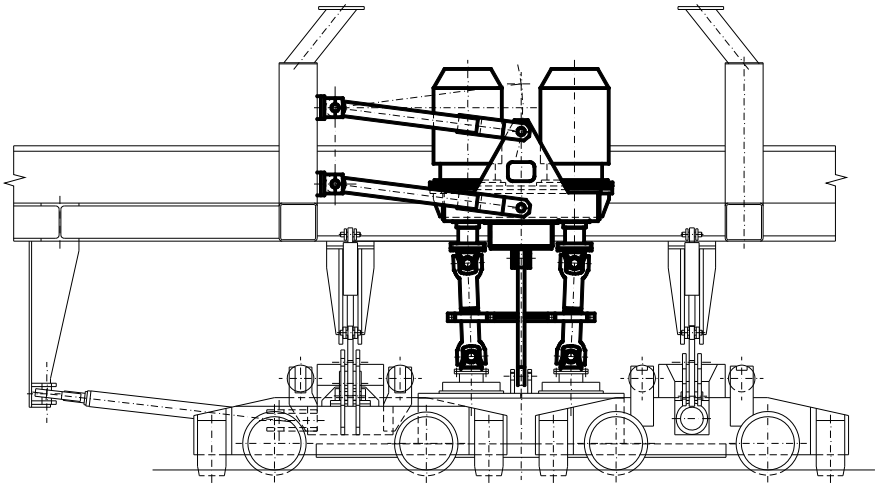

Fig. 16 Synchromesh gearbox and drive

To reach the required working frequency (i.e. motors RPM) both the electric motors are supplied across the static frequency converter.

The vertical thrust to the track is provided of the stabilizing aggregate weight and of four hydraulic cylinders which are equipped with the internal measuring of the piston rod shift out. Except of the vertical thrust the cylinders provide the manipulation of the stabilizing aggregate when seating on the track or hanging up to the suspension hooks. The vertical thrust value is controlled as per the used Working Mode by means of the proportional hydraulic valves.

6. 1. 13. Drivers and Working Desks

The basic control elements, operating devices of the power transmission, indication lamps and gauges are situated in the **JS1** and **JS2 drivers desks** which are located in the front and rear cabin and are identical. The basic functions are mutually electrically interlocked.
The technology and the working travel is controlled from the **JSP working desk** placed in the rear part of the front cabin.


Fig. 17, 18 Drivers Desk

Fig. 19 Working desk

The **OPV1** and **OPV2 external control panels** with available control elements equipped are used for the external stabillization aggregate control i.e. seating on the track or hanging up to the suspension hooks.

Fig. 20, 21 Circuit breakers, External OPV1, 2 control panels

6. 1. 14. MS 404 In Measuring and Control System

MS controls the parameters of the individual working modes by means of proportional hydraulic valves. It keeps the required thrust in the constant thrust mode and keeps the track drop by the thrust control in the constant drop mode in dependence on measured drop values.

For the further details on control the MS see the MS 404 In Operation Manual issued by the Vrchota Co., *Enclosure 12. 15.*

Fig. 22 Touch screen and PC

7. DESCRIPTION OF THE WORKING MODES

7. 1. Technology

The DTS performance **always** follows **every level and directional modification of a track or a turnout by means of a tamping machine** equipped with a measuring and control appliance of the track geometry. This cooperation is multiple i.e. it is being repeated.

- **after 1st and 2nd adjustment during track renewal or after the ballast bed cleaning** the ballast bed is still non-homogeneous and the maximum stabilization effect is required. It comes when the friction forces among the ballast bed and the sleepers are maximum. This condition occurs in the **constant thrust mode.** The stabilizing aggregate is pushed to the ballast bed by the constant force (maximum most often). The drop (push down) of the track is in balance of the thrust and the vertical resistance of the ballast bed as per the superstructure and substructure composition. Therefore it is **varying.** Its value together with the thrust value are detected by means of the DTS Measuring System MS 404 In, they are recorded and a report of the values is issued. The drop is between approx. 10 – 50 mm in accordance with the dependence of the ballast quality and quantity etc. The drop is measured under the DTS loaded track at the stabilizing aggregate spot and it is **definitely different** from the geodetic measuring carried out **after the DTS work** because of the track elasticity influence.

- **after the last adjustment during track renewal or after the ballast bed cleaning and after the separate adjustment (treatment)** – the ballast bed is strongly homogeneous, the track geometry the tamping machine adjusted is good enough and it is necessary only to eliminate a non-uniform ballast bed homogeneity caused by the way of tamping. In this case the **constant drop mode** is being used. The constant drop (push down) of the track is set by the thrust control for **not to damage the track geometry** created by a tamping machine. However, the vertical track resistance is variable in this case and therefore the **vertical thrust** must also be **variable** to realize the set constant drop. The values of the thrust and the drop are detected by the Measuring System VKL 404 IN, they are recorded and a report of the values is issued. The drop is usually in the range of approx. 5 – 10 mm.

7. 2. Working Modes

The DTS is able to work in four working modes:

7. 2. 1. Constant Thrust Mode CTM – 240 (Mode No. 1)

It is used for a section stabilization in which the ballast bed is not optimum homogenized.This condition comes always after the first and subsequent vertical and directional adjustment, not after the last one. The objective is to reach maximum possible homogeneity. During the work in this mode always comes to the track geometry failure and the subsequent work of a tamping machine adjusting the track geometry is essential. Stabilization is carried out with the maximum thrust effect together with the horizontal vibration influence acting. The vertical thrust is decreased to the value of 120 kN by the speed of minimum 1 kmph on the bridges and in the tunnels with a continuous ballast bed.

- The working speed 0,8 – 1,2 kmph
- The vibration frequency 33 – 35 Hz
- The maximum vertical thrust 240 kN

7. 2. 2. Constant Thrust Mode CTM – 160 (Mode No. 2)

The conditions for the use are identical to the Mode No.1. This mode is used when working on a light superstructure etc. The vertical thrust is decreased to the value of 160 kN in this mode. The vertical thrust is decreased to the value of 80 kN by the speed of minimum 1 kmph on the bridges and in the tunnels with a continuous ballast bed.

- The working speed 1 – 1,2 kmph
- The vibration frequency 33 – 35 Hz
- The vertical thrust 160 kN

7. 2. 3. Constant Drop Mode CDM (Mode No. 3)

It is used for the final stabilization on the geometrically adjusted track section with the treated track geometry after the last vertical and directional adjustment. For the carried out geometry not to be failed the track is pushed to the ballast bed of a constant value (copying the track geometry). This value is automatically set being defined of the drop value measured when the total vertical thrust of 140 kN (defined thrust) is reached. The vertical thrust is varying round the defined thrust with the maximum value of 240 kN as per the varying ballast bed vertical resistance. The maximum value is decreased to 100 kN on the bridges and in the tunnels with a continuous ballast bed. The steepness corresponds to the initial run-out ramp steepness.

- The working speed 1,2 – 1,8 kmph
- The vibration frequency 33 – 35 Hz
- The vertical thrust variable up to 240 kN

7. 2. 4. Constant Thrust Mode CTM – T (Mode No. 4)

It is intended for a **turnout stabilization**. It is not usually used for the final turnout height adjustment, but in a case that the stabilization caused and the measuring shows the drops of the individual rails are different. They are stabilized with a different thrust. The objective is to reach maximum possible homogeneity of the ballast bed both in a main and a branch line. There is no need to keep the final rails height because it is subsquently adjusted by a tamping machine. The stabilization is carried out with the variably set effect of the thrust by the minimum speed of 1 kmph. The transitions are created of 25 m long run-out ramps.

- The working speed 1 – 1,5 kmph
- The vibration frequency 33 – 35 Hz
- The total vertical thrust 2 x 20 – 120 kN stepwise set for both the sides by 20 kN

7. 3. Conditions for the DTS Operation

- When doing the dynamic stabilization **the run-out ramps must be always created at the beginning and the end** of the treated section and **in the vertical thrust alterations** by the working parameters adjustment. Those ramps are created by the controlled alteration of the vertical thrust value and the track drop through it as per the selected ramp length. This length can be possibly modified by the PC program in the range of 5 – 25 m.

- In the **Constant Thrust Modes the ramps at the beginning and the end** of the treated section are realized by the controlled thrust alteration in the range from the own stabilizing aggregate weight of 50 kN (5 t) up to the value as per the mode in a section of **10 m**. In the thrust alterations in the range of 50 % of its maximum values (work close to the structures) the ramps reach the length **6,3 to 7,3 m** (due to the selected mode). The speed must be increased up to the **minimum 1 kmph** and decreased to the former value behind the structure.

- In the **Constant Drop Mode the ramps at the beginning and the end** of the treated section are created by the controlled thrust alteration in the range from the own stabilizing aggregate weight of 50 kN (5 tonnes) up to the value of 140 kN (defined value) within the section of **20 m** with a restriction of maximum 240 kN. The maximum value is decreased to **100 kN** on **the bridges and in the tunnels with a continuous**

ballast bed. The ramp steepness corresponds to the defined thrust value along the selected ramp length. The track on the structure is stabilized this thrust (practically constant thrust); the maximum thrust is incrased to the former value along the ramp behind the structure.

- The ramp beginnings are to be marked on the sleeper heads – visibility from the working cabin - fixed beginning relates to the stabilizing aggregate centre. The command for the ramp beginning is given by the operator. The vibration frequency increase of the stabilizing aggregate is automatic. The working frequency is reached within 8 seconds after the ramp beginning. In the final run-out ramp, approx. 3 m in front of its end the vibrations are finished within appox. 8 seconds.

- The vehicle is equipped with a **safety device** which shuts down the stabilizing process i.e. stops stepwise the vibrations and the vertical thrust at the moment when the working speed decreases **below** the value of **approx. 200 mph.** When the speed increases to approx 400 mph the process is automatically stepwise re-started. The objective of that function is to prevent from a track geometry damage and a development of the incontrollable drops.

- The appropriate **track section must be inspected** by the responsible IR representative **before the DTS work. The concrete precautions are appointed** according to the inspection in view of the loading capacity, the age and the technical condition of the superstructure, the structures and the substructure (the retaining walls, the culverts and the drainage). The vibrations could cause the structures damage due to the resonance effect when working close to them without the inspection and evaluation of an IR expert. Especially on the old lines the uncontrolled drops can occur. The development of the landslides and the cracks can not be excluded.

- If the proper rigidity and resistance of the track fittings and fastenings are not ensured **the track section must not be dynamically stabilized.** The dynamic stabilization can not be used on the sections with the contaminated ballast bed.

- The ballast bed is to be raised of 50 – 100 mm behind the sleeper heads **before each dynamic stabilization.** The ballast bed must be adjusted to the correct shape as per the appropriate railway regulation. The space between slepers must be levelled and swept.

- **The dynamic stabilization must not be carried out** on the steel bridges with the continuous ballast bed provided, on the massive bridges with the supporting vault without the blanket and in the tunnels brick, natural stone and unreinforced concrete vaulted.

- **The DTS work must not begin or finish** in superelevation (cant) or on the structures (bridges with the continuous ballast bed provided, the retaining walls, tunnels etc.). The ballast bed on the concrete bridges with the continuous bed or in the tunnels could be stabilized using the selected mode after a structure assessment but the thrust value must be decreased as per the selected working mode. This decrease is carried out continuously along the ramps in front of the structure (and the increase the same way behind) with the working speed minimum 1 kmph at a distance of 30 m.

- **After the initial height adjustments** (during the repair works) the **Constant Thrust Mode** is used usually with full vertical thrust. The track alignment before the dynamic

stabilization prior to the final track height adjustment (the last tamping) is allowed to be maximum 10 mm below its final value as per the project.

- **After the final adjustment before a traffic opening** the DTS work with a controlled thrust is used - **Constant Drop Mode.** The track alignment before the stabilization by a tamping machine (which consolidates the ballast bed behind the sleeper heads contemporary) adjusted is to be of 5 – 10 mm above the position required as per the project**.**

- **In the curves with the superelevation higher than 60 mm** it is possible to stabilize several times in the necessary cases.

- The treated **section must be dynamically stabilized continuously without any work break.** If the break is necessary it must be carried out via the ramps with a S steepness course as per the used mode. The beginning and the end of the terminal ramp must be marked on the track, so that the subsequent initial ramp (restart of the vehicle work) and the terminal ramp were identical. The beginning of each ramp is set on MS by the operator.

- **The temperature restrictions** of the DTS work are identical as the conditions for a tamping machine and are determined by the **IR** regulations.

- During the work the conditions determined by **IR** regulations must be kept. The chief of work is to tell the crew the necessary data about the DTS work restrictions.

- **The turnouts** are stabilized using **the same modes as on the common line** always after the tamping machine work and the track height adjustment. **After the initial height** adjustment the **Constant Thrust Mode** is used. **After the second height adjustment or after the line treatment** the **Constant Drop Mode** is applied. The turnouts on the concrete sleepers mounted do not need the dynamic stabilization.

  The turnouts can be stabilized in the both lines. The main line should be stabilized with the through line simultaneously. **After measuring the superelevation** in the branch line this line is stabilized with a **different thrust** on the rails to reach the required superelevation. The height of the stock rail can possibly be raised by the tamping machine of approx. 5 mm and the line can be stabilized the same thrust. These facts should be operationally verified.

7. 4. Function of the MS 404 In Measuring and Control System

The dynamic stabilization results from a requirement of keeping 3 conditions of vibrations transmission to the ballast bed:

- the vibrations of the stabilizing aggregate (the exciter) in the range of the resonance
- the thrust force acting, which enables to transmit the vibration to the ballast bed
- the acting of the above mentioned conditions in the certain period of time

If one of the conditions is not met, the vibration is not transmitted or is not effective. Except of the mentioned 3 conditions the proper rigidity and resistance of the fastening elements must be kept. The whole system begins to vibrate when the frequency reaches round 15 Hz. In order to keep the uniform vibration i.e. its effects would be identical at time and length it is necessary to keep the constant speed i.e. the time period of acting the vibrations the ballast bed. **When the working speed decreases below 200 mph the safety device shuts down the stabilization stepwise** and stops vibrations within approx. 8 seconds. When the speed value reaches approx. 400 mph the stabilizing process restarts stepwise again. The working

speed is shown on the working desk pointer gauge because of being a very important parameter.

The track drop is caused by acting of the dynamic stabilizer. The drop value Δ´ is measured as a drop of the rear stabilizing bogie to the front one. The drop in such a way measured is not an actual track vertical alignment drop Δ geodesicly measured after the vehicle working drive. The value Δ´ is smaller than the real drop notably that measuring is carried out on the stabilizing aggregate while the track drop is caused after stabilization on the longer track length. In addition the track is being seated to the different position after the stabilizing aggregate passage because of its elasticity.

The measuring system is not separated from the vehicle underframe. The Δ´ difference between the front and rear part of the stabilizing aggregate is measured. The longitudinal tilting of the stabilizing aggregate is detected in the shift out difference of the thrust cylinder piston rods (equipped with the precise distance sensing units) to the underframe. The difference of the shift outs determines the relative value of the stabilizing aggregate drop Δ´. The relation between Δ : Δ´ = 3,5 has been set as a constant to the Measuring System. As the suspension points of the hydraulic cylinders are located close one to another and close to the longitudinal vehicle centre line the underframe deflection does not apply.

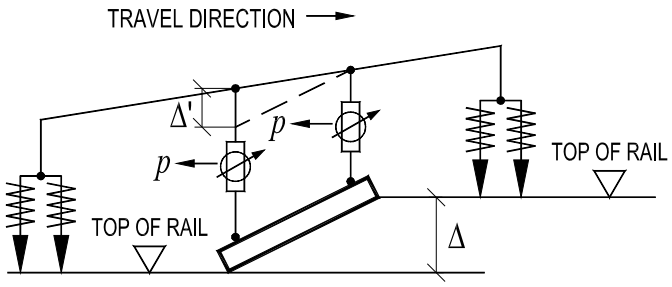

Fig. 23 Principle of track drop measuring

The MS controls the parameters of the individual working modes by means of proportional hydraulic valves. The thrust for both the sides is controlled separately, the front and rear cylinders are supplied the same oil pressure. The MS maintains the required thrust in the Constant Thrust Mode, the drop is variable. It maintains the defined drop by the thrust control for the left hand and the right hand side seperately in the Constant Drop Mode. The thrust of the both sides can be adjusted by 20 kN.

The and the cooperating vehicle working elements adjustment including the adjustment of the distance sensors zero position (calibrating) is carried out the way and in terms defined in the MS 404 in Operation Manual.

When doing the dynamic stabilization the run-out ramps must be created at the beginning and the end of the treated section and in the vertical thrust modifications. Those ramps are created by the controlled alteration of the vertical thrust value and the track drop through it. The ramp length of 10 m is pre-set in the control PC for the Constant Thrust Mode and length of 20 m in the Constant Drop Mode. These lengths could be adjusted by the operator at the range of 5 ÷ 25 m. The ramp “steepness” is defined as per its length and the used working mode by the vertical thrust value in one metre of the ramp length and it is constant in the

selected mode, i. e. the steepness does not alter not even during the thrust alterations required when working close to the structures.
The alteration course of the vertical thrust **S** [MPa/m] is as follows:

- Constant Thrust Mode CTM 240
  at the section beginning and the end and during the thrust alterations
  S_1 = 7,5 MPa/10 m = 0,75 MPa/m

- Constant Thrust Mode CTM 160
  at the section beginning and the end and during the thrust alterations
  S_2 = 4,32 MPa/10m = 0,432 MPa/m

- Constant Drop Mode CDM
  expected thrust 140 kN (pressure of 3,53 MPa) at the section beginning and the end
  S_3 = 3,5 MPa/20 m = 0,175 MPa/m
  Maximum pressure is limited the value of 7,5 MPa (240 kN). Close to the structures is the maximum pressure decreased to 2,3 MPa with a steepness of 0,175 MPa/m and it is increased the same steepness behind the structure

Note

- The active dia. of the thrust cylinder is 90 mm, 4 Nos. (1 No. for each pair of the rollers)
- The stabilizing aggregate weight is of 5 000 kg.

In adddition to the above mentioned measuring of the stabilizing aggregate longitudinal tilting
The measuring of a covered distance has been installed on the vehicle. This equipment provides besides the vehicle work control the graphic record of the vertical alignment drop course Δ and the vertical thrust both for the left and right rail. The cotrol PC stores above mentioned data and so enables their further processing.
Following technologic data are monitored on the screen **and recorded** on the printer:

- distance (parameter)	- 0
- drop left	- 2
- drop right	- 3
- thrust left	- 4
- thrust right	- 5

- grafic record is carried out in the distance scale 1 : 2000
- value of measured drops (left and right) Δ' is 3,5 constant modified

The parameters are printed immediately after the work.
Further details of the control, parameters recording, another data represeting and the MS performance including its adjustment **see MS 404 In Operation Manual**, *Enclosure 12. 15.*

7. 5. Concrete DTS Working Processes – Examples

During the **Constant Thrust Mode CTM** the DTS is lined behind a tamping machine and a ballast regulator which **supplies balast** among the sleepers and behind the sleepers heads or behind a tamping machine and a **train set supplying ballast.** The run-out ramps at the section beginning and the end or close the bridges and tunnels with a continuous ballast bed are modified the way shown in *Fig. 23*.

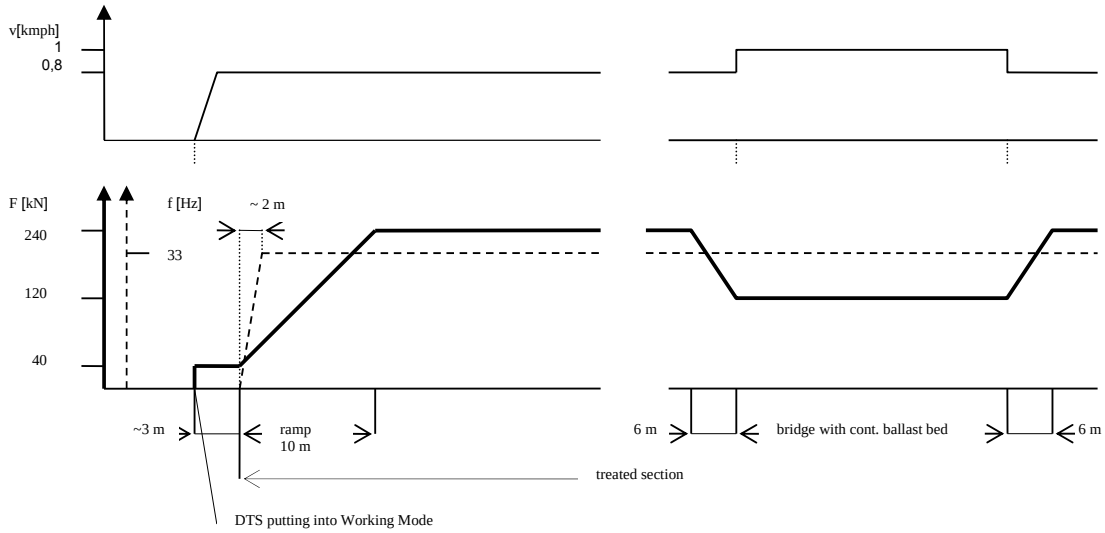

Fig. 24 ***The run-out ramps at the beginning of a section Constant Thrust Mode (240 kN) treated and the dynamic stabilization on a bridge with a continuous ballast bed. Ramp creating process is opposite at the section end to the section beginning.***

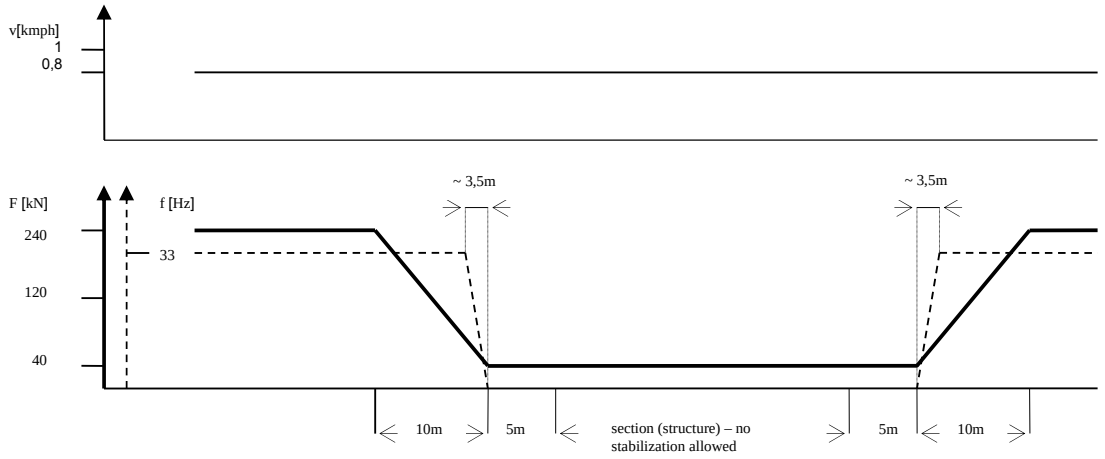

Fig. 25 ***It represents process of stabilizing interruption at a point the stabilization can not be done – e.g. a bridge with a straight fastening etc.***

Fig. 25

The value of the real vertical alignment drop Δ is in the range of 10 –30 mm most often when **working** in the Constant Thrust Mode. The real drop should not be less than 10 mm.

When working in the **Constant Drop Mode** the DTS is lined as the last machine i.e. behind the ballast regulator doing the last modification of ballast bed profile. The run-out ramps must be modified consistently. At the section beginning and the end, in front of the points where

a track can not be stabilized as well the run-out ramps are created as per the *Fig. 25.* The ramp is put to end resp. begins at the distance of 5 m round such a point (e.g. a bridge with a straight fastening).

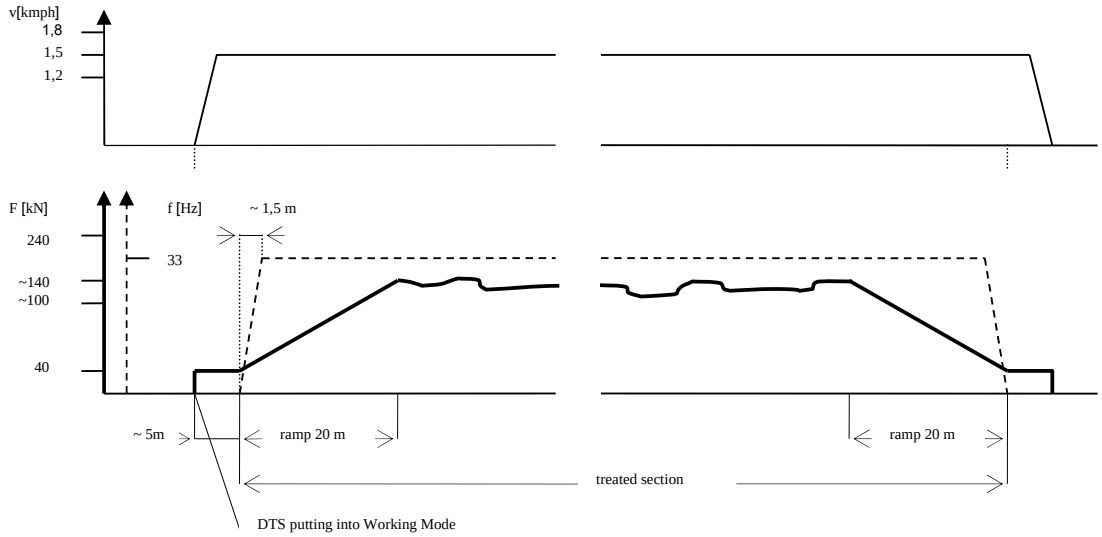

Fig 26 It represents run-out ramps at the beginning and at the end of a section Constant Drop Method treated

The course of work on the bridge or in a tunnel with continuous ballast bed

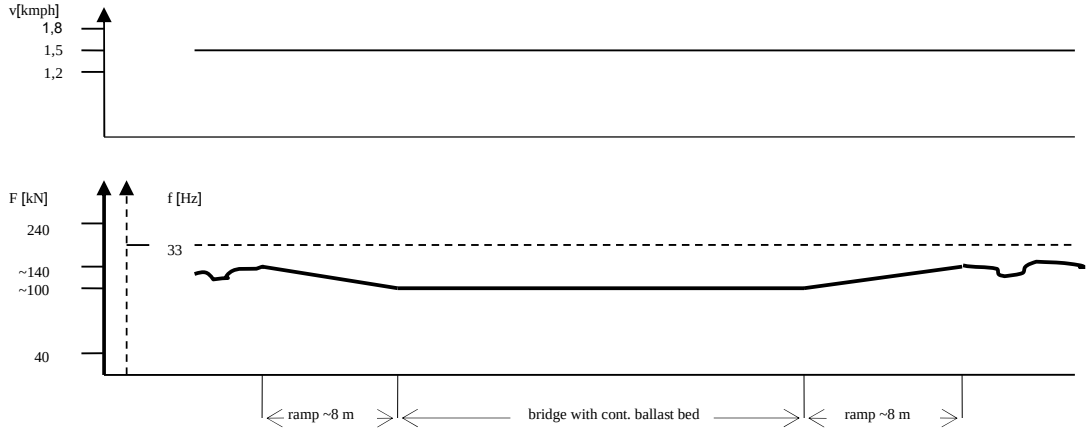

Fig 27 It represents the course of the dynamic stabilization the Constant Drop Method on the bridges and in the tunnels with continuous ballast bed

The value of the real vertical alignment drop Δ when working the Constant Drop Mode is usually approx. 5 mm, it can reach 10 mm exceptionally. Mentioned values of the reached vertical alignment drop quarentee the sufficient treated track consolidation including a resistance improvement against lateral shift (buckling).

Note: The above shown diagrams are only explaining examples corresponding the selected ramp length.

7. 6. Basic Operations of the Working Mode

- The vehicle is situated in approx. 20 m in front of the ramp beginning (work start), stabilizing aggregate placed on the track, the rollers pressed to the rails. The working mode is selected, MS put into operation as per the manual, the Mentor traction rectifier and frequency converter standby. The working frequency potenciometer set, the ramp length confirmed or the other value set.
- The vehicle is put in motion by the potenciometer and the required speed is set. The command to the MS is given by the operator at the point of the initial ramp beginning and the control (increase) of the thrust (hydraulic oil pressure) in all the thrust cylinders starts up to the value as per the selected mode and the ramp length. The vibration frequency is being simultaneously increased up to the value by the potenciometer set in approx. 8 seconds. The track is constantly expanded in a controlled way. The working speed is kept in the set value and prescribed tolerances. Possible frequency and speed adjustment can be carried out by the appropriate potenciometer.
- At the point where the thrust must be decreased to 50 % (in front of the bridges and tunnels with continuous ballast bed) a command to the MS is given by the operator for the ramp beginning as per the selected mode. If the working speed is lower than 1 kmph, it must be manually adjusted (reset).
- At the point where the thrust can be increased (after passing the structures) a command to the MS is given by the operator for the ramp beginning to the previous values as per the selected mode.The working speed (if increased) can be manually decreased by the potenciometer to the previous lower value.
- At the point of the final ramp beginning a command to the MS is given by the operator and the controlled decrease of the oil pressure starts in all the thrust cylinders from the selected mode values to zero along the set ramp length when only the stabilization aggregate weight is applied. MS gives a command to begin the working frequency decrease 3 m in front of the ramp end (electric braking approx 8 seconds). The beginning and the end of the run-out ramp should be suitably marked so that the initial ramp could be created if the stabilization continues.
- When the working speed gets under 0,2 kmph the MS gives a command to begin the working frequency decrease (electric braking approx. 8 seconds) and the thrust is being decreased stepwise. After the speed increase the stabilizer parameters are reset to the previous values.
- After completing the work the vehicle is switched-over to the Travel Mode, MS, Commander and Mentor are switched-off, the potenciometers set to zero. The stabilizing aggregate is removed to the transport position and locked.

8. OPERATION AND CONTROL

8. 1. Crew Qualification and Constitution

The number of the DTS crew members and their qualification must respond to the IR regulations for the DTS operators. The crew must be able profesionally and healthwise to operate the DTS as per the IR regulations and it must be acquaint with the vehicle operation provably. The operators must have appropriate approvals to operate and transport the vehicle.

The operator´s activities are as follows:

- the working machinery operation
- driving the vehicle
- vehicle maintenance
- vehicle cleaning
- small repairs and the vehicle transport as per the IR regulations.

8. 2. Vehicle Drive Description

The DTS provides the drive in two modes:

- **Travel Mode** - a transport of the vehicle to the working site and back under own power, max. speed of 75 kmph. This mode can be controlled on the JS1 drivers desk in the front cabin and JS2 drivers desk in the rear cabin. Both the desks are equally equipped and mutually interlocked.
- **Working Mode** - The vehicle can move constant controlled speed in the range of 0 – 3 kmph. This mode is controlled on the JSP working desk in the front cabin rear part located.

The instruments description of the JS1 and JS2 drivers desk and JSP Working desk *see NC 05 07, NC 05 08 , Enclosures 12. 10., 12. 11.*

8. 3. Diesel Engine Starting Procedure

a) Switch on the accumulator battery- knife cut-off switch at the walkway (the box besides the hydraulic aggregate)
b) Switch on the ECP2 (above the JSP working desk) – ***RUN*** position
c) Observe the engine parameters on the ECP2
d) Check the unlock of all the stop push-buttons (***DIESEL ENGINE STOP),*** move all the switches and controllers to the zero position
e) Switch on the JS1 or JS2 drivers desk ***DESK SWITCHING – ON*** - position ***1***
f) Press the ***START*** push-button to crank the engine and then release when the engine starts

Note: The engine can also be started on the ECP2 – ***START*** position

8. 4. Travel Mode

a) Switch on the JS1 or JS2 drivers desk ***DESK SWITCHING – ON*** - position ***2*** – the ***DESK ON*** indicating lamp is lit up (all the desk instruments and gauges are active)
b) Check the emergency and level signalization, the engine and battery gauges.
c) Check the air pressure in the main reservoir.
d) Engage the ***TRAVEL DIRECTION*** lever to the requested position.
e) Wait for indication the travel condition has been met – the ***TRAVEL CONDITION*** indicating lamp is switched off.
f) Set the vehicle in motion – ***TRAVEL SET*** lever - gradual increase of the notches.
g) In case of an extreme gradient use ***OUTPUT INCREASE*** push-button (*see conditions stated in 6.1.10.).*

Note: The Diesel engine should be heated up to the operational temperature before any travel. It is possible to increase the engine speed ***(TRAVEL SET)*** to shorten the preheating time while the direction lever is in the zero position.

8. 5. Travel Mode Completion

a) Move the ***TRAVEL SET*** lever to the zero notch, brake the vehicle, move the ***TRAVEL DIRECTION*** lever to the zero position in the JS1 or JS2 drivers desks.

b) Allow the engine to run at idle for 5 minutes to cool down.
c) Press the red ***DIESEL ENGINE STOP*** push-button.
d) Disconnect the drivers desk ***DESK SWITCHING - ON*** position ***0***.
e) Switch off the ECP2.
f) Disconnect the accumulator battery – knife cut-off switch **at least 10 minutes** after the engine stop.

8. 6. Working Mode

The Working Mode control is carried out solely in the JSP working desk.
The DTS is situated approx. 20 m in front of the work start point, the engine is running, the vehicle the SA-9 driver´s valve (JS1 or JS2) braked.

a) Move the ***TRAVEL DIRECTION*** levers (JS1, JS2) to the zero position.
b) Switch off the ***DESK SWITCHING ON*** switcher (JS1, JS2) – position ***0***
c) Brake the vehicle the SA-9 driver´s valve (JSP).
d) Release the SA-9 driver´s valve (JS1, JS2).
e) Switch on the JSP working desk ***DESK SWITCHING – ON*** - position ***2*** – the ***DESK ON*** indicating lamp is lit up (all the desk instruments and switches are active).
f) Wait until the engine speed is automatically set to 1 500 RPM, wait for the 3x400 V 50 Hz AC net connection (the working speed and frequency gauges are activated).
g) Switch on the hydraulic aggregate ***HYDRAULIC AGGREGATE*** switch - the indicating lamp (in the switch) is lit up.
h) Switch over the ***PRESSURE*** switch in the JSP working desk to the position 3 – 100 %

WARNING: It must not be switched over during the work in the AUTO MODE !

i) Switch over the stabilizing aggregate ***CONTROL MODE*** switch to the position ***1 – OUTSIDE*** for the control in the OPV1 or OPV2 control panels.

The further steps are done by the operator in the external OPV1 or OPV2 control panels outside the vehicle to place the stabilizing aggregate on the track.

j) Lift the stabilizing aggregate to the top position – ***THRUST – LIFTING L.H., R.H.*** switches, levers up.
k) Release the suspension hooks (expand) – ***CROSS SETTING L.H., R.H.*** switches, levers up.
j) Lower the stabilizing aggregate to the track - ***THRUST – LIFTING L.H., R.H.*** switches, levers down.
m) Close the suspension hooks - ***CROSS SETTING L.H., R.H.*** switches, levers down.
n) Check the stabilizing aggregate visually, all the rollers must touch the rails.
o) Expand the rollers so that they touch the inner rail head surface – ***EXPANDING*** switches, levers asunder.

The manipulation from the outside in the external OPV1 or OPV2 control panels has been completed and the operator returns to the JSP working desk.

p) Switch over the stabilizing aggregate switch ***CONTROL MODE*** to the position ***3 – AUTO***

CAUTION: It must not be switched-over during the work !

q) Switch on the MS control computer, wait for the operational system and the control SW are active
r) Select the Working Mode on the touch screen, *see the MS 404 In, Enclosure 12. 15.*

s) Switch on the frequency converter ***FREQUENCY CONVERTER*** switch - the indicating lamp (in the switch) is lit up.
t) Preset the required exciters RPM ***CONVERTER CONTROL*** potenciometer (converter start and run-in is automatically done by the MS after the work beginning – *see point y*) after the ***CONVERTER READY*** indicating lamp has been lit.
u) Select the travel direction ***W TRAVEL DIRECTION*** – positions:
0 – OFF, ***1*** - FORWARDS, ***2*** – BACKWARDS.
v) Wait for the indication the travel condition has been met – the ***TRAVEL CONDITION*** indicating lamp is switched off.
w) Release brake the SA-9 driver´s valve (JSP)
x) Set the required speed by ***SPEED CONTROL*** potenciometer, set the vehicle in motion and reach the required speed after the ***MENTOR READY*** indicating lamp has been lit.
y) Start the MS system at the point of the work beginning – *see the MS 404 In, Enclosure 12. 15.*
z) Possible adjustment of the working speed and frequency can be carried out by the appropriate potenciometers.

Note: *When the Commander frequency converter or the Mentor controlled rectifier get the failure, the* ***CONVERTER READY*** *or* ***MENTOR READY*** *indicating lamps do not shine. The reset is done by pressing these signalling push-buttons.*

The work in the individual Working Modes *(see article 7 .2.),* creating the transitions and the run-out ramps *(see article 7. 5.)* follow the MS 404 In, *see Enclosure 12. 15.*

8. 7. Working Mode Completion

The Working Mode completion is carried out by the stabilization end marking in the MS (*see the MS 404 In, Enclosure 12. 15.*). The controlled thrust decrease and stabilization end follow.

a) Decrease the working speed by the ***SPEED CONTROL*** potenciometer and stop the vehicle after completion the work MS controlled.
b) Brake the vehicle the SA-9 driver´s valve (JSP).
c) Move the ***W TRAVEL DIRECTION*** switch to the position ***0***.
d) Move the ***FREQUENCY CONTROL*** potenciometer to the zero (always before point **f)**)
e) Switch off ***FREQUENCY CONVERTER*** switch – the indicating lamp is switched off.
f) Switch over the stabilizing aggregate ***CONTROL MODE*** switch to the position ***1 – OUTSIDE*** for the control in the external OPV1 or OPV2 control panels.

The further steps are done by the operator in the external OPV1 or OPV2 control panels to remove the stabilizing aggregate to the transport position (process in analogous reverse order than in the article 8. 6.).

g) Expand the suspension hooks – ***CROSS SETTING L.H., R.H.*** switches, levers up.
h) Move the rollers together so that the piston rods of the expanding cylinders get maximum slid in – ***EXPANDING*** switches, levers together
i) Lift the stabilizing aggregate to the top position – ***THRUST – LIFTING L.H., R.H.*** switches, levers up.
j) Close the suspension hooks - ***CROSS SETTING L.H., R.H.*** switches, levers down.
k) Switch over the ***PRESSURE*** switch in the JSP working desk to the position **1** – minimum pressure (the stabilizing aggregate sinks to the suspension hooks by its dead weight).
l) Lower the stabilizing aggregate to the suspension hooks seats - ***THRUST – LIFTING L.H., R.H.*** switches, levers down.

m) Check the stabilizing aggregate visually to ensure the stabilizing aggregate sits properly in the suspension hooks !!

The manipulation from the outside in the external OPV1 or OPV2 control panels has been completed and the operator returns to the JSP working desk.

n) Switch over the stabilizing aggregate control from the external OPV1 or OPV2 control panels – ***CONTROL MODE*** switch – position ***CABIN.***
o) Switch off the hydralic aggregate ***HYDRAULIC AGGREGATE*** switch – the indicating lamp is switched off.
p) Switch over ***DESK SWITCHING ON*** switch – position ***0*** – the ***DESK ON***- indicating lamp is switched off, the DG set is automatically iddle set
q) Brake the vehicle the SA-9 driver´s valve (JS1 or JS2), release the SA-9 driver´s valve (JSP).

The vehicle has been prepared to be switched to the Travel Mode.
The values MS measured in the selected Working Mode are saved in the memory for the further disposal (print, data export etc.) – *see the MS 404 In, Enclosure 12. 15.)*

8. 8. Emergency Mode Completion

The Emergency Mode means the situation when such a failure appears which can not be removed by the operator at the site (e.g. the failure of the hydraulic aggregate, the Diesel Engine, the fall-out of the DG set energy supply etc.) and it is necessary to finish the work. It enables to switch the vehicle to the Travel Mode to ensure its transport under own power or as a connected load. It enables the Emergency Hydraulic Aggregate with 24 V DC drive which can be activated by a switch on the JSP working desk the part situated on the left leg. The drive can be switched on just for the stabilizing aggregate "folding" because of its high energy supply. The control is carried out in the external OPV1 or OPV2 control panels. The time of work is limited to **maximum 5 minutes**, the drive is thermal fuse protected in addition.

CAUTION: The Emergency Hydraulic Aggregate can be used only in case of the supply energy fall-out and solely for the stabilizing aggregate folding !

The control is carried out as follows:

a) Switch the ***DESK SWITCHING ON*** switch (JSP) – position ***2*** – the ***DESK ON*** indicating lamp is lit up.
b) Switch on the emergency hydraulic aggregate ***EMERGENCY AGGREGATE*** switch.
c) Switch over the stabilizing aggregate control ***CONTROL MODE*** switch – position ***1*** – ***OUTSIDE*** to the external OPV1 or OPV2 control panels.
d) All the switches in OPV1 or OPV2 external control panels are active only when the ***EMERGENCY AGGREGATE*** push-button is pressed.

9. MAINTENANCE GUIDELINES

9. 1. General

The purpose of the vehicle maintenance is to remove the results of wearing out the component parts and to create the conditions of reliable performance.
The scheduled maintenance is to be carried out in the respective steps as follows:

a) PO - Operational attendance (daily)
b) P1 - Periodic inspection
c) P2 - Periodic inspection
d) RO - Annual repair
e) GO - Complete overhaul

Every higher inspection step includes all the works comprise in the lower steps and the additional specified works.

The maintenance of the wheel sets, the brake system, the batteries and the bearings is to be carried out as per the guidelines of the IR.

The maintenance manual on the Diesel engine will be replenished by CIL and the manual on the traction alternator will be replenished by BHEL as the separate enclosures.

9. 2. PO Operational Attendance

It is carried out by the vehicle operator in two steps before the work beginning on the one hand and after the work termination on the other hand.

9. 2. 1. Before Starting the Work

a) simple inspection on the vehicle, equipment completness check
b) checking oil levels (Diesel engine, gearbox, hydraulic oil tank)
c) checking the fuel level
d) checking the air brake pressure
e) checking the automatic brake
f) checking the independent brake
g) checking the sand ejectors function, checking sand supply
h) checking the illumination
i) checking the horns
j) checking the wipers
k) inspection on the vehicle equipment (signals, props, tools and operational documentation)
l) checking the TM cooling (manually at the TM air outlet, DG set idling, Travel Direction lever on)
m) checking the brake shoes gap

9. 2. 2. After the Work Completion

a) draining the air reservoirs *)
b) checking the air brake system, inspection for leaks
c) checking the hydraulic system, remove leaks (hoses, connections, etc.)
d) visual checking the electric equipment, if mechanical damages especially
e) manual checking the temperature of the electric motors and devices (must not exceed 70° C)
f) manual checking the temperature of the main bearings (must not exceed 80° C)
g) lubrication as per the Lubrication Chart
h) checking the hand brake function
i) visual checking the stabilizing aggregate, especially its frame and rollers
j) visual checking the frame of the exciters drive
k) visual checking the Cardan shafts
l) works on the Diesel engine as per the manufacturer manual
m) cleaning the cabins

9. 3. P1 Periodic Inspection

It is carried out by the vehicle crew after 50 ± 5 operational days.

a) all the works in the PO included
b) visual checking the axles, wheels and hubs for cracks
c) visual checking the wheel treads
d) visual checking the bogie springs
e) visual checking a lubrication the buffing and the draw gear
f) checking the brake shoes worn out, replacement
g) inspection on the power cables connections, tightening
h) exhausting a dust from the electrical switchboards (cabinets)
i) checking the battery charging, supply the distilled water
j) checking the fuel tank suspensions, cleaning the inlet screens
k) inspection on the fuel system for leakages – pressure air blow out
l) inspection on the cooling system for leakages, cleaning the radiator
m) inspection on the whole stabilizing aggregate, rollers and blades worn out
n) checking the play of the Cardan shafts splining
o) inspection on the hydraulic system for leakages
p) visual checking the sensors, transmitters and cable connections of the measuring system
q) inspection on the recording appliance, adjustment
r) cleaning the cover eaves and the rain water drains
s) checking the TM cooling air inlet filters, cleaning

9. 4. P2 Periodic Inspection

It is carried out by the vehicle crew after 100 ± 10 operational days.

a) all the works in the P1 included
b) blowing through the electric motors (dry pressure air)
c) inspection on the electric cables and hoses for damages, replacement
d) visual inspection on the buffing and draw gear for cracks

9. 5. RO Annual Repair

It is carried out in the specialized workshop after a year operation before another working season.

Note: When the annual operation exceeds 150 days the additional P1 inspection must be carried out.

a) all the works in the P2 included
b) cleaning the whole vehicle especially the underframe, inspection for cracks
c) inspection on the cabins and DG set silentblocks
d) draining the sediment from the fuel tank
e) visual inspection on the pivot pin arrangement *)
f) inspection on the wheel sets, the tread condition, tread profile and wheel distance measuring, wheel crack detection *)
g) inspection on the traction motor nose hung *)
h) checking the sanding, the nozzles cleaning and adjustment *)
i) visual inspection on the axle bearings *)
j) brake cylinders: sealing rings, checking for the leakage *)
k) the buffer screws tightening *)
l) inspection on the stabilizing aggregate rollers bearings
m) inspection on the rollers and blades wear
n) removing the exciter covers and inspection on the bearings
o) checking the pressure in the hydraulic accumulator, supplying the N40 nitrogen up to the pressure of 6,4 MPa if necessary
p) hydraulic oil changing including oil filters

q) checking the hydraulic system reducing valves, adjustment
r) checking the wiper rubber blades
s) checking the insulation resistance – *see point 9. 7. 2.*
t) inspection on the vehicle painting, marking and lettering
u) inspection on the carbon brushes of the TM cooling blower motor, replacement

9. 6. GO Complete Overhaul

It is carried out in a specialized workshop after 3 year operation.
The list of required works is determined when taking over the vehicle to the workshop.

9. 7. Maintenance of the Selected Parts

9. 7. 1. Fuel System

Fuel Tank Filling:
The fuel tank can be supplied at both the vehicle sides after removing the closing cap. Check the inlet screen for dirt before every filling. The fuel level is transmitted to the gauges placed on the JS1 and JS2 drivers desks.

The fuel purity is the basic condition for the trouble-free and long service life. Use the fuel only from the suppliers who guarantee the fuel quality of the fuel storage and filtration.

Fuel Tank Draining:
The fuel drain plug is placed at the fuel tank bottom. The fuel draining must comply with the safety and enviromental protection regulations.

9. 7. 2. Electric Equipment

The maintenance especially includes the works as follows:

- Accumulator batteries
  - checking the electrolyte level
  - checking the electrolyte density
  - keeping the batteries in the dry and clean conditions
- Control circuits
  - checking the multipole screw connections, to tighten loose connections
  - checking the wire connection to the controlling instruments, switchers, indicators, to tighten loose connections
  - to check and keep clean the wire connections to the magnet valves and the limit switches
  - the insulation condition test min. once a year during the RO annual repair
    The value of the insulation resistance must not fall bellow 0,4 MΩ.
- AC and DC power circuits
  - the insulation condition test min. once a year during the RO annual repair
    The value of the insulation resistance must not fall bellow 1 MΩ
  - checking the cables and protect interconnections fixing
  - keeping the electrical switchboards (cabinets) clean, the dust must be exhausted -- **not blown out !**
- AC circuits of the 400/230 V sockets
  - the insulation condition test min. once a year during the RO annual repair.
    The value of the insulation resistance must not fall bellow 0,5 MΩ.

CAUTION: Disconnect all the measuring and indicating items of the electric circuits (Bender watcher, LCC, etc.) to prevent their damage. Only an appropriate QUALIFIED PERSON is permitted to carry out the insulation condition test !!

- TM cooling
  - checking the TM cooling air inlet filters, clean or replace
  - inspection on the carbon brushes of the TM cooling blower motor, replacement

9. 7. 3. Hydraulic System

The hydraulic system does not require nearly any maintenance as long as the oil purity and the periods for oil and filter inserts change are kept properly. Especially the hydraulic oil purity is the main condition of the long service life. Prior to any repair work on the hydraulic components clean their surrounding thoroughly and use clean tools only.

CAUTION: Only a profesionally trained specialist is permitted to carry out the maintenance and the repair works !!

Before starting any work cut off the electric supply, the Diesel engine must be shut down !
The pipe unions, instruments and the quick couplers must not be loosened when the system is under pressure !

- Hydraulic oil level checking
  Check the hydraulic oil level in the folded condition of all the mechanisms daily.

CAUTION: The new oil contains impurities up to the size of 50 μm and it must be filtered across the filter device when filling the oil tank !

- Hydraulic oil temperature
  Check the hydraulic oil temperature continuously.

CAUTION: Unusual temperature increase could be caused by impurities, seizing or wearing out of +the hydraulic components. Check the components !
The sudden temperature increase can represent the hydraulic aggregate crash.

- Inspection on the hydraulic oil qualities
  The oil aging depends on the operational conditions i.e. temperature, operational pressure, air humidity, surrounding contamination etc.
  It is recommended to have the hydraulic oil analysis done in a tribodiagnostic laboratory, which also determines the conditions for taking samples.

Hydraulic oil	Contamination	Cause
dark hue	products of oil oxidation	overheating, too old oil, foreign matter (e.g. motor oil)
milky opacity	water or foam	water penetration, air moisture infiltration
water separation	water	water penetration (e.g. after washing)
air bubbles and foam in the oil tank	air	air penetration, (leaky suction pipe, shortage of oil)

noisy oil distribution		
sedimented or floating impurities	solid contaminants	oil and sealing aging abrasive wear, impurities
burnt oil smell	products of oil aging	overheating

Change oil when its hue has been changed. Water penetration into the oil (milky opacity) makes an emulsion, which is very corrosive and dangerous for the whole hydraulic system.

- **Hydraulic oil change**
  The first change has to be done in 50 – 75 hours after setting the vehicle into operatin. The following changes are done after a year operation or due to the oil condition.

- **Replacement of the hydraulic oil filter inserts**
  The oil filter inserts must be replaced when changing the oil or the clogging is been indicated during operational oil temperature (approx. 40 °C). Clogged insert of the oil cooler and return filter is indicated on the JSP working desk.

CAUTION: Hand over the used oil and oil filter inserts to the authorized disposal facilities to protect the enviroment !

9. 8. Limit Operational Conditions

Note: This part has been worked out as per the Czech Railways Standards, practise and MTH experience and it may differ from the IR regulations.

The vehicle must be taken out of service when a failure or damage (as follows) is found.

- Wheel set
  - gauge must be min. ???? mm, max. ???? mm *)
  - wheel distance must be ???? ± 3 mm *)
  - bent axle is found out after measuring the wheel distance in 120°. The axle is expected to be bent when the measurements difference is higher than 1 mm.
  - crack on any place of the axle or the wheel
  - ground spot on the axle with sharp edges
  - loose wheel, (shift along the axle, cracks in the paint between the wheel and the axle)
  - tread slivers over 1 mm deep
  - tread chipping-offs and flat spots over 60 mm long
  - tread groove over 3 mm deep
  - wheel flange over ?? *) mm high
  - wheel flange thickness min. ?? *) mm
  - max. permissible wheel diameter difference:
    0,5 mm within one wheel set
    5 mm within one bogie wheel sets
  - tyre thickness must be after the P2 Inspection min. ?? *) mm
- Drive gear
  - it is permissible to operate a pinion with the pits on the area smaller than 5% of the involute tooth surface
  - the drive gear with even one tooth broken must not be operated.
- Axle bearings
  - axle bearing box does not lead the wheel set properly
  - broken bearing ring
  - noisy run
- Traction motor nose hung

- Pins wear out max. ? *)

- Vehicle bottom part
  - breaks or cracks of the underframe longitudinal, transversal beams, headstocks or bogie frame
- Buffing gear
  - buffer centre height over the top of rail must be within ??? - ???? *) mm
    height difference of the front and rear buffers max. 10 mm, within a headstock max. 5 mm
  - any buffer part missing including the fixing details
  - non-sprung travel over 30 mm
- Draw gear
  - visible break of the draw bar and the other parts
  - bent or moved round draw bar
  - non-sprung travel over 20 mm
- Air brake
  - *The whole article will be replenished by BHEL.*

9. 9. Extended Period of Non-Use

It is considered to put the vehicle out of operation for a period over 1 month in the open air.

9. 9. 1. Works before the Period

1) The works on the air brake system, traction alternator and batteries will be replenished by BHEL, the works on the Diesel engine will be replenished by CIL.

2) a) Coat the contacts of the contactors and relays with a grease.
   b) Lubricate the uncovered metal parts especially hydraulic cylinders piston rods with the conserving grease.
   c) Hang up four pouches with 100 grams of silica gel to the RM1, RM2, RM3 electrical cabinets (12 pcs together)

9. 9. 2. Works after the Period

1) a) Remove all the pouches of silica gel from the electrical cabinets
   b) Clean all the conservated parts including the contacts
   c) Test the insulation condition of all the circuits.
   d) Carry out the complete vehicle inspection including the equipment completeness check.
   e) Test all the working machinery and check the leakages of the pneumatic and hydraulic system
2) The works on the air brake system, traction alternator and batteries will be replenished by BHEL, the works on the Diesel engine will be replenished by CIL.

10. FILLINGS

Diesel engine

Lubricating oil	- type	*)
	- quantity	*)
Coolant	- specification	*)
	- quantity	*)

Compressor *see the Diesel engine*

Gearboxes

Traction motor gearbox	*)
Synchromesh gearbox	SAE 90, API GL-4, MIL-L-2105D, 9 litre
Hydraulic system oil - type	ISO 6743/4 HM 46 type DIN 51 524 part 2 – HLP CETOP RP 91H Category HM
- quantity	200 litre
Fuel - type	*)
- quantity	1 000 litre
Sand	*)

11. TROUBLESHOOTING

In the following section the steps for checking the system and troubleshooting the operational problems are described. It is **not** possible to include and predict all the possible problems. So the description contains the most probable problems that can happen and that can be removed by the crew. In case the problem can not be solved as per the following guide the problem is probably more complicated and the more detailed service expertise is needed. The small obvious problems which can be easily corrected [circuit breaker (CB) switching on, changing an indication lamp, a bulb etc.] are not mentioned.

Any NONprofessional manipulation on the vehicle equipment can cause a damage or a crew personal injury. To avoid above mentioned the troubleshooting must be carried out by the accredited and approved personnel.

11. 1. Starting problems

11. 1. 1. Diesel engine cannot be started on the ECP2

1. The ECP2 is not working
   - Check the battery switch on (battery switch box), battery voltage and connection
2. Engine has no reaction after starting impulse
   - Check failure report on the ECP2, in case of engine failure proceed according to the instructions of engine manufacturer
   - Check the unlock of all the stop-buttons ***DIESEL ENGINE STOP***
   - Check the battery condition, voltage and connection
   - Check the starter, magnetic switch and their connection
3. Engine has a reaction after starting impulse (cranking without successful procedure)
   - Check failure report on the ECP2, in case of engine failure proceed according to the instructions of engine manufacturer
   - Check the unlock of all the stop-buttons ***DIESEL ENGINE STOP***
   - Check the 80-FU2 fuse, 80A (battery switch box)
   - Check the 80-FA1 CB ***DIESEL ENGINE CONTROL***
   - Check the connection (LED signalization is lit up) of the LCC governor (RM2 electrical cabinet sideways)
   - Check the fuel level, condition of fuel filter and of all the fuel system, if necessary check fuel presence in the actuator inlet

11. 1. 2. Engine cannot be started in JS1, JS2

Try to start in the ECP2. In case of no success of process see 11. 1. In case of success of process proceed as follows:

- Check the desk ***DESK SWITCHING - ON*** (position 1 or position 2) switching- on
- Check the zero position of the controllers

11. 2. Problems during actuation in Travel Mode

11. 2. 1. JS1, JS2 desks cannot be switched on

Indicator ***DESK ON*** is not lit up after switching on ***DESK SWITCHING - ON*** to position 2 (excluding the indicator failure)

- Check switch off position of others desks
- Check the zero position of ***TRAVEL SET*** lever
- Check the 03-FA1 CB ***CONTROLLING 24V DC***

11. 2. 2. Travel condition is not met after *TRAVEL DIRECTION* engage

- Check the switch on of the appropriate desk (signalization ***DESK ON***) if necessary see 11. 2. 1.
- Check the air pressure in the main reservoirs (minimum 0,4 MPa), if necessary check function of air pressure switch (situated at the pneumatic panel under the cover)
- Check the battery charging – indicator ***CHARGING*** and gauge ***BATTERY CHARGING*** (JS1, JS2) – Indicator does not shine and charging current is mostly non zero in failure free condition (during charging).

  WARNING: Otherwise there is a failure in charging circuits and a service action is necessary !
- Check the TM cooling by hand directly near outlet from motors. In case of problems with TM cooling see 11. 2. 3.

11. 2. 3. Traction motors (TM) cooling is not working

Indicator ***TM COOLING*** is lit up after the ***TRAVEL DIRECTION*** engage, in failure free condition (travel direction gives signal for TM cooling)

- Check the 03-FA3 ***TM. BLOWERS***, 03-FA4 ***TR. RECTIFIER BLOWERS***, 03-FA5 ***AUXIL. ALT. CONTROL*** and 80-FA3 ***24V DC*** CBs (all in RM2)
- Check the drive and the connection of the auxilliary alternator
- Check the 03-KA5 or 03-KA6 relay (RM2) closing in dependence on travel direction engage. In case they do not close check condition (disconnection) of the 03-KM5, 03 KM6 line contactors (RM1) and condition of their auxilliary contacts.
- Check the 03-KT1, 03-KA34 (RM2) relays closing after travel direction engage

If the failure is in the TM cooling circuits, the vehicle cannot by operated. It is possible to unlock the failure by the switch located inside RM2. But it is an emergency case which enables to reach the nearest railway station without any connected load. Only low traction current i.e. low travel notches are permitted to use (TMs are not cooled).

11. 2. 4. Vehicle is not moving after Travel Set engage

Presumption: Desk on, travel condition is met, notch 1 - 8 is engaged

1. Traction current is zero
   - Check the 03-KM5 line contactor (RM1) closing. If it is not closed, check following points:
     - the 03-KT2 relay (RM2) switching and consequently 03-KA12 relay (RM2)
     - check visually the reversible contactor (RM1) switching, power contacts touch and the auxilliary contacts closing, check the air supply possibly
     - check the 03-KA5 or 03-KA6 relay (RM2) switching in dependence on the travel direction engage. If they do not switch, check condition of 03-KM5 and 03-KM6 line contactors (RM1) and condition of their auxilliary contacts.

- Check the 03-FA2 CB (RM2) ***VOLTAGE CONTACTORS*** and the 26-KM1 (RM2) contactor closing
- Check the 26-FU7, 26-FU8, 26-FU9 fuses (RM2) ***TRACTION RECTIFIER FUSES***
- Check the 03-KA22 relay (RM2) switching
- Check the sequence of notch setting on the LCC governor panel (RM2 sideways), it is indicated on column of LED indicators for notches 1 - 8

2. Traction current is not zero
   - Check brake release of all wheels, brake shoes gap, condition of hand brake and look for some mechanical barriers between wheels and rails
   - Check the 26-FU7, 26-FU8, 26-FU9 fuses (RM2) ***TRACTION RECTIFIER FUSES*** (current in circuit is of lower value in case of one of the fuses failure)

11. 3. Wrong quality of the travel features

11. 3. 1. Speed is lower

- Check the 26-FU7, 26-FU8, 26-FU9 fuses (RM2) ***TRACTION RECTIFIER FUSES***) (current in circuit is of lower value in case of one of the fuses failure)
- Check the sequence of notch setting on the LCC governor panel (RM2 sideways), it is indicated on column of LED indicators for notches 1 - 8
- Check switching the 03-R1 and 03-R2 shunting resistors (situated under the alternator) – see 11. 3. 3.

11. 3. 2. Power is not sufficient (lower than usual)

- Check engine diagnostic data on the ECP2, if necessary proceed according to instructions of engine manufacturer
- Check the 26-FU7, 26-FU8, 26-FU9 fuses (RM2) ***TRACTION RECTIFIER FUSES*** current in circuit is of lower value in case of one of the fuses failure)
- Check the sequence of notch setting on the LCC governor panel (RM2 sideways), it is indicated on column of LED indicators for notches 1 - 8
- Check the condition of air filter, air intake and exhaust system
- In case of troubles with switching the ***OUTPUT INCREASE***, check the coolant temperature and the 03-KT3 relay (RM2) switching

11. 3. 3. Shunting is not working

Presumption: 5 – 8. notch is engaged, speed is higher than 30 kmph and the speedometer function is correct

- Check the function and condition of speedometer in the front cabin, event. check the 84-FA1 CB (RM2) ***SPEEDOMETERS, WIPERS*** and condition of its drive (2nd axle, left side)
- Check the condition of shunting resistors, their cabling and connection
- Check the 03-KA16 relay (RM2) switching at the speed of 30kmph and consequently the 03-KM7 contactor (RM1) switching
- Check the 03-KA17 relay (RM2) switching at the speed of 40kmph and consequently the 03-KM8 contactor (RM1) switching

11. 4. Problems with transferring to Working Mode

11. 4. 1. JSP desk cannot be switched on

- The same procedure as in 11. 2. 1.

11. 4 .2. Engine speed is not automatically set to 1 500 RPM

- Check the 03-KA20 relay (RM2) switching

- Check the 5th notch set up on the LCC governor panel (RM2 sideways), it is indicated on column of LED indicators for notches 1 - 8

11. 4. 3. No voltage in AC power network

1. There is no voltage (400V) after switching to the Working Mode (no deflection on JS1, JS2 voltmeters)
   - Check the 03-KA20 relay (RM2) switching
   - Check the 03-C1 and 03-C2 relays switching (situated inside the alternator terminal box). In case of switching both the relays and the full voltage is not reached, than the problem is inside the alternator circuit.
2. There is no voltage (400V) in technology 3phase power network, but voltmeters on JS1, JS2 are showing 400V
   - Check the 26-FA1 CB (RM2) ***TECHNOLOGY***
   - Check switching the 26-KM3 contactor (RM2) and its 03-KT4 control relay (RM2) which provides delay after voltage increase
3. There is no voltage in 1phase power network (used only in the Working Mode)
   Absence of voltage can be indicated e.g. by inactive ***WORKING SPEED*** and ***STABILIZATION FREQUENCY*** gauges (JSP).
   - Check the 26-FA3 CB (RM2) ***TRANSF.-INPUT*** and 26-FA4 CB (RM2) ***TRANSF.-OUTPUT***
   - Check also point 11. 4. 3./2.

11. 5. Problems with technology in the Working Mode

11. 5. 1. Hydraulic aggregate cannot be switched on or it is not running

1. Aggregate cannot be switched on, drive indicator ***HYDRAULIC AGGREGATE*** is not lit after pressing the switch
   - Check the 15-FA1 starter (RM3) ***HYDRAULIC AGGREGATE***
   - Check the 80-FA4 CB (RM2) ***TECHNOLOGY CONTROL***
   - Check the 26-KM3 contactor (RM2) switching
2. Aggregate is not running after switching on, but indicator is lighting
   - Check voltage in system – see steps in 11. 4. 3.

11. 5. 2. Frequency converter cannot be started or turn to „ready“ condition

1. Converter cannot be started
   FREQUENCY CONVERTER switch indicator is not lighting after pressing the switch
   - Check zero position of the ***FREQUENCY CONTROL*** potenciometer
   - Check the 80-FA4 CB (RM2) ***TECHNOLOGY CONTROL***
   - Check the 26-KM3 contactor (RM2) switching
   - Check the vibrator motors cooling – the 08-FA1 CB (RM3) ***VIBRATOR MOTORS COOLING***
   - Check signalization (JSP) of ***MOTORS HEATING*** (it is not possible to start on the converter in case of high temperature)
2. Converter can be started, but there is no reaction on converter
   FREQUENCY CONVERTER switch indicator is lighting, ***CONVERTER READY*** push-button is not lighting and display is clear.
   - Check voltage of 3phase system – see steps in 11. 4. 3.
   - Check the 08-FU1, 08-FU2, 08-FU3 (RM3) fuses ***CONVERTER FUSES***
3. Converter is in a failure condition
   FREQUENCY CONVERTER switch indicator is not lighting, ***CONVERTER READY*** push-button is not lighting, but converter display is indicating a failure code.
   - Press the ***CONVERTER READY*** push-button to reset the converter failure.

- Check voltage of 1phase system – see steps in 11. 4. 3./1., 2., 3. (absence of voltage can be indicated by non active ***WORKING SPEED*** and ***STABILIZATION FREQUENCY*** gauges)
- When the failure is still present after reset and 1phase system is OK see point 11. 9. 3. 2. or the converter manual to analyse sort of failure

4. Converter (vibrator motors) is not running in ***AUTO*** mode
   - Try to start up the converter in manual (***CABIN***) mode. If it is still not working, check points according to steps in 11. 4. 3./1,2,3. Otherwise see another step.
   - Check the 08-KA1 relay (RM3) switching – switched from MS. If it is not switching, see 11. 7.

11. 5. 3. Hydraulic cooling is out of operation

- Check the 15-FA2 starter (RM3) ***HYDR. AGGR. COOLING***
- In case of trouble with automatic run (with thermostat), switch on continuous cooling by ***PERMANENT COOLING*** switch (JSP)

11. 5. 4. Emergency hydraulic aggregate is out of operation

1. Switch indicator ***EMERGENCY AGGREGATE*** is not lighting after switching on
   - Check connection of the JSP working desk - ***DESK ON***
   - Check the 80-FA3 CB (RM2) ***24V DC***
2. Switch indicator ***EMERGENCY AGGREGATE*** is lighting after switching on, but aggregate is still not working
   - Check the 15-FU1 fuse (battery switch box)
   - Check the aggregate motor temperature and connection of thermostat protection on its cover
   - Check also aggregate control on OPV1 and OPV2 – switches ***EMERGENCY AGGREGATE***

11. 6. Problems during actuation in the Working Mode

11. 6. 1. Traction Rectifier Mentor is not automatically turning to „ready“ condition

1. Rectifier is out of operation – no reaction, display is clear
   Driver indicator ***MENTOR READY*** is not lighting, display is clear
   - Check voltage of 3phase system – see steps in 11. 4. 3.
   - Check zero position of the potenciometer ***SPEED CONTROL*** (JSP) and the 03-KA18 relay switching (RM2)
   - Check 26-FU4, 26-FU5 fuses (RM2) ***MENTOR SUPPLY***
2. Rectifier is in a failure condition
   Driver ***MENTOR READY*** is not lighting and rectifier display is indicating a failure code.
   - Press the ***MENTOR READY*** push-button to reset the rectifier.
   - Check voltage of 1phase system – see steps in 11. 4. 3./1., 2. ,3. (absence of voltage can be indicated by non active ***WORKING SPEED*** and ***STABILIZATION FREQUENCY*** gauges)
   - When the failure is still present after reset and 1phase system is OK see the point 11. 9. 3. 1. or the rectifier manual to analyse sort of failure

11. 6. 2. Travel condition is not met after *TRAVEL DIRECTION* engage

- Check points according to steps in 11. 2. 2.

11. 6. 3. Vehicle is not moving after engage of working travel set

Presumption: working desk on, travel condition is met, ***SPEED CONTROL*** potenciometer is out of zero, Mentor rectifier is in „ready“condition

- Check brake release of all wheels, brake shoes gap, condition of hand brake and look for some mechanical barriers between wheels and track

- Check the 03-KM6 line contactor (RM1) closing If it is not close, check following points:
  - the 03-KT2 relay (RM2) closing and consequently 03-KA12 (RM2)
  - check reversible contactor (RM1) switching, touch of power contacts and switching of auxilliary contacts, if necessary check the air supply
  - check the 03-KA5 or 03-KA6 relay (RM2) closing in dependence on setting of the travel direction. If they do not close, check condition of 03-KM5 and 03-KM6 line contactors (RM1) and condition of their auxilliary contacts
- Check the 03-FA2 CB (RM2) ***VOLTAGE CONTACTORS*** and the 26-KM2 contactor switching (RM2)
- Check the 26-FU1, 26-FU2, 26-FU3 fuses (RM2) ***MENTOR FUSES***
- Check the 03-KA11 relay switching (RM2)
- Check the switch-on position of ***MENTOR BLOCKING*** switch (RM1)

11. 7. Problems with measuring and control system

In case of troubles with MS see the MS 404 In, *Enclosure 12. 15.*

11. 8. Other troubles

1. There is no voltage 24 V DC
   - Check the 80-FU2 fuse (battery switch box)
   - Check the condition and connection of battery
2. Acoustic alarm (JS1, JS2) of Bender insulation watcher (RM2) is active

Presumption: Bender watcher analysed critical failure in electric power system (indicated directly on watcher ***ALARM 1***)

- Acoustic alarm should be blocked by switch ***INSULATING WATCHER BLOCKING*** (inside RM2)

In case of this trouble it is recommended to interrupt work and hand over vehicle to service specialist to inspect the insulation system.

11. 9. Indicators and signalization

11. 9. 1 JS1 and JS2 signalization (identical)

1) ***INSULATION FAULT*** – fault accoustic signalization – active when the insulation resistance of electric system is lower than the safe value – proceeding according point 11. 8./2.
2) ***CHARGING*** – failure signalization – it shines when the charging is out of operation, (see 11. 2. 2.)
3) ***DESK ON*** – signalization – it shines in case of desk on (active desk)
4) ***LUBRICATION*** – fault signalization – lit up in case of lubrication failure (for details see ECP2 panel) – proceed according instructions of engine manufacturer
5) ***WATER LEVEL*** – warning signalization – lit up in case of low cooling water level (for details see ECP2 panel) – proceed according to instructions of engine manufacturer
6) ***WATER TEMPERATURE*** - warning signalization – lit up in case of high temperature of cooling water (for details see ECP2 panel) – proceed according to instructions of engine manufacturer
7) ***OVERSPEED*** - warning signalization – lit up in case of overspeed of engine (for details see ECP2 panel) – proceed according instructions of engine manufacturer
8) ***TM COOLING*** – fault signalization – lit up in case of TM cooling failure, (see 11. 2. 3.
9) ***INSULATION FAULT*** – warning signalization – lit up when the insulation resistance of electric system is low – danger of on-coming critical failure of insulation

10) ***TRAVEL CONDITION*** – warning signalization – lit up in case of travel condition is not met, (see 11. 2. 2.) – no possibility to move the vehicle.

11. 9. 2. JSP Signalization

1) ***DESK ON*** – signalization – lit up in case of desk on (active desk)
2) ***MOTORS HEATING*** - warning signalization – lit up in case of vibrator motors high temperature (check cooling and wait for temperature decrease)
3) ***TRAVEL CONDITION*** – warning signalization – lit up in case of travel condition is not met, (see 11. 2. 2.) – no possibility to move the vehicle
4) ***MENTOR READY*** - signalization – lit up in case of rectifier ready condition, (see 11. 6. 1.)
5) ***CONVERTER READY*** - signalization – lit up in case of converter ready condition (see 11. 5. 2.)
6) ***HA COOLING*** - signalization – lit up in case of hydraulic aggregate cooling is on
7) ***PRESSURE FILTER*** - warning signalization – lit up in case of clogged pressure filter (signalization means filter change)
8) ***OIL COOLER FILTER*** - warning signalization – lit up in case of clogged oil cooler filter (signalization means filter change)

11. 9. 3. Trip codes

11. 9. 3. 1. Mentor diagnostics

Code	Reason for trip	Remark
AOC	Armature overcurrent	An instananeous protection trip has been activated due to excess current in the arm.circuit
AOP	Armature open circuit	Drive has detected that the firing angle has advanced but no current feedback is detected
cL	Control loop is open	The input current reference is out of interval 4 - 20mA (less than 3mA) - terminal 3
EEF	EEprom failure	An error has been detected in the parameter set read from EEprom memory at power-up
EPS	External power supply	Overcurrent trip at the 24V supply output terminal TB4-33 has operated
FbL	Feedback loss	No signal from GEL encoder
hF	Hardware fault	A hardware fault has been detected during the self test routine performed after power-up
It	Time x current overload	The integrating overload protection has reached trip level (overcurrent)
Oh	Overheat	Thyristor heatsink overtemperature
PS	Power supply	One or more of the internal power supplies is out of tolerance
SL	Supply loss	One or more of the power supply phases is open circuit

11. 9. 3. 2. Commander diagnostics

Code	Reason for trip	Remark
cL	Control loop is open	The input current reference is out of interval 4 - 20mA (less than 3mA) - terminal 7
EEF	EEprom failure	An error has been detected in the parameter set read from EEprom memory at power-up
It.br	Ixt on breaking resistor	The integrating overload protection of breaking resistor has reached trip level (overcurrent)
It.AC	Time x current overload	The integrating overload protection has reached trip level (overcurrent)
Oa, Oh	Overheat	Overheat of sorround or of electronic
OI.AC	Over current trip	Instantaneous overcurrent trip (possibility of short circuit)
OU	DC link overvoltage	Excessive inertia in the machine during deceleration
Ph	Phase loss	One of the input phases has become disconnected from the drive
rS	Stator res.meas.failure	Stator resistance measurement failure, possibility of motor cable disconnecting
UU	DC link under voltage	Low DC supply voltage

12. ENCLOSURES

12. 1.	DTS VKL 404 Assy.	NC 05 03
12. 2.	Broad Gauge IR	NC 05 02
12. 3.	Air Brake System	1 720 19 06 000 Rev 01 *)
12. 4.	Electric Basic Diagram	3-320-26.1C pages 1 – 14
12. 5.	Hydraulic Diagram	1-320-24B
12. 6.	Fuel System	*)
12. 7.	DTS Performance Curve	NC 05 05
12. 8.	Front Cabin Equipment	3-320-05A
12. 9.	Rear Cabin Equipment	3-320-11A
12. 10.	JS1 (JS2) Drivers desk	NC 05 07
12. 11.	JSP Working Desk	NC 05 08
12. 12.	Painting	NC 04 63
12. 13.	Marking and Lettering Chart	*)
12. 14.	Lubrication Chart	NC 05 06
12. 15.	MS 404 In Operation Manual	NO 01/05 MS404In

*) will be replenished by BHEL