aibn Accident Investigation Board Norway

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REPORT ON RUNAWAY WORK MACHINE AT ENSJØ METRO STATION, 7 JUNE 2018

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This report has been translated into English and published by the AIBN to facilitate access by international readers. As accurate as the translation might be, the original Norwegian text takes precedence as the report of reference.

Photos: AIBN and Ruter As

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SUMMARY

At 16:20 on Thursday 7 June 2018, a mobile elevating work platform (MEWP) collided and derailed on tunnel track 1 between Ensjø and Carl Berners plass. During on-tracking at a gradient of 40‰, the MEWP started to run away, and shortly after the operator jumped off. Nobody was injured in the accident, but it caused major material damage.

The MEWP operator had not received adequate instruction in how the brake system worked, and operated the machine in a way that caused the parking brakes to be deactivated during on-tracking. Examination of the MEWP showed that it lacked technical barriers against incorrect operation, which meant that it was possible to deactivate the parking brakes. In the course of the investigation, the MEWP supplier has introduced technical barriers against incorrect operation, and it is claimed that this will prevent future recurrence of similar incidents.

The AIBN has found weaknesses in Oslo Metro AS's control mechanisms relating to supplier management, with inadequate control of operators' level of competence and the condition of hired vehicles.

The AIBN submits one safety recommendation for more extensive verification by infrastructure owners that hired personnel have the correct training and qualifications.

1. FACTUAL INFORMATION

1.1 Notification of the accident

At 08:15 on 8 June 2018, the Accident Investigation Board Norway (AIBN) was notified by Oslo Metro of a collision and derailment at Ensjø metro station. The incident had occurred at 16:20 on 7 June 2018, which meant that the rolling stock involved had been removed from the scene before the AIBN was notified. The parties involved were informed that the AIBN had initiated an investigation on 18 June 2018, and the European Union Agency for Railways (ERA) was informed on 25 June 2018. On 9 July 2018, the Norwegian Railway Authorities was informed about the investigation findings in accordance with Section 18 of the Railway Investigation Act.

1.2 The investigation and how it was organised

The decision to conduct a safety investigation was made on the basis of the degree of severity of the incident. The investigation mandate and how it was to be organised were decided at the start-up meeting. The investigation was carried out as project work under the leadership of the lead investigator. The Director of the AIBN's rail department is the investigation owner.

1.3 Data relating to the incident

Table 1: About the incident

Runaway work machine	
Time of accident:	16:20 on 7 June 2018
Incident site:	Ensjø metro station
Type of rolling stock:	Work machine, road-rail mobile elevating work platform (MEWP)
Rolling stock involved:	Rail Products UK / Manitou. ART17TH / 160 ATJ+
Registration:	43050 / 956615
Train data:	Road-rail MEWP with pantograph
Owner:	Norocs AS
Operator:	BMO Entreprenør AS
Entity in charge of maintenance:	Norocs AS
Crew:	1

1.4 Sequence of events

In connection with an assignment for Oslo Metro BMO Entreprenør AS (in the following referred to as 'BMO') used an MEWP for work on the tunnel ceiling near Ensjø metro station. During the night leading up to 7 June 2018, the operator found that the MEWP was leaking oil and therefore stopped the work. The operator parked the MEWP on the tunnel track at Ensjø, and raised the rail wheels to lower it onto the road wheels. T-banen had made it a requirement that this type of machine must not be parked on its rail wheels, as it was not equipped with brake shoes. The tunnel track was defined as a construction site and closed for all other access.

Later in the day on 7 June, the operator was given the task of accompanying a service mechanic from Hesselberg Maskin AS (in the following referred to as 'Hesselberg') to where the MEWP was parked. On arrival at the site, the mechanic removed a cover on

the side of the machine, but failed to find any obvious reason for the leakage. To facilitate inspection under the machine, it was decided to raise it by deploying the rail wheels. The operator started the engine and lowered the front rail wheels slightly, and then the back rail wheels slightly. At the very instant when the road wheels were lifted off the ground, the machine started to run away. The operator was in the basket at the time, while the mechanic was next to the MEWP between the two sets of road wheels. The operator has stated that he pressed the emergency stop button, but that this was without effect. When the machine had rolled approximately 20–30 metres, he jumped from the basket. The machine moved relatively slowly at first and both persons involved were able to get away without being injured. An attempt was made to stop the machine by throwing a block of concrete in front of the rail wheels, but it was pushed away and did little to reduce the speed of the machine. The MEWP continued to roll away for approximately 150 metres before it collided with a parked MEWP and derailed. The mechanic stated that the MEWP's engine was still running after the collision and that he switched it off by turning the key.

After the incident, BMO carried out salvage work by jacking up the MEWP and putting it back on the track. BMO stated that the MEWP's brakes were released when they started the engine. The MEWP was then transported to the company Hesselberg in Oslo.

Figure 1: The MEWP after the collision. Photo: BMO Entreprenør AS

1.5 Personal injuries

No one was injured in this incident.

1.6 Damage to rolling stock involved

The personnel basket and boom were damaged; see figure 1. A trailer attached to another work machine was broken.

1.7 Details of damage to infrastructure and track

There was no damage to the infrastructure or track.

2. INVESTIGATIONS CARRIED OUT

2.1 Focus and delimitations

The investigation has focused on training, design, requirements of this type of MEWP and supplier management of hired work machines and crew. The investigation has focused on the machine involved and has not considered the technical workings of other similar road-rail machines.

The AIBN decides the scope of the investigation and how it is to be conducted. When making the decision, account is taken of what lessons can be learnt from the investigation with a view to improving safety, the degree of severity of the accident or incident, its bearing on railway safety in general and whether it forms part of a series of accidents or incidents.

2.2 Parties involved

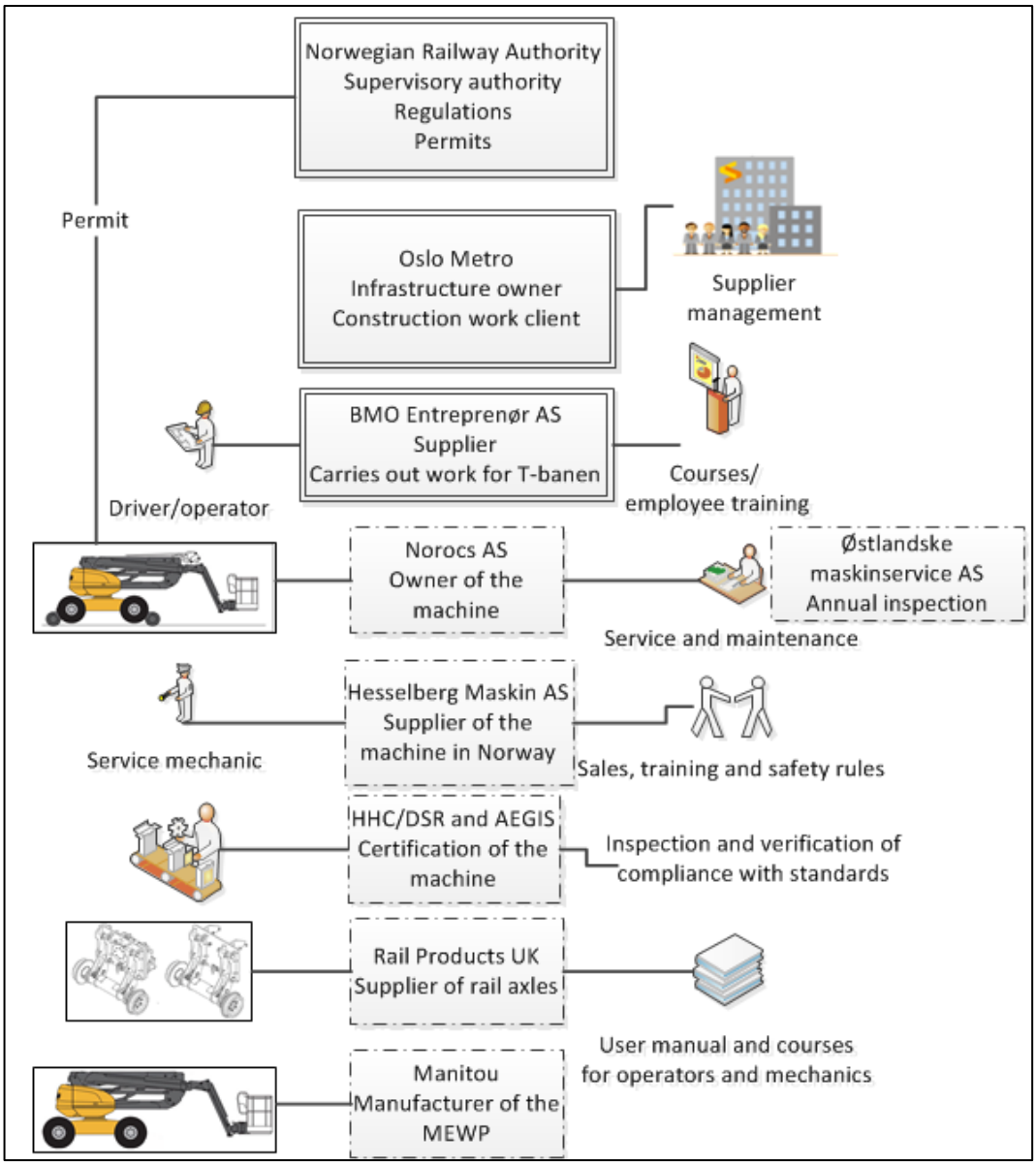


Figure 2: Parties involved and selected relevant areas of responsibility. Illustration: AIBN

2.2.1 Oslo Metro (Sporveien T-banen AS)

Oslo Metro is engaged in rail transport services, track operation and traffic control on the metro network in Oslo and Akershus. The metro operates five lines and carried around 118 million passengers in 2017. The company has just over 600 employees and has 115 train sets at its disposal. The MEWP that derailed was hired to carry out work for Oslo Metro.

The undertaking holds a permit for rail transport services, track operation and traffic control on the metro network in Oslo and Akershus, issued by the Norwegian Railway Authority on 15 April 2011. The permit was granted for an indefinite period.

2.2.2 BMO Entreprenør AS

BMO Entreprenør AS is a concrete and steel construction company with approximately 150 employees. Its head office is in Kongsberg. The company was hired to carry out work for Oslo Metro and made both crew and work machines available in that connection. The MEWP involved in the incident was hired from the company Norocs AS, as BMO needed additional work machines for the assignment.

2.2.3 Norocs AS

Norocs AS is a contractor specialising in contact line installations etc. for trams and railways. The company has more than 20 employees and undertakes contact-wire installation and maintenance assignments. The company also hires out machines for excavation work and work at height.

2.2.4 Østlandske Maskinservice AS

The company Østlandske Maskinservice AS distributes railway machines and equipment, and carries out repairs and annual inspections. The company is a certified under the Norwegian Labour Inspection Authority's certification scheme as competent to conduct inspections of elevating work platforms.

2.2.5 Hesselberg Maskin AS

Hesselberg Maskin AS is a subsidiary of the AS Sigurd Hesselberg group. The Hesselberg group has more than 300 employees and supplies plant and machinery and service work to the building and construction industry. The company is a supplier of the type of MEWP that was involved in the incident. The serviceman involved is an employee of the company. The road-rail mobile elevated work platform ART 17 TH was first handled by the company Normann Olsen AS, and subsequently transferred to Hesselberg. The Labour Inspection Authority has certified the company as competent to conduct inspections of elevating work platforms.

2.2.6 HHC/DSR Inspecties BV

HHC/DSR Inspecties BV (in the following referred to as 'HHC/DSR') is a Dutch certification company that has issued a certificate confirming that the machine is in compliance with the EN 15746 standard.

2.2.7 AEGIS Engineering Systems Ltd

AEGIS Engineering Systems Ltd (in the following referred to as 'AEGIS') is a UK certification company that has issued a certificate confirming that the machine is in compliance with the RIS-1530-PLT standard.

2.2.8 Rail Products UK Ltd

Rail Products UK (in the following referred to as 'Rail Products') is a supplier of the equipment for rail application with which the elevating work platform manufactured by Manitou BF was extended.

2.2.9 Manitou BF

Manitou BF (in the following referred to as 'Manitou') is the original manufacturer of the elevating work platform that Rail Products has extended with equipment for rail application. Manitou is an international company that designs, manufactures, distributes and offers to carry out service work on construction, agricultural and industrial equipment.

2.3 Personnel information

The MEWP operator is an employee of BMO and had a couple of years' experience on this type of machine. He had previous attended MEWP and road-rail machine courses at the Norwegian infrastructure manager Bane NOR SF. The operator had completed courses in the metro's operating regulations and had valid authorization for the railroad machine on the metro network.

The service mechanic from Hesselberg had not previously worked on the rail axles of an ART 17 TH, and had no training in maintenance and repair of such equipment.

2.4 Examination of the work machine

The machine involved in the incident was a MEWP (160 ATJ+) with hydrostatically operated road wheels with rubber tyres, manufactured by Manitou in 2016. The MEWP weighs approximately 12 tonnes and has a top speed of 10 km/h. The MEWP was fitted with rail axles delivered by Rail Products UK (ART 17 TH), so that it can also be used on railway tracks. The MEWP arrived in Norway in 2017 and has been in use since then. The MEWP is designated as follows: Manitou/Rail Products, production number 956723, ID number 0043050.

At the time of the accident, the machine had been approved by the Norwegian Railway Authority, subject to the limitation that it must only be used on construction sites and in areas predisposed for work and in accordance with other conditions in the declaration of conformity. It was also subject to requirements for brake tests and operator training. Sporveien had issued permission for use of the MEWP on the metro network.

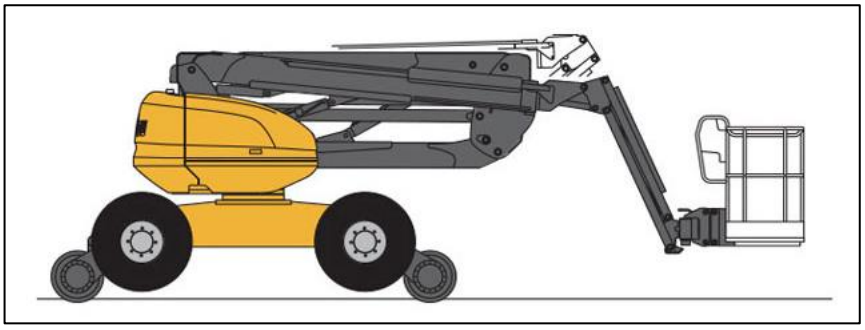


Figure 3: Schematic drawing of the machine involved. Source: Rail Products UK

The AIBN examined and tested the MEWP several times to determine how the brake system worked and whether the machine was defective. The machine was first tested at Hesselberg in Oslo on 13 June, and subsequently on 21 June and 6 July. A closer examination of the oil leakage from the machine revealed that it came from the slewing rim and not from the brake system.

In one of the tests, the machine was jacked up and the road wheels placed on wooden boxes so that the rail wheels were freely suspended. According to BMO, the company that salvaged the MEWP, the machine had not been modified since the accident and the rail wheels were in the same position.

Figure 4: Test of the machine on 21 June 2018. Photo: AIBN

Table 2: Test results

Engine	Rail wheels	Test	Result
Off	Mid position	Brake function	Rail wheels cannot be rotated manually. Parking brake effective.
On	Mid position	Brake function	Parking brake was deactivated approx. 10 seconds after starting the engine. It was possible to rotate all wheels manually in the same direction of rotation. One wheel pair showed slightly more resistance than the other.
Off	Lowered all the way (rail mode)	Brake function	The rail wheels could not be rotated manually.
On	Lowered all the way (rail mode)	Brake function	The rail wheels could not be rotated manually.

The conclusion from the test was that the parking brakes were released automatically on lowering or raising the rail wheels. The test also showed that if the emergency stop function was activated while lowering the rail wheels, the parking brake was engaged automatically. See Appendix A for more information about the tests.

On 6 July 2018, the incident was reconstructed and the MEWP that derailed was compared with two other machines of the same type. The purpose was to determine what force was needed to move the MEWP with the rail wheels in the mid position.

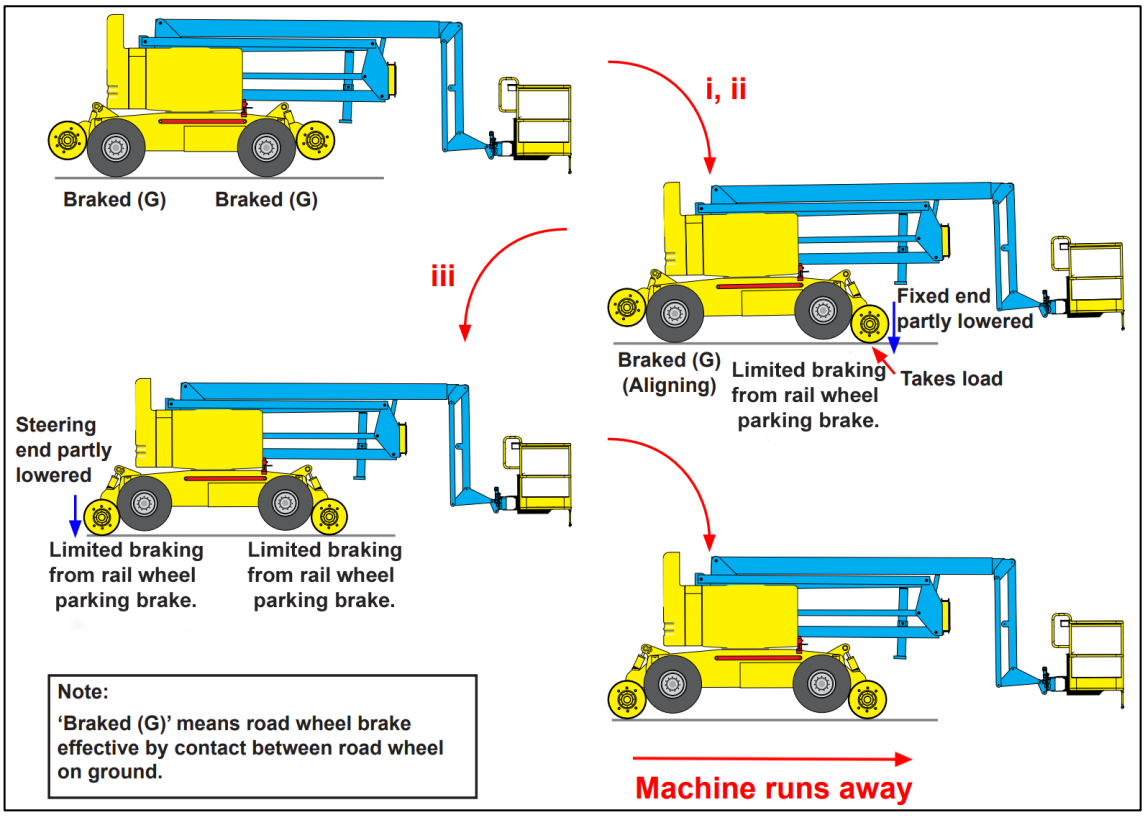


Figure 5: Illustration showing the on-tracking method that was tested. Source: RAIB, © Crown copyright 2019, modified by AIBN

Figure 6: Test of the machine on 6 July 2018. Photo: AIBN

The test was carried out on Oslo Metro's dead-end track at Majorstuen. The MEWP that was involved in the accident was parked on the track for approximately 13 hours before the test was carried out, the same amount of time as the MEWP was parked before the accident. For the test, the machine was chained to an end stopper, a jack was used to tighten the chain and the force needed to move the machine was measured using a dynamometer. In addition, a work machine was used to pull the MEWP over a longer distance in order to test the emergency stop function at speed. See Appendix B for more details about the test.

The conclusion from this test was that all three MEWPs behaved in the same way, and that it was possible to move them if they were on-tracked incorrectly. When both rail wheel sets were placed in the mid position, the machine released the parking brake. The MEWP weighs approximately 12.5 tonnes, and calculations carried out by HHC/DSR

(Appendix F) show that approximately 500 kg[1] braking power is required at a gradient of 40‰. In the test, the MEWP moved when it was pulled with a force of 300 kg. By adding the safety factor of 1.4 it is required that the machine has a braking force of 750 kg in a gradient of 40‰.

For the machine's brakes to be effective during on-tracking, one set of rail wheels must first be lowered all the way to ensure that the parking brake is effective before lowering the other set.

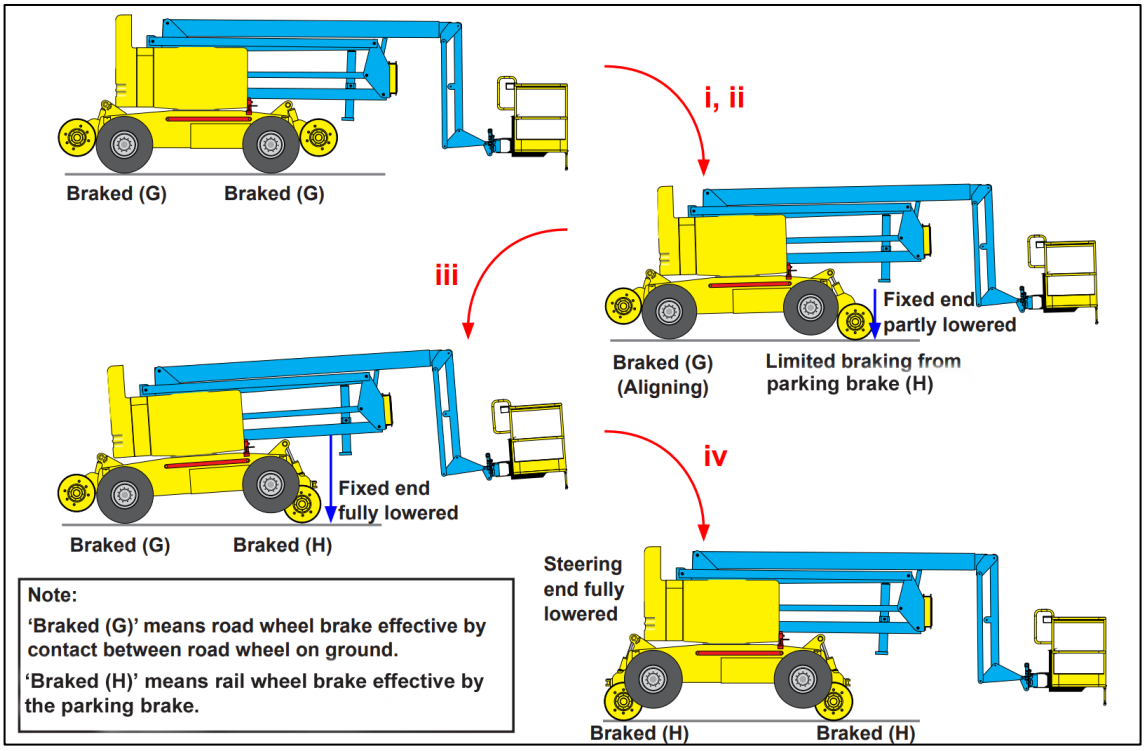


Figure 7: Illustration showing the correct on-tracking procedure. Source: RAIB, © Crown copyright 2019, modified by AIBN

Rail Products conducted an internal investigation in June 2018. The conclusion was that the MEWP was poorly maintained and that the operator had not followed the user manual. The user manual prepared by Railproducts specifies intervals and which controls are to be carried out on the elevating platform part. According to Hesselberg, they had not registered any work orders for carrying out maintenance. However, it emerged that, in connection with several assignments, there had been a need for both troubleshooting and repairs. In March 2018, there were faults relating to the machine's propulsion, lowering of the rail wheels and leakages. In March 2018, Norocs gave Oslo Metro confirmation that service had been carried out at the scheduled intervals. The company also confirmed that the machine had not been modified in any way. The AIBN has not received an overview as requested from Norocs with information about completed service work on the machine. According to the company, the service log for the machine is missing. The company has informed the AIBN that annual inspection is carried out by Østlandske Maskinservice AS, most recently in 2018. The annual inspection focuses on the elevating platform part of the MEWP, and no tests are specified for the rail axles.

[1] Force is normally stated in Newton, but during the tests and the certification, kilogrammes are used to express the force needed to move the MEWP.

Hesselberg completed its repairs of the MEWP in January 2019, approximately seven months after the accident, after which Norocs put the machine back into operation. However, in February 2019, Rail Products pointed out that the MEWP had structural damage that had not been repaired in accordance with the company's instructions. Hesselberg immediately examined the machine, and concluded that it could continue to be used until the time of the next scheduled service before the structural damage was repaired.

2.5 Examination of the infrastructure

The incident occurred on track 1 in the tunnel between Ensjø and Carl Berners plass. In this area, the track slopes in a northerly direction at a gradient of 40‰, which is considered steep in the context of railways.

The metro uses a third rail system along the track with an operating voltage of 750 V DC.

2.6 Traffic control and signalling system

The traffic control centre for metro operations is located at Tøyen in Oslo. Traffic operations are controlled with the aid of remotely controlled interlocking systems and, in special situations, by issuing verbal orders.

2.7 Communication channels

The TETRA system is used for verbal communication. The operator of the lift did not have the TETRA radio, but signed up for the traffic leader to enter the track. It was Oslo Metro’s safety guard who notified the traffic manager about the incident.

2.8 Acts and regulations

Oslo Metro (Sporveien T-banen AS) holds a permit for rail transport services, track operation and traffic control on the metro network in Oslo and Akershus. The permit was granted on 15 April 2011 for an indefinite period.

The Regulations of 10 December 2014 No 1572 relating to requirements for tramways, underground railways, suburban railways etc. (the Requirements Regulations) lay down minimum requirements relating to safety.

Pursuant to Section 2-1, Oslo Metro has overall responsibility for safety.

> *The railway undertaking is responsible for safe operation and control of any risks that may arise. The railway undertaking has a duty to implement necessary risk management and, where relevant, cooperate with the other undertakings.*

Section 3-1 contains the following requirement for the safety management system relating to the use of suppliers.

> *The safety management system shall include the use of suppliers. The railway undertaking shall apply the same control and safety requirements to activities carried out by suppliers as to activities carried out by the undertaking itself.*

Section 5-2 contains requirements for competence.

> *For any assignments with a bearing on safety carried out by a supplier, the railway undertaking shall have sufficient competence, among other things to be able to specify delivery requirements, follow up the supplier and assess the delivery.*
>
> *Own employees and those of suppliers who carry out assignments with a bearing on the railway undertaking's safety work shall have sufficient competence for these tasks.*

Section 7-1 contains requirements for audits of suppliers among other things.

> *The railway undertaking shall systematically conduct audits of suppliers to assess whether the suppliers comply with requirements provided for in or pursuant to agreements.*

Section 10-2 contains requirements for inspection and maintenance of vehicles.

> *The traffic operator shall carry out vehicle inspections, and have minimum safety requirements in place for systems, parts and components.*
>
> *The traffic operator shall carry out vehicle maintenance. The maintenance shall ensure that no systems, parts or components deteriorate to such an extent that they fail in their function. Among other things, safe wear limits shall be defined for wear parts, and maintenance and replacement intervals shall be defined for all safety-critical components.*
>
> *Traffic operators shall document the maintenance that is carried out.*

Section 12-1 contains general requirements for vehicles.

> *Vehicles shall be engineered, constructed, tested, upgraded and renewed in accordance with recognised current standards. The standards chosen shall maintain or improve the safety of all the vehicles to which they apply. A safety assessment shall be carried out of any nonconformity with chosen standards. The assessment shall be documented.*

Section 12-3 contains requirements for brakes.

> *All vehicles shall have brakes. The brakes must be capable of stopping the vehicle within a maximum braking distance defined by the traffic operator, regardless of the conditions. The brake systems shall have a fail-safe design.*
>
> *Vehicles shall have parking brakes or other equipment for safe parking of the vehicle.*

Section 13-3 contains requirements for technical competence.

> *…*
>
> *Drivers shall have an understanding of how vehicle brake systems work and be able to use and handle such systems.*

Section 13-8 contains requirements for authorisation.

> *Drivers shall hold an authorisation issued by the railway undertaking. Authorisation may only be granted to personnel who, in practical and theoretical tests, have demonstrated that they meet the competence requirements provided for in these Regulations, that they meet physical and mental health requirements and that they are otherwise fit for the safe performance of tasks assigned to drivers. Drivers who operate in mixed traffic environments are required to hold a Class B driving licence.*
>
> *A certificate of authorisation shall be issued, at minimum containing the following information:*
>
> *a) name and address of the authorising railway undertaking;*
>
> *b) name of driver;*
>
> *c) date of issue and period of validity;*
>
> *d) what types of vehicles the driver is authorised to drive;*
>
> *e) which sections the driver may drive and*
>
> *f) any limitations applying to the authorisation.*

In the Regulations of 14 March 2008 No 1360 concerning administrative arrangements within the area of application of the Working Environment Act (Regulations concerning Administrative Arrangements), Sections 8-6 and 8-7 contain requirements for enterprises of competence and what their inspection is to include.

In the Regulations of 6 December 2011 No 1357 concerning the performance of work, use of work equipment and related technical requirements (Regulations concerning the Performance of Work), Sections 13-1 and 13-2 describe what equipment is subject to a requirement for inspection by an enterprise of competence and the intervals of such inspections.

2.9 Standards and certification

According to Rail Product's user manual, the MEWP was designed in accordance with the following standards:

- *2006/42/CE Machine Directive*
- *EN 15746-1 Railway applications – Road-rail machines –Technical requirements*
- *EN 15746-2 Railway applications – Road-rail machines –Safety requirements*
- *EN 280 Mobile Elevating Work Platforms*
- *RIS-1530-PLT Issue 6 Engineering Acceptance of Possession-only Rail Vehicles*
- *EN 13001-2 Crane safety – General design – Part2: Load actions*

The Norwegian Railway Authority has informed the AIBN that it has not adopted any further requirements for the on and off-tracking function over and above those set out in the applicable standards EN 14033-2 (section 5.4) and EN 15746-1 (section 5.23). The standards consistently require that on and off-tracking of the vehicle must be carried out

while '*remaining in a position of safety*'. The standards also require that the user manual shall describe on and off-tracking in an unambiguous manner.

The type approval of the ART 17, which is in accordance with EN 15746 (Appendix D), states that the machine can be on-tracked at a gradient of 40‰ and maximum cant of 180 mm.

The rail axles were designed by the UK manufacturer Rail Products, and the AIBN has therefore been in contact with the UK Rail Accident Investigation Branch (RAIB) in connection with the investigation. There are more than 180 identical machines in use in the UK. The RAIB advises that the infrastructure controller in the UK, Network Rail, requires all machines of this type that operate on its infrastructure to comply with RIS-1530-PLT. This Rail Industry Standard (RIS) defines voluntary requirements developed by the Rail Safety and Standards Board Limited (RSSB) in the UK for machines with rail wheels. The standard states that during on and off-tracking, the brake effect shall be achieved by engineering means and not be reliant on operational procedures (RIS-1530-PLT section 6.1.2).

With respect to on-tracking, RIS-1530-PLT states that the machine shall be capable of on-tracking at a gradient of up to 40‰ (RIS-1530-PLT section 5.19.1.3).

The type approval of the ART 17, which is in accordance with RIS-1530-PLT (Appendix E), states that the machine can be on-tracked at a gradient of 40‰ and maximum cant of 150 mm in the UK.

The type approval with EN 15746 or RIS-1530-PLT requires that the machine cannot move during on or off-tracking at a gradient with the rail wheels in the mid position. This issue was not revealed under the type approval or in the risk analysis, dated February 2014, which Rail Products received in connection with the approval process

2.10 Inspection schemes for vehicles and work equipment

The certification scheme for compliance with the requirements for inspection and safety training by an enterprise of competence was established in 1998. Private certification bodies have been accredited by the Labour Inspection Authority since 2001. These bodies certify undertakings that comply with the requirements for inspections and certified safety training by an enterprise of competence.

The inspection scheme covers certain machines and units of work equipment such as mobile cranes, lorry cranes, elevating work platforms, excavators etc., and these are subjected to annual inspection by an independent third-party enterprise of competence to reduce the risk of accidents being triggered by technical defects.

The owner of the elevating work platform is obliged to ensure such annual inspection, while training in how to operate the machine comes under the requirement for documented safety training that may be given outside the certification scheme.

The MEWP had undergone annual inspection by an enterprise of competence in January 2018. The certified enterprise of competence did not comment on any matters relating to the machine's rail axles. The Regulations concerning the Performance of Work require a new inspection of the machine by an enterprise of competence in connection with major repairs.

The Norwegian Railway Authority has not had a certification scheme in place corresponding to that of the Labour Inspection Authority. The traffic operator or railway undertaking has sole responsibility for inspection and maintenance.

Bane NOR SF has similar inspection procedures in place in its management system. The following conditions are set out on the railway infrastructure vehicle card:

> *'Use of the vehicle is only permitted subject to a valid BN railway infrastructure vehicle card and valid technical inspection deadline (TKF).*
>
> *Registered road vehicles are subject to a requirement for periodic inspection and must also have valid documentation of periodic roadworthiness tests.*
>
> *The user is obliged to monitor the vehicle's technical condition, and to stop or limit any use during which, as a result of damage or defect, the required safety level cannot be maintained.'*

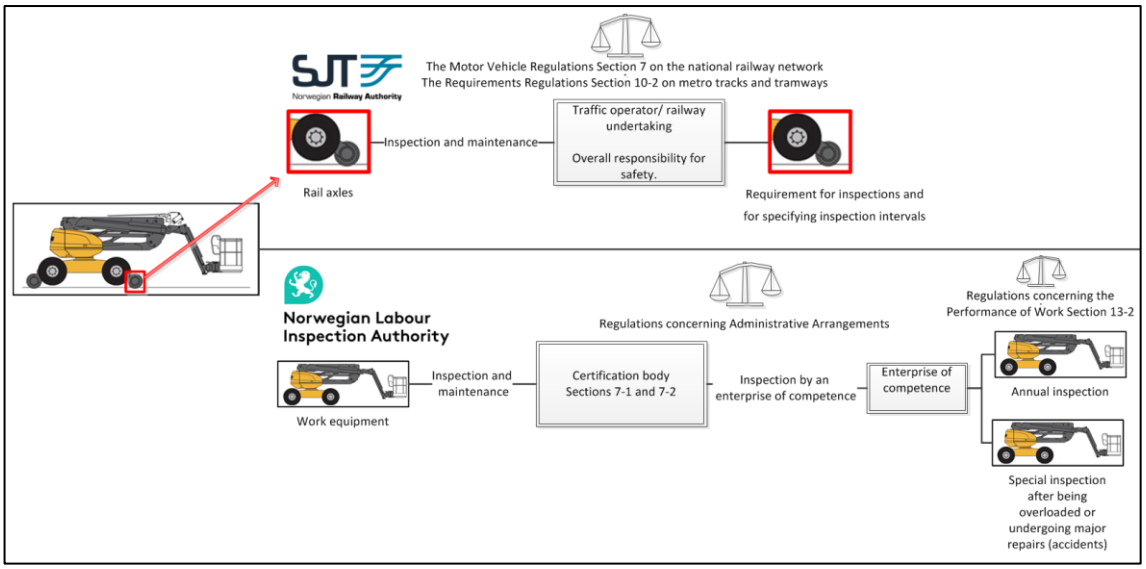


Figure 8: Comparison between the Norwegian Railway Authority and the Labour Inspection Authority's inspection schemes. Illustration: AIBN

2.11 Sporveien's supplier management

Sporveien's management system contains procedures for ensuring that the chosen suppliers are capable of delivering on requirements, at the best price and in compliance with the Public Procurements Act. In connection with major procurements and works, a contract is prepared in accordance with the guidelines in NS 8405:2008, Norwegian building and civil engineering contract.

On 18 February 2018, Sporveien AS and BMO entered into a contract for tunnel work on the Helsfyr–Majorstuen metro section, with an option on ordering further tunnel works.

The requirements specify that BMO is responsible for ensuring that all track-guided vehicles are approved by the Norwegian Railway Authority. Such approval had been obtained for the MEWP that was involved in the incident.

Sporveien's permission for use of hired track-guided vehicles sets out further requirements to be met by BMO, including requirements for competence as described in more detail in the following section.

2.12 Competence requirements for personnel

The permission for use of the MEWP, issued by Sporveien contains requirements for driver training to be completed before the machine is used. The operator held a certificate of competence confirming that he had received training in use of the equipment, but not specifically in the use of the modified track-guided part of the machine.

Sporveien's competence management system (KOS) contains information about which vehicles a driver is authorised to operate. Sporveien does not keep corresponding records relating to hired contractors' use of their own equipment.

In comparison, Bane NOR SF requires operators to complete the 'Road-rail machine operator' course before using such a machine on the national railway network. This is a general course offered by the Norwegian Railway Academy, and the course participants are assumed to have sufficient qualifications for the machines they are to operate at the time of attending the course. No specific training is provided in use of the machines used on the railway network.

2.13 Manuals and procedures

Rail Products has prepared a user manual for the track-guided part of the ART 17. It is intended to provide necessary information about implementation, maintenance and correct use. The user manual applies to use on tracks only. The Norwegian user manual is a 129 pages long translation of the Dutch version.

The user manual describes the responsibilities of the owner and users. It states that the MEWP must only be operated by authorised personnel with the requisite training and qualifications. It also contains some minimum requirements for personnel who maintain and use the MEWP. These requirements correspond to those that apply to use of the equipment in the UK.

The AIBN has been informed by BMO that the operator provides MEWP courses, but that these do not specifically deal with the runaway risk during on-tracking.

The user manual contains a description of how the MEWP is to be tracked on and off railway tracks; see Appendix C. An assessment of the instructions is included in the analysis part of this report; see section 3.4

2.14 Similar incidents

On 10 March 2015, the crane jib on work train 55208 struck a passenger train at Aker station in Oslo. Two barriers that should have prevented the jib from moving during transport failed in connection with this accident. The AIBN's investigation (JB 2016/03) found that the hydraulic lock failed at the same time as the securing bracket failed to keep the jib in place. The crane's securing device was designed to prevent lateral and downward movement and not upward movement. Neither the supplier nor the Norwegian National Rail Administration had considered such a scenario before the crane was put to use.

On 26 February 2016, there was an incident with a runaway road-rail vehicle near Sinsen metro station. The AIBN’s investigation (JB 2016/07) showed that the brake system for the rail wheels on the road-rail vehicle constituted a safety risk, as the brakes were not

fail-safe. The brake system did not meet the requirements of the Legal Requirement Regulations, BOStrab or EN 15746. The Norwegian Railway Authority did not detect the faults in the brake system when it authorised use of the road-rail vehicle.

On 27 October 2016, a vacuum excavator of the type Railvac 17000 started rolling out of control down a 25‰ gradient on the Sørlandsbanen line, and derailed after 5.6 km. The investigation (JB 2017/07) found errors in technical drawings, and a lack of risk assessments in connection with the introduction of new components and functions. The investigation of the operational procedures found errors in the procedures and a lack of compliance with procedures.

The UK Rail Accident Investigation Branch (RAIB) has conducted several individual investigations and one special investigation (RAIB report 27/2009[2]) into runaways of road-rail work machines. The special report contains several useful learning points that are also of relevance in Norway.

The correct on and off-tracking procedure is illustrated in RAIB report 15/2014[3] in a figure that is reproduced in this report.

RAIB report 01/2019[4] concerns an investigation into an MEWP road-rail vehicle that ran away while being on-tracked near Bradford in the UK. The incident had several features in common with the incident investigated in Norway, and several of the learning points listed in the report may also be relevant in Norway. The RAIB's recommendations seek to:

- Improve the competence management system for all machine operators
- Improve the competence management system for all employees (machine operators and fitters) of the company concerned in the runaway
- Improve the quality of maintenance instructions and training of fitters who carry out the repairs

Including the above, the RAIB has conducted six investigations into similar incidents involving runaway road-rail vehicles.

3. ANALYSIS

3.1 Introduction

This chapter is intended to give a presentation of the incident based on the AIBN's assessment of the sequence of events, and to identify areas in which improvements can benefit safety. Maintenance, training and supplier management are emphasised in the analysis.

[2] Investigation into runaways of road-rail vehicles and their trailers on Network Rail
[3] Runaway of a road rail vehicle and the resulting collision in Queen Street High Level Tunnel, Glasgow 21 April 2013
[4] Runaway of a road-rail vehicle at Bradford Interchange 8 June 2018

3.2 Analysis of the incident and its impact

At 16:20 on Thursday 7 June 2018, a mobile elevating work platform (MEWP) collided and derailed on tunnel track 1 between Ensjø and Carl Berners plass. At around 02:00 on the night leading up to 7 June, the operator had stopped working and parked the machine because of an oil leakage. In the afternoon, a service mechanic arrived to examine the leakage. The vehicle lost brake power as the operator was deploying the rail wheels to lift the road wheels off the ground in a slope with a 40‰ gradient. The vehicle ran away for about 150 metres before colliding with the trailer of a parked work machine and running off the rails.

The AIBN tested the vehicle's braking function with the rail wheels in the mid position, the same position as during the accident, and the results showed that the vehicle moved when pulled with a force of approximately 300 kg. At a gradient of 40‰, the vehicle, which weighs around 12.5 tonnes, would need a braking power of approximately 500 kg to keep it from moving. The vehicle did not have any technical barriers against running away, and this is described in more detail in section 3.3.

The investigation found no evidence that the oil leakage had anything to do with the runaway. The leakage came from the slewing rim, which presumably had no effect on the brake system. The operator has explained that he was raising the vehicle onto the rail wheels to facilitate troubleshooting by the service mechanic. Oslo Metro required that when this type of machine was parked, it should be lowered so that the weight was transferred from the rail wheels to the road wheels. The reason for this was that the vehicle was not fitted with stop blocks that could be placed in front of the rail wheels to prevent the vehicle from running away in the event of brake failure.

When tracking on, the operator lowered the axles a little at a time, alternating between the two. When the road wheels were lifted off the ground, the vehicle started rolling and, shortly afterwards, the operator jumped off. The operator stated that he pressed the emergency stop button, but that this was without effect. How the machine was operated is discussed further in section 3.4

The service mechanic has stated that the machine's engine was still running after the collision, and that he switched it off by turning the key. The emergency stop function was checked in the tests after the accident, and when the button was pressed, the engine stopped and the parking brakes were activated. The AIBN believes that the operator probably did not succeed in pushing the emergency stop button before he jumped off.

The AIBN conducted several tests to ascertain how much force was needed to move the machine with both rail wheels in the mid position. Several movement tests carried out in the Netherlands and the UK (see Appendix F) show the same results as in the present case, namely approximately 300 kg. The tests carried out in the Netherlands and the UK also looked at the amount of force that was needed for the vehicle to run away over a longer distance. When the rail wheels are rotating, the hydraulic system will produce more resistance than when they are at a standstill. Hence the force needed to move the vehicle over a distance is different from the force needed move it from a standstill. For the vehicle to roll freely over a long distance, it needed to be pulled with a force of approximately 800 kg.

The AIBN's examinations show that the hydraulic system for the rail wheels was probably faulty, causing the vehicle to roll faster than expected, when compared with the tests carried out in the Netherlands and the UK. In addition, the oil leakage may have lubricated the rails, which may in turn have contributed to increase the speed.

In connection with a review of the maintenance, it turned out that the maintenance log for the MEWP was missing. In connection with its examination of the machine, the supplier Rail Products pointed out, however, that it appeared to have been poorly maintained. This is discussed further in section 3.5.

3.3 Lack of technical barriers against uncontrolled movement

The MEWP was manufactured in 2016, and the supplier states that it was certified and approved based on several recognised standards. The vehicle had no technical barriers, however, that would prevent it from running away in the event that the operator inadvertently did not on or off-track it correctly.

The AIBN is of the opinion that the risk assessment and approval process did not identify the potential risk of uncontrolled movement should the vehicle be on or off-tracked incorrectly.

3.4 Inadequate training

The AIBN's investigation shows that on-tracking of the vehicle in the way it was done when the accident happened leads to deactivation of the parking brakes on both axles. This means that the vehicle can start to run away. For the parking brakes to be effective, one rail axle must be lowered first, before lowering the other in the same way. As the rail axle is lowered, the parking brake will be released so that the wheel can turn freely, to limit rail and wheel wear. The tests also showed that when the emergency stop button is activated with the rail axles in the 'mid' position, the parking brake is activated and braking is effective.

The AIBN believes that the parking brakes would have been effective had the vehicle been on-tracked correctly. Furthermore, the emergency stop button cannot have been activated as this would have activated the brakes, even if the vehicle had been on-tracked incorrectly. The operator had not been instructed in the correct method of on-tracking, however, and the vehicle also did not have any technical devices to prevent the unfortunate consequences of any such incorrect handling.

The review of the Norwegian user manual found that it was difficult to understand. It has clearly been translated from another language, and the instructions are set out in a manner that can be confusing for the reader. The description of the on and off-tracking procedures also appears to lack essential information. The manual fails to state clearly that the rail wheels at one end must be lowered all the way for the parking brake to be activated. The description of how to deploy the rail wheels at the other end is clearer in stating that the axle must be lowered all the way. Following the instructions in the user manual can lead to the machine being operated in such a way that the parking brakes will not be effective on any of the rail wheels.

In the AIBN's opinion, the user manual does not explain on and off-tracking in an unambiguous manner. The Norwegian manual has significant improvement potential when it comes to clarity of description on this point.

The operator was not aware that the way he on-tracked the vehicle would cause the parking brakes to be deactivated. The training he had received from BMO did not specifically include training in on and off-tracking procedures. When testing the MEWP involved and two corresponding MEWPs, it turned out that several other drivers were also unaware that the parking brakes are deactivated during lowering of the rail wheels.

In the AIBN's opinion, the operator had not received sufficient training in the use of the modified track-guided part of the machine. It is stressed, nonetheless, that it is Oslo Metro that has overall responsibility for ensuring that operators have a sufficient level of competence to carry out the tasks they are assigned.

3.5 Lack of historical data on maintenance and repairs

In connection with Sporveien issuing the permission to use the work machine in March 2018, Norocs submitted confirmation of its technical conditions. In the confirmation, Norocs stated that the MEWP had been serviced at scheduled intervals, and that the equipment had not been modified. Norocs has been unable to procure the maintenance log. Norocs has also informed the AIBN that annual inspection has been carried out by Østlandske Maskinservice AS, most recently in February 2018.

In the AIBN's view, the lack of documentation and the condition of the MEWP leave the impression that there has been inadequate follow-up. The annual inspection focuses on the elevating platform part of the MEWP, and no tests are specified for the rail axles.

When examining the MEWP in June 2018, Rail Products pointed out that it appeared to have been poorly maintained. They referred to it leaking oil and that some parts were identified that seemed to indicate that modifications or alternations had been carried out. Furthermore, there have been problems with the propulsion when climbing slopes and technical problems with the function that confirms that the machine is ready for use.

Following the accident, the MEWP was repaired by Hesselberg and then put back into operation. Rail Products has subsequently stated that the MEWP was not repaired in accordance with the company's instructions and that it had suffered structural damage that had not been repaired. Hesselberg examined the MEWP as soon as this became known and concluded that it could continue to be used until the time of the next scheduled service before the structural damage was repaired.

Rail Products has prepared tests to be completed before this type of machine is put into operation, but these tests were not conducted before the machine was put back into normal operation.

Oslo Metro does not require that repairs following accidents are followed up in any particular way or that repairs are approved by the equipment supplier.

The AIBN is of the opinion that there is inadequate follow-up and approval in connection with repairs to vehicles of this type. It is easy to lose overview of faults and defects in a machine that is hired out and used by different operators both on the national railway network and on Sporveien's infrastructure.

3.6 Weaknesses in supplier management control mechanisms

In addition to completing a course organised by his employer, the operator had attended courses in the use of road-rail machines at both Oslo Metro and Bane NOR. None of these courses addressed procedures for on and off-tracking of this specific MEWP, however.

The AIBN is of the opinion that on and off-tracking procedures for road-rail machines entail risks that have not been adequately followed up by Oslo Metro. Sporveien has required the supplier to provide training before the machine is used, but there has been no follow-up of whether operators have sufficient competence in the use of this specific equipment. The AIBN is aware that, after the accident, Sporveien has introduced more stringent requirements relating to the level of vehicle competence of operators who use this type of machine.

Following the accident, the MEWP was inadequately repaired before it was put into operation for Bane NOR SF. There is no formalised dialogue between Bane NOR SF and Oslo Metro about vehicles that have been involved in accidents, whereby the parties would be able to assess whether inspection might be necessary before work machines are permitted for use on their respective tracks.

In the AIBN's view, infrastructure managers are charged with a heavy responsibility for hired vehicles, and following up inspection and maintenance of this type of machines can be challenging. Consideration should be given to introducing systems to provide better support for infrastructure owners in following up that rail components on vehicles are inspected and maintained by recognised undertakings. In the area covered by the Labour Inspection Authority, there is a certification scheme in place along with a requirement for annual inspection of plant by a certified third party. The Norwegian Railway Authority only requires that vehicles are approved before they are put into use, after which inspection and maintenance of the vehicle is the responsibility of the traffic operator or railway undertaking. In the case of vehicles hired to carry out assignments for infrastructure owners that are also traffic operators, this means that they are responsible for ensuring that inspection and maintenance are carried out correctly.

The AIBN is of the opinion that before the traffic operator or railway undertaking grants permission to use equipment, it must ensure that information is obtained about whether the machine in question has been involved in an accident. That the parties exchange such information should be in everybody's interest. The AIBN is also of the opinion that if the equipment undergoes repairs, it must be checked that such repairs have been carried out in accordance with the supplier's instructions.

4. CONCLUSION

At 16:20 on Thursday 7 June 2018, a mobile elevating work platform (MEWP) collided and derailed on tunnel track 1 between Ensjø and Carl Berners plass. During on-tracking at a gradient of 40‰, the MEWP started to run away, shortly after which the operator chose to jump off the machine. Nobody was injured in the accident, but it caused major material damage.

The investigation has shown that the MEWP lacked technical barriers to limit the consequences of incorrect operation, barriers that could have prevented it from running away.

The Norwegian Railway Authority granted permission to use the machine in 2017, and did not detect any weaknesses in the user manual or relating to the lack of a technical barrier. Nor was the lack of a technical barrier identified by the supplier or the certification companies that examined the machine for compliance with EN 15746 and RIS-1530-PLT.

Furthermore, the MEWP's hydraulic system was probably faulty. This caused it to run away at greater speed than what would be expected had the system been in good working order. It has not been possible to ascertain whether maintenance of the MEWP's rail axles had been carried out as required, since the maintenance log is missing.

In addition to completing a course organised by his employer, the operator had attended courses at both Oslo Metro and Bane NOR. None of these courses addressed procedures for on and off-tracking this specific MEWP. Weaknesses were also found in the user manual's description of these procedures.

The MEWP was put back into operation on the national railway network in January 2019. However, in February 2019, the supplier pointed out that the MEWP had structural damage that had not been repaired in accordance with the company's instructions. The infrastructure manager is charged with a heavy responsibility for hired vehicles, and following up inspection and maintenance of this type of machine can be challenging. Consideration should be given to introducing systems to provide better support for infrastructure owners in their pursuance of this task.

The AIBN has found weaknesses in Oslo Metro AS control mechanisms relating to supplier management, with inadequate control of operators' competence and the condition of hired vehicles.

5. IMPLEMENTED AND PLANNED MEASURES FOLLOWING THE ACCIDENT

Rail Products Ltd. has updated the software to version V 2.0 on the ART 17 TH machine to prevent the parking brakes from being released on both rail axles during on and off-tracking. According to the information received, the new software will be installed on all MEWPs that have been delivered.

Oslo Metro AS updated the operating manual in December 2018, and added the requirement that all operators/drivers must have the requisite level of competence for the equipment they are to operate on the track.

6. SAFETY RECOMMENDATIONS

The Accident Investigation Board Norway proposes the following safety recommendation:[5]

Safety recommendation JB No 2019/02T

On Thursday 7 June 2018, a mobile elevating work platform (MEWP) collided and derailed on tunnel track 1 between Ensjø and Carl Berners plass metro stations. During on-tracking at a gradient of 40‰, it started to run away. The operator had not received adequate instruction in how the brake system worked, and operated the MEWP in a way that caused the parking brakes to be deactivated.

The Accident Investigation Board Norway recommends that the Norwegian Railway Authority request of Infrastructure Managers that they strengthen their supplier management with a view to detecting any lack of safety-critical competence in hired operators of this type of vehicle.

Accident Investigation Board Norway

Lillestrøm, 14 May 2019

[5] The investigation report is submitted to the Ministry of Transport and Communications, which takes necessary action to ensure that due consideration is given to the safety recommendations, cf. the Regulation of 31 March 2006 No 378 relating to official investigations into railway accidents and serious railway incidents etc. (the Railway Investigation Regulation) Section 16.

APPENDICES

Appendix A - Tests performed 21 June 2018 by AIBN

Appendix B - Tests performed on 6 July 2018 by AIBN

Appendix C - Description of on tracking in the user manual from Rail Products

Appendix D - Certificate EN-15746, HHC/DRS

Appendix E - Certificate RIS-1530-PLT, AEGIS

Appendix F - Test performed by HHC/DRS after software update

APPENDIX A - TESTS PERFORMED 21 JUNE 2018

Tests performed by AIBN 21 June 2018 at Hesselberg Maskin AS in Oslo.

No.	Engine	Rail wheel	Test	Result
1.	Off	Half Employed	Brake function	Rail wheels cannot be rotated by hand.
2.	On	Half Employed	Brake function	The parking brake is deactivated approx. 10 seconds after the engine has started. Possible to rotate all wheels by hand in the same direction. Four people used during the test. A little more resistance on the front wheels in the roller direction.
3.	Off	Up (Road mode)	Brake function	Rail wheels cannot be rotated by hand.
4.	On	Up (Road mode)	Brake function	Rail wheels cannot be rotated by hand.
5.	Off	Down (Rail mode)	Brake function	Rail wheels cannot be rotated by hand.
6.	On	Down (Rail mode)	Brake function	Rail wheels cannot be rotated by hand.
7.	Off	Half Employed	Brake function	Rail wheels cannot be rotated by hand.
8.	On	Half Employed	Brake function	Possible to rotate the wheels. Same result as test 2.
9.	On	Down (Rail mode)	Hydrostatic engine	Running the lift back and forth on track wheels, works normally.
10.	On	Half Employed	Brake function	Rail wheels cannot be rotated by hand. Same test as no 2 and 8, but not the same result.

APPENDIX B - TESTS PERFORMED 6 JULY 2018

Tests performed by AIBN 6 July 2018 on Majorstuen subway track.

No.	Engine	Rail wheel	Test	Result
1.	Off	Up (Road mode)	The leak	Parked 13 hours before the test. Did not reveal that the leak affected the brakes. The leak is thought to come from the turning ring.
2.	On	Half Employed	Brake function	Measures 300 kg of traction before the machine moves on. The parking brake is off. 
3.	Off	Half Employed	Emergency stop Brake function	Measures 2500 kg traction and the machine is stationary. The parking brake is on. 
4.	On/Off	Half Employed	Emergency stop Brake function At runaway	The lift is attached to a working machine and pulled a short distance before the emergency stop is pressed. This means that the engine and all hydraulic functions are stopped. The parking brake is added. The lift locks the rail wheels before it stops
5.	On	Down (Rail mode)	Stability on rail base	Uses the machine in multiple positions and drives back and forth. The rail base does not change position.
6.	On	Down (Rail mode)	Stop shoes	Testing stop blocks. Rail slider is in the way of test 1, and is adjusted before the next test. One shoe has a bad fit and falls off. Successful on one block at test 2.
7.	On	Half Employed	Compare with equal lift	Compares with two similar machines. Measures 300 kg of traction before the machines move. The parking brake is off.
8.	Off	Half Employed	Compare with equal lift	Compares with two similar machines. Measures 2500 kg traction and the machines are stationary. The parking brake is on.

APPENDIX C – ON TRACKING, FROM THE USER MANUAL

6.3. Operation handlings

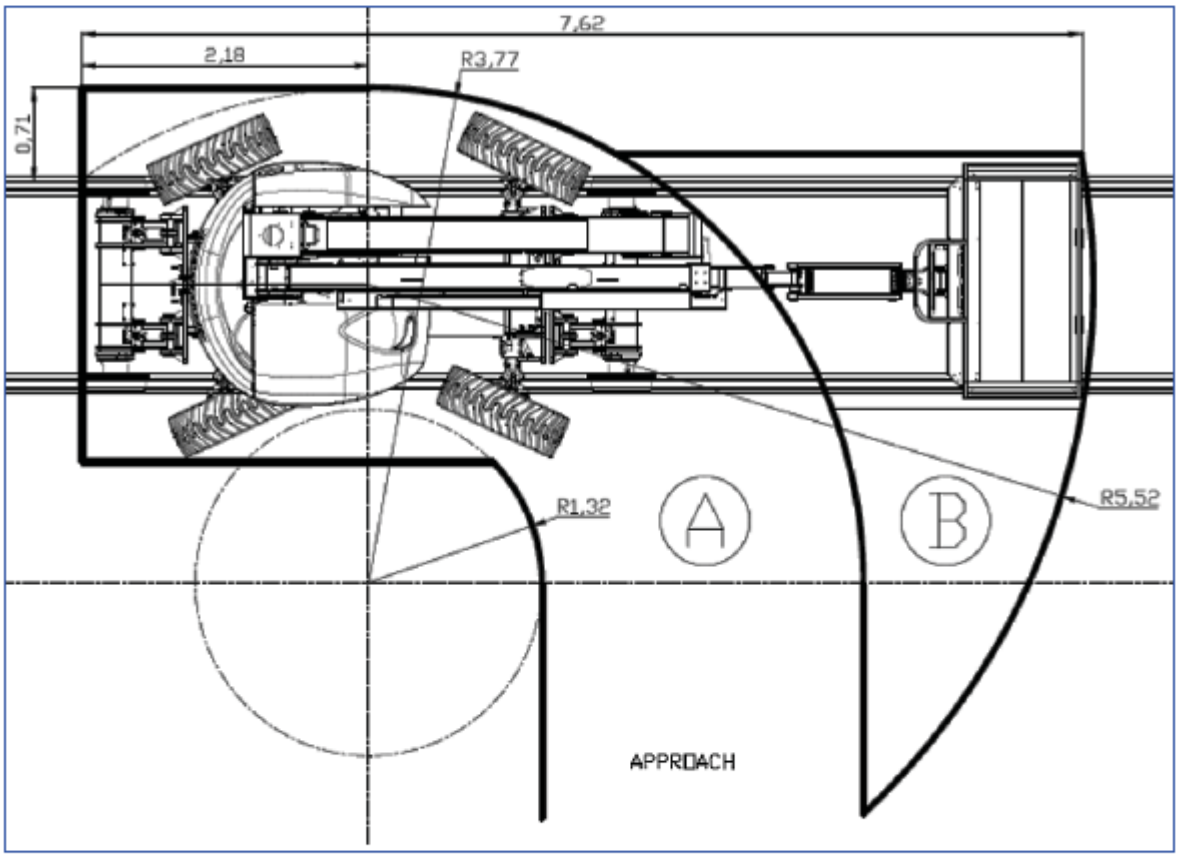
Remark!
Before operating:

- Only competent and authorised personnel shall operate the machine.
- Always check the general condition of the ART 17 T(H)(HM); *correct missing parts (protective guards), damages or leakages*.
- Area is free of personnel.
- Referenced manufacturer's manuals are to be read in conjunction with this document.

6.3.1. MEWP On tracking

On track the machine at a properly prepared road-rail access point (RRAP). The minimum size of the RRAP area to be used is illustrated in diagram below. The ART 17 T range is submitted as a zero tailswing machine as shown below.

Once the trailer has been coupled to the host machine, complete a functional brake test.



Area A is ground level & Area B is above ground level swept area boom (drawing based on the ART 17 T range).

STEP	Action / condition	Reference
1.	**Precondition** MEWP in transport position on road; - telescope arm completely retracted, - upper and lower lifting arms completely lowered, - turret in 0° (180°) position, **Action** • Position MEWP on rail track, • Fine position oscillating (fixed) bogie. Oscillating (fixed) bogie rail wheels are positioned above rails.	Manitou operating manual p. 2-55
2.	**Precondition** MEWP in transport position. Turret in 0° (180°) position Oscillating (fixed) bogie rail wheels positioned above rails. **Action** Lower oscillating (fixed) bogie Till rail wheels are in contact with the rail. • Operate switch to lower oscillating (fixed) bogie together with enable button till wheels mesh with rail; - parking brake on both oscillating (fixed) bogie wheels is hydraulically released, - oscillating (fixed) lifting cylinders lower oscillating (fixed) wheel structure, - upper liftings arms, lower lifting arm and telescope are disabled, - bogie not "fully up" is detected. - When lowering oscillating bogie, the oscillating axle is released. (this might cause the bogie to rotate) Oscillating (fixed) bogie rail wheels positioned on rails.	
3.	**Precondition** MEWP in travel mode. Turret in 0° (180°) position Rail wheel brakes engaged. Oscillating (fixed) bogie wheels on rail track. **Action** • Operate turret rotation and revolve 180°; MEWP 180° (0°) opposite to (in) transport position Oscillating (fixed) bogie on rail track **Remark** Clear view on fixed bogie.	

STEP	Action / condition	Reference
4.	**Precondition** MEWP 180° (0°) opposite to (in) travel mode. Rail wheel brakes engaged. Oscillating (fixed) bogie on rail track. **Action** • Fine position fixed (oscillating) bogie (using road wheels) Fixed (oscillating) rail wheels positioned above rails.	
5.	**Precondition** MEWP 180° (0°) opposite to (in) travel mode. Rail wheel brakes engaged. Oscillating (fixed) bogie on rail track. Fixed (oscillating) bogie wheels above rails. **Action** • Operate switch to lower fixed (oscillating) bogie together with enable button Till rail wheels are in contact with the rail; - parking brake on both fixed (oscillating) bogie wheels is hydraulically released - fixed (oscillating) lifting cylinders lower fixed (oscillating) wheel structure - When lowering oscillating bogie, the oscillating axle is released. - As soon as fixed and oscillating bogie not "fully up" is detected: - flashing beacon is disabled. - road tilt sensor deactived Fixed (oscillating) rail wheels positioned on rails. **Action** • Continue operating fixed (oscillating) bogie lifting cylinder till end of stroke; - parking brake on both fixed (oscillating) bogie wheels is hydraulically released. - fixed (oscillating) lifting cylinders lift fixed (oscillating) side of MEWP; fixed (oscillating) wheels rolling over track, oscillating (fixed) wheels braked avoiding the machine to run away. - at end of stroke position is detected. **Action** • Operate the switch to lift fixed (oscillating) bogie lifting cylinder for a short moment, so relieving the pressure in the lifting cylinder. Fixed (oscillating) side fully lifted. Road wheels up. All parking brakes engaged.	

STEP	Action / condition	Reference
6.	**Precondition** MEWP 180° (0°) opposite to (in) travel mode. Fixed (oscillating) side lifted. Rail wheel brakes engaged. **Action** • Operate turret rotation and revolve 180°; turret rotates back to 0° (180°) position. MEWP in travel mode Fixed (oscillating) side lifted Oscillating (fixed) bogie on rail track **Remark** Clear view on oscillating bogie.	
7.	**Precondition** MEWP 180° (0°) opposite to (in) transport position. Fixed (oscillating) side lifted. Rail wheel brakes engaged. **Action** • Put road wheels fixed (oscillating) side in straight position; *green led on basket operating panel Manitou is on.* • Put road wheels oscillating (fixed) side in straight position; *green led on basket operating panel Manitou is on.* Road wheels in straight position (in line with machine).	

STEP	Action / condition	Reference
8.	**Precondition** MEWP in travel mode. Turret in 0° (180°) position Fixed (oscillating) side lifted. Fixed and oscillating bogie brakes engaged. **Action** • Operate oscillating (fixed) bogie lifting cylinder till end of stroke; - parking brake on both oscillating (fixed) wheels is hydraulically released. - oscillating (fixed) lifting cylinders lift oscillating (fixed) side of MEWP; oscillating (fixed) wheels rolling over track, fixed (oscillating) wheels braked avoiding the machine to run away. - at end of stroke position is detected. **Action** • Operate the switch to lift oscillating (fixed) bogie lifting cylinder for a short moment, so relieving the pressure in the lifting cylinder. Vehicle lifted. All parking brakes engaged. 2 Red rail lights on both ends are illuminated automatically.	
9.	**Precondition** MEWP in travel mode. Machine raised. Rail wheel brakes engaged. **Action** • Switch key switch from road to rail operation; - circuit selection valve switched. Road wheel motor disconnected from oil supply. Rail wheel motors connected to oil supply. - working platform released for operation. - upper liftings arms, lower lifting arm and telescope arm are enabled. - Road wheel steering is blocked. - White control light continously ON. MEWP in transport position. Machine raised. **Remark** Road wheel steering is blocked in rail mode to avoid the wheels getting unintended out of the running gauge. It is important to put the road wheels straight (both LEDs on Manitou control panel ON) before switching to rail mode.	

APPENDIX D – CERTIFICATE EN 15746

HHC/DRS Inspecties BV
Kokkel 4A
1723 HX Noord-Scharwoude NL
Tel: +31 226 321 229

NoBo registration.: 1869

TYPE Examination certificate

Certificate number:	**1869/1/SB/2017/EN15746/EN/RP.UK/27204-1/v.1.0**
Date of issue:	5th October 2017
Issued to Manufacturer:	Rail Products UK Mountcairn 22 Cairneymount Road Carluke South Lanarkshire – ML8 4EN
Description of the machine:	Road-Rail MEWP
Type name:	**ART 17 TH**
Host vehicle:	Manitou 160ATJ+RC
Wheel base track:	3410 mm
Wheel diameter:	470 mm
Total weight:	12.300 kg

Scope of examination and Used standard(s):	**EN 15746-1&2:2010 + A1:2011** Railway applications-Track-Road-rail machines and associated equipment: Part 1: Technical requirements for running and working Part 2: General safety requirements
Technical file:	All evidence for compliance with the standard(s)is laid down in the technical file with the following identification: **27204-1 Type examination report v.1.0**

Detailed information as stated in Annex A & B of this document.

Signed by, [redacted]
Certification engineer

Checked by, [redacted]
Certification Manager

HHC/DRS Inspecties BV
Kokkel 4A
1723 HX Noord-Scharwoude NL
Tel: +31 226 321 229

NoBo registration.: 1869

Annex A of Type examination certificate

Description of the machine: Road-Rail MEWP

Type name:	ART 17 TH	
Host vehicle:	Manitou 160ATJ+RC	
Railgear:	Rail Products	
RCI system:	Rail Products / Manitou	
Wheel base:	3410 mm	Wheels: ø 470 mm
Wheel gauge:	1435 mm	
Vehicle category:	9A	
Total weight:	12.300 kg	

Restrictions of use:

This type of machine
- is NOT designed for operating train control/signalling systems;
- is NOT permitted to move over live conductor rail;
- cannot be on/off track in loaded condition;
- may NOT be used on light rail (σ_B < 880 N/mm²).

Maximum speed in travelling mode:	10	km/h
Maximum speed over switch & crossings:	5	km/h
Maximum speed in working mode:	1	km/h
Maximum unbraked trailing load:	525	kg
Maximum braked trailing load:	525	kg

Characteristics off the Infrastructure on which the vehicle can be used*

Maximum track cant in travelling mode:	180	mm
Maximum track cant in working mode, restricted from:	125	mm
Maximum gradient:	40	‰
Maximum gradient on which vehicle can be on/off tracked:	40	‰
Maximum cant on which vehicle can be on/off tracked:	180	mm
Minimum track radius:	80	m

*The vehicle is assessed on these infrastructure parameters as specified by the manufacturer / keeper of the vehicles.
In case of use of other Infrastructures with other characteristics the manufacturer must be informed.
This certificate is only valid within the limits as mentioned above.

This machine is not designed or intended for operating signalling and control systems and is only intended to work and run under special operating conditions specifically designated by the infrastructure manager.

This machine is not intended to be a vehicle as defined in the Interoperability Directive and is not permitted to run on the railway lines open to normal traffic. If this is required, it will need to be authorised or placed into service as set out in the Interoperability Directive 2016/797/EC.

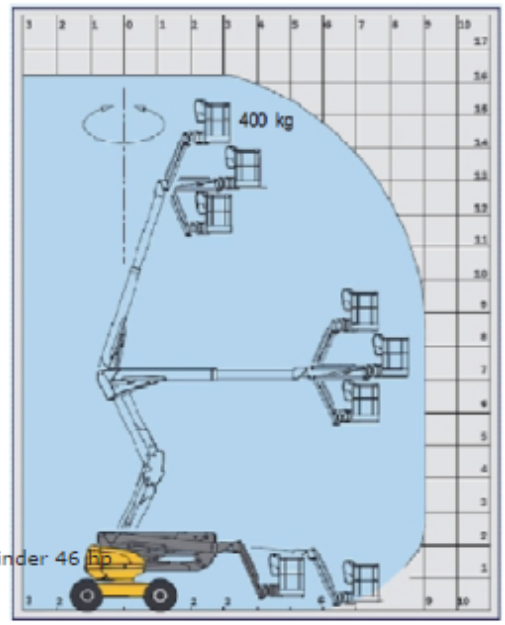
HHC DRS	**HHC/DRS Inspecties BV** **Kokkel 4A** **1723 HX Noord-Scharwoude NL** **Tel: +31 226 321 229** NoBo registration.: 1869	

Annex B of Type examination certificate

Specifications ART 17 TH

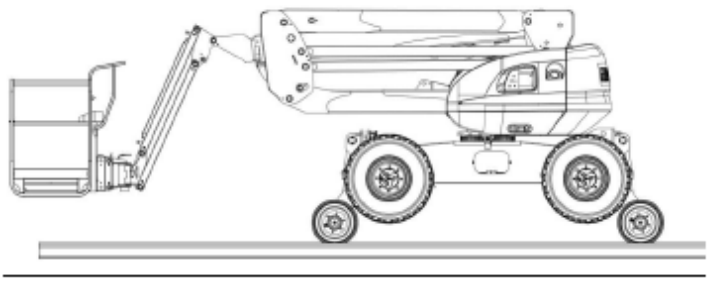
Specifications ART 17 TH on Road

Working height	16.25 m
Platform floor height	14.25 m
Max. outreach	8.95 m
Up and over clearance	7.00 m
Jib movement	+70°/-70°
Basket rotation	+90°/-90°
Turret rotation	360°
Capacity	400 kg
Maximum allowed wind speed wind	45 km/h
Basket size	2.30 x 0.93 m
Lifting time	40 s
Width (overall width with basket)	2.30 m
Length	6.93 m
Length (Travel/transport)	4.94 m
Height	2.37 m
Height (Travel/transport)	2.70 m
Inside turning radius	1.32 m
Outside turning radius	3.68 m
Outside turning radius with basket	6.39 m
Ground clearance	42.5 cm
Wheelbase	2.20 m
Working speed	0,6 km/h
Maximum travel speed	6 km/h
Engine Kubota type	V2403-M, 4 cilinder 46 hp
Grade ability on rough	40%
Max slope accepted	5° or 9%
Hydraulic	120L
Diesel	52L
Weight	12.300 kg



Specifications ART 17 TH on Rail track (1435 gauge)

Working speed	1 km/h
Maximum travel speed	10 km/h
Max. slope accepted	40‰
Max. cant	180 mm = 6,9°
Restrictions	Above 125 mm (=4,8°) cant the telescope arm will be blocked. Driving with turret slewed up to 90° L/R from centre track over fixed axle is possible when telescope arm is fully retracted up to a cant of 125 mm (=4,8°).



APPENDIX E – CERTIFICATE RIS-1530-PLT

ON-TRACK PLANT

ENGINEERING CONFORMANCE CERTIFICATE

This certificate issued in accordance with RIS-1530-PLT Issue 6.

NAME OF CERTIFICATION BODY	ACCREDITATION CODE
AEGIS Certification Services Ltd	**AC**

Machine Class/Description	Rail Products UK ART17 T(H) MEWP (Type 9A)
Vehicle Owner	Morgan Sindall Rail Electrification Ltd
Issue Date	16th March 2018
Expiry Date	16th March 2025

Vehicle Number: **99709 912430-4**

First of Class	No
Certificate Number of First of Class	NS/0067/17

Authorised by: [redacted]
AEGIS PAB Signatory

Official Stamp

Reason for Issue and Scope of Work

Previous Certificate:
None, first approval.

This certificate:
Approval of new build machine.
Maximum radius corrected from 8.65 m given on First of Class ECC to 8.95 m, as per NoBo Type Examination Certificates HHC/DRS_2015_22645_IRP_EN15746-1/2_Issue 1.2 and HHC/DRS_2015_22645_IRP_EN280_Issue 1.2.

Plant Asset Manager Copy **Certificate Number: AC/0014/18**

Deviations Associated with this Certificate

Reference Tracker Number 29075
Title Derogation against clause 5.3.1 c) - Use of 50 metre curve during calculations

Previous Certificate Number: None

Approved Maintenance Instructions

ID No.	Title	Issue No.	Date
P301	ROAD-RAIL MEWP ART 17 T-ART 17 T(H) Operation and Maintenance Instruction.	V6.4	8/12/2016
547408 EN	Manitou Instructions Manual	1	15/05/2012
P02-031-R	User Manual Instrumented Pantograph	0.4	22/06/2015

Machine Data

Gross Mass	12 300 kg	**Gauge**	W6a
Tailswing gauge exceedance	252 mm	**Maximum basket radius**	8.95 m
Software version	1.1		

Approved Values

Maximum number of people	3	**Maximum basket load**	400 kg
Maximum towed load	520.9 kg	**Maximum number of trailers**	1

Approved Track Conditions

	Travelling Mode	Working Mode	On/off-tracking
Maximum gradient	1:25	1:25	1:25
Maximum cant	200 mm	180 mm	150 mm
Minimum curve radius	80 m	80 m	

Approved Maximum Speeds

	Travelling Mode	Working Mode (basket over side)
Plain Line	7.5 mph (12 kph)	1 mph (1.6 kph)
Switches and Crossings	2.5 mph (4 kph)	1 mph (1.6 kph)
Raised check and guard rails	2.5 mph (4 kph)	1 mph (1.6 kph)
During recovery	3 mph (5 kph)	1 mph (1.6 kph)
Towing	2.5 mph (4 kph)	1 mph (1.6 kph)

Limitations of Use

1. This machine is not permitted outside a possession.
2. When in traveling mode, the machine exceeds Plant Gauge. For gauge see Machine Data section of this ECC.
3. Maximum basket payload (see Approved Values section of this ECC) shall not be exceeded.
4. Maximum number of people in basket (see Approved Values section of this ECC) shall not be exceeded.
5. Machine shall not be used in wind speeds exceeding 45 km/h (28mph) (12.5 m/s)
6. For on/off tracking, a site specific plan shall be used taking account of the applicable module of Network Rail Infrastructure Plant Manual NR/PLANT/0200.
7. When travelling in reverse, ground staff shall control movements.
8. The machine will not activate train operated points.
9. The machine shall not be used for any other lifting duties.
10. The machine shall not on/off track, travel or work on live conductor-rail lines.
11. The machine may on/off-track, travel and work on isolated conductor-rail lines.
12. The machine shall not work under live OLE.
13. The machine is permitted to on/off track and travel under live OLE when used in conjunction with a safe system of work.
14. The machine shall not on/off-track or travel under live OLE in areas where the OLE wire height is less than 4.165m.
15. When on/off-tracking or traveling under live OLE:
    - The basket shall be in the locked and stowed position, below 1.4m ARL, using the OLE keyswitch on Base Control. Once in the On/locked position the OLE key shall be removed.
    - There shall be no access onto the RRV except the basket.
    - The earth bonds on the RRV shall be examined for security and presence prior to the start of work.
    - The height of the basket floor shall be confirmed as below 1.4m ARL.
16. When working, the counterweight, articulated boom and basket can be out of gauge. See Machine Data section of this ECC.
17. This machine may be used with adjacent lines open to traffic, only if a safe system of work to be adopted has taken account of gauge exceedance.
18. The machine is fitted with a High Performance Movement Limiting Device. The machine may be used in ALO configurations where a High Performance MLD is required.
19. The slew limiting system is not capable of limiting movement over both sides simultaneously. The vehicle is not permitted to work with both sides adjacent to open lines (island working).
20. The machine shall not work with any adjacent lines open to traffic where the distance between the centre line on which the vehicle is working and the

centre line of any open line is less than 3600mm. This is to account for tailswing gauge exceedance (See Machine Data section of this ECC).

21. The machine shall not work ALO on London Underground Infrastructure.
22. The vehicle encroaches into the area reserved for infrastructure equipment in the lower sector. A site survey shall be undertaken to assess potential damage to infrastructure equipment prior to use.
23. For access/egress, the machine may only operate with the access adjacent to a cess or a line closed to all train movements or the documented safe system of work must take account of adequate safe clearances to adjacent lines.
24. The vehicle is permitted to tow or propel, through couplings fitted on both ends of the machine, a Rail Products UK ATR 450 alu trailer.
25. The maximum number of trailers and maximum towed load given in the Approved Values section of this ECC shall not be exceeded.
26. When towing or propelling, the trailer shall be fitted with an automatic trailer breakaway warning and marker lights, using the pin plugs connected to the machine and trailer.
27. The machine shall not be used on track less favourable than that given in the Approved Track Conditions section of this ECC.
28. The instrumented pantograph measuring device is restricted to 0° and 180° whilst in working mode.

Supplementary Information

1. This machine's first approval was assessed against RIS-1530-PLT issue 6.
2. The machine is a rail-conversion of a road based 4-wheel drive, 4-wheel steer mobile elevating work platform (MEWP).
3. The machine is fitted with foam filled tyres.
4. The machine is fitted with a High Performance Movement Limiting Device. The MLD was approved by Network Rail as High Performance in letter MLD/L054. 'Approval of MLD033', dated 24th July 2014.
5. The machine is fitted with an instrumented pantograph.

Chassis / Serial Number	43133
Fleet Number	MSRE010

Authorised by: [redacted]

AEGIS PAB Signatory

APPENDIX F – TEST AFTER SOFTWARE UPDATE

HHC DRS	**HHC/DRS Inspecties BV** **Kokkel 4A** **1723 HX Noord-Scharwoude NL** **Tel: +31 226 321 229** **NoBo-no. 1869**

REPORT No. 30610-1

On and off tracking test
ART 17 TH(M) (+ PA52)
s.n. 0043161

	Author:	Performance of inspection on site:
Name:	[redacted]	[redacted]
Function:	Certification engineer/inspector	Inspector
Signature:	[redacted]	
Date:	01 – 03 - 2019	01 – 03 - 2019

Inspection

Date:	01-03-2019
Place:	Veghel, The Netherlands
Type:	ART 17 TH
Serial no.:	0043161
Year of construction:	2018
Software version	2.0
Scope of inspection	Pull test during on- off tracking to simulate the on- off tracking on a slope.

Pulling test

Maximum weight machine : 12.700 kg
Slope : 40 ‰

Downward force along the slope : 508 kg
Factor of safety : 1,4

Pulling force for testing : 711 kg → 750 kg

During the on- off tracking procedure on a flat track the machine should remain his position while pulling the machine constantly with 750 kg.

On / off tracking			✓/✖/Ø
Item Nr.	**Action**	**Response**	**Check**
Procedure with software V 2.0			
1	Drive the machine with road wheels to the track	Road mode	✓
2	Position the track wheels above the track	Road mode	✓
3	Start pull test F > 750 kg	Machine not moving; road brakes on	✓
4	Bogies completely down; Pull test > 750 kg	Machine not moving; Rail brakes on	✓
5	Bogies front and rear halfway down; Pull test > 750 kg	Machine not moving; Rail brakes on	✓
6	Front bogie completely down on track, rear bogie up; Pull test > 750 kg	Machine not moving; Rail brakes on	✓
7	Rear bogie completely down on track, front bogie up; Pull test > 750 kg	Machine not moving; Rail brakes on	✓
8	Complete procedure on-tracking under constant pull force > 750 kg	Machine not moving; Rail brakes on	✓
9	Complete procedure off- tracking under constant pull force > 750 kg	Machine not moving; Rail brakes on	✓
Procedure with software V 1.0			
10	Bogies completely down; Pull test > 750 kg	Machine not moving; Rail brakes on	✓
11	Bogies front and rear halfway down; Pull test	Pull force = 300 kg; Machine moves for ca. 1 cm and stops after that. Machine holds his position until pulling force 800 kg	✓

Photos









Conclusion

The on and off tracking procedure of the ART 17 TH can be performed safely on a slope up to 40‰.

The result with V 1.0 was found positive but relays on a good condition of the hydraulic system.

Software version V 2.0 is found more safely than V 1.0.