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Evaluating the Effectiveness of Chosen Maintenance
Strategies for Dedicated Equipment

Plant and Asset AMCA6007

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1 Contents

1 Contents..... i

2 List of figures..... iii

3 Introduction..... 1

 3.1 Introduction to the Business..... 1

 3.2 Aims and Objectives..... 1

 3.3 Regulations, Legislations and Standards..... 2

4 Background: Rolling Road Test Station and Equipment..... 3

 4.1 Overview of the Rolling Road System 3

 4.2 Key Subsystems and Functional Components 3

 4.2.1 Roller Drive System 4

 4.2.2 Exhaust Extraction System..... 4

 4.2.3 Vehicle Positioning Sensors 5

 4.3 Importance of Maintenance for the Rolling Road System..... 6

5 Critical review of current maintenance practices..... 7

 5.1 Overview of Existing Maintenance Management System 7

 5.2 Current Preventive Maintenance Regime..... 7

 5.2.1 24-Month Major Preventive Maintenance..... 7

 5.2.2 Four-Month Calibration and Functional Testing..... 8

 5.2.3 Three-Month Ventilation Safety Maintenance..... 9

 5.3 Critical Evaluation of Current Strategy 10

 5.3.1 Strengths..... 10

 5.3.2 Limitations..... 10

 5.4 Critical Review Summary..... 11

6 Evaluation of Improved Maintenance Practice 12

 6.1 Strategic Direction 12

6.2	Condition-Based Maintenance Enhancements	12
6.2.1	Roller System	12
6.2.2	Belt Drives	12
6.2.3	Extraction Systems.....	12
6.2.4	Sensors	12
6.3	Reliability Centred Maintenance Application	12
6.4	TPM Operator Involvement	13
6.5	OEE Performance Integration.....	13
7	A Consideration of Costs and Resources for Improvements	14
7.1	Existing Cost Position	14
7.2	Cost of Proposed Improvements.....	14
7.3	Financial Benefits.....	14
7.4	Safety and Compliance Value.....	14
7.5	Recourse Requirements	14
7.6	Economic Conclusion.....	15
8	Conclusions/Recommendations.	16
8.1	Short/Medium/Long term Recommendation Roadmap	17
9	References	18

2 List of figures

Figure 1-Rolling Road Test Rig (Purnell-Whitehead, 2026)..... 3

Figure 2- Roller Drive system (Purnell-Whitehead, 2026)..... 4

Figure 3- Extraction ventilation (Purnell-Whitehead, 2026)..... 5

Figure 4-Vehicle Position Sensor (Purnell-Whitehead, 2026)..... 6

Figure 5-Shire, Aston Martin's Computerised Maintenance Management System (Aston
Martin, 2026)..... 7

Figure 6- Shire, Maintenance task (Aston Martin, 2026)..... 9

Figure 7-Shire. Extraction unit task (Aston Martin, 2026) 10

Figure 8-Eight pillars of TPM (Nakajima, 1988) 13

Table 1- Reliability Centred Maintenance strategy (Purnell-Whitehead, 2026) 13

Table 2-Improvement cost (Purnell-Whitehead, 2026) 15

3 Introduction

3.1 Introduction to the Business

Established in 1913 by Lionel Martin and Robert Bamford, Aston Martin Lagonda is a British luxury car manufacture. The St Athan plant in Wales, where the DBX is produced. Currently the use of automation, robotics is limited as it's not a high-volume facility compared to other mass produce motor manufactures.

3.2 Aims and Objectives

Maintenance engineering is essential in ensuring the reliability, safety and operational efficiency of industrial assets. In modern manufacturing environments, maintenance evolved beyond reactive repair activities but has evolved into a strategic function that directly influences productivity, cost control and asset longevity. As defined within maintenance theory, maintenance encompasses all technical and administrative action intended to retain equipment in or restore it to a condition in which it can perform its required function (Kelly, 2006).

The increasing complexity of manufacturing systems, coupled with higher expectations for product quality and process reliability has necessitated the adoption of more advanced maintenance strategies. Traditional approaches such as breakdown and time-based preventive maintenance are increasingly insufficient, particularly for systems characterised by complex and non-linear failure behaviours. Research in reliability engineering demonstrates that many failures are not strictly age relates, thereby limiting the effectiveness of purely scheduled maintenance interventions (Moubray, 1997).

This report focuses on evaluating the effectiveness of maintenance strategies applied to the rolling road test station at Aston Martins. A critical asset used in automotive production and testing environments. The rolling road system enables vehicles to be tested under simulated driving conditions, ensuring compliance with performance, safety and emissions requirements. Due to its role within the production and quality assurance processes, any failure within the system can lead to significant operational disruption, increased costs and potential safety risks.

The aim of this report is to critically assess the current maintenance approach used for the rolling road test station and to evaluate potential improvements based on modern maintenance strategies, including condition-based maintenance (CBM) and reliability-centred maintenance (RCM). The report will also consider the cost implications and practical

feasibility of implementing these improvements, with the objective of enhancing equipment reliability, reducing downtime and improving overall operational performance.

3.3 Regulations, Legislations and Standards

Planned maintenance is undertaken to improve equipment performance, maintain product quality and limit cost. A critical key driver is the range of legal, regulatory and industry requirements that must be adhered to.

1. Health and safety at work act 1974 (HSWA) (HSE, 1974).
2. Provision and Use of Work Equipment Regulations 1998 (PUWER) (HES, 1998).
3. Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) (HSE, 1998).

4 Background: Rolling Road Test Station and Equipment.

4.1 Overview of the Rolling Road System

The rolling road test station, commonly referred to as a chassis dynamometer, is a specialised piece of equipment used to simulate real world driving conditions within a controlled environment. The system allows a vehicle's wheels to rotate on powered rollers while measurements are taken relating to engine performance, drivetrain efficiency and exhaust emissions.

The rolling road station is positioned at a critical stage within the production process meaning that's its availability and reliability have a direct impact on throughput and operational efficiency. Any downtime associated with the equipment can result in production delays, increase operational cost, and potential bottlenecks within the manufacturing system.

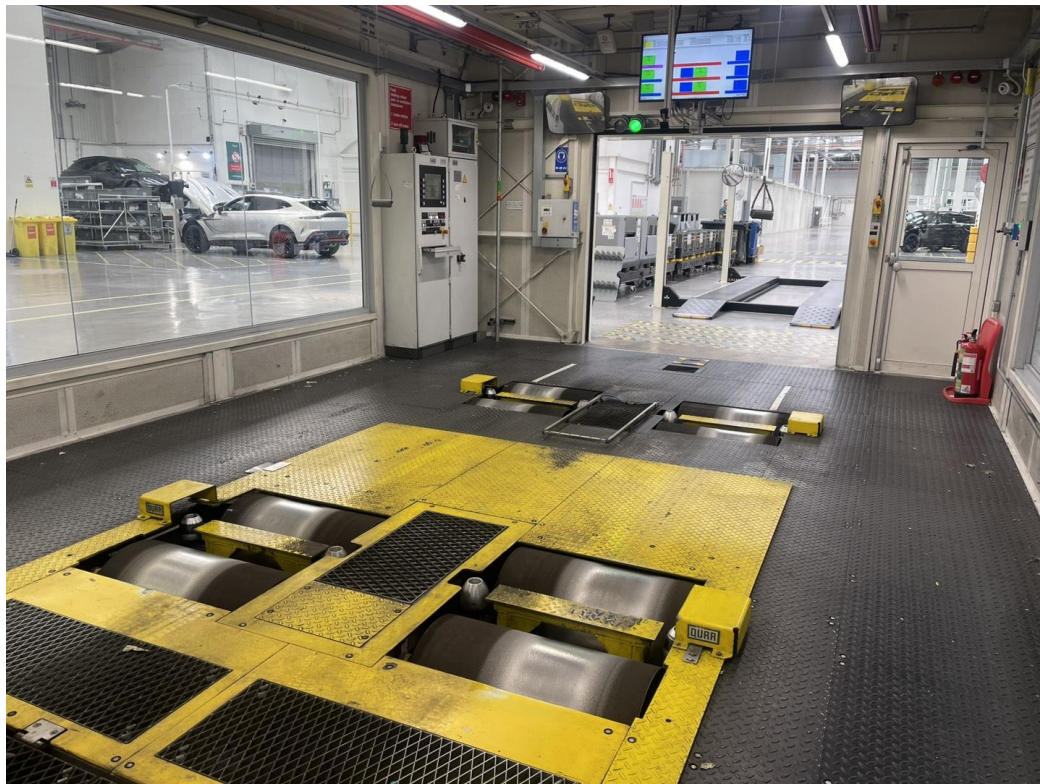


Figure 1-Rolling Road Test Rig (Purnell-Whitehead, 2026)

4.2 Key Subsystems and Functional Components

The rolling road test station consists of several integrated subsystems, each of which performs a specific function and exhibits distinct failure characteristics.

4.2.1 Roller Drive System

The roller drive system forms the core of the rolling road and is responsible for simulating road conditions by rotating under the vehicles driven wheels. This system comprises of mechanical rollers, bearings, and drive motors.

From a reliability perspective, the roller system is subject to both wear-out and random failure mechanisms. Bearings for example are prone to degradation over time due to fatigue and lubrication breakdown (Halme & Andersson, 2009), while motor failures may occur unpredictably due to electrical or thermal stresses. Such failure patterns align with reliability models, where components may exhibit early, random or wear-out failures depending on operating conditions

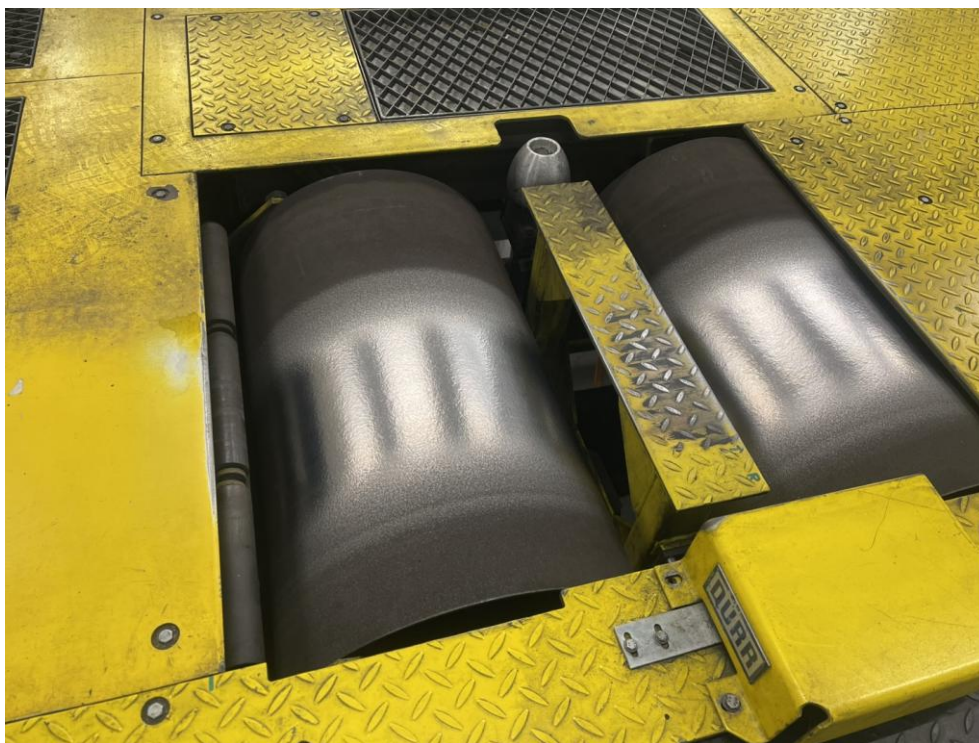


Figure 2- Roller Drive system (Purnell-Whitehead, 2026)

4.2.2 Exhaust Extraction System.

The exhaust extraction system is a critical safety subsystem designed to remove harmful exhaust gases generated during testing. The rolling road station cell contains a deployable extraction vent, ventilation fans ducting and filtration units.

Failures within this system, such as a fan malfunction leakage or blockage of the ducting system can have a significant safety and environmental consequences. Within the framework of reliable engineering, such failures are categorised as high-consequence

events, as they directly impact other safety and regulatory compliance. Consequently, maintenance strategies for this subsystem must prioritise reliability and risk mitigation rather than purely cost considerations.



Figure 3- Extraction ventilation (Purnell-Whitehead, 2026)

4.2.3 Vehicle Positioning Sensors

Positioning sensors are used to ensure that the vehicle is correctly aligned on the rollers prior and during testing. Typically, these sensors include proximity sensors, optical sensors or laser-based alignment systems.

Sensor systems are typically characterised by random failure behaviour, often resulting from electrical faults, signal degradation or calibration drift (ElHady & Provost, 2018). Unlike mechanical components, these failures are not strongly correlated with operating age, which limits the effectiveness of time-based preventive maintenance. Instead, condition monitoring and diagnostic tests are more appropriate approaches for managing such systems.

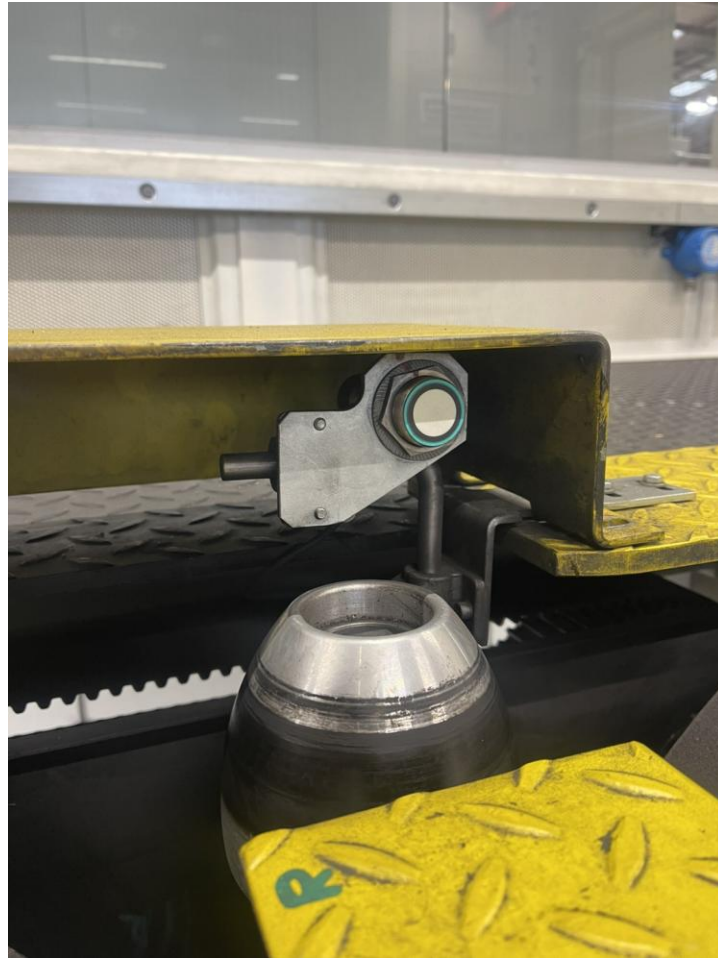


Figure 4-Vehicle Position Sensor (Purnell-Whitehead, 2026)

4.3 Importance of Maintenance for the Rolling Road System.

The rolling road test station represents a high-value, high-impact assets, where maintenance effectiveness directly influences operational performance. Maintenance contributes to:

- Increased equipment reliability and availability
- Improved product quality and testing accuracy
- Enhanced safety for operators
- Reduced operational lifecycle costs.

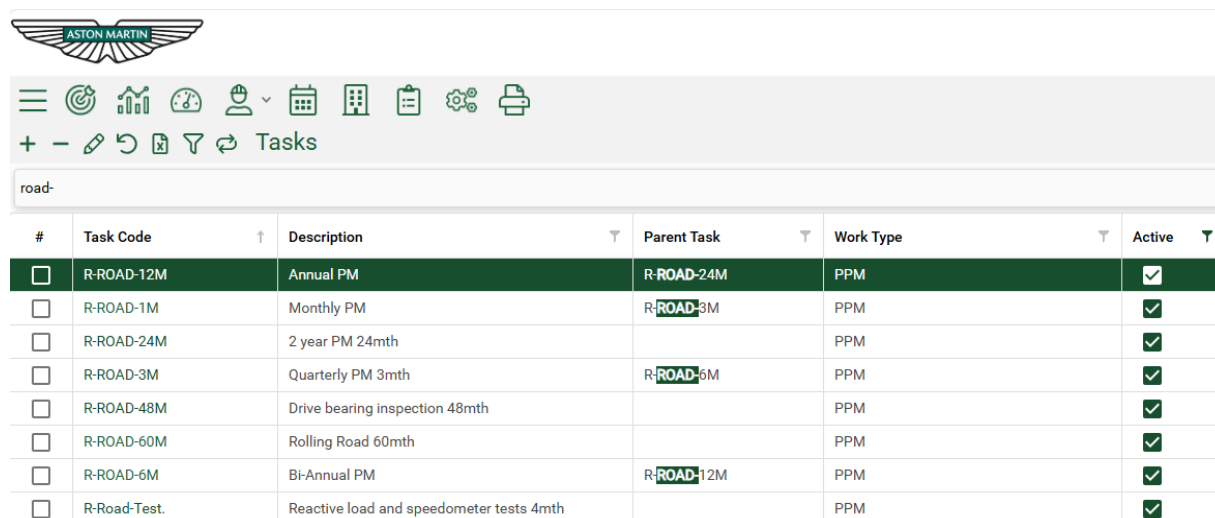
Furthermore, performance metrics such as Overall Equipment Effectiveness (OEE) can be used to evaluate the effectiveness of maintenance strategies by measuring availability, performance efficiency and quality output. (Corrales, et al., 2020)

Given the critical role of this equipment within the production process, an optimised maintenance strategy is essential to minimise downtime, reduced costs and ensure consistent operational performance.

5 Critical review of current maintenance practices.

5.1 Overview of Existing Maintenance Management System

The rolling road test station is maintained through a structured Computerised Maintenance Management System (CMMS) Shire, which is used to manage planned, reactive corrective, proactive and breakdown maintenance activities. This demonstrates that the organisation already operates a formalised maintenance framework rather than relying on ad hoc repair activity. (Smith & Hawkins, 2014) Suggests a 50% reduction in maintenance costs through preventive maintenance. The use of a CMMS is beneficial because it improves scheduling work, work-order control, historical record keeping and maintenance traceability.



#	Task Code	Description	Parent Task	Work Type	Active
☐	R-ROAD-12M	Annual PM	R-ROAD-24M	PPM	☒
☐	R-ROAD-1M	Monthly PM	R-ROAD-3M	PPM	☒
☐	R-ROAD-24M	2 year PM 24mth		PPM	☒
☐	R-ROAD-3M	Quarterly PM 3mth	R-ROAD-6M	PPM	☒
☐	R-ROAD-48M	Drive bearing inspection 48mth		PPM	☒
☐	R-ROAD-60M	Rolling Road 60mth		PPM	☒
☐	R-ROAD-6M	Bi-Annual PM	R-ROAD-12M	PPM	☒
☐	R-Road-Test.	Reactive load and speedometer tests 4mth		PPM	☒

Figure 5-Shire, Aston Martin's Computerised Maintenance Management System (Aston Martin, 2026)

This is a significant strength, as many maintenance inefficiencies arise from poor planning and lack of historical data (Crain, 2003). The presence of structured maintenance records provides a sound foundation for future optimisation and predictive maintenance development.

5.2 Current Preventive Maintenance Regime.

The rolling road station currently operates a multi-layered preventive maintenance programme based on fixed maintenance intervals.

5.2.1 24-Month Major Preventive Maintenance

The most intrusive planned maintenance activity occurs every 24 months and includes:

Mechanical activities:

- Roller bearing relubrication
- Bearing grease replacement

- Belt inspection and tension adjustment
- Roller coating inspection
- Guide lubrication and clearance check.

Electrical/Safety Activities:

- Emergency stop circuit testing
- Cooling unit servicing
- Screw connection checks

Sensor/Controls:

- Cleaning proximity sensors
- Cleaning ultrasonic vehicle detection sensors

Environmental/Extraction:

- Filter replacement
- Cleaning extraction telescopes, adaptors and oil pans

This indicates a comprehensive OEM-aligned preventive maintenance program focused on reliability preservation.

5.2.2 Four-Month Calibration and Functional Testing

Every four months, the station undergoes:

- Roller speedometer calibration
- Warm-up cycles
- Dynamic force calibration testing.

This is particularly significant because it demonstrates that maintenance is not limited to physical asset care but also includes performance assurance and measurement accuracy, both of which are critical for a test facility.



Task Details

Task Instructions

Tests / Instructions

Parts for Task

Where Used

Documents

Actions

Task Details - R-Road-Test.

Task Details

Task Code

R-Road-Test.

Click this button to add a picture

Task Description

Reactive load and speedometer tests 4mth

Parent Task

Work Type

PPM

Repeat Type

Manual

Repeat Every

4

Months

Estimated Man Hrs

Hours

Mins

Priority

3. Standard Priority

☐ Available on Work Request
☐ Downtime Mandatory on Work Order
☐ Available on Mobile (Pro)

Trade

Assigned To

Asset Category

Override WO Format

Email Notification To

Location (security)

Aston Martin/St Athan

Figure 6- Shire, Maintenance task (Aston Martin, 2026)

5.2.3 Three-Month Ventilation Safety Maintenance

The environmental extraction system receives quarterly maintenance, supported by specialist contractors who perform a smoke clearance test to validate safe extraction performance and rig entry conditions.

This reflects a strong compliance with health and safety requirements (HSE, 1974).

As the skillset is not internally available, having contractors who are specialist in this field to carry out the maintenance is crucial when health and safety is the key driver.



TASK DETAILS

TASK INSTRUCTIONS

TESTS / INSTRUCTIONS

PARTS FOR TASK

WHERE USED

DOCUMENTS

Actions

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⏵

Task Details - R-ROAD-3M

Task Instructions

Task Instructions

1 - Extraction unit. - Remove all carbon filters (6 off) and replace with new or clean. Clean removed filters for future use or inform Group Leader if new are required

2 - Environmental system. - remove oil and dirt residue from the extraction adaptor and oil pans. Ref:14.4.6.1 OEM

3 - Environmental system. - Remove all dirt residue and thoroughly clean the extraction box and telescopes. Ref:14.4.6.1 OEM

4 - Vehicle detection - Clean ultrasonic sensors

5 - Pneumatics - Check condensate tank and empty if necessary

6 - Pneumatics - Check for leaks

Safety Instructi...

Figure 7-Shire. Extraction unit task (Aston Martin, 2026)

5.3 Critical Evaluation of Current Strategy

5.3.1 Strengths

- 1. Highly structured maintenance control-** The use of Shire indicates mature maintenance planning and control.
- 2. Strong Preventive Maintenance-**The maintenance regime addresses mechanical, electrical, safety and environmental system comprehensively.
- 3. Safety-Critical Awareness-**Quarterly smoke testing demonstrates strong management of high-consequence failures.
- 4. OEM support-**The use of Durr for servicing and repairs provide specialist expertise.

5.3.2 Limitations

1. Heavy reliance on Time-Based Maintenance

Many tasks are fixed interval rather than condition based. This may lead to, premature servicing, unnecessary component replacement, Increased labour cost (Ahmad & Kamaruddin, 2012)

2. Limited Predictive Analysis

Although calibration data is collected, there is limited evidence of trend analysis for:

- Bearing deterioration
- Belt degradation
- Extraction efficiency decline

3. Intrusive major shutdowns

The 24-month overhaul is extensive and may require significant downtime. To limit disruption, the major overhauls are planned during the 2-week summer shut down where production is on stop.

4. Dependence on External OEM support

Reliance on Durr may increase cost and reduce response flexibility.

5.4 Critical Review Summary

The existing maintenance is significantly stronger than a basic preventive programme and reflects a professionally managed industrial asset. However, it remains primarily time based rather than data-driven, creating opportunities for optimisation through predictive and reliability centred maintenance which studies suggest can decrease unplanned downtime (Thomas & Weiss, 2021).

6 Evaluation of Improved Maintenance Practice

6.1 Strategic Direction

Given the maturity of the existing maintenance regime, improvement should focus on enhancing current systems rather than replacing them. The optimal strategy is a hybrid model integrating Condition based maintenance (CBM), Reliability-centered maintenance (RCM), Total productive Maintenance (TPM) and existing CMMS planning controls.

6.2 Condition-Based Maintenance Enhancements

CBM is a preventative maintenance strategy where maintenance actions are carried out based on the actual condition of equipment rather than at fixed time intervals. It uses condition monitoring techniques such as vibration, temperature, oil analysis, noise or sensor data to detect early signs of wear or failure. This allows maintenance to be performed only when needed, helping reduce unnecessary servicing, lower costs, minimise downtime and prevent unexpected breakdown (Ahmad & Kamaruddin, 2012).

6.2.1 Roller System

Install permanent monitoring for vibration, bearing temperature and the motor current signature. This would allow bearing or alignment faults to be detected before scheduled shutdown.

6.2.2 Belt Drives

The use of belt tensioning sensors, thermal monitoring and acoustic analysis may extend the replacement intervals where wear is low avoiding unnecessary replacement of components.

6.2.3 Extraction Systems

Introduce airflow trending, fan vibration monitoring and filter differential pressure monitoring. This would replace some manual inspection tasks with measurable performance indicators.

6.2.4 Sensors

Introduce automated self-diagnostics for ultrasonic sensors, proximity switches and communication faults.

6.3 Reliability Centred Maintenance Application

Reliability engineering principles should be used to classify failure by consequence (Geisbush & Ariaratnam, 2023). This prevents over maintenance of low-risk items while protecting critical systems. See table 1 for an example strategy for the rolling road station.

Table 1- Reliability Centred Maintenance strategy (Purnell-Whitehead, 2026)

Failure Mode	Consequence	Strategy
Exhaust extraction failure	Safety	Predictive + immediate action
Roller bearing wear	Operational	CBM
Sensor fault	Quality	Diagnostic monitoring
Cosmetic cover damage	Low	Run-to-failure

6.4 TPM Operator Involvement

Operator to perform daily checks. Checks could include unusual roller noise, extraction system damage, sensor contamination and any abnormal vibrations during the process routine. This could help create earlier fault detection and/or prevention between formal PM intervals. TPM Maintenance Prevention activity pushes reliability and performance improvement opportunity from the factory floor to equipment (Nakajima, 1988).

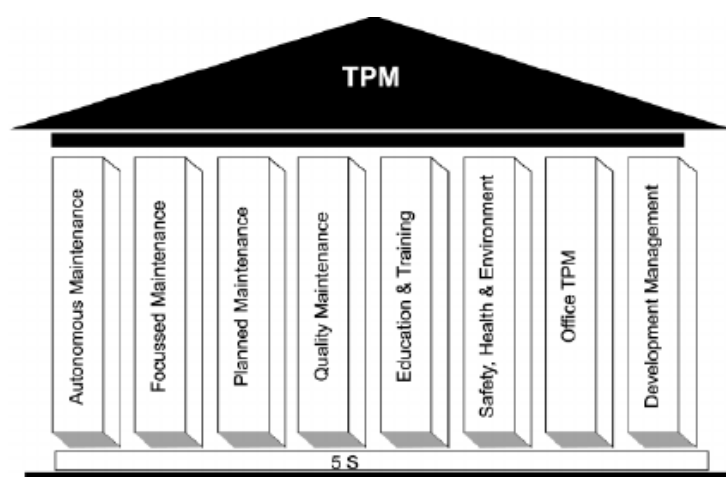


Figure 8-Eight pillars of TPM (Nakajima, 1988)

6.5 OEE Performance Integration

Use OEE metrics:

- Availability = Station uptime
- Performance = Test throughput rate
- Quality = Calibration pass rate/valid test completion.

This in turn will link maintenance directly to business performance.

7 A Consideration of Costs and Resources for Improvements

7.1 Existing Cost Position

The current maintenance strategy includes significant planned maintenance expenditure. However planned work is generally considered lower cost than reactive work. Breakdown maintenance can cost approximately three times planned intervention when downtime, emergency labour and disruption are included (Weidner, 2023).

7.2 Cost of Proposed Improvements.

Introducing CBM and predictive tools requires an initial capital investment. For the rolling road test station, typical industry cost is:

- Vibration and temperature sensors: £300-£600 per point
- Airflow and differential pressure sensors for extraction: £800-£1,200
- Data acquisition and dashboard integration: £5,000-£10,000

7.3 Financial Benefits

Reduced downtime: Due to earlier detection of faults would see a reduction in catastrophic failures and major station stoppages.

Lower Overhaul Costs: Some intrusive 24-month tasks may be deferred or targeted based on condition.

Reduced OEM Dependence: Improved internal diagnostics can reduce reliance on contactors such as Durr.

Increased throughput: Higher availability improve vehicle testing capacity.

7.4 Safety and Compliance Value

The extraction system is safety critical. Avoiding a ventilation failure may prevent unsafe operator exposure to harmful emissions, halted operation, investigation costs and reputational damage. These benefits are difficult to quantify but strategically important.

7.5 Recourse Requirements

Should improvements in the vibration and condition-based monitoring be introduced. Maintenance technicians would require training for the new systems as the concept is not widely used across the production site, although there are other departments such as the paint shop who have begun to introduce similar technology. After installation, there are contractors offsite currently monitoring the assets.

Further development of the Shire reporting software would need development to be capable of integrating the improvements and feeding into the current maintenance operations. PM frequencies of the process would also need to be revised using actual failure history.

7.6 Economic Conclusion

Because the organisation already has strong maintenance baseline, returns will come from optimisation rather than transformation. The most cost-effective strategy is selective predictive monitoring on critical assets while keeping structured planned maintenance. This minimises capital spend while delivering measurable gains in reliability, availability and maintenance efficiency.

Using estimated industry cost a table 2 shows improvement costs:

Table 2-Improvement cost (Purnell-Whitehead, 2026)

Cost / Benefit Category	Estimated Value
Initial investment	£15,000–£25,000
Annual operating cost	£2,000–£4,000
Downtime avoided (per event)	£6,000–£24,000
Overhaul cost reduction	£2,000–£5,000 per cycle
Reduced OEM call-outs	£2,000–£4,000 per year
Throughput efficiency gains	£3,000–£6,000 per year
Safety incident avoidance	£50,000+ (high-impact, low-frequency)

Under conservative assumption, a return on investment would be seen with 12-18 months, with additional annual savings. This demonstrates that predictive enhancements are not only technically beneficial but also financially compelling, especially for a single point failure asset like the rolling road station.

8 Conclusions/Recommendations.

Several strengths were identified within the current system. These include strong planning discipline, regular calibration activities, clear attention to safety-critical ventilation performance, and use of digital management systems. These practices significantly reduce the likelihood of unmanaged breakdowns and contribute positively to station reliability and operational continuity.

However, the report also identified limitations. The current maintenance philosophy remains predominantly time-based, meaning many tasks are performed at fixed intervals regardless of actual equipment condition. While effective for some wear related components, this can create over maintenance, unnecessary downtime and inefficient use of labour and spare parts (Mobley, 2004). In addition, there is limited evidence that collected calibration or maintenance data is being fully exploited for predictive analytics or trend-based decision making.

The evaluation of improved strategies showed that the most effective future approach is an integrated maintenance model combining:

- Condition-based Maintenance (CBM) for bearings, belts, motors and extraction performance
- Reliability-centered Maintenance (RCM) for prioritising failures by consequence
- Total Productive Maintenance (TPM) through operator checks and early defect reporting
- Continued use of structured CMMS planning through Shire

This approach would enable the organisation to evolve from a strong preventive maintenance system into a more efficient and data driven predictive maintenance environment.

From a cost perspective, full replacement of existing maintenance strategy is neither necessary nor economically justified. Instead, selective optimisation of critical assets offers the best return on investment by reducing downtime, improving asset utilisation, lowering dependence on emergency intervention and maintaining safety compliance.

Long term recommendations would be to transition into a predictive maintenance strategy using collected data and historical failures to dynamically schedule maintenance based on asset health (Hashemian, 2011).

Additionally implementing OEE monitoring. Availability × performance × Quality to quantify how maintenance improvements affect business performance.

Overall, it can be concluded that the rolling road station already benefits from a strong maintenance foundation, but significant gains in reliability, efficiency and cost effectiveness can be achieved through targeted predictive enhancements.

8.1 Short/Medium/Long term Recommendation Roadmap

Short Term

- Improve fault data recording in Shire
- Introduce operator daily checks
- Monitor downtime and failure trends

Medium term

- Install vibration and airflow sensors
- Review PM intervals using historical data
- Train internal staff in predictive maintenance methods

Long Term

- Move towards predictive maintenance
- Use OEE to monitor performance
- Reduce reliance on external OEM support where possible

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