NSW GOVERNMENT

NO MATTER WHAT YOU DO,
SAFETY STARTS WITH YOU.

GUIDE TO INSPECTING AND MAINTAINING PLANT

SAFEWORK NSW

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INTRODUCTION

This guide provides duty holders, including the controllers of plant and service providers, with information on the inspection, testing and maintenance of plant in general. SafeWork require details of records of inspections and maintenance of complex plant where the condition of the plant plays a major role in safe operation to be in line with the guidance provided. These plant include;

- Mobile Elevating Work Platforms (MEWP)
- Tower cranes
- Mobile cranes
- Concrete placing equipment
- Amusement devices
- Building maintenance units
- Mast climbing work platforms
- Passenger ropeways
- Powered gantry and bridge cranes
- Personnel hoists
- Materials hoists.

The inspection, which includes testing and maintenance of plant, plays a significant role in its safe operation and can be compared to the inspection and maintenance of a passenger vehicle by a competent person at the intervals nominated by the manufacturer.

A lack of inspection and subsequent maintenance, or improper repairs, has contributed to incidents that have resulted in serious injuries and deaths.

Persons conducting a business or undertaking have obligations under the Work Health and Safety (WHS) legislation to ensure, so far as is reasonably practicable, workers and other people are not exposed to health and safety risks arising from the business or undertaking. The inspection, testing and maintenance of plant, where required, is an important part of meeting this obligation.

Details of observations during inspection and the nature of failures are essential for planning for general maintenance, repair work and finding the cause of unusual failures.

Detailed records of inspection, testing and maintenance should be kept to:

- demonstrate the PCBU has been diligent, particularly if the plant was involved in an incident
- determine the trends and causes of premature or unusual failures
- determine the integrity of previous inspections, if necessary
- plan repairs and future inspections.

In this document, ‘safety critical’ or ‘safety system’ mean the failure or malfunction of a part or system that would increase the risk of injury to persons.

CAUSES OF FAILURE

Many failures of components can be attributed to corrosion, wear, overloading, fatigue or combination of these. Loose or missing fasteners, poor adjustment or poor lubrication can also contribute to these failures.

Corrosion

Corrosion in most places can be readily detected or prevented. Corrosion can reduce the fatigue failure time.

Wear

Components that wear should be inspected as recommended by the manufacturer or competent person, and repaired when necessary. Manufacturers provide maximum recommended inspection intervals and wear limits for many components.

Overloading

Exceeding the plant's rated capacity can most effectively be prevented by including engineering controls within the design of the plant to prevent or minimise the likelihood of overloading (e.g. platforms of some MEWPs cannot be raised if it has a load that is over the rated capacity – this is an engineering control). In all cases it is essential to only operate the plant within its capacity in accordance with the manufacturers' recommendations. A single instance of overloading can damage the plant or lead to premature failure as overloading can reduce fatigue life.

Fatigue

Fatigue failure occurs due to many reasons that include the number of load stress cycles, the amplitudes of stress cycles, shape and defects of the material. The maximum stress in this context is less than the stress required to permanently deform. Determining intervals for inspecting for fatigue, e.g. the presence of cracks is more difficult as the impact of contributing factors cannot be accurately estimated. Fatigue life is the number of stress cycles before the item suffers a failure.

WHY INSPECT

The main aim of inspections is to detect signs or causes for potential failure of components before they fail or become not fit for use.

Findings during inspections will allow repairing the deteriorating components immediately, scheduling to repair or determine if the plant is safe to use until the next inspection.

WHAT TO INSPECT

Inspections should as a minimum cover safety critical components, safety systems and whether operational control and safety systems function as designed. Although manufacturers normally provide inspection requirements for most of these, should these be missing or determined to be inadequate the inspection requirements should then be developed by a competent person.

Inspections should include:

- list of parts and systems that should be inspected based on manufacturer's recommendations. A competent person may prepare the list if manufacturer's recommendations are not available or they are inadequate
- identifying any modifications to safety critical components or systems that deviate from the manufacturer's specifications
- identifying worn parts
- identifying damage to items such as tyres, structural components and hydraulic hoses
- identifying abnormalities or defects - oils leaks, discolouration, cracks, unusual noises and vibrations
- checking fluid levels and greasing
- whether items or systems function as designed
- making adjustments as required
- replacing items or fluids as required – manufacturers may recommend replacing some items after a certain time period or hours of use irrespective of the condition
- assess for continued safe use, taking account of past and possible future use

- identifying loose or missing components including safety critical fasteners
- insulation damage (insulated MEWPs)
- whether any manufacturers' recommended safety upgrades have been done
- data plates, placards and warning labels are in place and legible.

WHEN TO INSPECT

Inspecting, testing, maintaining and repairing should be done in accordance with the manufacturer's instructions. If these are not available or if the recommendations are found to be inadequate, then in accordance with the recommendations of a competent person. The competent person preparing the instructions must consider the relevant information including the requirements of relevant technical standards and the following:

- components of equipment have finite lives; some have a longer life than others. Life expectancy may not be directly related to calendar periods, but a combination of time, type of material and usage.
- intervals of inspections can vary from daily to several years. Inspection intervals for most components are based on hours in operation which relates to number of stress cycles the components have gone through. In general, the useful lives of items that contain perishable material such as rubber, oil or material with similar characteristics are time based.
- road conditions and the distance travelled by vehicle plant, or those that are transported on road, would contribute to accelerated wear and tear of the plant's components.
- items such as seals may have a shorter life when used infrequently due to lack of lubrication.
- the frequency of inspections recommended by the manufacturers may have to be increased when operating in harsh conditions, for example, a corrosive, dusty, hot or cold environment.

It is not necessary to inspect plant that is not in service. Measures should be undertaken to protect the plant from the environment during long term storage. Before returning the plant to service, it should be inspected and all safety and operating systems inspected and tested. Any identified malfunctions or related problems should be rectified before use.

HOW TO INSPECT

Inspections include simple visual observations, functional testing, testing or measuring against acceptance criteria and identifying defects such as damage or corrosion, which may not be specifically included in the list of items to be checked. Manufacturers may not be able to prescribe all possible defects or be able to prescribe criteria for their acceptance.

The method of inspection or testing should suit the scope of the inspection. Inspection of some items may be subjected to more than one criterion. For example, the activation of controls should result in the movement in the corresponding actuator and the control lever should return to its off position when released.

One type of inspection is no less important or effective than the other. For example, visual pre-operation inspection could detect a crack on a structural member or an oil leak that can deteriorate quickly, spray oil onto a hot surface causing a fire.

Some items can only be inspected after dismantling. These include items such as pins, bushes, wear pads inside telescoping booms, or internal areas subject to corrosion including joints between fibreglass and steel, gearboxes and brakes. The amount of wear on pins, bushes or slew bearings need to be measured to see if they are within acceptable limits for continued safe use.

WHO SHOULD UNDERTAKE INSPECTIONS

Inspections should be undertaken by a person who is competent to do so. A competent person is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.

The principal competent person managing the inspection should:

- have sufficient knowledge to oversee, where necessary, competent persons undertaking related specialist work, understand their reports including whether they contain all the necessary information.
- have sufficient knowledge of the requirements for the model being inspected so that the inspection can be undertaken as required.
- be aware of the relevant safety information including safety bulletins from the manufacturer and other safety publications. These should be incorporated into the inspection program and documented.

A competent person should be able to demonstrate that they possess these attributes.

MONITORING & TESTING

CONDITION MONITORING

Condition monitoring is the monitoring of a parameter such as magnitude of vibration or temperature. Changes in the parameters could indicate the condition of the items. Analysis of data trends would assist in maintenance scheduling.

Examples of condition monitoring include:

- testing engine gearbox or hydraulic oil for metal particles which indicates the condition of the mating parts. This information is used to help schedule maintenance before the engine suffers a failure.
- trends of vibration characteristics of bearings measured periodically could show the remaining life of the item or it is misaligned.

It is not practicable to use continuous condition monitoring in all situations.

NON-DESTRUCTIVE TESTING

Non-Destructive Testing (NDT) is a method of testing that includes ultrasonics, magnetic particle testing or radiography that can be used to supplement other inspection techniques such as visual inspection. NDT is used when:

- detecting cracks in welds and parent metal of welded components
- measuring the wall thickness of components subject to corrosion or wear
- detecting cracks in pins and shafts subject to fatigue – particularly where there is a change in the geometry of, for example, the pin or shaft that may result in stress concentrations.

Not all NDT techniques are suitable in every situation and NDT does not generally replace other types of inspections, such as looking for cracks during pre-operational or routine inspections.

Before performing NDT, it is necessary to establish the purpose of the inspection. Critical components and areas, and the acceptance criteria must be nominated by the competent person and should be documented on an illustration or photograph. The appropriate technique must be nominated. The NDT technician should follow the instructions and record the results of every inspection performed. The technician should identify any test restrictions (e.g. lack of access, surface discontinuity due to poor weld profile, cutting or grinding) that may limit the ability to perform the NDT, and the problem should be remedied if possible.

NDT should also form part of the quality assurance process which is commonly known as qualification of a repair, when appropriate.

REMAINING LIFE

An assessment of remaining life could be applied to a component, an assembly or the whole plant.

It is not easy to determine the remaining fatigue life of some components, particularly those subjected to unknown or non-uniform stress amplitudes and frequencies. In general, it is very unlikely machines have been designed to avoid fatigue failures as all operational conditions are not known to the designer. Older machines, those that are used more intensively, or subject to harsh operating environments need to be inspected more frequently and some components may need replacing more frequently than originally recommended by the manufacturer.

As the fatigue life is limited, older machines that have undergone a large number of stress cycles come closer to their fatigue life. It is important to note that increasing inspections, including NDT, will not improve the fatigue life and it is necessary to establish whether the plant should remain in service.

Regular inspections of critical components must be undertaken as frequently as needed – daily, weekly monthly and annually to detect early signs of failure.

INSPECTION TYPES

Most examples and illustrations in the guide are based on MEWP but all or parts of guidance can be used for most types of plant. The Australian Standards (AS2550 series) on safe use also provide useful information.

To keep record sheets neat, use templates that include all items relevant to the model or to cover a range of similar models.

Generally, the following types of inspections should be undertaken:

I. Pre-operational inspection

II. Routine inspection and maintenance

III. Periodic inspections

IV. Major inspection—required for plant not subject to a periodic inspection regime. Major inspections should not be considered as a substitute for other inspections

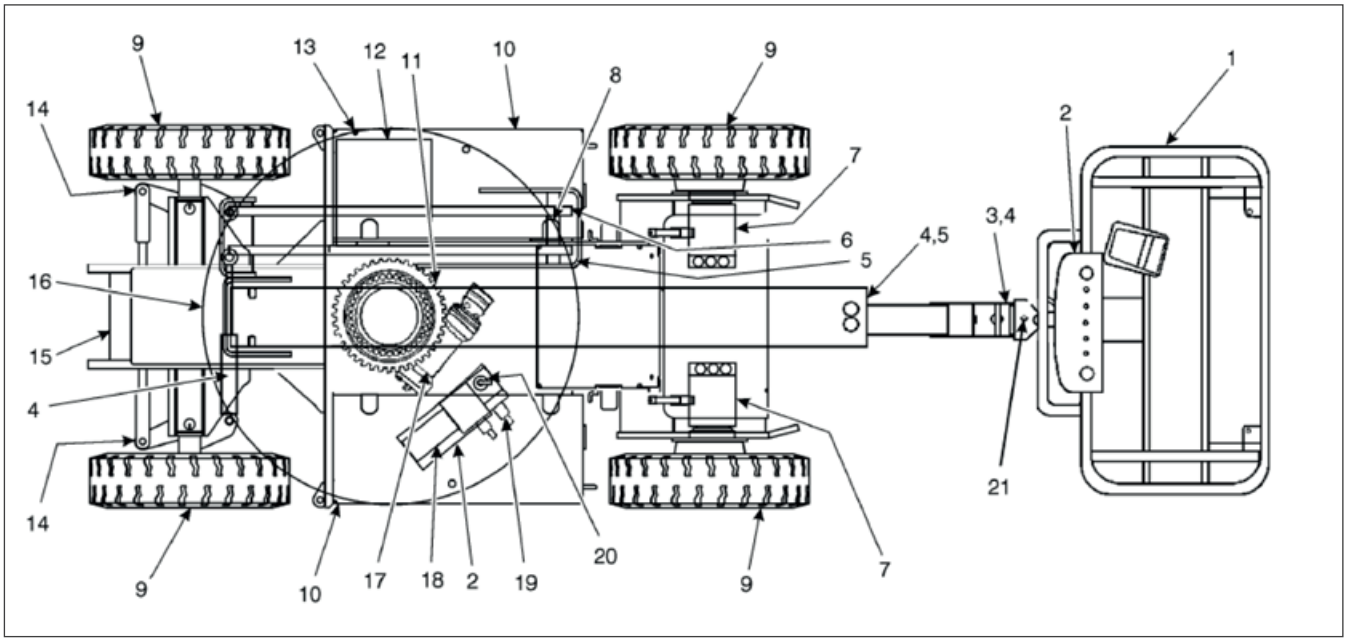
V. On-ground inspection – Inspections on plant such as tower cranes before being installed at another site.

PRE-OPERATIONAL INSPECTION

Pre-operational inspections are generally visual inspections and functional verification. These are conducted at the beginning of each shift for obvious faults (anomalies) and to confirm the plant's correct functioning of controls and travel limits. These inspections should also include detection of damage, tyre pressures, oil leaks, and oil levels.

Pre-operational inspections should be undertaken by persons familiar with the operation and maintenance of the particular model of plant e.g. suitably trained and experienced operators.

Preparation of a diagram like the illustration shown below or marking the inspection points clearly on the plant would assist in training, and when undertaking pre-operational checks and auditing inspection items.



A list of typical items to be inspected during pre-operational inspections is included in Appendix A. This is not an exhaustive list, so the items to be inspected should be based on manufacturer's recommendations.

ROUTINE INSPECTIONS

Routine inspections and maintenance are normally based on usage.

Routine inspections should be undertaken in accordance with manufacturer's recommendations but at least every three months. Routine inspections generally involve:

- dismantling some components to enable proper inspections
- removing covers of certain items
- review of logbook entries, for example, quality of previous records, identification of issues relating to pre-operational inspections or reasons for abnormal repairs
- availability of operator's manuals
- condition of signage and decals
- lubrication and necessary adjustments
- function testing
- torque checking (critical fasteners).

A written report should be provided to the person(s) in control of the plant.

A list of typical items to be inspected during routine inspections is included in Appendix B. This is not an exhaustive list, so the items to be inspected should be based on manufacturer's recommendations.

PERIODIC INSPECTIONS

Periodic inspection should be carried out in accordance with the manufacturer's recommendations. The intervals of inspections are usually based on usage in hours subject to a maximum time period, typically one year. Irrespective of the manufacturer's recommendations periodic inspections should be undertaken annually but not later than every 13 months.

Components that are recommended to be inspected at intervals more than 12 months, and which usually require a greater level of intervention, should be inspected at intervals recommended by the manufacturer.

The competent person inspecting the plant should:

- identify safety critical components as recommended by the manufacturer, or a competent person if manufacturer's recommendations are not available or found to be inadequate
- identify any issues raised in manufacturer's service bulletins and verify that they have been appropriately addressed or rectified
- identify and address any issues raised in other relevant safety publications
- use a method of inspection as recommended by the manufacturer or competent person
- assess the condition of items against the recommended acceptance/rejection criteria, and obtain a quantitative measurement where possible. Criteria may be obtained from the manufacturer, component supplier, relevant technical standards or accepted industry practice. The criteria and findings against criteria should be recorded in the inspection report
- recommend actions to be taken, for example repair immediately, or repair within 6 months providing justification for the time period.
- review logbook entries, for example:
  - for adequacy and clarity of details with respect to what has been done, found and recommended actions from the last periodic inspection
  - analyse and determine if the causes for premature or unusual failures, if any, have been addressed
  - invoices, receipts or other documentation to confirm the work that has been completed
- confirm the availability of operator manuals
- replace components and oil as required – some items are recommended to be replaced after prescribed intervals irrespective of their condition

- lubricate and make necessary adjustments
- perform all required function tests
- check the torque on critical fasteners
- undertake a weight test in order to verify there is no hydraulic cylinder creep.

The plant must not be returned to service until all safety-related malfunctions and problems have been corrected.

Invoices do not include evidence that the inspection has been undertaken as required. As such, invoices alone are not acceptable evidence that the periodic inspection has been undertaken appropriately – see the inspection report template.

A list of typical items to be checked is given in Appendix C. This is not an exhaustive list, so inspection should be against a list of items based on manufacturer's recommendations.

MAJOR INSPECTIONS

Plant should be subjected to a major inspection for continued safe use after ten years of service if the plant has reached the end of its design working period, and every five years thereafter if any of the following situations arise:

- if structured inspection and maintenance recommendations are not available. A structured maintenance and inspection program should include:
  - lists of recommended inspections and maintenance
  - components to be replaced at scheduled intervals
  - inspection criteria and method of inspection.
- assessments in accordance with the manufacturer's recommendations reveal that it is due for a major inspection
- the plant is to be recommissioned or imported, and the previous operating records are not available
- the plant is to be recommissioned or imported, and is designed or built to unknown technical standard – in which case a design review should be undertaken to ascertain whether the design meets the legislative requirements
- modifications to the plant which can impact on the safety
- the plant has suffered damage that could have adverse effects on a critical component or functions.

Major inspection should not be considered as substitute for other types of inspections.

The major inspection should involve:

- dismantling and examination of all safety critical components. Inspection of certain components will require stripping them down and removing grease and corrosion
- assessment and recording the serviceability of each component or assembly.

Absence of cracks on components subjected to stress cycles such as structural members should not be regarded as having another five years of life before they could suffer a crack or failure. Therefore, unless replaced, these components should be inspected during pre-operational, routine and periodic inspections as required.

Plant should be subjected to major inspection every five years after the first major inspection. Alternatively, each critical component or system should be inspected at recommended intervals not exceeding five years unless the manufacturer recommends inspection intervals greater than five years for the new components used.

A list of typical items to be checked is given in Appendix C. This is not an exhaustive list, so inspection should be against a list of items based on manufacturer's recommendations.

RECORDING & REPORTING

Details of tests, inspections, maintenance, repairs, commissioning, decommissioning, dismantling, alterations and relevant details of the plant should be recorded. The records of premature or frequent failure of components could help find the root cause of failures or whether the causes of premature failures have already been addressed.

The records should be kept until the plant is relinquished. Copies of the records should be handed over to the new owner or controller.

Logbooks or an electronic logging system can be used for recording the information. Electronic recording systems should have an effective backup system against data loss.

The logbook in use should be kept with the plant at all times. Completed logbooks and detailed documents may be kept away from the plant in a secure readily accessible location for inspection.

Each competent person involved in the inspection should provide a written report. Each report should have the name, signature, date of inspection, location of inspection, their qualifications and their contact details.

Reports should be in writing and should include sufficient information:

- for the reader to understand the scope of work, the state of items and action taken or recommended
- to identify all the critical components that have been inspected
- to confirm the work has been undertaken as required
- that supports conclusions – how the item was declared fit for use
- includes photos or sketches where necessary
- to facilitate further analysis to plan future work
- relating to future scheduled inspections – more frequent inspections or inspecting a specific part or system.

All these details need not be included in reports for all different types of inspections as per the guidance shown under respective headings below.

Where it is not practicable to include all details of work undertaken in the logbook, the logbook should have:

- a brief summary of the work undertaken
- date the work completed
- hour meter and odometer readings
- identify the detailed report – reference number
- date of the report, and
- name and the signature of the competent person.

Detailed documents form part of the logbook.

INSPECTION REPORTS - GENERAL

Each competent person performing different inspection activities of the plant item should provide a written report as described below. The report of the principal competent person that manages the whole inspection should include reports of other competent persons involved in the inspection.

All reports should include:

- inspection description (Pre-operational, routine, periodic, major)
- owner/controller details
- manufacturer
- model number

- serial number
- date of manufacture or commissioning
- rated capacity
- date of inspection
- place of inspection
- name and signature of the competent person.

This information, except the date, name and the signature, does not need to be repeated when using a book to record numerous different inspections on the same item of plant.

PRE-OPERATIONAL AND ROUTINE INSPECTION REPORTS

Pre-operational and routine inspection reports should contain:

- components to be inspected, and functions tested
- indication that they have been inspected
- any defects identified and action undertaken
- the date of inspection and the signature of the competent person.

PERIODIC, MAJOR INSPECTION REPORTS AND ON GROUND INSPECTIONS

The report of the principal competent person undertaking the periodic or major inspection should include:

- the reports of those providing additional inspections or repair services.
- documents reviewed:
  - document reference, date (or range) and title
  - date of review
  - remarks/comments
  - reviewers name and signature.

Reports of the principal competent person and those providing additional inspections and repairs should include:

- date of commencement of inspection
- date of completion of inspection
- components inspected
- inspection method for each component or assembly
- inspection criteria, result, status (acceptable/not acceptable), comments (e.g. replaced, repaired)
- details of repairs, repair procedures, tests and replacements
- details of functional and other tests
- observations and recommendations relating to future maintenance and inspections
- contact person and contact details of the controller of the plant
- name of the competent person, their qualifications, contact details and signature.

An example of a periodic or major inspection report is contained in Appendix D.

APPENDIX A – PRE- OPERATIONAL INSPECTIONS

This list is not exhaustive – refer to manufacturer's or competent person's recommendations for the for the items to be checked

Visual inspection for cracks, distortion or excessive wear
Adjustable components are within the recommended range
Operates smoothly
Controls return to off position when released
Clean and free of debris
Interlocks function as designed
Sign of hydraulic or fuel leaks
Decals and warning signs are in place and legible
Fluid levels are within specified range
Plant is properly lubricated
Signs of chafing and routing
Loose wiring or connections
Tyres are inflated to the recommended pressure, or are solid tyres
All tyres are in good condition and without damage
Batteries are charged
Ground controls overrides platform controls

APPENDIX B - ROUTINE INSPECTION ITEMS

This list is not exhaustive – refer to manufacturer's or competent person's recommendations for the items to be checked

Component	Visual inspection	Functional test
Platform and base controls	y	y
Emergency controls and retrieval system		y
Visual and audible alarms		y
Air, hydraulic or fuel leaks	y	
Cables and wiring for security and damage	y	
Loose or missing components	y	
Brakes		y
Tyre and wheels	y	
Placards, warnings, control markings	y	
Outriggers and stabilisers		y
Guard rails and gates self-closing		y
Control descent devices where fitted	y	y
Safety switches and interlocks		y
Slew brake function		y
Structural defects	y	
Drives operate correctly		y
Operator manual	y	
Log-book	y	

APPENDIX C – PERIODIC & MAJOR INSPECTION ITEMS

Example of items to be checked during routine, periodic or major inspections

This list is not exhaustive – refer to manufacturer's or competent person's recommendations for the items to be checked.

Operation and safety manuals
Decals and warnings are secure and legible
Modifications
Condition of structure and welds
Fasteners, pins shield and covers
Hoods and gas struts
Stub axle
Turret

Functional controls
Platform controls
Ground controls
Function control detents
Guards for controls
Function enable control (deadman)
Emergency stop switches (ground and platform)
Function limit, cut out switches and other safety devices
Manual descent or auxiliary power
Foot switch
Capacity limiter
Drive brakes
Slew brakes

Platform
Guard rails
Gates – self closing
Floor
Anchors for lanyard
Rotator

Scissor mechanism
Scissor arms
Arm safety stop
Cylinder pins, pivot pins and securing components
Arm pins, wear pads and securing components

Chassis assembly
Side compartment door assembly
Static strap
Wheel and tyre assemblies
Drive motors
Pot hole protection system
Platform ladder
Wheel bearings
Oscillating axle lockout cylinder system
Outrigger or stabilisers
Extendable axle system
Drive hubs
Pedestal

Boom assembly
Boom welds
Hose and cable carrier installation
Sheaves and sheave pins
Bearings
Wear pads
Slew bearing or worm gear
Oil coupling
Slew drive system
Insulation inserts

Power system
Batteries fluid
Battery charger

Hydraulic and electric systems
Hydraulic lift/steer pump
Hydraulic cylinders (arms and steering)
Steer cylinder attachment pins and pin retainers
Hoses, lines and fittings
Hydraulic tank, cap and breather
Fluid
Oil filter
Electrical connections and wire looms are not loose
Instruments, gauges, switches and horn

APPENDIX D - EXAMPLE REPORT OF A PERIODIC OR MAJOR INSPECTION

Note: Some items may have more than one observation, for example, slew bearings are typically checked at four positions and observation at all positions should be recorded.

Contents of these examples may be adopted in any format suitable for your operation.

Owner/Controller of the MEWP **Location of inspection (street address)**	**Contact person:** Joe Smith **Contact details.** Joe@email.com 0499 999 000 **Start date** **Date completed** Hour meter/odometer readings

Details of additional service providers		
Name	**Company**	**Contact details**
Hydro Jones	EP hydraulics	0444 444 999
Mark Ghandi	Hello Electricals	0494 949 494

Item	**Description**	**Method of inspection Example only**	**Acceptance criterion For illustration only**	**Observation**	**Status**	**Comments Photos taken (Y/N)**
1	Slew bearing	Using a dial gauge	0.15 mm	0.12	Ok	N
2	Outrigger jack – left front	Using dial gauge with rated load	Creep less than 0.4 mm/10 min	0.2 mm/min	Ok	N
3	Horizontal Outrigger member	In-situ Visual	Paint cracking	No cracks	Ok	Y
4	Knuckle Pin	Visual and measuring	Smooth surface and wear less than 0.1 mm in diameter	Rough surface Wear 0.2 mm	NG	Not lubricated
5	Main lift cylinder	timer	From fully retracted to fully extended in 24 to 27 sec	35 sec	Not serviceable	Too slow
6	Item X					
7	Item Y					
8	Item Z					

Comments (detailing the defect and how it was rectified):
4. Replaced the pin and the bush with new components
5. Tested the valve for the main lift cylinder before returning to service. Test result: 25 sec

Competent person	**Phone number and email**	**Qualifications**	**Date of inspection**

Signature	**Date**

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