Australian Government
Department of Defence
Defence Support Group

Department of Defence
Civil Engineering Policy Review

PROJECT REPORT

- Final
- May 2009

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Contents

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1. Introduction

1.1 General

SKM was engaged by the Department of Defence (Defence), Defence Support Group (DSG), Infrastructure Division (ID), Estate Policy and Environment (EPE) Branch, Directorate of Estate Engineering Policy (EEP) to review and update policies relating to the design of aircraft pavement assets on Defence airfields. The original scope of the review was to include:

- Standard clauses on Civil Engineering for inclusion in Function Design Briefs.
- Design Management Process.
- Aircraft Pavement Design Policy.
- Pavement Underboring Policy.
- Heavy Roller Operating Manual.
- Method of Work Plan Template.

1.2 Review Meeting

Defence and SKM staff met on 25 March to discuss the scope of the review and to discuss the intent with regard to each resulting policy document. This meeting was attended by:

- SQNLDR Danny Cusack, Senior Civil Engineer, DSG-ID-EPE-EEP.
- FLTLT Rowan Paice, Civil Engineer, DSG-ID-EPE-EEP.
- Greg White, SKM, Project Manager.

Based on the discussions and agreements from the meeting, it was concluded that the functional design brief requirements formed part of the design policy element. It was also concluded that the content of the design reports and the underboring methodology could also form part of the overall design policy document. This was seen as replicating the structure of the draft Electrical element of the Manual of Infrastructure Engineering. As a result, the scope of policy documents to be included in the policy review were agreed to be:

- Method of Work Plan Template.
- Heavy Roller Operating Manual.
- Aircraft Pavement Design Policy, incorporating:
  - Functional Design Brief requirements.
  - Specific requirements for civil engineering content of design reports.

- Underboring policy.

1.3 Civil Engineering Policy Hierarchy

The following details the hierarchy of policy documents that relate to Civil Engineering (Aircraft Pavements) policy proposed by Defence. A more definitive document covering the hierarchy of documentation can be seen at Annex A.

- **Aerodrome Design Manual**.
  - Replaces ADFP 602.
  - Largely based on MOS 139, with Defence specific requirements where applicable.
  - Section for Main/Forward Operating Bases.
  - Section for secondary airfields.
  - Section for heliports.
- **Aerodrome Planning Manual**.
  - Design management and review processes.
  - Standard material specifications.
  - Dispensation and Certification processes.
  - Method of Working Plan guidance.
  - Underboring guidance.
  - Heavy Roller Operating Manual.
- **Aerodrome Operations Manual**.
  - Aerodrome surveys.
  - Pavement Management System, including condition inspections and friction testing.
  - Aircraft Pavement Strength Evaluation Manual.
  - Aircraft Pavement Maintenance Manual.
- **Related documents**.
  - As required.

2. Method of Work Plan Template

2.1 General

The Method of Working Plan template and guidance was prepared by Defence staff in 2002. The template is available to Project Officers, consultants and Base staff. With the introduction of MOS 139 by CASA in September 2004, a review of the current template and guidance for consistence with MOS 139 advice was considered appropriate.

2.2 Review of template and guidance

In reviewing the template and guidance for the preparation of MOWPs, the following issues were assessed:

- Consistence with MOS 139 and CASA guidelines.
- Consistence with the normal practice for project delivery.

Defence should confirm that the abbreviations contained in the distributee section remains current.

2.3 Draft Template and Guidance Update

A Draft template and guidance notes for the preparation of MOWP's is contained in Annex B.

3. Heavy Roller Operating Manual

3.1 General

The heavy roller operating manual was prepared by Airplan in 2002. The manual was intended to provide guidance to designers on the design of proof rolling regimes as well as to constructors on the maintenance and operation of the equipment. Since the 2002 manual was released substantial limitations and changes in the proof rolling equipment has occurred. The manual was required to be updated to reflect these changes.

3.2 Changes impacting on heavy rollers

A number of changes have occurred which have impacted on the heavy rollers. These are detailed as follows.

3.2.1 OHS restrictions

In 2004 a number of projects, including those at Sydney Airport and Cairns Airport, were underway. During the preparation for the proof rolling of the granular layers, the Macro Roller tyre suppliers revoked the previous certification (of which no record can be found) to inflate the tyres to very high pressures. The tyres are rated to 1000 kPa whereas a previous agreement had been reached to allow 1400 kPa to be utilised with restrictions on the operation of the rollers (such as maximum travel speeds). Further discussion with Michelin and other tyre manufacturers (Bridgestone) revealed that due to increasing OHS issues and the increasingly litigious society, no earthmoving tyre would be rated or certified for inflation above 1000 kPa. The existing tyres were also deemed to be unserviceable due to their age and replacement tyres of the same type were not available, the line of tyres being virtually discontinued. This created a gap in the capability to prove the upper layers of flexible aircraft pavements for use by aircraft with high tyre pressures and lead to the development of a solid wheel with a neoprene outer.

Work has also been undertaken using solidified pneumatic tyres. These were anticipated to be able to produce surface pressures of 1,400kPa however recent testing has shown that at maximum weight on the roller (12.5T per wheel or 50T total) only surface pressures of 1,040kPa were able to be achieved.

3.2.2 Future workload projections

Defence internally reviewed their projected aircraft pavement construction expectations and determined that not all of the existing heavy rollers would be required in the future. In particular, Defence elected to discontinue maintenance on the Porter Supercompactor and the Test Rig rollers, with a view to disposal of these assets.

3.3 Revision of Heavy Roller Manual

Based on discussions with Defence and the above issues, it was agreed that the revision of the heavy roller operating manual would provide for:

- Inclusion of a summary of historical events since 2002 that impact on the rollers.
- Updating the condition report and photos for each roller.
- Updating the pneumatic roller details to reflect the 1,000 kPa tyre pressure limit.
- Removal of the Test Rig and Supercompactor from the manual.
- Inclusion of the solid wheel/neoprene heavy roller into the manual.
- Inclusion of the lease agreements as annexes to the manual.

A draft of the revised manual is contained in Appendix C.

4. Aircraft Pavement Design Policy

4.1 General

A number of existing policy documents exist covering various aspects of Aircraft Pavement Engineering for Defence airfields. These include:

- Standard Civil Engineering inclusions for Functional Design Briefs.
- Pavement Concession Policy.
- Design of Military Aerodrome Policy.
- Maintenance of Defence Airfields Policy.
- Draft pavement underboring method statement.

Through discussions with Defence staff, it was agreed that Pavement Concessions should be covered by the Aircraft Pavement Strength Evaluation Manual. The Design of Military Aerodromes would be generally covered by ADFP 602 and the Maintenance of Defence Airfields fell under the updating of the Aircraft Pavement Maintenance Manual and future development of the Defence Aerodrome Operations Manual. This left the main policy deficiency being the design of new aircraft pavements, including the content of design reports, standard inclusions for functional design briefs and the underboring policy.

4.2 Aircraft Pavement Design Policy document

A draft of the Aircraft Pavement Design Policy Document is included in Appendix D. It was acknowledged by Defence and SKM that the document would contain one person's views and opinions on Aircraft Pavement design standardisation and would require updating and continual review following input from others.

4.3 Pavement Underboring Policy

As underboring is both a design and construction issue, it has been excluded from the design policy document. A reviewed and updated draft of the Pavement Underboring Method Statement is included in Appendix E.

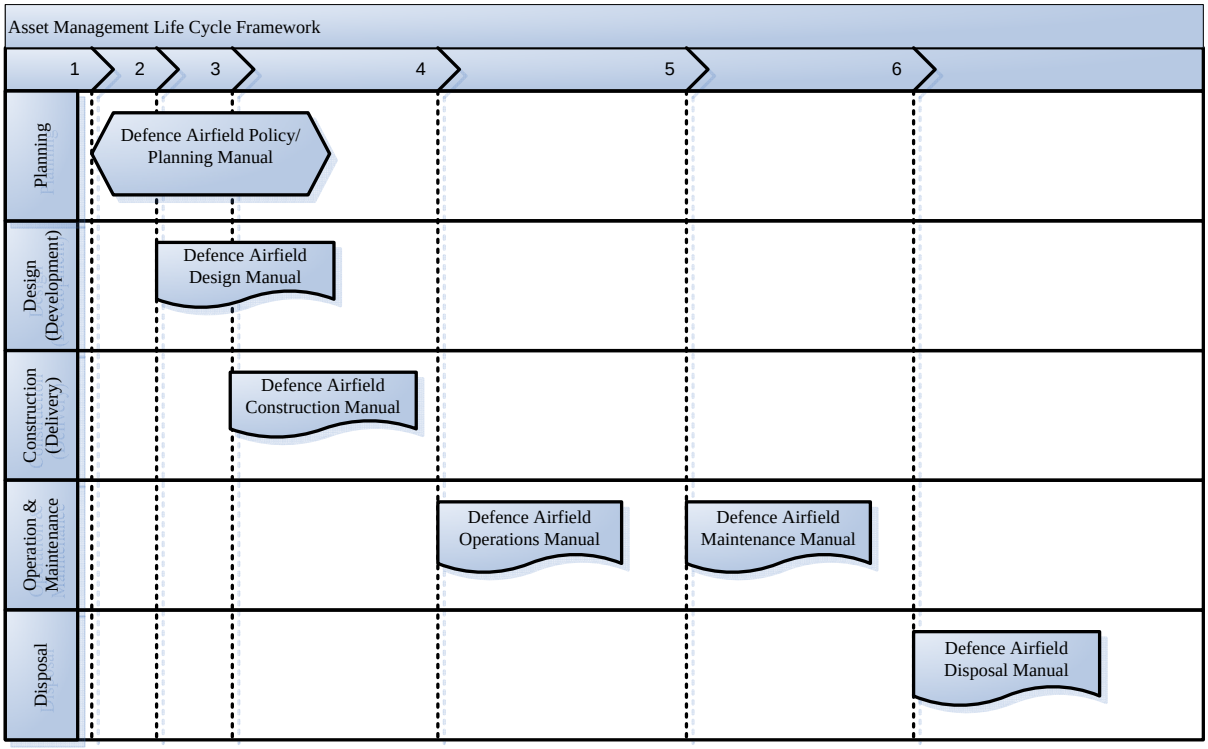
Appendix A Civil Engineering Policy Hierarchy

AUSTRALIAN DEFENCE FORCE (ADF) – CIVIL ENGINEERING – AIRFIELD PAVEMENTS DOCUMENTATION – TECHNICAL HEIRARCHY V2.1

The suite of documents setting out the design standards for ADF (*Defence*) sealed airfields[1] will be arranged/organised using the asset management life cycle framework as defined below:

ASSET MANAGEMENT LIFE CYCLE FRAMEWORK

1. Planning: -> Defence Airfield Policy/Planning Manual
2. Design (Development): -> Defence Airfield Design Manual
3. Construction (Delivery): -> Defence Airfield Construction Manual
4. Operation: -> Defence Airfield Operations Manual
5. Maintenance: -> Defence Airfield Maintenance Manual
6. Disposal: -> Defence Airfield Disposal Manual (if required)



[1] Airfield: Defined as "a field where aircraft can take off and land; specif., the landing field of an airport, usually a military field". Source: http://www.yourdictionary.com/airfield

1. DEFENCE AIRFIELD POLICY/PLANNING MANUAL

- Planning principles that inform design and construction:
  - Airfield master planning
  - Airfield navigation aid planning
- Airfield pavement design review policy:
  - Requirements of consultants during the "Design Management/Progression" Process.
  - Airfield pavement design certification policy
  - Airfield design dispensation policy.
    - Design Dispensation process;
    - Formalise a standing dispensation for construction activities (and *existing* infrastructure) within 300m master planned RWS (but outside the 230m operating RWS). *New* infrastructure would need to comply with 300m master planned RWS.
  - Aerodrome Pavement Thickness Design
- Airbase Doctrine:
  - Certification of new ADF austere airfields
- Defence Infrastructure Panel – Airfield Services Sub-Panel

2. DEFENCE AIRFIELD DESIGN MANUAL (DADM)

- Airfield pavement design standards/references
- Aerodrome Ground Lighting (AGL): Refer to Electrical Manual

Part A –Fixed Wing Aircraft

- Fixed-wing airfield & general aerodrome facilities design policy (Arrestor Barriers, TACAN, etc)
  - ADFP602: Design policy details "what Defence wants" and provides guidance on "How to do it".
    - Only discuss in ADFP602 where Defence differs from MOS-139 and why
    - Ordnance Loading Areas (OLAs)
  - Defence policy on Friction Requirements of grooved and ungrooved Runways (or move to operations manual)
  - Airfield Geometric Design: Minimum acceptable criteria for geometric design of pavements

Part B – Rotary Wing/Helicopter Operations

- Helicopter airfield design policy
  - New ADFP602:
    - ADF Design Policy is to align with CAAP 92-2(1), *Guidelines for the establishment and use of helicopter landing sites (HLS)*
    - ICAO Annex 14 Volume II as the ancillary standard for CAAP 92-2(1) as CAAP 92-2(1) does not cover Obstacle Limitation Surface (OLS) requirements.
  - Used for additional guidance only:
    - US Army Corp of Engineers - Unified Facilities Criteria (UFC) 3-260-01 (19 May 2006) - Airfield and Heliport Planning and Design

Part C –Airfield Equipment Siting Criteria

- GTESPO update of AFDP 602, Part 6

3. DEFENCE AIRFIELD CONSTRUCTION MANUAL

- Standard construction specifications# for Airfield pavement Works.
  - Extract of the bulk of Section F of the APMM (2003).
- Construction supervision guidance
- ADF Airfield Construction Delivery Process
- Environmental Management specific to aircraft pavements
  - Extract APMM (2003) Appendix D (Environmental Management Plan)
- OH&S Management
  - Extract APMM (2003) Appendix B (OH&S Management Plan)
- Use of Defence 'Macro Roller' Equipment, i.e. refer to Macro Roller Operating Manual
- Pavement under-boring policy/procedures/guidance
- Method of Works Planning policy
  - MOWP discussed in MOS-139 but not as detailed. Consolidate/amalgamate with APMM (2003) Appendix C (Safety Precautions during Aerodrome works).
- Construction certification policy.
  - Certification of new pavement areas at ADF MOB/FOB airfields (e.g. PCN recommendation)

4. DEFENCE AIRFIELD PAVEMENT OPERATIONS MANUAL

- Defence Airfield Pavement Management System (PMS), concessions, maintenance and construction:
  - The PMS provides the framework within which to organise and carry out all the work activities needed to provide, operate and maintain airfield pavements
  - Airfield Surveys Reports (ASRs).
    - ADFP 602, Part 8, Chapters 1 (Surveys) & 2 (Types of Surveys) and other parts from ADFP602 considered appropriate for inclusion in an 'operations manual'
    - ADF ASRs managed by HQAC (AsA) and 86WG (MAET).
  - Pavement Concession policy.
    - Management of Pavement Concession requests / APCT
    - Publish standing Pavement Concessions for commercial (QANTAS, Jet Star, etc.) and Defence (C-17) aircraft use of ADF airfields for normal, alternate and emergency use.
- Implementation of MOWP developed as part of the delivery process.

5. DEFENCE AIRFIELD MAINTENANCE MANUAL

- ADF Airfield pavement maintenance cycle
  - FACOPS & DNAP airfield maintenance works process:
    - Inspections (PIR) & Audit role -> NAP Maintenance Cycle, PIR (year before), budget bids, scoping visits and meetings (current FY), Scoping Studies (next FY)
    - Pavement Inspection & Friction Testing Program
    - Defence airfield SEST & Coal Tar product policy
- ADF Airfield Pavement Maintenance Manual (APMM).
  - FACOPS: Regional airfield maintenance works

- Refer to: Aeronautical Ground Lighting (AGL) Configuration Manual

6.0 DEFENCE AIRFIELD DISPOSAL MANUAL

- Disposal Plan for Defence 'Macro Roller' Equipment.
- Decommissioning pavements no longer in use or that is removed as part of an IAD/redevelopment project.

7.0 RELATED TECHNICAL REFERENCE MATERIAL

- Airfield Pavement Strength Evaluation Manual (APSEM)
- Past Defence Airfield biennial Pavement Inspections Reports/Audits (PIRs)
- Aircraft information/data
- AAA technical data
  - Kubu: Binder Research Program. Package B – Project Investigations into aspects of bitumen and asphalt on Australian Airports (Apr 06)
  - Kubu: Binder Research Program. Package C – Survey of Production of Bitumen for Australia (Aug 05)
  - Kubu: Binder Research Program. Survey of Runway Surfacings in Australia, Final Report (Jul 05)
- Austroads Report: Polyphosphoric Acid Modified Binders (Feb 07)

Appendix B MOWP Template and Guidance

B - Enclosure One: MOWP Template

DEPARTMENT OF DEFENCE

MOWP Number	XXX X/20XX
Issue Number	
Date of Issue	X XXX 20XX
Amendment Number	
Date of Amendment	

MOWP number is provided by the regional DSG office

METHOD OF WORKING PLAN

AERODROME:

PROJECT DESCRIPTION:

DATES:
Approval of MOWP _____
Commencement of works _____
Completion of works _____
Expiry of MOWP _____

CONTENTS

1. WORKS INFORMATION

1.1 Description of Work

A brief description of the works to be completed.

1.2 Execution of Work

Timings

List the commencement and completion date expected for the work.

The working hours for the various stages of work are:

List each stage and the working hours (local time) during each stage.

For each stage, the actual date and time of commencement will be advised by a NOTAM, to be issued not less than 48 hours before work commences.

Sequence of Work

Where multiple stages are included, describe or list the order or sequence of the work stage-by-stage.

Location and Duration of Work Stages

For each stage of the work, describe the scope, the location and the expected duration.

2. RESTRICTIONS TO AIRCRAFT OPERATIONS

2.1 Declared Emergencies

Describe the requirements for airfield availability necessary during a declared emergency. Typically this is for full availability within 30 minutes notice but this may not always be practical depending on the nature of the work.

2.2 Work Stages

List the restrictions to aircraft operations for each stage of the work. This includes displaced thresholds, restrictions to TXY and RWY use and unavailable lighting and other navigational aids/equipment. This information can be largely obtained from the various NOTAMs' text.

2.3 Markings

Areas of the airfield affected by the works are to be marked as shown in DWG____ and all markings are to comply with the requirements of ADFP 602 and MOS Part 139.

The Works Supervisor is to ensure that all markings are established and removed at the start and end of each work period, as detailed in the relevant NOTAM.

The Works Safety Officer is to ensure that the markings are appropriate and maintained at all times.

3. RESTRICTIONS ON THE CONTRACTOR

3.1 General

Works will generally be confined to the areas shown in drawing DWG____.

The limits of the works areas are to be defined by rows of orange 'witches hat' markers across the runway, taxiway or other aircraft operating surface.

On completion of each work period and on each occasion the runway is returned to active use, the Works Supervisor is to ensure the works area is made serviceable, including the removal of all Foreign Object Damage (FOD) hazards, to the satisfaction of the Works Safety Officer.

3.2 Personnel

All personnel associated with the work shall be bound by any instructions issued by the Works Safety Officer, who may refuse access to persons likely, in his/her opinion, to compromise aircraft safety on the airfield.

3.3 Vehicles and Plant

Vehicles and plant used for these works are not to exceed ___ metres in height. No movement of vehicles or plant is to take place outside the works areas or access routes without the consent of the Works Safety Officer.

A height restriction of 6 m is typical for vehicles and plant and increased heights will affect the degree by which thresholds must be displaced. The SATCO is able to provide advice on displacement lengths for various equipment heights.

At the end of each work period, all plant, equipment and material is to be moved clear of the works area and parked in the designated parking area shown on drawing DWG____.

3.4 Access to the Works and Security

Access to the works area is to be via the designated route shown on drawing DWG____.

All personnel are to have on their person at all times a valid security pass issued by the Base pass office. *If required. This is normally more common on RAAF Bases than other establishments.*

Personnel are only permitted to move about the areas on the base as described in drawing DWG____.

3.5 Visual Ground Aids

Markings, markers and lighting (as detailed in drawing DWG____) are not to be installed, altered or removed without the approval of the Works Safety Officer.

3.6 Protection of Electrical Services

The Works Supervisor is to obtain dig permits from the local DSG officer prior to performing any excavation (excluding surface milling).

This assumes that a dig permit system is utilised at the particular airfield.

3.7 Special Requirements

List any site or project specific restrictions or requirements. Common ones may be:

All loose material and equipment is to be secured against movement in strong winds or aircraft blast.

Any damage to Defence facilities is to be reported immediately to the Project Officer and to the Works Safety Officer.

Portable floodlights are to be shielded so that no direct light is projected above the horizontal plane.

Pavement surfaces are to be swept and left clean to the satisfaction of the Works Safety Officer prior to evacuation of the works area.

Prior to performing any hot work, the Works Supervisor is to obtain a Hot Work Permit from the local DSG regional office.

4. ADMINISTRATION

4.1 Contractor

The works will be carried out by *Contractor's Name* for DSG.

All contact, with the Base, by the Contractor, in relation to the work, is to be made through the DSG Project Officer.

4.2 Project Officer

The Project Officer will be DSG's *Project Officer's Name*.

All queries regarding this MOWP are to be directed to the Project Officer.

4.3 Works Safety Officer

The Works Safety Officer/s will be *Works Safety Officer's Name* or *Works Safety Officer's Organisation.*

The Works Safety Officer is responsible for ensuring that the works, in so far as they affect the safe operation of aircraft, are conducted in accordance with this MOWP.

The Works Safety Officer must be present on site at all times while work is in progress.

This may not be practical and presence at the start and finish of each work period may be more suited. On-call during the works may also be an option.

In particular, the Works Safety Officer will be responsible for:

The Works Safety Officer's roles will be project and site specific. Whatever the Works Safety Officer's duties are should be listed in the MOWP. MOS Part 139, Section 10.12 provides the following guidance for the responsibilities of the WSO:

"The Works Safety Officer performs the following responsibilities.
(a) Ensure the safety of aircraft operations in accordance with the standards for aerodrome works and the applicable MOWP;
(b) Ensure that, where applicable, the aerodrome works are notified by issue of a NOTAM and that the text of each NOTAM is exactly as set out in the applicable MOWP prior to works commencing on site;
(c) Supply the air-traffic controller, on a daily basis, with whatever information is necessary to ensure the safety of aircraft operations;
(d) Discuss with the works organisation, on a daily basis, any matters necessary to ensure the safety of aircraft operations;
(e) Ensure that unserviceable portions of the movement area, temporary obstructions, and the limits of the works area are correctly marked and lit in accordance with Paragraph 10.10.8, and the applicable MOWP;
(f) Ensure that the vehicles, plant and equipment carrying out aerodrome works are properly marked and lit or are under works safety officer supervision or within properly marked and lit works area;
(g) Ensure that all other requirements of the directions and MOWP relating to vehicles, plant, equipment and materials are complied with;
(h) Ensure that access routes to work areas are in accordance with the applicable MOWP and clearly identified and that access is restricted to these routes;
(i) Ensure that excavation is carried out in accordance with the MOWP and, in particular, so as to avoid damage or loss of calibration to any underground power or control cable associated with a precision approach and landing system or any other navigational aid;
(j) Report immediately to the air-traffic controller and the aerodrome operator any incident, or damage to facilities, likely to affect air-traffic control services or the safety of aircraft;
(k) Remain on duty at the works area while work is in progress and the aerodrome is open to aircraft operations;

(l) Ensure that the air-traffic controller is kept informed of the radio call signs of the vehicles used by the works safety officer;
(m) Require the immediate removal of vehicles, plant and personnel from the movement area where necessary to ensure the safety of aircraft operations;
(n) Ensure that the movement area is safe for normal aircraft operations following removal of vehicles, plant, equipment and personnel from the works area;
(o) In the case of time-limited works, ensure that the works area is restored to normal safety standards not less than 5 minutes before the time scheduled or notified for an aircraft movement; and
(p) Ensure that floodlighting or any other lighting required for carrying out aerodrome works is shielded so as not to represent a hazard to aircraft operations."

4.4 Senior Air Traffic Control Officer (SATCO)

The SATCO and the Air Traffic Control (ATC) personnel are responsible for flying safety and the safety of the work party.

The SATCO (or their nominated representative) is responsible for the arrangement of NOTAMS.

4.5 Works Manager and Works Supervisor

The Contractor's Works Manager will be *Title and Name* of *Company Name*.

The Contractor's representative on site will be the Works Supervisor, *Title and Name*.

The Works Manager, through the Works Supervisor, will be responsible, on behalf of the Contractor, for complying with the provisions of this MOWP.

The Works Supervisor will be present on site during all work periods.

4.6 Distribution

This MOWP is to be distributed to those persons and agencies listed on the distribution list attached at annex A.

4.7 Contact Details

Position	Name	Agency	Phone	Fax	Mobile
Project Officer					
Base Commander					
SCE					
SATCO					
BFSO/BASO					
BAEO					
Civil Airport Manager					

Base Security Officer					
Base Safety Advisor					
CMS Project Manager					
Works Safety Officer					
Project Manager/Contract Administrator					
Design Consultant					
Works Manager					
Works Supervisor					
Sub-Contractor 1					

This table represents a typical list of contacts with project specific contacts to be determined.

5. NOTAMS

SATCO is to arrange for NOTAMs for the duration of the restrictions to the airfield, associated with the works. Draft text for the NOTAM is attached at annex B. Dates and times are indicative only and will be confirmed 48 hours before the commencement of each stage

Noting that the NOTAM text is not to be modified without the entire MOWP being re-approved, the SATCO should be involved in reviewing or drafting the proposed NOTAM text.

The NOTAMs are to be released at least 48 hrs prior to the commencement of the works.

Works are not to commence until the Project Officer and the Works Supervisor are provided with a hard copy of the NOTAM.

6. AUTHORITY

6.1 Issue

This MOWP is issued in accordance with MOS-139, ADFP 602, RPAs and ICAO Annex 14. All works will be carried out in accordance with the MOWP.

6.2 Variation

No variation to this MOWP (including the NOTAM text) is to take place without the approval of all signatories.

Requests or proposals to amend or vary the MOWP, as well as queries on its content or meaning, are to be directed to the DSG Project Officer.

6.3 Expiry of this MOWP

This MOWP will remain current until _____ unless extended by amendment.

6.4 Approval

Under the authority of the following signatures, this MOWP is approved for release.

NAME	**NAME**	**NAME**
TITLE/RANK	TITLE/RANK	TITLE/RANK
Base Commander – *Base*	MI - *Region*	Airport Authority
XX XXXX XXXX	XX XXXX XXXX	XX XXXX XXXX
Xxx XX	Xxx XX	Xxx XX

The Airport Authority signatory is only applicable if on a joint user airfield.

Annexes:

A. Distribution List
B. NOTAM text

Drawings:

DWG0001 dated XX Xxx XX

ANNEX A TO
MOWP XXX X/20XX
DATED XXX XX

DISTRIBUTION LIST

Distributees should include all those with an interest in the project, an interest in the airfield or are assigned a responsibility in the MOWP.

A minimum should include:

RAAF:
AFHQ (DGPP-AF)
AFHQ (DIDA)
HQAC (DOS)
HQAC (A43 AFENGOPS)
All FEG HQ that operate regularly from the airfield
Base Combat Support Squadron CO / Base Commander
All Flying SQN COs on the base
SATCO/ 44 WNG DET CMDR, BFSO, BAEO and BSECO

DSG:
DSG (IAD-DEEP-SCE)
DSG (Manager for the region)

Contractors:
Base SAR operator
Project Manager
CMC contractor
Head contractor on the airfield works

Others:
The local airport operator on joint airfields
Any flying clubs that use the airfield

ANNEX B TO
MOWP XXX X/20XX
DATED XXX XX

NOTAM TEXT

For all Stages of work

SATCO / 44 WNG DET CDR to provide/draft/review based on the project requirements.

B - Enclosure Two: Example MOWP

DEPARTMENT OF DEFENCE

MOWP Number	YPTN 08/1
Issue Number	1
Date of Issue	21 Sep 08
Amendment Number	-
Date of Amendment	-

METHOD OF WORKING PLAN

AERODROME: **RAAF BASE TINDAL**

PROJECT DESCRIPTION: **RESURFACING OF PART OF RUNWAY**

DATES:

Approval of MOWP	**20 Sep 08**
Commencement of works	**13 Nov 08**
Completion of works	**24 Dec 08**
Expiry of MOWP	**25 Dec 08**

CONTENTS

Annex:

1. WORKS INFORMATION

1.1 Description of Work

The work involves removing and replacing a 200m long and 30 m wide section of asphalt on the western end of RWY 11/29, near the intersection with RWY 18/36, to a depth of 40 mm.

1.2 Execution of Work

Timings

The work is expected to commence on 13 November 2008 and finish on 24 December 2008.

The working hours for the various stages of work are:

STAGE 1 - 2300 h and 0630 h local time
STAGE 2 - 0800 h and 1400 h local time
STAGE 3 - 2300 h and 0630 h local time
STAGE 4 - 0800 h and 1400 h local time
STAGE 5 - 1400 h and 1800 h local time
STAGE 6 - 2300 h and 1500 h local time

For each stage, the actual date and time of commencement will be advised by a NOTAM, to be issued not less than 48 hours before work commences.

Sequence of Work

The work will be completed in six stages. The stages must be completed in numbered sequential order and no stages may be performed concurrently. Further, stages one to five are to be conducted on consecutive days, subject to weather, with stage six to be completed approximately one month later.

Location and Duration of Work Stages

Stage 1
Stage 1 of the works includes profiling a 200m x 15m section of runway, North of the CL, to a depth of 40mm. The location of the site is shown in drawing DWG0001. A detailed design drawing showing the chainage from the 11 threshold is found at drawing DWG0002. The duration of stage 1 will be 1 day.

Stage 2
Stage 2 of the works includes the laying of 40mm of asphalt over the 200m x 15m section of runway that was profiled in stage 1. The detailed design drawing DWG0002 contains the design levels and chainages of the asphalt. The duration of stage 2 will be 1 day.

Stage 3
Stage 3 of the works includes profiling a 200m x 15m section of runway, South of the CL, to a depth of 40mm. The location of the site is shown in drawing DWG0001. A

detailed design drawing showing the chainage from the 11 threshold is found at drawing DWG0003. The duration of stage 3 will be 1 day.

Stage 4
Stage 4 of the works includes the laying of 40mm of asphalt over the 200m x 15m section of runway that was profiled in stage 3. The detailed design drawing DWG0003 contains the design levels and chainages of the asphalt. The duration of stage 4 will be 1 day.

Stage 5
Stage 5 of the works consists of a painting operation to reinstate the runway centre line. Drawing DWG0004 shows the chainages for the line marking operation. The duration of stage 5 will be 1 day.

Stage 6
Stage 6 of the works will be undertaken approximately one month after the completion of the laying of the asphalt. Stage 6 of the works is comprised of cutting grooves in the 200m x 30m section of new asphalt (layed in stages two and four) and repainting the centre line markings obliterated by the grooving operation. The grooving and repainting of the new asphalt is to be completed in accordance with drawing DWG0005. The duration of stage 6 will be 1 day.

2. RESTRICTIONS TO AIRCRAFT OPERATIONS

2.1 Declared Emergencies

At all times during the works, the full length of runway 11/29 will be able to be made available for a declared emergency, with 30 min notice to the Works Safety Officer.

2.2 Work Stages

For all stages, restrictions to aircraft operations are:

Threshold 11 will be displaced 800m.
Runway 11 TVASIS not available.
Runway 29 end will be displaced (shortened) by 800 m.
Temporary APAPI available on left hand side. Not flight tested.
Runway 29 distance to run markers read incorrectly.
Runway 18/36 not available.
Taxiway A closed west of runway 18/36.
Compass swing bay not available.
Taxiway B available as directed by ATC.

2.3 Markings

Areas of the airfield affected by the works are to be marked as shown in DWG0006 and all markings are to comply with the requirements of MOS-139, ADFP 602, RPAs and ICAO annex 14.

The Works Supervisor is to ensure that all markings are established and removed at the start and end of each work period, as detailed in the relevant NOTAM.

The Works Safety Officer is to ensure that the markings are appropriate and maintained at all times.

3. RESTRICTIONS ON THE CONTRACTOR

3.1 General

Works will generally be confined to the areas shown in drawing DWG0001.

The limits of the works areas are to be defined by rows of orange ‘witches hat’ markers across the runway, taxiway or other aircraft operating surface.

On completion of each work period and on each occasion the runway is returned to active use, the Works Supervisor is to ensure the works area is made serviceable, including the removal of all Foreign Object Damage (FOD) hazards, to the satisfaction of the Works Safety Officer.

3.2 Personnel

All personnel associated with the work shall be bound by any instructions issued by the Works Safety Officer, who may refuse access to persons likely, in his/her opinion, to compromise aircraft safety on the airfield.

3.3 Vehicles and Plant

Vehicles and plant used for these works are not to exceed 6 metres in height. No movement of vehicles or plant is to take place outside the works areas or access routes without the consent of the Works Safety Officer.

At the end of each work period, all plant, equipment and material is to be moved clear of the works area and parked in the designated parking area shown on drawing DWG0001. Any vehicle or item of plant that is found to be leaking fuel or oil is to be immediately removed from the site.

3.4 Access to the Works and Security

Access to the works area is to be via the designated route shown on drawing DWG0001.

All personnel are to have on their person at all times a valid security pass issued by the Base pass office.

Personnel are only permitted to move about the areas on the base as described in drawing DWG0001.

3.5 Visual Ground Aids – Aerodrome Markers, Markings and Lights

Markings, markers and lighting (as detailed in drawing DWG0006) are not to be installed, altered or removed without the approval of the Works Safety Officer.

3.6 Protection of Electrical Services

The Works Supervisor is to obtain dig permits from the local DSG office prior to performing any excavation (excluding surface milling).

3.7 Special Requirements

All loose material and equipment is to be secured against movement in strong winds or aircraft blast.

Any damage to Defence facilities is to be reported immediately to the Project Officer and to the Works Safety Officer.

Portable floodlights are to be shielded so that no direct light is projected above the horizontal plane. Vehicles performing night works are not permitted to use ‘high beam’ while operating on the movement areas of the airfield.

Pavement surfaces are to be swept and left clean to the satisfaction of the Works Safety Officer prior to evacuation of the works area.

Prior to performing any hot work, the Works Supervisor is to obtain a Hot Work Permit from the local DSG office.

4. ADMINISTRATION

4.1 Contractor

The works will be carried out by GoodPave Pty Ltd for DSG-NT.

All contact with the Base by the Contractor in relation to the work, is to be made through the DSG Project Officer.

4.2 Project Officer

The Project Officer will be DSG’s Mr Steve Phillus.

All queries regarding this MOWP are to be directed to the Project Officer.

4.3 Works Safety Officer

The Works Safety Officer/s will Mr Peter Brown of GoodPave Pty Ltd.

The Works Safety Officer is responsible for ensuring that the works, in so far as they affect the safe operation of aircraft, are conducted in accordance with this MOWP.

The Works Safety Officer must be present on site during all work periods.

As detailed in MOS Part 139, Section 10.12, the Works Safety Officer performs the following responsibilities.
(a) Ensure the safety of aircraft operations in accordance with the standards for aerodrome works and the applicable MOWP ;
(b) Ensure that, where applicable, the aerodrome works are notified by issue of a NOTAM and that the text of each NOTAM is exactly as set out in the applicable MOWP prior to works commencing on site;
(c) Supply the air-traffic controller, on a daily basis, with whatever information is necessary to ensure the safety of aircraft operations;
(d) Discuss with the works organisation, on a daily basis, any matters necessary to ensure the safety of aircraft operations;
(e) Ensure that unserviceable portions of the movement area, temporary obstructions, and the limits of the works area are correctly marked and lit in accordance with MOS Part 139 Paragraph 10.10.8, and the applicable MOWP;
(f) Ensure that the vehicles, plant and equipment carrying out aerodrome works are properly marked and lit or are under works safety officer supervision or within properly marked and lit works area;
(g) Ensure that all other requirements of the directions and MOWP relating to vehicles, plant, equipment and materials are complied with;
(h) Ensure that access routes to work areas are in accordance with the applicable MOWP and clearly identified and that access is restricted to these routes;
(i) Ensure that excavation is carried out in accordance with the MOWP and, in particular, so as to avoid damage or loss of calibration to any underground power or control cable associated with a precision approach and landing system or any other navigational aid;
(j) Report immediately to the air-traffic controller and the aerodrome operator any incident, or damage to facilities, likely to affect air-traffic control services or the safety of aircraft;
(k) Remain on duty at the works area while work is in progress and the aerodrome is open to aircraft operations;
(l) Ensure that the air-traffic controller is kept informed of the radio call signs of the vehicles used by the works safety officer;
(m) Require the immediate removal of vehicles, plant and personnel from the movement area where necessary to ensure the safety of aircraft operations;
(n) Ensure that the movement area is safe for normal aircraft operations following removal of vehicles, plant, equipment and personnel from the works area;
(o) In the case of time-limited works, ensure that the works area is restored to normal safety standards not less than 5 minutes before the time scheduled or notified for an aircraft movement; and
(p) Ensure that floodlighting or any other lighting required for carrying out aerodrome works is shielded so as not to represent a hazard to aircraft operations."

4.4 Senior Air Traffic Control Officer (SATCO)

The SATCO and the Air Traffic Control (ATC) personnel are responsible for flying safety and the safety of the work party.

The SATCO (or their nominated representative) is responsible for the drafting and publication of NOTAM's. NOTAM's are to be promulgated as per Section 5 of this MOWP.

4.5 Works Manager and Works Supervisor

The Contractor's Works Manager will be Mr Phillip Markus of GoodPave Pty Ltd.

The Contractor's representative on site will be the Works Supervisor, Mr Richard Rott.

The Works Manager, through the Works Supervisor, will be responsible on behalf of the Contractor for complying with the provisions of this MOWP.

The Works Supervisor will be present on site during all work periods.

4.6 Distribution

This MOWP is to be distributed to those persons and agencies listed in the distribution list attached at annex A.

4.7 Contact Details

Position	Name	Agency	Phone	Fax	Mobile
Project Officer	Terry White	DSG	08 8973 3265	08 8973 6021	0418 362 254
Base Commander	John Smith	RAAF	08 8973 1000	08 8973 6021	0438 365 125
SCE	John Wither	DSG	02 6266 7745	02 6265 3907	
SATCO	Paul Witt	RAAF	08 8973 6542	08 8973 6021	0404 562 321
BFSO/BASO	John Doe	RAAF	08 8945 3212	08 8973 1243	0416 785 432
BAEO	Lex Jones	RAAF	08 8973 6150	08 8973 6021	
Civil Airport Manager	Henry Mango	Katherine Airport	08 8971 1154	08 8972 2154	0410 325 645
Base Security Officer	Barry Walker	RAAF	08 8973 3524	08 8973 6021	0487 546 412
Base Safety Advisor	Ted LeHunt	RAAF	08 8973 3485	08 8973 3485	0407 589 233
CMS Project Manager	Allen Little	Asset Services	08 8975 6325	08 8796 0223	0412 254 254
Works Safety Officer	Dorian Gray	GoodPave	08 8973 6254	08 8973 6021	0412 212 354
Project Manager/Contract Administrator	Charles Ryder	FWT PM Services	02 5678 2323	02 4879 7465	0418 515 365
Design Consultant	Dilbert Geeko	Runway Designs	02 5487 1264	02 4564 1545	0467 056 565
Works Manager	Phillip Markus	GoodPave	08 8975 4554	08 8975 4500	0478 546 656
Works Supervisor	Richard Rott	GoodPave	08 8975 5444	08 8975 4500	0411 254 915
Sub-Contractor 1	Tony Craw	CSR	08 8972 1212	08 8972 1210	

5. NOTAMS

SATCO is to arrange for NOTAMs for the duration of the restrictions to the airfield, associated with the works. Draft text for the NOTAM is attached at annex B. Dates and times are indicative only and will be confirmed 48 hours before the commencement of each stage.

The NOTAMs are to be released at least 48 hrs prior to the commencement of the works.

Works are not to commence until the Project Officer and the Works Supervisor are provided with a hard copy of the NOTAM.

6. AUTHORITY

6.1 Issue

This MOWP is issued in accordance with MOS-139, ADFP 602, RPAs and ICAO Annex 14. All works will be carried out in accordance with the MOWP.

6.2 Variation

No variation to this MOWP (including the NOTAM text) is to take place without the approval of the signatories.

Requests or proposals to amend or vary the MOWP, as well as queries on its content or meaning, are to be directed to the DSG Project Officer.

6.3 Expiry of this MOWP

This MOWP will remain current until 25 December 2008 unless extended by amendment.

6.4 Approval

Under the authority of the following signatures, this MOWP is approved for release.

J. B. SMITH	**R. P. STUFF**	**H. F. MANGO**
GPCAPT	LTCOL	CEO
OC TDL	MI-NT	Katherine Airport
08 8973 1000	08 8975 2763	08 8971 1263
20 Sep 08	20 Sep 08	20 Sep 08

Annex:

A. Distribution List
B. NOTAM text

Drawings:

DWG0001 dated 12 Jul 08
DWG0002 dated 12 Jul 08
DWG0003 dated 12 Jul 08
DWG0004 dated 12 Jul 08
DWG0005 dated 12 Jul 08
DWG0006 dated 12 Jul 08

ANNEX A TO
MOWP YPTN 08/1
DATED 20 SEP 08

DISTRIBUTION LIST

Main Distribution:

BFSO/BASO TDL	1
BAEO TDL	1
SECO TDL	1
44 WG DET CMDR (TDL)	1
Lloyds Helicopters (TDL Manager)	1
Asset Services Pty Ltd (TDL Manager)	1
GoodPave Pty Ltd (Mr Phillip Markus)	3
Katherine Airport (CEO)	2
CASA (Relevant Aerodrome Inspector)	1
Rescue & Fire Fighting Service Provider	1
Project Manager/Contract Administrator	1

For Information:

AFHQ (DGCP-AF)	1
AFHQ (DIDA-AF)	1
DSG	
DSG-ID-EPE-DEEP (SCE)	1
DS-NT/K (Regional Manager)	1
HQAC (Airfield Engineering Support)	1
HQAC (DOS)	1
HQCSG (SOAE)	1
HQTFG (SOPSO)	1
322 CSW (OC)	1
322 CSS (CO)	1
75 SQN (CO)	1

ANNEX B TO
MOWP YPTN 08/1
DATED 20 SEP 08

NOTAM TEXT

For all Stages of work

Workmen and equipment present on RWY 11/29 between 11 THR and intersection with RWY 18/36.

THR 11 displaced 800 m (2625 ft).
RWY 29 end displaced by 800 m (2625 ft).
THR 11 lighting not available.
RWY 29 end lighting not available.
RWY 11 TVASIS not available.
Temporary A-PAPI available on LHS of RWY 11 (nb: A-PAPI not flight tested).
RWY 18/36 not available.
TXYs A and B will have restricted availability as advised by ATC.

All movement areas available for a Declared Emergency with 30 min notice.

All unavailable areas marked by white/red or orange cones.
Displaced THR marked by white cones across RWY.

Declared Distances (m) will be:

	RWY 11	**RWY 29**
TORA	1835	1835
TODA	1895	1835
LDA	1835	1835
ASDA	1835	1835

B - Enclosure Three: MOWP Definitions

MOWP DEFINITIONS

Airfield:	As defined by ASCC Air Standard 85/1 *Glossary of Terms and Definitions*, current issue (incorporating NATO AAP-6(2007), *NATO Glossary of Terms and Definitions*). The individual airfield boundaries are usually described in Base Standing Instructions. Generally, the airfield is[1] *an area prepared for the accommodation (including any buildings, installations and equipment), landing and take-off of aircraft*.
Air Navigation Act:	Refers to the Air Navigation Act 1920
Air Traffic Control:	A service provided under DI(AF)AAP 8132.0043, Air Traffic Control Organisation and Administration or Regulation 93 of the Air Navigation Regulations.
Base Commander	The person designated as the Base Commander (Equivalent) / Senior Military Representative / Air Base Capability Manager (AIRCDR/GPCAPT) or their nominated representative, usually the Commanding Officer (CO) of the Combat Support Unit (CSU) (WGCDR).
Clearance Surfaces:	Those surfaces projected from the runways and taxiways both vertically and horizontally which determine obstructions.
Contractor:	The person or organisation responsible for executing the prescribed works.
Declared Distances:	Declared distances are distances associated with the runway and surfaces beyond the departure end on the runway that are used for the calculation of available distances associated with take off and landing of aircraft.
Defence:	See "Department"
Department:	The Department of Defence.
Manoeuvring Area:	That part of an aerodrome/airfield to be used for the take-off, landing and taxiing of aircraft, excluding aprons.
Method of Working Plan:	A document which sets out the scope, method and coordination of works to an airfield and safety measures to be implemented in the affected movement areas.
Movement Area:	That part of an aerodrome/airfield to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).
NOTAM:	Notice to Airmen. A promulgated message regarding the availability (or otherwise) of the subject airfield, for aircraft operations.
Originator:	The originator is the person who is responsible for detailing the criteria appropriate to the works to be carried out under the authority (control) of the MOWP.

[1] NATO Document AAP-6 2007: http://www.nato.int/docu/stanag/aap006/aap-6-2007.pdf

Overrun Areas:	Portions of the surface of the ground, rectangular in shape at the end of the runway strip.
Project Officer:	The Officer who uses the Originator's material to prepare the MOWP.
RPT	Regular Public Transport. An airfield is said to support RPT if a schedule of public transport flights to and from that airport is held.
Stopways/Clearways:	Stopways and clearways are generally cleared and prepared areas beyond the runways that are used in association with take off and landing of aircraft.
Time Limited Works:	The work is of a maintenance nature and the work is carried out in between aircraft operations without affecting aircraft operations. Generally the affected area can be vacated/restored within ten minutes to a state which will allow aircraft operations to take place within normal safety requirements and standards.
Works:	Inspections, surveys, new constructions, maintenance and other undertakings affecting airfield or route facilities, which require access to the area enclosing the movement area or infringe the clearance surfaces or overruns or other activity which the Authority considers jeopardises the safe operation of aircraft using the airfield and its facilities whether executed by, or on behalf of the Department or any other person.
Works Manager:	The Contractor’s authorised manager of the works. The Works Manager is responsible for ensuring the Contractor’s compliance with the MOWP through the Works Supervisor.
Works Safety Officer:	A designated person who is responsible for aircraft/airfield safety requirements in accordance with the MOWP.
Works Supervisor:	The representative of the Contractor who carries out the duties and has the responsibilities as described within the MOWP. The Works Supervisor must be on site during work periods.

Appendix C Heavy Roller Operating Manual

SINCLAIR KNIGHT MERZ

SKM

Australian Government

Department of Defence

Defence Support Group

Heavy Roller Operating Manual

- Final
- 06 May 2009

Australian Government
Department of Defence
Defence Support Group

Heavy Roller Operating Manual

- FINAL
- 06 May 2009

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1. Introduction

1.1 General

The Department of Defence - Defence Services Group – Infrastructure Asset Development Branch – Directorate of Estate Engineering Policy – Civil Engineering Section manages a number of heavy rollers specifically for use for compaction and proof rolling of aircraft pavements and subgrades during their construction or strength evaluation of existing pavements. These rollers are usually hired by construction companies contracted to construct aircraft pavements on Defence airfields. Construction companies contracted to construct aircraft pavements on non-Defence airfields and consultants are also permitted to hire the rollers.

Defence currently maintains a fleet of nine heavy rollers. These include eight pneumatic tyred rollers (previously called Marco and Macro Rollers) of which three have been refurbished as pneumatic tyred types, two have been refurbished with solidified pneumatic type tyres, and one (ninth) has been fitted with solid urethane rubber coated wheels designed to provide an average contact pressure of 1,700 kPa. The pneumatic tyred rollers are currently limited to a tyre inflation pressure of 1,000 kPa.

1.2 Aim of Document

This document is an update of the Heavy Roller Operating Manual prepared for Defence by Airplan (Pavement Specialist Services) in January 2003. The primary aim of this document is to detail the number, configuration, operation and use of the rollers for the compaction and proof rolling of aircraft pavements during construction. However, these heavy rollers are also suitable for strength evaluation of some existing aircraft pavements, if required, when other methodologies are inappropriate. Transport, maintenance, storage and operating requirements are also included.

1.3 Background

Compaction and proof rolling is the act of inducing a stress in a pavement layer that exceeds its expected in-service stress. By inducing a number of repetitions of stress that exceed the service stress, any deficiency in the quality of the materials or state of compaction in the layer can be identified prior to the acceptance of the layer being proven and its covering by the subsequent pavement layers. The proof rolling process applies additional construction compaction as the materials are proof rolled whilst at their optimum moisture content.

The current method for aircraft pavement thickness design is based on the full scale testing and design procedure developed by the US Army Corps of Engineers in the 1940s to 1970s. The development of this thickness design method was based on a number of assumptions regarding materials and construction processes. One of those assumptions was that all subgrade and granular pavement materials would be proof rolled during construction. Australia has retained proof rolling as a routine part of aircraft pavement construction. Other countries have not. The USA has largely discontinued proof rolling but has adopted cemented base course and thick asphalt surfacings instead[2)].

Proof rolling is considered an integral part of aircraft pavement construction in Australia, without which the basis of the pavement thickness design is voided. With the trend for aircraft manufacturers to produce heavier aircraft with increasing wheel loads (now up to 30 t for the A340-600 aircraft) and tyre pressures (1,570 kPa for the A340-600), proof rolling pavements is becoming increasingly critical.

Defence imported two rollers from the USA in the 1950s. These rollers, known as Macro rollers, were capable of applying up to 50 t on four wheels with a tyre pressure of up to 1,400 kPa. The Commonwealth then constructed, a number of additional Macro rollers, based on the US roller design. In additional, a roller was modified to replicate the stress with depth induced by a B727 aircraft and was known as the Test Rig. As the B727 is no longer an active aircraft type, this roller has not been maintained. Two 200t rollers known as the Porter Supercompactors were also developed for proving deep layers of hydraulically placed sand fill. One of these was sold to Hong Kong Airport in the 1990s and the other is located at RAAF Pearce. Due to the lack of demand for a Supercompactor, Defence have not maintained the remaining roller.

In 2004 a number of projects, including those at Sydney Airport and Cairns Airport, were underway. During the preparation for the proof rolling of the granular layers, the Macro Roller tyre suppliers (Michelin tyres at the time) revoked the previous certification (of which no record can be found) to inflate the tyres to very high pressures. The tyres are rated to 1000 kPa whereas a previous agreement had been reached to allow 1400 kPa to be utilised with restrictions on the operation of the rollers (such as maximum travel speeds). Further discussion with Michelin and other tyre manufacturers (Bridgestone) revealed that due to increasing OHS issues and the increasingly litigious society, no earthmoving tyre would be rated or certified for inflation above 1000 kPa. The existing tyres were also deemed to be unserviceable due to their age and replacement tyres of the same type were not available, the line of tyres being virtually discontinued.

The limitation of the pneumatic tyred rollers to 1,000 kPa inflation pressure left a gap between the stresses induced by modern aircraft and the capacity of the rollers. This

meant that pavement layers could not be proven for adequacy under design aircraft loads during construction. The 'gap' existed only for the proving of the upper base course layers of flexible pavements with thin asphalt surfacings (ie the top 200 mm of base course under a 50-60 mm asphalt surface) as shown in Figure 1.

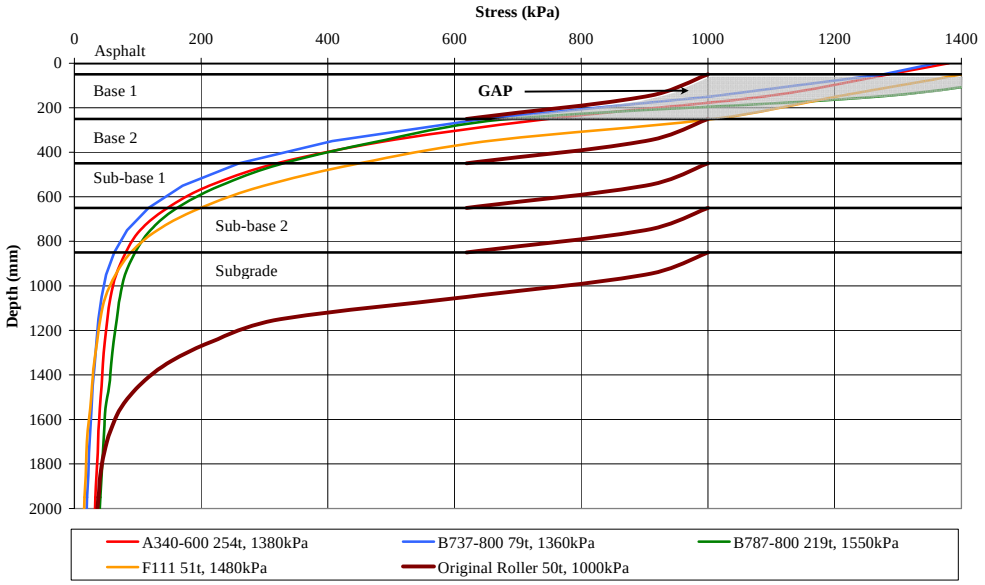

Figure 1. Proof Rolling Gap with 1,000 kPa pressure limit.

Following a number of investigations, one roller was upgraded to include solid steel wheels with a urethane rubber outer liner or solid tyre. The urethane was intended to have an average effective contact pressure of 1,700 kPa. This roller successfully filled the gap left by the 1,000 kPa tyre pressure restriction. A preliminary trial of the solid tyred roller was held at RAAF Base Amberley in June 2007. Following further trials, additional solid tyred rollers are expected to be developed through upgrading of the existing roller fleet.

Two rollers have also been equipped with 'solidified pneumatic tyres' and were intended to be able to create surface pressure of 1,000 kPa and 1,400 kPa. Recent trials have shown that at maximum weight (50t on the standard 4 wheel Marco roller, i.e. a 12.5t wheel load) only 1,020 kPa and 1,040 kPa have been achieved by these rollers.

1.4 Current Roller Fleet

As of May 2009, the Defence heavy roller fleet is detailed in **Table 1**.

Table 1. Heavy Roller Fleet.

Roller	Type	Location	Condition
R50-1	Pneumatic	RAAF Edinburgh	Sound except tyres
R50-2	Pneumatic	RAAF Edinburgh	Tow hitch removed
R50-3	Solidified Pneumatic 10,040 kPa*	RAAF Amberley	Modified to solidified pneumatic tyres
R50-4	Pneumatic	RAAF Learmonth	Unknown
R50-5	Pneumatic	Canberra Airport	Unknown
R50-6	Pneumatic 1,000 kPa	RAAF Williamtown	Refurbished
R50-7	Pneumatic 1,000 kPa	Gold Coast	Refurbished
R50-8	Solidified Pneumatic 1,020 kPa*	Sydney Airport	Modified to solidified pneumatic tyres
R50-9	Solid 1,700 kPa	RAAF Amberley	Upgraded and refurbished

**These 'Solidified Pneumatic' tyred rollers achieve this pressure at a load of 12.5T per wheel / 50T all up weight, on a standard 4 wheel Marco Roller.*

The rollers detailed in Table 2 also remain in Australia but are not being maintained or hired out by Defence.

Table 2. Disused Rollers.

Roller	Type	Location	Condition
R200-1	Supercompactor	RAAF Pearce	Unknown
R50-TR	Test Rig	Sydney Airport	Unknown

2. Roller Types and Description

2.1 General

There are three (3) types of heavy compaction/proof rolling rollers available from Defence for hire. Basically the body/frame & ballast are common to all, however the wheels and tyres differ depending on application. The different wheel types are described below.

a) Pneumatic Tyred Rollers

Four wheeled pneumatic tyred rollers fitted with wheels for use with high pressure Radial 16–R24 or similar tyres which are designed to carry a maximum tyre pressure of 800kPa (old type, generally Michelin tyres) and 1,000 kPa (refurbished type). It is noted that the old tyres limited to 800kPa have a weight limitation of 7.5 tonnes per wheel or 30 tonnes AUM due to the tyre pressure limitation.

Two rollers have also been fitted with solidified pneumatic tyres. These rollers are fitted with Indian made 'CEAT' brand tyres and have been shown to acheive 1040kPa surface pressure under 12.5 t wheel loads.

b) Solid Tyred Roller

A single four wheeled solid tyred roller fitted with solid steel wheels with a urethane coating, designed for operation at an effective contact pressure of 1,700 kPa at 40 t total roller mass is available. The roller is designed to operate at a maximum mass of 50 t.

The solid tyred roller is only suitable for operation on smooth, compacted, base course layers of high quality crushed rock. Its use on subgrade, fills of any type, sub-base and cement treated materials is not recommended and may result in bogging of and/or damage to the roller or wheel coatings

2.2 Physical Description of Rollers

The following physical description applies to both types of pneumatic tyred roller & the solid tyred roller.

The complete roller consists of two articulated units each 4,500 mm long, 2,000 mm wide and 1,400 mm high. The overall dimensions of the roller are 8,120 mm long (including drawbar), 4,180 mm wide and 1,400 mm high.

The frame is fabricated from 304 RSC 42 section. There are eight ballast boxes per roller, which each measure 1,050 mm long, 800 mm wide and 700 mm high. The two units are joined by three 65 mm pins through hinge plates which allow the units to articulate.

The four wheel assemblies are mounted in the frame on horizontally split mounting blocks and retained by caps using 32 mm (1.25 inch) Grade 5 bolts, nuts and structural grade washers. The bolts and nuts should be torqued to 1,400 Nm (which is a force of 70 kg on a two metre bar). Grade 5 bolts are identified by radial marks as illustrated in Figure 2.

Figure 2. Pneumatic tyred roller wheel nut, note radial marks denoting Grade 5 Bolt.

2.3 Transportation

The pneumatic tyred roller is typically transported in an un-ballasted condition on a standard semi-trailer or by rail.

Loading of the un-ballasted roller onto the semi-trailer is either by crane lifting the roller onto the trailer or through the use of a front end loader (eg Caterpillar 950 or similar) pushing the roller onto the trailer either through the use of earth loading ramps or trailers fitted with loading ramps. Transport operators are to make enquires of the individual airports and Defence installations as to whether loading ramps are available.

Weights are loaded either through cranage or lifting with a front end loader or similar.

Transport operators are to make their own assessment of cranage requirements for lifting of unballasted rollers and weights.

2.4 Ballasting

The empty roller should be placed approximately level with the rear blocked up. The jacks on the front corners of the boxes should be extended 250 mm to 300 mm after taking load. This will make the front of the box higher than the rear and make it easier to stack the weights.

The ballasting should be done with pig iron or steel ingots, which should be blocked or wedged as necessary to prevent them shifting when the roller moves.

To avoid injury during the ballast loading of the rollers, staff must never stand in areas over which the weights are lifted and must never enter the ballast boxes containing

weights. Optional ballast arrangements for different types of weights are shown in **Figures 3** and **Figure 4**.

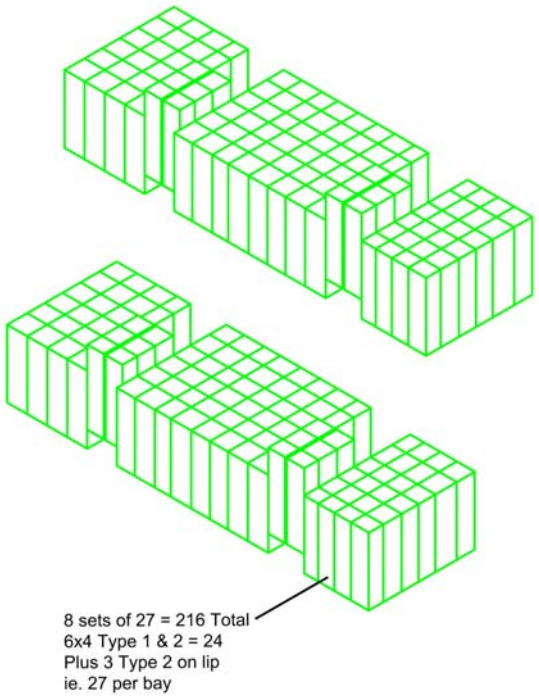

Figure 3. Ballast Arrangement for Red Weights.

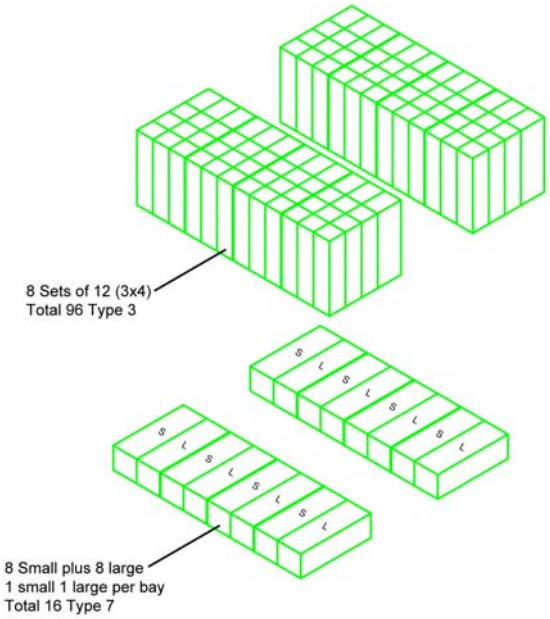

Figure 4. Ballast Arrangement for Yellow, White and Grey Weights.

The ballast for the solid tyred roller has been 'boxed' as shown in **Figure 5** to make loading and unloading more efficient and to minimise the OHS risks associated with handling the ballast.

Figure 5. Boxed ballast.

2.5 Weight and Tyre Pressure Restriction for Pneumatic Tyred Rollers Old Marco with 800kPa Tyre Pressures

a) When fully loaded with 21,800 kg of ballast, a tyre pressure of 800 kPa should be maintained at all times. Allowable tyre pressures for intermediate loadings are shown in Table 3 and graphically at Figure 6. Tyres can not be inflated beyond 800 kPa inflation pressure due to the withdrawal of previous relaxations allowed by the tyre manufacturers.

Ballast (kg)	Total Load (kg)	Minimum (kPa)	Maximum (kPa)
21,800	30,000	800	800
16,800	25,000	675	800
11,800	20,000	540	800
6,800	15,000	400	800
1,800	10,000	270	800

Table 3 *Allowable Tyre Pressures*

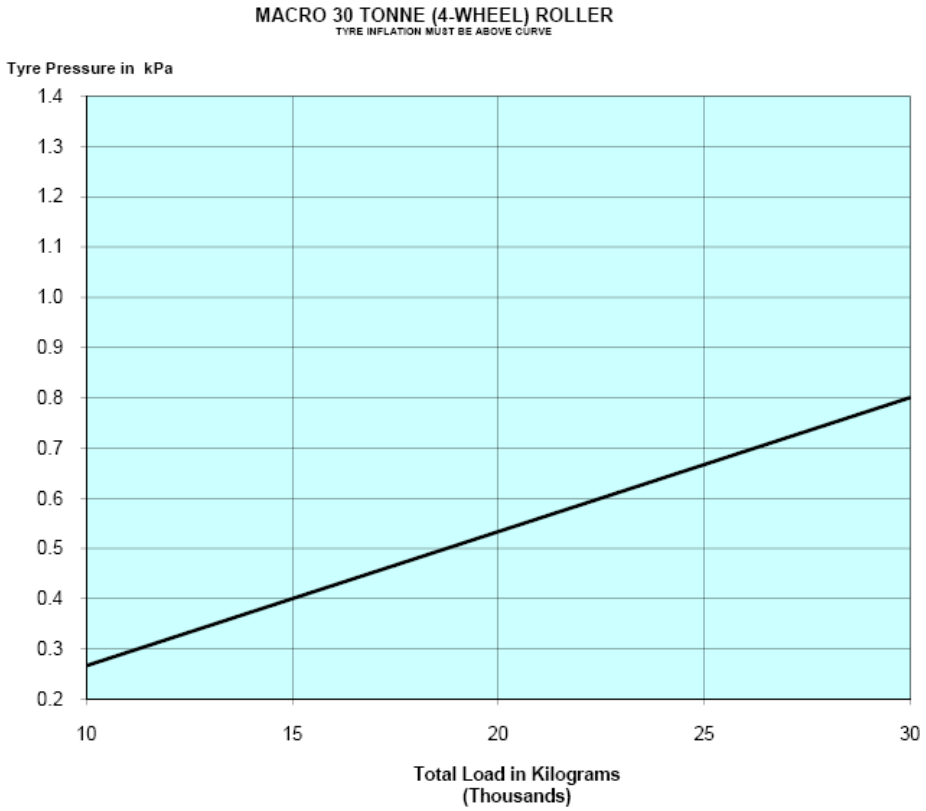

***Figure 6**. Minimum Allowable Tyre Pressure*

b) Refurbished Roller with 1,000kPa tyres and solidified pneumatic tyres

These instruction refer to the operation of rollers with refurbished tyres such as the Bridgestone Industrial Service 16.00-25 32 Ply YS2 or the CEAT 16.00-25 Tubeless, Slick 431L-47 tyre modified to solidified tyres by Bearcat.

Brisgeston Tyres can not be inflated beyond 1,000 kPa inflation pressure due to the withdrawal of previous relaxations allowed by the tyre manufacturers.

Solidified pneumatic tyres (rollers fitted with CEAT brand tyres) have been shown to achieve up to 1,040kPa surface pressure under 12.5t wheel loads.

Allowable tyre pressures for intermediate loadings are shown in **Table 4** and **Figure 7** for the Bridgestone Industrial Service 16.00-25 32 Ply YS2 tyre limited to 10 km/hr. The manufacturer must be consulted to determine the allowable tyre pressure-mass relationship for other tyres.

Table 4. Intermediate Tyre Pressure and Masses (Bridgestone Industrial Service 16.00-25 32 Ply YS2 tyre limited to 10 km/hr).

Ballast (kg)	Total Load (kg)	Minimum (kPa)	Maximum (kPa)
41,800	50,000	600	1,000
36,800	45,000	500	1,000
31,800	40,000	410	1,000
26,800	35,000	320	1,000
21,800	30,000	250	1,000
16,800	25,000	190	1,000
11,800	20,000	120	1,000
6,800	15,000	80	1,000
1,800	10,000	40	1,000

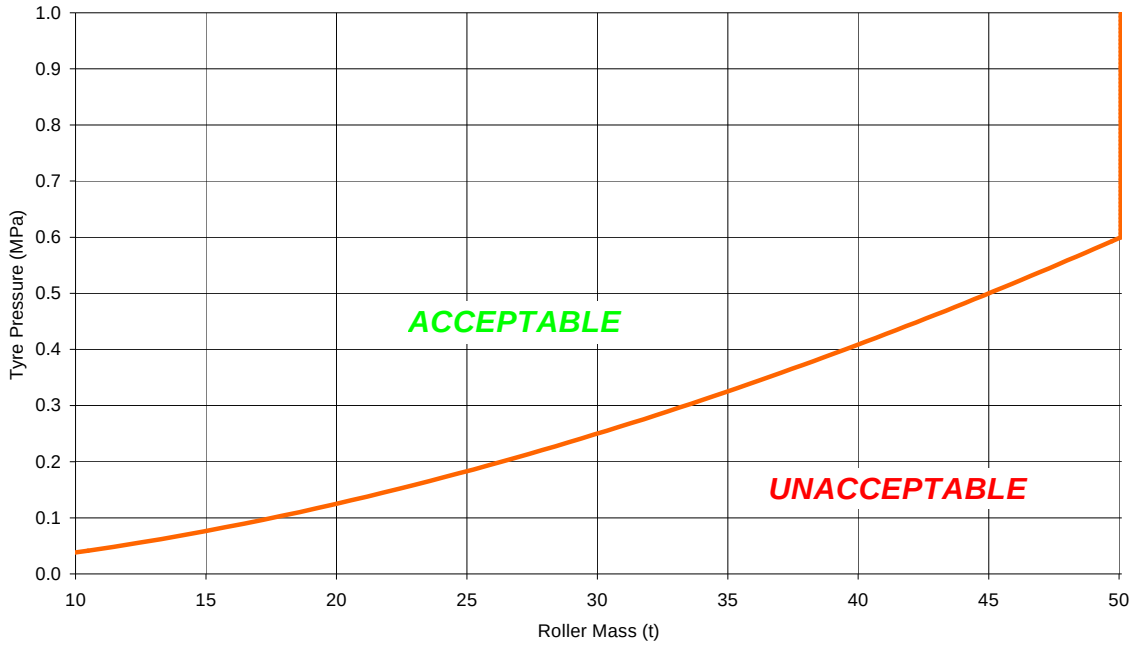

Figure 7. Allowable Tyre Pressure and Mass Combinations (for Bridgestone Industrial Service 16.00-25 32 Ply YS2 tyre limited to 10 km/hr).

2.6 Weight and Wheel Contact Pressure for Solid Tyred Roller

These Specification, Operating and Maintenance Instructions refer to four wheeled solid tyred roller fitted with solid steel wheels with a urethane coating, designed for operation at an effective contact pressure of 1,700 kPa at 40 t total roller mass. The roller is designed to operate at a maximum mass of 50 t.

The roller is fitted with solid steel wheels with urethane coating or tyre as shown in **Figure 8**.

Figure 8. Solid steel wheels with urethane tyre.

Due to the nature of solid tyres, the tyre pressure can not be selected for this roller. The tyre pressure is a direct function of the mass adopted. The relationship between roller mass and average effective contact pressure is detailed in **Figure 9**, based on load/contact area calculations of the actual wheels.

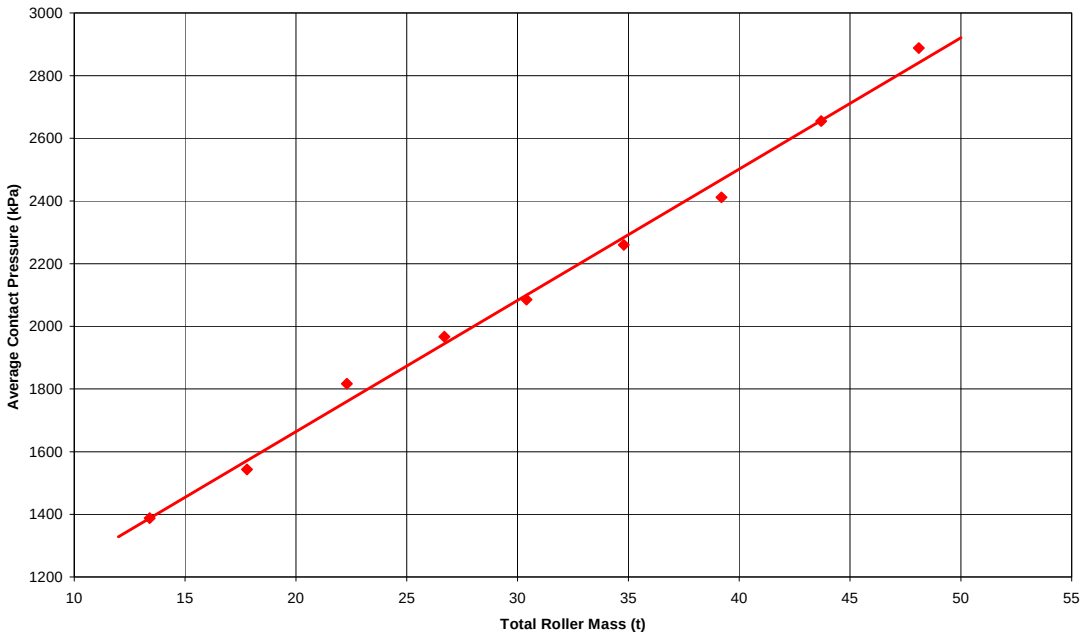

Figure 9. Mass and Effective Contact Pressure Relationship

2.7 Operating Speed Limits

One of the major causes of structural damage to tyres is excessive tyre deflection, which can cause cracking in the tyre wall.

Operation of the solid tyred rollers is limited to 6km/hr under all conditions.

In addition to the pressure-load relationship detailed above, deflection is affected by the speed at which the roller operates and the under-foot conditions. Therefore the following speed limits must be observed at all times for pneumatic tyred rollers:

- First passes over uncompacted fill or in transit over uneven terrain. 6km/hr.
- Subsequent passes over fill and in transit over smooth terrain. 10km/hr. The operation of the ballasted roller is restricted to 6 km/hr.

2.8 Tyre Data

Tyres must be a Bridgestone Industrial Service 16.00-25 32 Ply YS2 or equivalent earthmoving tyre rated for inflation to 1,000 kPa at maximum wheel load of 8,750 kg, as shown in **Figure 10**.

Figure 10. Bridgestone 16.00-25 32 Ply YS2 tyres fitted to roller.

Rollers with solidified pneumatic tyres have used Indian made CEAT 16.00-25 Tubeless, Slick 431L-47 Nylon industrial tyres.

2.9 Tyre Inflation Information

Because of the high energy stored in tyres when inflated with air only, operators and service people should be aware of the potential danger of a blowout.

As a safety precaution, all tyres should be ballasted first with water to 75% of their volume so as to reduce the stored energy.

The internal volume is approximately 390 litres

- 75% is approximately 290 litres
- mass of water ballast 290 kg

Rust prevention additive should be added to the water in accordance with the tyre manufacturer's recommendations.

Notwithstanding the recommendations and requirements of the tyre manufacturer the following procedures should be adopted as good practice:

- When inflating tyres, use an inflation device with at least three (3) metres of hose between the valve on the rim and the in line inflation control valve. This allows the

tyre service person to inflate the tyre and check inflation pressure without standing in front of the tyre and rim assembly.

- Always check that the components of the assembled tyre are correctly positioned and the tyre is safe to inflate.
- Inflate the tyre to 30% of the recommended cold working pressure and check that the tyre has seated correctly on the rim assembly. If the tyre has not seated correctly, deflate and recommence the inflation procedure. Refit the valve core and cap once the required inflation pressure has been reached.
- Leakage of air from the valve stems of these tyres is generally caused through over-tightening the valve stem cores. This may be corrected by replacement with new valve cores and avoidance of over-tightening.

The following safety guidelines should be observed during tyre inflation:

- Never under any circumstances leave an inflating tyre unattended.
- If there is any doubt about the seating of a tyre onto a rim base during inflation, turn the air supply off and deflate the tyre for inspection.
- Never stand in front of a vertical tyre during deflation.
- Never stand over or sit on a horizontal tyre during inflation.
- Never put yourself between the tyre and an immovable object.
- Rollers must be un-ballasted when undertaking tyre changes.

2.10 Roller Maintenance

2.10.1 Operating Roller Maintenance

The following procedures should be undertaken when the roller is in use:

- Grease all pivot points (daily).
- Check tyre pressure (daily).
- Check tyre wear (daily).
- Block roller at the end of each day to take load off the tyres (daily).
- Check tow bar coupling and drawbar pin for wear, damage and cracks (weekly).
- Check frame for cracks and signs of fatigue (weekly).
- Check all studs, bolts and nuts for tightness (weekly).

- Check welds on axle mounting blocks and gussets to ensure there are no cracks (weekly).
- Maintain all painted surfaces to ensure the roller remains free of corrosion (as required).

2.10.2 Periodic Roller Maintenance

Defence may require the following maintenance to be performed at no cost to the hiring contractor:

- Wheel and Tyre Maintenance:
  - Replace any damaged tyres (as required).
  - Repack wheel bearings with a NLGI 3 grease (12 monthly).
  - Replace wheel bearings (as required).
  - Replace hub seals (as required).
  - Apply rust preventive paint to the inner faces of the wheel rims and the cylindrical faces of the wheels (as required).
  - Apply anti-freeze compound to the axle clamp bolts (as required).
- Paintwork Maintenance:
  - Treat any rust and ensure that paintwork is in good condition (as required).
  - Repaint as required following maintenance (as required).
  - Particular attention should be given to welded joints, ballast boxes, carriage frame, underside of gusset plates and wheel rims.
- Crack and Weld Maintenance:
  - Undertake weld and crack repairs in equipment carriage frame, gusset plates, axle mounting blocks and gussets (as required).
  - Particular attention should be given to the tow frame, hinge plates and ballast boxes.

2.10.3 Periodic Roller Inspections

During long term hires or as directed by the Fleet Manager, the following inspections must be carried out:

- Wheel and Tyre Inspection:
  - Inspect tyres for visible cracks and edge fretting (on return from hire and prior to hire).
  - Inspect wheel rims for damage, rust or damaged paint (on return from hire and prior to hire).

- Check inflation pressure and maintain at not less than 300 kPa (3 monthly)- Pneumatic only.
- Rotate wheels to prevent etching of bearings (3 monthly).
- When rotating wheels listen for bearing noise (3 monthly).
- Inspect hub seals for leaks (3 monthly).
- Check wheel bearing adjustment. Bearing should have zero end-float (6 monthly).
- Apply anti-freeze compound to the axle clamp bolts (6 monthly).

- Paintwork Inspection:
  - Inspect paint for damage (6 monthly).
  - Identify paint scratches, paint peeling and signs of corrosion (6 monthly).
  - Treat any rust and ensure that paintwork is in good condition (as required).
  - Particular attention should be given to welded joints, ballast boxes, carriage frame, underside of gusset plates and wheel rims.
- Crack and Weld Inspection:
  - Inspect roller frame for cracks and tears (6 monthly).
  - Identify signs of corrosion, visible cracks at all welded joints (6 monthly).
  - Identify tears in equipment carriage frame, gusset plates, axle mounting blocks and gussets (6 monthly).
  - Particular attention should be given to the tow frame, hinge plates and ballast boxes.

2.11 Roller Storage

When not in use for a period exceeding 24 hours but not exceeding 7 days, the roller must be blocked to take the weight off the wheels. When not in use for a period of more than seven days, the roller must be stored as if being placed into long term storage.

Long terms storage requirements are:

- Undercover storage:
  - Unballast the roller.
  - Block machine and take weight off wheels.
  - Ensure the sufficient blocks are used to distribute weight to protect pavement.
- Open-air storage:
  - As for undercover storage

– Remove the wheels and store wheels in a covered area or cover with tarps. Note protection of wheels both tyred and solid urethane against UV degradation is important.

3. Design of Proof Rolling Regimes

3.1 General

The aim of proof rolling these heavy duty pavements is to expose the various layers to a level of 'damage' (indicated by calculated stress, strain or deflection) that is slightly greater than the maximum expected service 'damage', prior to constructing the next layer of the pavement structure. By proving pavements in this manner, the variability of the structural strength of the pavement is significantly reduced, allowing thinner pavements to be constructed with equal reliability.

The design of proof rolling regimes therefore comprises two steps:

- Calculating the values of the chosen indicator of damage at various depths through the pavement layers.
- Selection of a proof rolling regime (mass and tyre pressure combination) to be applied to the various layers of the pavement structure such that the calculated maximum service damage indicator value is just exceeded.

3.2 Damage Indicator Calculation

In 1996, MINCAD Systems first released the aircraft pavement specific version of CIRCLY, titled Aircraft Pavement Structural Design System (APSDS) (MINCAD, 2000). The layered elastic component of the design tool is used for the calculation of the damage (stress, strain or deflection at the critical points) induced by a single load application. Many other mechanistic aircraft pavement design tools are also available for the generation of these pavement damage indicators.

During each design scenario, the layered elastic design tool algorithms calculate the stresses, strains and deflections of the pavement at a range of depths, as well as at user defined lateral and longitudinal coordinates. The ability to view all damage indicators calculated at all pavement locations is not available in all layered elastic tools and is one advantage of APSDS. This provides for the ability to easily generate plots of stress, strain and deflection against depth under the aircraft wheels or between aircraft wheels.

An investigation performed by Greg White in 2007 determined that the most appropriate method of determining proof rolling regimes was by comparing stress with depth. Stress was selected as it provided the following advantages:

- Easy to visualise and understand compared to strain.
- Equal to tyre pressure at the pavement surface.
- Related to load per landing gear at depth.

- Essentially equal for all modeled subgrade strengths and granular pavement materials.
- Essentially equal, at depth, under the tyre and in the centre of a multiple wheel landing gear.
- Decreases smoothly with increased depth from a maximum value at the surface.

This investigation also determined that for practical purposes, a standard pavement of 1000 mm of crushed rock base course on CBR 6 subgrade could be used for stress with depth calculations for proof rolling regime design. This selection is based justified by:

- All materials having an essentially negligible differential effect.
- The relative or comparative (aircraft to roller) stress being more important than the accuracy of any absolute stress values.
- Base material having a modulus approximately equal to the mean of the moduli of asphalt and subgrade.
- CBR 6 being typical of many pavement subgrades at airports in Australia.

When absolute stresses or far from typical pavement structures are required, a customised pavement for the determination of stress with depth may be justified. However, as the roller and the aircraft stress with depth would be similarly affected by the non-standard pavement, it would be inconsequential to use a single layer pavement in most practical circumstances. Where required, customised stress with depth plots can readily be generated for any pavement structure, for both the design aircraft and the proposed proof rollers, using APSDS or other layered elastic tool.

3.3 Roller Stress with Depth

Roller stresses with depth are generated based on the level of the pavement layer being rolled. This is because the roller is applied directly to this pavement layer at the time that it is constructed and not to the finished surface level.

Example stress with depth plots are shown in **Figure 11** for the pneumatic tyred roller at varying mass and tyre pressure combinations as permitted for generic tyre types (maximum allowable mass adopted for each tyre pressure considered).

Figure 12 shows an equivalent stress with depth plot for the 1,700 kPa solid tyred roller. It is noted that the 1000 kPa/36 t pneumatic tyred roller is included for reference. The stress with depth induced in base course material (assuming a 50 mm thick surface layer) by the A340-600 and F111 aircraft are also included. Only 300 mm of pavement thickness is shown as the solid tyred roller is only for proving base course layers and these are generally limited to 200 mm thickness to enable adequate compaction to be

achieved. From **Figure 12** it can be seen that even at 30 t total mass, the solid tyred roller's 1,700 kPa effective contact pressure is more than adequate to prove the top 250-300 mm of base course for the A340-600 and F111 aircraft.

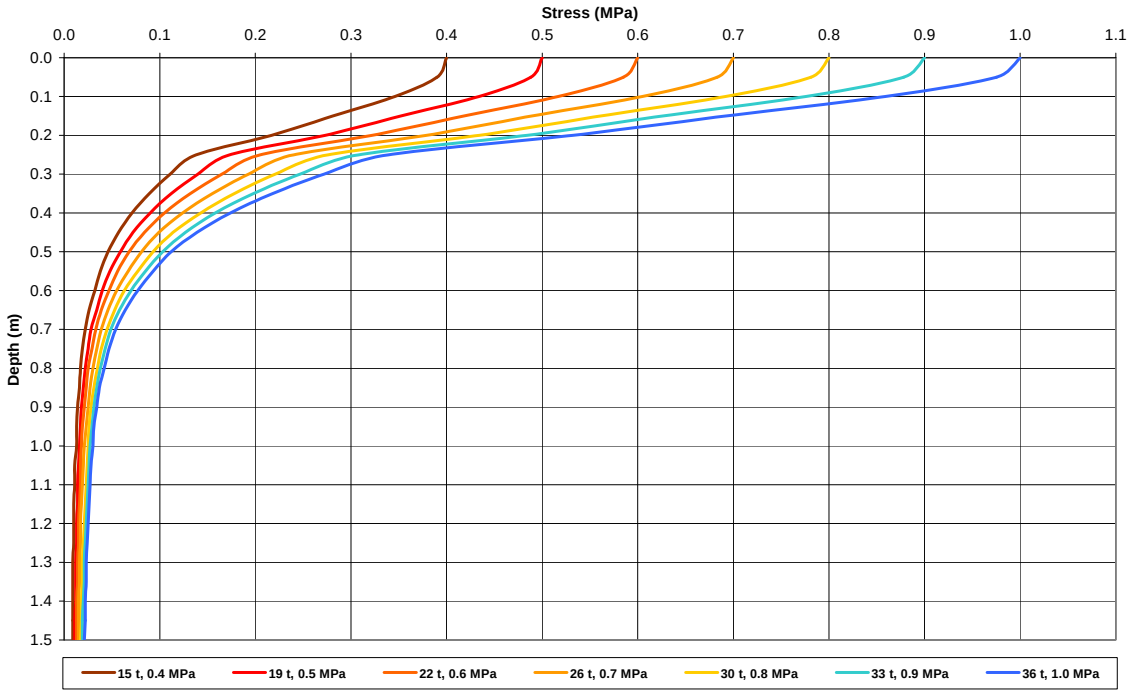

Figure 11. Example Pneumatic Tyre roller stress with depth plots.

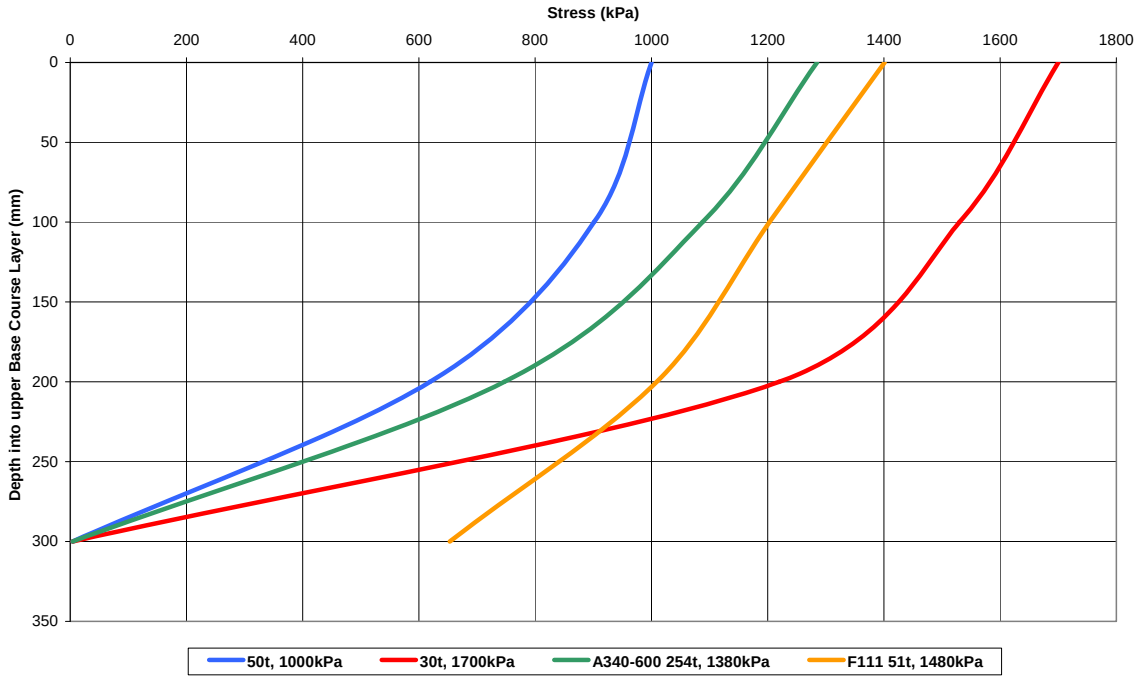

Figure 12. Example Solid Tyre roller stress with depth plots.

3.4 Aircraft Stress with Depth

Aircraft stresses with depth are generated from the theoretical finished surface level of the pavement as this is where the aircraft loads will be applied. Example stress with depth plots for a number of common aircraft are shown in **Figure 13**.

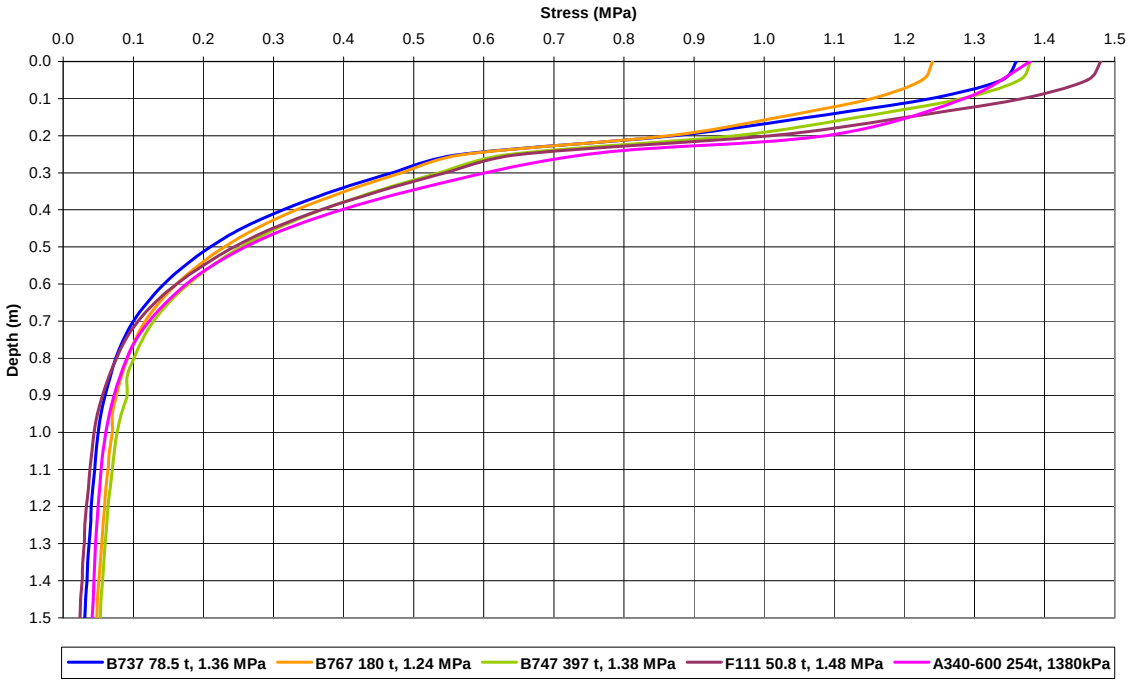

Figure 13. Common aircraft stress with depth examples.

3.5 Proof Rolling Regimes Design

The proof rolling regime is then generated on a layer-by-layer basis, with the combination of mass and tyre pressure for the pneumatic tyred roller selected so that the stresses at depth just exceed those induced by the aircraft when applied at the finished pavement surface. For the upper base course layers, the solid tyred roller will be required for pavements designed for high tyre pressure aircraft. To allow the depths in the pavement that the rollers are to be applied to be determined, the pavement composition must be known. Stresses with depth can remain generated for simplified pavement structures (eg 1000 mm base on CBR 6%) for convenience as long as the same simplified pavement structure is adopted for aircraft and roller stress with depth calculations.

An example (fictitious) proof rolling regime resulting from this process is detailed in **Figure 14**. The aircraft (F111 in this case) stress with depth is shown in blue. The roller stresses with depth (applied at each pavement layer shown) are detailed as follows:

- Red. Solid tyred roller applied to top of upper base course layer at 30t and 1,700 kPa.
- Purple. Solid tyred roller applied to top of lower base course layer at 30t and 1,700 kPa.
- Green. Pneumatic tyred roller applied to top of sub-base at 30 t and 0.8 MPa.

- Orange. Pneumatic tyred roller applied to top of subgrade or fill at 19 t and 0.5 MPa.

Typically 8-12 coverages of all areas of the pavement layer surface are specified.

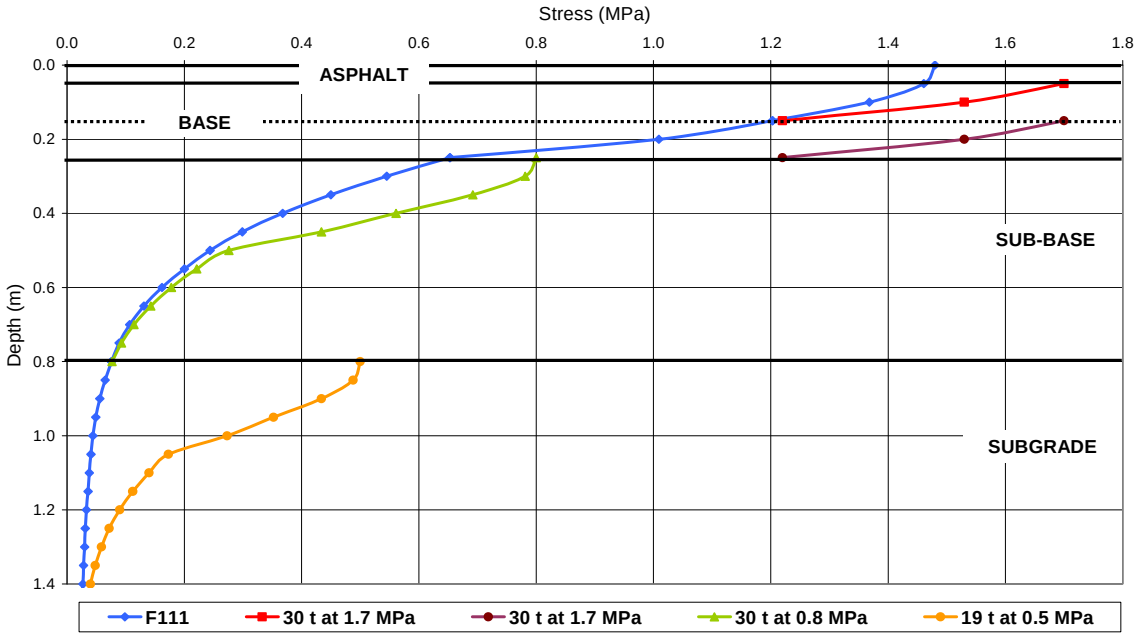

Figure 14. Example proof rolling regime.

Appendix A Roller Details

A.1 R1 – Pneumatic Tyred Roller

A.2 R2 – Pneumatic Tyred Roller

A.3 R3 – Pneumatic Tyred Roller

A.4 R4 – Pneumatic Tyred Roller

A.5 R5 – Pneumatic Tyred Roller

A.6 R6 – Pneumatic Tyred Roller - Refurbished

Photograph 1. Overview of Roller.

Photograph 2. Replaced hardened steel bushes.

Photograph 3. Replaced axle.

Photograph 4. Existing wheel hubs.

Photograph 5. New Wheel Rims.

Photograph 6. New Bridgestone 16.00-25 32 Ply YS2 tyres.

Photograph 7. New rear flanges.

Photograph 8. Replaced hardened steel draw-bar pin.

Photograph 9. Replaced steel plates.

Photograph 10. New tyre inflation instruction plate.

A.7 R7 – Pneumatic Tyred Roller

A.8 R8 – Pneumatic Tyred Roller

A.9 R9 – Solid Tyred Roller

Photograph 1. Upgraded roller overview.

Photograph 2. Urethane coating.

Photograph 3. UV shield.

Photograph 4. Boxed ballast.

Appendix B Supply and Service Details

Organisation	Location	Website	Phone number	Service

Appendix C Hire Agreement – Pneumatic and Solid Tyred Rollers

COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF DEFENCE
HIRE AGREEMENT

PNEUMATIC TYRE MARCO ROLLER

THIS AGREEMENT DATED The date set out in Annexure 1

BETWEEN The Commonwealth of Australia ('**Owner**')

AND The person set out in Annexure 1 ('**Hirer**').

1. The Owner shall hire the plant described in Annexure 1 and the spares referred to in clause 2 ('**Plant**') to the Hirer, subject to the terms and conditions of this Agreement, at the rates set out in clause 6 for the period set out in Annexure 1 as extended (if at all) by the written agreement of the parties ('**Hire Period**').

2. The Owner shall provide to the Hirer the number of spare tyres, spare wheels and weights for the Plant set out in Annexure 1.

3. The Hirer shall:

   a. Be responsible for all repairs and replacements to the Plant including tyre replacement and all costs of repairs and replacements. Costs for repairs and replacements shall be deducted from any hire charge not yet invoiced, however reimbursement shall not exceed the amount not yet invoiced.

   b. If repairs are executed by the Hirer, first obtain the Owner's written authority for such repairs.

   c. Make all necessary arrangements and meet all costs associated with the transportation, loading, unloading and cartage of the plant, weights and attachments from the Owner's depot at the pick-up point referred to in Annexure 1 ('**Pick-up Point**'), to the intended place of use referred to in Annexure 1 ('**Site**') and then to the Owner's depot at the drop-off point referred to in Annexure 1 ('**Drop-off Point**').

   d. Return the Plant in the same order and condition as at the time of delivery, fair wear and tear excepted, and ensure the tyres (including the spares) are in good condition on return of the Plant. What is fair wear and tear and good condition for the purposes of this clause shall be determined by the Director Estate Engineering Policy ('DEEP') or his or her authorised representative.

   e. Make payments for hire to the Owner in accordance with the payment schedule set out in Clause 6.

f. Accept responsibility for the safe keeping and return of any tools or equipment supplied by the Owner and, in the case of tools or equipment not returned, for the cost of replacement.

g. Retain the Plant for use at the Site and not transfer it to any other work site without the prior approval of DEEP or his or her authorised representative.

h. Bear the risk and indemnify and keep indemnified the Owner, its officers, employees and agents against:

(1) Loss of or damage (including, without limitation, damage by fire) to the property of the Owner (including, without limitation, the Plant);

(2) Claims by any person in respect of personal injury or death;

(3) Claims by any person in respect of loss of, or damage to, property; and

(4) Costs and expenses including the costs of defending or settling any claim referred to above,

arising out of or in connection with the use of the Plant or the performance or breach of this Agreement by the Hirer, its employees or subcontractors, other than to the extent that the loss or damage or death or injury results from a negligent act or omission of the Owner.

i. Carry out all the Owner's requirements for safe and correct operation including, but not limited to, tyre inflation, speed of travel, daily operational maintenance and inspection in accordance with the operating instructions and maintenance requirements set out in Annexure 2.

j. Provide grease, compressed air, tyres, tubes, jacks and any other items necessary for the service, maintenance and operation of the Plant.

k. Make the Plant available for inspection as and when required by the Owner at all times during the Hire Period.

l. Complete and lodge with the Owner a comprehensive insurance policy noting the interest of the Owner, covering:

(1) Loss of or damage to the Plant from any cause whatsoever, to the value of the Plant but not less than $250,000.

(2) Legal liability to third parties (including to the Owner) for personal injury (including death) or damage to property and loss of use of such property.

m. When requested by the Owner from time to time, provide to the Owner evidence that such insurance has been affected and remains current.

4. If in the opinion of the DEEP or his or her authorised representative the Hirer:

a. is not keeping the Plant properly maintained or misuses it in any way; or

b. otherwise fails to comply with any of its obligations under this Agreement (including, without limitation, a failure to make a payment under clause 6 strictly within the required time),

the Owner may immediately take possession of the Plant and terminate this Agreement without prejudice to the Owner's rights against the Hirer in respect of this breach or any antecedent breach of this Agreement.

5. The Plant remains the property of the Owner at all times, and the Hirer shall not sell, assign, mortgage, underlet, let or otherwise deal with the Plant or any parts and will keep it in its possession at all times.

6. a. Hire charges shall commence and cease as set out in Annexure 1.

b. The schedule of payments shall be as follows:

1 week (or part)	$4,336	(includes GST)
2 weeks (or part)	$8,130	(includes GST)
3 weeks (or part)	$11,382	(includes GST)
4 weeks (or part)	$13,550	(includes GST)
Thereafter each week (or part)	$1,626	(includes GST)

c. The Owner will issue a tax invoice on 30 day terms at monthly intervals in arrears throughout the hire. The Hirer shall be pay the invoice in accordance with the payment instructions on the invoice.

7. a. The Owner will allow a complete or partial remission of hire charges if:

(1) Plant is unable to work owing to a mechanical defect due wholly to negligence of the Owner; and

(2) the Hirer gives immediate notice of the breakdown (in any event, not later than 48 hours after the breakdown) to the Owner,

for that portion of the Hire Period for which the Plant is unable to work as referred to in paragraph (7.a.1).

b. The Owner will not be liable to the Hirer upon any claim for any delays, costs expenses, losses, damages or liability suffered or incurred by the Hirer arising out of or in connection with the non-availability of the Plant for any reason (including, without limitation, breach of contract or negligence of the Owner) and the Hirer releases the Owner from any such claim and acknowledges that its entitlement under paragraph (7.a) is its only entitlement to compensation from the Owner in respect of any such claim and is conditional upon compliance with paragraph (7.a.2).

8. Subject to any extension agreed in writing by the parties, the Hirer shall return the Plant by

the date stated in Annexure 1 (‘**Return date’**) to the Drop-off Point. The Hirer is not entitled to any reduction in charges for an early return.

9. Each of the parties comprising the Hirer shall be jointly and severally liable for the performance and observance of the Hirer's obligations under this Agreement.

10. The laws of the state of the Intended Place of Use stated in Annexure 1 shall apply to this Agreement.

11. a. Subject to paragraph (b), this Agreement, may be terminated by either party giving one month's notice in writing to the other of intention to terminate the same and at the expiration of the time specified this Agreement shall be terminated but without prejudice to any right of action of either party in respect of any antecedent breach.

b If the Hirer wishes to so terminate the Agreement it shall arrange and pay all associated costs for the Plant to be delivered to the Drop-off Point before the expiration of the time specified.

SIGNED as an agreement.

SIGNED for and on behalf of the **OWNER** by)
)
.....) .....
(Name in Full) (Signature)

in the presence of:

.....
(Signature of Witness)

.....
(Name of Witness in Full)

SIGNED for and on behalf of the **HIRER** by)
)
.....) .....
(Name in Full) (Signature)

in the presence of:

.....
(Signature of Witness)

.....
(Name of Witness in Full)

Annexures:
1. Agreement Particulars

ANNEXURE 1

Date of Agreement:	.....
Hirer: Company Name:	.....
Company Address:	..... Suburb: ..... State: ..... Postcode: .....
Contact Person:	.....
Contact Phone:	.....
Contact Email:	.....
Plant: (clause 1)	Pneumatic wheel Marco roller
Period of Hire: (clause 1)	..... weeks or part thereof From: ...../...../..... To: ...../...../.....
Number of Spare Tyres, Wheels and Weights: (clause 2)	.....
Pick-up Point: (clause 3(c))	.....
Intended Place of Use: (clause 3(c))	.....
Drop-off Point: (clause 3(c))	.....
Return Date: (clause 8)	.....

Appendix D Aircraft Pavement Design Policy

Australian Government

Department of Defence

Defence Support Group

Aircraft Pavement Design Policy

- FINAL
- May 2009

Australian Government
Department of Defence
Defence Support Group

Aircraft Pavement Design Policy

- FINAL
- May 2009

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Australian Government
Department of Defence
Defence Support Group

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Name of project:	Aircraft Pavement Design Policy Review
Name of document:	Aircraft Pavement Design Policy
Document version:	Final
Project number:	QI99829

Contents

Australian Government
Department of Defence
Defence Support Group

1. Foreword

The Manual of Infrastructure Engineering - Civil (MIEC) is the primary Defence policy document when determining Civil engineering requirements for Defence facilities and infrastructure. Its provisions are mandatory.

This manual can be accessed from the Defence Infrastructure Management System web site on the Defence Intranet. It is also available to the public on the Internet at http://www.defence.gov.au/im/.

The MIEC nominates Regulations and Standards as the minimum construction standard for Defence infrastructure, but, recognising the unique nature of some Defence equipment which utilises that infrastructure, the manual generally nominates additional levels of civil engineering than those required by Regulations and Standards.

All Defence new construction and refurbishment projects are required to be certified by the designer as meeting the civil engineering requirements detailed in this manual.

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XX Xxxx 2009

2. Design Principles

2.1 Introduction

The overall Civil Engineering philosophy for Defence facilities and infrastructure is the provision of infrastructure that is compliant, safe, functional, efficient and offer the best through life performance. Any special Defence capability requirements must be taken into account when determining the Civil Engineering requirements for Defence assets.

2.2 Aim

The aim of this manual is to assist those concerned with formulating requirements for Civil Engineering in the construction of new infrastructure and facilities, existing facilities and infrastructure upgrade for use by Defence aircraft.

2.3 Non-Aircraft Pavement Infrastructure

The respective Commonwealth, State and Territory legislation, regulations, ordinances, codes of practice and Australian and international standards (*regulations and standards*) form the Defence minimum construction standard. However, in recognition of the additional Defence capability requirements, this manual generally specifies additional levels of Civil Engineering than those required by the *regulations and standards* for Aircraft Pavements.

2.4 Application

The requirements of this manual apply to the design, construction and maintenance of Aircraft Pavements. Alterations or additions to existing infrastructure shall comply with the provisions contained herein in addition to those required by the *regulations and standards*.

When referring to *regulations and standards* in this manual, this is intended to apply to all regulatory requirements and recognised standards including Commonwealth, State and Territory regulations, codes of practice and other subordinate legislation, Australian Standards, Defence standards and recognised overseas standards.

Where any difference is perceived between the requirements described herein and those defined in the regulations and standards, the Defence standard and/or requirements is to apply and the matter referred to DEEP for confirmation and/or clarification. In most cases, the Defence requirement should exceed the minimum requirements of the regulations and standards.

The content of reference *regulations and standards*, and other publications, have not been repeated in this publication unless necessary for descriptive purposes. Where necessary and appropriate, reference is made to the source of the information.

2.5 References

Reference is necessary to current issues of the following documentation:

a) ADFP602 (to be replaced by the DADM);

(b) CASA MOS-139;

(c) ICAO Annex 14 (Volume I, Aerodrome Design and Operations; Volume II, Heliports)

(d) CASA Advisory Circulars;

(e) ICAO Design/Planning and Services Manuals.

(f) Commonwealth, state and territory legislation, regulations, ordinances, codes of practice and other subordinate legislation.

2.6 Dispensations

Dispensations from the requirements of this manual and alternative design solutions shall be approved in accordance with Section 4.1.3 Alternate Methods and Designs.

2.7 Responsibilities and Roles

Defence Support Group (DSG) is responsible for the provision of and maintenance of facilities and infrastructure in support of Defence activities and capability. DSG carries the responsibility for the construction and maintenance of Aircraft Pavement infrastructure. DSG responsibilities are summarised as follows:

Assistant Secretary Estate Policy and Environment (ASEPE) is the DSG Technical Authority (TA) for the development and promulgation of Infrastructure Engineering policy, DSG Business Rule 11 refers.

Directorate of Estate Engineering Policy (DEEP) are the subject matter experts responsible for developing technical engineering design policy, and for providing technical engineering support pertaining to the management and development of Defence estate.

Directorate of Engineering Services and Technical Regulation (DESTR) are the subject matter experts responsible for developing technical engineering maintenance policy, and for providing technical engineering support pertaining to the maintenance of Defence estate.

Regional Managers are responsible for the implementation of engineering policies at base level for regionally delivered projects and operations and maintenance activities.

These are normally delivered through the Comprehensive Maintenance Services (CMS) contract.

Infrastructure Asset Development (IAD) Branch is responsible for the implementation of engineering policies for Medium and Major New Works projects.

Directorate of National Airfields Projects (DNAP) is part of IAD and is responsible for delivering the approved National Airfield Projects program of airfield maintenance works each financial year

Sponsors are responsible for ‘identification of the need’ for new or upgraded infrastructure, advising the use of infrastructure and identifying an appropriate source of funding.

3. Documentation Standards

3.1 Documentation Process

The designer and contractor are responsible for complying with the requirements of this manual, the additional requirements outlined in the Functional Design Brief (FDB) and the requirements of regulations and standards. This responsibility encompasses documenting the infrastructure to meet the required standards and also verifying that the final as-built infrastructure complies with these requirements.

The designer and contractor must also ensure that the documentation is adequately detailed so that the identified procedures and activities can be undertaken safely and reliably at the facility.

In addition to the requirement for design documentation such as specifications and drawings, the Designer must provide design reports and other reports as outlined in the Infrastructure Management (IM) *Design Management/Progression* requirement, this manual and any other technical investigations or reports as detailed in the FDB.

3.2 Documentation Standards

Defence attaches considerable importance to the provision of proper documentation of the design (including specification, drawings, datasheets, etc.) and due regard shall therefore be paid to the detail and completeness of such documents. Documentation shall be clear, concise and precise.

3.2.1 Specification of Products

In general equipment and materials shall not be specified by product name but shall be selected on the basis of their performance, suitability, availability, maintainability and cost effectiveness. On occasion products with industry standard names may be sited as an example however where this occurs an annotation should be made to state that approved equivalent products would also be accepted.

In most cases when new airfield pavements are constructed, Defence does specify the use of heavy construction rollers (i.e. Marco Rollers) for the purpose of compacting and proof rolling. The Marco Rollers are owned and available for lease from Defence. Information on Marco Rollers is available on the Infrastructure Manual Website (www.defence.gov.au).

3.2.2 Text Documentation Format

The format of all text documentation, whether this is for the FDB, Concept Design Report (CDR), design specifications or any other Design Reports shall be generally as follows:

- The page size shall be A4 but may be A3 where drawings are also incorporated.
- Shall be provided in both Microsoft Word and PDF formats.
- New sections shall commence on new pages.
- A revision box with:
  - Revision number;
  - Author;
  - Checked;
  - Approved; and
  - Date.

3.2.3 Drawings Format

The drawings shall be clearly legible when printed on A3 size sheets.

All drawings shall be to a professional standard and drawn in accordance with the relevant Australian/New Zealand (AS/NZ) or International (ISO) Standards. Drawings shall be provided in both their native format (e.g. DGN, DWG) and PDF formats.

Where appropriate, the drawing scale must be shown. The drawing shall also include a graphic scale to facilitate scaling when a sheet is reproduced at a different size to the original.

All drawings shall have a revision box containing:

- Revision number and status.
- Designed.
- Drawn.
- Checked.
- Approved.
- Date.

3.3 Requirements for Design Reports

The Designer shall submit design reports as required by the IM *Design Management/Progression* process and in accordance with the respective project requirements. In summary, design reports for Aircraft Pavements will be required, as a minimum, at the following stages for DEEP review:

- Concept Design Report (30%).

- Schematic Design Report (50%).
- Detailed Design Report (90%).
- Final Design Report (100%).

The design must be progressed to meet the following requirements at each design report stage.

- Concept Design Report (30%).
  - All user requirement options detailed for Defence decision.
  - All assumptions stated.
  - MOWP basis prepared where impact on constructability and design is likely.
  - Pavement types assessed and preferred type(s) selected.
  - Aircraft traffic assumptions and calculations documented.
  - Geotechnical investigations complete and design subgrade condition determined.
  - All Runway, taxiway and apron lengths and widths determined.
  - Runway, taxiway and apron centrelines defined in plan.
  - Design options submitted for Defence consideration.
- Schematic Design Report (50%).
  - Design solution options presented for Defence consideration.
  - All technical queries submitted for Defence consideration.
  - All requested dispensations advised for Defence consideration.
  - Pavement thickness design complete.
  - Runway, taxiway and apron centrelines graded (centreline long sections).
- Detailed Design Report (90%).
  - Draft MOWP prepared.
  - All documentation complete with no gaps in the design.
  - All assumptions stated.
  - Pavement Classification Numbers recommended.
- Final Design Report (100%). No new design should be included. Only amendment to address quality reviews and comments raised by Defence review of the 90% design.

4. Design Requirements

4.1 Certification and Verification

4.1.1 Certification

The principle concept for ensuring the fitness for purpose, safety and compliance of the Defence Estate is that nominated professionals and service providers must independently certify all works and services. This is a fundamental requirement of Defence contracts and is provided in addition to certification required by the *regulations and standards*.

All Defence new construction and upgrade projects must be certified as meeting the Civil Engineering requirements for Aircraft Pavements detailed in this manual.

All aircraft pavement thickness designs must be certified as being suitable for the project aircraft traffic and subgrade conditions by a Chartered Professional Engineer (CPEng) specialising in aircraft pavement thickness determination and with substantial experience Aircraft Pavement thickness determination. DSG-ID-EPE-DEEP-SCE shall approve the expertise of the certifying Engineer.

4.1.2 Verification

Where a designer that is not a full or reserve member of the Defence Infrastructure Engineering- Airfield Services Panel, performs the design, a recognised member of that sub-panel must be engaged by the Project Officer to verify that the design is adequate. This verification must be conducted in addition to the Certification required by the designer. The Project Officer is not to novate or otherwise sub-contract the sub-panel member. The sub-panel member is to directly work for and report directly to Defence. Clause 5.1 discusses further.

4.1.3 Alternate Methods and Designs

This manual details the minimum requirements for Aircraft Pavement infrastructure. There are a number of reasons why a project may find it difficult to implement all requirements and under certain circumstances it may be unnecessary or impractical to comply with the full requirements of this manual. Any alternative methods and designs that do not comply with the specific policy requirements of this manual, but give equivalent results to those specified, are not necessarily prohibited. Requests for Technical Authority approval of alternate methods and design must be supported by appropriate tests, solutions or other supporting evidence to ensure that the proposal still affords an equivalent level of safety, functionality and reliability.

To gain Technical Authority approval a RFI is to be sent from the Designer through the IAD appointed Project Manager with a copy sent to the IAD Project Officer. The Project Manger is to forward the RFI to the appropriate Technical Authority within DEEP for action or comment. If the PM/Project Officer approves, Direct Liaison Authority may be granted between the Designer and the DEEP POC in order to resolve technical issues, with copies of all correspondence forwarded to the IAD Project Manager and Project Officers.

4.2 Design Requirements

The requirements for designing Aircraft Pavements for Defence airfields is governed by the requirement for cost effective, functional and reliable airfield infrastructure.

Where practical, Defence has aimed to comply with civilian design criteria to achieve best industry practice. Rather than having two similar documents for civilian and military airfields, Defence has made the decision to adopt:

(a) CASA MOS 139 as the accepted standard for Department of Defence aerodromes.

(b) CASA CAAP 92-2(1) as the reference document for Defence helicopter facilities.

(c) ICAO Annex 14 Volume II as the ancillary standard for CAAP 92-2(1) as CAAP 92-2(1) does not cover Obstacle Limitation Surface (OLS) requirements.

DADM replaces the ADFP 602 and contains only Defence exceptions from MOS 139 and military specific requirements

The following sections detail the requirements of the various design elements as inputs for Defence Aircraft Pavements.

4.2.1 Geotechnical Investigation

The designer is to prepare a geotechnical investigation brief that meets the requirements of the project. The designer must review and comment on the geotechnical report prior to its finalisation. The results of this investigation are to be used to inform the Concept Design Report.

4.2.2 Aircraft Traffic

Aircraft traffic projections for Aircraft Pavements are to be provided to the designer by Defence, usually through the Project Officer via the Transition Team supporting new aircraft capabilities.

Designers must convert the projected aircraft traffic into numbers of passes or coverages for input to design methods as appropriate.

Where existing pavements are being considered for structural capacity or strengthening, the historical traffic should also be considered where appropriate.

4.2.3 Pavement Types

The most appropriate pavement types should be selected based on through life cost and value for money. An assessment of all practical pavement types must be performed by the designer in the context of the project condition. The relevant project conditions include:

- Climate: Rainfall and ultraviolet (UV) exposure.
- Subgrade conditions: Including any proposal to improve or stabilise the subgrade.
- Design aircraft: Tyre pressures and masses.
- Operating conditions: Refuelling, ordnance loading, engine run-ups, aircraft wash.

Areas of pavement subject to regular refuelling, exposure to hydraulic fluids, used for engine runs, as an aircraft wash or ordnance loading, must be provided with a non-bituminous surface or an approved fuel resistant surface treatment to resist degradation under operations. Other pavement areas would generally be expected to be of flexible pavement construction with an asphalt surfacing. Sprayed sealed surfacings should be limited to blast-resistant pavement only and pavements in very remote areas for limited aircraft traffic. Sprayed seal surfaces are not acceptable for military fighter aircraft.

4.2.4 Design Life

Design lives for the structural (thickness) design of new and upgraded pavements are to be:

- 40 years for rigid pavements.
- 20 years for flexible pavements.

It should be assumed that maintenance will be provided at appropriate times during the pavement's life cycle.

4.2.5 Thickness Determination

The thickness of all aircraft pavements must be based on the project specific aircraft traffic and geotechnical conditions. The thickness of pavement required must be determined using either the Federal Aviation Administration's (FAA's) COMFAA or Airport Pavement Structural Design System (APSDS). Design thicknesses may be checked using other design methods.

4.2.6 Geometry

The geometry of Aircraft Pavements includes:

Lengths, widths and spacing. Whilst the critical runway and taxiway dimensions shall be detailed in the FDB, the minimum requirements for length, width and spacing of a runway, taxiways and aprons is contained in ADFP 602. Defence's intention is to comply with the requirements of MOS 139, except where specific military requirements dictate otherwise.

Fillet and turning circle geometry. Fillets and turning circles must be designed using Autoturn, Autotrack or similar software with specific application to aircraft pavements. Where designing using these tools, the designer must determine fillets and turning circles using the 'nose tracking the centreline' option. The subsequent positioning of line marking is to be based on the results of the design tool.

Surface levels. Surface levels and stormwater drainage systems for Aircraft Pavements and supporting structures must be designed such that the following limits are achieved.

Facility	Drainage Requirements
Runways	No ponding during the 100 year average recurrence interval (ARI) event.
Taxiways	No ponding during the 50 year ARI event.
Aprons (General)	No ponding during the 10 year ARI event.
Aprons (within 65 m of buildings)	No ponding during the 50 year ARI event.
Runway strip	Duration of ponding within 75m of runway centreline during the 5 year ARI storm not to exceed 12 hours.
Taxiway and apron flanks	Duration of ponding within 1m of pavement edge during the 5 year ARI storm event not to exceed 12 hours.
Operational Buildings	Floor level 0.3m above the 100 year ARI flood level.
Other buildings	Floor level 0.2m above the 50 year ARI flood level.
Main access road	Depth of flooding during a 50 year storm should be less than 0.1m.
Other roads, carparks, etc	Depth of flooding during 10 year ARI storm should not exceed 0.1m for roads and 0.03m for carparks.

Surface grading. Surfaces must be graded to meet the requirements of ADFP 602 and MOS 139.

4.3 Pavement Classification Numbers

Following the completion of the design of any Aircraft Pavement project, the designer must submit to Defence the recommended Pavement Classification Number (PCN) for

each element of the pavement work. The PCN must be equal to or greater than the largest ACN of the various design aircraft for that element of pavement.

4.4 Maintenance Allowances for Whole of Life Costing.

Whole of life pavement costs should be addressed during the scoping or preliminary design phase for new pavement projects by experienced pavement engineers. They have an implication on the suitability and value for money of pavement design and material options and should be included in Net Present Value (NPV) cost analysis of design options.

Estimation of whole of life costs for a pavement area is a complicated task as the costs are highly specific to the pavement type (i.e, concrete, asphalt, spray seal), the subsequent design life, and the pavement application (i.e. Runway , Taxiway, Apron).

5. Construction Support

5.1 General

The Defence suite of construction contracts generally details the requirements for designers to provide support to the contractor and Defence during the construction phase of any project. This policy provides additional guidance specific to the construction of Aircraft Pavements.

It is recommended that significant Aircraft Pavement infrastructure be delivered via Head Contractor contracts to allow independent and un-filtered advice to be provided to Defence. Where a complex and multidisciplinary project requires delivery via a Managing Contractor contract, additional audit and advisory requirements are mandatory.

5.2 Managing Contractor Delivery

Where a Managing Contractor delivery methodology can not be avoided for Aircraft Pavement delivery, an independent auditor, from the DIP Aircraft Pavement Sub-panel, must be engaged by the Project Officer (via the PM/CA) separately from the Managing Contractor. The auditor's role is to review design, specification and QA documentation and to audit the construction as required to independently confirm suitability of the design and compliance of the construction with the design. DEEP-SCE shall approve the scope of work upon which the auditor is engaged as well as the key staff nominated by the auditor for this work.

5.3 Traditional Head Contractor Delivery

Under a Head Contractor form of delivery, the Design Consultant is engaged by Defence (via the PM/CA) and is therefore independent of the contractor. The role of the design consultant in relation to certification of the construction is detailed in the Design Services Contract. Project Officers are to ensure that adequate resource and input is provided to the design consultant to allow meaningful certification that the construction complies with the design intent.

5.4 Special Tasks

The following notes are made with regard to the need for design input during special construction tasks that are considered to be high risk.

- Asphalt as an Aircraft Pavement surface. Full time presence by the designer.
- Concrete for Aircraft Pavement. Full time presence by the designer.

- Concrete block pavers as an Aircraft Pavement surface. Full time presence by the designer.
- Cement or lime stabilisation for Aircraft Pavements. Full time presence by the designer.

5.5 DEEP Technical Involvement

In order to enhance the continuity of technical input between projects and better capture corporate knowledge of pavement issues, the IAD Project Officer is to invite the DEEP-SCE to attend practical completion inspections of new or upgraded aircraft pavements prior to Defence acceptance.

6. Post Construction

6.1 General

At the completion of the project the Design Consultant is to provide the following suite of relevant information to DEEP-CES for all capital and major maintenance works.

6.2 As Constructed Drawings

A set of drawings is to be provided that accurately reflects the pavement works undertaken and provides an accurate representation of the work area and final pavement profiles.

Where no significant amendments to the design has occurred during construction a copy of the 100% design drawings marked “As Constructed” will be appropriate.

Where significant changes have occurred a new set of as constructed drawings must be produced with additional survey works being undertaken as necessary.

6.3 Post Construction Report

A brief post construction report is to accompany the as constructed drawings and must contain the following information:

- Details of extend of works and dates of construction;
- Pavement profile;
- Materials used (including details of aggregates, binders, sealants, concrete and asphalt mix’s etc);
- Problems with products or materials used; and
- Recommended PCN for area.

Appendix E Pavement Underboring Policy

Aircraft Pavement Underboring Policy

Introduction

This document details Defence's policy requirements related to underboring for the installation of services beneath aircraft pavements.

The decision to underbore as opposed to trench through pavements may be driven by a number of factors including:

- Timing requirements. Underboring is potentially quicker and as such aircraft pavements may be closed for shorter duration.
- Cost analysis. This will be specific to each project.
- Contractor preference. This will be based on the experience and preference of each contractor and the availability of equipment.
- The pavement condition and life cycle.
- Pavement composition. As a rule underboring tends to be more economical for rigid pavements than flexible.
- Viability of alternatives such as alternate service routing or trenching.

The submission and subsequent review of a suitably detailed underboring plan is critical and the requirements of this plan are detailed below.

Underboring Plan Approval

A boring plan must be submitted to Defence for approval by DSG-ID-EPE-EEP-SCE. The boring plan must address all the issues listed below in 'Underboring Details' and must provide details of the contractor's proposed methodology and risk assessment. No underboring shall commence until written approval of the plan has been provided by DSG-ID-EPE-EEP-SCE. Such approval shall in no way remove any responsibility from the contractor for the underboring planning and execution and any repairs to the pavements that may be required as a result of the boring.

Insurance

Insurance must be obtained by the contractor to indemnify Defence for any damage caused to the pavements by the bores. Damage includes subsidence, heaving and/or cracking or any other damage that may occur to the pavements.

It should be noted by Defence Project Officers that such insurance generally excludes consequential damages (such as loss of revenue by aircraft operators and/or joint users/lessees of the airport due to a runway closure). Where a pavement failure as a result of underboring could cause unacceptable consequential damages or prevent critical military operations, underboring is not recommended and services should follow an alignment which does not require underboring.

Underboring Details

The contractor is the party responsible for selecting the technical parameters for the boring operations to minimise risk. If necessary, Defence project managers should guide this decision making process to ensure the following factors are fully considered:

- **Soil Type.** Soil condition and type is to be known prior to boring being approved and the conditions are to be understood by the contractor. Soil type will determine the appropriateness or otherwise of any particular method of underboring and it must be noted that certain subgrades are unacceptable for underboring. The most notable example of this is highly expansive clays.

- **Bore depth**. The minimum depth of the bore and its relationship to the pavement structure must be considered for the specific pavement being underbored.

- **Bore diameter**. Diameter determines the total number of bores required to achieve the aim. If multiple conduits are planned, it may be quicker and/or lower risk to increase the size of the bore and create less of them.

- **Pre-reaming and sleeving**. This practise increases boring time, but reduces risk of pavement damage. Metal sleeving over the bore head is recommended to control rod wander. It is strongly recommended that sleeving be used for the underboring of all aircraft pavements.

- **Pressure relief valves.** At additional cost, these may be installed and maintained at various intervals along the bore to monitor slurry flow and reduce the likelihood of heaving/cracking.

- **Direction control**. The bore head can wander up to 10% on any given rod. The ability for the bore operators to correct this wander depends on the soil type. The likelihood of cumulative bore wander should be assessed by the contractor in the planning stage, so that allowances can be made in the surface monitoring regime (see section below on *surface monitoring*). In terms of depth, a threshold should be nominated beyond which bore-head wander will result in the bore being terminated and a new bore attempted.

- **Contingencies**. Upon discovery of latent conditions, the contractor may need to change boring equipment and slurry additives.

- **Scheduling**. Works should minimise disruption to aircraft. At additional cost, bore length can be increased so that boring equipment may be located outside the runway strip.

- **Location of underground services**. A service locater should be employed to confirm the location of any services that may be located within the boring zone. Reliance upon GFIS data and service locations is discouraged.

Surface monitoring

A system must be established to validate surface levels and check for damage during and after boring. The complexity of this system must be tailored to the consequences of the subject pavement being damaged and becoming unserviceable. For example, the touch-down area on a primary runway warrants a more rigorous monitoring regime than a low-speed taxiway.

The consultant/contractor must propose a suitable monitoring system in the underboring plan which would be reviewed by Defence and is to be in accordance with the specification requirements for the activity. Examples of requirements to be included in the specification are provided following.

- **Example 1 – Low speed taxiway**. Prior to each bore, the route is to be lightly marked on the surface and measurements recorded at 2m centres using either a 3m straight edge (perpendicular to the bore path) or survey equipment. Measurements to be re-taken immediately after the bore (prior to reopening the taxiway) and again 4 weeks later.

- **Example 2 – Main runway**. Prior to each bore, the route is to be marked and measurements recorded at 2m centres using survey equipment. These marking and measurements are to be duplicated at 2m and 4m offsets from the target route, to create an eight-metre-wide grid. This will allow for any potential bore-head wander. During boring, measurements should be taken periodically to check for any surface movement. Once pre-boring is complete, and depending how well the target route has been followed, the outer measurements may be dropped for expediency. A 3m straight edge is to be available to assess any surface deformation which may become visible or occurs between survey grid points. Final measurements are to be taken upon the completion of all boring and again 4 weeks later.

Repairs

Any repairs to the pavements shall be undertaken in a timely fashion to a standard approved by Defence using a contractor and designer approved by Defence with costs borne by the contractor.

Defence should carefully consider the need for the contractor to have a repair capability on standby during the works; such a capability will come at significant cost.

Provided all the above control measures are in place (i.e. surface monitoring, pre-reaming, pressure relief valves) the risk of an adverse event occurring, which may cause damage or make a pavement non-trafficable, is considered reduced.

The consequence of significant damage (eg surface deformations up to 25mm, cracking and/or spalling) should be considered and the subsequent repair time required for their correction must also be considered. Minor repairs to rectify cracking or spalling may be completed within 24 to 48 hrs. Significant repairs to concrete, or full depth repairs to asphalt may take a considerable time to complete.