T h e A u d i t o r - G e n e r a l
Audit Report No.30 2001–02
Performance Audit

Test and Evaluation of Major Defence Equipment Acquisitions

Department of Defence

Australian National Audit Office

ISSN 1036–7632

ISBN 0 642 80612 8

Australian National Audit Office

Canberra ACT
24 January 2002

Dear Madam President
Dear Mr Speaker

The Australian National Audit Office has undertaken a performance audit in the Department of Defence in accordance with the authority contained in the *Auditor-General Act 1997.* I present this report of this audit, and the accompanying brochure, to the Parliament. The report is titled *Test and Evaluation of Major Defence Equipment Acquisitions.*

Following its tabling in Parliament, the report will be placed on the Australian National Audit Office's Homepage—http://www.anao.gov.au

Yours sincerely

P. J. Barrett
Auditor-General

The Honourable the President of the Senate
The Honourable the Speaker of the House of Representatives
Parliament House
Canberra ACT

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Abbreviations

ADF	Australian Defence Force
AEW&CS	Airborne Early Warning and Control System
AINS	Acceptance into Naval Service
ANAO	Australian National Audit Office
ARDU	Aircraft Research and Development Unit
ATEA	Army Technology and Engineering Agency
ATS	Accredited Test Services
CA	Chief of Army
CAF	Chief of Air Force
CDF	Chief of the Defence Force
CDS	Chief Defence Scientist
CKO	Chief Knowledge Officer
CN	Chief of Navy
COSC	Chiefs of Staff Committee
COTS	Commercial “Off the Shelf” (Purchase)
CSP	Commercial Support Program
DCIC	Defence Capability Investment Committee
DMO	Defence Materiel Organisation
DOT&E	Director of Operational Test and Evaluation (US Defense)
DSTO	Defence Science and Technology Organisation
DT&E	Development Test and Evaluation
DTEC	Defence Test and Evaluation Committee
FOCT	First of Class Trials
FPS	Functional Performance Specification
HDIS	Head Defence Information Systems
HF	High Frequency
HKS	Head Knowledge Systems (formerly CKO)
IV&V	Independent Verification and Validation

JALO	Joint Ammunition Logistics Organisation
JORN	Jindalee Operational Radar Network
JLSA	Joint Logistics Support Agency
LEA	Land Engineering Agency
MC AUST	Maritime Commander Australia
MHC	Minehunter Coastal
NATA	National Association of Testing Authorities
NTEA	Naval Test Evaluation and Acceptance
NTEAP	Naval Test Evaluation and Acceptance Plan
OCD	Operational Concepts Document
OEM	Original Equipment Manufacturer
OPEVAL	Operational Evaluation
OT&E	Operational Test and Evaluation
PA	Provisional Acceptance
PRINCE	**Pr**ojects **In C**ontrolled **E**nvironments
PSGDIV	Policy and Strategic Guidance Division
PT&E	Production Test and Evaluation
RAAF	Royal Australian Air Force
RANTEAA	RAN Test, Evaluation and Acceptance Authority
RANRAU	RAN Ranges and Assessing Unit
SETE	System Engineering Test and Evaluation
SPMM	Standard Project Management Method
SPO	System Program Office
SRG FEG	Strike Reconnaissance Group Force Element Group
SR SPO	Strike Reconnaissance Systems Program Office
ST&E	Supportability Test and Evaluation
T&E	Test and Evaluation
T&EWG	Test and Evaluation Working Group
T&EPG	Test and Evaluation Planning Group
TCD	Testing Concepts Document
TECHEVAL	Technical Evaluation

TEMP	Test and Evaluation Master Plan
TRA	Technical Regulatory Authority
TTCP	Tri-Partite Technical Cooperation Plan
UDSM	Under Secretary Defence Materiel
V&V	Verification and Validation
VCDF	Vice Chief of the Defence Force
WRC	World Radio Conference
WSSF	Weapons Systems Software Support Facility

See also the Glossary

Summary and Recommendations

Summary

Background

1. The Australian Defence Force (ADF) relies on advanced technology, complex logistics support systems and skilled personnel to provide defence capabilities. Defence manages some 270 major equipment acquisition projects with a total estimated cost of $46 billion. Defence spent $2.7 billion on purchasing specialist military equipment in 2000–01.

2. The costly, advanced technologies involved in military equipment require well-developed test and evaluation (T&E) procedures and appropriately skilled T&E personnel within the organisations that acquire, support and operate the equipment. The fundamental purpose of T&E, whether at concept, design, acquisition or in-service phase of an equipment's life cycle, is to reduce the risk that equipment will not satisfy user expectations regarding cost, quality, delivery time (schedule), mission success, system vulnerability and personnel safety.

3. Defence has T&E organisations in the Defence Materiel Organisation (DMO), Navy, Air Force and the Defence Science and Technology Organisation (DSTO). DMO's Land Engineering Agency (LEA) conducts T&E for Army. Joint projects, such as those that will form part of the 'knowledge system' shared by the individual Services, are subject to T&E by DMO and the Service that would have most use of the particular project. The audit included T&E case studies of single-Service and joint projects.

4. The objective of the audit was to assess Defence's management of the T&E aspects of its capital equipment acquisition program. The audit sought to identify, from Defence T&E practice, any barriers that might limit the efficiency and effectiveness of its T&E activities. A principal aim of the audit was to formulate practical recommendations that would both improve Defence's T&E practices and provide a degree of assurance about Defence's ongoing capacity to manage its T&E program efficiently and effectively.

Conclusion

5. Defence's T&E policy aims to promote a unified approach to T&E to guarantee effective and efficient use of all T&E resources and to avoid unnecessary duplication of effort and resources. In practice, however, there was little evidence of effective corporate initiatives to promote that approach. The individual Defence groups have formulated their own

individual policies and practices and personnel training. Accordingly, the policy needs to be reviewed and to articulate how the '*unified approach*' is to be implemented. The policy also calls for T&E resources to be costed, to assist in management and funding of T&E. However, in practice the cost of the resources applied to T&E is unknown.

6. Proposed improvements to Defence's force development process may improve T&E implementation on a project-by-project life-cycle basis, by establishing stronger incentives for T&E to contribute much more to the development of defence capability. Defence could also benefit by establishing an office responsible for common standards for, and independent oversight of, operational T&E (OT&E), which is conducted in the final stage of acquiring major equipment, before acceptance into service. This would also help in achieving the desired '*unified approach*' to T&E.

7. T&E records relating to the acquisition of Navy major capital equipment indicate the need for the DMO to improve aspects of its T&E policy and practice. Some vessels and systems that DMO has offered to Navy for OT&E have been accompanied by insufficient T&E data and with significant engineering modifications and defect rectifications still under way or planned. Navy projects with well planned and managed T&E benefited from easier progress towards acceptance into naval service.

8. T&E of Army and Air Force projects examined during the audit was well planned and managed. T&E of a Bushmaster vehicle prototype, the Army project selected in the audit, has helped identify the vehicle's strengths and weaknesses and thus mitigate project risk. T&E of Air Force's F-111s, C-130J and AEW&C aircraft programs was found to benefit from close working relationships established between contractors, the DMO and Air Force T&E personnel. This is necessary for greater effectiveness given the highly integrated nature of aircraft systems engineering.

9. The audit examined two 'knowledge system' projects—the JORN radar project and the Deployable Joint Force Headquarters-Afloat. JORN shows the benefits of recent application of careful T&E. The Joint Headquarters-Afloat project reveals a need for careful T&E for projects involving extensive software and compressed development and installation schedules.

Key Findings

Introduction (Chapter 1)

10. Defence's T&E policy notes that the cost of T&E for a weapon system using electronic technology could amount to 25 per cent of total project costs. Even though the policy calls for costing of T&E, the resources applied to T&E cannot readily be disaggregated from systems engineering and other project costs. Given the amounts involved in Defence's equipment acquisitions ($2.7 billion in 2000–01), expenditure of 10 per cent of total project costs on T&E would amount to some $270 million a year. Information on T&E costs is needed for management purposes to assist in proper project costing and budgeting and for overall organisational efficiency, but DMO's business systems at present do not provide this information.

Corporate Governance (Chapter 2)

11. Defence links its capability-related corporate governance arrangements with systems engineering and capability development processes, and treats T&E as a secondary process. Many positions have responsibility for elements of the T&E process without the benefit of proper integration across areas of responsibility. Defence policy calls for a unified approach to T&E to guarantee effective and efficient use of all T&E resources and to avoid duplication of effort and resources. In practice, however, there was little evidence of effective corporate initiatives to achieve a unified approach to T&E to ensure that use of T&E resources has been effective and efficient.

12. The individual Defence groups have formulated their own policies and practices. Although individual T&E groups and practitioners in Defence seek to maintain contact with each other, there would seem to be advantage in having a more formal, coherent and coordinated approach to T&E throughout Defence.

13. Proposed improvements to the Defence force development process may assist T&E implementation on a project-by-project life-cycle basis. A draft instruction on Defence capability systems life cycle management would assign accountability for monitoring compliance with approved capability baselines, technical regulatory frameworks and in-service performance of elements of capability. This should establish stronger incentives for T&E to contribute more to the development of defence capability.

14. Further, it would be useful for Defence to assess the merits of establishing, in its Owner Support Executive,[1] an office responsible for common standards for, and independent oversight of, operational T&E (OT&E), which is conducted in the final stage of acquiring major equipment. Improvements over current arrangements would come from improved OT&E strategic management and better integration of T&E efforts from improvements in OT&E standards and reporting of any capability shortfalls. It would also assist major equipment technical regulation and facilitate Defence's policy of a *'unified approach'* to T&E. The proposal would be similar to the US Department of Defense's Director of Operational Test and Evaluation.

Defence Materiel Organisation (Chapter 3)

15. DMO's role in delivering major capital equipment to the Services and coordinating the delivery of all elements of capability makes its Systems Program Offices responsible for a large portion of the overall 'T&E continuum'—developmental, production and some operational T&E.

16. A review of 23 projects transferred from DMO to Navy found that seven had no T&E master plan. However, some projects, such as the Navy's Minehunter project, give T&E a high managerial priority, which is evident in the quality of T&E planning and funding, and in configuration control. Others, such as the New Submarine Project and Kalkara project, require improved T&E.

17. Project outcomes would be more satisfactory for the Services if DMO enforced its T&E policy; made T&E provisions in its capital equipment manual more consistent with Defence's T&E policy; and ensured its project management method contains adequate provision for T&E management.

Navy Test and Evaluation (Chapter 4)

18. Navy has extensive T&E policy, backed by technical regulations and an operational T&E agency in support of its safety and capability management responsibilities.

19. Navy has a substantial capability development program, with new ships and submarines in various stages of development and operational T&E. The program incorporates high levels of risk because the vessels proceeded from design to full-scale production without first completing development T&E and operational T&E of a first of class. Under these

[1] The Owner Support Executive consists of the Vice Chief of the Defence Force, Chief Defence Scientist, Chief Finance Officer, Inspector-General, Head Defence Personnel Executive and Head Public Affairs & Corporate Communications.

circumstances the Commonwealth is heavily dependent on T&E to assess the extent of which program risks have been successfully managed by project management and systems engineering processes.

20. Evidence indicates significant variations in the way T&E is planned, funded and conducted prior to capital equipment being offered to the Navy for acceptance. Defence records show projects that experienced improved paths to acceptance into service, such as the Minehunter project, have detailed operational requirements documents, sound T&E planning and implementation and good records of T&E conducted during full-scale development. However, some projects suffer protracted post-delivery T&E and were not supported by basic T&E documentation.

21. OT&E on the Collins-class submarines is experiencing significant difficulties caused mainly by the amount of engineering development still under way in the program as well as significant in-service support problems. The Collins class has shifted from development into operational service without a distinct end to development T&E, placing further demands on the overall program.

22. Many Collins-class performance deficiencies were not corrected prior to DMO offering the submarines to Navy for acceptance into service. These have caused extra cost and delays in gaining required naval capability and in achieving acceptance into naval service. The need to spend substantial amounts on modifications to achieve 'limited capability level' improvements in two submarines, and to extend the Collins program by seven years to accommodate modifications and upgrades to all Collins submarines, reinforces the importance of this issue. The submarines' existing and planned redesign, modification, upgrade and sustainability enhancement costs represent an increase of 39 per cent on the approved submarine project cost of $5.09 billion (December 2000 prices).

23. Shortages of Navy technical personnel have led to a chronic shortage of T&E trained personnel in Navy's T&E agency (RANTEAA).

Army Test and Evaluation (Chapter 5)

24. Army policies and procedures enable it to assess the integrity of vehicles and other equipment offered for acceptance into service. Army uses as its T&E organisation the DMO's Land Engineering Agency (LEA). LEA is equipped to conduct developmental T&E as its primary role and, as required, operational T&E on a wide range of vehicles and other land-based military technology. LEA's T&E of a Bushmaster prototype vehicle has mitigated risk to the Commonwealth in terms of cost, reliability and

safety. This highlights the value in ensuring competent and effective T&E of prototypes before full-scale production commences.

Air Force Test and Evaluation (Chapter 6)

25. Air Force is responsible for the airworthiness of all Service aircraft. It implements extensive technical regulations and T&E policies to ensure aircraft comply with essential operational and technical standards.

26. The Aircraft Research and Development Unit (ARDU), as Air Force's T&E organisation, performs the full spectrum of military flight testing for Air Force and Army Aircraft. Some Air Force Groups such as the Strike Reconnaissance Group Force Element Group (SRG FEG), Tactical Fighter Group and Air Lift Group conduct their own OT&E with support from ARDU for management, planning and reporting as may be necessary.

27. Developmental T&E results for aircraft are submitted to airworthiness boards. Defence advised the ANAO that the boards consider OT&E results and assess overall suitability but are not known to review effectiveness in the context of, for example, weapons effectiveness.

28. Review of the F–111 Block Upgrade Program indicates that DMO, Air Force and contractors are conducting their T&E tasks on this project with care. It has a test plan working group and detailed T&E documentation. A software verification and validation contractor assists in oversight of software development. These arrangements allow application of a broad range of expertise, while ensuring stakeholder interests are managed and represented.

29. Like the F-111 project, the $2.2 billion Wedgetail Airborne Early Warning and Control (AEW&C) project has benefited from close integration of DMO, Air Force and contractor expertise. The Wedgetail project recently proceeded to the acquisition phase. DMO is completing the aircraft's Test Verification Matrix and will amend the project's T&E management plan to reflect a revised testing concept, strategy and sequence. Although these T&E documents and arrangements should already be complete, action is in hand to meet the requirements.

30. Records of the OT&E program on the C-130J Hercules aircraft project indicate that the aircraft is experiencing significant operational shortfalls which await resolution by the manufacturer, and that may justify contractual changes to define and fund future modifications.

31. Audit examination of these projects indicates the T&E is proceeding satisfactorily in identifying problems and possible remedial action.

Knowledge System Test and Evaluation (Chapter 7)

32. The audit examined two projects sponsored by Defence's Head Knowledge Systems (HKS) that aim to make significant contributions to the ADF's knowledge edge. The Jindalee Operational Radar Network (JORN) project is attempting to overcome numerous technical difficulties. The project is conducting T&E carefully with a view to ensuring the project achieves its objectives.

33. The Deployable Joint Force Headquarters-Afloat is to be a complex software-based communication and intelligence system. It has undergone compressed development and installation schedules to satisfy tight delivery schedules. However, some fundamental systems engineering effectiveness measures are not available to Navy's T&E agency (RANTEAA) to enable it to gauge the project's success systematically. In view of the accelerated development and installation, it would seem reasonable to expect that the project would receive increased systems engineering and integrated logistics support to overcome performance shortfalls that can occur under those circumstances. Records indicate that the system was falling short of expectations.

Defence Science and Technology Organisation (Chapter 8)

34. DSTO is responsible for assessing future Defence science and technology trends, but Defence records indicate that it will provide this service only if tasked by the Services or other Defence groups. Therefore any deficiencies in the Services' strategic management of T&E capabilities would reduce the opportunity for forward planning or priority being placed on defining future T&E needs. This adds to Defence's difficulties in strategically managing its major investments in T&E research and infrastructure.

Training in Test and Evaluation (Chapter 9)

35. Major Defence equipment such as aircraft, ships and submarines depend almost entirely on advanced and complex safety-critical systems. Relevant Defence personnel, especially its T&E personnel, should have expertise in assessing such systems in the various acquisition and in-service support stages.

36. Training of T&E personnel in DMO, the Services and DSTO is decentralised and ad hoc, and not well linked in terms of coordination or information sharing. The absence of a standardised policy on T&E training has resulted in a 'shopping cart' approach to T&E training, with decisions on training largely left to individual preferences. Defence advised the ANAO that RANTEAA is currently formally developing a training course to provide its staff the requisite training. Although this training may not reflect a standardised ADF approach to T&E, it will be appropriate to RANTEAA's quality accredited system and Navy's approved processes.

37. The use of T&E-related tertiary training and education services by Defence provides an important on-going government agency and university interaction and it links with the universities' collaboration with industry. It also represents an opportunity for Defence and industry to work toward the aims of both the Defence White Paper and the Defence and Industry Strategic Policy.

38. Standardised training programs recognised by professional bodies would help improve strategic management of T&E training; analysis of T&E training needs and skills gaps; and planning, sourcing and scheduling of appropriate training.

39. DMO's internal survey of competency-based training and work experience of its professional and technical staff indicates the probability of gaps between the knowledge edge expected by Defence and the actual capabilities of personnel involved in T&E. It also indicates a need to ensure that T&E is conducted by competent and skilled practitioners.

Test and Evaluation Ranges and Facilities (Chapter 10)

40. Defence has maintained its own T&E ranges and facilities, in order to protect sensitive information and maintain objectivity in T&E operations. The Services and DMO have extensive ranges and facilities for T&E, with an estimated facilities replacement cost of nearly $400 million. DMO recently accepted responsibility for strategic management, acquisition and logistic support of Maritime and Land ranges. This assists their strategic management.

41. A consultant's report has indicated that there was negligible coordination of aerospace range resources; duplication of some range facilities; and diffusion of responsibility for range problems. The ranges had a systems acquisition process that omitted an obligation to invest in long-term infrastructure and that often included 'cost-effective' range

solutions based on the use of overseas facilities. The report also indicated that, even though the ADF had a number of basic aerospace range facilities and capabilities, there were significant range capability shortfalls.

42. The developments and growth in mobile radio communications in the last 10 years have resulted in radio spectrum congestion and commercial pressures being particularly acute below 3 GHz. This could restrict availability of the radio frequency spectrum for aeronautical telemetry systems with a T&E role. Defence access to the radio spectrum to meet its own requirements, including interoperability (or connectivity) with coalition forces, needs careful strategic management, as it has a direct impact on current and future Defence capabilities. Defence's Knowledge Staff is preparing a biennial Defence Spectrum Strategic Plan for endorsement by senior Defence committees to meet this strategic requirement.

Response to recommendations

43. The ANAO made five recommendations designed to improve Defence's management of T&E and ensure its T&E personnel receive adequate training (see Recommendations section below). Defence agreed with two recommendations and two parts of a three-part recommendation. Defence's disagreements relate to strategic management and oversight of T&E and training of personnel responsible for safety-critical system development, maintenance and test and evaluation. The recommendations are discussed at the relevant parts of the report. This section summarises the issues.

44. Defence maintained strong disagreement with the ANAO's recommendation (No.2) that Defence consider the costs and benefits of establishing an office responsible for common standards for, and independent oversight of, operational test and evaluation. Defence argued that the scale of procurement and level of acquisition program risk does not justify the costs of establishing such an office. The ANAO considers that only a small office would be required, since it would rely on existing T&E and technical regulatory organisations.

45. Defence disagreed with a recommendation (No.3(a)) concerning confirmation that T&E has been adequate before equipment is accepted into operational service. Defence consider that the critical issue is not the quantity of T&E but confidence that equipment will meet specified requirements based on T&E and satisfactory systems engineering outcomes. The ANAO considers that the aim of the recommendation is

to improve project outcomes through an accountability mechanism designed to ensure adherence to T&E policies and that equipment is accepted on the basis of adequate T&E.

46. Defence disagreed with a recommendation (No.5) that it aim to ensure that its personnel responsible for computer-based safety-critical system development, acquisition, maintenance and test and evaluation have training and skills adequate for their responsibilities. Defence considers that the recommendation is impossibly wide and that compliance would be difficult to assess. The ANAO maintains that appropriate training and skills development assists Defence in being an informed purchaser of safety-critical goods and services, and in meeting its duty of care obligations.

Recommendations

Set out below are the ANAO's recommendations, with report pargraph references and an indication of the Defence response. The recommendations and responses are discussed at the relevant parts of this report.

Recommendation No.1
Para. 2.33

The ANAO recommends that Defence reviews and updates its T&E policy organisation and responsibilities, and articulates the way that the policy is to be implemented.

Defence response:
Agreed.

Recommendation No.2
Para. 2.54

The ANAO recommends that, with a view to improving the strategic management of operational test and evaluation (OT&E), Defence assess the costs and benefits of establishing, in its Owner Support Executive, an office responsible for common standards for, and independent oversight of, OT&E.

Defence response:
Disagreed.

Recommendation No.3
Para. 3.24

The ANAO recommends that, in the interests of improved risk management and equipment safety and suitability for service, Defence aim to ensure that:

(a) major equipment is acquired on the basis of Test and Evaluation Master Plans (TEMPs) and supporting documentation, as required by T&E policy, and that there is confirmation that adequate T&E has been conducted before equipment is offered for release into operational service or acceptance;

(b) DMO T&E policy and project management processes are consistent with Defence T&E policy; and

(c) training in its project management method includes adequate coverage of T&E principles and practices.

Defence response:

Recommendation No.3 (a) Disagreed.

Recommendation No.3 (b) and (c) Agreed.

Recommendation No.4 Para. 9.37

The ANAO recommends that, as part of the strategic 'people theme' for policies and programs to support professional development, Defence aim to ensure that its T&E practitioners have training and skills adequate for their responsibilities, through a consistent policy and program that encourage training and education in T&E.

Defence response:

Agreed.

Recommendation No.5 Para. 9.39

The ANAO recommends that Defence aim to ensure that its personnel responsible for safety-critical system development, acquisition, maintenance and test and evaluation, have training and skills adequate for their responsibilities.

Defence response:

Disagreed.

Audit Findings and Conclusions

1. Introduction

This chapter provides an overview of Defence's Test and Evaluation process and sets out the audit objective and scope.

Background

1.1 The Defence[2] outcome is 'the defence of Australia and its national interests'. The Australian Defence Force (ADF) relies on advanced technology, complex logistics support systems and skilled personnel to provide defence capabilities that can achieve the Defence outcome. Major acquisitions are the responsibility of the Defence Materiel Organisation (DMO), which manages some 270 major equipment acquisition projects with a total estimated cost of $46 billion.[3] Defence spent $2.7 billion on purchasing specialist military equipment in 2000–01.[4]

1.2 The costly, advanced technologies involved in military equipment require well-developed test and evaluation (T&E) procedures and skilled T&E personnel within the organisations that acquire, support and operate the equipment.[5] The fundamental purpose of T&E, whether at the concept, design, acquisition, or in-service phase of an equipment's life cycle, is to reduce the risk that the equipment acquired will not satisfy user expectations in terms of cost, quality, delivery time (schedule), mission success, system vulnerability and personnel safety.

1.3 Defence has in the main adopted US Defense system engineering standards that emphasise T&E's continuing risk management function throughout the acquisition cycle. The US Defense Systems Management College's *Test and Evaluation Management Guide* states that T&E:

> *… is an integral part of the systems engineering process which identifies levels of performance and assists the developer to correct deficiencies. It is also a significant element in the decision-making process, providing data supportive of trade-off analysis, risk reduction and requirements refinement.*

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2 'Defence' comprises the Department of Defence and the Australian Defence Force. The latter comprises the three Services: Navy, Army and Air Force.

3 M. Roche (Under Secretary Defence Materiel), *Acquiring a National Defence Capability for the 21st Century*, Defence Industry Conference, 26 June 2001, p. 3.

4 Department of Defence, *Defence Annual Report 2000–01*, 28 October 2001, p. 38.

5 Aspects of Defence test and evaluation were reported in ANAO Audit Report No.34 1997–98 *New Submarine Project—Department of Defence*, 24 March 1998, pp.xix, 12, 50–55.

Correcting defects in weapons has been estimated to add from 10–30 per cent to the cost of each item… Such costly redesign and modification efforts can be reduced if carefully planned and executed test and evaluation programs are used to detect and fix system deficiencies early in the acquisition process…[6]

1.4 The US General Accounting Office, which audits the US Defense organisation, considers that:

…testing is the main instrument used to gauge the progress being made when an idea or concept is translated into an actual product. Evaluation refers to what is learnt from a test. …The ultimate goal of testing and evaluation is to make sure the product works as intended before it is provided to customers.[7]

1.5 In extreme cases, inadequate T&E could have tragic consequences. Safety is a fundamental user requirement and design consideration. Therefore safety tests, verifications and validations must be integrated into the overall T&E effort and be conducted within a technical regulation framework. Safety issues include equipment fitness for intended purpose, ordnance safety and suitability for service and equipment maintenance and repair procedures.

1.6 As a general rule, managers who apply a competent T&E process identify risks earlier, and thus have available to them less costly and less difficult corrective measures. To wait until the final stage of development to measure acceptability of products invites project cost overruns, reduced capability and reduced safety.

Test and evaluation in Defence's capability cycle

1.7 Equipment tests and evaluations have important risk management roles during each phase of the Defence capability management cycle. Defence policy states:

The three categories of T&E [Development, Acceptance and Operational T&E] are to be used either separately or in combination in Defence. Programs may decide the combination of the categories and timing to suit their specific needs. … The underlying objective is to conduct T&E throughout a Defence materiel project, from conception to disposal (ie a 'T&E continuum'), to confirm the successful completion of a stage and gain information useful to the conduct of the next stage. T&E is to be

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6 Defence Systems Management College, *Test and Evaluation Management Guide*, March 1998, p. 1.1.

7 United States General Accounting Office, Report to the Chairman and Ranking Minority Member, Subcommittee on Readiness and Management Support, Committee on Armed Services, US Senate, *Best Practices, A More Constructive Test Approach Is Key to Better Weapon System Outcomes,* July 2000, p. 4.

> *used to produce objective evidence in terms of operational capability or materiel performance, confirming that some specific milestone has been achieved and assessing the technical risk of proceeding to the next milestone in the project plan.*[8]

The three main categories of T&E referred to in the policy have in practice become development T&E, production T&E and operational T&E; and they are used in each phase of defence capability development as outlined below.

1.8 In the project conception phase, T&E assists the Defence Capability Investment Committee (DCIC), through the Vice Chief of the Defence force (VCDF) and Head Capability Systems (HCS) and one or more of the Services (Navy, Army and Air Force), to expand their knowledge of any deficiencies in current capability and the performance requirements of new capability options. Defence and its supporting industry both need T&E to develop an understanding of the most important aspects of equipment performance and the ways available to test and evaluate the equipment during acquisition, acceptance off-contract,[9] acceptance into service, and throughout the equipment's operational life.

1.9 In the acquisition phase, T&E in development and production assists the Defence Materiel Organisation's (DMO's) System Program Offices (SPOs)[10] to assess progress and reduce risks in equipment development and production projects. Project teams need to observe or apply various tests and evaluations during technical review processes so that they can manage the risks related to equipment performance, costs and delivery schedules. DMO requires T&E data to assist decisions regarding progress claims and acceptance of equipment from prime contractors.

1.10 When DMO presents new or enhanced capabilities to the relevant Service (Navy, Army or Air Force) for acceptance, the Service tests and evaluates the capabilities to assess whether the equipment and its logistic support satisfy requirements. Acceptance into service should provide assurance and confidence that weapon platforms and systems will perform when and as required.

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8 Defence Instruction DI(G)LOG08-10, *Defence Test and Evaluation Policy*, 1996, para 13.

9 Acceptance off-contract normally occurs when the acquired equipment meets contractual requirements. Often in complex acquisitions, such as the Collins submarines, the Defence Materiel Organisation on behalf of the Commonwealth may provisionally accept the equipment off-contract, subject to the contractor undertaking to correct deficiencies as required by the contract. Acceptance from the DMO by the Services normally occurs when the equipment and its logistic support meet all agreed capability requirements.

10 DMO was formed on 1 July 2000 by the merger of the Defence Acquisition Organisation (DAO) and Defence's logistics support organisation, Support Command Australia (SCA). DMO began forming its System Program Offices (SPOs) on 1 December 2000 by merging the former DAO project offices with the former SCA's Class or Force Element Group Logistics Offices. SPOs were to become fully operational by 30 June 2001.

1.11 Operational T&E (OT&E) provides Capability Managers (the three Service Chiefs) with additional information that equipment acquired and logistically supported by the DMO meets operational needs. OT&E allows for a more complete understanding of the capability delivered by new or upgraded systems in the hands of trained operators, and it is the only available method of measuring operational effectiveness and suitability, including elements of capability beyond equipment.

1.12 After a Service Chief accepts major capital equipment or platforms into service, ongoing tests and evaluations remain vital components of capability maintenance. Continuing in-service T&E assists Defence to develop and refine military doctrine, procedures and tactics that are fundamental to effective employment of new and established capabilities.

1.13 The increasing need for nations' military forces to operate together as coalitions in peacekeeping and security operations requires system interoperability. This is particularly important for command, control, communication, intelligence, surveillance, reconnaissance and other systems that comprise the defence information environment.[11] T&E activities include force interoperability assessments.

1.14 In line with Defence's Defence and Industry policy, acquisition and support strategy is shifting toward developing and sustaining local industry capabilities in the repair, maintenance and adaptation of ADF capabilities.[12] This increases the importance of using T&E techniques to assess operational effectiveness and suitability of new or enhanced equipment against user requirements, and to ensure capability is adequately supported while in service. Indeed, equipment capability enhancement programs need to use T&E as an important capability change tool, as it provides vital feedback data that indicate the scope of systems engineering work to be done and the progress made toward engineering goals and objectives.

1.15 T&E can be regarded as one of the key risk management tools available in the capability management cycle, since it provides a sound basis for fundamental decisions concerning a Defence capability's progress through its conception, acquisition, acceptance into service, operation and through-life management. Notably, a Defence expert on T&E advised the ANAO that T&E is a universal process that could be

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11 Audit Report No.11 2000–2001 *Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000, p. 69.

12 Department of Defence, *Defence and Industry Strategy Policy Statement*, June 1998, pp. 6, 7, 35.

applied to measure the effectiveness of Defence's risk management 'system' in its entirety.[13]

1.16 The Glossary sets out the categories of T&E used in Defence's capability management cycle.

Cost of T&E

1.17 Defence's T&E policy states that T&E requirements for capital equipment projects are to be identified in each Major Capability Submission and Equipment Acquisition Strategy so that the full cost of T&E can be identified, budgeted and resourced. The policy indicates that T&E costs for a weapon system using electronic technology could amount to 25 per cent of total project cost,[14] and that T&E is to be included as a cost category in equipment life-cycle costing in accordance with Defence's capital equipment project processes.[15]

1.18 Despite the policy requirements regarding costing, the ANAO was unable to ascertain the cost of T&E in Defence. The cost is not identified and, accordingly, not budgeted and resourced in the way the policy envisaged. DMO advised the ANAO that DMO's Electronic Systems Division's activity based costing showed that in May 2001 it spent some $1.65 million on 'Coordinate Tests and Trials' out of a total of some $9.44 million for all its activities. This represents 17.4 per cent expenditure on these T&E activities by Electronic Systems Division.

1.19 It is not clear whether the $1.65 million includes total T&E expenditure such as the amounts included in capital equipment acquisition contracts to pay for contractor provided T&E. Other DMO divisions may spend much more on T&E than Electronic Systems Division. For example, T&E expenditure by the Collins submarine program included $49 million (June 1986 prices) in payments to the Australian Submarine Corporation for harbour tests and sea trials.[16] That indicates over $5 million a year has been spent on T&E by Maritime Systems Division on the Collins project

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13 Australian/New Zealand (AS/NZ) Standard 4360:1999—*Risk Management,* states *'Approaches used to identify risks include checklists, judgements based on experience and records, flow charts, brainstorming, systems analysis, scenario analysis, and systems engineering techniques.*', p. 12, section 4.2.4. Test and evaluation may fit into each of these techniques either as the source of data or as an integral part of better practice. It is especially important in systems analysis and systems engineering of advanced technology.

14 Defence Instruction DI(G)LOG 08-10 *Defence Test and Evaluation Policy* (1996), footnote 6, states: *The cost of T&E will vary depending on the nature of the project. For example, if the project is an 'off the shelf' purchase, then T&E will be lower than if the equipment is developed from 'scratch'. The cost of T&E, in the latter case for a weapon system using electronic technology, could be as high as* 25 per *cent of the total project costs.*

15 Defence Instruction DI(G)LOG 08-10 *Defence Test and Evaluation Policy* (1996), p. 4 section 19.

16 ANAO Audit Report No.34 1997–98, *New Submarine Project*, 24 March 1998, p. 54.

alone. The T&E cost of DMO's Airborne Early Warning and Control (AEW&C) project is estimated at up to 25 per cent ($525 million) of total project cost (paragraph 6.33). Hence it may not be valid to extrapolate of the Electronic Systems Division's T&E expenditure to arrive at an estimate for total T&E expenditure in DMO.

1.20 The Defence Inspector-General advised the ANAO that capture of T&E cost information is somewhat sporadic and therefore unlikely to provide reliable data. The ANAO found it impracticable to ascertain total T&E costs. However, given the amounts involved in Defence's equipment acquisitions ($2.7 billion a year), an expenditure of 10 per cent of overall project costs on T&E would total $270 million a year. Information on these costs is needed for management purposes to assist in proper project costing and budgeting and for overall organisational efficiency, but DMO's business systems at present do not provide this information to the extent envisaged in the T&E policy.

1.21 This is part of the wider issue of costing and business systems in Defence. The former Minister for Defence, in a statement in 2000, referred to a review aimed at reforming Defence's business systems to improve financial reporting and the audit process and enable Defence to understand and manage its costs, thereby allowing Defence to make good business decisions. He said that $40 million was available for business systems reform.[17] Defence commented recently that it had made progress in improving its management information systems but that the inordinate effort required to produce its 2000–01 financial statements highlighted the urgent need to dramatically improve those systems.[18]

The audit

1.22 The ANAO's objective in this audit was to assess Defence's management of the T&E aspects of its capital equipment acquisition program. The audit sought to identify, from Defence T&E practice, any barriers that might limit the efficiency and effectiveness of its T&E activities.

1.23 The audit reviewed a selection of Defence capital equipment projects and related records from which to draw conclusions on the general approach to T&E by DMO, the three Services, and the Defence Science and Technology Organisation (DSTO). The audit did not include the T&E aspects of explosive ordnance and weapons ranges, or Navy's

17 The Hon John Moore MP, Minister for Defence, 19 December 2000 MIN388/00 *Minister Announces Retirement from Parliament,* p. 4.

18 Department of Defence, *Defence Annual Report 2000–01*, 28 October 2001, p. 17.

Aircraft Maintenance and Flight Trials Unit (AMAFTU) projects and activities. Post-acceptance OT&E was also beyond the scope of the audit.

1.24 A principal aim of the audit was to formulate practical recommendations that would both improve Defence's T&E practices and provide a degree of assurance about Defence's ongoing capacity to manage its T&E program efficiently and effectively.

1.25 An audit preliminary study began in December 2000 and proceeded to an audit in February 2001. Discussion papers on audit findings were put to Defence as the audit progressed. The proposed report of the audit was provided to Defence in October and the report was completed after considering Defence's comments received in November and December 2001. The audit was conducted in conformance with ANAO auditing standards and cost $350 000.

Report structure

1.26 The remainder of this report is structured as follows:

- corporate governance of Defence T&E policy and practice (Chapter 2);
- T&E policy and practice in DMO, Navy, Army, Air Force, Knowledge systems and DSTO (Chapters 3–8);
- training for Defence personnel in T&E (Chapter 9); and
- Defence T&E ranges and facilities (Chapter 10).

2. Corporate Governance

This chapter provides an overview of the Defence's corporate governance of test and evaluation and Test and Evaluation policies and costs.

Introduction

2.1 Defence is a significant organisation with a workforce of 66 000 full-time Service and civilian personnel and an annual budget in excess of $15 billion. Accordingly, it requires a corporate governance structure capable of ensuring that Defence's personnel, facilities, equipment and records are managed effectively, efficiently and ethically, and that responsibilities can be delegated to achieve clear systematic accountability for results.[19]

2.2 A central feature of corporate governance is its dependence on management controls that ensure decision-makers have valid, credible information on which to base decisions. In the context of T&E, organisations that manage high-risk equipment acquisition projects require organisational designs and processes that produce and act upon high-quality T&E data. Defence's equipment acquisition projects cost some $2.7 billion a year and have a significant T&E content.

2.3 As outlined in Chapter 1, Defence's T&E processes should provide decision-makers with key risk management data on the progress of acquisition projects in each phase of the Defence capability management cycle. Capability management makes significant demands on Defence's corporate governance because Defence has 14 specialist functional groups that contribute to six primary 'outputs' or capabilities.[20] It requires strategies and designs to ensure high-level cross-functional group integration occurs so that outputs are achieved as planned effectively and efficiently and within available resources.

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19 *Financial Management and Accountability Act 1997* (FMA Act) section 44; and the *Defence Act 1903* section 9A(1). Public Sector corporate governance concepts are outlined in Australian National Audit Office, *Applying Principles and Practice of Corporate Governance in Budget Funded Agencies*, 1997, pp. 7–10.

20 Defence outputs consist of Defence Operations, Navy Capabilities, Army Capabilities, Air Force Capabilities, Strategic Policy and Intelligence. See Department of Defence, *Portfolio Budget Statements 2001-02*, pp. 12–13, 25–64.

Corporate governance and test and evaluation policy

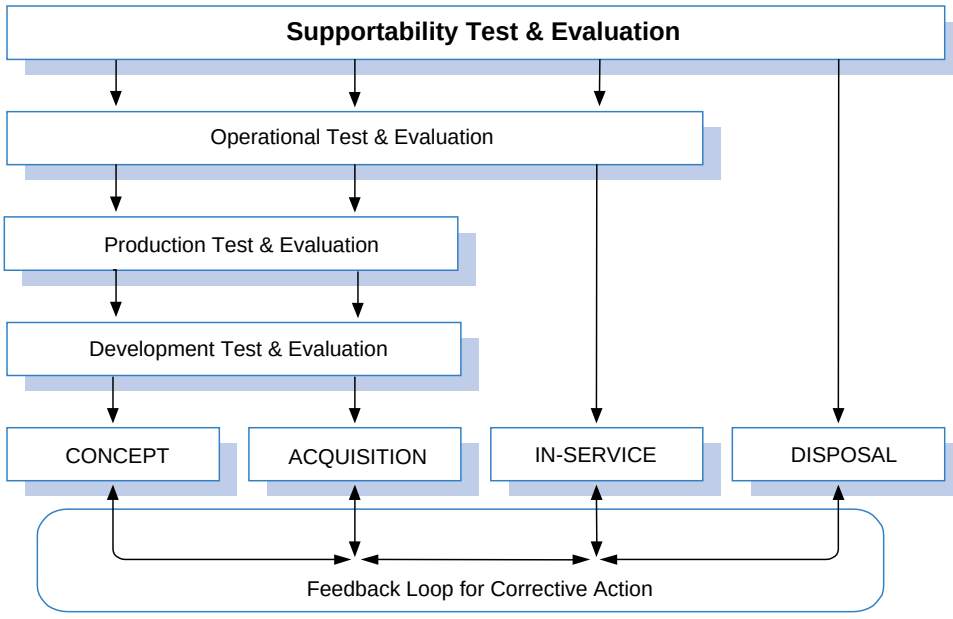
2.4 As indicated in paragraph 1.7, Defence policy requires that T&E be used to produce objective evidence, in terms of operational capability or materiel performance, confirming that some specific milestone has been achieved and assessing the technical risk of proceeding to the next milestone in the project plan. The policy states further:

> *The responsibility for T&E is shared among the Programs. However, the Defence aim is to promote a unified approach to T&E to guarantee effective and efficient utilisation of expensive T&E resources and to avoid the duplication of effort and resources.*[21]

2.5 Each group in Defence's capability management cycle has responsibilities for particular testing and evaluation phases that extend from capability conception to eventual removal from service. Figure 1 shows the various defence equipment life cycle phases and the types of T&E that apply to each of the phases. It is important to note that successful T&E depends not only on the activities within each particular phase but also on the quality of T&E coordination and feedback between the phases.

Figure 1

Defence Materiel Life Cycle—Test and Evaluation Aspects



Source: Department of Defence

[21] Defence Instruction DI(G)LOG 08-10, *Defence Test and Evaluation Policy,* 1996, p. 4 section 23.

2.6 The policy provides for a Defence Test and Evaluation Committee (DTEC), chaired by a Colonel (or other Service equivalent) from Defence Headquarters, which is to meet as required or at least every six months. DTEC's role includes fostering a corporate and standard approach to planning, management and application of T&E. Defence advice indicates that DTEC has not formally met since 1997.

2.7 The policy refers to other Defence organisations that no longer exist. For example, it requires the former Force Capability Development Division (FCDDIV), in Defence Headquarters, in conjunction with the former Policy and Strategic Guidance Division (PSGDIV), to identify costs for new or upgraded T&E facilities in support of capital equipment projects. It provides that FCDDIV is to assign responsibility for resources, including equipment test and trial ranges, to the Services.

2.8 Table 1 lists T&E responsibilities, the pre-DRP organisations responsible for them and the post-DRP organisations likely to be responsible. It indicates that the unified approach to T&E sought by the Defence policy is not yet in sight. Defence accepts that the lack of a sponsor responsible for T&E policy has effectively prevented T&E policy implementation from achieving:

- centralised strategic guidance or direction on the application of T&E in terms of applying a coordinated, cohesive, and rational approach to T&E-based risk management;
- coherence in T&E standards development, with Defence groups left to make their own 'judgements' about standards accreditation[22] and the way they report T&E results; and
- alignment with the Defence and Industry policy objective of developing and sustaining in local industry the capability needed to repair, maintain and adapt ADF equipment.[23]

2.9 At the time of the audit, Defence was proceeding with a fundamental review of its capability management principles and practices which began in July 1998 (paragraphs 2.35–2.43). This added to difficulties the ANAO had in accurately determining the post-DRP T&E responsibility matrix. An increased governance risk during such protracted and widespread change is that, if those who exercise authority over resources are not held accountable for the relevant outcomes, they are likely to exercise that authority with decreasing effectiveness.

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22 Section 16 of the Defence T&E policy requires its testing agencies to make judgements on the need for technical/functional and quality accreditation by authorities such as the National Association of Testing Authorities (NATA). This is to ensure that all T&E data produced is verified as to its reliability, accuracy, repeatability, traceability and validity.

23 Department of Defence, *Defence and Industry Strategic Policy Statement*, June 1998, pp. 6, 33–35.

Table 1

Defence Test and Evaluation Responsibilities

Responsibility (With reference to the Defence Instruction)	Pre DRP Organisation	Likely Post-DRP Organisation
T&E Policy (para. 27).	Policy and Strategic Guidance Division (PSGDIV)	Head Strategic Policy and Plans (HSPP)
Identifying strategic and long term T&E capability development resource implications including T&E resources for Australian Industry or as a national asset (para. 24).	Force Capability Development Division (FCDDIV)	Capability Development (CD)
Identification of T&E costs, including investment costs for T&E facilities stemming from Major Capability Submissions and Equipment Acquisition Strategies (para. 24).	FCDDIV and PSGDIV	Defence Materiel Organisation (DMO)—Project Directors
Maintenance and distribution of Australia's Defence-Owned Ranges and Test Facilities—Summary of Capabilities (para. 28).	Industry Involvement and Contracting Division (II&C DIV)	Director of Training Area Management (DTAM) (Corporate Services)
Maintaining T&E resources and ranges (para. 25).	The Services	Corporate Services and Infrastructure Group, Service Chiefs and DMO
T&E trained personnel to conduct T&E to international standards (para. 25).	The Services	Service Chiefs and DMO
Conduct of OT&E, including resources (Annex A, footnote 15)	The Services	Service Chiefs and DMO
Development and planning of all T&E requirements for individual capital equipment projects (para. 29).	Project Directors	DMO Project Managers
Development of the Test and Evaluation Master Plan (para. 29).	Project Directors	DMO Project Managers
Resources and funding of T&E (para. 29).	Project Directors	Project Directors
Identification of T&E requirement in support of replacement Equipment decisions, disposal plans, changes in operational requirements or to quantify design deficiencies (para. 30).	In-Service Equipment Managers	In-Service Managers
Maintaining Research and Development T&E resources and provide T&E advice to other programs (para. 26).	DSTO	DSTO
Defence Trials (para. 31).	DTRIALS	DTRIALS
Providing advice on T&E planning, management and application to higher authority (para. 32).	Defence T&E Committee (DTEC)	DTEC

Source: Defence document dated June 1999. Subject to change.

2.10 Appendix 1 summarises the roles and accountabilities of the managers and key stakeholders as they apply to Defence capability management. The relationship linkages between them, with respect to T&E, are unclear but may emerge from changes under way, particularly in the major equipment acquisition process.

2.11 T&E policy needs to be reviewed to update responsibilities and, more substantively, to explain how the '*unified approach*' is to be implemented as a means of ensuring effective and efficient utilisation of expensive T&E resources.

Defence Reform Program impact on test and evaluation

2.12 The Defence Reform Program (DRP) was introduced in 1997 on the basis of the Defence Efficiency Review (DER). DRP instigated organisational changes and responsibility shifts throughout Defence. It changed the organisational structure and responsibility assignments embodied in the 1996 Test and Evaluation policy. DRP removed the centralised T&E policy sponsorship and put aside the DER's Recommendation R32:

> *All test and evaluation functions in the Services should be placed in the Science and Technology program as an integrated unit, where they should be rationalised and used with a greater degree of 'user pays'.*[24]

2.13 However, action on this recommendation was reported in March 2001 as follows:

> *Action Complete—Update: Test & Evaluation function including AEA Test & Evaluation Ranges and DSTO test facilities was market tested and successfully won by an In-House-Option bid.*[25]

2.14 Notwithstanding this notification of 'action complete', T&E remains dispersed in Defence, and without 'user pays' practices. The Defence Inspector-General advised the ANAO that the recommendation was never accepted by Defence and is not supported now by DSTO. Defence considers that, to place all T&E in the Science and Technology program (DSTO), as envisaged by the recommendation, would require changes to DSTO's role and T&E capabilities.

2.15 The DRP's most significant effect was the market testing of some Army and Air Force T&E capability, discussed later in this report. DRP also resulted, at least indirectly, in disestablishment of the committee concerned with coordinating Defence T&E, the Defence Test and Evaluation Committee (DTEC—see paragraph 2.6).

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[24] Department of Defence, *Future Directions for the Management of Australia's Defence—Report of the Defence Efficiency Review,* 1997, pp. 39, 40 and E-6.

[25] Organisational Effectiveness Branch, Department of Defence, *The Defence Reform Program Internal Review and Lessons Learned—March 2001* [internal report].

2.16 However, since the DRP, there have been meetings of T&E 'Principals' from each of the Defence groups concerned with T&E. (See paragraph 2.28.)

2.17 In November 2001 Defence advised the ANAO that VCDF has issued a direction to DTrials to initiate a review of Defence T&E policy. This provides Defence the opportunity to identify roles and responsibilities in the management of T&E policy.

Defence operational-level T&E policy and processes

2.18 As outlined in Chapter 1, Defence uses T&E processes in development, acquisition and acceptance into service of new and enhanced systems and equipment. These processes are decentralised, with some scope for improved strategic-level policy guidance and support, particularly on standards and reporting of T&E.

2.19 Each of the three Services, the DMO and DSTO have, to differing extents, developed policy for T&E in support of their respective roles.

2.20 This decentralised T&E policy results from the individual Services' former Materiel Divisions establishing their own T&E resources and procedures more or less in isolation. The heads of these divisions were two-star officers accountable to both their Service Chief and Deputy Secretary Acquisition and Logistics for defining and acquiring capital equipment and coordinating all processes necessary to achieve satisfactory acceptance into service. This gave rise to significant differences in T&E resources and procedures in DMO, the three Services and DSTO laboratories.

2.21 The present position is that each of the Services, DMO and Corporate Services and Infrastructure Group (CSIG) have mixed responsibilities for:

a) maintaining T&E resources, including ranges, as required to meet weapon system acquisition and in-service needs. (The Defence Inspector-General advised the ANAO that DMO is constantly sharing the cost of resources and upgrades to T&E ranges.)

b) maintaining an adequate pool of skilled personnel for the conduct of T&E to international standards and conducting OT&E on the services capital equipment; and

c) contributing to the DTEC

2.22 As discussed in the next chapter, the DMO is developing a new T&E policy, notably without effective portfolio policy guidance. This

raises some risk that DMO policy may in part become superseded when a new strategic-level policy is developed. Similarly each of the Services continues to develop its own T&E policies and procedures to satisfy its own requirements.

2.23 An area offering scope for better strategic management is Defence's approach to Operational Test and Evaluation (OT&E) of acquisition projects. Defence bases its OT&E on project-by-project decision-making that lacks clear requirements to provide OT&E data that demonstrate to the Owner Support Executive and Government the overall quality of capability provided.

2.24 The Inspector-General advised the ANAO that Defence has difficulty in maintaining staffing levels at the T&E agencies due to the posting cycle and that, by default, DMO performs a substantial amount of the OT&E prior to contract delivery.[26] The ANAO notes that this falls short of the preferred situation whereby operators perform the bulk of OT&E 'controlled by independent agency' outside the acquisition organisation and with 'no system contractor involvement'.[27] This relieves the acquisition organisation and others from possible conflicts of interest.

2.25 The Inspector-General advised the ANAO that the level of T&E conducted by DMO must be consistent with the T&E budget allocated at the time of project approval. He further advised that this would place an obligation on the owner or sponsor to identify up front performance requirements so that these can be built into the contract and the entire acquisition approach. The ANAO notes that Defence's Capital Equipment Manual (CEPMAN 1) holds DMO project managers ultimately responsible for the sponsorship and coordination of all T&E activities in relation to projects.[28] Therefore the project's owner, sponsor and manager need to work together to ensure that Commonwealth interests are protected by ensuring that system performance requirements form a critical part of the acquisition contract and the project's system engineering process.

2.26 Defence uses OT&E to monitor system performance after equipment is accepted into service. Post-acceptance OT&E is beyond the scope of this audit. However, as discussed below, Defence is revising its capability development cycle, and the relevant draft instruction offers better strategic management of T&E on a project-by-project life-cycle basis than did the former Force Development Process.

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26 ARDU and Force Element Groups also perform OT&E prior to contract delivery.

27 Department of Defense, Defense Systems Management College, *Systems Engineering Fundamentals*, October 1999, pp. 61, 62. US General Accounting Office, *Test and Evaluation: Impact of DOD's Office of the Director of Operational Test and Evaluation,* GAO/NSIAD-98-22, October 1997, pp 1–3, 15, 20-24.

28 Department of Defence, *Capital Equipment Procurement Manual* (CEPMAN 1), Part 2, Chapter 14, para 1417.

Test and Evaluation Principals' Forum and T&E working groups

2.27 A way to improve coherence in T&E practices at the working level is by means of practitioners' forums and working groups. Defence is using a coalition of T&E practitioners and managers from DMO, DSTO and the three Services.

2.28 The most senior group is the Test and Evaluation Principals' Forum, which re-formed in Melbourne in September 2000.[29] The forum aims to promote a common approach to T&E by:

a. sharing T&E knowledge, capabilities, facilities and experiences;

b. agreeing on the use of common standards, terms, procedures and practices;

c. promoting the value and uses of T&E throughout the ADF;

d. maintaining links with external Australian T&E organisations;

e. educating Australian industry on the role of T&E in projects;

f. identifying opportunities to link with overseas T&E organisations and exchange information;

g. arranging national and international recognition and accreditation; and

h. developing advice and requirements for discussion within the DTEC.

2.29 DMO personnel also belong to T&E groups and associations including:

- DMO T&E Working Group;
- International Test and Evaluation Association (ITEA);
- System Engineering Test and Evaluation (SETE); and
- ADF Aviation Capability Improvement Team.

2.30 About two thirds of the respondents to a recent DMO internal survey indicated they were members of internal project T&E working groups that conducted regular T&E meetings between the project office, prime contractor and relevant T&E agencies. Project directors also form Test and Evaluation Planning Groups to assist them to develop test and evaluation master plans and to coordinate the project's T&E activities. The audit found that these groups provide a useful influence on T&E processes.

[29] The T&E Principals' Forum consists of Director of Trials DSTO; Commandant Land Engineering Agency; Officer in Charge Aircraft Research and Development Unit; Director RAN Test, Evaluation and Acceptance Agency; Officer in Charge RAN Aircraft and Maintenance Flight Trials Unit; and an officer from Defence Materiel Organisation.

Conclusion

2.31 Defence policy calls for a unified approach to T&E to guarantee effective and efficient use of all T&E resources and to avoid duplication of effort and resources. In practice, however, there has been no concerted effort to implement a unified approach to T&E as a means of ensuring that use of T&E resources has been effective and efficient. As indicated in Chapter 1, policy calls for costing of T&E but, in practice, the costs of resources applied to T&E cannot readily be disaggregated from systems engineering and other project costs. Nevertheless they are likely to represent a substantial proportion of total outlays on new equipment acquisitions. Given the amounts involved in Defence's specialist military equipment acquisitions ($2.7 billion a year), an expenditure of 10 per cent of overall project costs on T&E would total $270 million a year. Information on these costs is needed for management purposes to assist in proper project costing and budgeting and for overall organisational efficiency.

2.32 In the absence of a unified approach, the individual Defence groups have formulated their own policies and practices. Individual T&E groups and practitioners seek to maintain contact, and this indicates a need for a coherent, coordinated approach to T&E throughout Defence. The Defence policy needs to be revised, at least to update references to those responsible for it. More substantively, the policy should articulate how a '*unified approach*' is to be implemented as a means of ensuring effective and efficient use of T&E resources.

Recommendation No.1

2.33 The ANAO recommends that Defence reviews and updates its T&E policy organisation and responsibilities, and articulates the way that the policy is to be implemented.

Defence response

2.34 Agreed. Defence has initiated action that relates to this recommendation. The Vice Chief of the Defence Force has directed the Directorate of Trails to initiate a review of Defence T&E policy.

Capability systems life-cycle management

2.35 During the audit the Vice Chief of the Defence Force (VCDF) circulated for comment proposed wide-ranging changes to the ADF force development process approved in 1992.[30] The proposed changes are the latest since Defence commenced a fundamental review of its capability management process in July 1998.[31]

30 Defence Instruction DI(G) Admin 05-1 *Force Development Process,* 1992.

31 ANAO Audit-Report No.13 1999-2000, *Management of Major Equipment Acquisition Projects Department of Defence*, 11 October 1999, paragraph 3.7, pp. 67–68, 124–126.

2.36 The proposed changes are set out in a draft Defence instruction on capability systems life-cycle management. The draft instruction would apply to the life-cycle of individual projects and would highlight the need for T&E to underpin the important capital equipment-based capability development milestones in the capability development cycle.[32] It specifies the use of the following four key documents, drawn principally from already established Defence systems engineering practice and the Prince 2 project management method, namely an equipment project's:

- Operational Concepts Document (OCD);
- Test and Evaluation Concept (T&EC);
- Functional Performance Statement (FPS); and
- Acquisition Business Case.

2.37 These documents would emerge from each equipment project's requirements analysis and functional analysis to describe:

- the capability required;
- the functions it must perform;
- the level of performance and the conditions under which this performance must be achieved; and
- the acquisition strategy.

2.38 In terms of T&E, these proposed documents, in conjunction with other documents such as contracted systems engineering standards, would:

- provide the basis for project-level T&E during a major capital equipment's capability development and acquisition phase, and during its operational test and evaluation;
- form the T&E framework within each acquisition project's Test and Evaluation Master Plan (TEMP); and
- form the basis of reporting to stakeholders on a project's progress toward approved objectives.

2.39 The draft instruction would hold DMO responsible for ensuring that all materiel considered for introduction into service is evaluated against the capability baseline.[33] It also would hold Output Managers accountable for accepting new or upgraded capability into service, including their logistic support arrangements, by certifying that approved

32 Draft Defence Instruction DI(G) ADMIN 05-1, *Defence Capability Systems Life Cycle Management,* 15 June 2001.

33 Draft Defence Instruction DI(G) ADMIN 05-1, *Defence Capability Systems Life Cycle Management,* 15 June 2001, p. 6–10.

capability baselines have been met 'and any exceptions have been noted'.[34] The draft indicates to the ANAO that approvals to acquire new capital equipment would include reasonable estimates for all the T&E costs and resources needed by DMO and the Output Managers to satisfy their responsibilities, and to assist the Owner Support Executive with T&E feedback on the progress toward closing the targeted capability gap. In the case of Joint Service projects, such as the kind of 'system of systems' model found in the Defence Information Environment,[35] sufficient T&E resources should be available to allow T&E of the integration of new systems into the existing system. The Inspector-General advised the ANAO that the inclusion of T&E costs in submissions leading to project approval is implemented to varying degrees already.

2.40 As stated earlier, the T&E policy includes the requirement for each Major Capability Submission and Equipment Acquisition Strategy to identify T&E requirements so that the full cost of T&E can be identified, budgeted and resourced. In practice this does not occur in the manner intended. For example, many Navy projects listed in Appendix 2, have insufficient OT&E funding and that requires Navy's T&E agency (RANTEAA) to request OT&E funding from DMO System Program Offices.

2.41 The draft instruction would specify that Integrated Project Teams (IPTs),[36] guided by Project Management Boards (PMBs), run the systems engineering managerial process that make capability development trade-offs, manage risks, monitor performance and exercise oversight over the recording of capability baselines, technical tasks and decisions. The draft superseded an earlier draft that was more specific in holding IPTs accountable for providing the documentation necessary to assist Output Managers to determine whether a new capability is fit for service. That documentation was to include In-service Support Plans, and Operational and Supportability T&E Master Plans. The IPTs were also to provide a baseline Whole-of-Life cost model to assist in-service managers with future trade-off analysis tasks.

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34 Integrated project teams have been formed to assist a holistic approach to capability development through the use of teams consisting of representatives of relevant stakeholders. Draft Defence Instruction DI(G) ADMIN 05-1, *Defence Capability Systems Life Cycle Management,* 15 June 2001, p. 2–3.

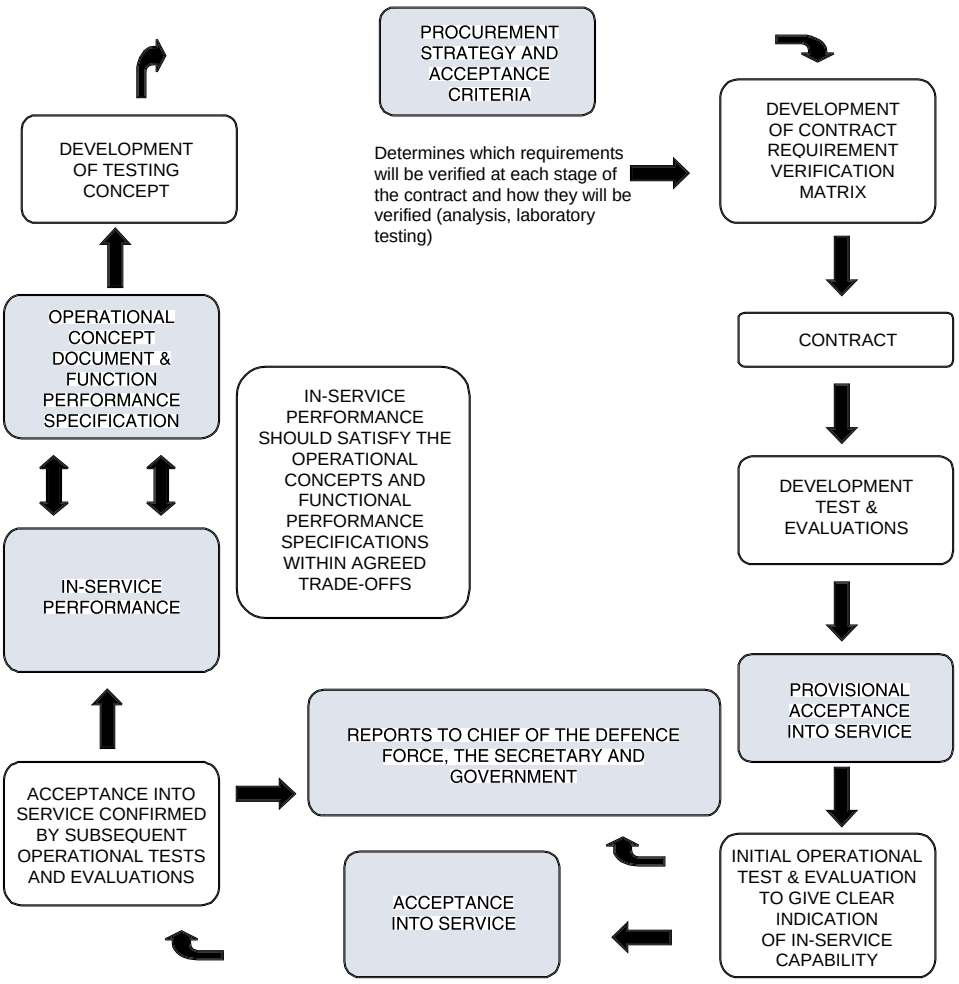
35 Audit Report No.11 2000–2001*, Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000, pp. 31–32, 41–43, 69.

36 Integrated project teams have been formed to assist a holistic approach to capability development through the use of teams consisting of representatives of relevant stakeholders. Draft Defence Instruction DI(G) ADMIN 05-1, *Defence Capability Systems Life Cycle Management,* 15 June 2001, pp. 3–3, 5–17—5–19.

2.42 The overall T&E responsibility placed on DMO, the Output Managers and IPTs, and the strong inter-relationships between development, production and operational T&E, indicate a need for a uniform approach in the 'T&E continuum'. That would help minimise the organisational and process boundaries between the Capability staff in the Owner Support Executive, the DMO Systems Program Offices, and the Output Managers' capability management organisations. It would allow best practice in major acquisitions to be adopted across Defence and in Defence's Standard Project Management Method (SPMM).[37] Figure 2 shows T&E as an integral part of the draft instruction.

Figure 2

Test and Evaluation aspects of the Defence Capability Development Cycle



Source: Department of Defence

[37] The SPMM is discussed in Audit Report No.13 1999–2000, *Management of Major Equipment Acquisition Projects, Department of Defence*, 11 October 1999, pp.117–124; and Audit Report No.11 2000–2001, *Knowledge System Equipment Acquisition Projects in Defence*, 15 September 2000, pp. 52–54.

Project decision databases

2.43 The earlier draft instruction mentioned in paragraph 2.41 would have mandated a standardised decision database system for all projects, but the latest draft no longer contains that provision. The decision database would assist project management, requirements development and traceability, resource and schedule management, contract management and reporting. It would provide necessary links between the key documents mentioned in paragraph 2.36, as well as contain the test and evaluation data showing project progress and risk management. Defence records indicate that some projects use requirements traceability tools like DOORS and other systems engineering tools such as CORE to achieve similar functional aims. The current draft instruction could usefully include provision for such decision database systems.

Conclusion

2.44 Defence proposes to improve T&E policy implementation on a project-by-project basis through improvements to its force development process. The improvements proposed in its draft instruction on capability systems life-cycle management would assign accountability for monitoring compliance with approved capability baselines, technical regulatory frameworks and in-service performance of elements of capability.

2.45 The instruction would establish incentives for T&E to contribute more to the development of defence capability, in terms of its use as a risk management tool and an accountability mechanism for all stakeholders. There is scope for enhancing the draft with respect to Integrated Project Teams' T&E responsibilities.

The principle of independent Operational T&E

2.46 In the normal course of acquiring major new equipment, DMO, as the acquisition organisation, would conduct developmental and production T&E with the contractor, and would pass the equipment to the relevant Service for operational T&E (OT&E) and acceptance into service. An important T&E principle is that the organisation responsible for OT&E be, and be seen to be, independent of the equipment acquisition organisation and system contractors who are responsible for developmental and production T&E.[38] Defence T&E policy does not address the importance of this principle.

[38] US Department of Defense, Defense Systems Management College, *Systems Engineering Fundamentals*, October 1999, pp. 61–62. International Standard ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories, 1999-12–15, states: …testing laboratories shall [among other things] …*have arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures that may adversely affect the quality of their work.*

2.47 Navy accepts the principle. Its T&E policy states that the Chief of Navy requires expert and independent advice on safety, governance, fitness for purpose, test and evaluation and acceptability for Naval service. Navy has placed its OT&E organisation (RANTEAA—see Chapter 4) in its Systems Command, which has direct responsibility to Chief of Navy. This arrangement extends the independence principle in Navy itself by having its OT&E organisation independent from its operational organisations including Maritime Command, as well as providing independence from delivery organisations including DMO.[39] However, as indicated in paragraph 2.24, the acquisition organisation (DMO), by default, performs a substantial amount of the OT&E prior to contract delivery.

2.48 Army's T&E organisation (LEA) is part of DMO. Air Force's T&E organisation (ARDU) reports to the Air Commander and to the Chief of Air Force.

2.49 The ANAO raised the issue of independence and adequate testing in its 1998 report on the New Submarine Project. At the time, the submarines' Inspections Test and Trials (IT&T) results, together with general project management difficulties, led the ANAO to conclude that there were significant risks in the project, notwithstanding Defence's advice that the majority of defects identified during IT&T were very minor.[40] The ANAO also noted that the Defence Acquisition Organisation's project office had agreed with the submarine Prime Contractor's proposal to remove important trials from the submarines' sea trials program.[41]

2.50 Since then, the submarines' post delivery T&E has exposed a wide range of deficiencies costing some $266 million to partially rectify in two submarines,[42] with much larger additional costs to come for all submarines (paragraphs 4.34–4.35). Projects discussed in Chapter 4 confirm the need for T&E supervision and reporting. Furthermore, the growing extent of Australian industry participation in systems engineering and in-service support in Service capability programs, justify strengthening of the Services' OT&E capabilities.

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39 Australian Defence Force Publication, ABR 6205*, Naval Test, Evaluation and Acceptance Manual (NTEMAN),* 17 July 2000, p. 2–5.

40 Department of Defence Inspector-General, IG 373/97*, New Submarine Project—Proposed Audit Report*, 25 November 1997, enclosure p. 25.

41 ANAO Audit Report No.34 1997–98, *New Submarine Project* (1998), paras 4.59 and 4.61 and pp. 51–55 and 79–80.

42 Minister for Defence, *Upgraded Submarines Arrive in Perth*, Press Release, 14 December 2000, p. 1. See also references to the Project in chapter 4 of this report.

2.51 The Australian Defence acquisition process typically involves Defence acquisition of weapon system prototypes and full-scale production within one contract through a single Government approval. By comparison, the US acquisition process is more risk averse in that development and production risks are reduced by the transition from prototypes to full-scale production proceeding only when weapon systems satisfy performance criteria and independent OT&E. T&E then further underpin full-scale development as mandated in defence-system acquisition statutes and regulations.[43] With regard to independent OT&E, in 1983 the US Congress established the Director of Operational Test and Evaluation (DOT&E) in the Office of the Secretary of Defense to coordinate, monitor and evaluate operational tests and evaluations of major weapon systems.[44] Appendix 3 provides a brief overview of the DOT&E organisation.

2.52 The ANAO considers that one practical option for strengthening Defence's OT&E and for promoting a unified approach to T&E would be to establish an office in the Owner Support Executive,[45] similar in concept to the US DOT&E. It would be responsible for common standards for, and independent oversight of, OT&E policy and processes, and assist in strategic management of OT&E. The Services' OT&E organisations would continue to conduct OT&E and report the results to their Service Chiefs, who would remain responsible for accepting equipment into service. The Service Chiefs would report to the Owner Support Executive on any capability shortfalls identified by OT&E and the standard of T&E performed at the various stages of the acquisition.

2.53 DMO, as the acquisition organisation, would remain responsible and accountable for developmental, production and logistics T&E. The Services would remain responsible for OT&E, technical regulation and Occupational Health and Safety-related duty of care obligations. The main improvements over present arrangements would come from improved OT&E strategic management, and better integration of T&E efforts from improvements in OT&E standards and capability shortfall reporting.

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43 Statute: Title 10 US Code, 2399, Operational Test Plan (Director of Operational Test and Evaluation Oversight Programs). Regulation: Department of Defense, Interim Regulation, DoD 5000.2R, *Mandatory Procedures for Major Defence Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs,* 4 January 2001, Part 3 Test and Evaluation.

44 Title 10 of the US Code, Section 139.

45 The Owner Support Executive consists of the Vice Chief of the Defence Force, Chief Defence Scientist, Chief Finance Officer, Inspector-General, Head Defence Personnel Executive and Head Public Affairs & Corporate Communications.

Recommendation No.2

2.54 The ANAO recommends that, with a view to improving the strategic management of operational test and evaluation (OT&E), Defence assess the costs and benefits of establishing, in its Owner Support Executive, an office responsible for common standards for, and independent oversight of, OT&E.

Defence response

2.55 Disagreed. Defence strongly disagrees with the ANAO's suggestion that Defence establish an independent T&E office similar in concept to the US T&E. The Australian context recognises the fundamental relationship between T&E and the systems engineering approach to materiel management. This relationship and Defence's management structure does not easily lend itself to the creation of a single organisation responsible for the conduct of all T&E within Defence. This recommendation mimics the US model without consideration of Australian circumstances.

2.56 With few exceptions, the Australian approach is geared to acquiring and integrating weapons and platforms developed by the US and other countries that have already completed rigorous T&E including OT&E. Defence incorporates the outcome of this testing in its OT&E programs where applicable. It then carries out the additional quantity of testing required to confirm that the Australian implementation meets agreed operational and support requirements for formal introduction into service. The amount of OT&E required is typically small by comparison with that required by the US. The higher levels of risk and cost involved in US Defense have justified the establishment of a large and very expensive independent organisation to carry out operational testing and evaluation. The scale of procurement in Australia would not warrant a similar relatively high level of investment. The creation of an additional office to provide independent oversight of OT&E and consider reports from existing OT&E authorities would create an additional overhead with questionable benefit.

2.57 There is a case for the establishment of an office responsible for overarching T&E policy generally, and coordinating facilities, capabilities and infrastructure. The precise roles and responsibilities of such an office should be developed and implemented as part of implementing the policy framework developed under Recommendation No.1.

ANAO comment

2.58 The recommendation does not raise a need to change the T&E responsibilities of DMO or the Services or to change the degree to which T&E is integrated into the systems engineering process. The US Defense acquisition process seeks to reduce risk through mandated T&E and independent oversight of OT&E. In Australian Defence acquisition, however, there is inconsistent adherence to T&E policies—see Chapter 3. Acquisition projects such as the Collins submarine project (see Chapter 4) and the Jindalee Operational Radar Network (JORN) Project (see Chapter 7) are largely developmental, involve significant risk and require extensive T&E. The Kalkara project (Chapter 3) indicates that even commercial off-the-shelf acquisitions can be subject to significant risks. These factors indicate a need to consider closely the costs and benefits of independent oversight of OT&E of major defence weapon systems.

2.59 Such oversight need not be expensive. The US DOT&E organisation (paragraph 2.51), with 60 T&E personnel, is small in relation to the 3 500 Operational Test Agency (OTA) personnel employed or engaged by US Defense.[46] For Defence here, independent oversight of OT&E would be likely to involve only a small office, with a staff of three or four in the Owner Support Executive, considering reports from the Services on any capability shortfalls identified by the Services' OT&E bodies and on the standard of T&E performed at various stages of equipment acquisition. The aim would be to improve acquisition project outcomes through an improved T&E strategic management and accountability mechanism. The ANAO accepts that there may be a case for establishing an office responsible for overarching T&E policy, but the recommendation concerns only operational T&E, which is the important third category of T&E that leads to the Services' final acceptance of equipment into service.

Regulation of technical integrity

2.60 Related to T&E is the Service Chiefs' responsibility for ensuring that Defence materiel is fit for service, does not hazard personnel or public safety, and does not pose a hazard to the environment. Each Service Chief relies on the Service's Technical Regulatory Authority (TRA) to establish, through T&E and other means, reasonable levels of confidence that the requisite levels of safety and fitness for service of materiel are achieved.

[46] US Defense also has 28 000 T&E personnel (including OT&E personnel) engaged in Major Range and Test Facility Base (MRTFB) activities (paragraphs 10.11-10.12). See DOT&E Annual Report FY2000, available www.dote.osd.mil

2.61 The Service TRAs administer policies on regulation of technical integrity.[47] In terms of the processes used to demonstrate acceptability or compliance with approved technical standards, the Services' policies place heavy reliance on:

- certification by suppliers that the materiel for which they are responsible complies with regulatory requirements;
- configuration management of systems and equipment; and
- quality assurance of procured goods and services.

2.62 The policies focus primarily on the process of achieving reasonable levels of safety and fitness for service, and it is T&E programs that measure achieved performance in terms of safety and military capability.

2.63 Defence is developing an overall general Defence instruction on regulation of the technical integrity of ADF materiel. This general instruction is expected to require all Defence groups to comply with the relevant Service's technical regulations. It would assist the Services' TRAs with their responsibility for ensuring materiel is designed, manufactured and maintained to approved standards by competent and authorised members of an authorised organisation.[48]

2.64 Army requested that DMO acquisition processes comply with the Army's technical regulation requirements for land materiel. This is necessary in the absence of a general Defence instruction that binds all Defence groups to each of the Services' technical regulations. As indicated in paragraph 5.4, the request was met by means of an instruction issued in October 2001.

Design Approval and Acceptance Authorities

2.65 The Defence practice of contracting out responsibility for capital equipment design and construction results in a need to ensure that contracts hold contractors responsible for instituting management systems that ensure the technical integrity of design and construction.

2.66 Under normal contracts, the Design Approval Authority, usually the Prime Contractor or Original Equipment Manufacturers (OEMs), have responsibility for approving designs submitted to the Commonwealth. As the Design Acceptance Authority DMO accepts, on behalf of the

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47 Defence Instructions (Navy) LOG 47-3, *Technical Regulation of Navy Materiel*; 24 February 1999; Defence Instruction (Army) LOG 12-1, *Regulation of the Technical Integrity of Land Materiel*, 3 April 2001; AAP 7001.053, *Technical Airworthiness Management Manual*, 13 December 1999, and AAP 7001.054, *Airworthiness Design Requirements Manual*, 2 February 1998 and AAP 7001.059, *Aircraft Maintenance Management Manual*.

48 Draft Defence Instruction, *Regulation of Technical Integrity of ADF Materiel*, p. 1.

Commonwealth, defence capital equipment designs based on a number of factors such as the competence of the designer, the engineering management system, the use of accurate technical data, and the quality system.

2.67 Each Service's technical regulations call for design acceptance processes and technical certification plans. The Defence Inspector-General advised the ANAO that certification plans in most cases specify the need for a test and evaluation master plan, and that T&E is an integral part of verifying that equipment complies with its allocated baseline.

Conclusion

2.68 Defence links its capability-related corporate governance arrangements with systems engineering and capability development processes, and treats T&E as a secondary process. Many positions have responsibility for elements of the T&E process without the benefit of proper integration across areas of responsibility. Defence's T&E policy calls for a unified approach to T&E to guarantee effective and efficient use of all T&E resources and to avoid duplication of effort and resources. In practice, however, there was little evidence of effective corporate initiatives to achieve a unified approach to T&E. The individual Defence groups formulated their own policies and practices, thus raising risks to effective T&E. Defence should review and update its T&E policy and articulate the way that the unified approach is to be implemented.

2.69 Defence's improvements to its force development process may assist T&E governance on a project-by-project life-cycle basis. The improvements proposed in its new instruction on Defence capability systems life-cycle management would assign accountability for monitoring compliance with approved capability baselines, technical regulatory frameworks and in-service performance of elements of capability. The instruction would establish incentives for T&E to contribute more to the development of defence capability, in terms of its use as a risk management tool and an accountability mechanism for all stakeholders.

2.70 Defence has not addressed in its T&E policy the importance of independence between those conducting OT&E and the acquisition organisation and system contractors. By default, DMO performs a substantial amount of the OT&E prior to contract delivery (see paragraph 2.24).

2.71 There may be benefits in having an office in the Owner Support Executive responsible for strategic management of OT&E policy and processes. The Services' OT&E organisations would continue to conduct

OT&E and report to their Service Chief, who would remain responsible for acceptance into service. The Service Chiefs would report to the Owner Support Executive on any capability shortfalls identified by OT&E and the standard of T&E performed. The main improvements over the current arrangements would come from improved OT&E strategic management, and better integration of T&E efforts from improvements in OT&E standards and capability shortfall reporting. This would help facilitate Defence's present policy of a '*unified approach*' to T&E.

3. Defence Materiel Organisation Test and Evaluation

This chapter provides an overview of the DMO's T&E policy, and T&E planning and implementation.

Introduction

3.1 Defence Materiel Organisation (DMO)[49] is responsible for acquiring major Defence equipment from contractors, delivering it to the relevant Service and supporting it in service. DMO plays an important part in Defence's 'T&E continuum' and T&E costs would represent a substantial proportion of total DMO outlays on new equipment acquisitions. An internal survey indicated that DMO perhaps has Defence's largest T&E capability in terms of T&E personnel, with some 45 per cent of its professional and technical staff involved in T&E-related tasks.[50] The Defence Inspector-General advised the ANAO that, in terms of T&E capability, most of Defence's T&E capability resides in the Services' T&E agencies.[51]

3.2 Major Defence capital equipment contracts typically hold prime contractors responsible for developing and implementing a T&E program that demonstrates compliance with Commonwealth requirements. Consequently, each DMO System Program Office (SPO) is responsible for confirming, through measures such as T&E, that the equipment or systems being procured meet specifications.

DMO's T&E policy

3.3 The DMO T&E policy assigns responsibility for T&E activities to DMO's System Program Offices (SPOs). The Annex to this chapter summarises DMO's T&E responsibilities. DMO's Policy Support Cell (PSC) is revising DMO's T&E policy and is promoting the coordination of T&E planning in the DMO. Also, given DMO's logistics support responsibilities, its Joint Logistics Support Agency (JLSA) is developing a supportability test and evaluation (ST&E) process.

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49 Formed in July 2000 by merging Defence Acquisition Organisation and Support Command Australia.

50 Directorate of Strategic Personnel Planning and Research, *The Qualifications and Work Experience Levels of Professional and Technical Acquisition Staff in the Defence Materiel Organisation*, DSPPR Technical Note 1/2001, January 2001.

51 For example, the RAN Test and Evaluation Agency and the Aircraft Research and Development Unit.

3.4 However, Defence has not promoted its policy of a unified approach to T&E (see Chapter 2), and this has hindered the PSC's efforts to revise DMO's policy on T&E and its implementation, and to create a unified approach in DMO.

3.5 The draft instruction on Defence capability life cycle management discussed in Chapter 2 would hold DMO responsible for ensuring that all material considered for introduction into service is evaluated against the capability baseline (see Glossary). These responsibilities cover project conception and acquisition phases of the capability management cycle, as well as the presentation of acquired capability to the Services for acceptance into service.

Test and evaluation planning in DMO

3.6 DMO policy requires SPOs to develop and implement Test and Evaluation Master Plans (TEMPs) for their projects, and to assess whether contractors':

a. Developmental Tests and Evaluations (DT&Es) demonstrate that systems and equipment designs meet Defence missions;

b. Production Tests and Evaluations (PT&Es) demonstrate that the contracted products contain good engineering practice; and

c. Operational Tests and Evaluation (OT&Es) demonstrate the effectiveness and suitability of systems and capabilities.

3.7 In the DMO internal survey mentioned above, some two-thirds of respondents reported that their project had a current TEMP. Since T&E policy requires each project to have a TEMP, this represents a significant departure from the policy position. The survey results were available in January 2001 but, at the time of this audit, the survey report had not been completed and conclusions had not been drawn from it. Nevertheless, it indicates that DMO should ensure that its project staff comply with T&E policy on production and implementation of TEMPs; Project Boards should approve their project's TEMP before projects begin technical reviews and audits;[52] and each TEMP should address critical T&E issues, including resource needs, identified by T&E planning and working groups (see paragraphs 2.27–2.30).

[52] Military systems engineering standards used by DMO include MIL-STD-1521B (USAF) *Technical Reviews and Audits for Systems, Equipment and Computer Software,* 4 June 1985; MIL-STD-499B, *Systems Engineering*, 4 May 1994; MIL-STD-882B, *Safety Program Requirements*, 1987; and DOD-STD-2167A, *Defense System Software Development*, 4 June 1985. These standards include the need for project teams to confirm the completeness of test plans and procedures that will confirm necessary performance.

3.8 DMO's capital equipment procurement manual (CEPMAN 1) states that DMO Project Managers:

- must confirm that the system procured meets functional or detailed performance specifications stipulated by the sponsor;
- must disseminate results of T&E activities conducted as directed by a higher Defence committee;
- must ensure T&E is independent, objective, competent, timely and cost-effective;
- should decide the type, range, scope and timing of T&E (if any) to be conducted;
- should develop a Test and Evaluation Master Plan (TEMP) with the initial Equipment Acquisition Strategy (EAS);
- should define schedules and responsibilities for detailing the TEMP in the Project Management and Acquisition Plan (PMAP); and
- should negotiate the priority of effort with individual T&E agencies, and formally record the priority in the EAS and PMAP documentation.[53]

3.9 Defence T&E policy defines each project's TEMP as the primary document for planning and managing T&E,[54] but CEPMAN's use of the word 'should' instead of 'must' indicates that TEMPs are not viewed as being mandatory. This is inconsistent with DMO's policy stance.

Test and evaluation implementation in DMO

3.10 DMO provides major equipment acquisitions to the three Services for acceptance into service, subject to the Services' operational T&E processes. The ANAO's review of T&E in selected Navy, Army and Air Force and Knowledge System projects (next four chapters) provide information on DMO's implementation of T&E.

3.11 The Defence Inspector-General advised the ANAO that in DMO various corporate governance arrangements are in place, or are being established. These include Project Governance Boards now being established to provide an independent check of projects and an opportunity to ensure that all project management issues, including T&E, are properly addressed. The Inspector-General also advised that at the

53 Department of Defence, *Capital Equipment Procurement Manual,* (CEPMAN 1), Part 2, Chapter 14.

54 Defence Instruction DI(G) Log 08–10, *Defence Test and Evaluation Policy,* 1996, p. 3.

DMO group level, T&E policy and procedures continue to be addressed, along with all other aspects of materiel acquisition and support, in the context of the continuing DMO reform program.

3.12 At the time of the audit, seven of 23 projects submitted by DMO to Navy for Operational Tests and Evaluation were not accompanied by a TEMP (Appendix 2). This is inconsistent with DMO policy that requires a TEMP and creates difficulties for Navy's T&E authority, and for Navy itself. It is also inconsistent with Navy policy mandating that Project Managers (in DMO) produce a TEMP and that they identify and integrate the effort and schedules for all T&E to be accomplished during a project.[55]

3.13 The Defence Inspector-General advised the ANAO that a 'reasonable person' would prepare TEMPs and supporting documentation, and that CEPMAN and integrated logistics manuals have for some years demanded this rigour. The ANAO considers that the findings indicate that more work should be done to implement the requirements and that training should cover the need to prepare basic T&E documentation.

3.14 The ANAO's review of three Navy equipment acquisition projects (see next chapter) indicated that successful use of T&E depends largely on the managerial response to work done by T&E professional and technical personnel. The projects were to acquire Minehunter ships, New Submarines and Kalkara unmanned aerial targets. In the Minehunter project, T&E received high managerial priority. Navy records (see Appendix 2) show the project had:

- a high-standard TEMP,
- OT&E funding provided by DMO as required;
- satisfactory production T&E by DMO;
- satisfactory configuration control; and
- a comprehensive and regularly updated report of material state at delivery.

3.15 The New Submarine Project and the Kalkara (unmanned aerial target) project lacked these advantages, and were experiencing difficult progress toward acceptance into naval service. In these projects, DMO's planning and funding of T&E were inadequate for Navy's OT&E requirements. Both projects have configuration control problems, resulting largely from acquisition management problems or systems engineering problems. These inadequacies, and those in paragraph 3.12,

[55] Australian Defence Force Publication, ABR 6205, *Naval Test, Evaluation and Acceptance Manual (NTEMAN),* 17 July 2000, Annex A to Chapter 3, p. 1.

indicate a systemic failure in DMO's implementation of T&E principles and policy and deficiencies in the implementation of Defence's capability management cycle.

3.16 Subsequent chapters of this report indicated that Army's Bushmaster vehicle project, Air Force's F-111 block update project and the Knowledge System JORN project have satisfactory T&E processes (Chapters 5, 6 and 7).

3.17 Chapter 9 concerns T&E training. It comments that a DMO staff survey indicates the probability of gaps between the knowledge edge expected by Defence and the actual capabilities of personnel involved in T&E. It also indicates a need to increase the number of personnel skilled in T&E to ensure that competent and skilled practitioners prepare risk management strategies associated with T&E.

3.18 ANAO's earlier reports on the New Submarine Project and the Jindalee Operational Radar Network (JORN) Project showed that, even though T&E data was produced, project risks were not adequately managed by the Defence Acquisition Organisation's project offices.[56] It is important that project managers respond adequately to project risks identified in T&E data. This is a project monitoring and control issue of a kind that the Prince 2 (**Pr**ojects **in C**ontrolled **E**nvironments) project management method was designed to prevent.[57] This method was to be adopted by DMO, but DMO's current reform agenda indicates that DMO no longer regards that method as suitable and plans to augment it. DMO is reviewing its project management method and has assessed T&E as high priority in that review. The standard project management method needs to have adequate provision for T&E management.

3.19 Defence's Management Audit Branch's (MAB's) medium term audit strategy for the period 2001–04 rated the likelihood of failure of major capital projects, inadequate contract management, and ineffective IT systems (not delivered, not integrated), as very high for the next three years, and rated the consequences of those risks occurring as very high.[58]

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56 Audit Report No.28 1995–96 *Jindalee Operational Radar Network Project,* 14 June 1996, pp. 18–19, 26–27, 33–37. Also Audit Report No.34 1997-98 *New Submarine Project,* 24 March 1998, pp. 50–55, 59–60, 99–101, 107–108, 115.

57 Previous ANAO recommendations concerning Defence's Standard Project Management Method (SPMM) are in Audit Report No.13 1999–2000, *Management of Major Equipment Acquisition Projects, Department of Defence*, 11 October 1999, p. 129; and Audit Report No.11 2000–2001*, Knowledge System Equipment Acquisition Projects in Defence*, 15 September 2000, pp. 52–54.

58 Defence Audit Committee Agendum 18/2001, DAC Meeting—14 May 2001, *MAB's Medium Term Audit Strategy 2001/2004.*

This is a higher rating than in MAB's previous annual risk assessments. In the ANAO's view, proper implementation of T&E in DMO can assist in managing those risks.

Conclusion

3.20 T&E is an important part of the equipment acquisition process. When properly planned and implemented, T&E offers assurance concerning value for money, compliance with specifications, suitability for military service and safety of personnel. Nevertheless, the evidence indicates that on some Navy equipment, DMO has not met basic T&E requirements that are intended to offset risks regarding equipment performance to expectations, safety and suitability for service. This creates difficulties for Navy. The Defence policy aim of a unified approach to T&E is not being met in DMO.

3.21 DMO's role in delivering major capital equipment to the Services, and coordinating the delivery of all elements of capability makes its System Program Offices' responsible for a large portion of the overall 'T&E continuum'-developmental, production and some operational T&E.

3.22 A review of 23 Navy projects found seven with no T&E master plan. However, some projects, such as the Navy's Minehunter project, give T&E a high managerial priority and this shows in the quality of T&E planning, T&E funding, and configuration control. Others, such as the New Submarine Project and Kalkara project, require improved T&E. The ANAO considers that DMO should enforce its T&E policy regarding the production and implementation of TEMPs. T&E provisions in DMO capital equipment manual should be consistent with Defence's T&E policy. DMO's review of its project management method has assessed T&E as high priority in that review. The standard project management method should have adequate provision for T&E management.

3.23 Management Audit Branch has rated the likelihood of failure of major capital projects, inadequate contract management, and ineffective IT systems as very high for the next three years. Proper implementation of T&E in DMO can assist in managing those risks.

Recommendation No.3

3.24 The ANAO recommends that, in the interests of improved risk management and equipment safety and suitability for service, Defence aim to ensure that:

(a) major equipment is acquired on the basis of Test and Evaluation Master Plans (TEMPs) and supporting documentation, as required

by T&E policy, and that there is confirmation that adequate T&E has been conducted before equipment is offered for release into operational service or acceptance;

(b) DMO T&E policy and project management processes are consistent with Defence T&E policy; and

(c) training in its project management method includes adequate coverage of T&E principles and practices.

Defence response

3.25 Recommendation No.3(a)—Disagreed. Major capital equipment acquisition methodology incorporates a wide range of disciplines of which T&E is but one which ensures that equipment offered for introduction into service will be fit for its intended purpose. The recommendation distorts the role of T&E which is just one element of the systems engineering processes. Changes to the capability development process already being implemented will require the development of agreed test concepts and related T&E funding arrangements to be incorporated into project proposals before they are approved. This approach will overcome current inconsistent adherence to T&E policies and funding of T&E.

Recommendation No.3(b)—Agreed. Current DMO policies and practices will be updated to reflect policy issues in accordance with Recommendation No.1.

Recommendation No.3(c)—Agreed. DMO project management methodology is being substantially augmented and superseded by the DMO Standard Acquisition Management System, which addresses training requirements, including that for T&E.

ANAO comment

3.26 Recommendation No.3(a) reflects T&E policy that requires TEMPs to be developed and implemented. The aim is to achieve improved project outcomes through an accountability mechanism designed to prevent inconsistent adherence to T&E policies and to ensure equipment is accepted on the basis of adequate T&E.

Annex—DMO Test and Evaluation in the Materiel Life Cycle[59]

Pre-contractual Test and Evaluations	Test and evaluation (T&E) may be applied to commercially available equipment or prototypes prior to contract signature. The DMO is required to evaluate designs for compliance with functional and performance specifications.
Contractual	DMO is required to ensure equipment and systems acceptance meet contractual specifications. This requires acquisition project personnel to observe functional and performance tests of product procured under contract. Often this testing forms the basis for 'acceptance' under the contract. Therefore, system and equipment testing are often classified as contractual events, which have clear consequences for 'acceptance' by the Commonwealth. Delays in acceptance testing have a flow-on effect to subsequent operational testing. DMO Project Directors have a responsibility together with the contractor to complete the acceptance testing on schedule.
Introduction into service	In large design and construction projects such as the ANZAC Ship project, New Submarine Project and the JORN Project, DMO, in conjunction with the Services' T&E authorities, uses OT&E and ST&E to assess platforms, systems and equipment in their operational environments to determine their operational effectiveness, system performance and logistic support. Defence Instruction DI(G)LOG 08–10 *Defence Test and Evaluation Policy* November 1996, at paragraph 15, stipulates the importance of Operational T&E (OT&E) as the means to evaluate the operational effectiveness and suitability of systems before acceptance into service. The Service Chief via the Maritime, Land and Air Commands is generally responsible for acceptance into service and any associated T&E.

59 Source: Defence Materiel Organisation.

The Army's Defence Instruction DI(A) LOG 1–33 *Integrated Logistic Support and the Army Materiel Process* specifies that DMO Project Directors are responsible for initiating and maintaining the Integrated Logistic Support (ILS) Instruction that details the introduction into service plan for the system. The Equipment Acquisition Strategy (EAS) supplemented the ILS instruction raised by the DMO project provide the initial planning for T&E to support mid-life reviews and upgrades.

In-service life

The DMO has responsibility for in-service T&E, as this falls within the responsibility of the Systems Program Offices.

Disposal

The DMO has responsibility for in-service T&E, as this falls within the responsibility of the Systems Program Offices.

DMO materiel acquisition life cycle diagram

The figure [Chapter 2 Figure 1] illustrates the different categories of T&E applied during the Defence materiel life cycle.

A T&E program typically follows a sequential build-up of tests that culminates in the capability being delivered and accepted by the Commonwealth. Testing follows the format of:

- Development T&E (DT&E) leading into
- Production T&E (PT&E) completion of which is a contractual delivery, then
- Operational T&E (OT&E) for assessment in the operational environment.
- Supportability T&E (ST&E) begins at the conceptual stage of the project and continues through to disposal of the asset, and looks at supportability issues.

The results of earlier tests can assist in decision making later in the materiel life cycle. So test results should be retained and forwarded onto the next phase in the life-cycle so as to avoid unnecessary re-testing.

The figure [Chapter 2 Figure 1] shows the relationships between the four categories of testing and the Defence material life cycle from concept to disposal. The feedback loop indicates how the results of T&E can be fed back to assist in further decision making during the acquisition.

All categories of T&E can also appear during the in-service phase during mid-life refits and so on, which require some form of T&E before the systems and equipment are returned to service.

Source: Defence Materiel Organisation, Department of Defence

4. Navy Test and Evaluation

This chapter provides an overview of Navy's test and evaluation policy and processes.

Introduction

4.1 Navy has established extensive T&E policy, backed by technical regulation of design, construction and modification of new vessels and systems. Navy has also established T&E organisations that emphasise rigorous T&E processes leading to system and platform acceptance into naval service and beyond into operational service.

4.2 Equipment tests and evaluations conducted by DMO in the development and production phases of a project do not formally test the equipment and its supporting infrastructure in parallel. Only when new systems or platforms are fully assembled can operational T&E (OT&E) be used to verify the adequacy of equipment's design and construction and its integrated logistic support.

4.3 OT&E is a key element in Navy's risk management strategy applied to newly-introduced capability. Navy considers that to disregard the risk in the capital equipment acquisition may jeopardise equipment safety and suitability for service and materially affect the ability of the ADF to accomplish its mission successfully. According to the Chief of Navy:

> *…the process used by the RAN to measure the effectiveness and suitability of new capability against the Capability Systems Statement (CSS) are rugged and stringent. Although at times protracted, this process ensures that Government and Navy get the agreed contracted capability.*[60]

4.4 The small numbers of major naval platforms (vessels) that Defence acquires - such as six Collins submarines, eight Anzac destroyers, and six Huon minehunters - together with time, budget and industry infrastructure constraints, virtually require these projects to proceed from design to full-scale development without the benefit of completed development T&E and OT&E of the first of class.[61]

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60 Chief of Navy, Dot Point Brief for USDA and A/CDF, *Acceptance into Naval Service (AINS) of Collins and Anzac Class*, August 2000, p. 2. Navy withheld acceptance of the first ANZAC Ship into service for five years after commencing acceptance trails. Navy has not yet accepted any Collins submarine into service, after five years of Provisional Acceptance arrangements.

61 The total project cost approval for these projects is some $12.1 billion, comprising: Anzac ships $5.2 billion; Collins submarines $5.4 billion; and Minehunter Coastal ships $1.2 billion—Department of Defence, *Annual Report 2000–01*, 28 October 2001, p. 217.

4.5 This situation constrains the use of T&E in assessing the effectiveness of the acquisition program's risk abatement, prior to the Commonwealth entering into significant long-term financial and national defence commitments.[62] Therefore, once naval construction contracts are signed, the Commonwealth is heavily dependent on T&E to assess the extent to which program risks have been successfully managed by project management and systems engineering processes. For this reason the ANAO placed emphasis on auditing two high-cost Navy projects, namely the Collins Submarine project and the Mine Hunter Coastal project.

4.6 The submarine project was subject to detailed review and analysis in both T&E terms and general progress terms, given the likelihood that the Commonwealth would make additional substantial investments in the submarine program. The aim is to show how T&E has exposed performance shortfalls and that the knowledge gained should make an important contribution to the future management of the project.

Navy's T&E policy

4.7 Navy T&E policy[63] focuses on acceptance into naval service (AINS) and is based on the naval test, evaluation and acceptance of ships into operational service. The policy addresses achievement of capability readiness through T&E to confirm the effectiveness and suitability of the 'platform' (ship) as part of ADF capability. It mandates the use of Test and Evaluation Master Plans (TEMPs) for each type of vessel or major equipment. The TEMP is the master long-term planning document, and the policy document provides advice on TEMP format.

4.8 Navy's T&E focus is on evaluation of 'fitness for purpose' of the capability as delivered by the contractor, largely in the period between a vessel's Provisional Acceptance (PA) from the Prime Contractor and its AINS. This period is called the Naval Test, Evaluation and Acceptance (NTEA) period.

4.9 Any system deficiencies and operational limitations not resolved by the Prime Contractor or DMO at the time of PA remain in the vessel's Report of Material State at Delivery (TI-338). The TI-338 document forms

62 The US DoD mandates the use of early operational assessments (EOAs) to reduce project risks before approving a project to commence engineering and manufacturing development and low rates of initial production—points that occur well before full-scale development.

63 Department of Defence, ABR 6205, *Naval Test, Evaluation and Acceptance Manual,* 2001. This publication was first released in 1994 and revised in 2000 and 2001.

part of the certification basis of the vessel and is used in post-delivery T&E. The DMO provides this OT&E data through developmental T&E and production T&E.

4.10 By virtue of its extent, detail and analysis requirement, Naval T&E takes longer for the first unit delivered (first of class) than for subsequent production units, and often identifies a need for modifications or changes in follow-on production equipment.

Technical regulation in Navy

4.11 As discussed in Chapter 2, each of the three Service Chiefs is responsible for ensuring that Defence materiel is fit for service, does not hazard personnel or public safety, and does not pose a hazard to the environment. The Service Chiefs rely on their Service's Technical Regulatory Authority (TRA) to establish reasonable levels of confidence that the requisite levels of safety and fitness for service of materiel are achieved.

4.12 At the time of the audit the Navy was reviewing its technical regulation promulgated in 1999. Navy's TRA is the Chief Naval Engineer, appointed by the Chief of Navy. The Chief Naval Engineer is responsible for establishing and administering Navy's technical regulatory system, including associated standards, regulations and orders. Assisting the TRA is the Director-General Naval Certification, Safety and Acceptance Agency (DGNCSA), who in turn assists Project Managers in DMO to develop their project's Materiel Certification Plan (MCP) and Naval Test, Evaluation and Acceptance Plan (NTEAP). The Naval Materiel Regulatory System (NMRS) establishes the Naval materiel certification requirements.[64]

4.13 Materiel certification and test, evaluation and acceptance processes aim to provide assurance that equipment is safe and fit for service. The RAN Test, Evaluation and Acceptance Authority (RANTEAA) is responsible for T&E of vessels offered for acceptance by DMO. This requires RANTEAA to assess safety and fitness for service, as discussed below.

4.14 Materiel certification may require several levels and series of licences before commencing Naval tests and evaluations. For example, the Collins Submarine project contained an extensive inspections, test and trials program that was the responsibility of Australian Submarine Corporation Pty Ltd, as well as an extensive T&E program which was the responsibility of Navy.[65]

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64 Defence Instruction DI(N) LOG 47-3, *Technical Regulation of Navy Materiel*, 24 February 1999.

65 ANAO Audit Report No.34 1997–1998, *New Submarine Project Department of Defence*, 24 March 1998, p. 50.

RAN Test, Evaluation and Acceptance Authority

4.15 The RAN Test, Evaluation and Acceptance Authority (RANTEAA) was formed in July 1996 as a division of Maritime Command. In 2000 RANTEAA was transferred to the Naval Systems Command, which is part of the Navy Executive, headed by the Chief of Navy. RANTEAA is primarily responsible for planning, managing and conducting T&E of naval vessels and systems offered to the RAN for acceptance. This requires RANTEAA to:

- provide early advice on all aspects of test evaluations and acceptance;
- identify and monitor the levels of risk in a project in relation to AINS and OT&E;
- establish measurable parameters for the new or enhanced capability required;
- evaluate the capability through all phases of its introduction to decide whether the capability conforms to the requirement and warrants progress to the next stage;
- identify corrective action if the requirement is not being met; and
- evaluate the final product to establish the operational effectiveness and suitability of the equipment for naval service.[66]

4.16 RANTEAA, in exercising its T&E role, focuses on operational evaluations (OPEVALs) of new or modified naval vessels and systems to assess their full operational capability. An OPEVAL involves:

a. measuring the performance of equipment and systems beyond the specifications of contract acceptance (ie beyond the Baseline Capability Systems Statement (BLCSS)); and

b. determining the operational effectiveness and suitability of the unit 'as a whole'.

4.17 RANTEAA's work culminates in assessments and recommendations that are passed through the Navy Systems Commander to the Chief of Navy. These assessments are supported by assessments and recommendations from the Maritime Commander, who is the vessel's end-user. The assessments and recommendations address:

- Provisional Acceptance (PA)—whether a vessel is safe to test operationally; and
- Acceptance into Naval Service (AINS)—where a vessel is safe to operationally use and if it satisfies operational requirements.

66 Director General Navy Certification and Safety Directive No. 2/2000, 12 December 2000, p. 2.

4.18 The audit team found RANTEAA's personnel to be working under heavy demands. As discussed below, the demands mostly result from Navy's current phase of capability development, which involves introduction of new classes of Navy destroyers, submarines and minehunters, and numerous other Navy projects with their own particular range of technical complexity and risk. Shortages of Naval technical personnel and an unstable posting situation add to organisational demands.

4.19 Like other Navy organisations, RANTEAA is endeavouring to meet demands that arise from the Navy development program. However, as outlined above, RANTEAA has major responsibilities regarding acceptance testing and evaluation of new Navy weapon systems and platforms. With that responsibility comes a level of accountability that is rare in such a small organisation (29 personnel).

First of Class Trials

4.20 One of RANTEAA's key responsibilities is to manage First of Class Trials (FOCT), which measure and record equipment performance limits for the first delivered class of naval vessel, through the acceptance into service testing phase. This process is defined in the Navy's test, evaluation and acceptance manual (ABR6205).[67] DMO develops and funds a FOCT package, which after provisional acceptance RANTEAA manages through the OT&E phase.

4.21 RANTEAA conducts first of class trials in consultation with relevant authorities such as DMO System Program Offices, Director-General Maritime Development (DGMD), Systems Command, and Force Element Group Commanders (FEG CMDR). First of class trials aim to:

a. compile a comprehensive picture of the full capabilities of the class of equipment;

b. establish a measured baseline against which the future performance of the class of equipment can be compared;

c. validate models used by the contractor and the Commonwealth;

d. allow operators to witness the capabilities of their equipment; and

e. contribute to the operational evaluation (OPEVAL) process.

4.22 First of class trials normally complement and expand on the contractor's delivery tests and trials, which often do not explore the full capabilities of the equipment. These trials measure the actual performance

[67] Australian Defence Force Publication ABR 6205, *The Naval, Test, Evaluation and Acceptance Manual*, 17 July 2000, p. 4–7.

of the equipment and are designed to be independent of operator performance. They address platform seaworthiness, mobility, and weapons performance to establish a progressive appreciation of the platform's safety and performance.

4.23 Data derived from the first of class trials are recorded in the relevant platform documentation such as the Report of Material State at Delivery (TI 338), the Ship's Book, Navigation Data Book, and Seamanship Data Book. This data provide the basis for later evaluation of the integrated capabilities of the platform such as the systems and operators during OPEVAL. The data also provide the end-user with a documented baseline for operations and maintenance, and for developing improvements in configuration management, tactics and personnel training.

Risk in the naval capital equipment program

4.24 RANTEAA records indicate that T&E periods are progressively becoming extended and integrated into Navy's Fleet Activity Schedule. Furthermore, some development T&E remains incomplete. For example, the Collins submarines are undergoing configuration changes to improve major areas of their performance, and the latest ANZAC ship is being fitted with a missile system that had not successfully completed developmental T&E.

4.25 RANTEAA's complement of 27 uniformed personnel and two civilian staff face a substantial task of conducting OT&E on the following naval projects:

- five Collins-class Submarines, each configured differently and requiring different OT&E;
- one ANZAC ship which is the first ship fitted with the Evolved Sea Sparrow Missile that is still undergoing development T&E;
- two Amphibious Transport Ships (LPAs) with different configurations and offering a new amphibious capability;
- four new design Huon-class Minehunter Coastal ships;
- two new design Hydrographic ships;
- Seasprite helicopters;
- Penguin anti-ship missiles; and
- some 40 minor projects that introduce new or significantly modified equipment.

4.26 DMO offered these vessels and projects to RANTEAA for OT&E, in many cases without a documented trail of data and information needed to conduct OT&E. This contravenes T&E principles.

4.27 The Defence Inspector-General advised the ANAO that, apart from LPA, Statements of Work for the projects listed were agreed and signed before Navy's Naval Test, Evaluation and Acceptance Manual (ABR 6205) was promulgated, and that DMO was not contracted and resourced to perform this new T&E requirement under the auspices of ABR 6205. The Inspector-General advised the ANAO that DMO has made best endeavours to meet the requirements of ABR 6205. The ANAO notes that some projects listed in Appendix 2 such as the minehunter project and other projects not studied in depth by this audit, show the success of improved acceptance paths for projects that have good Operational Concepts Documents (OCDs), TEMPS, and T&E concepts. Such OCDs, TEMPS and T&E principles are a normal part of systems engineering process and the Navy's ABR 6205 explicates the T&E that should have already been systems engineering practice.

4.28 Navy nevertheless accepts the vessels and projects for OT&E and makes the best of the situation. Appendix 2 was compiled from RANTEAA records at the ANAO's request, and provides an indication of the current state of the major projects undergoing OT&E by RANTEAA.

4.29 The appendix shows that projects that have experienced improved paths to acceptance into service (such as the minehunter project and some others not reviewed by the ANAO) have good Detailed Operational Requirements documents (DORs), good T&E planning and implementation and good audit trails of T&E conducted during full-scale development. However, some projects listed in the appendix suffer protracted post delivery T&E and in the main these projects are not supported by basic T&E documentation, such as:

- clear statements concerning detailed operational requirements—how the platforms and weapon systems are to be employed and supported in the operational environment;
- statements on how DMO validated the platform's and weapon system's in-service support (statements that would provide confidence that performance will not decline after acceptance into Naval service); and
- schedules covering the equipment's acquisition and introduction to service.

4.30 Such omissions indicate failures in DMO's implementation of T&E principles and policy and deficiencies in the implementation of Defence's capability management cycle.

4.31 The ANAO selected three of the projects listed in Appendix 2 for further consideration; the Collins submarines, Huon class minehunters and Kalkara unmanned aerial target aircraft.

New Submarine Project

4.32 The New Submarine Project—to build six Collins-class submarines—began in 1987. The first Collins submarine, HMAS *Collins*, was launched in 1993 and the other five followed. But the project continues to have difficulties.[68] None of the submarines has been formally accepted into naval service. RANTEAA is struggling with a range of major T&E difficulties on the submarines, which are now being modified to overcome deficiencies.[69] Although some performance improvements have been achieved, the modifications are adding to the project's overall complexity. The ANAO was advised that, due to the various modification states of the delivered submarines, RANTEAA has been unable complete the first of class trials that would establish seaworthiness, mobility and combat capability T&E baseline for the Collins class. RANTEAA is proposing to submit the last (sixth) submarine (*Rankin*) to first of class trials.

4.33 In November 2001, Defence advised the ANAO that:

- many decisions, at the highest levels of Navy, Defence and Government, have led to diverse submarine configurations and delays in First of Class trials. RANTEAA is working with Navy Systems Command and the Submarine Force Element Group to develop a plan to review the now extensive operating experience of Collins against baselined configurations, to establish what First of Class trials remain outstanding.
- *Rankin* has been identified (yet to be endorsed) as the submarine which should undergo an OPEVAL to validate the trials assessments and provide greater confidence in the submarine's real performance envelope, beyond contractual compliance requirements.

4.34 In July 1999, in response to the McIntosh / Prescott report on the Project,[70] Defence formed a Submarine Capability Team with the mission to achieve a fully operational and sustainable submarine capability as

68 See ANAO Audit Report No.34 1997–98 *New Submarine Project—Department of Defence,* March 1998, (T&E references at pp.xix, 12, 50-55) and Joint Committee of Public Accounts and Audit *Report 368 Review of Audit Report No.34, 1997–98 New Submarine Project Department of Defence*, June 1999.

69 See *Defence Capability Plan 2001-2010* Public Version, Defence Publishing Service, 2001, p. 247–254.

70 Sir Malcolm M. McIntosh, and John B. Prescott AC, *Report to the Minister for Defence on the Collins Class Submarine and Related Matters*, Canberra, 20 June 1999.

quickly as possible, within approved resources. During 1999–2000 two Collins-class submarines, HMAS *Dechaineux* and HMAS *Sheean* underwent modifications costing some $266 million, which sought to correct a range of design and other deficiencies. Defence records indicate these modifications achieved *'limited capability level'* improvements in reliability, noise signature, combat system and electronic support measures performance. Defence records indicate that the process used to achieve these improvements deliberately shortened planning and accelerated 'normal' systems engineering processes. OT&E data and other records indicate that the improvements were only partially successful, thus indicating that the project still faces extensive developmental T&E and risk. Navy is seeking to mitigate the risk by exposing potential and actual performance shortfalls.

4.35 In addition to modifying *Dechaineux* and *Sheean,* Defence proposes to extend the Collins acquisition program by seven years from 2001 at a cost of some $860 million to rectify the submarines' deficiencies and replace their combat systems. It is also proposed to apply a further $840 million to a program of weapons upgrades and follow-on continuous upgrades aimed at resolving remaining deficiencies and sustaining full capability. These redesigns, modifications, upgrades, rectifications and sustainability enhancements amount to almost $2 billion, and represent an increase of 39 per cent on the approved submarine project cost of $5.09 billion (December 2000 prices).[71]

4.36 This extensive program requires a T&E program capable of providing the knowledge needed to ensure resources are expended cost-effectively. Furthermore, the T&E must be capable of measuring, not only the remaining risks in the project, but also the ongoing effectiveness of DMO's systems engineering and risk management processes. A program such as this must implement competent T&E to manage its risks properly.

4.37 RANTEAA's current OT&E work on the Collins submarines has been hampered by several factors, as follows:

- the project's Test and Evaluation Master Plan (TEMP) does not reflect the significant changes in the project since 1995;
- the absence of a current Naval Test Plan or other associated plans and documents that flow from the TEMP, leading to poor T&E status reporting by DMO;

[71] See paragraph 1.3. The US Defense Systems Management College considers that the need to correct costly defects can be avoided by a careful T&E program early in the acquisition process.

- the absence of a complete and endorsed Concept of Operations Document leading to difficulties in T&E;
- the lack of periodic meetings of the Trials and Evaluation Planning Group and Working Group (TEPG & TEWG) over the last two years;
- difficulties in coordinating T&E because of the submarines' slow improvements in performance, and the operational demands placed on the submarines from their integration into the Fleet Activity Schedule;
- poor submarine reliability and logistic support and apparent lack of Original Equipment Manufacturers' verification and validation of maintenance and repair procedures;
- poor configuration data covering all six submarines, leading to greatly increased T&E requirements, and increased program risks;
- serious in-service support deficiencies, including deficient configuration management practices by the submarine project's Prime Contractor;
- instances when repair and modification supplies do not conform with specified requirements, resulting in the need for contractors to apply to the Commonwealth's design acceptance authority or its contracting authority for contract deviations or waivers; and
- chronic shortages and turnover in RANTEAA of Naval personnel with the required submarine T&E skills and qualifications.

4.38 The Collins class has not progressed to a distinctive end to development T&E. The inevitable result is:

- increased cost and delays in gaining required military capability and achieving acceptance into naval service;
- increased program complexity because the vessels are being modified in an operational environment, which places a strain on crews and on engineering, personnel, training, logistics, T&E and fleet management organisations;
- increased uncertainty in defining, in objective and impartial T&E terms, the extent to which project goals and objectives are achieved;
- increased scope for deficiencies discovered late, at the in-service stage, that will need to be fixed during maintenance or refit, thus obscuring the true cost of the acquisition;
- decreased accountability for acquisition program results, given the difficulty of objectively measuring achievement against customer expectations; and
- decreased ability to obtain recourse from the contractor for design and construction deficiencies.

4.39 In November 2001, Defence advised the ANAO that remedial actions are already in place. The submarine configuration 'get well' program includes:

- improved control of repair material;
- increased configuration and certification audits;
- increased SUBSAFE oversight;
- reinvigoration of original equipment manufacturer relationships with Navy; and
- assessment of Submarine intermediate and depot level maintenance by Rolls Royce.

Defence advised that these are specific initiatives by Navy Systems Command and DMO, which are getting the class on the road to recovery. Navy is seeking to mitigate the risk by using T&E to expose potential and actual performance shortfalls. (The ANAO has not audited the submarine project's recovery program.)

Submarine software reviews

4.40 An important part of RANTEAA's role is to determine whether a vessel is safe for operational use and satisfies operational requirements. This would include inspecting safety case studies conducted by DMO or its contractors. In evidence to a parliamentary committee review of the New Submarine Project, a Defence representative commented as follows in relation to additional software safety case studies covering the integrated ship control management and monitoring system, the ship information management system and the ship information system:

> *These are software systems that are essentially used to control the submarine once it has dived and also to gather information for repair and maintenance purposes. We have engaged the support of the Defence Science and Technology Organisation and the University of Queensland's Software Verification Research Centre to support this safety case work…*[72]

4.41 The ANAO requested advice from Defence on the safety case work reported to the JCPAA, and in August 2001 Defence advised that:

> *… the anticipated involvement of both DSTO Trusted Systems Group and the Software Safety Research Centre (SVRC) reported at JCPAA in Mar 99 has not eventuated. Initial discussions investigating options*

[72] Joint Committee of Public Accounts and Audit, *Review of Auditor General's Report No.34 1997–98, New Submarine Project*, 11 June 1999, p. 65–66.

for how TSG/SVRC consultants could be used were held with both groups and the Director Software Acquisition Reform in the autumn/ winter of 1999.

… Although the intended process reported to the JCPAA in Mar 99 was not followed, the objective sought by the committee (an affirmation that there are no safety issues with the software in the Collins Class) has been achieved.

4.42 The ANAO has not audited the submarine project's safety case studies. However, the ANAO notes that a number of Collins class submarine software safety assessments remain open as at August 2001, while others such as 'Year 200 *(sic)* Check and Contingency Plans' for the Collins class submarines are listed as complete.

4.43 When DMO offers systems to the Services for their acceptance, there should be sufficient T&E data and information to enable the respective Service's T&E and acceptance authority and technical regulatory authority to assess the system's safety and suitability for service. In this instance, submarine systems' software safety case work continues albeit without the degree of independence and expertise offered by DSTO Trusted Systems Group and the University of Queensland's Software Verification Research Centre, and not in the way indicated at paragraph 4.40.

4.44 Defence advised the ANAO in November 2001 that Navy recognises the scarcity of safety-critical software management expertise in Australia, and supports the use of Independent Verification and Validation (IV&V) agents including University of Queensland's SVRC. Defence advised that it is understood that DMO's Head of Maritime Systems (HMS) and its Director General Submarines (DGSM) are now considering use of DMO Electronic Systems Division's Directorate of Systems Engineering and the Software Acquisition Management's Standing Panel for IV&V of submarine software.[73]

Minehunter Coastal Project

4.45 The Minehunter Coastal (MHC) Project—to build six Huon-class minehunter vessels—began in 1991. It will contribute to the Defence outcome by providing capability for mine clearance from beaches, shallow and deep water, route survey and lead-through operations, and ADF capability for mining.[74]

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[73] See Glossary for V&V. See also paragraphs 6.27, 6.28, and 9.22–9.26.

[74] Department of Defence, *Defence Report 1999–2000*, 16 October 2000, p. 199

4.46 In June 1994 Defence awarded Australian Defence Industries (ADI) a $1.2 billion fixed price contract for design and construction of six Minehunter vessels.

4.47 Defence's Management Audit Branch in January 2001 reported that the acquisition project appeared highly successful when benchmarked against other DMO projects of similar complexity and risk, and gained a high level of customer satisfaction from its sponsor in Defence Headquarters (Capability Division) and ADF customer Maritime Command. The report said that the project's major risks had been identified and were being managed.[75]

4.48 Navy has provisionally accepted into service four Huon-class ships: HMA Ships Huon, Hawkesbury, Norman and Gascoyne. RANTEAA is progressing their OT&E.

4.49 Project records show the DMO's minehunter project office has conducted a comprehensive and effective T&E program. The ANAO examined the T&E process related to two key operational requirements of the project: the external communications system and the mine field lead-through role.

4.50 Developmental T&E identified two problems in the communication system software and hardware, which were largely resolved before OT&E commenced.

4.51 In June 2000 HMAS *Huon*, while on passage to Singapore with HMAS *Anzac*, experienced serious electromagnetic interference (EMI) to a number of its systems, caused by radar emissions from *Anzac*. This led, among other things, to a loss of steering control that caused *Huon* to pass ahead of *Anzac* at close range. *Huon* sought urgent advice from RANTEAA on an EMI trial. An EMI trial concluded that there were a number of EMI problems that required further investigation.

4.52 *Huon* had already conducted an EMI trial by operating near a ship of another class, the FFG HMAS *Sydney*, apparently without serious EMI. Nevertheless, the incident prompts questions concerning the adequacy of EMI testing during developmental T&E and whether the Services should complete more extensive OT&E before integrating new platforms into defence exercises.

4.53 Defence advised the ANAO that, notwithstanding the opportunity to conduct more OT&E than currently occurs, it can be expensive and one needs to weigh the potential benefits against the costs incurred; a

[75] Inspector General Division Management Audit Branch, *Minehunter Coastal Project SEA 1555,* January 2001, p. 4.[Internal report.]

risk-based approach is warranted. Defence considers that field exercises can provide an opportunity to conduct OT&E without the additional resource impact of special trials.

4.54 The ANAO considers that the use of *'field exercises'* to replace special trials would need to be cited in T&E planning, along with the recognition that the required capability may not be assessed until very late in the acquisition program. Delaying OT&E until *'field exercises'* may delay testing of operational safety, performance and logistics to a time when some deficiencies may prove too costly to correct.

4.55 It seems more efficient and effective to conduct development and operational T&E as early as possible so that risks can be removed or reduced before they become dangerous or too difficult to manage. In November 2001 Defence advised the ANAO that MHC risks have not all been identified. Force Element Group experience and T&E are illuminating these risks; for example, MHC sustainability could be less than was required. Furthermore, considerable amounts of DT&E have been postponed until late in the fielding phase, leaving much evaluation to be done with OT&E. It is an example of an advanced-technology platform for which the RAN is the parent Navy, and where T&E is both revealing and mitigating risks.

Kalkara Project

4.56 The Kalkara project managed by DMO's Head Aerospace Systems, is one of many small projects that RANTEAA has OT&E responsibility for. This capability is intended to meet both Navy and Air Force needs for a pilotless drone or unmanned aerial target (UAT). The ANAO found that RANTEAA had some 22 kilograms of correspondence on Kalkara, a project that by Defence standards is a small commercial off the shelf (COTS) purchase.

4.57 The project received cabinet approval in March 1991, under the title Joint Project 7 (JP7). JP7 aimed to develop a aerial target system for Navy and Air Force, consisting of digital ground control system and an upgraded Jindivik pilotless drone target system. The project was originally conceived as a joint UK Ministry of Defence—Australian Defence project to upgrade the Jindivik target aircraft.[76]

4.58 However, in 1997 Defence awarded a $47 million contract to US aerospace firm Tracor for the supply of 20 MQM-107E Kalkara UATs and associated ground facilities. Since then, Marconi purchased Tracor and

[76] *Defence Report 1991–1992*, p. 102.

British Aerospace Engineering Systems (BAE Systems) purchased Marconi. The US Army and US Air Force have had earlier versions of the MQM-107E in service since 1979.

4.59 The ADF's Director General Technical Airworthiness (DGTA-ADF), is the airworthiness authority for Kalkara. RANTEAA and the RAN Force Element Group Commander are responsible to the Chief of Navy for the Navy aspects of Kalkara T&E, and Headquarters Air Command, represented by the Aircraft Research and Development Unit (ARDU) is responsible for Air Force aspects of Kalkara T&E. Overall coordination of surface assets associated with the OT&E remain the responsibility of RANTEAA.

4.60 Between 19 June 1998 and 4 March 1999 Navy and Air Force conducted Kalkara flight qualification trials (FQTs), with ARDU providing photographic and safety chase services. The flight trials revealed that Kalkara suffered numerous:

- uncommanded tow separations;
- uncommanded pod separations;
- uncommanded and unexpected manoeuvres; and
- premature loss of command causing ocean impact large distances from the recovery point.

4.61 The ARDU report warned Air Force aircrew that *'Kalkara differs from manned aircraft and that it deserves respect and caution'* and that they should observe a minimum 1000 feet separation from Kalkara and its stores.[77]

4.62 On two occasions during flight testing, Kalkara exited the flight corridor due to uncorrected rolls in flight. These required the controller to command emergency recovery.

4.63 During 1999 Defence engaged an Australian flight test company to analyse the Kalkara uncommanded roll problems. On the basis of the firm's reports, DGTA -ADF[78] found that:

> *Type certification of the Kalkara system should not proceed until there has been a satisfactory resolution of the uncommanded roll problems identified during test flight and further investigations by [the flight*

[77] Aircraft Research and Development Unit, *F/A-18 Support to Project Kalkara*, 26 February 2000. pp. 1, 12.

[78] DGTA is responsible for Technical Airworthiness Regulations and provides advice to the Airworthiness Board concerning the issuance of Australian Military Type certifications.

test firm]... Additional UAV [unmanned aeronautical vehicle] configurations should not be flown until resolution of the uncommanded roll on launch problem... .

4.64 Defence records indicate that in May 1999 it became clear to Defence's Kalkara Project Office that the Kalkara could not meet the aircraft specification (specifically endurance and payload), the project office decided to trade off the contracted requirement in return for one additional aircraft (bringing the total to 21), additional functionality for all 21 aircraft, and other specified modifications.

4.65 Defence's June 2000 major projects guide stated, in respect of Kalkara, that *'Flight testing has been completed with operations now being conducted on the east and west coasts'*.[79] Defence advised the ANAO that in July 2000 DGTA-ADF provided a recommendation that supported Type Certification of the Kalkara while requiring the resolution of several 'second-order' issues. The ADF Airworthiness Authority approved an Australian Military Type Certification, subject to limitations, to enable Navy to conduct operations leading to Acceptance into Naval Service.[80]

4.66 At the time of audit in 2001, developmental and operational T&E of Kalkara remained incomplete. In April 2001 a Kalkara on launch pitched up, rolled to the right and crashed some 650 metres from its launch site in the Woomera Prohibited Area. A Kalkara flew more successfully in August 2001 but there was another crash in October 2001. RANTEAA records indicate that more developmental T&E is needed, particularly in regard to the Kalkara HMI (human-machine interface) and its general operational performance. Defence advised the Kalkara UAT does not meet Navy requirements; in some areas its performance does not fulfil the manufacturer's claims; and Defence records indicate its performance in some aspects falls short of the original Jindivik UAT performance that Kalkara was meant to replace.

4.67 The Kalkara project, costing some $47 million, is small compared to the great majority of Defence capital equipment projects. Nevertheless, it is an expensive aircraft. It represents an important investment that falls short of the capability required.

4.68 In November 2001 Defence advised the ANAO that, although tests and trials to date indicate that the Kalkara has not yet achieved the contracted performance or capability required, the performance achieved

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79 Department of Defence, Defence Major Projects June 2000, Defence Publishing Service, June 2000, p. 36.

80 CAF 683/2000, *Australian Military Type Certificate and Service Release—Kalkara Aerial Target System*, 11 August 2000.

will provide ships with useful training. T&E is facilitating that process. Defence further advised that much of the difficulty that has been presented by Kalkara has been directly due to the increasingly strict regulatory framework that it is required to operate within as an unmanned aircraft. Kalkara is still subject to continuing DT&E (with the risks borne predominantly by the contractor) as well as OT&E. It was therefore unlikely to achieve its AINS target date of 12 December 2001.

ILS evaluation

4.69 A large component of OT&E requires an evaluation of Integrated Logistics Support (ILS). The Defence Inspector-General advised the ANAO that DMO's Joint Logistics Support Agency (JLSA) is currently in the process of developing supportability T&E (ST&E) evaluation guidance and policy.

4.70 Defence advised the ANAO that RANTEAA has established an ILS evaluation cell within its organisation, and is developing processes along the lines of DMO and Navy's Systems Command working groups to evaluate ILS of projects undergoing Navy test evaluation and acceptance. This approach is consistent with the ILS Certification business model jointly developed by Navy's Certification and Safety Agency (NCSA) and DMO's Director General Maritime Systems (DGMS).

Conclusion

4.71 Navy has established extensive T&E policy, backed by technical regulations and an OT&E organisation in support of its safety and capability management responsibilities. However, there is also a chronic shortage of T&E trained personnel in RANTEAA as a result of serious Navy technical personnel shortages leading to a unstable posting situation.

4.72 Navy has a significant capability development program, with new ships and submarines in various stages of development and OT&E. The program incorporates high levels of risk because the vessels proceeded from design to full-scale production without first completing development T&E and OT&E of a first of class. Under these circumstances the Commonwealth is heavily dependent on T&E to assess the extent of which program risks have been successfully managed by project management and systems engineering processes.

4.73 Evidence indicates significant variations in the way T&E is planned, funded and conducted prior to capital equipment being offered to the Navy for acceptance. RANTEAA records show projects that have experienced improved paths to acceptance into service, such as the Minehunter project, have good Detailed Operational Requirements documents and good planning, implementation and documentation of T&E during full-scale development. However, some projects suffer protracted post delivery T&E and lack basic T&E documentation. These omissions indicate a systemic failure in DMO's implementation of T&E principles and policy, deficiencies in project management and possibly deficiencies in the implementation of Defence's capability management cycle.

4.74 The Collins-class submarines' OT&E is experiencing significant difficulties caused mainly by the amount of engineering development still under way as well as significant in-service support problems. The Collins-class has shifted from development into operational service without a distinct end to development T&E, placing further demands on the overall program.

4.75 Many Collins-class performance deficiencies were not corrected prior to DMO offering the submarines to Navy for acceptance into service. This has caused extra cost and delays in gaining required capability and in achieving acceptance into naval service. Once systems are placed into their operating environment, it becomes more difficult to obtain recourse from contractors for design and construction problems. It also becomes likely that deficiencies discovered late, at the in-service stage, will need to be fixed during maintenance or refit, thus obscuring earlier inadequacies and the true cost of the acquisition. Defence's need to modify two submarines and then to extend the Collins program by seven years to accommodate modifications and upgrades to all class submarines, reinforces the importance of this issue. The submarines' existing and planned redesign, modification, upgrade and sustainability enhancement costs represent an increase of 39 per cent on the approved submarine project cost of $5.09 billion (December 2000 prices).

4.76 When DMO offers systems to the Services, there should be sufficient T&E data and information to enable the respective Service's T&E and acceptance authority and the Service's technical regulatory authority to assess the system's safety and suitability for service. Deficient T&E decreases accountability for acquisition program results, given the difficulty of objectively measuring achievement against customer expectations. The general issues of improved procedures regarding risk management and equipment safety and suitability for service are taken up in the ANAO's Recommendation No.3, at the end of Chapter 3.

5. Army Test and Evaluation

This chapter provides an overview of the Army's Test and Evaluation policy and processes.

Army's T&E policy

5.1 Army has a smaller capital equipment program than Navy, and its equipment acquisitions are less complex and less IT intensive. Army T&E policy focuses mainly on operational and logistics aspects of equipment presented for evaluation or acceptance into service.[81] The following comment by the former Chief of Army underscores the importance of T&E for the Army:

> *... the Army is in the business of relativities. It is not so much the absolute capability that you field as the relative capability to everyone else. You model, you test and you evaluate, using a variety of exercise scenarios...the judgement of the commanders is key…they are the people that have actually got to go and do it…they have got a vested interest in ensuring that their judgements are properly based and are sound.*[82]

Technical regulation in Army

5.2 In April 2001 Army established its technical regulation arrangements,[83] including the function of the Director of Technical Regulation Army (DTR-A). Located in Melbourne, DTR-A is responsible for implementation of the Army Technical Regulatory Framework and for:

- assisting Chief of Army in meeting responsibilities as Army's Capability Output Manager;
- assuring land materiel meets an endorsed operational requirement by virtue of its design, production and maintenance;
- assuring the safety of Defence personnel and contractors and the general public when and where land materiel is in use;
- assuring good practice in design, development, procurement, production and maintenance of land materiel; and

[81] Defence Instructions (Army) DI(A)ADMIN 64-3 *Army Materiel Processes* July 1995; DI(A)ADMIN 64-2 *Responsibilities of Materiel Division - Army*; and DI(A)ADMIN 72-5 *Army Procedures for the Management of Scientific and Technological Support.*

[82] Joint Standing Committee on Foreign Affairs, Defence and Trade, Defence Sub Committee, *From Phantom to Force—Towards a more efficient and effective Army,* 2 June 2000, p. 158, transcript 323.

[83] Defence Instruction DI(A)LOG 12-1, *Regulation of the Technical Integrity of Land Materiel*, 3 April 2001.

- empowering those responsible for the safety and fitness of land materiel to competently and confidently perform their duties.

5.3 The regulation of technical integrity by DTR-A assists in satisfying Army's duty of care to its personnel, contractors and the public in the use of land materiel.

5.4 In April 2001, the Acting Chief of Army requested that Defence Materiel Organisation (DMO) acquisitions for Army comply with Army's technical regulation requirements for land materiel. This was to assist in gaining the assurance that the Chief of Army needs regarding the safety and suitability for service of Army materiel. This request seems necessary in the absence of a general Defence instruction that binds all Defence groups to each of the Services' technical regulations. Defence advised the ANAO in November 2001 that DCM 36/2001 *Compliance with the requirements of technical integrity for land materiel within the Defence Materiel Organisation* was issued on 23 October 2001.

Land Engineering Agency and Accredited Test Services

5.5 Army's T&E organisation, the Land Engineering Agency (LEA), is located in Melbourne[84] with DTR-A. LEA differs from other Service T&E agencies, such as RANTEAA and ARDU (see Chapter 6), in that it is part of DMO. Currently the DMO's Director of LEA is also the Army's Design Acceptance Authority.

5.6 LEA's Manoeuvre Systems Program has laboratory arrangements for the design, engineering, test and evaluation of land vehicles. The Defence Reform Program (initiated in 1997) included the market testing of Army's T&E laboratory function. The successful tenderer was the in-house bid by Accredited Test Services (ATS). ATS's business case involved reduction in its numbers of technical and engineering personnel by about a third, which forced it to concentrate its skills and experience in fewer personnel and reduce its scope to cope with surges in LEA engineering operations and T&E tasks.

5.7 The international standard for testing and calibration laboratories states that testing laboratories shall [among other things]:

[84] LEA was formerly the Army Technology and Engineering Agency (ATEA) and later Support Command Australia's Army Engineering Agency (AEA).

> *…operate a quality system for their testing and calibration activities that also meets the requirements of ISO 9001 when they engage in the design/development of new methods, and/or develop test programmes combining standard or non standard test and calibration methods, and ISO 9002 when they only use standard methods.*
>
> *…have arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures that may adversely affect the quality of their work; and*
>
> *…have policies and procedures to ensure the protection of its clients' confidential information.*[85]

5.8 Defence is cognisant of the these requirements, and it is noteworthy that both Navy and Air Force have retained their T&E organisations (RANTEAA and ARDU) as core defence activities and they both have ISO 9002 certification, as does LEA and ATS.

Accredited Test Service's standards compliance

5.9 ATS represents a considerable investment in personnel skills, equipment and facilities. ATS, as part of the former Army Engineering Agency, has an AS/NZ ISO 9002 compliant management system, and has National Association of Testing Authorities (NATA) certification in a broad range of technology areas including:

- environmental testing;
- mechanical testing;
- data acquisition and analysis;
- calibration of transducers and measurement systems;
- electrical, electronic and communications testing;
- electromagnetic compatibility testing;
- electro optics testing; and
- TEMPEST testing.[86]

5.10 This broad range of technologies and certifications would allow ATS to extend its developmental and operational T&E services to the other Services. For example ATS has the capacity to test diesel engines, which has application for the other Services, particularly Navy.

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85 International Standard ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories,* 1999–1215, p. 3.

86 See Glossary.

Project Bushranger

5.11 As indicated earlier, Army has fewer major complex capital equipment acquisition projects than Navy. The ANAO examined Army's Project Bushranger. The project began in 1994 with the aim of enhancing the strategic and tactical mobility of Army Brigades by equipping battalions and support elements with Infantry Mobility Vehicles (IMV). The DMO's June 2001 report to the Defence Committee stated the project faced significant risks regarding cost, schedule and capability.[87]

5.12 LEA's Manoeuvre Systems Program Laboratory has submitted the Army's preferred prototype, the Bushmaster vehicle, to extensive T&E against the project's Concept of Operations and detailed performance requirements. Current T&E activities focus on assessing the extent to which the Bushmaster falls short of expectations and on available engineering solutions to improve the vehicle's performance with respect to the operational requirements.

5.13 The ANAO found that LEA has conducted extensive engineering reviews of the Bushmaster design and construction as well as extensive OT&E. LEA's T&E of a Bushmaster prototype vehicle has mitigated risk to the Commonwealth in terms of cost, reliability and safety. This highlights the value in competent and effective T&E of prototypes before full-scale production commences. The ANAO's review of the project's T&E indicates that LEA has extensive knowledge of Bushmaster's capabilities.[88]

Conclusion

5.14 The Army has instituted policies and procedures that enable it to assess the integrity of land materiel offered for acceptance into service. Army uses as its T&E organisation DMO's Land Engineering Agency (LEA), situated in Melbourne and collocated with DTR-A. LEA differs from other Service T&E agencies, such as RANTEAA and ARDU (see Chapter 6), in that it is part of DMO. Currently the DMO's Director of LEA is also the Army's Design Acceptance Authority

5.15 The Land Engineering Agency is equipped to conduct developmental T&E as its primary role and as required operational T&E on a wide range of vehicles and other land-based military technology. The calibration and testing facilities at LEA may extend to other Services to assist with T&E requirements.

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87 Defence Materiel Organisation, *DMO Report to the Defence Committee: Top 20 Major Projects*, June 2001. [Internal report.]

88 See comments on Army vehicles in Joint Standing Committee on Foreign Affairs, Defence and Trade, *From Phantom to Force,* August 2000, p. 161.

5.16 LEA's T&E of the Bushmaster vehicle has mitigated risk to the Commonwealth in terms of cost, reliability and safety. This highlights the value in ensuring competent and effective T&E of prototypes before full-scale production commences.

6. Air Force Test and Evaluation

This chapter provides an overview of Air Force's Test and Evaluation policy and T&E organisational arrangements. It comments on three Air Force projects that are undergoing T&E planning, developmental T&E and operational T&E.

Introduction

6.1 Air Force is responsible for the airworthiness of all Service aircraft. It implements formal procedures that ensure aircraft introduced into service, or substantially modified while in service, comply with essential operational and technical standards. Safety of aircrew is a particular concern.

6.2 Air Force relies on contractors to design, develop, test and produce the majority of technical equipment. To obtain assurance that new technical equipment meets requirements, the Chief of Air Force (CAF) has endorsed a set of procedures to monitor and record the technical activities of contractors at significant stages of design and development of equipment. Air Force conducts T&E, with contractor assistance, to verify aircraft design and performance.

Air Force's T&E policy

6.3 Air Force T&E policy is set out in Defence instructions.[89] The policy covers Development T&E (DT&E) in respect of airworthiness and requires the conduct of Operational T&E (OT&E) before acceptance of aircraft into operational service.

6.4 The primary Air Force T&E authority is the Aircraft Research and Development Unit (ARDU). Its functions are set out in Appendix 4. ARDU advised the ANAO that it has found no clear Service arrangements for OT&E of aircraft leading to their acceptance into operational service. Air Force capability management policy, in the context of weapon system planning, states that ARDU is responsible for Test and Evaluation Plans[90] but offers no guidance on how T&E is to be conducted or to whom reports are to be submitted. However, the Air Force aircraft stores certification process[91] integrates DT&E and OT&E, whether undertaken by ARDU or not.

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89 Defence Instruction (Air Force) DI(AF)LOG 2-7 *Test and Evaluation of Technical Equipment,* 2001. T&E is also referred to in DI(AF)ADMIN 2-3 *Capability Management in the RAAF* 1998 and DI(G)OPS 02-2 *Australian Defence Force Airworthiness Management* 2000. DI(AF)ADMIN 5-18, which provided a process for ARDU support, was cancelled without replacement at the time of DRP. Draft DI(G)OPS 2-3 *Aircraft Stores Certification* April 2001 also refers to OT&E and its relationship to Service release.

90 In Defence Instruction DI(AF)ADMIN 2-3 *Capability Management in the RAAF* September 1998.

91 Australian Air Publication 7001.053 (AM1), *Technical Airworthiness Management Manual*, 13 December 1999, Chapter 22—Aircraft Stores Compatibility.

6.5 Developmental T&E results for aircraft are submitted to airworthiness boards. Defence advised the ANAO that the boards consider OT&E results and assess overall suitability but are not known to review effectiveness in the context of, for example, weapons effectiveness.

6.6 ARDU's facilities and 300 personnel are situated at RAAF Base Edinburgh South Australia. ARDU's role is particularly important, given the modifications being made to Air Force aircraft such as the F/A-18s, PC-3s and F-111s and future aircraft acquisitions such as Wedgetail (see below).

6.7 Defence market tested ARDU through the Commercial Support Program (CSP) from 1995 to 2000. This resulted in ARDU's Maintenance and Transport Support being contracted out in 1998.

6.8 Late in 2000 Defence halted CSP action on the Instrumented Range and Drafting Services, when it decided that these were core Defence activities and that T&E data needed protection in terms of national security and intellectual property.

6.9 ARDU contributes to the multi-national Air Standardisation Co-ordinating Committee (ASCC) working parties in areas such as air armament, stores compatibility and test range interoperability standards. It also contributes to Tri-Partite Technical Co-operation Plan (TTCP) Weapons working groups. ARDU is the point of contact for the Aircraft Stores Compatibility Testing MOUs with US / Australian Mutual Weapons Development Data Exchange Agreement, the Canadian-Australian Implementing Arrangement and the UK-Australian Information Exchange.

6.10 Aircraft T&E authority may also be vested in the Air Force's Force Element Groups (FEGs), which have T&E resources for non-instrumented flight tests flown within established operating limits using approved procedures. For example, Air Force Groups such as the F-111 Strike Reconnaissance Group FEG (SRG FEG), the Tactical Fighter Group and Air Lift Group conduct their own OT&E within their T&E resource limits, operating limitations and approved procedures. They receive support from ARDU for management, planning and reporting as necessary. The ANAO examined the SRG FEG's T&E activities as part of the F-111 Block Upgrade Program's T&E, discussed below.

Air Force Technical regulation

6.11 Air Force has developed procedures to validate the airworthiness of all ADF aircraft. Air Force considers an aircraft type to be airworthy if it:

- has been designed to, and certified as meeting, approved standards;

- has been constructed by an approved organisation in accordance with approved standards;
- has been maintained by qualified people in accordance with an approved system; and
- is operated by qualified people in accordance with approved instructions.

6.12 Defence Instructions establish the basis for the conduct of airworthiness certification in Air Force.[92]

Air Force test and evaluation

6.13 Air Force is required to apply rigorous T&E to ensure that, before an aircraft is declared airworthy, all practical steps have been taken regarding the safety of its pilots and missions. To this end, ARDU performs the full spectrum of military flight testing (see Appendix 4), and is responsible for T&E of the integration of foreign and locally acquired or adapted products into Air Force and Army aircraft, and monitoring their effectiveness, suitability, and performance. This activity contrasts with RANTEAA, which focuses on OT&E.[93]

6.14 Figure 3 shows T&E applied to each phase of the aircraft capability development cycle. DT&E and OT&E are scheduled into the phased introduction of a capability so that Force Element Groups may start training their operational and support personnel from the time the capability is released into service (the IOC date)

6.15 Appendix 5 provides some early lessons learnt at ARDU, as presented to the 1994 International Telemetering Conference in Las Vegas USA. The case demonstrated that the application of telemetry to Software Validation and Verification flight testing offers a 'do it once, correctly' solution to test and evaluation tasks. In that case, transmission of undetected data faults to a 'fleet' of aircraft was prevented, which saved the cost of attempting to remedy the faults later.

6.16 Set out below are summaries of ANAO's examination of T&E aspects of three current Air Force projects. They demonstrate that T&E is proceeding satisfactorily and identifying problems in time for remedial action.

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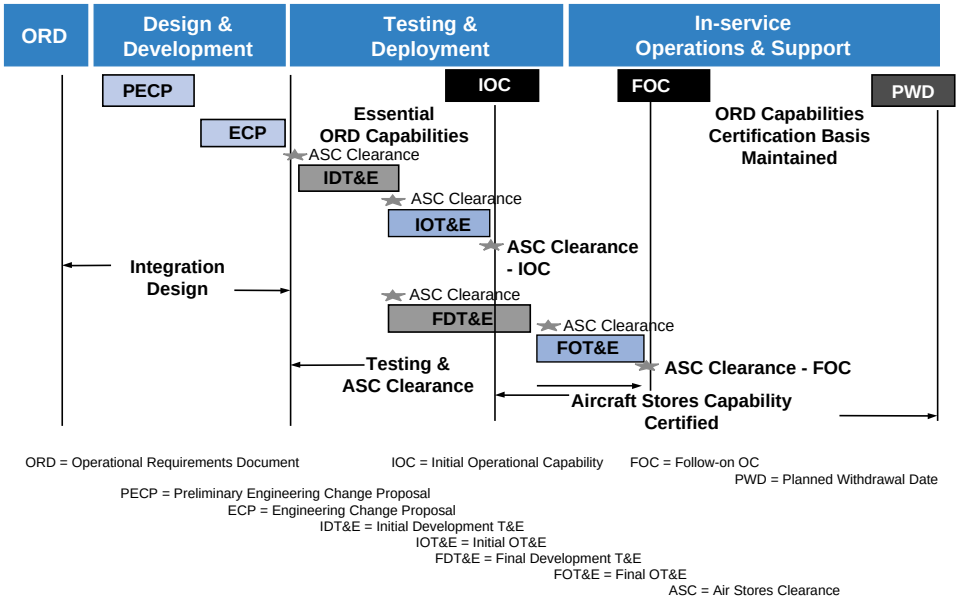
92 Defence Instruction DI(AF) OPS 2-2, *Airworthiness Certification in the RAAF,* sets out responsibility for airworthiness of Air Force aircraft (and, by extension, Army aircraft). Australian Air Publication 7001.053 (AM1), *Technical Airworthiness Management Manual*, 13 December 1999 concerns technical airworthiness management. DI(AF) LOG 2-112 covers engineering aspects.

93 Navy has its own flight test organisation: the Aircraft Maintenance and Flight Trials Unit (AMAFTU), situated at HMAS *Albatross,* near Nowra.

Figure 3
Aircraft Capability Development Cycle—Test and Evaluation



Source: Aircraft Research and Development Unit (AAP 7001.053, Sect 4 Chap 22)

F-111 Block Upgrade Program

6.17 T&E for the F–111 aircraft Block Upgrade Program is conducted at RAAF Base Amberley.

6.18 Defence considers that its F–111 aircraft provide Australia's premier airborne strike capability against land and marine targets. It intends to upgrade the F-111s over a 10 year period to ensure they are operationally effective until their planned removal from service by about 2020.

6.19 Australia is now the sole operator of F-111 aircraft since the US Air Force retired the last of its fleet in June 1998. This heightens the importance of Defence's F-111 capability management, given that Australia now has the only F-111 support infrastructure in the world.

6.20 Defence is implementing the F-111 upgrades via a single program consisting of six projects that include a combination of capability enhancements covering avionics, bomb systems, communication systems, navigation systems and stand off weapon systems.

Block Upgrade Program organisational arrangements

6.21 The organisational arrangement of the Program involves iteration between DMO's Strike Reconnaissance Systems Program Office (SR SPO), the Air Force's Strike Reconnaissance Group Force Element Group (SRG FEG), its operations wing (82 WG) and ARDU. The contractors include the prime contractor Boeing Australia Limited (BAL) and the independent software validation and verification (IV&V[94]) contractor Sverdrup Technology Australia (SvTA).

6.22 The SR SPO is responsible for coordination of the integrated projects that form part of the Block Upgrade Program, supervision of contractors and management of T&E and the Weapons System Software Support Facility (WSSF). The SR SPO charts the Program and has oversight approval for T&E planning.

6.23 Strike Reconnaissance Group T&E is conducted by the following organisations:

- Software IV&V by Sverdrup;
- DT&E by ARDU, 82 WG and SP SPO;
- AT&E by ARDU, 82 WG and the SR SPO; and
- OT&E by ARDU and 82 WG.

Block Upgrade Program Test and Evaluation

6.24 The SR FEG, through its 82 WG, and ARDU bring an operational perspective to the program so that user interests are brought to bear during engineering development and T&E. ARDU, in conjunction with 82 WG, provides F-111 development and operational T&E. The SR SPO coordinates T&E tasking.

6.25 ANAO review of Program T&E documents indicated that T&E is being conducted with care. A test plan working group (TPWG) has representatives from the SR SPO and SRG FEG, ARDU and Boeing. A detailed TEMP for the Program is supported by Human Interface Concepts Documents and Test and Evaluation Plans.

94 See Glossary.

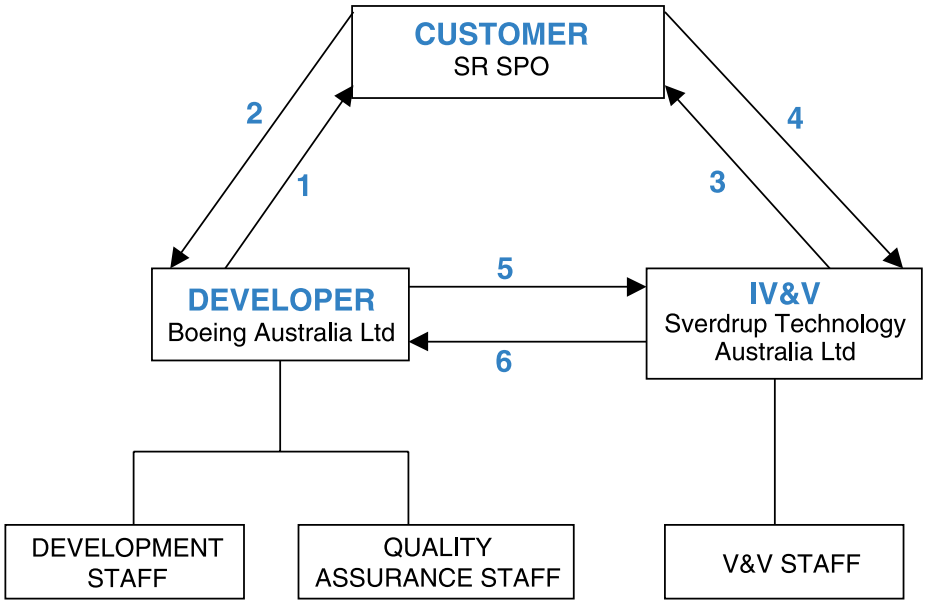
Weapons Systems Software Support Facility

6.26 The Weapons Systems Software Support Facility (WSSF) is funded by DMO and located at RAAF Base Amberley. The WSSF provides the SRG FEG with mission support, the SRG SPO with an operational flight software maintenance and development facility, and a system test facility for F-111 safety-critical and mission critical software.

6.27 The WSSF's personnel include contractors from Boeing and Sverdrup, the SRG FEG, 82 WG and the SR SPO. This relationship represents an important defence-industry link. Further, it emphasises the operational closeness of the SRG FEG (the operators and testers) and the SRG SPO. Figure 4 shows the organisational arrangements for the F-111 running system software IV&V

Figure 4

F-111 Running System Software IV&V Organisational arrangements



The numbered lines represent the flow of control and data as defined as follows:

1 Submission of program documentation such as concept documents, requirements documents, design documents, user manuals, source code, program status reports, program budgets, and development plans and schedules as part of formal review process.

2 Approval or denial and recommendations on development issues and deliveries listed in 1 above.

3 Submission of the Software Verification and Validation Plan, IV&V task results and anomaly reports (Engineering Reports), activity summary reports (Phase Summary Reports) and other special reports.

4 Approval, denial and recommendations on IV&V issues and deliveries listed in 3.

5 Submission of program documentation such as concept documents, requirements documents, design documents, user manuals, source code, program status reports, program budgets, and development plans and schedules as part of formal review process as part of peer review process and normal contracted deliveries.

6 Submission of IV&V task results and anomaly reports (Engineering Reports), activity summary reports (Phase Summary Reports) and special reports as directed by the Customer.

Source: Department of Defence

6.28 The IV&V arrangement provides a practical solution to a shortage of Commonwealth personnel with the skills and experience to carry out validation and verification of complex software such as that used in the F-111 Program (see paragraphs 9.22—9.26). The SRG SPO and the SR FEG and its 82 WG oversight the software development process. This allows the application of a broad range of expertise, while ensuring stakeholder interests are managed and represented. The UK's National Audit Office report on acceptance of equipment into service highlighted a need for systems operators and specially qualified test personnel involvement in platform tests and evaluations.[95]

6.29 In addition to the normal range of software development and test tools, the WSSF contains an F-111 cockpit and avionics suite (containing actual F-111 components) which provides a simulator that assists software development and maintenance T&E. Another simulator, the F-111 C mission simulator, also provides an important T&E facility for software development and maintenance.[96]

Wedgetail AEW&C project

6.30 Air Force's $2.2 billion 'Wedgetail' Airborne Early Warning and Control System (AEW&C) aircraft project proceeded to the acquisition phase in 2000.

6.31 At the time of the audit, the DMO's AEW&C Systems Program Office (SPO) was amending its TEMP to make it comply with the draft defence capability management process which Defence was rewriting (see paragraphs 2.35–2.43). The SPO was also negotiating with Boeing on the detail of the AEW&Cs' Test Verification Matrix. When these negotiations are complete, the SPO intends to amend the TEMP again to reflect the revised testing concept, strategy and sequence.

6.32 The SPO advised that an Operational Utility Demonstration (OUD) program would be conducted as part of the Acceptance Test program. The OUD provides the Commonwealth with an opportunity to bring the AEW&C aircraft to Australia and operate it in representative operational environments. The OUD is scheduled prior to acceptance and provides an opportunity to exercise the aircraft and demonstrate satisfaction of operational requirements. The SPO advised the ANAO that this arrangement would be included in the next edition of the TEMP.

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95 Report by the Comptroller and Auditor General, UK National Audit Office, *Accepting equipment off contract and into service,* 11 February 2000.

96 The ANAO commented on this simulator in Audit Report No.17 1998–99 *Acquisition of Aerospace Simulators, Department of Defence*, 25 November 1998, p. 32–36.

6.33 The SPO advised the ANAO that it would be fair to assume that the total T&E costs, including OT&E, could approach the general estimate of 25 per cent (about $525 million) of total project cost—see paragraphs 1.17–1.21). This is based on T&E costs directly funded within the approved project cost and estimates of the cost associated with Boeing-funded T&E effort for the 737 AEW&C Product line.

6.34 At the time of the audit, the AEW&C project's whole-of-life cost model remained undeveloped. The SPO advised the ANAO that it had assessed annual running and support costs of the capability, but this assessment did not include the planning or costing of future mid-term upgrades of the system.

6.35 The SPO advised the ANAO that these costs would be included in the whole-of-life cost model when the AEW&C's design was stable, and that the cost model would be provided to the Chief of Air Force as part of the AEW&C introduction into service.

C-130J-30 Airlift Aircraft

6.36 In August 2001 the ANAO was advised of Air Force's new heavy lift aircraft T&E results, which indicate the Air Force's extensive OT&E of the aircraft has revealed the need for additional development work by the manufacturer.

6.37 Air Force's C-130J-30 Hercules military transport aircraft was designed to deliver combat troops, personnel and cargo by Airdrop or Airland to sites worldwide. C-130J series aircraft are designed and manufactured by Lockheed Martin Aeronautics Company (LM Aero), USA. The C-130Js are significantly updated derivatives of the basic C-130 aircraft produced since 1955. The primary differences between the C-130J and earlier models include a digital avionics suite, improved engines, propellers and payload and two less flight crew (flight engineer and navigator).

C-130J-30 OT&E program

6.38 Air Force's C-130J OT&E program was originally intended to validate the C-130J-30 in all roles performed by RAAF C-130E and C-130H aircraft. However, at the time of the audit the OT&E program was awaiting further developmental T&E regarding aircraft missions that require:

- provision for the aft ramp or paratroop doors to be opened in flight, as a caution due to evidence of changed aft body airflow conditions caused by the newly designed propellers;

- the aircraft to operate in 'hot and high' conditions; and
- night vision goggle operations.

6.39 Because of these exclusions, the Air Force had only conducted OT&E in the aircraft's Air Logistics Support and Aero-medical Evacuation roles. The need to include other roles will require an ongoing multi-year role expansion effort and additional T&E.

6.40 Air Force has generally assessed the C-130J-30 as effective for the Air Logistics Support role. But immature software, lack of automated mission planning, high built-in test false alarm rates, unreliable High Frequency (HF) communications and technical publication deficiencies may limit its effectiveness or suitability. The OT&E revealed additional deficiencies in logistics support and the flight simulator.

6.41 The Air Force OT&E reported the C-130J six-bladed propeller design produced higher levels of vibrations in some areas of the aircraft cargo compartment than in earlier C-130 variants. Air Force advised that it is likely that it will seek remedial action.

6.42 In the meantime Air Force has asked sponsors of vibration sensitive equipment (including explosive ordnance) to review the suitability of their equipment to be carried in a C-130J. Passengers are only being seated in line with the propeller arc when absolutely necessary and explosive ordnance is not being carried.

6.43 Air Force advised that it could not fully assess the C-130J-30's suitability in the Aero-medical Evacuation role because the portable Aero-medical Evacuation equipment was still to be certified for use onboard the aircraft.

6.44 As a result of these test and logistic support limitations, Air Force has decided to delay further testing of all elements of the C-130J Weapon and Logistic Support systems until their designs are more mature.

6.45 Air Force advised that LM Aero's ongoing block upgrade program will continue to rectify identified aircraft deficiencies and introduce new or revised aircraft capabilities. Air Force advised that its Air Lift Group will continue to perform OT&E aircraft to assess the suitability of Aero-medical Evacuation role equipment and to evaluate the C-130J-30 in Airdrop, Combat Airland and Paratroop roles.

6.46 Previous RAAF and USAF OT&E results suggest that the aircraft will be effective in some of these roles and partially effective in others. Consequently, new contracts may need to be raised to provide any necessary modifications.

Conclusion

6.47 Air Force is responsible for the airworthiness of all Service aircraft. It implements extensive technical regulations, T&E policies and formal procedures that ensure aircraft introduced into service, or substantially modified while in service, comply with essential operational and technical standards. ARDU, as Air Force's T&E organisation, performs the full spectrum of military flight testing for Air Force and Army Aircraft. Some Air Force Groups such as the F-111 Strike Reconnaissance Group Force Element Group, Tactical Fighter Group and Air Lift Group conduct their own OT&E with support from ARDU for management, planning and reporting as may be necessary.

6.48 Developmental T&E results for aircraft are submitted to airworthiness boards. Defence advised the ANAO that the boards consider OT&E results and assess overall suitability but are not known to review effectiveness in the context of, for example, weapons effectiveness.

6.49 Records of the F–111 Block Upgrade Program indicate that T&E for the Program is being conducted with care. The Program has a test plan working group (TPWG) and a detailed TEMP well-supported by comprehensive Human Interface Concepts Documents and a Test and Evaluation Plan (TEP). The Program has engaged a software verification and validation contractor to assist in oversight of the software development process. This allows the application of a broad range of expertise, while ensuring stakeholder interests are managed and represented.

6.50 The TEMP for Air Force's $2.2 billion Wedgetail AEW&C project, which recently proceeded to the acquisition phase, is being revised to comply with the draft defence capability management cycle requirements. The AEW&C SPO was also negotiating with Boeing on the detail of the Test Verification Matrix. When these negotiations are complete, the SPO intends to amend the TEMP again to reflect the revised testing concept, strategy and sequence. Although these T&E documents and arrangements should already be complete, action is in hand to meet the requirements.

6.51 The Air Force's C-130J OT&E program indicates that its C-130Js are experiencing significant operational shortfalls which await resolution by the manufacturer, and that may justify contractual changes to define and fund future modifications.

6.52 ANAO examination of these projects indicates the T&E is proceeding satisfactorily in identifying problems and possible remedial action.

7. Knowledge System Test and Evaluation

This chapter provides an overview of the test and evaluation of two projects that contribute to Defence's knowledge system, which is shared by the Services.

Introduction

7.1 The Defence mission is '*to prevent or defeat the use of armed force against Australia and its interests*'. This calls for effective command and control of the ADF. ADF command and control depend on a wide range of information and administrative system technologies to assist the analysis of requirements, allocation of resources, integration of effort, management of logistics and coordination and monitoring of force behaviour.

7.2 In July 1999 Defence established a Division in Defence Headquarters, and under VCDF, with the title C^4ISREW Staff and headed by Head C^4ISREW (HC^4ISREW). In 2000 the HC^4ISREW position was later changed to the Chief Knowledge Officer (CKO) in recognition of the knowledge edge significance of C^3I systems and their close interaction with combat information systems and sensors. In December 2001 Defence changed the title CKO to Head Knowledge Systems (HKS).

7.3 The ANAO audited the T&E aspects of two projects sponsored by HKS; the Jindalee Operational Radar Network (JORN) and Joint Project 8001-Deployable Joint Force Headquarters (DJFHQ)-Afloat. Both these projects aim to provide significant contributions to the ADF's knowledge edge. Joint projects, such as these that form part of the *'knowledge system'* shared by the Services, are subject to T&E by DMO and the Service that would have most use of the particular project's contribution to the knowledge edge.

Jindalee Operational Radar Network Project

7.4 The Jindalee Operational Radar Network (JORN) is a high-risk project that is seeking to advance state-of-the-art High Frequency Over-the-Horizon Radar technology. When JORN becomes operational, it will form part of the surveillance element of the ADF's C^4ISREW 'system of systems'.[97]

[97] The C^4ISREW system of systems consists of the following system elements: command and control (C^2), communications and computers; intelligence, surveillance and reconnaissance (ISR); electronic warfare (EW); and information operations (IO). See Audit Report No.11, 2000–2001, *Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000, pp. 1–25.

7.5 At the time of the ANAO's 1996 audit of JORN, some 80 per cent of the prime contract target price was spent (or 73 per cent of the ceiling price) and 80 per cent of the schedule had elapsed but less than 20 per cent of the configuration items had passed the design review stage.[98]

7.6 Defence records of recent design reviews and configuration audits indicate that the contractors have made progress in resolving many technical and managerial difficulties apparent during the ANAO's 1996 audit of the project. The JORN is now scheduled for completion in the second half of 2002, some five years over the original six year full-scale development schedule. Defence payments to the Prime Contractors total some $960 million (or 78 per cent) of the ceiling price of $1.223 billion (2001 prices).

7.7 The T&E program conducted by the Over The Horizon Radar System Program Office (OTHR SPO) aims to verify whether the contractor has complied with the Project's contractual specification requirements. The OTHR SPO verifies JORN's development progress through a series of reviews and audits based on military standard MIL-STD-1521B, *Technical Reviews and Audits for Systems, Equipment and Computer Software.* The OTHR SPO's reviews and audits follow a process that progressively tests and evaluates JORN's development from the lowest level 'building blocks' through to the top network level.

7.8 The JORN contractors have tested most of the JORN lower-level elements and progressed to formal testing of 'system' level elements of Operations Centre, Radar and Frequency Management System. The contractors will eventually bring these elements together and formally test them again as Segments. Once the contractors have tested and evaluated the JORN Segments, they will bring them together and, along with the Software Support and Training Facility, test the JORN as a complete system.

Verification of contract compliance

7.9 The JORN contract contains two principal sets of requirements. The first set contains JORN performance requirements that cover the full range of operational performance requirements, such as detection and tracking of targets through to equipment reliability and maintainability. The second set of requirements contain the JORN system engineering requirements that specify the processes that the contractor needs to comply with when performing work under the contract.

98 ANAO Audit Report No.28 1995–96, *Jindalee Operational Radar Network Project, Department of Defence,* 14 June 1996, pp. 18–19.

7.10 The OTHR SPO verifies contractor compliance with the performance requirements by observation of approved testing, analysis of results and inspections of equipment and documentation by appropriately qualified personnel. Compliance with systems engineering requirements is established through participation in development of test procedures as well as the conduct of testing and review and approval of test reports.

7.11 The OTHR SPO advised the ANAO that, at March 2001, it had verified some 700 of 2180 Network level requirements, and that complete verification of most of these requirements is scheduled for early 2002.

JORN operational test and evaluation

7.12 The OTHR SPO's responsibilities include verifying the testing of many of JORN's operational requirements as part of the formal testing conducted under the provisions of the JORN contract. The OTHR SPO's knowledge of JORN's operational features, particularly in the areas of the Operations Centre System, the segments and the overall network is of particular importance.

7.13 Defence has formed an OTHR SPO Transition Working Group to complete an OT&E Plan by mid 2002. The Group consists of representatives from: the Air Force Surveillance and Control Group, which will manage JORN when it is accepted into service; DSTO's Surveillance Systems Division; and the OTHR SPO.

7.14 After JORN's acceptance from the contractor, Air Force's Surveillance and Control Group will continue the OT&E. The OTHR SPO will then be responsible for logistically supporting the JORN to agreed levels of performance and operational availability.

Deployable Joint Force Headquarters—Afloat Project

7.15 Phase 3A of Joint Project 8001 aims to develop a deployable joint force headquarters (DJFHQ) aboard the transport ships HMAS *Manoora* and *Kanimbla* that will provide an ADF deployed Joint Task Force Commander with improved command, control, communications and intelligence (C^3I) capability.[99]

[99] The ADF's C^3I structure is discussed in Audit Report No.11, 2000–2001, *Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000, pp. 39–42.

7.16 A Defence media release in June 2001 stated that the whole capability was designed, installed and set to work on HMAS *Manoora* within the scheduled nine months.[100] The ANAO found, however, that the somewhat compressed development and installation schedule has meant that many of the documents needed by RANTEAA to conduct acceptance tests and evaluations remain incomplete. Furthermore, it appears that DMO has been unable to provide the systems engineering and logistic support needed to ensure the DJFHQ-Afloat has adequate C^3I operational availability. Consequently the project has not received the benefit of a similarly timely acceptance into service by Navy.

7.17 The Navy's test, evaluation and acceptance manual (ABR 6205) requires equipment acquired under joint project arrangements to undergo identical acceptance into operational service process to that of single-Service equipment.[101] It requires DMO projects offering equipment for acceptance into naval service to have a Test and Evaluation Master Plan (TEMP) and a detailed operational requirement (DOR) from which RANTEAA can determine the equipment's T&E history and operationally test and evaluate the equipment against an agreed capability baseline.

7.18 However, a detailed TEMP, DOR or capability statement does not exist for the DJFHQ-Afloat despite the requirements in ABR 6205 and the requirements in DMO's own T&E policy.[102] Indeed, at the time of the audit, the equipment's sponsor (Chief Knowledge Officer) and Navy and Air Force had not endorsed the system's concept of operations. This meant that RANTEAA has been unable to conduct any tests and evaluations against the following most critical systems engineering metrics that reflect customer expectations and satisfaction:

- measures of effectiveness (MOEs)—how well must the system perform the customer's mission, its safety and reliability etc; and
- measures of suitability (MOS)—how well the system performed in its intended environment, including measures of supportability, maintainability and ease of use.

7.19 RANTEAA advised the ANAO that it had no OT&E results from which the system's functionality and performance could be accurately established. Furthermore, RANTEAA records indicate that it had no knowledge of the system's development and production tests and evaluations conducted by DMO or the contractors. Defence records

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100 Department of Defence Media Release PACC 194/01, *HMAS Manoora Receives New Warfighting Command Capability,* 14 June 2001.

101 Department of Defence, ABR 6205 - *Naval Test Evaluation and Acceptance Manual,* 2000.

102 Defence Materiel Organisation, *Capital Equipment Manual 1*, Chapter 14, section 7, para. 1417.

indicate that by September 2001 various systems engineering and logistics problems had resulted in the system performing short of expectations. This casts doubt on the statement that the whole capability was set to work within nine months.

Conclusion

7.20 The JORN project is attempting to overcome numerous technical difficulties. It is carefully conducting T&E with a view to ensuring the project achieves its objectives.

7.21 The Deployable Joint Force Headquarters-Afloat Project is complex and has undergone compressed development and installation schedules to satisfy tight delivery schedules. However, some fundamental systems engineering effectiveness measures are not available to the customer's T&E organisation (RANTEAA) to enable it to gauge the project's success using reasonable, objective and impartial measures of effectiveness and suitability. In view of the accelerated development and installation, it would seem reasonable to expect that the Project would receive increased systems engineering and integrated logistics support to overcome the expected performance shortfalls that often occur under those circumstances. Defence records indicate that the system was falling short of expectations.

8. DSTO Test and Evaluation

This chapter provides an overview of the DSTO's Test and Evaluation services.

Introduction

8.1 The Defence Science and Technology Organisation (DSTO) role is to provide scientific and technical advice to Defence. Defence's T&E policy states DSTO is responsible for maintaining research and development (R&D) T&E resources to support the development of concepts, demonstrate the application of technology to defence equipment requirements and provide advice on technology and concepts.

8.2 DSTO's laboratories conduct R&D in an extensive range of Defence technologies, and this may include developmental test and evaluation (DT&E) of prototype equipment. Defence advised the ANAO that DSTO should not be regarded as a T&E organisation in the same sense as RANTEAA. However, DSTO has a defence trials organisation (DTrials) that manages T&E and conducts Defence trials using the services and capabilities of a wide range of agencies, including the Services.

8.3 DSTO has made major investments in T&E-related R&D technology such as wind tunnels, hardware-in-the-loop (HWIL) facilities, man-in-the-loop facilities, structural fatigue rigs, and electromagnetic test facilities. Defence advised the ANAO that such facilities have been developed to service DSTO plans in support of Defence capability development and management. Defence advised that some R&D facilities may become dedicated T&E facilities when R&D programs end and the completed capability is in place.

8.4 DSTO is responsible for developing the Defence Strategic Simulation Plan that covers the 'prediction' component of defence capability measurement. Most of the more significant 'observation' components—such as test ranges, training ranges and instrumentation used for exercise evaluation, are single-Service owned. This requires DSTO to engage in extensive cooperative strategic planning with the Services so that the links between the scientific method's 'prediction', 'observation' and 'comparison' components are harmonised and translated into ADF capability needs.

DSTO's T&E-related R&D program

8.5 DSTO maintains international associations with foreign Defence organisations through joint Defence science and technology programs,

and maintains contact with the other Defence groups through its scientific adviser program. DSTO works with Australian industry through Defence's $60 million (July 1998 prices) Capability and Technology Demonstrator (CTD) program. The CTD program provides a vehicle for T&E of emerging technology.[103]

8.6 However, a restructure in DSTO in 1988 included dis-establishment of DSTO's primary engineering branch—the Advanced Engineering Laboratory (AEL), and a general shift in focus to scientific research. Defence indicated at the time that there would be a reduction in DSTO's full-scale engineering development work.[104]

8.7 DSTO advised the ANAO that it changed its focus from research and engineering development in order to respond to the science and technology needs of its clients. In that regard, DSTO has increased its numbers of research scientists by 260, increased its professional officers by 232 and decreased its technical officer numbers by 552. DSTO advised the ANAO that it is not in a position to provide a wide range of T&E services to the rest of Defence because that is not its role.[105]

8.8 As discussed in paragraphs 2.12 et seq, the Defence Reform Program (DRP) put aside the Defence Efficiency Review recommendation that all T&E functions in the Services should be placed in DSTO as an integrated unit, where they should be rationalised and used with a greater degree of 'user pays'. The ANAO found the DRP's most significant effect in this area was the market testing of some Army and Air Force T&E capability (paragraphs 5.6 and 6.7–6.8).

8.9 Defence records indicate that, although DSTO is responsible for assessing future Science and Technology trends, it will provide this service only if tasked by the Services or other Defence groups. Tasking related to future T&E capabilities may come from any of the T&E agencies. However, advice received by the ANAO from Defence indicates that deficiencies in the centralised strategic planning of T&E capabilities have reduced the opportunity for forward planning or priority setting in defining future T&E needs.

Operations-level T&E research and infrastructure management

8.10 The ANAO was advised that Defence's Senior Executive provides instructions that guide DSTO's research. These specify that single-Service research and resource committees must endorse DSTO's research programs and so guide and shape DSTO's investments.

[103] ANAO Audit Report No.11 2000–2001, *Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000, p. 33.

[104] *Defence Report 1987–88,* pp. 40–41

[105] FASSP, SP54/01, *ANAO Audit of Defence T&E—DSTO Capabilities*, 3 August 2001.

8.11 The absence of a research and resource investment strategic management system, above the single-Service-level, would increase the risk to effective strategic management of major research programs and resource investments in terms of cohesion, ranking, coordination and rationality across the ADF. These risks spread beyond the ADF where major test and evaluation resources, such as the Woomera test range, are one-of-a-kind in Australia or the region. Some other examples might include the underpinning branches of scientific endeavour, such as telemetry science and measurement science, prediction tools (models and simulations) and observation tools (test and training ranges and exercise evaluation tools).

8.12 However, Defence advised the ANAO that increasingly the Services and DSTO's partners are beginning to move their thinking towards 'joint' capability and so DSTO is changing to align with that shift, as evidenced by the establishment of its Theatre Operations Branch and the Military Experimentation Branch.

Project-level Test and Evaluation in DSTO

8.13 DSTO has significant T&E capabilities which are of greatest value in concept development and systems acquisition, but perhaps of lesser value in operational T&E. Examples include prediction tools (models and simulations); observation tools (wind tunnels; electro-magnetic interference and compatibility); environmental test chambers; and facilities for 'hardware-in-the-loop' and 'man-in-the-loop'.

8.14 DSTO has operations analysts who can help formulate system independent measures of effectiveness (MOE) and measures of performance (MOP). Defence needs such metrics throughout the capability development cycle to assess candidate solutions to capability gaps; measure progress and control risk during system design and construction; and assess delivered capability. DSTO's charter requires it to advise on next generation T&E tools (virtual and real and inclusive of models and simulation; test and training range technologies; and joint battlespace instrumentation).

8.15 DSTO provides research and development T&E to support individual Defence projects. An important example of this is the T&E and scientific support DSTO provided to the Jindalee Operational Radar Network (JORN) Project Office, and the Collins class submarine project.[106]

[106] ANAO Audit Report No.28 1995–96, *Jindalee Operational Radar Network Project Department of Defence*, 14 June 1996, p. 29; ANAO Audit Report No.34, 1997–98, *New Submarine Project, Department of Def*ence, 24 March 1998, pp. 23, 90–93.

8.16 DSTO also provides scientific, engineering and technical advice to all Defence groups, through direct liaison with DSTO laboratories or indirectly through its Director Trials (DTrials) organisation. In particular, DTrials is responsible for:

- arranging and coordinating T&E services on request;
- maintaining a database of ADF T&E resources, including ranges; and
- contributing to the Defence T&E Committee.

Conclusion

8.17 Much of DSTO's priorities are focused on the science and technology needs identified by the Services. Therefore any deficiencies in the Services' strategic management of T&E capabilities would reduce the opportunity for forward planning or priority setting in defining future T&E needs. This adds to Defence's difficulties in strategically managing its major investments in T&E research and infrastructure.

9. Training in Test and Evaluation

This chapter provides an overview of arrangements for training Defence personnel in Test and Evaluation.

Introduction

9.1 The recent Defence White Paper stated that the key to maintaining the ADF as a first-class military force is having the right people, with skills and experience they need to succeed in complex military operations. It said that Defence is investing in modern, effective, and efficient education and training. It referred to the advantages of combining well-trained people with effective use of technology as '*the knowledge edge*'. This in turn would assist in maintaining the ADF's 'capability edge'.[107]

9.2 Defence acknowledges that it is unable to recruit and retain sufficient, suitable personnel. Its '*People Matter*' perspective relates to attracting and retaining people and maximising their skills and knowledge to deliver Defence outputs. One of the five strategic '*people themes*' that Defence is focusing on this financial year is: '*developing—putting in place policies and programs that support our people's capacity to grow and develop professionally and personally in partnership with Defence*'.[108]

9.3 The 1998 Defence and Industry Strategic Policy Statement stated that Defence has a strong interest in ensuring that project oversight is conducted by a professional project management stream. It also stated that the government was using the Defence Reform Program to implement mandatory competency levels for all Defence project directors and managers.[109]

9.4 Proper training combined with proper application of T&E contributes to the knowledge edge by:

- enabling the ADF to receive capable, cost efficient and timely delivery of equipment through better knowledge of the risks that remain within each phase of the capability development cycle; and
- informing the ADF of the extent of an equipment's performance capabilities under a range of realistic environmental conditions.

9.5 The increasing sophistication of weapon systems and platforms, together with the increasing amounts of local industry design and full-scale development of Defence capability, requires increased focus on T&E

[107] Department of Defence, *Defence 2000: Our Future Defence Force*, Commonwealth of Australia, 2000, pp.xii and 55.

[108] Portfolio Budget Statements 2001–02 Defence Portfolio p. 105

[109] Department of Defence, *Defence and Industry: Strategic Policy Statement*, June 1998, p. 27.

training. T&E training requirements need to be factored into each project's T&E master plan (TEMP), and each TEMP should refer to T&E training plans and training funds.

Defence personnel T&E training needs

9.6 T&E training comprises two distinct areas—theory and practice. T&E training needs for Defence personnel are diverse. They extend from Air Force Test Pilot schools, costing some $1.6 million per student, to practical on-the-job training such as vehicle test driver training. Most capital equipment project T&E training is based on postgraduate training in software development and systems engineering disciplines, and post technical qualification training.

9.7 Defence needs personnel skilled in T&E at each stage of the capability management cycle. It requires skilled project teams to oversight the T&E of capital equipment during capability development, as specified in the Defence Capital Equipment Procurement Manual (CEPMAN) and its successor the Defence Materiel Organisation Knowledge System (DMOKS). The teams also need T&E skills to assist with the development of test and evaluation master plans (TEMPS) and all the T&E plans and records that connect with the TEMP. Service personnel responsible for subsequent acceptance of equipment into operational service also need T&E skills. The training needs of the main T&E bodies are outlined below.

9.8 Navy's RANTEAA personnel require T&E management and practical skills to conduct OT&E for platforms prior to acceptance into Naval service. There is a chronic shortage of T&E trained personnel in RANTEAA. As a result, DMO occasionally undertakes some OT&E to prove naval platform *'fitness for purpose'*. Defence advised the ANAO that RANTEAA is formally developing a training course to provide its staff the requisite training. Although this training may not reflect a standardised ADF approach to T&E, it will be appropriate to RANTEAA's quality accredited system and Navy's approved processes.

9.9 Army's LEA personnel require T&E management and practical skills in the increasing range of technology used in Army vehicles, as well as radio communication, armaments and electromagnetic compatibility technology. LEA's technical and engineering personnel need to keep pace with technological developments and maintain professional certifications.

9.10 Air Force's ARDU has recognised the need for T&E training and has developed an integrated T&E policy to merge with local test pilot and navigator training for its billets.

9.11 Defence Science and Technology Organisation requires skilled T&E personnel within the broad range of technologies DSTO routinely deals with, particularly in simulation and modelling of advanced technology.

Strategic management of T&E training

9.12 There is a general lack of effective strategic management of T&E personnel training and development. This has resulted in each Defence group developing and implementing its own T&E training policy to meet their own perceptions of the T&E training need.

9.13 ARDU and DMO have each developed different T&E training and education strategies and funded them differently. ARDU encourages its staff to enrol in the one-semester full-time equivalent T&E Graduate Certificate and pays 100 per cent of the HECS up-front fee.

9.14 DMO's Joint Logistics Systems Agency (JLSA) pays 100 per cent of short-course fees and reimburses 75 per cent of the HECS when staff members successfully complete a semester's study. DMO's LEA pays 100 per cent of short course fees where a course is directly related to core business and reimburses staff for 75 per cent of HECS fees upon successful completion of tertiary study on a semester basis. Defence advised that LEA has a capability development process in place, which includes the development of intellectual capital, and the ad hoc approach has been replaced with a formal planning process. This includes considering the payment of professional body membership fees if an organisational advantage could be demonstrated.

9.15 As a result, the selection of courses and programs tends to be on a *'shopping cart'* basis and professional development becomes largely dependent on an individual's initiative and financial situation, rather than on workforce strategic planning and analysis.

9.16 Defence groups make use of both tertiary education facilities and short T&E courses tailored to specific needs and conducted in-house by external providers. An example is the three-day *'Principles of T&E'* course conducted for RANTEAA and for ARDU by the University of South Australia. This course has also been attended by personnel from DTrials, LEA and Project Offices in DMO.

9.17 A Portfolio-level evaluation of strategic workforce planning was completed in 1999–2000. The principal recommendation was the need for a defined strategic workforce management system. The report concluded that a great deal of attention was focused on recruitment, training and career management of personnel but with insufficient linkages to strategic policy direction and capability development proposals. The report noted that specific attention needed to be concentrated on compiling reliable and accessible personnel data.[110]

9.18 In respect of T&E training and development, the recommended strategic workforce management system needs to be implemented as a matter of priority.

Major Test and Evaluation education institutions

University of South Australia—Systems Engineering and Evaluation Centre

9.19 The University of South Australia's Systems Engineering and Evaluation Centre provides a program of T&E training at short-course, undergraduate and post-graduate levels. Many Defence personnel have completed these courses. The ANAO understands that they are unique in Australia and that only the Georgia Institute of Technology in the USA has a similar T&E training program.

9.20 Advice from the University indicates that past graduates of the Centre have improved the implementation of T&E in their workplace. Defence students now show a much higher level of familiarity with the fundamentals of T&E than their predecessors did some two years ago.

9.21 Most of the University's post-graduate students in T&E report having seen a Test and Evaluation Master Plan (TEMP), whereas two years ago very few reported having seen one. This evidence points to an improved workplace awareness of T&E fundamentals. The greater awareness has assisted the University to provide increasing amounts of materiel as its students' level of experience and assumed knowledge have risen in recent years.

University of Queensland—Software Verification Research Centre

9.22 The University of Queensland's Software Verification Research Centre (SVRC) represents a significant investment in tertiary-level T&E education in Australia in the area of safety-critical computer-based

[110] *Defence Annual Report 1999–2000,* p. 67.

systems. These systems (computer hardware and software) contain units whose errors can result in a potential hazard, or loss of predictability or control of a system.[111]

9.23 The University has links with overseas universities doing safety-critical computer-based systems work, such as the University of York in the UK and the Software Engineering Research Lab at the Massachusetts Institute of Technology, Boston USA.

9.24 Software verification activities have four components:

- verification that mission requirements have been correctly translated into data processing requirements;
- verification that the data processing requirements reflect the computer-applicable portion of the mission requirements;
- verification that the computer program design specification represents a true translation of the computer program requirements; and
- verification that the actual code complies with the computer program design specification.[112]

9.25 The SVRC has conducted safety-critical software studies for DMO, including a survey and comparison of international software safety standards and specification and acquisition of safety-critical systems. It conducts both generic and industry-specific training courses in test and evaluation topics, including:

- development of safety-critical systems;
- reliability, availability, maintainability and safety;
- software review and testing; and
- software safety standards.

9.26 The SVRC tailors specific courses for Defence and industry personnel. This presents an opportunity for strategic alliance in T&E training; development of synergy between Defence and industry; and 'workshopping' of specific technology domains or project needs. At the time of this audit Defence had no personnel undertaking courses at the SVRC. Software verification is required during design, development and support of software-intensive systems integrated into ADF weapon systems and platforms. Major new Defence equipment, particularly new aircraft, ANZAC ships, Collins submarines (see paragraph 4.40) and

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111 Joint Software System Safety Committee, *Software Safety Handbook A Technical & Managerial Team Approach*, Joint Services Computer Resources Management Group, US Navy, US Army and the US Air Force, December 1999, p. A-7.

112 Michael S. Deutsch, *Software Verification and Validation: Realistic Project Approaches*, Prentice-Hall Series in Software Engineering, 1982, pp. 9–10.

JORN, depend almost entirely on advanced and complex safety-critical systems. Defence's T&E policy states that 'Defence must have the ability to verify and validate (V&V) software development.'[113] It is therefore important that relevant Defence personnel, especially its T&E personnel, have expertise in assessing such systems in the various acquisition and in-service support stages.

Training in Defence Materiel Organisation

9.27 The ADF is heavily reliant on DMO's T&E capacity, and therefore DMO needs competent T&E personnel. In October 2000 the DMO surveyed the competency-based training and work experience held by its professional and technical staff. The survey included civilian, military and contracted Professional Service Providers (PSPs) employed in engineering, test and evaluation, integrated logistics support and configuration management.[114] It received 368 responses from the 804 survey forms issued to individual positions in DMO. DMO estimated that staff vacancies would have reduced the target population to between 700 and 740 staff.

9.28 The survey data showed that 166 personnel who reported an involvement with T&E activities had completed 185 technical courses in various areas of T&E theory and practice. At the time of the audit, the survey report remained incomplete in terms of final analysis, conclusions and recommendations.

9.29 DMO's survey staff and Defence Personnel Executive's strategic planning and research professionals commented that, although the response rate was only some 50 per cent, it was better than they expected from such a survey.

9.30 The survey indicates the probability of gaps between the knowledge edge expected by Defence and the actual capabilities of personnel involved in T&E. It also indicates a need to increase the number of personnel skilled in T&E to ensure that competent and skilled practitioners prepare risk management strategies associated with T&E.

9.31 Since the survey document itself sought to gain important data needed for strategic management of training in DMO, it would seem timely to consider a follow-on survey and how this might best be conducted.

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[113] Department of Defence, Defence Instruction (General*), Defence Test and Evaluation Policy,* 8 November 1996, p. 2.

[114] Directorate of Strategic Personnel Planning and Research, *The Qualifications and Work Experience Levels of Professional and Technical Acquisition Staff in the Defence Materiel Organisation*, DSPPR Technical Note 1/2001, January 2001.

Conclusion

9.32 Major Defence equipment, like aircraft, ships and submarines, depend almost entirely on advanced and complex safety-critical computer-based systems. It is important that relevant Defence personnel, especially its T&E personnel, have expertise in assessing such systems in the various acquisition and in-service support stages.

9.33 Training of T&E personnel in DMO, the Services and DSTO is decentralised and ad hoc, and not well linked in terms of coordination or information sharing. There is no standardised policy on T&E training and this has resulted in a 'shopping cart' approach to T&E training, with decisions on training largely left to individual preferences. RANTEAA is formally developing a training course to provide its staff the requisite training. Although this training may not reflect a standardised ADF approach to T&E, it will be appropriate to RANTEAA's quality accredited system and Navy's approved processes.

9.34 The use of tertiary training and education services by Defence provides an important on-going government agency and university interaction, and links with the collaboration that universities have with industry. Further, it represents the opportunity for Defence and Industry to work toward the aims of both the Defence White Paper and the Defence and Industry Strategic Policy.

9.35 Standardised training programs recognised by professional bodies would help improve strategic management of T&E training; analysis of T&E training needs and skills gaps; and planning, sourcing and scheduling of appropriate training.

9.36 DMO's internal survey of competency-based training and work experience of its professional and technical staff indicates the probability of gaps between the knowledge edge expected by Defence and the actual capabilities of personnel involved in T&E. It also indicates a need to ensure that T&E is performed by skilled and competent practitioners.

Recommendation No.4

9.37 The ANAO recommends that, as part of the strategic 'people theme' for policies and programs to support professional development, Defence aim to ensure that its T&E practitioners have training and skills adequate for their responsibilities, through a consistent policy and program that encourage training and education in T&E.

Defence response

9.38 Agreed, for designated T&E positions.

Recommendation No.5

9.39 The ANAO recommends that Defence aim to ensure that its personnel responsible for safety-critical system development, acquisition, maintenance and test and evaluation, have training and skills adequate for their responsibilities.

Defence response

9.40 Disagreed. The recommendation is impossibly wide and compliance would be difficult to assess.

ANAO comment

9.41 The recommendation recognises Defence's need to have key personnel skilled in each phase of safety-critical systems' life cycle. The recommendation arises from T&E policy that Defence must be able to verify and validate software development and retain responsibility for Operational T&E of weapons systems. Such training and skills development would assist Defence in being an informed purchaser of safety-critical goods and services, and in meeting its duty of care obligations.

10. Test and Evaluation Ranges and Facilities

This chapter provides an overview of the investments Defence has made in test and evaluation ranges and facilities and discusses radio spectrum issues of importance to Defence.

Introduction

10.1 Defence conducts T&E as specific tasks in individual acquisition projects and during the in-service phase of deployed weapon systems and platforms. When the T&E needs of specific weapon systems and platforms exceed the normal capability of Australian T&E ranges and facilities, then the T&E is conducted offshore or reduced in scope, according to the limitations of local T&E capabilities.

10.2 Defence has a growing need to develop its T&E capabilities in line with advanced technologies used in military equipment, as well as a need to develop better coherence and integration with Australian industry. Australia's economic, workforce and geographical resources provide a strong basis for further development of T&E facilities that meet the needs of Defence and Australian industry.

Policy and management

10.3 The 1998 Defence and Industry policy statement contains a vision for the defence of Australia based on a concept that draws together the ADF and the wider community as partners in providing for Australia's security. The statement calls for industry to be ready to support ADF elements whenever and wherever they are sent. In some circumstances, this will involve industry supporting deployed elements directly and will require a cultural shift in Defence away from '*owning and controlling*' its own resources to '*utilising*' assets owned by the private sector.[115] A key strategy is to integrate industry into capability development.

10.4 However, Defence has decided to retain its T&E organisations and facilities. Specifically, Navy and Air Force have retained their T&E organisations (RANTEAA and ARDU) as core defence activities and DMO has retained the Land Engineering Agency as an in-house T&E agency.

[115] Department of Defence, *Defence and Industry Strategic Policy Statement*, June 1998, p. 1.

As discussed earlier, Defence is cognisant of the requirements of the international standard for testing and calibration laboratories states that testing laboratories shall [among other things]:

> *…have arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures that may adversely affect the quality of their work; and*
>
> *…have policies and procedures to ensure the protection of its clients' confidential information.*[116]

10.5 Furthermore, Defence's T&E policy states:

> *Defence must… retain responsibility for the conduct of OT&E (where such T&E is required) given that few contractors have appropriate operational expertise or resources to conduct OT&E and contractors cannot be expected to make the necessary subjective assessments. Nevertheless, to reduce potential replication of effort, DT&E, AT&E and OT&E are to be combined to the maximum extent practicable without compromising objectivity, thereby ensuring that the operational requirement is constantly considered during development (including contractors' trials), and the T&E process is as efficient as possible. It is important that OT&E is used to determine the operational effectiveness and suitability of equipment before acceptance into service.*[117]

10.6 Defence's ownership and control of its T&E facilities helps it protect the confidentiality of government-to-government information and the commercial interests of companies that submit equipment to Defence for T&E. It also helps maintain T&E objectivity and impartiality.

10.7 The strategic management of Defence's T&E capability may need to consider issues wider than Defence's contribution to national security. Examples include Woomera Prohibited Area's commercial and scientific T&E applications related to space vehicles, and the Land Engineering Agency's T&E facilities for land vehicles. The dual use of Defence T&E facilities may justify a more coherent strategic management of national test and evaluation resources.

10.8 Defence has made major investments in T&E ranges and facilities. The total replacement cost of the ADF's T&E ranges and facilities is estimated at nearly $400 million (see below). Each Service manages its own ranges and facilities.

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116 International Standard ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories,* 1999–12–15, p. 3.

117 Defence Instruction DI(G) LOG 08-10, *Defence Test and Evaluation Policy*, 1996, p. 3.

10.9 Until July 2000, when DMO formed its Maritime Ranges Systems Program Office (paragraph 10.14), Defence developed most of its T&E ranges through individual capital equipment projects. This ad hoc project-by-project approach increased the difficulty of achieving consistency and rationality in T&E range planning, programming and budgeting. It hindered investment priority setting for specific T&E range capabilities needed to support new and existing operational weapon systems and platforms—a task for which the former FCDDIV, in Defence Headquarters, was responsible under the 1996 T&E policy (see paragraph 2.7 and Table 1). It was also inconsistent with Defence T&E policy which 'aims to promote a unified approach to T&E to guarantee effective and efficient use of expensive resources'.[118]

10.10 US Defense policy on T&E ranges and facilities, outlined below, indicates the priority the US gives T&E range management, and the important links between Defense and the industries that support it.

US Defense policy on Test and Evaluation facilities

10.11 The US Department of Defense policy on T&E facilities is stated mainly in its Major Range and Test Facility Base (MRTFB) directive.[119] It states that the MRTFB is a national asset that is to be sized, operated, and maintained primarily for DoD test and evaluation support missions, but also be available to all users having a valid requirement for its capabilities.

10.12 The MRTFB consists of a broad base of T&E activities managed and operated under uniform guidelines to provide T&E support to DoD components responsible for developing or operating materiel and weapon systems. Other US Government agencies and allied foreign governments and, when authorised, private organisations may be permitted to use the MRTFB.

ADF Test and Evaluation Ranges and Facilities

10.13 As indicated below, the Services and DMO have extensive ranges and facilities for T&E, with an estimated facilities replacement cost of nearly $400 million.

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[118] Defence Instruction DI(G)LOG 08-10, *Defence Test and Evaluation Policy,* 1996 pp. 5, 7.

[119] Department of Defense Directive 3200.11, *Major Range and Test Facility Base*, 29 September 1980.

Navy ranges and facilities

10.14 DMO's Maritime Ranges System Program Office and Sonar Group (MRSPO&SG) is responsible for the acquistion and logistic support of all current and future maritime ranges in support of Naval System Command's RANRAU and RANTEAA. This offers improved strategic management necessary to provide a coherent capability integrated with portfolio business processes, and designed to meet the current and future operational requirements of Defence, as well as the needs of the industries that provide systems engineering, logistics and other support to Defence. MRSPO&SG's responsibilities include:

- Developing and managing the strategic plan for maritime ranges, sonars and acoustic requirements.
- Providing maritime range acquisition and logistic support services to Navy in accordance with agreed acceptance into service and configuration management criteria.
- Providing sonar and acoustics requirements for towed arrays, sonobouys, specialised sonar systems, non-platform specific acoustic devices and acoustic rapid response activities acquisition and logistic support services to Navy in accordance with agreed acceptance into service and configuration management criteria.

10.15 Navy has the following test and evaluation ranges and facilities.

- Sydney Harbour Degaussing Range is managed by the RAN Ranges and Assessing Unit (RANRAU). The degaussing range provides measurement, data processing and analysis of magnetic fields emanated by steel-hulled surface vessels, submarines and specialist mine counter measures vessels.
- Sydney area Land Based Magnetic Test Range is managed by RANRAU and provides measurement of the magnetic moment of equipment and systems to be fitted in a magnetically sensitive environment.
- Jervis Bay Shallow Water Sound Range is managed by RANRAU and provides measurement of underwater radiated noise from surface vessels.
- Jervis Bay Telemetry Data Acquisition Facility is managed by RANRAU and provides a ground based telemetry receiving, processing and display system for testing missiles.
- Underwater Tracking Range WA is managed by RANRAU and measures submarine underwater dynamic performance and sensor

alignment, and analyses air, surface and sub-surface coordinated training exercises.

- Magnetic Measurement Range WA is managed by RANRAU and provides measurement data of the magnetic signature of steel-hulled vessels.
- Magnetic Treatment Facility WA is managed by RANRAU. This facility reduces the magnetic signature (deperms) of steel-hulled vessels.

10.16 The total replacement cost of Navy's ranges and facilities is estimated at $104.7 million (the main one is the $40 million Underwater Tracking Range in WA).[120]

Land ranges and facilities

10.17 The DMO's Land Engineering Agency's (LEA's) main facilities are situated at Maribyrnong in Melbourne and at Monegeetta, north of Melbourne. The numerous Army 'proving ground assets' at those locations have an estimated replacement cost of $55.4 million (Maribyrnong $24.4 million, Monegeetta $31.0 million).[121]

Aerospace ranges and facilities

10.18 The Director General Aerospace Development commissioned a US defence firm to conduct a study of the future requirements for air weapons ranges. The firm reported in 2000 that there was negligible coordination of aerospace range resources, some range facilities were duplicated, and there was no single authority with ownership of range problems. The ranges had a systems acquisition process that omitted an obligation to invest in long-term infrastructure, and that often included 'cost-effective' range solutions based on the use of overseas facilities. The firm also reported that, even though the ADF had a number of basic aerospace range facilities and capabilities, the ADF also had a number of significant range capability shortfalls. The firm made recommendations aimed at improving the management of ADF's aerospace range capabilities.[122] The report indicates there is much to be done to bring Defence's aerospace ranges under a coordinated, and '*unified approach*' sought by Defence T&E policy.

10.19 The total replacement cost of aerospace range T&E systems is estimated at $228 million (Woomera instrumented range $181 million; Edinburgh telemetry and tracking systems $47 million).[123]

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120 Information provided by RAN Ranges and Assessing Unit.

121 Information provided by Land Engineering Agency.

122 Raytheon Australia, *Air Weapons Ranges Study*, 30 November 2000, p.xi.

123 Information provided by ARDU.

Test and measurement system calibration policy and management

10.20 Test and measurement equipment must perform to acceptable standards of accuracy and stability. If it does not, the measurement information on which Defence T&E programs are planned, conducted and reported may have no external validity.

10.21 To maintain such external validity, Defence needs to comply with its own Calibration Policy on Test and Measurement Systems (TAMS); legislation such as the *National Measurements Act 1960*; and the Memorandum of Understanding between the Commonwealth and the National Association of Testing Authorities (NATA).

10.22 Defence's organisation for calibrating instruments for the ADF consists of a central office in Air Force's Aeronautical Equipment Systems Office at RAAF Richmond, which has strategic management control over six test equipment calibration laboratories geographically dispersed throughout Defence.

Radio frequency spectrum for Test and Evaluation

10.23 Defence faces strategic management challenges regarding the continued availability of the radio frequency spectrum used by its weapons and communications systems, including T&E systems. Defence advised the ANAO that developments and growth in mobile radio communications in the last 10 years has led to spectrum congestion and commercial pressures being particularly acute below 3 GHz. Defence believes bands below 3 GHz have insufficient capacity to support the wide band telemetry services it expects will be required in the longer term. Accordingly Defence considers that spectrum above 3 GHz should be allocated on a worldwide basis for telemetry, and it has successfully advocated the placement of this topic on the International Telecommunications Union's World Radio Conference (WRC) agenda for 2005–2006.

10.24 Defence advised that reallocation and sale of some bands below 3 GHz has caused some microwave links to migrate to the 2200–2900 MHz band, which is the principal band used by defence aeronautical telemetry systems with a T&E role. Defence advised that the Australian Communications Authority is making arrangements that permit Defence's continued use of this band for telemetry purposes in a large number of T&E ranges and in the transit corridors to those ranges.

10.25 The cost of Defence users compelled to migrate to other radio bands can, according to Defence, be larger than the replacement cost of the radio equipment directly involved. Defence advised that often telemetry and other radio equipment form integral parts of weapons systems. Consequently enforced spectrum migration may require system redesigns followed by expensive testing and proving programs. In the case of Navy's Nulka project, the redesign cost was some $0.75 million, which was met from the project's contingency funds.

10.26 The radio spectrum strategic management challenge extends to the need for Defence to harmonise many of its radio bands with bands used for Defence purposes in other countries, particularly those in North America and Europe. This harmonisation is essential for logistic and interoperability reasons. In these countries there is also pressure to re-allocate spectrum from Defence to civil use.

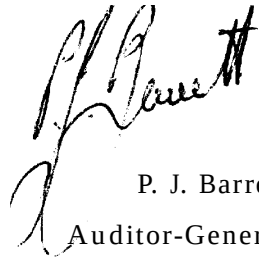
10.27 Defence advised the ANAO that the Knowledge Staff is preparing a biennial Defence Spectrum Strategic Plan, with the aim of having the plan endorsed by senior Defence committees. This work includes a comprehensive survey of all aeronautical telemetry requirements to assist future spectrum planning for telemetry systems and also to assist the preparation of a national position on the preferred telemetry bands above 3 GHz for the WRC in 2005–2006.

Conclusion

10.28 Defence has maintained its own T&E ranges and facilities, in the interests of confidentiality of sensitive information and objectivity in T&E operations. The Services and DMO have extensive ranges and facilities for T&E, with an estimated facilities replacement cost of nearly $400 million. The DMO has recently accepted responsibility for strategic management, acquisition and logistic support of Maritime and Land ranges. This would assist their strategic management in terms of providing a coherent capability integrated with portfolio business processes. A report provided to the Director General Aerospace Development indicates there is much to be done to bring Defence's aerospace ranges under a coordinated, and '*unified approach*' sought by Defence T&E policy.

10.29 The developments and growth in mobile radio communications in the last 10 years have resulted in spectrum congestion and commercial pressures being particularly acute below 3 GHz. This could restrict

availability of the radio frequency spectrum for aeronautical telemetry systems with a T&E role. Defence access to the radio spectrum to meet its own requirements, including interoperability (or connectivity) with coalition forces, needs careful strategic management, as it has a direct impact on current and future Defence capabilities. Defence's Knowledge Staff is preparing a biennial Defence Spectrum Strategic Plan for endorsement by senior Defence Committees to meet this strategic requirement.



Canberra ACT
24 January 2002

P. J. Barrett
Auditor-General

Appendices

Appendix 1

Test and Evaluation Managers and Stakeholders

1. The following paragraphs summarise the roles and accountabilities of the managers and key stakeholders as they apply to Defence capability management. At the time of the audit, Defence was revising its capability development process. Accordingly, the following roles and accountabilities may change.

Deputy Secretary Strategy

2. DEPSEC S, as part of the Output Executive, is responsible for interpreting Government strategic guidance, developing military strategy, conducting strategic reviews and deciding broad capability priorities. These responsibilities require the DEPSEC S organisation to evaluate, at the strategic-level, current Defence capabilities to identify gaps between Defence's strategic objectives and Defence's capability to satisfy those objectives.

Vice Chief of the Defence Force

3. VCDF, as part of the Owner Support Executive, chairs the Defence Capability Investment Committee (DCIC) and has responsibility for managing the definition of future Defence capability in terms of its functions, performance levels, performance conditions and whole-of-life costs. VCDF aims to achieve the Defence Outcome[124] in the most cost-effective way, taking into account risk and opportunity. VCDF is accountable for:

- monitoring acquisition projects' compliance with approved capability, cost and schedule baselines, and approved information environment architectures;
- ensuring proposals for major changes to these baselines are referred to the DCIC;
- ensuring project baselines and architectures[125] are congruent with both the Defence Plan, which provides a 'whole of business' focus for Defence on the capabilities the Government requires to be delivered / developed in the near term to 10-20 years from now; and the Defence Financial and Management Plan (DFMP), which focuses on the financial and management aspects of Defence's capability plans; and
- ensuring supportable and sustainable capability proposals are produced.

[124] 'The defence of Australia and its national interests'.

[125] An architectural approach to capability development is discussed in Audit Report No.11 2000–2001 *Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000 pp. 32, 44–45.

4. VCDF requires T&E data to manage each of these areas of accountability.

Head Strategic and International Policy

5. HSIP, as part of the Owner Support Executive, is responsible for defence force preparedness and thus needs T&E data for information on the current state of the force's operational capabilities.

Capability Managers

6. Each of the three Capability Managers (Chief of Navy, Chief of Army and Chief of Air Force), as a member of the Output Executive, is accountable to the Chief of the Defence Force (CDF) and the Secretary for delivering capabilities or outputs to agreed performance levels in terms of quantity and quality (including timeliness), and within agreed levels of resources.[126] They are also accountable for contributing to development of future capability, and delivery of nominated elements of capability, including accountability for acceptance into service. In exercising these accountabilities, the Capability Managers are to:

- contribute to the definition of all whole-of-capability and whole-of-life elements;
- where necessary, monitor compliance with the technical regulatory frameworks that ensure materiel systems are designed, constructed, maintained and supported to approved standards by competent personnel working in accredited organisations;
- advise when new or enhanced materiel systems have been formally accepted into service, including the certification that approved baselines have been met and that any exceptions are noted;
- recommend a planned withdrawal date of the capability; and
- monitor, assess and advise on the performance of nominated elements of capability in meeting preparedness objectives.

7. The three Service Chiefs and their Headquarters staff require T&E data to carry out their responsibilities and report on their areas of accountability.

Under Secretary Defence Materiel

8. USDM heads the DMO and, as a member of the Enabling Executive, is accountable for acquiring the materiel and timely and appropriate materiel support and providing in-service support required by Output Executives in

[126] The other Output Executives are: Commander Australian Theatre; Deputy Secretary—Strategy; and Deputy Secretary Intelligence and Security.

accordance with approved capability, cost and schedule baselines, and by Performance Price Agreements with Output Executives. USDM is also accountable for coordinating the delivery of all elements of capability to the relevant Capability Managers in accordance with the requirements of the agreed Capability Acquisition Mandate. USDM requires T&E data to carry out those responsibilities and to report on those areas of accountability.

Chief Information Officer

9. The CIO heads the Defence Information Systems Group and is accountable for providing in-service support for most Defence administrative information systems as required by Output Executives in accordance with approved capability, cost and schedule baselines, architectures and Performance Price Agreements. HDIS project teams require T&E data in order to carry out their responsibilities and report on information system performance and user satisfaction. This audit did not include the CIO's T&E responsibilities.

Chief Finance Officer

10. Defence's CFO, as a member of the Owner Support Executive, is accountable for ensuring that future and current capability plans are affordable. This is largely achieved through his stewardship of the Defence Plan and the Defence Financial and Management Plan (DFMP). Additionally, CFO is accountable for rigorous, independent scrutiny of capability Business Cases.

Head Knowledge Systems

11. Defence's HKS, as a member of the Owner Support Executive, is responsible for policy direction and capability development of the Defence Information Environment (DIE), which includes Defence's command, control, and communications systems, intelligence systems, surveillance, reconnaissance and electronic warfare systems.[127] The HKS requires T&E data to carry out DIE policy and capability development responsibilities.

Chief Defence Scientist

12. CDS is a member of the Owner Support Executive and heads the Defence Science and Technology Organisation (DSTO). He is accountable for advice on the adequacy of scientific and technological input to capability proposals, especially for new major capital investment. CDS and DSTO require extensive knowledge of T&E principles and practices in order to carry out their responsibilities.

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[127] The ANAO audited the management of knowledge system acquisition projects in 1999–2000, see ANAO Audit Report No.11 2000–2001*, Knowledge System Equipment Acquisition Projects in Defence,* 15 September 2000.

Other stakeholders

13. Other stakeholders include senior ADF personnel, such as Navy and Air Force Force Element Group (FEG) commanders and Army Brigade commanders, who are responsible for managing ADF capabilities. They support their Capability Managers in meeting their assigned responsibilities. These responsibilities extend to defining new or improved capabilities and the ways that the ADF may maximise the effectiveness of new capabilities at minimum total ownership cost. FEG and Brigade commanders and their staff require T&E data to meet their responsibilities and report on their areas of accountability.

14. Among the principal stakeholders outside Defence are the suppliers of defence equipment. The University of South Australia's Systems Engineering and Evaluation Centre and the University of Queensland's Software Verification Research Centre, are also stakeholders because of their significant long-term investments in T&E research and education.

Appendix 2
Status of Major Capital Equipment at RANTEAA

1. The following table prepared by RANTEEA indicates variations in T&E practice in DMO (see paragraphs 4.25—4.27).

PLATFORM	Detailed Operational Requirement (DOR) / Capability Systems Statement (CSS) —Does one exist —If so, what was the standard of the document	Test and Evaluation Master Plan —Does one exist —If so, what was the standard of the document	T & E RESOURCES To what extent was T&E (especially OT&E) funded by the Project	T&E HISTORY Extent of testing and access to tests and test data	CONFIGURATION CONTROL Configuration state and supporting documentation	Report of Material State at Delivery (TI 338) —Does one exist —If so, what is its state	Provisional Acceptance Date	Planned Acceptance Into Naval Service Date	Overall T&E Assessment —Naval Test, Evaluation and Acceptance Manual Compliant Transient Non – Compliant
Sea1411 Seasprite Helicopter Acquisition	Yes.	Yes. Early draft being re-written. The Plan is a framework only	NAPO paying for DT&E and AT&E. OT&E funding not included and has been bid for separately	DT&E under way, yet to be completed. PT&E under way, yet to be completed. Project presents significant schedule risk. OT&E is still to be identified.	Due to delays in weapon system development, DMO deciding whether to proceed with incremental acceptance or wait for full compliance.	No.	Not known	Not Known	
Seasprite FMFS (Seasprite Simulator)	Included in Sea 1411	Included in Sea 1411	Included in Sea 1411	Simulator will be tested against the Training Needs Analysis, which is yet to be delivered.		No.	Tied to 1411	Tied to 1411	

Sea 1414 Penguin Missile AGM-119B	Included in Sea 1411	Included in Sea 1411	NAPO is funding DT&E and AT&E. OT&E funding is not included and has been bid for with Sea 1411.	Not known to RANTEAA	Not known to RANTEAA	No.	Tied to 1411	Tied to 1411	
Sea1405 Seahawk FLIR/ESM	Yes	Yes. An early draft currently undergoing a re-write	NAPO are funding DT&E and AT&E. OT&E funding is not included and has been bid for separately	The contractor is understood to have indicated that the current T&E schedule is unachievable. An updated Acceptance Test Plan has yet to be developed.	Commonality with Sea 1411 Seasprite means significant delays are being experienced with this project.	No	Tied to 1411.	Tied to 1411.	
JP7 Kalkara	Yes. DOR now re-engineered from SOR, and is adequate.	No. Project's initial plan for T&E consisted of three flights only. The plan was expanded as the performance of Kalkara became known.	Although Kalkara is in operation T&E is still progressing. T&E funded by NAPO. Due to major delays, T&E funding is now exhausted.	DT&E and PT&E completed, with the exception of flight to 20ft and proof of performance by the Miss Distance Indicator. OT&E has highlighted performance deficiencies which need to be mitigated. Funding will need to be identified for this.	Many issues still to be resolved.	Yes. Satisfactory	12 April 2001	12 December 2001, although most likely to slip again.	

MIS1640 Acoustic Data Recorder	Yes	No Minor project TEMP not required.	OT&E funded by the Project.	Operational Evaluation (OPEVAL) complete. RANTEAA recommended against AINS. Rectification work is ongoing.	Satisfactory	Not required	August 1999	June 2002	
EWTS Electronic Warfare Training System	No. A SOR was issued by FEWO.	No An outline was raised by RANTEAA. No further activity to date.	MHQAUST are funding this capability. Any T&E process has yet to be clearly defined.	No testing other than in service "user trials" conducted. Training needs have been defined to enable rudimentary suitability testing.	Not Known to RANTEAA. EWTS is a contracted 'service' for which a clear concept for operations does not exist and the need for T&E was not envisaged.	No	Not known to RANTEAA	Not known to RANTEAA	
Sea 1428 Evolved Sea Sparrow Missile	Yes Did not provide details of the capability required from each phase.	Yes. But still being developed and the scope of T&E required is still being decided by DMO	The ESSM consortium has funded DT&E. Funding by project for P/OT&E was initially restricted to one missile firing. Further funding has been identified for four missile firings. No funding has been identified for OT&E.	DT&E has been conducted by the contractor from a fixed land base site. There has been no testing in Australia to date. The project is facilitating appropriate certification before the weapon is installed in the ANZAC Class. P/OT&E is scheduled for November 2001.	Not known. The missile is understood to be at a pre-production stage of configuration.	No too early	Not know to RANTEAA	Not known to RANTEAA	
Sea 1418—Maritime Ranges	Yes Good	No	The Project Authority is responsive to any request for T & E funding	Has been comprehensive testing for two of the three major elements of the capability being delivered. Third element yet to	Not known to RANTEAA. However, the recent introduction of the ranges SMO should give impetus to this requirement.	TI338 being developed; its format is satisfactory, but requires	Soon (Once TI338 is established)	September 2002	

			from RANTEAA.	demonstrate functionality and be delivered to the Commonwealth.		work before release for signature.			
JP 8001 Deployable JFHQ	No. RANTEAA does not know the if the required capability is defined. The RAN and RAAF have recently agreed to a Concept of Operations.	No	Project Authority has informally agreed to fund T&E.	This equipment has recently been installed in the first of two platforms. There has been no comprehensive T&E conducted.	Not known by RANTEAA.	No too early	Not known to RANTEAA	Not Known to RANTEAA.	
Sea 1412 Maritime Warfare Training Centre	Yes Good	No In the process of being developed.	None identified	No T&E (in any form) has been conducted as this project is still in its early development stages.	Not known to RANTEAA.	No too early	Not known to RANTEAA	Not known to RANTEAA.	
Sea 1100 LFAPS (ASSTASS)	Draft	No	None identified	No T&E (in any form) has been conducted as this project is still in its development stages.	Not known to RANTEAA.	No too early	Not known to RANTEAA	Expected 2005/06	
Sea 1390 FFG Upgrade	Yes Part 2 currently under development	No Draft being developed with RANTEAA involvement.	None Yet	No T&E has been conducted, as the project schedule has been delayed by 12-18 months.	Not known to RANTEAA.	No too early	Not known to RANTEAA.	Not known to RANTEAA.	

Sea 1444 FCPB replacement	Draft	Draft Under development with RANTEAA involvement	None Yet	No T&E (in any form) has been conducted as this project is still in its development stages. (Just approved in the FY 2001/02 budget)	- N/A	No too early			
JP2070 Lightweight Torpedo	Draft	Draft	None Yet	No T&E has been conducted as this project is still in its development stages. (Just approved in the FY 2001/02 budget)	N/A	No too early			
Sea 1229 ASMD (Nulka)	Yes Satisfactory	Yes Satisfactory	Funding agreed	All PT&E activities have been completed. OPEVAL in Oct 01	Satisfactory	Yes Awaiting signature	Expected 27 July 2001	Expected 31 October 2001	
JP 2043 Modernised HF Communication System	Yes Satisfactory	Yes Draft under further development	Funding agreed	PT&E being conducted. CAT 5 and OT&E testing to begin December 2001.	Satisfactory	No	January 2002	Expected late 2005	
Amphibious Transport Ships (LPAs)	Yes Satisfactory.	Yes Satisfactory.	T &E has been satisfactorily provided for mostly within the operational program	OT&E has been conducted to date within the operational employment of the two platforms.	In the process of development of a configuration baseline.	Yes Satisfactory for both ships.	*Manoora* Dec 1999. *Kanimbla* 31 Oct 2000	*Manoora*—31 Dec 2001 *Kanimbla*—28 Jun 2002	

Sea 1348 Anzac Class	Yes	Yes. TEMP is generic and class based with modification to reflect the configuration of each ship of the class.	T &E substantially relied on the provision of assets and resources from operating budgets.	Ships of the ANZAC class are functionally proved but all operational evaluation activities have to be completed.	Understood by RANTEAA to be substantially satisfactory overall.	Yes Getting better for each ship and now fully computerised and delivered in hard copy and CD	*Anzac* 28/3/96 *Arunta* 30/10/98 *Warramunga* 27/2/01	11 October 2000 11 October 2000 31 March 2002	
Sea 1114 Collins Class	Yes. Originally no DOR. DOR Part 1 introduced retrospectively but never endorsed. DOR Part 2 produced in 1999 and endorsed by HCD.	Yes Produced in 1995 and not subsequently updated. Does not cover the required performance of the class.	Project has not identified funding or the cost covering the conduct of OT&E.	Some DT&E/PT&E conducted by DMO. Some of these trials remain outstanding. Very limited RAN First of Class trials conducted by RANTEAA.	Currently five submarines are in service operating within the Fleet Activity Schedule. Each has a different configuration. Considerable work is continuing to bring the configuration management to the required standard. The submarines are continuing to be developed and modified.	Yes For each submarine at delivery. Standard good.	Various (PA granted for each submarine)	Expect December 2002 (intention is to AINS class by OPEVAL *Rankin* and assessing other boats' capability against this submarine).	

Hydrographic Ship 1401 Sea	No TLS was agreed as the basis for Acceptance	Yes Dated August 1996 covers the vessels well	Adequate	Comprehensive T&E have been conducted to date.	Still to be assured but understood to be satisfactory.	Yes – a well-maintained document	9 September 2000	31 December 2001	
Mine Hunter Coastal Sea 1555	A suite of documents is being used to provide the required function.	Yes High standard	Project provides funding as required.	Satisfactory PT&E has been conducted to date. OT&E is under way, and proving to be satisfactory in scope and application.	Satisfactory MHC SPO at HMAS *Waterhen* runs this for all 6 MHCs	Yes Comprehe-nsive and updated on a regular basis	*Huon* March 1999 *Hawkesbury*December1999 *Norman* July 2000 *Gascoyne* April 2001	14 December 2001 (Actual) 14 December 2001 (Actual) 22 March 2002 19 July 2002	
Mine Warfare Systems Centre Sea 1297	Yes Re-written from Functional Performance Specification	Yes. But has not been updated since the change in scope to the project	Project provides this when required	Initial involvement with incremental PT&E occurred in December 2000.	Not known to RANTEAA	No	Not Known to RANTEAA.	Not known to RANTEAA.	

Source: RAN Test, Evaluation and Acceptance Authority

Appendix 3

US Defense Director of Operational Test and Evaluation

1. The US Congress in 1983 established the Director of Operational Test and Evaluation (DOT&E) in the Office of the Secretary of Defense to coordinate, monitor and evaluate operational testing of major weapon systems.[128]

2. More recently, the US GAO has reported that DOT&E forms part of the Office of the Secretary of Defense and is separate from the weapons acquisition community that conducts developmental and operational testing. This places DOT&E in a position to provide the Secretary and Congress with two key sets of advice. Firstly, DOT&E provides independent advice on whether tests and evaluations of weapon systems were adequate and whether results confirmed that the system is operationally suitable and effective for combat before a decision is made to proceed to full-rate production. Secondly, it provides annual reports to the Secretary and congressional decision-makers summarising the operational test and evaluation activities conducted during the preceding fiscal year.

3. The GAO considers that the foundation of DOT&E's effectiveness is its authority to report directly to Congress. GAO reported that Congress created the DOT&E in response to reports of conflicts of interest in the acquisition community's oversight of operational testing that led to inadequate testing of operational suitability and effectiveness and fielding of new systems that performed poorly. GAO commented that '*commanders and action officers within the service operational agencies were nearly unanimous in their support for an independent test and evaluation office within the OSD*' [Office of the Secretary of Defense].[129]

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[128] Title 10 of the US Code, Section 139.

[129] General Accounting Office, *Test and Evaluation: Impact of DOD's Office of the Director of Operational Test and Evaluation,* GAO/NSIAD–98–22, October 1997, pp 1–3, 15.

Appendix 4

ARDU's functions

1. Air Force's Aircraft Research and Development Unit (ARDU) provides specialist advice on major ADF acquisitions, sponsors and collaborates with external agencies and the DSTO and manages permanent T&E resources located at RAAF Base Edinburgh, the DSTO site at Salisbury and within the Woomera Prohibited Area in South Australia. ARDU also manages limited air-transportable equipment that enables limited T&E programs to be supported at remote sites within Australia and, if necessary, overseas.

Flight test ranges

2. In 1991 the Minister for Defence Science and Personnel transferred DSTO's Range Management Branch (RMB) to Air Force so that Air Force could provide better test and evaluation services to the ADF. The transfer was not to detract from the primary duties of ADF personnel. Funds were to be transferred to assist the future promotion of Woomera capabilities.

3. Air Force then transferred to ARDU much of the resources once controlled by DSTO's RMB. This was to enable ARDU to conduct test programs that require accurate and timely meteorological data (test conditions) and certain other technical data.[130] This allowed ARDU to take on additional T&E responsibilities in Electronic Warfare, Aircraft Stores Compatibility Engineering, and management of the Woomera Instrumented and Air Weapons Range.

4. At the time, DSTO considered that the additional resources provided to ARDU, together with the expected growth in future test programs, would result in a tenfold increase in ARDU's data complexity and data volumes.

ARDU's flight test platforms and facilities

5. Current instrumented test, chase and support platforms permanently located at ARDU include two F/A-18 Hornet aircraft; three PC9/A aircraft; one S-70A-9 Black Hawk helicopter; one UH-1H Iroquois helicopter; and one Super KingAir (B200) being purchased. Other test aircraft and systems for specific projects are provided by ADF operational units and other sources as required.

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[130] These data include Time-Space-Position-Information, which describe the location and time of the System-Under-Test, and telemetry/recorded data, which describe the behaviour of the System-Under-Test.

6. ARDU also manages, develops and maintains a number of unique test facilities that enable it to execute its T&E mission. These include electronic warfare data management and analysis tools. It also has:

- an electromagnetic environment test chamber capable of electromagnetic compatibility (EMC) and Radio Frequency (RF) test facility that enables limited EMC testing of subsystems up to the size of a Harpoon missile[131] and to enable a wide range of RF testing to be undertaken prior to platform fitment;
- an Armament Static Ejection Test Rig that enables new and modified weapons and stores to be released in a controlled environment. This enables T&E of arming and release sequences, correct ejection, and examination of free fall characteristics;
- a Weapons Separation & Analysis System which enables an engineering assessment of the fidelity of stores separation effects through analysis of high-speed film/video and comparison with computational predictions and wind tunnel modelling;
- an Aircraft Structural Test Rig facility which enables the large-scale calibration of strain gauges fitted to F/A-18 aircraft to enable accurate flight load data acquisition and reduction;
- a Telemetry Section capable of providing Real Time and post flight data processing of various data formats; and
- ARDU's IMS maintains and installs modifications required to conduct D/AT&E and OT&E of modified ADF aircraft equipment. These modifications include high-speed cameras, pods and calibration equipment.

[131] Compliant with MIL-STD-461E.

Appendix 5

Economics of Telemetry

This appendix summarises some early lessons learnt at Defence's Aircraft Research and Development Unit (ARDU), as presented to the 1994 International Telemetering Conference in Las Vegas USA. (Report paragraph 6.15 refers.)

The Economics of Telemetry systems in Test and Evaluation

In 1994 ARDU learned some valuable lessons during a series of software verification and validation flight testing sorties at the Woomera weapons range. These lessons significantly highlighted the economics of using a $5 million telemetry system to improve its test and evaluation capabilities.

In this case, the ARDU's Real-Time Monitoring Facility (RTMF) at Woomera used a telemetering system to detect three major problems with an airborne system under operational tests and evaluations. It took approximately three days to fix two of these problems and four days to fix the other one. The telemetering system detected other system problems that, although not critical to the specific test missions being flown, spurred the rectification of those problems prior to future missions.

Without the real-time feedback from the telemetering system, ARDU may not have detected these problems until its analysts had completed detailed analysis of test data some two months after the test flights were completed. Only then would ARDU have discovered that the test program had failed to yield much of the critical operational data it was expected to provide.

The test program costs were as follows:

Aircraft flight time costs = $55,000 per hour x 40 flights	= $2.2 million
Airborne/ground instrumentation preparation & activation ($150,000 per sortie x 40)	= $6 million
Post-processing effort = 4 staff x 8 weeks x $200/day	= $32 000
Woomera deployment cost	= $60 000
Partial Cost	= $9.12 million

This excludes costs of chase aircraft, weapons and stores.

This case showed that the $5 million telemetry system enabled the operational tests and evaluation program to detect problems early, while they were inexpensive to fix. It showed that telemetry is a low-cost investment and an 'early warning system' capable of detecting problems before they become expensive to fix or simply not affordable to fix. Telemetry systems also monitor safety-of-flight conditions and thus offer further cost savings.

Often productivity is defined as 'the ratio of valuable output to input'.[132] In the case of test and evaluations, the productivity ratio may be defined as 'the cost of recovering deficiencies if they had remained undetected' divided by 'the cost of the test program'. However, such productivity ratios remain academic, since customers often find that repeating a failed test program, such as the $9 million example above, is not affordable. Analysts then spend months trying to salvage anything useful from the available data. These salvage jobs are rarely costed.

This case demonstrated that the application of telemetry to Software V&V Flight testing offers a 'do it once, correctly' solution to T&E. In this instance, the transmission of undetected data faults to a 'fleet' of aircraft was prevented, which avoided a need to try to overcome faults later, when such action may have been unaffordable.

Source: Aircraft Research and Development Unit

[132] Cross Jr., E.J. and Ward, D T., *Measuring Test Productivity—The Elusive Dream,* presented at the 2nd Flight Testing Conference, Las Vegas, NV, 16–18 November 1983.

Appendix 6

Performance Audits in Defence

Set out below are the titles of the ANAO's previous performance audit reports on Defence operations tabled in the Parliament in the last five years.

Audit Report No.15 1996–97
Food Provisioning in the ADF

Audit Report No.17 1996–97
Workforce Planning in the ADF

Audit Report No.27 1996–97
Army Presence in the North

Audit Report No.34 1996–97
ADF Health Services

Audit Report No.5 1997–98
Performance Management of Defence Inventory

Audit Report No.34 1997–98
New Submarine Project

Audit Report No.43 1997–98
Life–cycle Costing in Defence

Audit Report No.2 1998–99
Commercial Support Program

Audit Report No.17 1998–99
Acquisition of Aerospace Simulators

Audit Report No.41 1998–99
General Service Vehicle Fleet

Audit Report No.44 1998–99
Naval Aviation Force

Audit Report No.46 1998–99
Redress of Grievances in the ADF

Audit Report No.13 1999–2000
Management of Major Equipment Acquisition Projects

Audit Report No.26 1999–2000
Army Individual Readiness Notice

Audit Report No.35 1999–2000
Retention of Military Personnel

Audit Report No.37 1999–2000
Defence Estate Project Delivery

Audit Report No.40 1999–2000
Tactical Fighter Operations

Audit Report No.41 1999–2000
Commonwealth Emergency Management Arrangements

Audit Report No.45 1999–2000
Commonwealth Foreign Exchange Risk Management Practices

Audit Report No.50 1999–2000
Management Audit Branch—follow–up

Audit Report No.3 2000–2001
Environmental Management of Commonwealth Land—follow–up

Audit Report No.8 2000–2001
Amphibious Transport Ship Project

Audit Report No.11 2000–2001
Knowledge System Equipment Acquisition Projects in Defence

Audit Report No.22 2000–2001
Fraud Control in Defence

Audit Report No.26 2000–2001
Defence Estate Facilities Operations

Audit Report No.32 2000–2001
Defence Cooperation Program

Audit Report No.33 2000–2001
ADF Reserves

Audit Report No.41 2000–2001
Causes and Consequences of Personnel Postings in the ADF

Audit Report No.51 2000–2001
ADF Health Services follow–up audit

Audit Report No.16 2001–2002
Defence Reform Program—Management and Outcomes

Audit Report No.24 2001-2002
Status Reporting of Major Defence Equipment Acquisition Projects

Glossary

Acceptance into Naval Service. AINS is the milestone at which the Chief of Navy, based on advice and recommendation from Maritime Commander Australia (MCAUST), is satisfied that the equipment is in all respects acceptable for operational service. MCAUST develops the recommendation for or against AINS on advice from a number of authorities (eg the relevant HSA) and on the outcome of OT&E. OT&E activities are conducted by RANTEAA and the outcome reported to MCAUST through Commander Naval Systems Command (COMNAVSYSCOM).

Acceptance T&E is a RAAF-specific term equivalent to PT&E. It is not a recognised category of testing under the 'Lexicon of T&E Terms'. AT&E is carried out to demonstrate that the items developed and produced fulfil the contractual requirements and specifications. Pre-production AT&E is conducted to ensure design integrity over the specified operational and environmental range. This is carried out on prototype or pre-production items manufactured to the proposed production design specifications and drawings.

Analysis. A study method resulting in data which is used to verify the conformity of characteristics with specified requirements. Analysis may include simulation or modelling techniques, extension of established results from comparable equipment or design comparison with existing equipment.

Capability Baseline contains the most important performance objectives of a particular defence capability (weapon system or platform) as endorsed by the Defence Capability Investment Committee. The Capability Baseline is used to manage and control the technical development of a capability.

Configuration Baseline of a capability identifies its functional and physical characteristics. The configuration baseline should align with the endorsed capability baseline and be used as the basis for testing and evaluating the capability.

Configuration Management is a system engineering process that permits the orderly development of a system, sub-system or configuration item. Good configuration management ensures designs and products are traceable to systems engineering requirements and to configuration and capability baselines. Configuration management includes technical data

management and management visibility of what is supposed to be produced, what is being produced, and what modifications have been made to what was produced. This enables products to be tested and evaluated to determine compliance with approved specifications.

Criticality levels of test and evaluation. Three major criticality levels should be considered for T&E. They have implications for test stringency, acceptance of systems, design systems, design reviews, etc and may overlap several categories of T&E. They are: safety critical T&E; security critical T&E; and mission critical T&E.

Delivery. Delivery is the milestone at which the contractor demonstrates, to the satisfaction of the PM, that the specifications and associated requirements of the contract have been met. Contractor compliance with the contract is measured by PM staff (using data from PT&E and associated activities), and by early OT&E activities, undertaken by RAN Test, Evaluation and Acceptance Authority (RANTEAA) staff. At delivery initial material certification is issued by PM staff. The certification process for naval material is outlined in Chapter 4—'Naval test, evaluation and acceptance planning process'. At delivery 'ownership' of the equipment passes from the contractor to the relevant Head Systems Acquisition (HSA). Because the Defence Acquisition Organisation does not possess the resources to 'caretake' equipment, PA of items such as platforms is normally scheduled to occur at or very close to delivery.

Demonstration A variation of the test method used to verify conformity of functional characteristics with specified requirements. Demonstration involves the use of go/no-go criteria, without the use of elaborate measuring equipment.

Development Test and Evaluation (DT&E). Development Test and Evaluation (DT&E) is T&E to assist system design and development and to verify attainment of technical or other performance criteria and objectives. DT&E allows risks to be mitigated in the development phase of a new system. The system is checked against user and technical requirements to ensure that it fits the need. DT&E is performed across the capability development and acquisition processes and allows feedback between production and design. Potential problem areas are identified and the success or failure of a solution can be verified. DT&E also contributes to post-acquisition re-fits and modifications. DT&E attempts to answer the question, 'Does this design work?'. The DT&E period begins in the material definition stage and continues until delivery, when the capability is provisionally accepted. DT&E is normally initiated by the project sponsor and the Defence Acquisition Organisation Project Manager (PM). DT&E is normally conducted by Defence resources such as Defence

Science and Technology Organisation (DSTO) (eg Director of Trials (DTRIALS)) or in some cases by a contractor. During the DT&E period a close liaison is maintained between the conducting authority and the Operational Test and Evaluation (OT&E) authority to ensure that testing outcomes are available for OT&E purposes.

Evaluation. The review and analysis of quantitative or qualitative data to provide an objective assessment of a system's performance against agreed criteria to determine its fitness for purpose

Inspection. Used to determine characteristics by examination of, and comparison with, engineering drawings, flow diagrams, code and other documentation for Configuration Item (CI) development, specified requirements, or simple measurements without the use of precision equipment.

Interoperability: "is the ability of systems, units or forces to provide services to, and accept services from, other systems, units or forces and to use the exchanged services to operate effectively together without altering or degrading the information exchanged." [ADF Command & Control Information Systems Plan (CCISP) 1995 (Issue 1.0)]

OPEVAL. Operational evaluation is a sub-group of OT&E covering tests and evaluation on production-representative baseline equipment—software and hardware—using the maintenance and support personnel and equipment planned for normal operational use. It aims to:

- demonstrate operational effectiveness and suitability
- provide data to assist in the development of tactical doctrine for the equipment, and
- verify data, handbooks and documentation covering the operation of the system.

In the context of OPEVAL, the types of OT&E are:

- **Operational Effectiveness—**the ability of the system to perform its mission over the operational spectrum in the expected environment and in face of the expected threat.
- **Operational Suitability—**the ability of the user to operate and maintain the system in its expected environment over the long term.

Operational Test and Evaluation. Operational Test and Evaluation (OT&E) is T&E conducted under realistic combat conditions with representative users of the system, in the expected operational context, for the purpose of determining its operational effectiveness and suitability to carry out the role and fulfil the requirement that it was intended to satisfy.

OT&E is conducted to assess the effectiveness and suitability of a new system once it has been accepted into service. Testing is done under realistic operating conditions and is conducted by the end user.

The DMO project office will involve the end user in any OT&E performed prior to contractor delivery where a requirement is to be 'demonstrated' to the Commonwealth and the ADF.

OT&E determines the ability of the system to:

- Perform its intended function—operational effectiveness; and
- be operated and maintained in its operating environment—operational suitability.

It also identifies any deficiencies and the need for any potential modifications to the system so the operational requirements are met. It attempts to answer the question, 'Is this what the user needs?'.

Naval OT&E of the capability is undertaken after provisional acceptance (PA) to evaluate suitability for operational service or *'fitness for purpose'*. OT&E may extend over a long period for some major capabilities (eg two years or more for new ships or submarines) to allow time for a comprehensive assessment and evaluation of the performance and suitability of the capability. The focus of OT&E is on an Operational Evaluation (OPEVAL) of the capability. A successful OPEVAL normally culminates in AINS by CN. The success of OT&E is heavily dependent upon the adequacy of the statement of requirement (ie capability specification measurables). To ensure that capability specification measures are adequate, OT&E includes *'early involvement'* in the project. This involvement begins with development of the Capability Options Document (COD) and Capability Systems Statement (CSS).

Production Acceptance Testing (Aircraft). Testing conducted to determine the compliance of a particular aircraft to the criteria defined within the Australian Military Type Certificate (AMTC) prior to the inclusion of that particular aircraft on the operational Service Register.

Provisional Acceptance. PA is the milestone at which CN, based on the advice and recommendation of MCAUST, is satisfied that the material and operational state of the equipment are such that it is safe to begin the major OT&E phase. PA will normally occur at or shortly after delivery. Where PA follows delivery, the intervening post delivery phase is used to continue development of the recommendation for or against PA. At PA *'ownership'* of the equipment passes from the relevant HSA to CN

represented by MCAUST. PA readiness is measured by provisional acceptance inspections, undertaken by MCAUST staff, and early OT&E activities, undertaken by RANTEAA staff.

Production Test and Evaluation (PT&E). Production Test and Evaluation (PT&E) is T&E conducted on a system during its production to ensure that it meets the technical and performance specifications of the contract. The prime contractor usually is responsible for implementing a PT&E program to demonstrate contract compliance at delivery. PT&E seeks to answer the question, 'Is this what I ordered?'. Production T&E is a series of formal contractual tests conducted on behalf of the customer to ensure the effectiveness of the manufacturing processes, equipment and procedures. The PT&E period matches the contractor production period and ends when the capability is provisionally accepted. PT&E is normally managed by the PM and conducted by the Prime Contractor in concert with the Project Office.

Qualification T&E. Testing used to verify the design and manufacturing processes which provides a baseline for subsequent acceptance/ production tests.

Regression Testing. Repeating tests to ensure modifications implemented as a design change or to fix one defect have not introduced another previously non-existent defect.

Safety and Suitability for Service (S^3)—the ability of the system to meet all aspects of system safety, duty of care and occupational health and safety to allow it to be deployed into service. S^3 T&E may include the disposal phase of the system and is usually applied to explosive ordnance.

Supportability Test and Evaluation (ST&E). ST&E assesses the effectiveness of the logistic support arrangements, including industry through-life support of the system.

ST&E is a newly introduced type of T&E and includes training of personnel to use the system, spare parts availability, manufacturer back-up, disposal etc. It attempts to answer the question, '*Is it supportable?*'.

Supportability testing addresses the organisational, intermediate and depot level logistic support issues for the procured capability and associated supplies either delivered under the prime contract or separately procured to support the procured capability. It is conducted to ensure that the:

- Procured capability includes adequate support characteristics, and
- Logistics resource infrastructure is adequate to sustain the operational capability of the procured capability.

The supportability test program will ensure that supportability requirements are appropriate to enable the newly acquired capability to meet its operating requirements with a high level of availability. Assessment of the total support system must provide a level of confidence that the logistics support infrastructure and business management arrangements are effective and sustainable in meeting through-life support of:

- procured capability defence outputs;
- procured capability assets;
- procured capability contracts; and

Procured capability resources—equipment, personnel and facilities.

TECHEVAL—Technical evaluation, is a sub-group of DT&E covering aspects of test and evaluation on production-representative equipment—hardware and software. It aims to:

- identify technical deficiencies and determine whether the equipment meets the technical specification and requirements, and
- provide a major source of data for the certification of production equipment readiness for operational evaluation.

TEMPEST. TEMPEST testing involves monitoring the level of electromagnetic emissions from devices such as communications equipment that carry classified information. TEMPEST is the acronym for Telecommunications Electronics Material Protected from Emanating Spurious Transmissions (SANS Institute, USA http://www.sans.org).

Test. A process by which data is accumulated to serve as a basis for assessing the degree to which a system meets, exceeds or fails to meet the technical or operational criteria ascribed to the system.

'Test and Evaluation and Acceptance' is the generic term for all tests and trials required to evaluate the proposed equipment against specified requirements during development, production and acceptance into service.

Trial. Used to establish functional characteristics and performance, which may be used to validate conformity with specified requirements. A trial will generate data which requires analysis or review as an integral trial activity.

Verification and validation. Verification is the inspection of documentation representing an intermediate baseline of the product, such as the allocated baseline, to determine if it meets all design requirements. Validation is the test of the product baseline to demonstrate that the product meets the performance specification.

Verification and validation and test and evaluation. Several of the sub-types of test and evaluation (T&E) include a number of verification and validation (V&V) elements which may be employed either individually or in combination. These elements are: inspection; test; demonstration; trial; analysis; and evaluation.

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