DMO Verification and Validation Manual

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Foreword

The development and delivery of materiel capability solutions is a complex business that requires a considered and consistent Verification and Validation (V&V) process. This V&V Manual is a major step toward realising such a process for the DMO.

V&V is about managing and reducing the numerous project risks that we face each day. Better V&V processes will allow us to identify defects or issues associated with our projects earlier, thus allowing us to remedy problems before they escalate, both in consequence and cost.

The V&V Manual provides guidance to DMO staff on how to gather the V&V evidence required for system acceptance and acceptance into service. It will ensure that activities required to achieve V&V are better planned, through the Test Concept Document (TCD) and the Test and Evaluation Master Plan (TEMP). It will also place greater emphasis on a wider range of V&V activities, including those conducted early in the Materiel Life Cycle.

The V&V Manual aims to standardise the way in which the planning of V&V activities is conducted in the DMO. The V&V Manual also discusses how V&V issues should be prioritised. The V&V Manual will bring DMO processes, such as the development of TEMPs, in line with best industry practice by using the ASDEFCON philosophy of V&V that is based on the approach to V&V discussed in the EIA-632 systems engineering standard.

The development of the V&V Manual is part of a wider range of initiatives under the Materiel Acquisition and Sustainment Framework (MASF) aimed at improving our business outcomes and delivering complete capability solutions to the ADF.

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1.1 Introduction

Contemporary capability systems are often characterised by complexity and high levels of integration across both mission and support systems. The ADF seeks operational advantages through capability systems that are usually at the forefront of what is technically feasible. The successful fielding of such systems is often threatened by significant risks in a number of forms. An essential tool in managing these risks is the ability to make objective assessments of a materiel system's development throughout its life cycle, and thus determine that the system being acquired, upgraded or modified is compliant with requirements and fit for purpose.

1.2 V&V in DMO

Verification and validation (V&V) are the principal activities adopted within DMO to allow for the objective assessment of a capability system as it progresses through the Materiel Life Cycle. The DMO approach to V&V is founded on the accepted approach described by the ASDEFCON contract templates which provide for concurrent V&V of the mission system and support system, and progressive V&V throughout the duration of the contract. The aim of this two pronged strategy is to ensure that through the provision, examination and evaluation of objective evidence, that project acceptance milestones are achieved within the allocated budget and schedule, and that the mission system can be properly supported during its in-service phase. Additionally, the terminology of V&V is consistent with the key international standards for the design and development of systems and software, which reflect the systems engineering processes utilised by the DMO.

1.3 The role of V&V

The role of **verification** is to provide confirmation that a system complies with its specified requirements while the role of **validation** is to provide proof that the system capability (ie. capabilities of the combination of the mission system and the support system) satisfies the user's needs. Given the general use of systems engineering (SE) processes across the Materiel Life Cycle, there is an additional role for V&V to validate the adequacy of requirements baselines and system specifications, and to verify that requirements and system specifications are entirely consistent with higher level requirements.

1.4 DMO Policy

DI (M) X-XX 'DMO Verification & Validation Policy' was developed to clearly enunciate the role of V&V in DMO, how V&V is to be applied and who is responsible for applying it. The policy also identifies the sources of objective evidence necessary to satisfy DMO V&V requirements. DI (M) X-XX 'Acceptance Process for New, Modified or Upgraded Capability' describes how V&V is to be applied to support a progressive and sequential acceptance process thereby ensuring that a capability system achieves the required milestones on time and on budget, culminating in Operational Release/Acceptance.

1.5 V&V Manual

The V&V Manual was developed to provide DMO System Program Offices (SPOs), in particular project engineering managers and test and evaluation (T&E) managers, with further instruction on how to implement the DI (M)s on V&V in major capital equipment acquisition and sustainment projects.

1.6 Defence T&E Policy

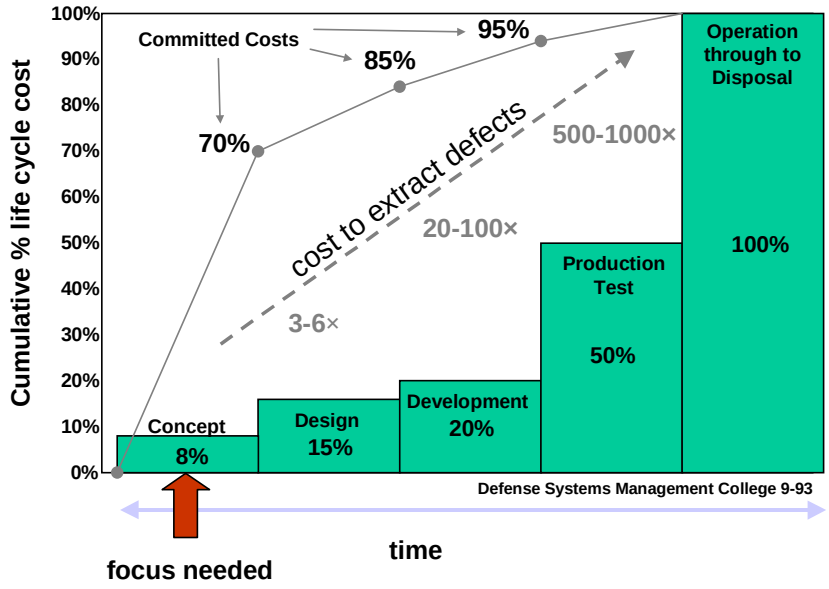
The purpose of T&E in Defence is to obtain information to support the objective assessment of a capability system with known confidence. Defence T&E Policy provides that the results from T&E are to be used within the Materiel Life Cycle to inform decision making and mitigate risk. Objective evidence for the purposes of T&E can be obtained through physical testing, modelling, simulation, demonstration and inspection. DI (G) OPS 43-1 Defence T&E Policy provides that key milestones for acquisition life cycle management require some form of V&V through the results of T&E so that risk is contained within acceptable boundaries, and that the intended system meets safety standards and the end users' requirements.

The DMO V&V policy is compliant with Defence T&E Policy while still remaining consistent with the ASDEFCON approach. This approach acknowledges T&E's significant role in determining a system's fitness for purpose or for contractual compliance as one of a number of methods that satisfy DMO V&V requirements. Other methods include analysis methods, audits, walkthroughs, system reviews and documentation reviews. By acknowledging all the methods that can be considered for satisfying DMO V&V requirements, project and test managers can employ the most appropriate methods for determining the acceptability of systems development products, including concepts, requirements, designs and delivered equipment.

1.7 Importance of timely V&V

A key outcome from a well managed V&V program is the management of cost, technical, capability, safety and schedule risk achieved through the early identification of requirements and system design, and the resolution of development and construction defects. Significant cost savings can be achieved by identifying and rectifying defects early in the Materiel Life Cycle. As shown in Figure 1, rectifying a defect during concept development can be up to 1000 times cheaper than rectifying the defect once the system has been introduced into service.

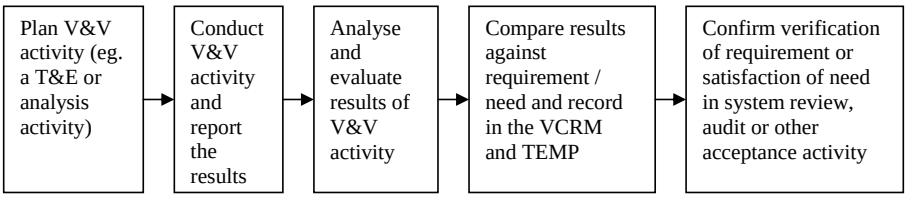
Figure 1: Relative cost of correcting defects over the Materiel Life Cycle (DMO 2003)



Consequently, a V&V program must be developed and implemented from early in the Materiel Life Cycle. This requires placing emphasis on requirements analysis, operational assessments and on reviewing the contractor test processes prior to contract signature, and validation of the outputs from requirements analysis, functional allocation and the elicitation of operational requirements. Commonwealth review of the contractor's progressive testing during integration from the lowest level hardware and software assembly also requires emphasis. Early testing is particularly important in the context of software V&V where if a defect is not identified in unit testing it is more difficult, and therefore expensive, to identify and remedy the defect in component, integration or system level testing.

Figure 2, below, describes the process of achieving verification of a requirement.

Figure 2: The process of achieving verification of a requirement



1.8 Funding

The TCD indicates, well in advance, to the DMO SPO and the relevant Service(s) what the T&E activities are expected to cost and therefore reduces the risk of cancellation or postponement of major T&E activities. The DMO SPO will not usually fund all of the T&E costs. For example, a part of the OT&E costs may be borne by CDG or the relevant Service(s) (since the operators will be participating in OT&E). The completed TCD, produced at Second Pass approval, is to contain a funding estimate which must identify the extent of the costs of T&E activities that will be paid for by the DMO, using project funding, and what will be paid for by other groups in Defence. The majority of funds for V&V would be spent in conducting T&E activities.

T&E, on average, costs around 13% of the total project acquisition cost (Crouch 1995). This figure would be higher for high-risk projects and lower for low-risk projects. The funds allocated to T&E would be lower for commercial off the shelf (COTS) integration projects than for projects where there is a high proportion of new design since less Developmental Test and Evaluation (DT&E) is required
It is also important to ensure when planning a V&V activity that the value to be obtained from the V&V activity is greater than cost of conducting the V&V activity. The extent that the financial, schedule and technical risk is likely to be mitigated by the V&V activity should be significant in comparison to the costs and risks associated with the actual conduct of the V&V activity.

1.9 Risk Management

Risk is defined as the chance of an event happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood. Risk is the expectation of this event occurring. That is, the estimated probability that the event will occur multiplied by the consequence of that event.

The greater the risk associated with a function performed by a system, the higher the priority of the V&V activities associated with that function. Thus the need for, and level of, V&V should be based on a risk assessment.

Risks may be cost, schedule or performance related. Risks to achieving the desired capability can either be categorised as mission critical or safety critical. The magnitude of safety critical risk associated with a function is assessed through various types of hazard assessments. The Safety thread in QEMS provides further details on the process of conducting these assessments.

V&V is an effective risk management tool through which system deficiencies can be identified and rectified early in the system development process. Early identification and rectification ensures that the system being developed achieves key milestones and meets the user's needs, and results in significant cost savings. An important part of V&V planning is to prioritise the deficiencies associated with non-compliances where the prioritisation is based on:

a. identifying the magnitude of the risk presented by the defect, and
b. the difficulty of remedying the defect.

This prioritisation will guide the level of effort applied to remedying the deficiencies by improving the design processes or the design of the system. Through analysis of the set of defects, V&V may also allow the identification and rectification of systemic defects in the developmental processes.

An acceptable level of risk is determined in consultation with the Capability Manager. Based on these agreed levels the acceptance criteria that the system will be judged against in Acceptance Testing are determined.

For example, the MIL-STD-498 guide on prioritisation of defects, shown in Table 1, could be used as guidance for determining the number of unresolved defects, of a given level of severity, that would be deemed to represent an acceptable level of risk. This could form one of the acceptance criteria.

Defect resolution can also be managed using a Failure Reporting and Corrective Action System (FRACAS) as described in MIL-HDBK-2155.

Table 1: System Defect Priorities (Department of Defense 1998)

Priority	Applies if a problem could:	
1	Prevent the accomplishment of an operational or mission essential capability	Jeopardise safety, security, or other requirement designated "critical"
2	Adversely affect the accomplishment of an operational or mission essential capability and no work-around solution is known.	Adversely affect technical, cost, or schedule risks to the project or to life cycle support of the system, and no work-around solution is known
3	Adversely affect the accomplishment of an operational or mission essential capability but a work-around solution is known.	Adversely affect technical, cost, or schedule risks to the project or to life cycle support of the system, but a work-around solution is known
4	Result in user/operator inconvenience or annoyance but does not affect a required operational or mission essential capability.	Result in inconvenience or annoyance for development or support personnel, but does not prevent the accomplishment of those responsibilities
5	Any other effect	

1.10 Systems engineering

V&V is used across the Materiel Life Cycle and within the underlying SE processes to provide a feedback mechanism whereby the output of each stage of system development is assessed for adequacy. Progression to the next stage of system development cannot take place until the outputs are validated and/or verified as appropriate. V&V across the Materiel Life Cycle is undertaken by the conduct of V&V activities, such as test or analysis activities, the results of these activities are then evaluated to determine whether they confirm the verification of a requirement or the validation of the system. The V&V is then confirmed in a series of system reviews and audits, at which technical data packages are presented for Commonwealth approval.

1.11 Variations between Services and project categories

ASDEFCON defines different acquisition processes for each of the materiel acquisition categories (i.e. Complex Materiel 1; Complex Materiel 2; Support or Strategic Materiel). Accordingly the application of V&V will vary depending on the materiel acquisition category for which the project is responsible. Further details on the ASDEFCON approach to V&V for each of these project types are provided in the relevant ASDEFCON Handbooks.

There are some variations to the V&V processes described in this Manual for the different Services. These relate specifically to the variations in the T&E processes. These are described in the specific T&E policies for each of the Services, which are listed below:

a. RAN: ABR 6205 –Naval Operational Test and Evaluation Manual (NOTEMAN)
b. RAAF: DI (AF) LOG 2-7 – Test and Evaluation of Technical Equipment
c. Army: DI (A) LOG 12-1 – Regulation of the Technical Integrity of Land Materiel.

1.12 Key Definitions

Listed below are definitions for some key terms used throughout this Exposure Draft V&V Manual. Other definitions of V&V related terms contained within this document are contained in the glossary in annex A. Annex D contains a list of definitions of acronyms used throughout this manual.

Capability – The power to achieve a desired operational effect in a nominated environment within a specified time and to sustain that effect for a designated period. Capability is delivered by systems that incorporate people, organisation, doctrine, collective training, platforms, materiel, facilities, in-service support, and command and management. [Adapted from the Defence CSLCM Manual v1.1]

Acceptance Criteria – The criteria upon which a decision to grant contractual acceptance of the mission system and support system will be determined.

Mission System – That element of the capability that directly performs the operational function. Examples include platforms (e.g. ship, tank, or aircraft), distributed systems (e.g. communications network), and discrete systems that integrate into other Mission Systems (e.g. a radar upgrade for a platform). Major Support System Components (such as simulators, Automatic Test Equipment (ATE) and Logistic Information Management Systems (LIMS)) could also be classified as Mission Systems if the level of management attention to be applied to these components warranted this classification.

Support System – The organisation of hardware, software, materiel, facilities, personnel, data, processes, and services required to enable the Mission System to be effectively operated and supported so that the Mission System can meet its operational requirements. The Support System includes the support required for Support System Components. The Support System embraces the support responsibilities undertaken by the Australian Government, in-service support contractors and in-service support subcontractors.

Verification – Confirmation by examination and provision of objective evidence that specified requirements to which a product or service, or aggregation of products and services, is built, coded, assembled and provided have been fulfilled.

Validation – Proof through evaluation of objective evidence that the specified intended end use of a product is accomplished in an intended environment.

2. Scope and Exclusions

2.1 Scope

The V&V Manual is intended as guidance to assist DMO SPO staff to implement the DMO V&V policy to plan, approve and conduct V&V activities. The detailed explanation of V&V activities that should be managed by a SPO contained in this manual follows the phases of the Materiel Life Cycle described in Quality and Environmental Management System (QEMS).

The sub-phases within the Acquisition Phase in QEMS, are the:

a. Needs Phase
b. First Pass Phase
c. Second Pass Phase
d. Solicitation Phase
e. Manage Contracts and Project Commitments
f. Transition Into Service
g. Project Closure

These are then followed by the following activities in the In-Service Phase (as defined in QEMS), which are:

h. Perform Mission System Availability Planning
i. Sustain Mission System
j. Change Mission System
k. Manage Support System
l. Perform SPO Management Activities
m. Provide In-Service Capability Support Input to Capability
n. Manage Disposal

The intent of this manual is to provide on overview of DMO V&V processes and how V&V evidence should be gathered to support informed acceptance decisions. However, this manual provides only limited detail on how to conduct these processes. This manual does, however, refer to other references and courses for more detailed information on how to conduct V&V activities.

It should be stressed that during the Needs Phase, First Pass Phase and Second Pass Phase the Integrated Project Team (IPT) that manages the project is led by the Capability Development Group (CDG) with support provided by DMO and other groups in the ADO. This support function includes, as a minimum, the review and endorsement of all acquisition business case documents including the capability definition documents (CDD). The CDG may not necessarily manage V&V in the same manner as described in this document. In subsequent phases the project is managed by the DMO.

2.2 Exclusions

Issues concerning the roles and responsibilities of CDG with respect to T&E are covered in the Capability Systems Life Cycle Management Manual (CSLCMM) and so they are not discussed in this manual. The CSLCMM can be found at http://defweb.cbr.defence.gov.au/home/documents/departmental/manuals/cslcm.htm.

The current portfolio level T&E policy is contained within DI (G) OPS 43-1, which is maintained by DTRIALS. The V&V Manual is consistent with the approach to T&E described in DI (G) OPS 43-1.

The V&V Manual also refers to QEMS (http://qems.dcb.defence.gov.au) where necessary.

Where applicable, the V&V Manual also refers users to the ASDEFCON (Strategic Materiel) Handbook for further information. The ASDEFCON contract templates and associated handbooks can be found on the DRN at http://intranet.defence.gov.au/dmoweb/Sites/CPO/

3. V&V References

3.1 Current standards and policies relevant to V&V

ABR 6205 –Naval Operational Test and Evaluation Manual (NOTEMAN)

ABR 6492 – Navy Technical Regulations Manual

ANSI/EIA-632-1999 – Systems Engineering

AS 4216: Information technology—Software product evaluation - Quality characteristics and guidelines for their use

AS 14598: Information Technology – Software Product Evaluation

AS 15288: Systems Engineering – System Life Cycle Processes

ASDEFCON Contract Templates and Handbooks

Capability Definition Documents Guide

CSLCMM – Capability Systems Life Cycle Management Manual

Defence Simulation Proposal Guide (SPG)

DI (A) LOG 12-1 – Regulation of the Technical Integrity of Land Materiel

DI (AF) AAP 7001.053 – Technical Airworthiness Management Manual

DI (AF) LOG 2-7 – Test and Evaluation of Technical Equipment

DI (G) ADMIN 06-1 – Procedures for the Implementation of Defence Trials

DI (G) LOG 07-1 – Explosive Ordnance – Safety Policy and Responsibilities

DI (G) LOG 8-15 – Regulation of Technical Integrity of ADF Materiel

DI (G) OPS 02-2 – Australian Defence Force Airworthiness Management

DI (G) OPS 42-1 – Defence Simulation Policy

DI (G) OPS 43-1 – Defence Test and Evaluation Policy

DI (G) TECH 05-1 – Management of Technical Data Packages

DI (N) LOG 47-3 – Technical Regulation of Navy Materiel

DI (N) TECH 09-1 – Design Approval of RAN Systems and Equipment

Draft DI (M) X-XX – DMO Verification and Validation (V&V) Policy

Draft DI (M) X-XX – DMO Acceptance Process for New, Modified or Upgraded Capability

IEEE 1012 – IEEE Standard for Software Verification and Validation,

IEEE Std. 1220-1998: IEEE Standard for Application and Management of the Systems Engineering Process,

US Department of Defense Verification, Validation and Accreditation Recommended Practices Guide.

3.2 Other documents referred to in this manual

Crouch V. 1995, *The Test and Evaluation Process Used to Design and Develop Weapons Systems in the United States Department of Defense*, minor thesis for a Masters of Engineering (T&E), University of South Australia, Adelaide, SA, Australia

Defense Acquisition University 2001, *Test and Evaluation Guide 4th Ed.*, DAU Press, Fort Belvoir, VA, USA

Department of Defense 1998, *MIL-STD-498 Software Development and Documentation*, US Department of Defense, Washington, DC, USA

DMO 2003, *System Review Guide v1.1*, Department of Defence, Canberra, ACT, Australia

Sessler A., Cornwall J., Dietz B., Fetter S., Frankel S., Garwin R., Gottfried K., Gronlund L., Lewis G., Postol T. & Wright D. 2000, *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned US National Missile Defense System*, Union of Concerned Scientists, Cambridge, MA, USA

4. V&V Principles

4.1 V&V Overview

Requirements listed in the Functional and Performance Specification (FPS) should each have an appropriate verification method associated with them. Verification activities must be traceable to the verification methods listed in the requirements in the FPS, System Specification (SSPEC), and the contractor's Verification Cross Reference Matrix (VCRM).

Validation activities must be traceable to operational scenarios that are consistent with those in the Operational Concept Document (OCD) and the Concept of Operations (CONOPS).

The verification method listed in the FPS, SSPEC and VCRM would usually be one or more of the following:

a. Test and Evaluation, consisting of,
   i. Test
   ii. Simulation
   iii. Modelling
   iv. Demonstration
   v. Inspection
   vi. Experiments
   vii. Trials
b. Analysis
c. Comparison
d. Audit
e. Walkthrough
f. System Review
g. Historical Data
h. Conformance Certificates

Validation should be conducted using scenarios that are consistent with the OCD. This would normally be performed in an OT&E activity, although it may be conducted in conjunction with analysis methods such as modelling and simulation.

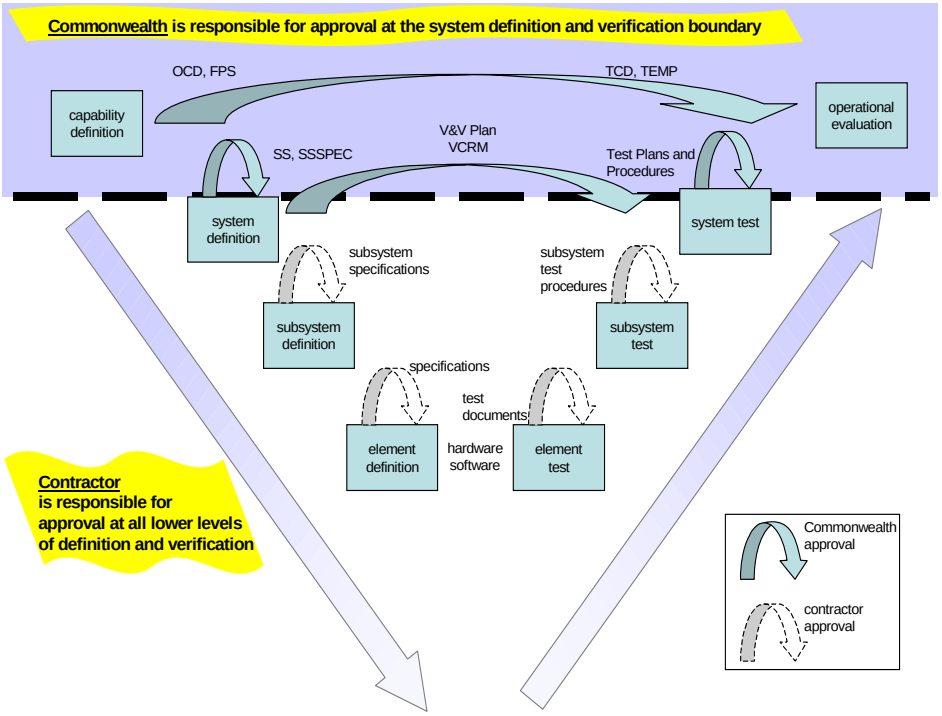
Requirements, end products and enabling products all need to be validated. The performance and functionality of systems and sub-systems are verified by demonstrating the system's compliance with the validated requirements. Systems and sub-systems are verified prior to System Acceptance. Requirements should be validated prior to Second Pass approval. End products (e.g. the mission system) are validated prior to System Acceptance, during the transition into service and in the In-Service Phase. The enabling products (e.g. the Support System) are validated usually through Supportability V&V, which is conducted in the Acceptance V&V and, later, in the In-Service Phase.

4.2 Summary of DMO responsibilities in relation to V&V

The responsibilities of the SPO and the Contractor with respect to approval of the plans, procedures and results of V&V activities are outlined in Figure 3. This diagram demonstrates

the principles of Clear Accountability in Design (CAID) that are fundamental to the approach to V&V in the ASDEFCON contract templates:

Figure 3: CAID – Australian Government and Contractor responsibilities



The V&V clauses in the ASDEFCON (SM) SOW uses the terms ‘Acceptance Verification’ and ‘Acceptance Validation’ to highlight that the DMO’s role in the V&V program is almost solely related to determining whether or not contractual deliverables are able to be accepted.

The DMO should not have a hands-on role in the contractor’s internal testing activities, unless the results of those activities are expected to be utilised for the purposes of obtaining Acceptance. Instead, the DMO should adopt a monitoring role over the contractor’s internal testing activities for risk-management purposes. This approach helps to ensure that the contractor retains responsibility for ensuring that the requirements of the contract are met as determined by the Acquisition Baseline.

A typical SPO’s responsibilities in relation to V&V are summarised below:

An IPT, led by the staff from CDG but including DMO representatives, produces a TCD to define the T&E strategy required to ensure verification and validation of requirements and operational needs stated in the FPS and OCD. The financial and managerial responsibilities of the DMO, the T&E agencies, DSTO, CDG, the relevant Service(s) and the contractor with respect to T&E conducted throughout the materiel life cycle are identified in the TCD. The development of the TCD is produced through negotiation between the members of the IPT before second pass approval.

For example, if flight testing is required for a project then this will involve using the resources of various groups. The DMO has to be satisfied that the funds and resources required to conduct the necessary T&E activities required for the various stages of acceptance will be available when needed to ensure that the capability will be delivered on time and on budget. The TCD must state these details.

The TCD has to be approved by the relevant one star officer (or equivalent) from the DMO before the project can be recommended for second pass approval.

The IPT that is responsible for the development of the TCD should contract out the development of the TCD to a CDD Panel qualified expert to ensure that the TCD is a high quality document.

After second pass approval the IPT, now led by the SPO, drafts a Test and Evaluation Master Plan (TEMP) to more precisely define the T&E strategy stated in the TCD. The TEMP should also address the other verification methods, which are listed in section 4.1 of this manual. A guide on how to draft a TEMP is provided in Annex B of this manual. A hierarchy of V&V related plans is provided in Figure 4.

The contractor must produce five V&V related deliverables that the SPO must review and approve. These are the V&V Plan (V&VP), the VCRM, the Acceptance Test Plans (ATPs), the Acceptance Test Procedures (ATProcs) and the Acceptance Test Reports (ATRs).

The SPO must monitor the V&V activities of the contractor prior to Acceptance Testing (i.e. those V&V activities conducted at the element and sub-system level). The risk that problems will occur during this stage is mitigated through review of the V&V Plan.

The SPO holds Test Readiness Reviews (TRRs) with the contractor before each acceptance testing activity to ensure that the acceptance testing activity will provide reliable evidence to support an acceptance decision.

The SPO must also plan and manage the conduct of V&V activities that may also be outside the scope of the V&VP. They will largely consist of validation activities that will be defined in the Validation Plan and Supportability Verification and Validation (SV&V) activities that will be defined in the SV&V Plan. SV&V is used to assess the extent to which the mission system design and the support system facilitates supportability (supportability includes such ILS considerations as reliability, maintainability and availability).

Planning and managing the conduct of V&V activities by the SPO will consist of a analysis to determine whether the activity will provide the required data for V&V in a timely and objective manner and to determine whether it will constitute unnecessarily duplication of activities already conducted. The V&V activity will then be planned and conducted and the results analysed and evaluation with respect to V&V made.

They will also include other V&V activities as required by the Technical Regulatory Authority (TRA) in order to verify that all requirements needed to achieve design acceptance have been met.

The SPO must then coordinate the data analysis from these activities. The results will then be used to validate the system against the operational needs defined in the OCD and to determine if there are any deficiencies in the system with respect to fitness for purpose.

For those activities that are directed to be conducted by a higher Defence committee (ie to assist a committee make an informed consideration on a capital equipment project) the project director is responsible for disseminating the results of such T&E in a timely manner to the members of the originating committee.

Project directors are responsible for the sponsorship of T&E and possess the authority to act upon the results and implement the recommendations arising from those results. Project directors are also responsible for seeking authorisation for the necessary resources required - through the appropriate division of CDG - for the conduct of project specific T&E by Defence T&E agencies.

The SPO must then arrange to have the system accepted into service in consultation with the relevant Service(s).

The SPO must manage ongoing operational testing to determine the operational suitability and operational effectiveness of the system in new scenarios or of the system with modifications after the system has been transitioned into service. This testing, along with supportability testing, will also support the business process closure. A large part of this testing in the In Service Phase may be managed by an ADO T&E agency. In this instance the SPO will just be the sponsor for this testing.

At the end of the capability lifecycle the SPO will then manage the disposal of the system.

The responsibilities normally held by the SPO in relation to V&V are further described in sections 6 to 9 of this document. The specific responsibilities that the SPO will have in relation to test activities should be stated in the TCD.

Acceptance V&V is discussed further in DI (M) X-XX ‘Acceptance Process for New, Upgraded and Modified Capability’.

4.3 T&E organisations

Within Defence there are a number of T&E agencies that can provide support in relation to the planning and conduct of T&E activities. These include the Directorate of Trials (DTRIALS), the Land Engineering Agency (LEA), Royal Australian Navy Test, Evaluation and Analysis Authority (RANTEAA), Joint Ammunition Logistics Organisation (JALO), Aerospace Operational Support Group (AOSG) and the RAN Aircraft Maintenance and Flight Trials Unit (AMAFTU). These agencies also provide services in analysis and interpretation of the results of T&E activities, particularly in relation to OT&E.

The responsibilities of a T&E agency with respect to major T&E activities must be stated in the TCD since there may be long lead times associated with T&E agency support to a T&E activity.

The general roles of the T&E agencies are identified in DI (G) OPS 43-1.
The specific skills that these agencies have are described in Table 2.

In this table the types of materiel systems are divided into the four major groups namely mobility, firepower, surveillance and target acquisition and communications and information systems. These categories of systems are described in the Army Technical Staff Officer's Course (ATSOC).

The services that can be provided by the various T&E agencies that can contribute to V&V of these four types of systems are described in Table 2.

Table 2: Services Provided by T&E Agencies

T&E agency	Types of materiel systems supported	Services that can be provided	Point of contact
DTRIALS	All	Management and conduct of OT&E activities and trials. Development of concept technology demonstrators. DTRIALS are also responsible for the development of T&E policy.	See http://web-vic.dsto.defence.gov.au/workareas/DTRIALS/Contacts.1.htm for a list of contacts at DTRIALS
LEA	Land systems – Mobility, Communication and information systems, Surveillance and target acquisition	LEA conducts design acceptance and T&E activities for land projects, including environmental testing, EMC testing and vehicle testing. Staff from LEA may also assist in witnessing acceptance testing.	See http://intranet.defence.gov.au/DMOWeb/sites/LEA/ for a list of contacts at LEA
AOSG	Aerospace systems – Mobility, Communication and information systems, Surveillance and target acquisition	Flight testing (OT&E), evaluation of aircraft modifications, aircraft stores clearance T&E, EW T&E,	See http://ednww002.cer.defence.gov.au/aosghome/phone.asp for a list of contacts at AOSG
DGTA	Aerospace systems - mobility	Design acceptance	See http://sorweb.sor.defence.gov.au/dgta/ for a list of contacts at DGTA
OSG	All Services – Firepower	Safety verification and design acceptance for ordnance	See http://intranet.defence.gov.au/dmoweb/Sites/JLC/ for a list of contacts at OSG

JALO	All Services – Firepower	Evaluation of safety, suitability for service and effectiveness of ordnance	See http://intranet.defence.gov.au/dmoweb/Sites/JALO/ for a list of contacts at JALO
AMAFTU	Maritime systems – Mobility (aircraft)	Flight testing, evaluation of naval aircraft modifications, advice on T&E and supportability for naval aircraft	See http://niw.albatross.navy.gov.au/albatross/ for a list of contacts at AMAFTU
ADSO	All	Advice and policy in relation to simulation	See http://intranet.defence.gov.au/hks/26/5506_1.html for a list of contacts at ADSO
NAVSYSCOM	Maritime systems – Mobility, Communication and information systems, Surveillance and target acquisition	Operational Analysis and Naval Operational Test and Evaluation to support Operational Release (RANTEAA), Safety verification (DGNCSA) Design acceptance (DGNAVSYS) Acoustic and magnetic signature analysis, combat systems analysis (RAN Ranges and Assessing Unit - RANRAU) Modelling and Simulation	See http://defweb.cbr.defence.gov.au/navysyscom/safety_cert/ranteaa/RANTEAA_Home.html for a list of contacts at RANTEAA See http://intranet.defence.gov.au/navyweb/Sites/Navyscom/ or further information on NAVSYSCOM See http://intranet.defence.gov.au/navyweb/sites/RAU/ for a list of contacts at RANRAU

Information on test and evaluation ranges and facilities operated within Defence can be found on the DRN at http://intranet.defence.gov.au/nod/131/7062_1.pdf

Independent V&V (IV&V) organisations and the DSTO can also provide V&V and T&E services to the DMO.

In addition to this there are some T&E and V&V related working groups which are described below.

The T&E Principals Forum is a group that liaises with industry and overseas T&E agencies. The T&E Principals Forum meets at least once annually, to discuss and review Defence T&E and DMOV&V policy and to ensure that Defence T&E and DMOV&V policy is consistent with current best practices. The T&E Principals Forum consists of the heads of the above-mentioned T&E agencies and the DMO Director of Systems Engineering.

The DMO Test and Evaluation Working Group (DMOT&EWG) is a group of T&E practitioners within Defence, that exists in the form of an e-mail group, which discusses and reviews Defence T&E and DMO V&V policy.

5. V&V Planning

5.1 V&V plans needed for a project and their roles

The V&V plans and reports that must be developed for a project and the description of these documents is provided in Tables 3 and 4 below.

Table 3: Commonwealth produced V&V plans needed for a project and their roles

Commonwealth Plans / Reports	The V&V documents that the Commonwealth must produce for a major capital equipment acquisition project are listed below.
Test Concept Document (TCD)	During the First and Second Pass Phases, the IPT led by staff from CDG produces a Test Concept Document (TCD) to define the project's T&E strategy. The CDD consists of the TCD, the OCD and the FPS. The IPT will consist of representatives from CDG, DMO, the Capability Manager and the relevant T&E agency. It should also include a representative from the relevant TRA. The purpose of the TCD is to define the Critical Operational Issues (COIs), Critical Technical Parameters (CTPs), the objectives of all of the major test activities and to determine the level of risk associated with the project and consequently the level of funding required for T&E. The TCD must also link the funding to stages of the project and schedule and determine the input of external agencies. The TCD should also detail what facilities, special resources and personnel requirements exist for T&E. The template for the TCD and the associated guidance in relation to producing the TCD is contained in the annex to Chapter 6 of the Defence Capability Life Cycle Management Manual (CSLCMM).
Test and Evaluation Master Plan (TEMP)	After Second Pass approval, a Test and Evaluation Master Plan (TEMP) is developed by the IPT, under the leadership of the DMO SPO, to describe the DMO V&V strategy in detail. The TEMP forms part of the Project Management Plan. The TEMP is updated throughout the Acquisition Phase as new test requirements arise. Plans produced by the Commonwealth that are subordinate to the TEMP are the Validation Plan and the Supportability V&V (SV&V) Plan.
Validation Plan	The Validation Plan covers the full scope of all mission system validation activities and the SV&V Plan covers the full scope of all SV&V activities. For smaller projects the Validation Plan and the SV&V Plan may be included as annexes to the TEMP. The Validation Plan would usually be developed by the DMO SPO in consultation with a T&E agency (such as RANTEAA, AOSG or

	LEA). Validation Plans will be similar in scope to OT&E Plans. A Validation Plan will cover the scope, schedule and responsibilities for the validation program for a project.
Supportability V&V Plan (SV&V Plan)	The SV&V Plan needs to be developed by the DMO SPO. There will be a need for the SPO, in consultation with the relevant T&E agency, to develop detailed test plans and procedures subordinate to the Validation Plan (e.g. detailed OT&E Plans such as an OpEval Plan) and the SV&V Plan. Some of the detailed SV&V plans will be developed by the Contractor in accordance with the relevant ASDEFCON (SM) ILS DIDs (such as the Support Test and Equipment Plan DID). Other detailed SV&V plans will need to be developed according to the SV&V templates that are to be included in the SV&V Guidance to be produced as part of MASF release 4.
Other V&V related Plans / Reports	There will also be a need for additional test plans to be produced by T&E agencies as they conduct additional test activities to address the differences between the Capability Baseline and the Acquisition Baseline or perform OT&E activities. T&E agencies may also need to conduct testing that requires the use of Government Furnished Material (GFM), special test resources (e.g. electromagnetic compatibility (EMC) or environmental testing labs) or government staff (e.g. pilots). Detailed guidance in relation to the SV&V Plan, the Validation Plan and their subordinate plans and procedures is currently under development. In the meantime the OT&E Plan format in ABR 6205 can serve as a good guide to the format of a Validation Plan. The ASDEFECON (SM) ATP, ATProcs and ATR DIDs can be used as a good model for the sorts of details that need to be included in Defence produced test plans, test procedures and test reports. Alternatively, the list below can be used as a guide as to what should be included in a test plan, test procedure and test report.

Table 4: Contractor produced V&V plans and reports needed for a project and their roles

Contractor Plans / Reports	The V&V documents that the prime contractor for a strategic materiel project must produce according to the ASDEFCON (Strategic Materiel) template are listed below. The Data Item Descriptions (DIDs) for these can be found as part of the Asset Library associated with the ASDEFCON (SM) Template at http://intranet.defence.gov.au/dmoweb/sites/cpo/default.asp?p=load.asp?page=10888. These DIDs should not normally be tailored to suit the project. Equivalent DIDs for Complex Materiel and Support projects were under development at the time of writing of this manual.
V&V Plan (V&VP)	The V&VP defines the contractor's V&V strategy pertaining to the mission system and the support system. The SPO must ensure that the V&VP addresses as much as possible of the testing required in the TCD and TEMP.
Acceptance Test Plan (ATP)	The ATPs for each phase of Acceptance Testing, describe the test cases, test conditions, configuration of the system under test and equipment, documentation and personnel required for conducting the acceptance test. It should also list the requirements to be verified in each test case. At least one requirement should be verified in each test case. The SPO, or an ADO specialist (T&E or technical) as their representative, must formally witness the acceptance testing.
Acceptance Test Procedures (ATProcs)	The ATProcs describe the detailed test steps and the acceptance criteria for each test case. The SPO must determine the acceptance criteria that the contractor must meet based on requirements contained in the FPS. The SPO must ensure that the ATProcs contains test steps that are in an appropriate logical and temporal sequence, contain sufficient detail to be repeatable and are suitable for determining achievement of the acceptance criteria.
Acceptance Test Report (ATR)	The ATR records the results of the acceptance testing, including the PASS/FAIL status for each test case. The SPO approves all ATRs but only if it believes they represent an accurate record of the test results that they have witnessed in the Acceptance Testing.
Verification Cross Reference Matrix (VCRM)	The VCRM is a table that specifies how the contractor will verify each requirement. The contractor completes the VCRM progressively as the design program progresses. The SPO must ensure that the VCRM states the appropriate verification method to be used for verification against all requirements and must ensure that it is updated and accurately reflects the current status of system verification. At SRR the VCRM is agreed with the contractor and the verification methods are contractually binding and cannot change without a CCP.

Generic test plan, test procedure and test report content:

Test plan contents: As a minimum a test plan should include the following:

- a description of the system under test (SUT) (including the system software and hardware configurations being tested);
- a description of interdependencies between the SUT and other systems;
- a description of all stakeholder responsibilities;
- a description of the purpose of the testing and its relationship to other V&V processes;
- references to other relevant documentation (e.g. OCD, FPS, VCRM etc.);
- a definition of project specific terms;
- reference to the requirements to be verified or operational scenarios that the system will be validated against ensuring that all tests can be traced through to the FPS or OCD;
- a brief description of the test strategy including a brief description of the testing conducted to date;
- the test schedule;
- test sequence;
- test constraints and assumptions;
- test limitations (in terms of the extent to which the test will be able to accurately verify compliance with requirements);
- risks to completing the test (e.g. resource availability / staff availability) and a description of how those risks will be mitigated;
- a description of the key functionality to be tested;
- a description of the major outstanding defects;
- a list of the test cases with prioritisation of the test cases. The prioritisation of test cases will be partly based on areas perceived to be the highest risk which will include tests of functions in which defects have been found to date and tests of critical functions or critical performance requirements;
- a description of major external and internal interfaces;
- a description of how test results will be recorded and analysed;
- a description of what verification methods will be used for the various requirements (e.g. demonstration for observable results, inspection for examining code or examining a system for compliance with a design requirement or standard or analysis for comparing baseline test results with new test results);
- a description of measurement instrumentation, how the instrumentation will be configured and how this instrumentation will impact the accuracy of the test results; and
- an identification of all test tools and test data to be used (this may include references to files containing the test data).

Test procedure contents: As a minimum a test procedure should include the following:

- a description of the system under test;
- reference to the relevant test plan;
- other relevant references (e.g, FPS, TEMP, OCD, standards outlining test procedures, outstanding problem reports etc.);

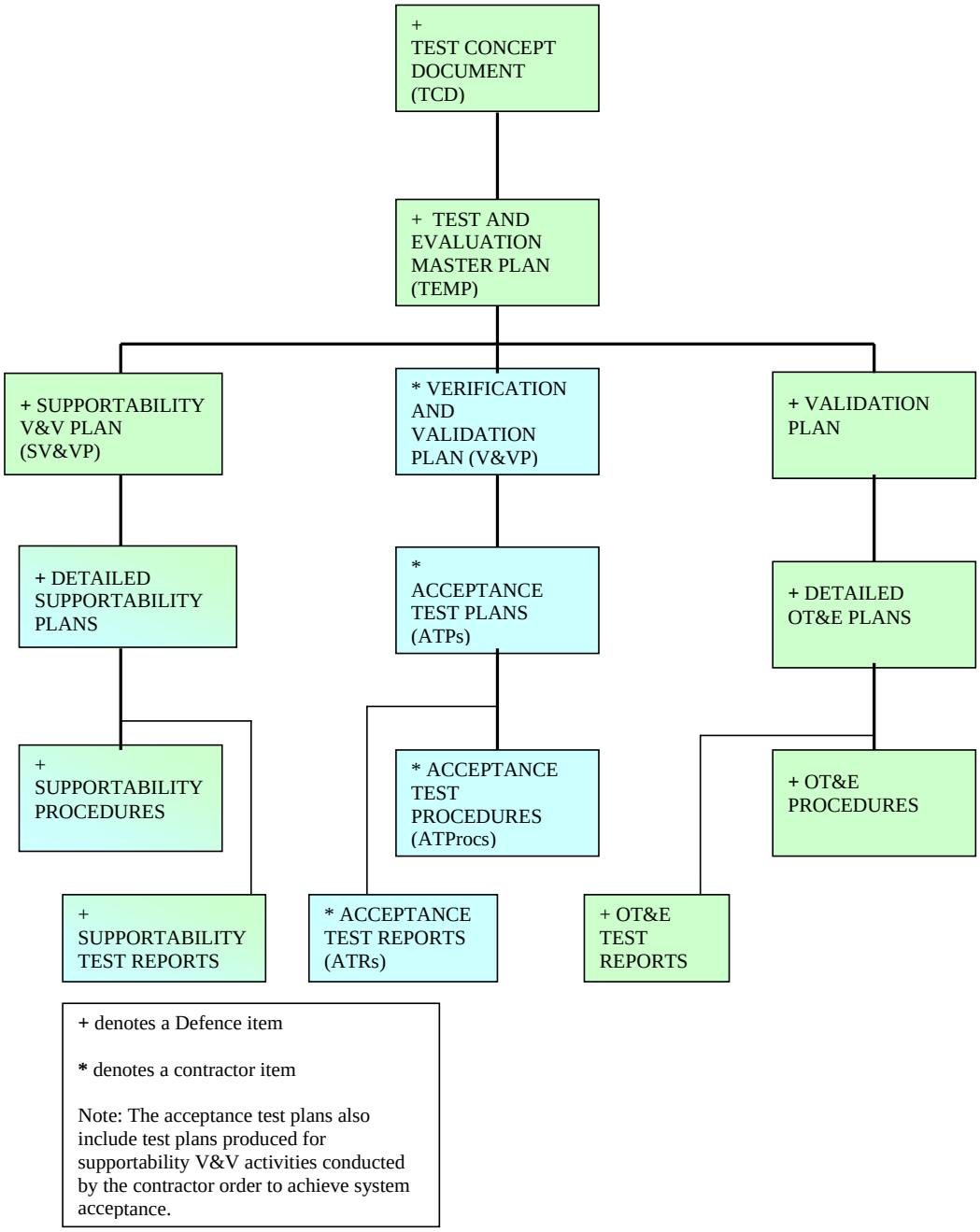
- a description of the type and level of the testing (i.e. system level or component level etc.);
- a description of the objectives for each test case (e.g. verification of a specific requirement);
- a description of the acceptance criteria;
- a description of the non-system related uncontrollable factors that will influence the outcome of the test (e.g. environmental factors) and how the impact of these factors will be minimised (e.g. through randomisation or blocking);
- prioritisation of the tests;
- the test sequence;
- the test steps expressed in sufficient detail such that they are repeatable but in no more detail than is absolutely necessary for the test steps to be repeatable;
- a column for indicating whether the test has passed/failed or if the requirement is only partially verified;
- reference to the requirement being addressed in each test case or alternatively a description of the test objective for each test case;
- inputs for each test step (this may include reference to files containing test data);
- the expected result for each test step;
- test preconditions; and
- a signature block for the tester and the witness to sign off each test case.

Test report contents: As a minimum a test report should include all of the content of the test procedure (since it is often an annotated version of the test procedure) as well as: :

- reference to the relevant test plan, test procedure and requirements;
- changes in the test steps relative to the test procedure;
- changes to the test configuration relative to the description given in the test procedure;
- the actual results observed for each test step;
- whether the system passed/failed/was partially verified against each requirement;
- whether the system met the acceptance criteria;
- test status of the system (i.e. how many tests the system passed, how many it failed),
- a list of the existing Problem Reports that are still outstanding after the testing (i.e. defects still not resolved);
- a discussion of the most significant issues associated with the testing (e.g. most significant defects discovered or problems with conducting the test);
- a discussion of the overall performance of the system with respect to the requirements, evaluation thresholds and acceptance criteria; and
- a description of the defects observed in the testing, including a prioritisation of the defects (perhaps using the classifications described in Table 1) and the methods to be used to rectify these defects.

A summary of the V&V and T&E plans hierarchy is provided in Figure 4. This is a list of the main plans/documents that are required for Strategic Materiel projects. In some projects there may be a need for additional plans such as Modelling and Simulation Plans or Software V&V Plans. Some of these additional plans may fall under the scope of detailed OT&E plans for instance. In the case of minor projects it may be possible to merge some of these plans into one plan. For instance, the Validation Plan and the Supportability V&V Plan can be included as annexes to the TEMP in the case of Complex Materiel projects.

Figure 4: VERIFICATION AND VALIDATION PLANS HIERARCHY



6. Needs Phase V&V

6.1 Introduction

Chapters 6, 7, 8 and 9 of this manual outline what is expected of Defence and the Contractor with respect to V&V throughout the various phases of a project. The phases referred to and the Unique Identifiers (UI) referred to are those described in QEMS (ref. http://qems.dcb.defence.gov.au). Consult the QEMS references and the standards referred to in the text in this section for further information.

An acquisition program is managed by CDB during the Needs Phase and the Requirements Phase and by the DMO in the remaining phases. The DMO must contribute to the development and must review the CDDs in consultation with the other members of the IPT during the Requirements Phase. The IPT that develops the CDD is led by CDB until second pass approval at which point the leadership of the IPT is transferred to the DMO. The purpose of chapters 6 and 7 is to outline the processes that are to be conducted during the Needs Phase and the Requirements Phase and how the DMO contributes to this process. The CSLCMM and the CDD Guide should also be consulted for information on capability development processes throughout the Needs Phase and Requirements Phase.

6.2 V&V tasks in the Needs Phase

The main objectives of V&V in the Needs Phase are to:

- assist in determining what the operational needs are;
- assist in determining what the capability gap is;
- evaluate solutions considered for addressing the capability gap; and
- identify the critical operational issues and to prove that the solutions proposed are feasible and valid approaches for addressing the operational need.

Below is a list of V&V related activities that need to be conducted in the Needs Phase.

- Review results of tests of the systems to be replaced and review the performance of these systems with respect to the missions they need to accomplish and determine the required improvements in capability.

- Review the threats likely to be encountered by the system being acquired at the time that the system is expected to be introduced into service.

- The initial stages of an Operational Assessment (OA) are conducted at this point, usually in consultation with DSTO (see DI (G) ADMIN 06-1 for details on tasking DSTO). This will usually involve modelling and simulation. In the first instance, business process modelling using a computer aided systems engineering (CASE) tool such as CORE is required to ensure that the proposed operational concept is valid.

- Analytic studies and military experimentation to explore the costs and benefits of different force structure options in performing strategic tasks in the context of the Australian Illustrative Planning Scenarios (AIPS) (QEMS reference: UI 2177).

- Identify potential technical risks to achieving the desired capability that may present throughout the project and identify ways to mitigate these risks through V&V.

7. Requirements Phase V&V

7.1 V&V in the First Pass Phase

In the First Pass Phase a solution-independent set of Capability Definition Documents (CDDs) is produced by the IPT. This will usually consist of sections 1-4 of the OCD.

Requirements definition during the First Pass Phase, culminates in production of CDD documentation of which section 1 to 4 of the OCD can be viewed as the major Requirements Baseline resulting from the First Pass process. It should be noted that other 'intermediate' Requirements Baselines may be produced progressively as more detail is developed prior to completing the OCD. Requirements validation is a critical activity during the First Pass Phase which confirms that each Requirements Baseline developed, including the OCD, is an accurate and complete representation of the capability need and meets an established set of quality and content criteria. Requirements validation activities, and requirements quality characteristics, are described in more detail in Annex C and in the CDD Guide. In summary the following Validation activities must be performed in the context of Requirements development.

a. Requirements Validation must be performed at the conclusion of any Requirements Analysis activities during Requirements development.
b. The completed Requirements Baseline must be subjected to Requirements Validation to assure its adequacy for the next stage of the CDD process.

A Preliminary Capability Options Document (PCOD) is developed in the First Pass Phase to determine the feasibility of the various capability options that have been proposed. (QEMS reference: UI 2193).

More detailed modelling and simulation can be performed in the First Pass Phase than is conducted in the Needs Phase. This initially involves determining what types of models would be appropriate to conduct an Operational Assessment (OA) to evaluate the overall likely system effectiveness, implementing the models and validating the models. These models may include physical models (i.e. mock-ups or prototypes), simulations and technology demonstrators. These models can then be used to evaluate the capability options that were identified in the PCOD to determine which of the options best addresses the operational need. Any models or simulations proposed to be developed should follow the guidance of the Defence Simulation Proposal Guide. The Australian Defence Simulation Office (ADSO) recommends the use of the US DoD Modeling and Simulation Office 'Verification, Validation and Accreditation (VV&A) Recommended Practices Guide' for VV&A of simulations.

Models, simulations or technology demonstrators could be developed by DSTO or by industry during the First Pass Phase.

In the First Pass Phase a Risk Management Plan is developed as part of the Project Management Plan (PMP). This should include a section on how V&V will be used to mitigate risks throughout the project including IV&V.

In the First Pass Phase it may be necessary to conduct a Project Definition Study (PDS) which, amongst other aims, will identify legal, doctrinal, environmental, electromagnetic spectrum and TRA constraints (QEMS reference: UI 2194). The PDS should also contain the results of OA, trade-off studies used to compare the capability options under consideration and the functional and performance priorities with respect to the mission and support systems, which would be determined from the results of the OA.

7.2 V&V in the Second Pass Phase

The solution dependent CDD (i.e. the OCD, FPS and TCD), addressing both the mission system and support system, is to be completed and endorsed in the second pass phase (QEMS reference: UI 2113).

As part of this, the IPT produces a TCD to describe the V&V strategy to be used for the system being acquired throughout the Defence Capability Life Cycle. The TCD is produced according to the process described in the CDD Guide and must comply with the format provided in that document.

V&V in the second pass phase involves the validation of requirements in the FPS against the OCD to ensure that compliance with the requirements is likely to address all of the operational needs.

Requirements must be drafted so that they are unambiguous, verifiable and address the complete set of operational needs to address the complete set of COIs. A verification method must be listed for each requirement.

Requirements validation is often conducted in consultation with IV&V staff at this point since an experienced systems engineer must review the FPS to ensure that the requirements cover the full scope of the user needs. Requirements validation is discussed further in Annex C.

The Second Pass process develops the capability requirements articulated in the OCD into more detailed representations of the requirement through a more developed OCD, FPS and TCD. This can be achieved, in part, through application of the SE activities of functional analysis and synthesis, which enable derivation of greater requirements and system detail. Verification must be applied to the resulting functional and physical architectures, to ensure complete traceability between the underlying Requirements Baseline and functional and physical architectures, and a complete absence of voids and conflicts between these items. Further detail on applying verification is provided in Annex C. The OCD, FPS and TCD can also be considered the primary Requirements Baselines resulting from the Second Pass Phase given that these will provide the set of requirements on which the Solicitation Phase will be based. Accordingly, Requirements Baselines developed through the Second Pass must also be subjected to Requirements Validation as described in Section 6.3 and Annex C to ensure that they provide a sound foundation for subsequent work.

8. Acquisition Phase V&V

8.1 V&V in the Solicitation Phase

On approval of the Capability Baseline at Second Pass approval, the leadership of the IPT transfers from CDG to the DMO for the further development of the required V&V products.

On the establishment of the SPO, the SPO must commence development of the TEMP (QEMS reference: UI 2162). The person responsible for development and maintenance of the TEMP is identified in the Acquisition PMP. The requirements derived from the TEMP and TCD are then flowed into the FPS and sent out with the Request For Tender (RFT).

During the Solicitation Phase, the prospective Contractor(s) is provided with an OCD (identifying scenarios detailing 'fitness for purpose' requirements), the FPS and the TCD. The Contractor will then produce a V&V Plan to describe the full scope of the V&V activities that they intend to conduct and how they intend to satisfy the V&V of the requirements detailed in the FPS. The Contractor(s) must also produce the System Safety Program Plan (SSPP) in response to the RFT. These must be reviewed and evaluated by the project office to evaluate the tender(s), using the DMO Checklists that can be found on the ASDEFCON web site.

During the Solicitation Phase the tenderer's processes may also be evaluated by suitably qualified IV&V staff to ensure that the processes will identify and assess defects efficiently and that the tenderer(s) have a suitable System Problem Reporting process that ensures that defects are prioritised and remedied according to priority. A CMMI evaluation may also be useful in the solicitation phase. The project office has a responsibility to ensure that this prioritisation of defects is in line with the users' functional and performance priorities.

At the completion of the Solicitation phase (i.e. after contract negotiations) the CDD is further refined and the TEMP further developed by the project office to reflect any changes that may arise during the Contract Negotiations. This establishes the Acquisition Baseline that the contractor will be expected to deliver against for Final Acceptance.

8.2 V&V when managing the contract and project commitments

Some of the details in relation to the responsibilities of the project office with respect to managing the Contractor V&V activities are not included in this manual. This is because some of these details can already be found in QEMS and in the ASDEFCON (Strategic Materiel) Handbook; Part 3 – Draft SOW & Annexes – guidance associated with clause 7; and in section 13 of the Supplementary Information – Philosophy Behind the Draft SOW & Annexes. The ASDEFCON (Strategic Materiel) Handbook can be found at http://intranet.defence.gov.au/dmoweb/sites/cpo/default.asp?p=load.asp?page=8176

The Contractor must develop the system and verify that the system meets the requirements stated in the System Specification (SSPEC) (which is traceable to the FPS) by ensuring that the system meets the acceptance criteria in the acceptance testing. These specifications establish the two functional baselines of;

a. Mission System Functional Baseline; and
b. Support System Functional Baseline.

Prior to acceptance V&V, the project office must monitor the contractor's internal V&V processes at the sub-system and configuration item level. This is done to ensure that the system development is proceeding according to schedule, that system problem reports are being raised, prioritised and resolved in a timely and efficient manner and that project risk is being systematically and progressively reduced. Importantly, the project office must ensure that the problem (i.e. defect) reports are prioritised according to the functional and performance priorities of the users and that the resolution of the defects is proceeding sufficiently rapidly to ensure the likely achievement of acceptance criteria in the acceptance testing.

In managing the contractor's V&V activities the project office must review and approve the contractor's V&V Plan, VCRM, ATP, ATProcs and ATR. The project office must check that these documents comply with the requirements of the associated Data Item Descriptions (DIDs). The project office must also review and approve the Contractor's SSPP to ensure that the V&V methods proposed for assuring compliance with System Safety Requirements (SSRs) is acceptable. The Safety Case Report will also be developed at this point in the Materiel Life Cycle. Prior to system acceptance the project office must monitor the verification of compliance with SSRs which are raised during the development of the Safety Case.

The DIDs are listed in the ASDEFCON (SM) Asset Library. For strategic materiel projects the DIDs and the DMO Checklists for system reviews can be found in the ASDEFCON (SM) Asset Library on the ASDEFCON (SM) web site at:
http://intranet.defence.gov.au/dmoweb/sites/cpo/default.asp?p=load.asp?page=10888

The SPO must monitor the developmental V&V activities of the contractor to ensure that the development of the system is likely to be within quality, budget and schedule constraints. This will involve tracking the resolution of problem reports (PR) (i.e. comparing the number of PRs raised to PRs closed) to ensure that all high priority (i.e. high risk) defects are resolved in a timely manner. The project must also ensure that sufficient element and sub-system level testing is conducted to mitigate the risk of their being a significant likelihood of high priority defects left unresolved after Acceptance Testing. The SPO manages this risk by ensuring that it evaluates a contractor's V&V processes by reviewing the contractor's V&V Plan during the Solicitation Phase.

The contractor must establish, through a completed VCRM, that the system requirements have all been verified such that the system meets the acceptance criteria with respect to the Mission System Functional baseline and the Support System Functional baseline.

In Strategic Materiel projects, according to the ASDEFCON (SM) CDRL:

a. The **V&V Plan** has to be delivered by the Contractor to the project office by 30 days after Effective Date (ED). The project office then has 30 days to review and approve the plan. The Contractor must update the V&V Plan once every three months.

b. The **VCRM** is typically presented in draft form 10 days prior to the System Requirements Review (SRR). The project office must review and approve the draft, usually within 30 days after the SRR. The VCRM is then updated by the Contractor on a monthly basis or as required. The VCRM should be contained within a requirements management tool such as DOORS or RDT and the

project office should have visibility of the database containing the up-to-date VCRM. The final VCRM is presented at the Functional Configuration Audit (FCA) and the project office must review and approve the final VCRM within 30 days of the FCA. The draft and final VCRM are to be reviewed at each relevant system review.

c. The **ATP** is delivered to the project office 30 days prior to the Detailed Design Review (DDR) and must be ready for approval by the project office at the DDR. The ATP is to be updated at each relevant system review.

d. The **ATProcs** are delivered to the project office 30 days prior to the TRR and must be ready for approval by the project office at the TRR. The ATProcs are updated at each relevant system review.

These timings may be tailored to the specific needs of the project.

The project office must demonstrate that the system will meet the operational needs stated in the OCD operational scenarios (against the projected threats if feasible). The scenarios to be used for this purpose are determined by the IPT when the OCD is developed. Demonstration that the system will meet operational needs is done through, either the demonstrations listed in the AV&V (minimum requirement) or an OpEval activity (maximum requirement). This will be determined by the IPT at the time of accepting the Contractor's V&V Plan. The objectives of the OpEval should be described in detail in the OpEval Test Plan, at a higher level in the Validation Plan, at a higher level again in the V&VP (if the Contractor is required to conduct Mission System Validation according to the contract) and also in the TEMP.

The project office must ensure that the system achieves Design Acceptance and System Acceptance during the contract management phase of the Materiel Life Cycle through an effective acceptance V&V Program.

Acceptance Verification and Validation (AV&V)

Under the ASDEFCON (Strategic Materiel) SOW template, there are two fundamental groups of activities that need to be performed before the system(s) can be formally accepted. These are:

a. Verification of the Mission System and Support System against their respective functional baselines (Acceptance Verification): and

b. Validation of these systems when operated in their actual use environments or an agreed representation of the actual use environment (Acceptance Validation).

The V&V clauses in the ASDEFCON (SM) SOW use the terms 'Acceptance Verification' and 'Acceptance Validation' to highlight that the Australian Government's role in the V&V program is almost solely related to determining whether or not contractual deliverables are able to be Accepted.

The Australian Government should not have a hands-on role in the Contractor's internal testing activities, unless the results of those activities are expected to be used for the purposes of obtaining Acceptance. Instead, the Australian Government should adopt a monitoring role over the Contractor's internal testing activities for risk-management purposes. This approach

helps to ensure that the Contractor retains responsibility for ensuring that the requirements of the Contract are met as determined by the Acquisition Baseline.

The objective for AV&V is to conduct AV&V on equipment that is of the same hardware and software configuration as that which will be offered for System Acceptance. Refer to DI (M) X-XX 'DMO Acceptance process for New, modified or Upgraded Capability' for more information on AV&V.

The V&V clauses have been linked to the Acceptance provisions to clarify the Australian Government's role under the Contract, which was unclear under the previous terminology of 'Developmental T&E (DT&E)', 'Operational T&E (OT&E)', and 'Acceptance T&E (AT&E)' because these terms are not independent and can overlap each other. Under the CAID principles, the Australian Government should not have a hands-on role in the Contractor's internal testing activities, unless the results of those activities are expected to be used for the purposes of obtaining Acceptance. Instead, the Australian Government should adopt a monitoring role over the Contractor's internal testing activities for risk-management purposes. This approach helps to ensure that the Contractor retains responsibility for ensuring that the requirements of the Contract are met, which is one of the primary aims behind the adoption of the CAID philosophy.

Acceptance Test and Evaluation (AT&E) is but one process by which Acceptance Verification and Acceptance Validation may be conducted. Other processes may involve design reviews, audits, analysis of modelling and simulation results.

Acceptance Verification

Verification of the Mission System involves verifying a predetermined set of requirements specified for the Mission System Functional Baseline, identified in the TCD and further detailed in Contractors' V&V Plan and VCRM, has been satisfied.

Verification of the Support System involves verifying that each of the Support System Constituent Capabilities satisfy its relevant specification and that the Support System overall satisfies the requirements defined in the Support System Functional Baseline. Verification of the Support System Components involves verifying that each of these components satisfies its specification.

Acceptance Validation

Mission System Validation

The Contractor is to demonstrate to the Australian Government that the Mission System will satisfy the Mission System Functional Baseline when operated in accordance with the OCD. In other words, this clause is assessing fitness for purpose in the actual operating environment. Operational Test and Evaluation (OT&E) is a subset of Mission System Validation. However, OT&E under ASDEFCON (Strategic Materiel) is limited to that required for Acceptance purposes. For example, the Mission System elements of the RAN's processes for Operational Release could come under this umbrella if desired by the Project Authority. From a supportability perspective, this aspect of V&V would validate that the supportability characteristics of the mission system meet the specified requirements. Supportability factors for the mission system would normally be defined in the FPS for the mission system and, as

part of the validation of the mission system, these supportability factors/characteristics need to be validated.

Support System Validation

The contractor must demonstrate to the Australian Government that the support system will satisfy the Support System Functional Baseline when operated in accordance with the OCD. Some V&V is to be performed to provide confidence that;

a. the associated support with training, documentation, facilities etc, has been developed to specification and is operational; and

b. the processes and procedures are mature enough to provide support to the mission system once delivered into the operating field.

The demonstrations as identified by ASDEFCON (listed below) or an Operational Evaluation (OpEVAL) could perform this.

The IPT, through the development of the TEMP, will be required to determine and approve as to the level required for Support System Validation (i.e: Between an ASDEFCON (Strategic Materiel) demonstration to a full RAN style OPEVAL). Support System Validation demonstrations are listed below.

c. Engineering Support Effectiveness Demonstrations

(1) The purpose of this clause is for the Contractor to validate to the Australian Government in the Defence environment the effectiveness of the Engineering Support Constituent Capability, developed as part of the Support System, which has been documented in the Approved Support System Specification (SSSPEC).

d. **Maintenance Support Effectiveness Demonstrations**

(1) The purpose of this clause is for the contractor to demonstrate to the Australian Government the effectiveness of the maintenance support constituent capability, developed as part of the support system, which has been documented in the approved SSSPEC.

e. Supply Support Effectiveness Demonstrations

(1) The purpose of this clause is for the contractor to demonstrate to the Australian Government the effectiveness of the supply support constituent capability, developed as part of the support system, which has been documented in the approved SSSPEC.

f. **Training Support Effectiveness Demonstrations**

(1) The purpose of this clause is for the contractor to demonstrate to the Australian Government the effectiveness of the training support constituent capability, developed as part of the support system, which has been documented in the approved SSSPEC.

g. **Support System Endurance Demonstrations**

(1) The purpose of this clause is for the contractor to demonstrate to the Australian Government that the complete integrated support system performs

effectively over an extended period. The extended period means that the demonstration may extend beyond other acquisition AV&V activities and the preferred timing for the final payment under the contract. Hence, to ensure the contractor has provided an effective support system, the endurance demonstration may be linked to a performance guarantee along with other extended demonstrations such as for reliability.

(2) The rationale for this activity being conducted over an extended period is that a number of measures of the effectiveness of the support system are statistical in nature, and a reasonable amount of time is needed for the results to be valid. Additionally, implementation problems during rollout and a partial build-up of a fleet during transition may falsely indicate a support situation that differs from what will actually be achieved in the long-term in-service support environment. For these reasons, the start of endurance testing may also be delayed until late in the transition period.

Refer to ASDEFCON (SM) SOW and DI(G) LOG 03-6 Annex A for further detail.

Failure reporting and analysis

For all V&V failures that occur during AV&V of the mission and support system elements, the contractor is to provide the Australian Government with access, in accordance with the approved V&V Plan, to the contractor's system that:

a. collects failure data;

b. defines corrective actions; and

c. identifies the scope of additional V&V activities.

Because of the complexity of the systems that are being addressed and the significant time and effort required to conduct a comprehensive V&V program, the likelihood of completing a V&V program without need for rework is low. It would not be cost-effective for the Australian Government to demand a complete retest for any rework. The alternative is, where a design or configuration change is made during the V&V program, to conduct regression testing based on the knowledge of the implementation and the risk to the Australian Government.

It is important that all test environments and equipment used during the V&V phases are controlled and validated to confirm that they will meet their objectives as used in the program. This includes the more straightforward elements, such as the calibration of test equipment, as well as the need to validate and accredit more elaborate models used in the V&V program (e.g. underwater propagation models used as part of the V&V program for a sonar system). In the latter case, if the models were well established and known to be valid, then they might be validated by reference to subject matter experts. If however the models are relatively new or developed specifically for the project then further scrutiny and potential supplementation by real world trials (i.e. as part of the Acceptance Validation) may be required. It is important that an appropriately qualified accreditation agent accredit the model.

Regression Testing

If changes are made to the Mission or Support System configuration after starting AV&V, the contractor must repeat those activities where results are shown by regression analysis to have been potentially affected by the configuration changes.

8.2.1 V&V required for Design Acceptance

The V&V requirements for achieving design acceptance consist of ensuring that the mission system and support system meet the relevant Technical Regulatory Authority's (TRA) requirements. The high level technical regulations applicable to ADF Materiel for the purposes of achieving Design Acceptance are defined in DI (G) LOG 8-15 'Regulation of Technical Integrity of ADF Materiel'.

DTR-A, DGTA and DGNAVSYS are the TRAs for the Army, RAAF and RAN respectively and should be used by the IPT to ensure TRA requirements are identified for V&V evidence required for Design Acceptance. The Ordnance Safety Group (OSG), formerly known as the Australian Ordnance Council, is the TRA that should be contacted regarding V&V of system safety requirements required for design acceptance of ordnance systems.

Design acceptance requirements, specified by a TRA, usually state that a system must be fit for purpose in order to achieve design acceptance. This implies that some validation activities and safety verification activities would need to take place prior to design acceptance. The Design Acceptance Authority assesses a system for its suitability for acceptance into service and advises the project director of the status of a system with respect to its suitability for acceptance into service. Please note that acceptance into service is often referred to in Defence documents as operational acceptance or operational release.

The Defence Instructions outlining the technical regulation policies of the DTR-A, DGTA, DGNAVSYS and OSG are:

DI (A) LOG 12-1

DI (G) OPS 02-2

DI (N) LOG 47-3

DI (G) LOG 07-1

The Service specific TRAs requirements for V&V evidence required in order to achieve Design Acceptance are further discussed in the following:

ARMY – TRAMM (http://defweb.cbr.defence.gov.au/home/documents/army/mmanuals.htm)
RAAF - TAMM (http://wilap006.sor.defence.gov.au/aaplib/7001_053(AM1)/prelim.pdf)
RAN - ABR 6492 (http://defweb.cbr.defence.gov.au/home/documents/navy/mabr.htm)

8.2.2 V&V required for System Acceptance

In order to achieve System Acceptance all contractual requirements need to be met. System Acceptance should occur at approximately the same time as Initial Operational Capability (IOC), in the RAAF, or Initial Operational Release (IOR), in the RAN.

In Navy projects, IOC will lead to SG1 certification.

In order to achieve System Acceptance the following must be demonstrated:

a. Objective evidence that the capability has met the relevant technical regulatory requirements:

b. Delivery of the Mission System and Support System:

c. The system is determined to be ‘fit for purpose’ as demonstrated by successful completion of an Operational Evaluation:

d. V&V in accordance with the project office approved V&VP to ensure completion of all contractual obligations as demonstrated by completion of acceptance testing in accordance with approved ATP and ATProcs:

e. Compliance with contractual requirements including acceptance criteria; and

f. The ATR needs to be approved and VCRM approved to indicate that the system has passed the acceptance testing (and therefore met the acceptance criteria) and verification of all requirements listed in the VCRM has been demonstrated.

g. V&V, in System Acceptance, is conducted with respect to the Acquisition Baseline.

8.3 V&V in the Transition Into Service Phase

Depending on the level of AV&V the Contractor has undertaken in the lower level testing activities, the Contractor may not be required to conduct any further Mission System Validation (apart from the ASDEFCON demonstrations as a minimum) since this section of the contract is entirely tailorable in the ASDEFCON (SM) contract template.

The project office must ensure that the system achieves Acceptance Into Service during this phase of the Materiel Life Cycle.

The transition plan describing the V&V activities that need to be conducted in order to achieve Acceptance Into Service should be described in the TEMP.

8.3.1 V&V required for Operational Acceptance / Release (Acceptance Into Service)

The V&V activities required for operational acceptance/release include testing of product improvements, operational characteristic modifications and changes implemented to reduce system life cycle costs.

The system should also be validated against the OCD at this point by conducting further Initial Operational Test and Evaluation (IOT&E) activities, to demonstrate the operational effectiveness and operational suitability of the system against the measures described in the TEMP with typical users in realistic operational scenarios. This testing is conducted in consultation with the Capability Manager and the relevant T&E agency. The extent of responsibility that the Contractor has for the mission and support system validation at this point is determined by the content of the relevant clause in the contract.

Acceptance Into Service (AIS) is granted by the Capability Manager on the basis of recommendations from the relevant T&E agency and the DMO. AIS can be granted when the system has been validated against OCD, all testing identified in the TCD has been completed, when the TRA requirements have been satisfied and when the Capability Manager is satisfied that the Functional Inputs to Capability are in place.

Before the OT&E required for Acceptance Into Service can be conducted both System Acceptance and Final Acceptance (as defined in clause 6.6 of the ASDEFCON (SM) SOW) must be achieved.

The following has to be demonstrated in order to achieve Acceptance Into Service.

a. Fitness for purpose as demonstrated by validation of operational needs stated in the OCD by conduct of all OT&E activities listed in the TCD to resolve all of the COIs listed in the OCD and the TCD.

b. Completeness of operational support arrangements.

c. Establishment of the Acceptance Into Service Baseline.

d. Completion of an Operational Configuration Audit (including physical and functional configuration audits).

V&V required for Operational Acceptance / Release (Acceptance Into Service) is conducted against the Capability Baseline.

The output of the acceptance into service process is the Transition Certificate.

Further information on the process of obtaining V&V evidence to achieve Operational Acceptance / Release (Acceptance Into Service), including a Functional Flow Block Diagram (FFBD) describing the process, can be found in DI (M) X-XX (draft) ‘DMO Acceptance Process for New, Modified or Upgraded Capability’.

Table 5 provides a summary of what V&V evidence is required to achieve the various types acceptance and what issues need to be resolved at each stage.

Table 5: V&V evidence required for the various acceptance stages

Acceptance Stage	**V&V activities that need to be completed**
Design Acceptance	As per TRA requirements
System Acceptance	Design Acceptance (except in the RAAF where Design Acceptance is often conducted after System Acceptance) Demonstration of fitness for purpose in the form of satisfactory completion of an OpEval Completion of all V&V activities identified in the V&VP with a completed VCRM
Operational Acceptance (Acceptance Into Service)	Design Acceptance System Acceptance Demonstration of fitness for purpose in the form of completion of all V&V activities identified in the TCD and TEMP except for FOT&E and SV&V activities that may be conducted after Acceptance Into Service Completion of the Operational Configuration Audit (including physical and functional audits)

8.4 V&V required for Project Closure

The relevant project governance board will review the project closure report and the DMO project manager will produce the project closure certificate.

9 In-Service Phase V&V

9.1 In-Service Phase V&V overview

During the In-Service Phase the SPO manages V&V activities that are outside the scope of the V&V Plan. These activities include various OT&E and Supportability V&V (SV&V) activities that should be described in the TEMP, the SV&V Plan and the Validation Plan. The through life support contractor will also produce a V&V Plan relating to the support contract in accordance with the ASDEFCON (Support) contract template.

V&V in the In-Service Phase is used to support operational acceptance, business process closure and acceptance of system upgrades and modifications.

As with the Acquisition Phase, the SPO will review the contractor's V&V Plan, test plan, test procedures and test report during the In-Service Phase. However, during the In-Service phase there will be a greater degree of involvement of Commonwealth employees due to the fact that most of the V&V activities will be conducted on operational equipment, often with typical users of the system.

During the In-Service Phase the SPO, T&E agencies and support agencies manage the V&V of system modifications and upgrades, conduct further SV&V activities and conduct Follow-On OT&E (FOT&E) of the system to evaluate the performance of the system in new operational scenarios and to refine tactics and doctrine. In-Service Phase V&V also includes V&V of support systems, which includes systems set up for maintenance and training.

FOT&E is conducted during the In-Service Phase to verify the correction of deficiencies with respect to operational effectiveness and operational suitability. FOT&E is also performed to validate the system against additional scenarios, environments and threats, that are derived from those listed in the OCD, that the system was not validated against in the OpEval.

The key emphasis at this stage of the Materiel Life Cycle is to ensure that all in-service support arrangements are complete and that the in-service support facilitates operational suitability of the system.

During the In-Service Phase V&V is conducted against the established and accepted Acceptance Into Service Baseline.

9.2 V&V in Mission System Availability Planning

During the mission system availability planning a range of OT&E activities will be conducted to provide the project office with the assurance that the operational availability requirements will be met. This includes gathering data from in service use to determine the operational availability of the system. The operational availability is dependent upon the time it takes to perform various maintenance task, the frequency with which these maintenance tasks are needed to be performed and the reliability of the system. Therefore maintenance verification tasks are required to be performed and an evaluation of the reliability of the component sub systems and the reliability of the complete system are required to assess operational availability. Operational availability is often defined as the proportion of the time in which a materiel system is available for use in military operations.

9.3 V&V in Sustaining Mission System

Further verification of maintenance requirements, in addition to the verification of maintenance requirements conducted prior to acceptance, is conducted in sustaining the mission system with the benefit of the reliability, availability and maintainability (RAM) data gathered from in-service use of the system. The verification methods required for each maintenance task is detailed in the respective maintenance instructions and manuals for a Mission System. Verification may take the form of internal quality audits and surveillance. Quality audits and surveillance activities evaluate the status of the through life support management organisation's quality planning, process control, products and associated records. The quality audits may include the review of historical data from the in service use of the system, which is of particular importance in verifying requirements that could not be verified during acceptance testing, such as RAM requirements.

Verification of maintenance tasks to ensure that the support system enables RAM requirements to be met should be conducted in sustaining the mission system. This would involve performing a range of maintenance tasks by typical maintenance staff to ensure that they can be performed in a timely and accurate manner in compliance with the through life support requirements.

As with other V&V activities, supportability V&V requires identifying the appropriate parameters that need to be measured, gathering the data, analysing the data, identifying corrective action (if required) and implementing corrective action (if required). This process should be outlined in the project’s Supportability V&V Plan. Examples of appropriate parameters to be measured at this stage of the Materiel Life Cycle could include the Mean Time To Repair, Mean Time Between Failures and Mean Administration and Logistics Delay Times.

In sustaining the mission system a FRACAS should be implemented to track and report on defects recorded by users and the rectification of these defects. Further information on FRACAS can be found in MIL-HDBK-2155.

This should follow a similar procedure to problem reporting during the development of a system whereby defects are prioritised and the Contractor that provides the Through Life Support will rectify the defects and demonstrate through V&V that the defect has been remedied. Further information on this can be found on QEMS (QEMS Reference: UI 3319).

Further information on producing Supportability V&V Plans is contained in the Supportability V&V Plan Template and Guide, which can be found in QEMS in the list of MASF 4 products. The DIDs for lower level Supportability V&V related documents can also be found in QEMS in the list of MASF 4 products.

9.4 V&V in Changing Mission System

V&V in this activity associated with the In-Service Phase involves planning and implementing V&V programs for minor and major changes and enhancements required to rectify deficiencies discovered through operational use of the system to the point at which the modified system can be accepted into service.

These V&V activities will include more involvement from the end users since it is performed on an accepted and operational system.

These V&V activities will involve regression testing to ensure that all of the original functions are not adversely affected by the modifications made. This is particularly critical for software intensive systems. Regression testing should be performed on all units that have been modified and all units that are dependent upon the outputs of modified units. This principle can be applied to testing both software and hardware.

9.5 V&V in Managing Support System

The V&V in managing the support system should be described in the Supportability V&V Plan. Guidance on the development of Supportability V&V Plans will be available on QEMS in MASF 4.

9.6 V&V in Performing SPO Management Activities

The V&V activities required in this activity associated with the In-Service Phase include maintaining the TEMP and the Supportability V&V Plan and ensuring that the V&V training of SPO staff is adequate.

9.7 V&V in Providing In-Service Capability Support (ISCS) Input to Capability

In this activity associated with the In-Service Phase the SPO must determine whether the output of supportability V&V activities indicate whether any modifications are required to the support system or the design characteristics of the mission system in order to enable the materiel system to meet the supportability requirements. This should be managed through the Supportability V&V Plan.

9.8 V&V in Disposal

V&V in the Disposal Phase involves verification that the system has been safely disposed of (i.e. verification of the appropriate System Safety Requirements produced in the Safety Case Report that relate to disposal).

V&V in the Disposal Phase also includes verification of compliance with security requirements to ensure that the disposal of the system will not result in any security breaches (i.e. that classified material has been appropriately disposed of). This involves verifying compliance with the relevant sections of the Defence Security Manual (DSM). This would include ensuring that the system documentation is securely stored to ensure that the documentation can be retrieved if there is a need to recommission the system in future.

10. V&V Methods

10.1 Overview

The most appropriate V&V method is that which provides the most cost effective way of verifying compliance with a requirement or validating the system with the required degree of confidence. The main methods of performing V&V are:

a. Test and Evaluation, comprising:
   Test,
   Simulation
   Modelling,
   Demonstration,
   Inspection, and
   Experimentation.
b. Analysis.
c. Audit.
d. Walkthrough.
e. System Review.
f. Historical Data.
g. Conformance Certificates.

The logical approach to V&V is to use techniques and methods that are most effective at a given level. For example, in software V&V the most effective way to find anomalies at the component level is inspection. However, inspection is not applicable at the system level since when handling a higher level of complexity it is far more efficient to use test methods.

Some methods of V&V, such as design reviews and trade-off analyses, are analysis techniques that do not require experimentation themselves but which may involve the analysis of the results of experiments already conducted.

Information on the purpose and conduct of system reviews is contained in the System Review Guide and therefore detailed information on this method of V&V has not been described in this manual. The System Review Guide and the DMO Checklists, which can be found in the ASDEFCON (SM) Asset Library at http://intranet.defence.gov.au/dmoweb/sites/cpo/default.asp?p=load.asp?page=10888, must be consulted to obtain information on what is expected of the project office when participating in system reviews.

10.2 Descriptions of the V&V methods

The V&V methods listed in section 10.1 are described in further detail below. All of these methods can be used for both verification and validation.

Test & Evaluation

The most commonly used V&V method, in terms of cost and effort, is T&E.
All forms of T&E have a single purpose, which is to evaluate the results of testing to support achieving defined objectives. When this principal is applied in decision-making at key milestones, a traceable link is established through the results of T&E for assuring risk is contained within acceptable boundaries. The results of T&E are fundamental for decision-making when validating operational concepts and end-user requirements, evaluating designs or modifications, identifying alternative designs, comparing and analysing trade-offs when capability specifications cannot be met, verifying contract compliance, and evaluating system performance.

While T&E can be applied during all phases within a capability system's life cycle, a significant concentration of T&E effort is necessary in the Requirements and Acquisition phases. T&E is often characterised according to its objective and linkage to key project milestones. Accordingly, specific terminology can be used to more succinctly describe the T&E activity being undertaken. The most commonly used descriptions are Developmental Test and Evaluation (DT&E), Acceptance Test and Evaluation (AT&E), Production Test and Evaluation (PT&E) and Operational Test and Evaluation (OT&E).

Explanations of T&E in relation to an objective activity are provided below.

DT&E reflects T&E conducted to assist the system design and development process and support verification of technical or other performance criteria and objectives. The Contractor usually manages DT&E. However, there may be DT&E activities conducted prior to Second Pass approval which will be managed by an ADO T&E agency (eg. environmental testing) and/or conducted as a joint DSTO/industry arrangement (eg. the development of concept technology demonstrators). DT&E is conducted in a controlled and repeatable manner to verify system compliance with contract specifications. DT&E is conducted first at the element level, then at the sub-system level followed by the system level. In software testing this is often referred to as unit testing, component testing, integration testing and system testing. In software testing the system level testing is often performed according to System Level Use Cases, which describe the inputs and expected outputs for a test.

AT&E is T&E carried out to determine whether or not the material developed and produced fulfils the contractual requirements and specifications. During AT&E the system being acquired undergoes Factory Acceptance Testing (FAT) and System Acceptance Testing (SAT). In ASDEFCON (SM) this is referred to as Acceptance Testing. AT&E is usually conducted by the contractor and culminates in the Final Acceptance Test, which the project office formally witnesses to verify that compliance with the contract specifications and acceptance criteria have been met. This is referred to in ASDEFCON (SM) as Final Acceptance Testing. The acceptance criteria are defined in the Acceptance Test Procedures (ATProcs), which is produced by the Contractor and reviewed and approved by the project office. Detailed test steps of the acceptance testing are contained in the ATProcs while the

pass/fail status of the system against each test is contained in the Acceptance Test Report (ATR). The status against the requirements is then provided in the updated Verification Cross-Reference Matrix (VCRM). The AT&E conducted by the contractor is often referred to as PT&E in the Navy. With higher risk projects there is usually a need to conduct a further AT&E activity in consultation with a T&E agency to provide additional confidence that the system can be accepted and that design acceptance can be achieved.

OT&E is T&E conducted under realistic operational conditions. OT&E is conducted with representative users of the system, in the expected operational context, for the purpose of determining a system's operational effectiveness and suitability to carry out the role and fulfil the requirement that it was intended to satisfy. OT&E activities can span the entire capability life cycle. The scope of the OT&E will vary with the level of development involved in the acquisition. For COTS/MOTS acquisition the amount of OT&E will be less than that expected for a large developmental project.

OT&E can consist of Operational Assessments (OA), Initial Operational Test and Evaluation (IOT&E) (also known as Operational Evaluation or OPEVAL) and Follow-On Operational Test and Evaluation (FOT&E). OA is performed to identify what the risks to achieving the desired capability are likely to be. IOT&E is performed to validate the system against the COIs listed in the TCD using a scenario based on the scenarios listed in the OCD. FOT&E is performed to assess the system against COIs listed in the TCD using other scenarios, to evaluate tactics and doctrine and to assess the need for future modifications to the system.

OT&E is initially identified in the TCD and described in further detail in the TEMP and the Validation Plan.

The extent to which OT&E will include the involvement of the Contractor will depend upon the content of the Mission System Validation clause in the contract. This clause is blank in the ASDEFCON (SM) template. The content of the clause must be tailored to the specific project needs. The degree of responsibility that the Contractor should have with respect to mission system validation should be dependent upon the level of risk that the system would not be fit for purpose after it has undergone acceptance verification. If there is a high risk of the system not being fit for purpose then the Contractor should have a greater degree of responsibility in the OT&E program. In this instance the Contractor should be responsible for rectifying defects to ensure successful mission system validation. The mission system validation should be conducted as identified and agreed in the TEMP and the V&V Plan.

The level of OT&E that is required depends upon the magnitude of risk associated with the project. A strategic materiel project will require OT&E activities since the risk that the system won't satisfy the operational needs is higher for strategic materiel projects than other acquisition projects. The risk that is mitigated by OT&E is the risk that the system, whilst it should have passed development and acceptance testing, it may not necessarily satisfy the users' operational needs when used as intended in a practical scenario.

The following definitions of the various phases of OT&E are adapted from the US Defense Acquisition University's T&E Management Guide (Defense Acquisition University 2001) to reflect the roles of these phases of OT&E as they relate to OT&E processes in Australia.

OAs are performed to:

a. assess the potential of the new system in relation to existing capabilities:

b. assess system effectiveness and suitability so that affordability can be evaluated for program cost versus military utility:

c. assess the adequacy of the concept for employment from the perspective of supportability, doctrinal, tactical and training requirements and critical issues:

d. estimate the need for the selected system in consideration of the threat and system alternatives based on military utility:

e. assess the validity of the operational concept: and to

f. determine the key risk areas and critical operational issues that need to be resolved before the construction of the system is initiated.

IOT&E is performed to:

a. assess operational effectiveness and suitability:

b. assess the survivability of the system:

c. assess the systems reliability, maintainability and plans for ILS:

d. evaluate manpower, personnel, training and safety requirements:

e. validate organisational and employment concepts: and to

f. determine training and logistics requirements deficiencies.

FOT&E is conducted in the In-Service Phase to ensure the operational suitability and effectiveness in operations and exercises is as required. FOT&E is performed to:

g. assess the logistics readiness and sustainability:

h. evaluate the weapon support objectives:

i. assess the implementation of ILS planning:

j. evaluate the capability of ILS activities:

k. determine the disposal of displaced equipment: and to

l. evaluate the affordability and life cycle cost of the system.

FOT&E is similar to Supportability T&E. FOT&E is also used to identify capability gaps which will be addressed either in an upgrade or replacement project.

Test

Test methods in this context refers specifically to physical testing. Test methods should be used if the associated requirement needs a detailed evaluation of performance and/or functionality of a system.

Test methods are used to verify compliance with a requirement only if the requirement can be verified with sufficient confidence through a physical test within the given resource constraints. Test methods are also to be used if the requirement cannot be verified with sufficient confidence by some less resource intensive verification method such as inspection, demonstration, audit, system review or comparison.

Test methods should be used when the requirement needs a repeatable test sequence to be conducted to ensure compliance with the requirement and the requirement specifies a level of performance or functionality that is too complex to be evaluated by either inspection or demonstration.

Test instrumentation should be appropriately calibrated prior to testing. This requires that the SPO ensures that the test facilities are National Association of Testing Authorities (NATA) accredited (or equivalent).

Testing may include comparison tests to guide a decision as to which piece of equipment is selected for procurement.

Modelling and Simulation

Time and costs may preclude actual physical testing of a system/capability. In this case, modelling and simulation may be a better choice. For example, firing war shot missiles is a costly process, so the decision may be made to use a test missile or to simulate the firing process. Modelling in the physical (eg wind tunnels) or in software, could also be cost and/or time effective.

Simulation and modelling methods have some risk inherent in them in that the development of a simulation model is a development project in itself and considerable effort may be required to verify, validate and accredit a simulation and model if this is deemed necessary. This may involve physical testing to validate a simulation model to ensure that the simulation model can simulate the intended performance of a system with respect to the relevant parameters. The US DoD Verification, Validation and Accreditation Recommended Practices Guide should be followed for guidance on verification, validation and accreditation of simulations and models. The Defence Simulation Proposal Guide should also be consulted for guidance on the development and implementation of simulations.

In may be useful to conduct automated testing, using a software tool. The benefits of this include that these methods allow a larger number of tests to be conducted within a given period of time and they often allow the simulation of enabling systems, thus providing greater confidence in the performance of the system in an operational scenario. However, the simulators within these tools have been accredited for a specific application at a determined level of fidelity. It is recommended that the user accredit these simulators for the intended application. It also may take a considerable amount of time to develop and maintain the test

scripts and validate the test harness. Consequently, automated test methods should only be used if the system is not undergoing a rapid rate of modification.

Demonstration

Demonstration may be used in low risk areas where you are confident in the system's ability to achieve the desired function. The difference between test and demonstration is that demonstration is less rigorous. Demonstration is when you are interested in the outcome and not necessarily to process that got you there. Demonstration methods involve the use of a system, sub-system or component operation to show that a requirement can be achieved by the system. These methods are generally used for basic confirmation of system functionality without measurement of performance. These methods should be used as the verification method for a requirement only where the requirement does not require much detailed data in relation to performance or functionality of the system in order to confirm compliance with the requirement.

Inspection and demonstration verification methods are also to be used to verify compliance with requirements that cannot be expressed meaningfully in quantitative terms (e.g. usability requirements).

Inspection

In very low risk areas or simple test criteria, inspection may suffice. Inspection methods consist of visual examinations of the system, component or sub-system. These are used to verify physical design features or specific manufacturer identification. These may be used when a formal test is not required since we are not verifying functionality or performance and are instead just verifying the physical configuration of the system as in physical configuration audits where. For example, are the safety labels required present? You have to check, but it is not an involved process.

Experimentation

In the early stages of producing a capability, experimentation can be appropriate. Prototyping is an example of experimentation. You may also be asking the question 'Can this concept work in the field?' and conduct a field exercise and evaluate the results.

A Defence Trial will usually be comprise of one or more of the activities described above.

Analysis

Analysis methods involve the development of mathematical modelling and analytical techniques to predict whether the system will comply with requirements. Analytical methods, in the form of simulations and models, may also be used in conjunction with physical testing to validate a system against the operational need since it may provide additional data to supplement the data obtained through operational testing.

Analysis methods are required when it is not physically possible to conduct a test capable of confirming compliance with a requirement within the budgetary, schedule or availability constraints. An example of a requirement to meet certain reliability, availability or maintainability thresholds (e.g. An MTBF of no less than 5000 hours). These requirements

could only be verified by demonstration in the In-Service Phase. Consequently the only way of confirming compliance with the requirement prior to contractual acceptance would be through analysis methods. Analysis verification methods are to be used in the early stages of the capability lifecycle when a physical prototype is not available or is not cost effective to produce. In summary, analysis verification methods are used to verify performance requirements that are too costly or difficult to verify by other means.

As in simulation and modelling, the analysis techniques have an inherent risk in that the analysis system may need to developed and so need be tested and evaluated prior to it's use.

In software V&V the main analysis methods are: Software requirements traceability analysis, software requirements interface analysis, design traceability analysis, source code traceability analysis, algorithm analysis and simulation. These are discussed further in IEEE 1012 - 1998. Additional optional activities that suit the V&V of software are described in IEEE 1012-1998.

One important consideration with analysis methods is that often the conduct of an analysis activity results in the production of a data item, which has to be reviewed by the project office. The project office must consider whether it has the time, skills and resources to review all of the data items that will be produced in the V&V program.

Audits

Audits are independent examinations of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria. Audits are a type of inspection. These are required to provide assurance of functional and physical configuration of a system. The three main types of audits are Functional Configuration Audits, Physical Configuration Audits and Quality Audits.

Walkthroughs

Walkthroughs are a process of examining documentation and systems to ensure the technical integrity and validity of the design. The types of walkthroughs that are conducted are requirements walkthroughs, design walkthroughs, source code walkthroughs and test walkthroughs. Requirements walkthroughs are conducted in requirements' validation. Design walkthroughs and source code walkthroughs are conducted in detailed design reviews. Test walkthroughs are conducted prior to TRRs. These types of walkthroughs are described further in IEEE 1012-1998.

System Reviews

System reviews are conducted to verify the status of the system is such that it can be transitioned into the next phase in the system engineering process.

A brief summary of the activities conducted in system reviews is provided in Table 6 below:

Table 6: Summary of Activities in System Reviews

System Review	Activities conducted in system review
System Requirements Review (SRR)	The purpose of the SRR is to validate the requirements to ensure that the set of requirements is complete, consistent with the CoA intent and understood by the contractor and sub-contractors.
System Definition Review (SDR)	The readiness to initiate the system design phase is determined in the SDR. To this end, the RTM is reviewed at the SDR to ensure that the SSPEC contains a full coverage of the requirements listed in the contract (ie. the FPS). The review of the RTM should consider the criteria listed in the relevant ASDEFCON DID.
Preliminary Design Review (PDR)	In the PDR the CoA must review the sub-system specifications to ensure that they will satisfy the requirements. The contractor should present trade study results or demonstrate how the recommended design will meet or exceed the functional requirements of the materiel system.
Detailed Design Review (DDR)	At the DDR the CoA reviews the product designs to ensure that they satisfy the parent requirements. It is also necessary to check that the enabling product requirements have been defined in the design documentation presented by the contractor at the DDR.
Functional Configuration Audit (FCA)	The purpose of the FCA is to verify that the configuration items comply with the requirements.
Physical Configuration Audit (PCA)	The purpose of the PCA is to verify that the configuration items were built as per the design documentation.
Test Readiness Review (TRR)	In the TRR the coverage of the requirements must be checked to ensure that the tests will enable the accurate verification of compliance with requirements.
Support System Detailed Design Review (SSDDR)	In the SSDDR the final RTM is reviewed, outstanding ATPlans are reviewed and requirements pertaining to support system facilities and equipment are validated.

Support and Test Equipment Provisioning Preparedness Review (S&TEPPR)	In the S&TEPPR the CoA must confirm with the contractor that the support and test equipment will enable achievement of the functional requirements baselines for both the mission system and the support system at minimal support and test equipment cost.
Spares Provisioning Preparedness Review (SPPR)	The SPPR is conducted to verify that the spares to be acquired will enable the mission system and the support system to comply with requirements at minimal spares cost. The requirements for packaging are also reviewed at the SPPR. Facilities Requirements Analysis Reports (FRAR) may be used in the verify that the spares provisioning will allow the requirements to be met.
Task Analysis Requirements Review (TARR)	In the TARR the CoA must determine whether failure modes and preventative maintenance requirements and operator and non-maintenance tasks with logistics requirements have been addressed by the documented tasks. The Training Needs Analysis Report is to be reviewed by the CoA to ensure that the full set of training requirements have been identified.
Training Equipment Provisioning Preparedness Review (TEPPR)	The TEPPR is conducted to verify that the training equipment to be acquired will enable the mission system and support system requirements to be met.
Training Readiness Review (TNGRR)	The TNGRR is performed to check that the delivery of training is ready to proceed. For this to be achieved the training plans must therefore address all of the training requirements listed in the support system functional baseline. This then leads on to acceptance of the acceptance of training support requirements.
Facilities Readiness Review (FACRR)	In the FACRR the training support requirements are verified and the facilities requirements are verified.
Long Lead Time Items Review (LLTIR)	In the LLTIR the requirements for long lead time items (ie. spares, equipment and other supplies) must be validated.

System reviews are discussed further in the System Review Guide which can be found on QEMS at http://qems.dcb.defence.gov.au.

Historical Data

Data collected in the past on similar systems, used in similar configurations, to support V&V in acquisition or sustainment of a materiel system can be employed for verification of a system being acquired or sustained. This may include data from analysis, demonstration, inspection or

test activities conducted on similar systems and may include data collected from the in-service use of a similar system being used to support V&V (eg. RAM data).

Using this verification method may involve applying analysis methods to determine whether the historical data is relevant to the system being acquired or sustained. This may include checking to see whether the system configuration that was used in deriving the historical data was significantly different from that intended for the system being acquired or sustained or checking to see whether a test lab that was used was appropriately certified (eg. NATA certified) to conduct the relevant test.

Conformance Certificates

The conformance Certificate method of V&V is to be used when an item that is to be acquired has already been subjected to a number of tests in the past, either by Defence or an independent agency, and the test results indicated that the system conforms to the requirements of a standard that is quoted in a requirement. A conformance certificate should only be accepted for testing conducted by appropriately certified test laboratories (ie. NATA certified). It is also important to consider the configuration of the system under test and the specific test procedures used in order to determine whether the test results will be relevant for verifying whether the system being acquired is fit for purpose. If the configuration of the system being acquired is to be modified for its intended application in the ADF then the results of the previously conducted testing may not be relevant for the purposes of V&V

COTS products should undergo at least AT&E and OT&E.

T&E differs from Quality Assurance (QA) in that Quality Assurance basically aims to ensure the repeatability of product from a production process, including an audit trail via the process documentation. However, the overall aim of T&E is to mitigate the risk of the product delivered not fulfilling its intended capability role. T&E achieves this by assessing whether the user's needs have been fulfilled, and so is a higher level goal than the goal of QA.

10.3 Independent V&V

Independent staff to conduct V&V (ie. IV&V staff) are employed when financial and management independence from both Defence and the contractor are required. For example, safety case evaluators must be IV&V staff. When there are insufficient staff, either within Defence or the Contractor's operation, with the requisite skills to conduct a V&V activity then IV&V staff may be engaged to conduct the V&V activity.

At the time of writing the preferred method for obtaining IV&V services is to either use the PMSS panel, details of which can be found at http://intranet.defence.gov.au/dmoweb/sites/BCS/), or to use the ASDEFCON (Services) RFT and contract templates, which can be found at http://intranet.defence.gov.au/dmoweb/sites/CPO/). The DMOSS panel is in the process of being established. It will be possible to select IV&V staff using the DMOSS panel when it is operating in 2005.

10.4 Common mistakes in V&V

One of the major problems is that people view T&E as something that should be done late in the project rather than understanding that it is part of a V&V process that provides the best value for money when it is performed earlier in the process.

This may not be a comprehensive list of problems that can occur with V&V but it lists of some of the major issues.

Broadly the five main types of errors that can occur in V&V are:

1. The requirements have not been validated and consequently compliance with the requirements would not result in satisfaction of the operational need.

2. The requirements have not been communicated clearly to the Contractor leading to an inappropriate solution.

3. The Contractor has not implemented the validated requirements correctly in the system design.

4. The verification of the system with respect to requirements has not been conducted properly leading to the system being erroneously identified as compliant with the requirements.

5. The end system validation has not been conducted properly.

Some specific mistakes that relate to all of these types of errors are listed below.

a. The responsibilities of various stakeholders with respect to V&V may be ill defined.

b. Insufficient training or experience of T&E staff may lead to problems being overlooked.

Some specific mistakes relating to the first type of error are listed below.

a. The requirements are not verifiable (e.g. verification of a requirement for an MTBF of 5000 hours would take a significant and excessive time to verify with a high degree of confidence).

b. The requirements may not be valid, in the sense that they do not indicate the appropriate verification method, are incomplete or may be ambiguous and so there is uncertainty in terms of how to go about verifying compliance with the requirement.

c. The requirements may not be valid in that they do not individually or collectively address the operational need (i.e. you could strictly comply with the requirements but not address the operational need). For example, a requirement may specify that the system shall carry out a function but it may not specify the performance required or the system configuration that the function must be performed in. Consequently, that function may not be performed sufficiently fast to satisfy the operational need or it may not function well enough in a configuration that would be used in practice.

d. Insufficient operational assessment, concept demonstration or business process modelling may have been performed to determine if the selected system solution is valid, or the best solution, for satisfying the operational need.

e. Suitable measures (parameters) may not have been properly identified to assist in determining whether the system will actually satisfy the operational need. Performance against the measures selected may indicate that the system performs well by some criteria but not by all of the relevant criteria required to demonstrate operational effectiveness or operational suitability.

Further details relating to the second and third types of error are listed below.

The second and third errors are usually prevented by appropriate requirements elicitation and ensuring that the system design is valid for addressing the full set of requirements. These topics are further discussed in Annex C.

The main problem arising from the second and third types of errors are that user requirements may not have all been captured in the design process or the requirements elicitation process. Consequently some of these deficiencies may have been overlooked in a system review process and the requirements may not have been recorded or verified.

Some specific mistakes relating to the fourth and fifth types of errors are listed below.

f. The test steps are not adequately described in that they do not contain enough detail to be repeatable to provide Defence with sufficient confidence that the test will adequately verify compliance with the requirement.

g. The testing does not include representative types of test input data (this is particularly relevant in software testing).

h. The test results may not be recorded in sufficient detail and consequently a test result that has only demonstrated partial verification may be recorded in the VCRM as having passed (particularly if the only types of verification status recorded are PASS or FAIL).

i. Expensive testing that requires the involvement of large numbers of specialist users, such as OpEvals, may not be planned or funded well in advance enough for them to be conducted, or conducted properly, prior to System Acceptance or Acceptance Into Service. This may cause either a delay in the delivery of the system or a higher residual risk that the Capability Manager may have to accept.

j. The test procedures do not provide details of the test preconditions.

k. The expected result of the test is not adequately described in the test procedures.

l. The system configuration is not properly recorded to enable the tests to be repeatable. For example, changes to the system, such as various configurable system parameters that will affect performance (such as the time delay between sending packets of data) may have been made prior to testing that have not been recorded.

m. Emphasis is not placed on planning V&V to ensure that defects will be identified early in the lifecycle (obviously it is much cheaper to rectify a defect early in the lifecycle).

n. The tests may not be conducted under controlled conditions meaning that the tests are not repeatable - or randomisation or blocking to minimise the impact of factors other than factors pertaining to the system performance itself wasn't conducted to enable the test to be repeatable.

o. The tests may not have been prioritised according to risk and consequently compliance with some high-risk requirements may not have been verified as thoroughly as they should have been.

p. Sometimes contractors don't produce test plans well in advance enough to enable the plans to be reviewed in detail by Defence T&E staff thus increasing the risk of invalid testing being conducted.

q. Various alternative V&V techniques other than physical testing such as analysis techniques (e.g. simulation) may be insufficiently used. In some instances these may be the only viable way of determining compliance with a requirement (because of the difficulty of conducting physical testing or the lack of control often inherent in physical testing).

r. Automated testing may be under utilised.

s. The OT&E may not exercise the system in a realistic operational scenario (for example a system may be tested in a very limited configuration or a very limited scenario that is not representative of how it would be used in practice).

t. Sometime insufficient care has been given to determine the acceptable level of residual risk that the Capability Manager is prepared to accept when determining the acceptance criteria.

u. Sometimes, the requirements database is not kept up to date and so some requirements may not be adequately verified.

v. Insufficient testing is conducted to provide the necessary level of confidence required for verification of a requirement.

w. The TRA's requirements (including safety issues) may not be considered until too late in the process - making them more difficult and expensive to comply with.

x. Sufficient time between acceptance testing and delivery to the users has not been allocated to take into account the amount of time that may be required for rectification of defects.

y. The limitations of the testing are not recorded.

z. Insufficient detail in TEMP or infrequent updating of TEMP.

aa. Insufficient regression testing after modifications of a system.

11. Objective Measures for V&V

For V&V to be conducted in a valid and repeatable manner, objective measures must be identified.

11.1 Identifying critical issues to be resolved through V&V

The are two main types of critical issues pertaining the acquisition of a capability. These are critical operational issues (COIs) and constraints.

COIs form a basis for rejecting or accepting a capability. Identifying COIs is done by determining what the major risks are to achieving the desired capability. That is, the system would not be suitable for operational deployment and would not exhibit the desired capability unless all COIs are resolved. COIs are solution independent. COIs are usually phrased as a question and *not* in the form of requirements. COIs are usually resolved in OT&E.

COIs are identified in the OCD and the TCD, before Second Pass approval, and are derived from the system mission scenarios and the operational needs described in the OCD. COIs must address a specific system capability and significantly impact system effectiveness or suitability. COIs state the mandatory operational requirements of a capability. They may refer to requirements that are already satisfied, partially or fully, by the present capability.

For instance, if a means of enhancing the operational range of frigates is to be acquired by the Navy 'Will the system enable a fully-equipped frigate to deploy (without stopovers) from Australia to any port in the world?' may be a relevant COI. If, perhaps, frigates were not satisfactorily protected against various threats such as an enemy submarines by our current capabilities it may be that we need to find a new solution to enhance detection of enemy submarines. There may be various solutions to achieve this. 'Will the system enhance the protection of Navy assets against enemy submarines in a combat environment?' or 'Will the system detect the threat in a combat environment at adequate range to allow successful engagement?' would be example operational effectiveness related COIs. It should be possible to relate these to the operational scenarios that are described in the OCD.

There are also operational suitability COIs which relate to the ability of the system to be suitable for service. In this example operational suitability COIs could include: 'Will the system be able to maintain its detection capabilities throughout a typical mission described in the OCD?' or 'Will the system be safe to operate in the anticipated operational environment?'

Constraints are political, social, legal, technical or economic limitations placed on a system acquisition. An example of a constraint is a legal limitation that prevents a solution for achieving a capability that uses prohibited substances (e.g. depleted uranium). This then places technical constraints on a project, which are listed in the Critical Technical Parameters (CTP) in the TCD.

Critical technical parameters (CTPs) are also to be identified in the TCD. CTPs state technical characteristics of the system (ie. design characteristics) that must be met in order for the system to be able to satisfy the desired capability. A CTP is so important that failure to meet the threshold may cause the project to be cancelled. For example, that the bore of a gun must

be 155mm would be a CTP if, in this case, 155mm ammunition were required in order to achieve the desired capability. Compliance with CTPs is determined in Acceptance Testing.

11.2 Identifying measures for V&V

COIs can be decomposed into a number of testable measures that collectively enable the satisfaction of each COI to be confirmed. A number of Measures of Effectiveness (MOEs) and Measures of Suitability (MOSs) can be directly derived from a single COI while Measures of Performance (MOPs) can be derived from the MOEs and MOSs. The MOEs, MOSs and MOPs form a hierarchy of measures that describe the desired effectiveness and performance of a system against the underlying COIs.

MOEs are:

a. metrics of warfighter effectiveness;
b. attributes of a system that directly contribute to the operational effectiveness of a system in the intended operational scenario;
c. mission oriented;
d. solution independent; and
e. measures of how well the system meets the user needs.

MOSs are derived from operational suitability related COIs.

MOPs are the technical parameters that are directly measured when evaluating a system. Against each MOP is an evaluation threshold.

A certain amount of data needs to acquired through the various V&V methods to determine whether the evaluation threshold has been achieved. The data requirements (DRs) are the type and number of measurements that need to be taken in order to measure the MOP with the required level of confidence.

The number of V&V activities that need to be conducted is dependent upon the factors listed below.

f. Whether the system is new or is an upgrade or modification of an existing system.
g. The effect of a system failure, which can range from catastrophic (a total failure of the mission) to minor (results in inconvenience or additional cost).
h. The variability of effectiveness in the operational environment.
i. Whether the system will meet opposition and what the nature of the opposition might be (Sessler et al 2000).
j. The level of confidence required in the result of the V&V activity.

The level of confidence required in the result, and therefore the level of confidence in meeting the requirement, is dependent upon the priority of the requirement. This, in turn, is dependent upon the level of risk associated with the relevant aspect of operational effectiveness or operational suitability that the requirement concerns.

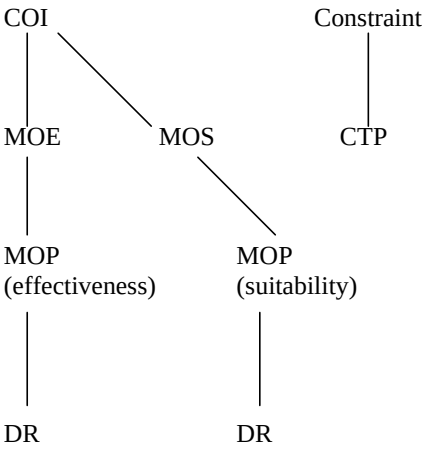
Below is an example of a subset of a hierarchy of measures for a tank:

COI: Is the system sufficiently survivable in the attacking environment?
MOE: The probability of being killed when engaged by enemy fire after firing.

MOP: Probability of armour penetration when engaged by contemporary anti-tank missiles at 1000 metre range.

Figure 5 shows the hierarchy of measures in diagrammatical form.

Figure 5: A hierarchy of measures



AS 4216 lists the main software quality characteristics. Software only satisfies its intended need within the context of a complete system and all complex Defence systems use software to perform their intended functions and so these characteristics are actually system quality characteristics that are applicable to any type of complex system. The software quality characteristics listed in AS 4216 are also general enough to be applied to any type of system. These sorts of quality characteristics should be addressed in the MOEs and MOSs for a system.

These characteristics, and various sub-characteristics associated with them, from AS 4216 are listed below.

Functionality

Functionality relates to whether the system performs the functions that it must in order to satisfy the specified requirements and the operational need.

The sub-characteristics of functionality are:

a. Suitability of the system with respect to tasks that need to be performed;
b. Accuracy, which refers to the closeness of the output of a test to agreed expected results;
c. Inter-operability with systems that it must be inter-operable with to satisfy the operational need;
d. Compliance, which includes the extent to which the system is compliant with the relevant regulations, laws and standards; and
e. Security, which includes the prevention of unauthorised access.

Reliability

Reliability is the ability of a system to perform its intended function consistently over a given period of time.

It has sub-characteristics of:

a. Maturity, which is the frequency of failure by faults;
b. Fault Tolerance, which includes the robustness and vulnerability of the system; and
c. Recoverability, which includes the time and effort required to return the system to a functional state from a non-functional state (e.g. the time required to recover lost data).

Usability

Usability is a measure of how much effort is required to use the system.

It has sub-characteristics of:

a. Understandability, which is the effort required to understand the logical concepts used in the system:
b. Learnability, which is the effort required for the user to learn how to use the system functions; and
c. Operability, which is the effort required to use the system to perform the functions it is intended to perform in an operational scenario.

Efficiency

Efficiency is the level of performance of the system given a set of resources (i.e. hardware and communications systems) under controlled conditions.

It has sub-characteristics of:

a. Time Behaviour, which includes such parameters as response times, processing times and throughput rates; and
b. Resource Behaviour, which relates to the resources required to use to perform a function.

Maintainability

Maintainability is the level of effort required to make a certain type of modification to a system.

It has sub-characteristics of:

a. Analysability, which is related to the level of effort required to diagnose problems;
b. Changeability, which is related to the level of effort required for modification);
c. Stability, which is the extent of the impact on the functionality of the system in response to unexpected modifications; and
d. Testability, which is the level of effort required for verification and validation.

Portability

Portability is the ability for the system to be integrated into alternative environments.

It has sub-characteristics of:

a. Adaptability, which is the level of effort required to adapt the system such that its functions can be operated in a new environment;
b. Installability, which relates to the level of effort required to install a system into an operating environment;
c. Conformance, with respect to standards related to portability; and
d. Replaceability, which is related to the level of effort required to use a system to execute functions in the place of an existing system that is designed to perform those functions.

MOPs need to be determined for each of these MOEs and evaluation thresholds need to be determined for each MOP.

Software evaluation needs to be conducted in the context of a complete system. AS 14598 is the Australian standard for software product evaluation. However it only describes a generic evaluation process that can be applied to any system. It refers to external measures and direct measures. AS 14598 defines an external measure as *'an indirect measure of a product derived from measures of the behaviour of the system of which it is a part'*. In AS 14598 a direct measure is defined as *'a measure of an attribute that does not depend upon a measure of any other attribute'*.

MOEs are external measures while MOPs are direct measures.

MOEs are also measures of external quality. External quality is defined in AS1598 as **'**the extent to which a product satisfies stated and implied needs when used under specified conditions'

12 T&E and V&V Training

12.1 Training and Education

There is no single course that covers all of the T&E and V&V training requirements of the ADO at present. The various T&E organisations and DMO have identified some courses which combined together have the potential to provide a basis for DMO V&V. Some of these courses are still being assessed or are under review.

The T&E Practitioners Course, run by PlanIT, is currently being reviewed by RANTEAA to ensure its suitability for use in training T&E practitioners in the DMO and T&E agencies. ARDU currently require their test engineers to do the Principles of T&E and Operational T&E courses run by the University of South Australia.
DTRIALS is assessing a combination of the Principles of T&E, Operational T&E and the T&E Practitioners course as a means of providing the required T&E training. DTRIALS is also looking to review the competencies required for T&E practitioners and trying to ascertain if other training providers exist.

The DMO recommends the courses listed in Table 7.

Table 7: DMO recommended courses

Course	Comments	Provider
Principles of T&E	Three day overview of T&E	University of South Australia
T&E Practitioners Course	Four day overview of T&E management	PlanIT (this course is sponsored by RANTEAA)
ASDEFCON (SM) training	Five day overview of the ASDEFCON (SM) contract template (including one session on V&V aspects)	DMO
DOORS training	Two day course on the requirements management tool, DOORS	DMO
CORE training	Two day course on the functional modelling tool, CORE	DMO
LSA Workshops 1 and 3	These five day workshops include training on supportability V&V	DMO
Capability Definition Documents (CDD) Training	Four day course on the CDDs that contains a section on drafting TCDs. This course has the CORE and DOORS training as a prerequisite	DMO

End to End Software Testing	Two day overview of the software testing process	IV&V Australia
Advanced T&E	Five day course building on the Principles of T&E course	University of South Australia
Operational T&E	Two day course on OT&E	University of South Australia
Design of Experiments, Tests and Trials	Distance education course covering experimental design using statistical methods	University of South Australia

13 T&E and V&V Tools

13.1 V&V Tools

The DMO recommends using CORE for the development of scenarios and recommends using DOORS or RDT for requirements management, including the tracking of verification of requirements in the VCRM.

13.2 T&E Tools

A T&E management tool is to be selected by the ADO. The benefit of a test management tool would be in providing traceability from requirements to test plans to test procedures and test reports. A test management tool can be used to monitor progress towards addressing requirements, tracking problem reports, tracking the resolution of defects, recording variations to test procedures, MOPs, MOEs and ultimately COIs to ensure that the project is on schedule and within budget.

An evaluation of T-Plan Professional was conducted by some projects to assist in producing a list of requirements for a preferred test management tool. RANTEAA and DTRIALS have also been assessing T-Plan. T-Plan, produced by PlanIT, will be proposed as the preferred test management tool. However, a decision on whether this tool should be adopted as the DMO preferred tool has not be made at the time of writing.

Annexes

Annex A: GLOSSARY OF TERMS THAT MAY BE ENCOUNTERED

These definitions have been developed in a generic form and may require qualification when used in specific contexts. If elaboration is required then the definition of the term should be used with any explanatory comment following. These definitions include the complete list of terms from the T&E Lexicon, which has been endorsed by DTRIALS, as well as some additional definitions from relevant Defence policy.

Acceptance – means acceptance of the Supplies in accordance with clause 6.5 of the conditions of contract signified by the Project Authority's signature of the Supplies Acceptance Certificate; and "Accept" has a corresponding meaning.

Acceptance Into Naval Service (AINS) – this term referred to the milestone, in the Materiel Life Cycle, at which Chief of Navy was satisfied that the equipment was, in all respects, suitable for RAN operational service. *This milestone has been superseded by Operational Release (OR), and is used only in reference to legacy projects.*

Acceptance into Service – A process by which a capability system is proven to meet sufficient contractual and user requirements that in all aspects the capability is accepted for operational service. It is a systematic process in which key milestone decisions are supported by results of T&E.

Acceptance Into Service Baseline – the approved configuration documentation describing the technical documentation that describes the configuration of the system accepted into service and the verification performed together with the results obtained. Further information on what the Acceptance Into Service Baseline consists of can be found at: http://qems.dcb.defence.gov.au/SPTINFO/C2/PPGUI2166%20-%20Materiel%20Baselines_1.1.doc

Acceptance Test and Evaluation (AT&E) – T&E carried out to demonstrate whether or not the materiel developed and produced fulfils the contractual requirements and specifications. AT&E is a subset of Acceptance V&V.

Acceptance Verification and Validation – a process employed by DMO to demonstrate compliance with all contract requirements.

Acquisition Baseline – the approved configuration documentation describing the performance (functional, inter-operability, and interface characteristics) of the system(s) to be acquired, the commercial conditions governing the acquisition and the verification required to demonstrate the achievement of those specified characteristics. Further information on what the Acquisition Baseline consists of can be found at: http://qems.dcb.defence.gov.au/SPTINFO/C2/PPGUI2166%20-%20Materiel%20Baselines_1.1.doc

Aircraft Stores Clearance Test and Evaluation - The process of test and evaluation necessary to clear carriage and/or release of an airborne store from an aircraft.

Analysis – a process of separating constituents/elements of something (can be material or thoughts) and studying them to make a determination (prediction or conclusion). In the context of capability systems, analysis becomes a method of studying data to verify conformity or evaluate functionality, and can include simulations or modelling techniques, extension of established results from testing comparable materiel or design comparison with existing materiel.

Audit – These are checks used to assure the SPO that the functional and physical configuration of a system is as specified. The three main types of audits are Functional Configuration Audits, Physical Configuration Audits and Quality Audits.

Capability - The power to achieve a desired operational effect in a nominated environment within a specified time and to sustain that effect for a designated period. Capability is delivered by systems that incorporate people, organisation, doctrine, collective training, platforms, materiel, facilities, in-service support, and command and management. [Adapted from the Defence CSLCM Manual v1.1]

Capability Baseline - the approved configuration documentation describing a capability's performance (functional, inter-operability, and interface characteristics) and the verification required to demonstrate the achievement of those specified characteristics. Further information on what the Capability Baseline consists of can be found at: http://qems.dcb.defence.gov.au/SPTINFO/C2/PPGUI2166%20-%20Materiel%20Baselines_1.1.doc

Critical Issues – the requirements that are of such significance that together they characterise the required outcomes of the proposed system. They are deemed critical because any one, if not resolved, can be a 'show stopper'. Critical issues are usually categorised as either Critical Operational Issues or Critical Technical Parameters (CTPs). CTPs can be derived from policy, cost related or specified technical constraints.

Critical Operational Issue (COI) – questions (hence qualitative issues) that need to be answered to prove functional aspects (operational and support) of the required capability system have been met by the acquired system. The COIs or questions are decomposed by T&E specialists into testable elements to provide a data that enables the issues to be evaluated.

Critical Technical Parameter (CTP) – technical aspects that directly describe or quantify a system's performance, or impact compatibility of components within the system or interaction with other systems. They are 'system qualifiers' and can impose design limits in the form of weight, length, area, volume, frequency response, temperature, electrical or magnetic thresholds, etc. CTPs will be tested by direct measures.

Defence T&E Community - the Australian Defence Organisation's test facilities, T&E agencies/authorities, industry and personnel concerned with T&E.

Defence Trial – A trial conducted under the authorisation of the Director of Trials.

Demonstration - the operation of a system, sub-system, or component to show that a requirement can be achieved by the system. It is generally used for a basic confirmation of

performance capability and is differentiated from testing by the level of risk involved and the subsequent reduced detail in data gathering.

Design acceptance – certifying that an approved design is acceptable and meets the individual ADO technical requirements, as detailed in the DMO's Technical Certification Plan. The design review should involve some assessment of the ability of the design to meet the operational requirements.

Design approval – certifying a design's specification.

Development Test and Evaluation (DT&E) – T&E conducted specifically to assist the system design and development process and to verify attainment of technical or other performance criteria and objectives. It normally applies in the design stage when developing new systems, but also applies to in-service systems when developing upgrades or modification to those systems.

Evaluation – the process of review and analysis of quantitative or qualitative data to provide an objective assessment of a system's safety, performance, functionality and supportability in measurable terms, to determine fitness for purpose or for contractual compliance. Generally, the review will be to compare results against agreed criteria, but can also be to identify design or system limitations, and operational use issues.

Final Acceptance – means acceptance of the Capability in accordance with clause 6.6 of the conditions of contract signified by the Project Authority's signature of the Final Acceptance Certificate.

Follow-On Operational Test and Evaluation (FOT&E) – testing to verify operational effectiveness and operational suitability of the system through T&E of any deferred or incomplete test items from IOT&E and to assess modifications to the original system. This testing is usually performed after Initial Operating Capability (IOC) is achieved.

Independent Verification and Validation (IV&V) – Verification and Validation conducted by an organisation that is managerially and financially independent of the acquirer and the Contractor.

Initial Operational Capability (IOC) – the point in time at which a capability system is deemed by the Capability Manager as ready to be deployed in an operational role. IOC coincides with Operational Acceptance or Operational Release of whole or partial capability. If IOC coincides with the operational acceptance/release of the system's full capability, the system is deemed to have achieved its In-Service Date (ISD)

Initial Operational Release – the first operational release in a progressive release of full operational capability.

Initial Operational Test and Evaluation (IOT&E) – T&E that is the first time the system (full or partial capability) is tested on production representative test articles used by typical operators with typical field equipment in a realistic environment. The objective of this type of testing is to determine operational effectiveness and suitability through resolution of critical operational issues, and to ensure deficiencies discovered in earlier operational assessments/evaluations have been corrected. Whether this will include the involvement of

the Contractor will depend upon the Mission System Validation clause in the contract. IOT&E usually follows system acceptance, but can be combined with T&E in support of system acceptance.

In-Service Date (ISD) - the point in time when a capability system achieves operational acceptance / release.

Inspection – the process of conducting a visual examination of the system, component, or sub-system. It is generally used to verify physical design features or specific manufacturer identification.

Integrated Logistic Support (ILS) - a disciplined approach to the management and technical activities necessary to:

- cause support considerations to positively influence concepts, design requirements and design selection;
- define and integrate logistic support requirements and optimise support requirements with weapon system performance;
- acquire the required support;
- provide the required support during the operational phase at minimum life-cycle cost; and
- address logistic support requirements during the disposal phase.

Materiel System - the combination of the Mission System and Support System, which covers most aspects of the Fundamental Inputs to Capability (FIC), ie organisations, personnel, collective training, major systems, supplies, facilities and support (for materiel system), and command and management (for support system), but does not include operational doctrine.

Measure of Effectiveness (MOE) – a parameter that describes the ability in which a system accomplishes its assigned role and is independent of equipment solution.

Measure of Performance (MOP) – A specific measure of a system's capability to which a numeric value can be assigned.

Measure of Suitability (MOS) - A parameter that describes the success or otherwise of a system being able to sustain its assigned role.

Model – A physical, mathematical or otherwise logical representation of a system, entity, phenomenon or process (DI (G) OPS 42-1).

Modelling – application of a standard, rigorous, structured methodology to create and validate a physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Operational Acceptance/Release – the acknowledgment by the relevant Capability Manager that a capability system has been proven effective and suitable for its intended role.

Operational Effectiveness – the ability to perform its intended function over its intended operational spectrum, in the expected operational environment, and in the face of expected threats when operated by typical operational personnel.

Operational Evaluation (OPEVAL) – A trial conducted by competent T&E agencies to provide an early, but limited, operational assessment to add confidence to a production or procurement decision.

Operational Suitability – the capacity of the system, when operated and maintained by typical operational personnel in expected numbers, at the expected level of competency, to be reliable, maintainable, available, logistically supportable, compatible, interoperable, safe and ergonomically satisfactory

Operational Test and Evaluation (OT&E) – T&E conducted under realistic operational conditions. OT&E is conducted 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.

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

Production Test and Evaluation (PT&E) – T&E conducted by a manufacturer on a system during its production to ensure that it meets the technical and performance specifications of the contract.

Qualification Testing – testing employed to verify that the design and manufacturing processes comply with mandated specifications and standards and provides a baseline for subsequent acceptance/production tests. Qualification of a product must be done to set standards. When a design is qualified, product that complies with the design does not need to undergo additional testing against those standards each time it is manufactured.

Regression Testing - The repeating of 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 (S3) – a term used to summarise the requirements for materiel to be acceptably free from hazards and to have inherent characteristics that meet specified requirements during its agreed life cycle. This definition generally excludes operational effectiveness and lethality but may include certain performance characteristics if these aspects are deemed to be part of the item design function.

Safety and Suitability for Service (Ordnance specific) - The inability of an item which contains explosives to hazard the lives of Servicemen or the public at large, or to cause damage to Australian Government or private property, the capability of parts which contain explosives to function as designed and the assurance that this functioning will not be unacceptably degraded by the Service environment.

Simulation – The implementation or exercise of a model over time (DI (G) OPS 42-1).

Support System - the organisation of hardware, software, materiel, facilities, personnel, data, processes, and services required to enable the mission system to be effectively operated and support to meet its operational requirements.

Supportability - the degree to which planned support (including test, measurement, and diagnostic equipment; spares and repair parts; technical data; support facilities; transportation requirements; training; manpower; and software support) meets system reliability, availability, and maintainability requirements.

Supportability Test and Evaluation (ST&E) – a management process employed to assess the effectiveness of the logistic support arrangements including industry support provided for through life support of the system.

System Acceptance – the acknowledgment by the DMO project authority that an acquired system complies with contractual requirements.

System Reviews - a series of system engineering activities by which the technical progress on a project is assessed relative to its technical or contractual requirements. The formal reviews are conducted at logical transition points in the development effort to identify and correct problems resulting from the work completed thus far before the problem can disrupt or delay the technical progress. The reviews provide a method for the Contractor and procuring activity to determine that the development of a CI and its identification has met contractual requirements.

System Performance Parameter (SPP) – a system parameter, the value of which can be calculated or derived from a number of direct measurements.

T&E Activity - an activity that has an outcome of producing objective evidence to support making critical decisions. A T&E activity may encompass a combination of inspections, testing, demonstration and analysis to deliver the necessary outcome.

T&E Community - the collective term for test facilities, T&E agencies/authorities and personnel concerned with T&E, particularly within Australia. The T&E Community is inclusive of the Defence T&E Community. Example members of the T&E community include the CSIRO, NATA, and SEEC.

T&E Principals' Forum – a group of Defence T&E Principals representing their Services, Capability and Analysis Group, DSTO and DMO who have the responsibility of commanding or directing T&E agencies and authorities.

Technical Performance Parameter (TPP)—A system parameter that may be directly measured in quantifiable units, for example, by direct observation or through instrumented data retrieval techniques.

Test Concept Document (TCD) – The Commonwealth document that outlines the T&E strategy (including major T&E objectives, activities, funding and identification of responsibilities) throughout the Materiel Life Cycle. The TCD is one of the Capability Definition Documents and is produced to assist in achieving Second Pass Government approval.

Test and Evaluation Master Plan (TEMP) – document that describes the T&E objectives, activities, funding and organisation and staff roles and responsibilities for planning the conduct of T&E.

Test – an activity in which a scientific method is used to obtain quantitative or qualitative data relating to the safety, performance, functionality and supportability of a system.

Test and Evaluation (T&E) - A structured process by which a system or product is compared against technical or functional criteria through gathering data from testing, and evaluating results to assess its fitness for purpose or for contractual compliance.

Trial - an activity consisting of single or multiple tests conducted to establish the performance and/or characteristics of equipment, a system or a concept. In this context, a trial usually takes the form of a planned process aimed at exercising the subject under test in its actual or simulated environment to produce data for analysis.

Validation – Proof through evaluation of objective evidence that the specified intended end use of a product is accomplished in an intended environment.

Verification – Confirmation by examination and provision of objective evidence that specified requirements to which a product or service, or aggregation of products and services, is built, coded, assembled and provided have been fulfilled.

Walkthrough – A process of examining documentation and systems to ensure the technical integrity and validity of the design.

Annex B: TEMP Guide

Introduction

This annex is a guide to assist test managers in developing a TEMP for strategic materiel projects.

The TEMP is a single document that outlines the whole V&V program and its relationship to other engineering activities. It provides traceability up to the CDD (and in particular the TCD) and down to the lower level test plans. The TEMP summarises the current status of the system with respect to compliance with the Acquisition, Capability and Acceptance Into Service Baselines (compliance with respect to the Acquisition Baseline is more comprehensively described in the VCRM). The TEMP summarises what the major risks of failing to achieve V&V against these baselines are and how they are to be mitigated. The TEMP ensures that all of the V&V activities have been planned and funded and have clear objectives. The TEMP ensures that the status of the system with respect to requirements' compliance and fitness for purpose (i.e. validation) are clearly documented in a single document. The TEMP also provides a hierarchy of measures that the fitness for purpose of the system can be measured against. The TEMP ensures that a consistent program has been set in place to verify compliance with requirements, manage contractor V&V activities, develop acceptance criteria and validate the system. The TEMP describes the hierarchy of test plans and refers to lower level test plans for further details on the V&V program. The TEMP does not have to be issued to the contractor but the contractor may request it for information to assist in drafting the V&VP.

The TEMP is developed by an IPT immediately after second pass approval under the direction of the DMO SPO. However, in some projects it may be necessary to start to develop the TEMP before second pass approval if the TCD does not provide sufficiently detailed information on the cost of T&E activities in order for second pass approval to be achieved.

The IPT consists of representatives from the DMO SPO, the relevant T&E agency, CDG and the Capability Manager. In practice, the TEMP would be developed by the T&E Manager in the DMO SPO and reviewed by the other representatives of the IPT. A TEMP for a RAAF project must be endorsed by the project director, the Aerospace Acquisition Division Chief Engineer, the RAAF operational sponsor and the Design Acceptance Authority for an aircraft project or the appropriate ground system Design Acceptance Authority Representative for a ground based project. A TEMP for a RAN or Army project needs to be endorsed by the project director and the RAN or Army operational sponsor.

The TEMP must initially be consistent with the CDD. However, unlike the TCD, the TEMP is a living document. The TEMP is updated whenever a major test activity is completed, whenever there are changes to the Acquisition Baseline, whenever there are changes to the acceptance criteria or whenever changes need to be made to the nature of V&V activities required in order to achieve acceptance.

The TEMP provides more detail than is described in the TCD and is the plan that outlines how the V&V evidence required for Design Acceptance, System Acceptance and Acceptance Into Service will be obtained. It also describes the status of testing conducted to date and identifies the necessary verification and validation activities. The TEMP relates the V&V program

schedule and required resources for conducting V&V to the COIs, CTPs, test objectives, evaluation thresholds and the milestone decision points.

The value obtained in mitigating the risk of non-compliances with respect to requirements and operational needs that is provided by planning, conducting and tracking a V&V program through the TEMP and subordinate test plans, procedures and reports greatly exceeds the cost of producing these documents.

As a rough guide it is expected that the TEMP should be approximately 50 pages in length.

Annex B.1: TEMP Format

SECTION I - SYSTEM DESCRIPTION

1.1 Mission Description
- 1.1.1 Operational Need
- 1.1.2 Mission(s) to be Accomplished
- 1.1.3 Specified Environment

1.2 System Description
- 1.2.1 Key Functions
- 1.2.2 System Architecture and Interfaces
- 1.2.3 Unique System Characteristics

1.3 Critical Operational Issues (COI)

1.4 System Threat Assessment

1.5 Required Operational Characteristics
- 1.5.1 Key Operational Effectiveness Characteristics
- 1.5.2 Key Suitability Characteristics
- 1.5.3 Thresholds

1.6 Key Technical Characteristics

SECTION II - PROGRAM SUMMARY

2.1 Project Phases and V&V Phases

2.2 Stakeholder Responsibilities with respect to V&V

2.3 Integrated Schedule

2.4 Funding Aspects of the V&V process

SECTION III – DT&E OUTLINE

3.1 Critical DT&E Issues

3.2 DT&E to Date

3.3 Future DT&E
- 3.3.1 DT&E Phases and Objectives
- 3.3.2 DT&E Activities and Scope of Testing
- 3.3.3 Critical DT&E Resource Requirements
- 3.3.4 Constraints and Limitations associated with D&TE

SECTION IV – VALIDATION OUTLINE

4.1 Critical Validation Issues

4.2 Validation to Date

4.3 Future Validation
- 4.3.1 Validation Phases and Objectives
- 4.3.2 Validation Activities and Scope of Testing
- 4.3.3 Critical Validation Resource Requirements
- 4.3.4 Constraints and Limitations associated with Validation

SECTION V – ACCEPTANCE V&V (AV&V) OUTLINE

5.1 Critical AV&V Issues

5.2 AV&V to Date

DRAFT

5.3 Future AV&V
- 5.3.1 AV&V Phases and Objectives
- 5.3.2 AV&V Activities and Scope of Testing
- 5.3.3 Critical AV&V Resource Requirements
- 5.3.4 Constraints and Limitations associated with AV&V

SECTION VI - SAFETY
6.1 Assessment of Safety
6.2 Critical Safety Issues
6.3 Safety Management for V&V activities

SECTION VII - SPECIALTY TEST PROGRAMS
7.1 Specialty Test Program Requirements
7.2 Specialty Test Program - Critical Issues

SECTION VIII – SUPPORTABILITY TEST PLAN

SECTION IX – TRANSITION PLAN

SECTION X – SPECIAL RESOURCE SUMMARY
10.1 Schedule of V&V activities with special resource requirements
10.2 Special Resource Requirements for V&V activities

SECTION XI – HUMAN RESOURCE LIMITATIONS

Annex B.2: TEMP Development Checklist

General

- Does the TEMP justify the V&V activities to be undertaken in terms of costs against the estimated costs of the risks involved?
- Does the TEMP comply with the (suggested) thirty page limit, including annexes, attachments, etc?
- Are all of the roles of the appropriate T&E agencies defined?
- Is the Project Authority shown as the approving authority?

Section I (System Description)

- Why is the system being built? (need)
- What does the system consist of? (description)
- What tasks will be performed by the system? (functions)
- How does the system relate to other Defence weapon systems? (interface)
- What makes this system different from similar/existing systems? (unique characteristics)
- What level of performance must this system provide? (required operational and technical performance requirements)
- When will performance be demonstrated?
- Is there a concise physical description of the system? The reader may be unfamiliar with the system and its major sub-systems.
- Is there a functional description that clearly states the functional relationship between the system elements?
- Are the system's characteristics logically divided into key functions, interfaces, and unique characteristics?
- Do the required operational and technical performance requirements relate clearly to the mission and system characteristics?
- Are performance thresholds prior to system maturity clearly identified with the program phase in which the performance will be demonstrated?
- Have the COIs, MOEs, MOSs, MOPs and CTPs been identified?
- Has a reference to the System Threat Assessment been included?

Section II (Program Summary)

- Are the organisations and their responsibilities in the program identified?
- Has an organisation chart been included? Does it show management relationships among user, developer, testers etc? Are all organisations included?
- Has an integrated test summary been included identifying the major V&V activities, costs, responsibilities for costs,

Section III (Developmental Test and Evaluation)

- Is there a correlation to TEMP Format paragraph 1.5?
- Is there a clear relationship between the test objectives and the key functions, interfaces, unique characteristics and required technical and operational characteristics?
- Are the critical issues clearly addressed by test objectives? Does the proposed test plan adequately address each of them?
- Do both the 'DT&E to date' and 'future DT&E' sections clearly describe the development status of the item that is subject to testing? A basic issue to be addressed is the degree to which the test article is truly representative of a production article.

- Is the section written from the perspective of Defence monitoring of Contractor DT&E activities?
- Does it identify the nature and scope of DT&E to be required of the Contractor?
- Are the basic test phases/blocks clearly described?
- Are the criteria expressed in terms of where in the overall program specific values are to be met (milestones at which incremental/final values are to be met)?
- Is the scope of testing (quantity) clearly stated for each phase/block?
- Is it clear how the objectives are to be met?
- Are items outside the control of the SPO clearly identified?

Section IV (Validation)

- Is there a correlation to TEMP Format paragraph 4.1 - 4.3?
- Has the relevant OT&E agency been involved in the development of Validation objectives?

Section V (Acceptance V&V)

- Is there a correlation to TEMP Format paragraph 5.1 - 5.3?

Section VI (Safety)

- Is there a correlation to TEMP Format paragraph 6.1 – 6.3?

Section VII Specialty Test Programs)

- Is there a correlation to TEMP Format para 7.1 - 7.2?

Section VIII (Supportability Test Plan)

- Are the business models identified?
- Are all the business model organisations identified?
- Are the funding/resource requirements identified?
- Is a schedule provided showing when all testing is to be conducted?

Section IX (Transition Plan)

- Have all items been identified that have to be transitioned into service?
- Are all the organisations identified to accept assets?
- Are the funding/resource requirements identified?
- Is a schedule provided showing when all major and key resources are to be transitioned?

Section X (Special Resource Summary)

- Are the quantities, types and configurations of test articles identified?
- Are all of the major test sites, instrumentation and facilities identified?
- Are all the major support resources identified?
- Is the source organisation identified for each resource?
- Are the funding requirements and any known shortfalls identified?
- Is a schedule provided showing when all major and key resources are required, and any conflicts identified?
- Are the resources adequate to conduct the test program?

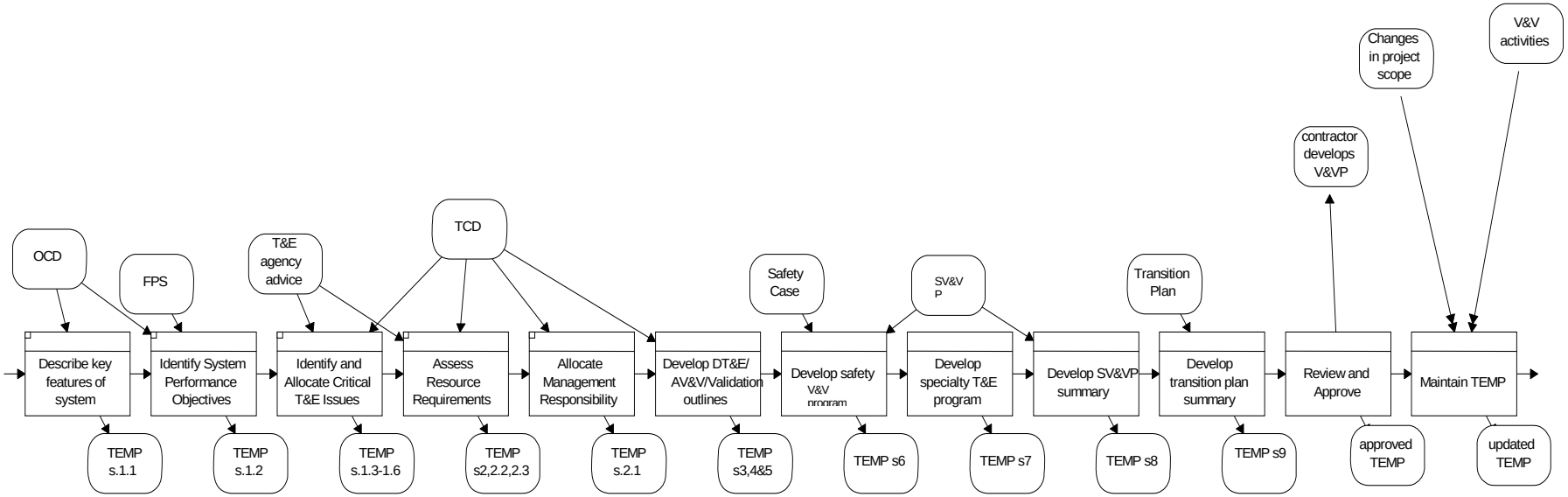
Section XI (Identify/Estimate Funding and Human Resource Limitations)

- Have any/all shortfalls in funding or human resources been identified?

Annex B.3: TEMP Development Process

The process for the development of the TEMP is described below in Figure B1 in the form of a Functional Flow Block Diagram (FFBD).

Figure B1: FFBD of the TEMP Development Process



This process is then broken down into the development of each section of the TEMP as described below.

The references to sections of the OCD are based on the OCD format contained in version 1.2 of the Capability Definition Documents (CDD) Guide. The references to section of the TCD are on the TCD format, which is also contained in version 1.2 of the CDD Guide. These are the latest versions of these formats at the time of writing.

Section 1 – The System Description

The mission description is described in **section 1.1** of the TEMP.

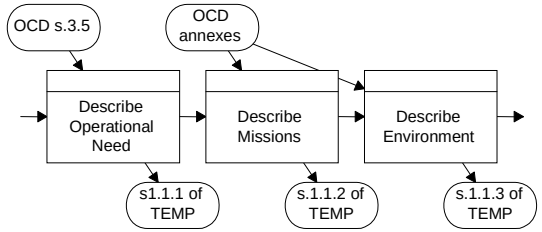
Within this section the operational need must be described in **section 1.1.1**. **Section 1.1.1** should contain the content of section 3.5 of the OCD for details on objectives of the system within the context of the sorts of missions it is to be used in and the general capabilities that the system must have. This section should refer to the OCD rather than paraphrase from the OCD to ensure that the intent of the OCD is fully captured and to simplify configuration control of the documents.

Section 1.1.2 should describe the missions that need to be accomplished by the system. This should be taken from the relevant annex of the OCD.

Section 1.1.3 should describe the logistical and operational environment that the system will be used in as per the operational scenarios listed in Annex A of the OCD. This section should also describe the type of physical environment in which the system will be used to provide a reference for determining the acceptance criteria for compliance against environmental engineering specifications.

The FFBD describing the process for developing **section 1.1** is provided below in Figure B2:

Figure B2: FFBD for development of TEMP section 1.1



The system description is described in **section 1.2** of the TEMP.

Within this section the key functionality of the system must be described in **section 1.2.1**. This should list the solution independent consolidated functional needs listed in section 3.6 of the OCD and the solution dependent description of the system functionality and performance in section 5.5 of the OCD.

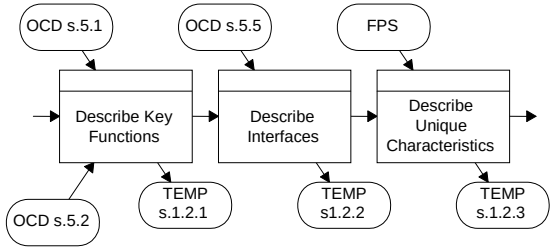
In **section 1.2.2** a brief description of the system architecture, a description of the hardware and software to be used, a general description of the components and sub-systems to be included for each configuration of the system and the internal and external interfaces of the system must be included. This information should initially be sourced from section 5 of the OCD. This section will need to be updated as further information becomes available, in particular after the receipt of the Contractor's system specification and in the event of any accepted engineering change proposals.

In **section 1.2.3** a list of the critical system characteristics and unique support concepts that will require special verification or validation requirements must be included. For instance, if the system threat assessment indicates that new countermeasures to the system being acquired are likely to emerge before the system is accepted for service then it may be that new threat simulators are required. These characteristics are potentially high-risk elements of the system, since they may impact greatly on the COIs, they may be difficult to verify or validate or they may be difficult to support logistically. Some of these characteristics can be determined from the system characteristics that impact greatly on the COIs and CTPs listed in sections 3.1 and 3.2 of the TCD respectively. The T&E support issues listed in section 3.3 of the TCD and the major

T&E activities listed in section 5.2 of the TCD may provide information as to which system characteristics will be difficult to verify or validate. The currently unsupported requirements in the FPS (i.e. those requirements that are intended to address the capability gap) are also likely to include unique system characteristics.

The FFBD describing the process for developing **section 1.2** of the TEMP is provided below in Figure B3:

Figure B3: FFBD for development of TEMP section 1.2



Section 1.3 should contain a list of the COIs taken directly from section 3.1 of the TCD. It may be that as new threats are identified or new requirements are added the COIs may change. This section of the TEMP will have to be reviewed when changes to the requirements are approved.

Section 1.4 should refer to the Threat and Risk Assessment for the system and should contain a summary of the threat environment copied directly from the Threat and Risk Assessment. The Threat and Risk Assessment should be the latest version from the DIO. There may be more than one Threat and Risk assessment, including perhaps a TEMPEST Threat and Risk Assessment. In this situation, all of those Threat and Risk Assessment that are relevant to describing the operational environment should be included in this section. This section is necessary because the likely countermeasures to a system need to be considered when developing plans for mission system validation.

The required operational characteristics should be described in **section 1.5**.
Section 1.5.1 should contain a list of the key operational effectiveness characteristics. This must consist of a hierarchy of measures including all of the operational effectiveness related COIs (i.e. those COIs that relate to how well the system needs to perform its intended mission), which can be taken from section 3.1 of the TCD, and the MOEs and MOPs that relate to each COI. See section 9.2 of the V&V Manual for a list of generic operational effectiveness characteristics taken from AS 4216. MOEs relate to things that the system must do and things that it must not do.

Section 1.5.2 should contain a list of the key operational suitability characteristics. This must consist of a hierarchy of measures including all of the operational suitability related COIs (i.e. those COIs that relate to the suitability for service of the system), MOSs and MOPs.

Examples of generic effectiveness and suitability characteristics are provided in sections 5.3 and 3.2 of the V&V Manual.

Section 1.5.3 should contain a list of evaluation thresholds. These should be based on the thresholds identified in the FPS. These evaluation thresholds should represent the level of performance to be demonstrated that will represent a level of risk (that the desired level of operational effectiveness and operational suitability won't be met) that the members of the IPT are willing to accept.

Sections 1.5.1 – 1.5.3 can, alternatively, be represented in the form of a table listing the COI, MOE, MOP, evaluation threshold, validation method and the CDD reference in a similar format to that in the example in Table B1 below. The validation method should be identified according to the V&V methods listed in section 8.2 of the V&V Manual and the validation activities should be determined based on the activities listed in section 5.2 of the TCD. Since the TCD contains only a basic list of V&V activities, further V&V activities will need to be identified in the TEMP such that sufficient V&V activities are planned to address all of the COIs.

The highest priority performance parameters (Key Performance Parameters) should be marked as such. Typically a system will have no more than 10 COIs, with a few MOEs per COI, a few MOPs per MOE and an evaluation threshold against each MOP.
A discussion of the identification of COIs, MOEs and MOPs is contained in section 9.2 of the V&V Manual and is also provided at the end of this section.

The validation method should be included in the table along with details of at which test activity compliance with respect to the evaluation threshold is expected. It may be that, due to time or budgetary constraints, that there may be different evaluation thresholds that the systems

performance will need to be judged against at different test activities. For instance, it may only be possible to test compliance with an evaluation threshold in a very limited sense in a demonstration but it may be possible to evaluate compliance with the threshold fully in the Operational Evaluation.

Table B1: An example of a table listing the Required Operational Characteristics for section 1.5 of the TEMP

COI	**MOE**	**MOP**	**Evaluation Threshold**	**Validation method and stage which validation will occur**	**CDD References**
COI 1: Are the detection capabilities of the radar system sufficient to support the user expectation in scenarios described in the OCD?	MOE 1.1: Probability of detection of aircraft type y in mission type x?	MOP 1.1.1 Mean and variance of detection range for a given type of aircraft*	1.1.1 Mean detection distance of plane of type y must be no less than x km with 90% confidence	Initially tested in a pre-Acceptance Test demonstration with 50% confidence At OpEval with 90% confidence	FPS para x OCD para y TCD para z
		MOP 1.1.2…	1.1.2…		
	MOE 1.2…	MOP 1.2.1…	1.2.1…		
		MOP 1.2.2…	1.2.2…		
COI 2: Are the targeting capabilities of the radar system sufficient to support the targeting needs in the missions described in the OCD?	MOE 2.1 The probability of target acquisition within an operationally acceptable time	MOP 2.1.1 Mean time to conduct one 360 degree sweep	2.1.1 The mean time to conduct one 360 degree sweep shall be no greater than 10 seconds with 90% confidence	Operational testing – to be validated in the OpEval	FPS para a OCD para b TCD para c
COI 3 Will the radar	MOS 3.1: Level of	MOP 3.1.1: The	The SAR must be less		FPS para r

be safe for typical personnel to use?	exposure to ionising radiation. (This is a measure of suitability since it does not directly relate to how well the radar performs but relates to its suitability for use)	maximum Specific Absorption Rate (in W/kg) that a user will be exposed to.	than AS2772.1 requirements for maximum occupational exposure to ionising radiation		

∗ indicates Key Performance Parameters

The key technical effectiveness characteristics need to be defined in **section 1.6**. This must include the CTPs from section 3.2 of the TCD. The CTPs may include critical inter-operability requirements (such as the system shall be capable of being powered by a 240V 50Hz power supply), critical design constraint requirements from the FPS. The CTPs are any important technical characteristic of the system that the system *must* have in order for the operational need to be satisfied.

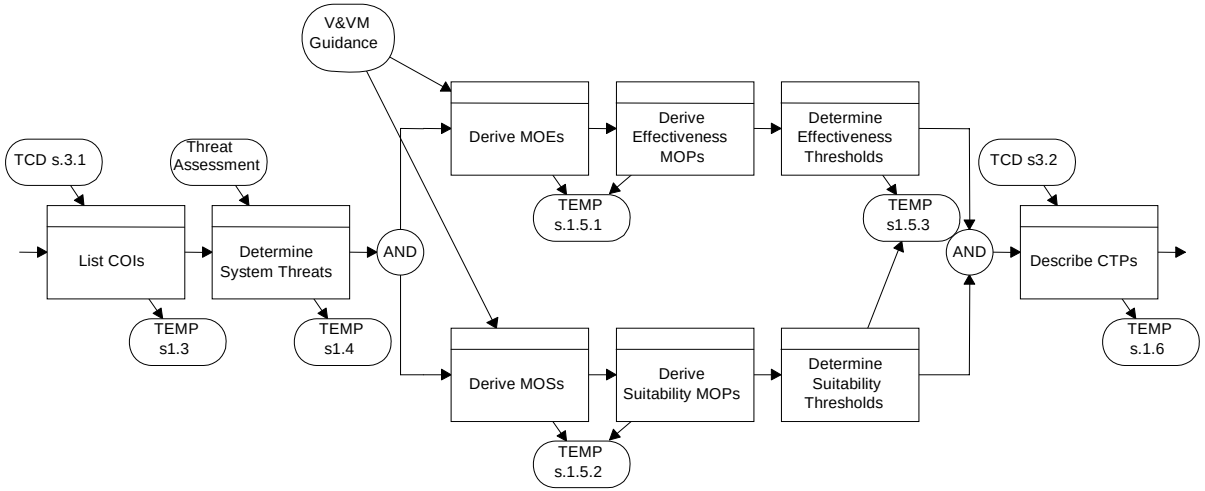
The CTPs must be described in the form of a table in the following format. An example is provided in Table B2 to demonstrate the concept:

Table B2: An example of a table listing the Key Technical Effectiveness Characteristics for section 1.6 of a TEMP

Critical technical parameter	**CDD Reference**	**V&V activity in which compliance will be verified**	**Decision Supported**	**Threshold Value**
CTP 1: Bore of the main tank gun	FPS para x	Inspection prior to Acceptance Test	System Acceptance	Must be 155mm±0.5mm

The process for producing sections **1.3 – 1.6** is described in the FFBD in Figure B4.

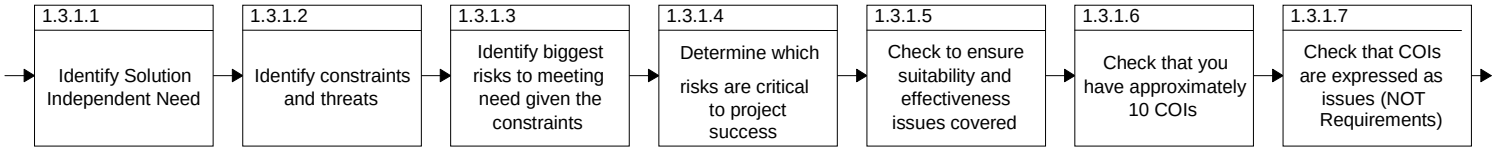
Figure B4: FFBD for development of TEMP sections 1.3-1.6



The process for producing the COIs, MOEs, MOSs, MOPs and CTPs

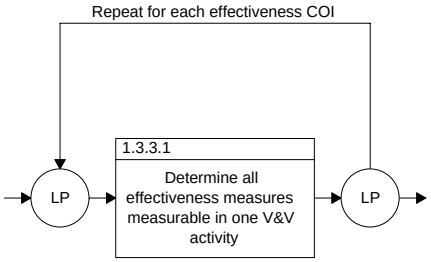
If the COIs are not listed in the TCD or the OCD it will be necessary to produce the COIs in consultation with the other members of the IPT using the process described in Figure B5.

Figure B5: FFBD for deriving COIs



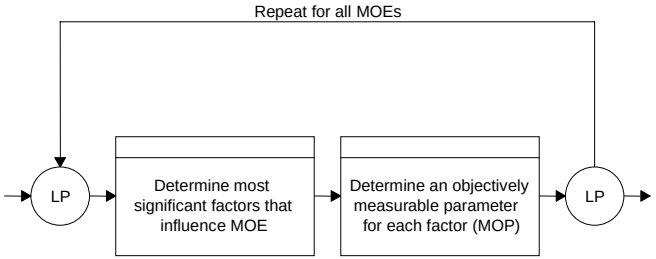
The MOEs should be derived in consultation with the other members of the IPT as per the process described in Figure B6.

Figure B6: FFBD for deriving MOEs



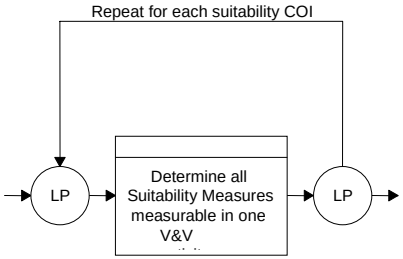
The Effectiveness MOPs should be derived in consultation with the other members of the IPT as per the process described in Figure B7.

Figure B7: FFBD for deriving Effectiveness MOPs



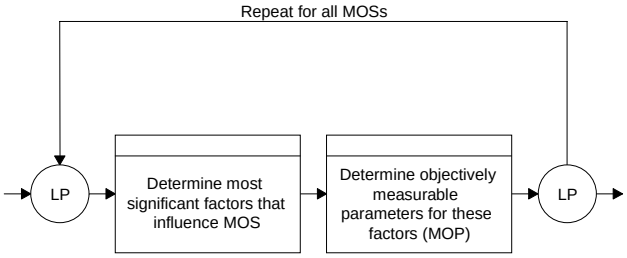
The MOSs should be derived in consultation with the other members of the IPT as per the process described in Figure B8.

Figure B8: FFBD for deriving MOSs



The Suitability MOPs should be derived in consultation with the other members of the IPT as per the process described in Figure B9.

Figure B9: FFBD for deriving Suitability MOPs



The CTPs should be derived in consultation with the other members of the IPT by examining the 'essential' technical requirements from the FPS. Consideration of what level of 'important' requirements that can fail before the system under test (SUT) can be deemed to have reached a Critical failure level must also be made. The OCD should also be checked for possible additional CTPs, which were not transferred into the FPS.

Section 2 – The Program Summary

A short description of the project phases and the associated V&V phases should be contained in **section 2.1**. This should include a description of the project phases, which should be taken from the Equipment Acquisition Strategy (EAS) and the project V&V phases, which should include all of the phases described in section 5.2 of the TCD. This section will need to be updated if there are any major changes to the scope of any phases of the project.

A description of the responsibilities of all stakeholders in relation to V&V should be contained in **section 2.2**. The major stakeholders whose roles need to be described in this section will include as a minimum the DMO SPO, the Contractor, T&E Agency and the Sponsor. This should describe the responsibilities of the stakeholders with respect to all of the V&V activities discussed in this TEMP. For instance, the role of the Contractor in planning, conducting and reporting on the Acceptance Testing should be identified and the role of the DMO (in consultation with the T&E Agencies if required) in reviewing and approving the ATP, ATProcs (including the acceptance criteria) and the ATR should be

identified. As the roles of stakeholders change this section will need to be updated. This section could be described in a table that clearly identifies the responsibilities of the various stakeholders. Sources of information for developing this section are the details contained in section 4.1 of the TCD, the Contract, the System Review Guide, the ASDEFCON (SM) Handbook and consultation with the project stakeholders.

The responsibilities of the project stakeholders for the funding of the V&V activities should be discussed in **section 2.3**. This should be refined from the TCD and should address the complete list of V&V activities discussed in the TEMP is section 1.5. This section must be updated to ensure that the priority of funding of various V&V activities is kept up to date. It is also important to ensure that the level of funding of V&V activities is commensurate with the level of risk mitigation that the V&V activity will contribute to such that adequate resources will be devoted to conducting V&V early in the project lifecycle. Advice on the cost of various T&E activities should be sought from the relevant T&E agencies and the users. The agreement of the various stakeholders with respect to the level of funding that they are responsible for must be obtained prior to producing this section.

Section 2.4 should contain an integrated schedule in the form of a Gantt Chart detailing the project phases and V&V phases (including Validation phases such as OpEval, OA, IOT&E or FOT&E, AV&V phases, DT&E phases and other V&V phases). It should also indicate relevant decision points, such as when Design Acceptance, System Acceptance and Acceptance Into Service should occur. This should also contain details of funding and responsibilities of the project stakeholders with respect to funding. The decision points should include important dates such as the various system reviews, contract signature and the In-Service Date. The major V&V activities identified in the tables in sections 1.5 and 1.6 of the TEMP should also be identified in the integrated summary.

This section should follow the format indicated in Table B3.

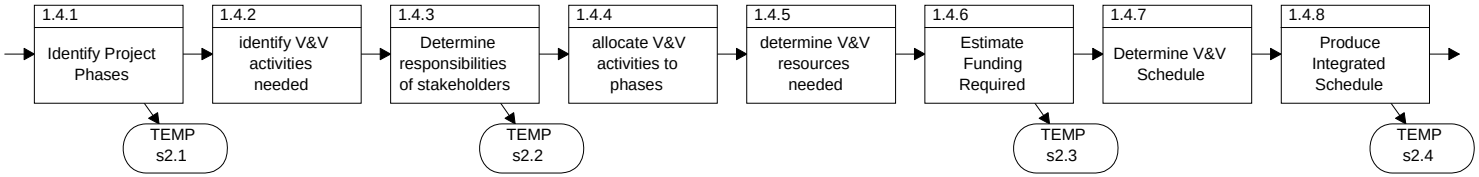
Table B3: Integrated Test Schedule format

	FY 03/04	FY 04/05	FY 05/06	FY 06/07
Milestone				
Formal Solicitation / Release				
Contract Award / Event				
Deliveries				
DT&E activities				
AV&V activities				
Validation (OT&E) activities				
DMO expenditure on T&E	$x	$x	$x	$x
Service expenditure on T&E	$x	$x	$x	$x
Total T&E expenditure	$x	$x	$x	$x
Total project expenditure	$x	$x	$x	$x

This area should contain a Gantt Chart showing the schedule of the DT&E, AV&V, Validation activities, the delivery of capability, contract signature, delivery of various contract deliverables and phases of the project.

An FFBD describing the process for developing **section 2** of the TEMP is described in Figure B10.

Figure B10: FFBD for development of TEMP section 2



Section 3 – DT&E Outline

Section 3.1 should contain a list of the critical DT&E issues. This would include the critical issues listed in the TCD in section 3.2 that would be best addressed in DT&E. The V&V methods used to address these critical issues should be discussed here. The discussion of critical DT&E issues will cover how the achievement of the CTPs will be verified in terms of:

- what activities will be conducted to verify that the CTPs have been met;
- what the critical resource requirements are for these activities;
- what risks there may be to achieving these CTPs; and
- what will be done to mitigate these risks.

Section 3.2 should discuss the DT&E conducted to date. This will include the range of V&V activities described in section 8.2 of the V&V Manual (i.e. audits, comparisons, inspections, demonstrations and analysis) as they relate to V&V throughout the development of the system. This section should also provide a brief description of the functional configuration of the system when these activities were conducted. For example, it may be mentioned that a particular DT&E activity was conducted using a particular version of a software package that is being developed as a major component of the system. After the V&VP has been produced this section should refer to the V&VP for further details on the DT&E conducted by the Contractor to date. Importantly, this section should also highlight any high priority deficiencies in the system with respect to requirements (i.e. defects) identified so far and the methods proposed for rectifying these defects.

Section 3.3 should discuss the future DT&E activities to be conducted. After the V&VP has been produced this section should refer to the V&VP for further details on the DT&E responsibilities of the Contractor.

Section 3.3.1 should contain a discussion of the objectives of each of the future DT&E phases for the project. This section should also contain a diagram explaining the hierarchy of DT&E related test plans and procedures. The relationship between the outputs of these DT&E phases and the decision points throughout the project should be described here.

Section 3.3.2 should contain a listing of the future DT&E activities along with details of the objectives and scope the each of these activities in terms of what decisions they will support and what parts of the Acquisition Baseline they will verify compliance with. This section should also provide a brief description of the functional configuration status of the system that is expected when these activities are to be conducted.

Section 3.3.3 should contain a list of the critical resource requirements for conducting these DT&E activities in terms of the personnel, funding and equipment required. This section should also contain a discussion of how the risks associated with obtaining these resources will be mitigated.

Section 3.3.4 should contain a discussion of the constraints and limitations that apply to the DT&E activities, how the limitations will affect the ability to draw conclusions from the data and how these limitations may be overcome in other non-developmental V&V activities (e.g. Mission System Validation).

Section 4 – Validation Outline (including OT&E)

Section 4.1 should contain a list of the critical validation issues (i.e. the COIs). The COIs would derive from section 3.2 of the TCD. The methods used to address both the effectiveness and suitability COIs should be discussed here. The main method for validation is OT&E. The discussion of critical validation issues will cover how the achievement of the COIs will be validated in terms of what activities will be conducted to verify that the COIs have been resolved, what the critical resource requirements are for these activities, what risks there may be to achieving these COIs and what will be done to mitigate these risks. There may be a combination of validation methods used to resolve the COIs. A discussion of why the particular validation methods proposed for resolving the COIs were deemed to be the most accurate, timely and cost effective methods for resolving the COIs should be included in this section. This section should also highlight any high priority deficiencies in the system with respect to requirements (i.e. defects) identified so far and the methods proposed for rectifying these defects. This section should also highlight any high priority deficiencies in the system with respect to validation (i.e. defects) identified so far and the methods proposed for rectifying these defects.

Section 4.2 should discuss the validation conducted to date. This discussion of validation conducted to date should include the OT&E activities as well as the range of validation activities other than OT&E. This will include the range of V&V activities described in section 8.2 of the V&V Manual (i.e. audits, inspections, demonstrations and analysis) as they relate to validation of the mission system and the validation of the support system's contribution to maintaining the operational suitability of the system. This section should also provide a brief description of the functional configuration status of the system when these validation activities were conducted and the scenarios in which the validation was conducted. For example, it may be mentioned that validation activity X was conducted using version or configuration Y of the system in operational scenario Z described in the OCD. After the Validation Plan has been produced this section should refer to the Validation Plan for

further details on validation activities conducted to date. After the V&VP is produced this section should refer to the V&VP for further details on the Contractor's involvement in validation activities.

Section 4.3 should discuss the future validation activities to be conducted.

Section 4.3.1 should contain a discussion of the overall objectives of future validation phases for the project (e.g. Operational Evaluation, FOT&E etc.). This section should also contain a diagram explaining the hierarchy of validation related test plans and procedures. The relationship between the outputs of these validation phases and the decision points throughout the project should be described here.

Section 4.3.2 should contain a listing of the future validation activities along with details of the objectives and scope the each of these activities in terms of what decisions they will support and what parts of the Capability Baseline they will validate the system against. This section should also provide a brief description of the functional configuration status of the system that is expected when these activities are to be conducted.

Section 4.3.3 should contain a list of the critical resource requirements for conducting these validation activities in terms of the personnel, funding and equipment required. This section should also contain a discussion of how the risks associated with obtaining these resources will be mitigated.

Section 4.3.4 should contain a discussion of the constraints and limitations that apply to the validation activities and how the limitations will affect the ability to draw conclusions from the data. It should also discuss how these limitations may be overcome in other V&V activities or whether the Capability Manager would be willing to accept the risk resulting from the uncertainties in the results of the validation activities due to the limitations of the validation activities.

Section 5 – AV&V Outline

Section 5.1 should contain a list of the critical AV&V issues (i.e. the highest priority acceptance criteria). This would include the critical issues listed in the TCD in section 3.2 that would be best addressed in AV&V. The V&V methods used to address the high priority acceptance criteria should be discussed here. The main method for AV&V is Acceptance Testing. The discussion of critical AV&V issues will need to include a discussion of how the achievement of the acceptance criteria will be verified. This will include a list of AV&V activities that will be conducted to verify that the acceptance criteria have been met, what the critical resource requirements are for these activities, what risks may prevent meeting the acceptance criteria and what will be done to mitigate these risks. There may be a combination of AV&V methods used to verify that

the acceptance criteria have been met. A discussion of why the particular V&V methods proposed for verifying that the acceptance criteria have been met were deemed to be the most accurate, timely and cost effective methods for verifying that the acceptance criteria have been met should be included in this section. Importantly, this section should also highlight any high priority deficiencies in the system with respect to acceptance (i.e. defects) identified so far and the methods proposed for rectifying these defects.

Section 5.2 should discuss the AV&V conducted to date. This should include the Acceptance Testing as well as the range of other V&V activities needed to ensure compliance with the requirements listed in the FPS and the acceptance criteria. This will include any mission system and support system validation activities that the Contractor has been contracted to perform. This may include the range of V&V activities described in section 8.2 of this manual (i.e. audits, comparisons, inspections, demonstrations and analysis) as they relate to validation of the mission system and the validation of the support system's contribution to maintaining the operational suitability of the system. This section should also provide a brief description of the functional configuration status of the system when these activities were conducted and the scenarios in which the validation was conducted. After the V&VP has bee produced this section should refer to the V&VP for further details on the Contractor's involvement in validation activities. This section should also refer to the ATP, ATProcs, ATR and VCRM for further details on AV&V conducted to date. Whether the DMO has reviewed approved the Contractor's V&VP, ATP, ATProcs, ATR and VCRM should also be mentioned in this section.

Section 5.3 should discuss the future AV&V activities to be conducted.

Section 5.3.1 should contain a discussion of the overall objectives of future AV&V activities for the project (e.g. Acceptance Testing). This section should also contain a diagram explaining the hierarchy of AV&V related test plans and procedures. The relationship between the outputs of these AV&V activities and the decision points throughout the project should be described here.

Section 5.3.2 should contain a listing of the future AV&V activities along with details of the objectives and scope the each of these activities in terms of what decisions they will support and what parts of the Acquisition Baseline they will verify compliance with. This section should also provide a brief description of the functional configuration status expected of the system when these activities are to be conducted.

Section 5.3.3 should contain a list of the critical resource requirements for conducting these AV&V activities in terms of the personnel, funding and equipment required. This section should also contain a discussion of how the risks associated with obtaining these resources will be mitigated.

Section 5.3.4 should contain a discussion of the constraints and limitations that apply to the AV&V activities and how the limitations will affect the ability to draw conclusions from the data. It should also discuss how these limitations may be overcome in other V&V activities, such as Defence-run validation activities, or whether the Capability Manager would be willing to accept the residual risk resulting from the uncertainties in the results of the AV&V activities due to the limitations of the AV&V activities.

Section 6 – Safety

Section 6.1 should describe how safety issues will be assessed. Under ASDEFCON (SM) the Contractor would be expected to produce a System Safety Program Plan (SSPP) and a Safety Case Report (SCR) as per the ASDEFCON (SM) DIDs. This section will refer to the SSPP and SCR and provide a summary of the V&V activities that need to be conducted in order to assure the Capability Manager that the residual safety risks associated with use of the system are acceptable. The standard that the Contractor will use for assessing safety risks and for safety assurance (i.e. mitigation of unacceptable safety risks) must be specified in this section of the TEMP.

Section 6.2 should list the highest risk safety issues, as listed in the Safety Case Report. It should also outline the schedule for the verification activities that will ensure that the highest priority risks will be mitigated to an extent such that the Capability Manager would deem the residual risk acceptable. The status of safety assessment activities and the status of verification of System Safety Requirements should be updated in this section after each major safety assessment or safety verification activity to reflect the current status of the safety assurance program.

Section 6.3 should describe the methods to be employed and the standards to be complied with for ensuring safety within V&V activities with particular emphasis placed on the Mission System Validation activities.

Refer to the Safety thread in QEMS (http://qems.dcb.defence.gov.au) for further information on safety.

Section 7 – Speciality Test Programs

Section 7.1 should contain a list of the Specialty Test Program requirements.

The Specialty Test Program includes test and evaluation to verify compliance with requirements pertaining to specialty engineering fields.

This includes verification of requirements in relation to system security, standardisation (e.g. compliance with various safety standards), human factors engineering, electromagnetic interference and electromagnetic compatibility (EMI/EMC), environmental engineering, vulnerability to sophisticated threats such as EW systems and compliance with frequency spectrum restrictions.

Section 7.2 should contain a list of critical issues that have been resolved within the Specialty Test Program and the critical issues expected to be resolved within the remaining parts of the Specialty Test Program. This section should also describe any major system defects with respect to the specialty engineering fields relating to the system and what will be done to rectify these defects.

Section 8 – Supportability Verification and Validation Plan

This section should contain an overview of objectives of the Supportability Verification and Validation (SV&V), provide a summary of SV&V activities conducted to date and SV&V activities to be conducted in the future. This section should describe the hierarchy of SV&V plans and an overview of the SV&V process. This section should also refer to the source in the FPS and OCD for SV&V requirements. This section should also refer to the SV&VP for further details.

Section 9 – Transition Plan

This section should describe the V&V evidence required for Acceptance Into Service and should describe the relationship between the TEMP and the Transition Plan. It should list the schedule for conducting the major V&V activities that need to be completed to achieve the ISD (especially the IOT&E activities). This section should describe and list the status of any risks to the successful completion of the test activities required to achieve AIS. This section should be updated if the scope of the IOT&E activities that need to be completed to achieve AIS changes.

Section 10 – Special Resource Summary

Section 10.1 should contain a schedule of V&V activities that have special resource requirements. These are resources that may be expensive or difficult to obtain.

Section 10.2 should contain the details of the special resource requirements in terms of facilities, GFM and special instrumentation for each of the V&V activities listed in section 10.1. This may include targets, threat simulations or other simulations and models, ranges or other T&E facilities and other special support.

Section 11 – Human Resource Limitations

Any significant risks associated with obtaining suitably qualified staff to plan, conduct, analyse or report on V&V activities that have not been identified in previous sections should be listed in this section. The proposed means by which these risks will be mitigated should be described in this section.

Annex C: V&V in the CDD Process

Application of Validation and Verification (V&V) activities to the CDD process is critical to ensure that the requirements documentation used in the Materiel Life Cycle provides a sound, accurate and complete representation of Defence needs.

The term V&V is conventionally used to describe activities undertaken across a system development lifecycle, which commence with a user requirement and conclude with an operational capability. In the context of system design, development and construction V&V is usually applied after the user requirements have already been defined. An extended view of V&V must be taken for the Materiel Life Cycle, that is V&V should be applied when developing requirements through the CDD process. This extended view draws on the principles of Systems Engineering (SE) and Requirements Engineering (RE) as they apply to the CDD process.

Validation must be applied to confirm that requirements baselines produced through requirements elicitation and analysis are accurate and complete representations of the user needs, relevant constraints and meet an established set of criteria. Validation activities should therefore be applied to requirements baselines developed within the CDD process such as the OCD and FPS.

When the SE process is used to develop increased requirements detail through functional analysis and design synthesis activities, verification must be applied to the resulting outputs. In particular there must be complete traceability between the requirements baseline and functional and physical architectures and a complete absence of voids and conflicts between these entities. Given that development of the OCD and FPS can involve some level of functional analysis and synthesis, relevant outputs of the CDD process must be confirmed through functional and physical verification.

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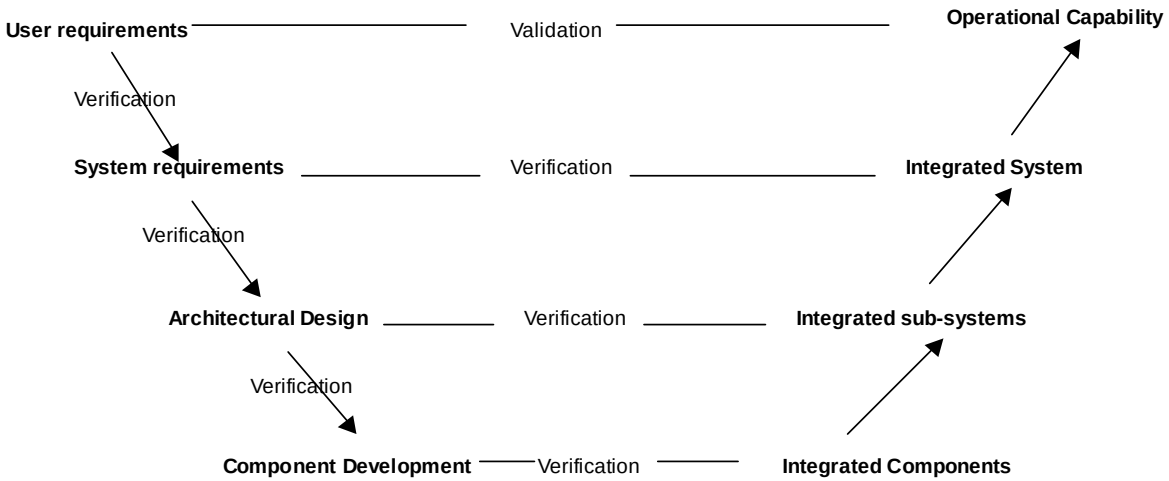
Vee Process Model

When considering V&V across a system development lifecycle it is frequently described through a Vee Process Model (Figure C1). This model starts with user needs on the upper left and ends with a user-validated operational capability on the upper right. Validation is undertaken by comparing the user requirements with the completed operational capability ie. validating that the requirements for the intended use have been fulfilled. On the left side decomposition and definition activities progressively resolve the system architecture, creating details of the design. Verification is undertaken down the left side of the 'Vee' as each level of system design is developed ie top level system requirements, architectural design through to definition of components. In this way verification confirms that the higher level design requirements have been fulfilled by the lower level design details. Verification is also undertaken across to the right side of the 'Vee' by confirming that each level of the design has been satisfied by the corresponding level of the produced system ie successively higher levels of subsystems are verified against the corresponding design, culminating at the system level.

Figure C1: Vee Process Model



In addition to this, requirements validation, where requirements are checked to ensure that compliance with the requirements would imply the fitness for purpose of the system, is also conducted during the development of the CDDs.

In requirements validation the following issues must be considered:

1. Conformance to Documentation Standards: the document structure and individual requirements must conform to relevant documentation standards eg inclusion of all necessary sections as defined in the OCD, FPS and TCD DIDs. If there is a departure from the standards it should be justified;

2. Conformance to Editorial Standards: the requirements document must not possess any spelling errors, cross-reference errors, incomplete text and diagrams, and all diagrams, tables etc. must be correctly numbered and referenced;

3. Understandability: individual requirements must be expressed clearly and be readily understood.

4. Ambiguity: requirements must be expressed using terms which are clearly defined. It should not be possible to make different interpretations of the same requirement;

5. Completeness: There should not be any information missing from individual requirements nor should the overall requirements baseline (RB) be missing requirements at the system level. The RB must be assessed to determine whether: all identified Sponsor expectations and project and external constraints have been addressed; and that the full spectrum of possible system operations and system life cycle support concepts has been adequately addressed;

6. Consistency: There must be consistency between requirements, i.e. there should not be inconsistencies or contradictions between individual requirements or individual requirements and higher level requirements e.g. at the system level;

7. Redundancy: Information should not be unnecessarily repeated in the RB;

8. Traceability: Each requirement must be unambiguously identified and clearly show links to higher level requirements or other sources from which it originated. All relationships between requirements must be provided.

9. Accuracy: The RB must accurately represent identified Sponsor expectations and project and external constraints.

10. Organisation: The description of requirements must be organised so that the system capabilities can be easily understood and related requirements are readily recognised.

11. Testability: All requirements should be testable, that is it should be possible to define one or more tests that may be carried out on the finished system which will clearly demonstrate that the requirement has been met. Development of test cases at this stage can reveal problems in requirements such as incompleteness or ambiguity and thereby assist in validating the requirement.

12. Feasibility: The requirements must be assessed to determine whether they can be implemented with the technology available or other constraints.

13. Validity of Models: Part of the RB may include one or more system models, such as data-flow models of the system's functionality, object models, event models etc. which must be checked for internal and external consistency. All models must include all information which is necessary, possess no conflicts between the parts of a model, and no conflicts between different models.

Assessing validity of the RB may result in identification of a range of deficiencies, which will require rectification. Depending on the type of deficiency, rectification action will usually require:

1. Rewriting and/or restructuring the content of the document (including individual requirements) to improve understanding, consistency etc;
2. Repeating Requirements Analysis to identify requirements which are missing, incomplete, untraceable etc; and
3. Negotiating between stakeholders to resolve conflicts or deficiencies which are not the result of inadequate Requirements Analysis.

Applying the above concepts to the CDD process, RB Validation can be defined as the activities, which evaluate the RB to ensure compliance with Sponsor expectations, project and organisational constraints and external constraints. Two major iterations of the RB will be the completed OCD and the FPS, although there may be a number of iterations of these documents prior to their completion. RB Validation should be performed at the conclusion of any Requirements Analysis activities within the CDD process and most importantly at the completion of any major CDD document. The inputs to the RB Validation process are the RB, higher-level requirements statements, relevant organisational standards, and organisational and domain knowledge. The outputs of the RB Validation process are a list of problems of the current RB document (such as variances and conflicts), an agreed list of actions to rectify the problems (including iterating through Requirements Analysis), and ultimately, a validated RB document.

Further details on requirements validation in the development of CDDs is contained in the CDD Guide, which can be found on QEMS at *http://qems.dcb.defence.gov.au*

Annex D: Acronym List

ABR	Australian Book of Reference
ADSO	Australian Defence Simulation Office
AINS	Acceptance Into Naval Service
AIPS	Australian Illustrative Planning Scenarios
AIS	Acceptance Into Service
AMAFTU	Australian Maritime Aviation Flight Test Unit
AOSG	Aerospace Operational Support Group
ARDU	Aircraft Research and Development Unit
ASDEFCON (SM)	ASDEFCON (Strategic Materiel)
AT&E	Acceptance Test and Evaluation
ATP	Acceptance Test Plan
ATProcs	Acceptance Test Procedures
ATR	Acceptance Test Report
AV&V	Acceptance Verification and Validation
CCP	Contract Change Proposal
CDD	Capability Definition Documents (i.e. OCD + FPS + TCD)
CDG	Capability Development Group
CDRL	Contract Deliverable Requirements List
CM	Capability Manager
COI	Critical Operational Issue
COTS	Commercial Off The Shelf
CSLCMM	Capability Systems Life Cycle Management Manual
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTP	Critical Technical Parameter
DDR	Detailed Design Review
DGNAVSYS	Director General Navy Systems
DGTA	Directorate General Technical Airworthiness
DID	Data Item Description
DMOT&EWG	DMO Test and Evaluation Working Group
DRN	Defence Restricted Network
DSE	Directorate of Systems Engineering (in Materiel Policy and Services Branch)
DSM	Defence Security Manual
DT&E	Development Test and Evaluation
DTR-A	Directorate of Technical Regulation - Army
DTRIALS	Directorate of Trials
ED	Effective Date
EMC	Electromagnetic Compatibility
EW	Electronic Warfare
FA	Functional Architecture
FCA	Functional Configuration Audit
FFBD	Functional Flow Block Diagram
FOT&E	Follow-On Operational Test and Evaluation
FPS	Functional and Performance Specification
FRACAS	Failure Reporting and Corrective Action System

IOT&E	Initial Operational Test and Evaluation
IPT	Integrated Project Team
IV&V	Independent Verification and Validation
JALO	Joint Ammunition Logistics Organisation
KPP	Key Performance Parameter
LEA	Land Engineering Agency
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Suitability
NATA	National Association of Testing Authorities
NAVSYSCOM	Navy Systems Command
OA	Operational Assessment
OCD	Operational Concept Document
OpEval	Operational Evaluation
OSG	Ordnance Safety Group
OT&E	Operational Test and Evaluation
PA	Physical Architecture
PCOD	Preliminary Capability Options Document
PR	Problem Report
PT&E	Product Test and Evaluation
QEMS	Quality and Environmental Management System
RANTEAA	Royal Australian Navy Test, Evaluation & Analysis Authority
RE	Requirements Engineering
RB	Requirements Baseline
S3	Safety and Suitability for Service
SCR	Safety Case Report
SE	Systems Engineering
SEEC	Systems Engineering and Evaluation Centre (University of South Australia)
SPO	System Program Office
SRR	System Requirements Review
SSPEC	System Specification
SSPP	System Safety Program Plan
SSR	System Safety Requirement
SSSPEC	Support System Specification
ST&E	Supportability Test and Evaluation
SUT	System Under Test
SV&V	Supportability Verification and Validation
SV&VP	Supportability Verification and Validation Plan
T&E	Test and Evaluation
T&EA	Test and Evaluation Agency
TAMM	Technical Airworthiness Management Manual
TCD	Test Concept Document
TEMP	Test and Evaluation Master Plan
TRA	Technical Regulatory Authority
TRAMM	Technical Regulation of Army Materiel Manual
TRR	Test Readiness Review
V&V	Verification and Validation

V&VP	Verification and Validation Plan
VCRM	Verification Cross Reference Matrix