THE AUDIT OFFICE

THE QUALITY AND RELIABILITY OF DEFENCE EQUIPMENT: THE ARMY

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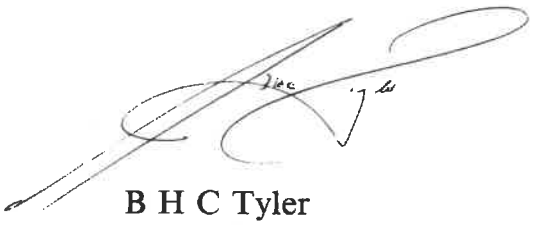
THE QUALITY AND RELIABILITY OF DEFENCE EQUIPMENT: THE ARMY

This report is one of a series of reports published this year as a result of major value for money studies undertaken by the Audit Office.

Considerable public expenditure is involved with defence equipment and the quality and reliability of that equipment is essential. In producing this report we have focused on the Army and the attention it pays to the quality and reliability of its equipment. This audit reviewed the Scorpion armoured fighting vehicle specifically and makes other more general assessments.

It is appropriate to acknowledge the work of the three officers from my Major Projects Group primarily responsible for the report, Bill Gebbie, Anne Gooch and Keith Marshall.

I hope that the results of this audit, as set out in this report, will make a useful contribution to increasing the attention paid to the quality and reliability of equipment by the Army specifically and the New Zealand Defence Force in general.



B H C Tyler
Controller and Auditor-General

31 August 1990

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Introduction

Equipment is critical to an effective defence force. The quality and reliability of equipment is essential where lives may depend on that equipment. Around $200 million will be spent on capital equipment this year by the New Zealand Defence Force.

The range and complexity of defence equipment precludes examining the quality and reliability of each item. Further, each service applies different equipment management policies. In order, therefore, to gain an insight into the quality and reliability of defence equipment, an initial audit in one service was necessary. Separate audits of the other services are currently under way.

We chose the Army for our initial audit. For a sample item of equipment within the Army, we selected the Scorpion because it met our criteria of military and financial significance and was not too numerous. The Scorpion is this country's only tank, the purchase price was $19 million in 1980, replacement would cost around $50 million and there are only 26 of them.

Having assessed the information that existed, we determined that we could review the initial procurement of the Scorpion, its in-service performance and a proposed overhaul. The fieldwork involved review of files, interviews with people connected with the Scorpion including vehicle and workshop personnel, and analysis of available data.

Findings—Scorpion

The procurement process was unsatisfactory and inadequate attention was paid to the quality of the Scorpion. Shortcomings of the process included:

- directly assessing only one alternative vehicle at the time of selection;
- no assessment of whole-of-life costs;
- buying more vehicles than could be justified at the time;
- purchasing the Scorpion without adequate regard for known defects; and
- subsequently conducting no trial. (Paragraphs 412–436.)

The Scorpion's in-service performance reflects the procurement decisions. Our analysis indicates that, overall, the proportion of operational vehicles in the combat unit is, on average, no better than 54%. That is, only around half the Scorpions are operational at any one time. It is fortunate that spare vehicles are available because these were not an original requirement. However, even with the spare vehicles, we have doubts as to whether the Army could meet all its operational requirements. (Paragraphs 514–523.)

Furthermore, the Army cannot determine the reliability of the Scorpion or its components. This situation is potentially serious considering the reliance placed on equipment. (Paragraphs 610–616).

A proposed $10.5 million overhaul of the Scorpion includes various hull components including the engine. The basic information neccessary to justify an overhaul has not been produced. Indeed, our analysis indicates that the engine does not warrant overhaul on mechanical grounds. There may be other valid reasons, however, stemming

from improvements to military capability. We believe, therefore, that the Army should reconsider the costs and benefits associated with the overhaul. (Paragraphs 708–718.)

Conclusions

Inadequate technical understanding of reliability, combined with a lack of reliability standards and reliability information, indicates to us that the Army cannot assure or assess the reliability of its equipment. Inadequate attention to reliability directly affects operational capability. Furthermore, unreliable equipment costs money through down-time, repairs and overhauls. The Army's financial systems are not, however, adequate enough to estimate the costs associated with unreliable equipment.

Given these factors, we can only conclude that the Army does not yet pay adequate attention to the reliability of its equipment. (Paragraphs 801–812.)

In the case of Scorpion, it is difficult to conclude that the vehicle has provided value for money given that:

- too many were bought;
- the proportion of operational vehicles is low; and
- an inadequately justified overhaul is proposed.

To its credit, the Army appears to have recognised its past failings and has instituted a new system to specify quality and reliability in purchase contracts and to monitor ongoing equipment performance. However, it will be some 12 to 18 months before this system is fully in place.

1

INTRODUCTION

Mandate

101 This audit examines the attention paid to the quality and reliability of New Zealand Defence Force equipment. The authority for the audit is section 25(3) of the Public Finance Act 1977.

Scope

102 Armed forces must have both equipment and personnel to be able to enter a conflict.

103 In the 1989/90 year, around $200 million has been allocated to the purchase of capital equipment for the New Zealand Defence Force. The total value of existing equipment is estimated to exceed $3.5 billion. With such a large amount of equipment, there are considerable costs associated with poor performance. Non-financial costs include the impact on military capability.

104 Given the reliance placed by the armed forces on their equipment, the quality and reliability of that equipment is critical.

105 This audit focuses, therefore, on the attention the New Zealand Defence Force pays to those factors.

Audit Approach

106 The range and complexity of defence equipment precludes examining the quality and reliability of each item. Further, each armed service applies different equipment management policies. In order, therefore, to gain an insight into the quality and reliability of defence equipment, we chose to conduct separate audits of each service.

107 We selected the Army for our initial audit. Our criteria for an item of equipment were that the item was not too numerous and had military and financial significance. The Scorpion armoured fighting vehicle met these criteria. Additionally, a proposed overhaul provided an opportunity to examine the Army's reasons for that overhaul.

108 In order to assess quality and reliability, it is necessary to describe what is meant by those two words. In New Zealand Standard 5604:1987, which is internationally adopted, the definitions are:

- Quality; the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.
- Reliability; the ability of an item to perform a required function under stated conditions for a stated period of time.

109 It is these definitions that we have applied when referring to quality and reliability.

110 Common to both definitions are pre-stated functions or needs. For audit purposes, therefore, the first stage is to establish those functions or needs. In the case of Scorpion, this required identifying the intended role of the vehicle.

111 The inherent quality and the reliability of equipment becomes apparent during its operation in service. Accordingly, we focused on the in-service performance of Scorpion and related that to its procurement and proposed overhaul.

112 To assess in-service performance, we reviewed:

- the operational state of vehicles; and
- the actual reliability.

113 The report structure arising from this audit is, therefore, as follows:

- Background;
- Role;
- Procurement;
- Operational state of vehicles;
- Reliability; and
- Overhaul.

114 While our audit concentrated on the Scorpion, we did test the Army's reliability information systems in general. The final two sections in this report cover the attention paid by the Army to reliability generally and conclude by offering some general comments based on our experience with the Scorpion.

2

BACKGROUND

Introduction

201 Two organisations share the responsibility for defence; the Ministry of Defence and the New Zealand Defence Force. The Ministry of Defence is responsible for policy advice and monitoring. The New Zealand Defence Force provides the necessary support and co-ordination of the Air Force, Army and Navy.

202 Although co-ordinated by Defence Force Headquarters, each armed service operates autonomously and has a different structure.

203 In simple terms, the Army's main functions are combat, represented by operational combat units. Two activities support this main function:

- training; represented by various training schools; and
- logistics; represented by supply and workshop units.

Explanatory Notes

204 This report uses various terms which are described below:

- **Ready Reaction Force**; consisting of infantry, armoured vehicles, artillery and supporting services capable of being deployed at short notice for low intensity conflicts.
- **Integrated Expansion Force**; consisting largely of all the Army combat units, including Territorial Forces, and the necessary logistic and other support for extended low intensity conflicts or for higher intensity conflicts.
- **Main Battle Tank**; this tank has tracks and is equipped with heavy armour and a large gun so that it has the ability to both inflict and withstand substantial damage.
- **Fire Support Vehicle**; can have wheels or tracks and is usually equipped with light armour and a less powerful gun than a Main Battle Tank; intended to operate in the absence of enemy tanks to provide direct fire in support of friendly forces.
- **Direct Fire**; gun-fire when the target is in the line of sight.
- **Tank Squadron**; a combat formation consisting primarily of tanks and intended to provide anti-tank and other direct fire support.
- **Cavalry Squadron**; a combat formation with a mix of armoured vehicles; intended for reconnaissance, direct fire support and other duties.
- **Reconnaissance**; information gathering on or around the battlefield.

3

ROLE OF THE SCORPION

Introduction

301 The Scorpion is, in military terminology, a combat vehicle reconnaissance (tracked) or CVR(T) (see Figure 1 below). This description denotes a combination of features peculiar to the fire support and reconnaissance roles for which this vehicle is designed.

302 The main features of the Scorpion are its size and mobility. The Scorpion is light, small and fast.

303 Weighing only eight tonnes, the Scorpion is much lighter than "light tanks" which are up to three times heavier. Main battle tanks are up to eight times heavier than the Scorpion. Being compact, the Scorpion is also easy to transport by aircraft where rapid deployment is required. On the battlefield, the Scorpion's small size (it is barely two metres high) makes it a difficult target to hit. With a road speed of up to 75 kph, the Scorpion is able to move rapidly across most types of terrain, climb hills and negotiate confined spaces.

FIGURE 1
SIDE VIEW OF A QUEEN ALEXANDRA'S SQUADRON SCORPION
(Note size in comparison with a landrover)

304 A reconnaissance vehicle must also be able to pass on a constant flow of information about the enemy. The Scorpion is equipped with a communications system to enable it to carry out this task.

305 In terms of firepower, the Scorpion possesses a 76mm main gun which is adequate to engage lightly armoured targets but limited in its effectiveness against a main battle tank.

306 In a direct fire support role, the Scorpion's main gun and machine gun enable it to protect infantry in low intensity operations. Smoke dischargers can provide emergency concealment for the vehicle.

307 Regardless of the role, a decision to fire will be made because a critical situation has occurred. Thus the speed that the turret rotates is important to subsequently engaging a target. For these reasons the Army purchased an electrically powered traverse for its Scorpions' turrets.

308 Although of limited effectiveness against most anti-armour weapons, the Scorpion's armoured protection enables it to withstand small arms fire, light mortars, anti-personnel mines and shell fragments.

309 Of the Army's 26 Scorpions, 16 are in Queen Alexandra's Squadron, a tank squadron, at Waiouru. The School of Armour, also at Waiouru, which trains crew for the Scorpion, holds a further 4 vehicles. One vehicle is undergoing trials fitted with a diesel engine and the remaining 5 vehicles are in a Repair and Maintenance Pool based at Trentham. These pool vehicles are used to replace Squadron and School vehicles where necessary. They also constitute a reserve of vehicles in the event of war.

Conclusions

310 The primary task of Queen Alexandra's Squadron is to act in direct fire support and security roles. It has a secondary role in reconnaissance duties.

311 Because of its versatility, we believe that the Scorpion is well-suited to its current roles. It is also our view that commendable effort and thought have gone into ensuring that the Scorpion will be effective for the combat roles it is intended to fulfil.

312 The Army's Scorpions do not have night vision or night fighting devices. Our only concern about the Scorpion is whether it can operate effectively at night without such devices. However, the Army has trialled such equipment and purchasing is under way.

4

PROCUREMENT

Introduction

401 The last main battle tank operated by the Army, the Centurion, was taken out of service in 1969. From that time, the Army's armoured fighting capability was provided by 10 M41 fire support vehicles which it used for training in tank skills and as a reconnaissance and fire support vehicle.

402 In the early 1970s, the Army recognised that the M41 was nearing the end of its economic life, and would need to be replaced in the early 1980s at the latest. At the same time, the Army was re-examining its armoured capability generally.

403 In 1970, the Defence Council gave its approval to reorganise the armoured capability. This reorganisation involved forming a cavalry squadron which would carry out the functions of reconnaissance and direct fire support. The Council authorised the purchase of 10 fire support vehicles for that purpose.

404 In light of the need to replace its ageing M41 vehicles and to maintain a viable cavalry squadron, the Army evaluated the Scorpion in 1974. As a result of that study, it concluded that the Scorpion was well–suited to the roles of fire support and reconnaissance.

405 Along with the requirement for 10 fire support vehicles, the Army's capital equipment programme also provided for the purchase of main battle tanks. Because of their high cost, however, it was decided not to purchase main battle tanks at that time. The Army saw itself faced, as a consequence, with the loss not only of its combat tank capability but also with a decline in its armoured skills.

406 Having already selected the Scorpion for direct fire support and reconnaissance duties, the Army then saw the opportunity to extend the vehicle's role to that of a tank training expedient in place of a main battle tank. For the tank training role, the Army stipulated a requirement for 16 additional vehicles, consistent with the orthodox tank squadron arrangement of 4 troops of 4 tanks each. This increased the Army's total vehicle requirement from 10 to 26.

407 Cabinet approved the purchase of 26 Scorpions on 26 May 1980 and the Ministry of Defence signed a contract with Alvis Ltd, the manufacturer, on 20 August 1980. The total estimated cost in 1980 dollars was $19.29 million.

408 Alvis delivered the first four Scorpions in June 1982 and the remainder entered service over the latter part of 1982 and into 1983. Since that time, the Scorpion has performed a number of roles covering reconnaissance duties, direct fire support, and tank training.

Method

409 We examined the procurement process which led to the purchase of the Scorpion in order to establish whether decisions made by the Army were sound.

410 The decision to purchase an item of equipment involves defining needs and establishing requirements based on those needs. In order to establish requirements adequately, managers must make judgements about the quality of an item of equipment, and about likely performance over its economic life. 411We focused on three key aspects of the procurement process:

- the selection of the Scorpion;
- the number of vehicles the Army required; and
- the vehicle specification.

Each aspect had a direct impact on the quality of the equipment which the Army was to purchase.

Findings—Selection

412 We found the evaluations undertaken by the Army to have been inadequate on two counts:

- the comparison of alternative vehicles; and
- the assessment of whole-of-life costs.

413 When purchasing equipment, full consideration should be given to all available options in order to ensure that the best choice is made. The equipment selected should satisfy the needs and requirements defined by the purchaser.

414 A complete evaluation of the available options should take account of:

- military capability;
- technical capability;
- risks; and
- costs associated with those risks.

415 Given the significance of the procurement project, in terms of both capital expenditure and defence capability, we would have expected the Army to have undertaken a systematic evaluation of all those vehicles which might be capable of meeting its needs. This was not done.

416 Defence purchasing can be influenced by political constraints, such as the requirement for compatibility with allies, which reduces the number of possible options. In 1969, the Australian Army assessed and rejected an American fire support vehicle. The Army stated to us that it had rejected the American vehicle as an option because of the Australian Army's trial. However, we would note that the Australian trial was conducted five years prior to selection of the Scorpion by the New Zealand Army. In any event, the only direct comparison made with the Scorpion at the time of assessment was an Australian vehicle. We could find no evidence to show that the Army had considered all possible vehicle options at the time.

417 In the absence of any systematic evaluation of all vehicle options available, it is not possible to demonstrate that the Scorpion was the best choice.

418 The Army failed to assess the impact of whole-of-life costs on the procurement of the Scorpion. Their decision to purchase the Scorpion with a petrol engine rather than a diesel alternative illustrates this point.

419 In 1980, when the Army signed the contract, a diesel engine, although proven for commercial use, was still under development for operation in the Scorpion. In the following year Alvis announced that it was offering the diesel Scorpion at no extra cost. The Army, nevertheless, did not seek to renegotiate the contract, on the grounds that the diesel version was still unproven.

420 Although the Army identified risks associated with the diesel vehicle, it failed to quantify those risks in financial or reliability terms. Nor did the Army compare the operating and maintenance costs of running a diesel as opposed to a petrol engine, in order to estimate whole-of-life costs for each. Hence, the Army was not in a position to make an informed judgement about the relative merits of the two types of engine it was considering buying. In a more general sense, this is an illustration of the Army's failure to specify the quality of the vehicle it was looking to purchase.

Findings—Number of Vehicles

421 A second key aspect of the procurement process was consideration of the number of vehicles which the Army required. We examined two related issues:

- deployment of the Scorpion; and
- the number of vehicles the Army required.

422 When the Army first considered purchasing the Scorpion, it was looking for 10 vehicles to carry out a variety of reconnaissance and direct fire support duties within a cavalry squadron. At the time of the submission that was made to Cabinet to purchase the Scorpion, the requirement was little changed, the intention being to equip a cavalry squadron with 8 vehicles. Two further vehicles were to be used by the School of Armour for crew training.

423 A short time later, however, the Army abandoned its commitment to separate armoured reconnaissance and direct fire support capabilities. We found that, only months after securing Cabinet agreement to the purchase of 8 Scorpions for a cavalry squadron, the Army intended to deploy only 3 Scorpions in that role.

424 Furthermore, the submission to Cabinet seeking approval to purchase the vehicles made no reference to the need for a pool of spare vehicles. Yet, of the vehicles not deployed in the cavalry squadron, three were allocated to a repair and maintenance pool. The current Chief of General Staff told us that this had always been the Army's intention. The School of Armour received an additional two vehicles above its original allocation of two.

425 The Army never deployed Scorpion, therefore, in the manner which Cabinet, and the public, were given to believe at the time of their purchase.

426 This led us to question whether the Army needed to buy as many vehicles as it did.

427 The 16 vehicles designated for use in the tank training role were allocated to Queen Alexandra's Squadron. These 16 vehicles have been used in the combat roles for which the Army had set 24 as its original requirement—16 for a tank squadron and 8 for a cavalry squadron.

428 Not surprisingly, the number of Scorpions deployed in non-combat roles increased accordingly.

429 The balance of 10 vehicles are held by the School of Armour or as spares. Yet the Army's original submission for 26 vehicles did not provide for a pool of spare vehicles, and only two Scorpions were to be allocated to the School of Armour for crew training. Assuming that its assessments at the time for spare vehicles and crew training were correct, then the only conclusion possible is that the Army bought 8 vehicles more than it could justify.

Findings—Vehicle Specification

430 The Army decided to purchase the Scorpion in late 1974. From then until 1980 when the contract was signed, the Army gathered a range of information about the performance of the Scorpion under various climatic conditions and in various terrains.

431 In short, the Army was aware of the various features and characteristics of the vehicle, including the known defects, when it agreed to purchase the Scorpion.

432 Reports obtained by the Army identified a variety of problems encountered by users.

433 Reports on vehicle performance were not, however, uniformly negative. Further, where users had encountered design problems, the Army was led to believe that the manufacturer would incorporate modifications into the New Zealand vehicle to correct those problems.

434 Nonetheless, we noted that:

- having asked for and been assured of design modifications to the Scorpion, the Army did not monitor the critical modifications promised by the manufacturer to ensure that all the noted problems were in fact eliminated;
- the contract contained a 5-year warranty against stress corrosion cracking and a general 15-month or 1,000 miles warranty against vehicle defects, but did not contain special warranties covering the performance of critical components, such as the transmission, which were known to have encountered problems; and
- the Army did not trial the vehicle in order to evaluate its performance. This seemed surprising, given the extent of known problems.

Conclusions

435 In summary, the shortcomings in the procurement of Scorpion include:

- directly assessing only one alternative vehicle at the time of selection;
- not assessing whole-of-life costs;
- buying more vehicles than could be justified at the time;
- purchasing Scorpion without adequate regard for known defects; and
- not conducting a trial.

436 We believe, therefore, that the Army did not take adequate precautions to minimise the risks, consequences and associated costs of equipment failure. This reflects, in our view, the Army's failure to pay adequate attention to the quality of the equipment it was purchasing, or to its requirements.

5

OPERATIONAL STATE OF VEHICLES

Introduction

501 The primary role of the Scorpion is as a direct fire support vehicle. To fulfil this role it must be able to both move into action and engage targets. In other words, a Scorpion must be operational.

502 Almost as important as whether an individual vehicle is operational is whether a troop of vehicles is operational. In a squadron of four troops of four vehicles, if a single vehicle is not operational the effectiveness of a troop reduces, as does the effectiveness of the squadron. Queen Alexandra's Squadron is an important and integral part of either the Ready Reaction Force or the Integrated Expansion Force and the Scorpion is its main combat vehicle.

503 The Army repair system recognises the importance of having the maximum number of operational vehicles by replacing defective major assemblies unless they can be repaired with available resources and within eight hours. Access to spare parts and assemblies is therefore essential and accordingly supplies of these are kept.

504 In summary, the number of Scorpions operational on any one day in Queen Alexandra's Squadron is an indicator of:

- the inherent quality of the vehicle; and
- the Army's ability to maintain its equipment.

Method

505 Individual vehicle log books record kilometres run, fuel and oil use, major assembly changes, repairs carried out, vehicle faults noted at various inspections and other fleet management information. The log books are, however, not complete, especially with regard to repairs and vehicle faults. Nor do log books show whether a Scorpion is operational. Some other information was necessary to make that assessment.

506 Queen Alexandra's Squadron records the state of each vehicle every Friday. A vehicle is recorded as either on-road or off-road. An off-road condition is when a vehicle cannot be driven or is in a workshop. The weekly vehicle state reports also show the current faults for each vehicle found by crew or workshop inspections.

507 The Army told us that records are generally not kept when a vehicle is on a military exercise or when all of the squadron personnel are on leave. We found, however, that some records do cover exercise periods. Information exists for 242 weeks out of the 358 weeks between July 1983 when the Scorpions joined the squadron and our visit in May 1990.

508 Not all faults that prevent a vehicle from fulfilling a direct fire support role mean that it will be listed as "off-road". For example, a vehicle incapable of firing its main gun is "on-road" if it can be driven. Furthermore, there was little consistency for what constituted an on- or off-road condition. For example, a vehicle having an inoperable power traverse for its turret, with no other faults of any kind, could be shown as either on- or off-road.

509 Nevertheless, using the weekly vehicle state records as a basis, it was possible for us to assess the number of operational Scorpions per day where information existed.

510 The unit of measure we applied was one vehicle-day. That is, a vehicle's state was taken into account for only the day to which information related.

511 We accepted an off-road listing as indicating that a vehicle was not operational for that day unless the vehicle was due back from a workshop that day. Similarly, we accepted a vehicle as operational where on-road listings recorded no faults or only minor faults. We noted as operational a vehicle that was not physically present when on a military exercise, or when on loan to another operational unit, but not when on loan to a training school for courses. From the off-road listings, we noted all instances due to engine faults in order to gauge the affect of the engine on operational numbers.

512 While any fault is potentially lethal in a combat situation, we considered that the following items if unserviceable would prevent a vehicle from fulfilling an effective fire support role:

- gunners' or commanders' sights;
- radios and internal communications;
- power traverse or jammed turrets; and
- the main guns' mechanisms preventing firing, e.g. unserviceable elevation gear.

513 Where any doubt existed on its operational state, a vehicle was accepted as operational.

Findings

514 Where data covered all 16 Scorpions in the squadron, there was no day when all 16 were operational. The highest number of operational Scorpions was 13. In the worst instance, only 1 Scorpion of the 16 was operational.

515 During 1985 when transmission failures were high, the year's average proportion of operational Scorpions was only 37%. Conversely, the average proportion of operational Scorpions peaked at 63% over 1986. Over the last 18 months, the proportion of operational vehicles has averaged 56%.

516 Since the Scorpion came into service, the proportion operational has averaged 54%. That is, only 9 out of 16, on average, have been operational on any day.

517 We believe the existing data to be representative of the numbers of Scorpions each day over 7 years that could, if required, effectively move into action and engage targets. After all, the number of operational vehicles will be conservative because it is unreasonable to assume that routine wear and tear would cause more faults than other uses such as combat exercises.

518 While we accept that the weekly vehicle state records are indicative rather than precise, the pattern emerging from the data reveals what we consider to be a poor record. This record indicates the number of operational vehicles that Queen Alexandra's Squadron could deploy in a direct fire support role to either the Ready Reaction Force or the Integrated Expansion Force. In fact, the data raises the question of whether the Integrated Expansion Force requirements could be met at all from Queen Alexandra's Squadron alone.

519 At this point, we must consider the impact of having five repair and maintenance pool vehicles. If all five of these Scorpions were operational all of the time, and were given to the squadron, it could deploy, on average, 14 vehicles. The overall proportion of operational vehicles would then be 66% (see Figure 2 below).

FIGURE 2
OVERALL OPERATIONAL STATE OF VEHICLES

	Allocated	*Average Number of Operational Vehicles*	*Percentage Operational*
Queen Alexandra's Squadron	16	9	54%
Repair and Maintenance Pool	5	5	100%
TOTALS	21	14	66%

520 There are, therefore, still some doubts as to whether the Integrated Expansion Force requirements could be met without considerable preparation time. It is indeed fortunate that a repair and maintenance pool now exists, given that there was no initial requirement for such vehicles.

Conclusions

521 The information available indicates that a low proportion of Scorpions has been operational since their introduction into service. This record reflects on the combination of the inherent quality of Scorpion and the Army's ability to maintain vehicles in a serviceable condition, even though the repair system is intended to maximise the number of operational vehicles.

522 For whatever reason, and even allowing that the available data is not precise, such a low proportion of operational Scorpions is cause for grave concern and directly affects the military capability of the Army. The Army told us that the resources necessary to improve the numbers of operational vehicles would be made available in a state of emergency.

523 Furthermore, the Army should urgently undertake adequate recording of the information necessary to accurately assess the operational state of vehicles. A lack of such information indicates to us that the Army may not adequately monitor its overall military capability.

6

RELIABILITY

Introduction

601 The reliability of an item of equipment is the ability of that item to perform a required function under stated conditions for a stated period of time. The principal measure of reliability is the probability that an item can perform as required, and is calculated from failure rates and the average time or distance between failures.

602 The importance of having reliable defence equipment cannot be emphasized too strongly. Lives may depend on equipment being reliable.

603 The potential costs of unreliable equipment are not just monetary but are also safety-related. It is important, therefore, to continuously monitor reliability in order to detect any deterioration. Such monitoring presumes a reliability standard stating:

- the function(s) required;
- operating conditions; and
- a period of time.

604 Monitoring data needs to be collected regularly and in enough detail to calculate the rate of failure, the type of failures occurring, downtime due to those failures and the average time or distance between failures. Assemblies that critically affect reliability and will be repaired after a failure should be individually identifiable.

605 From this information, detection of a deterioration in reliability and the associated costs is possible.

Method

606 Each item of Army equipment has an Equipment Management Policy Statement (EMPS) which contains the Army's policy requirements for the management of that item.

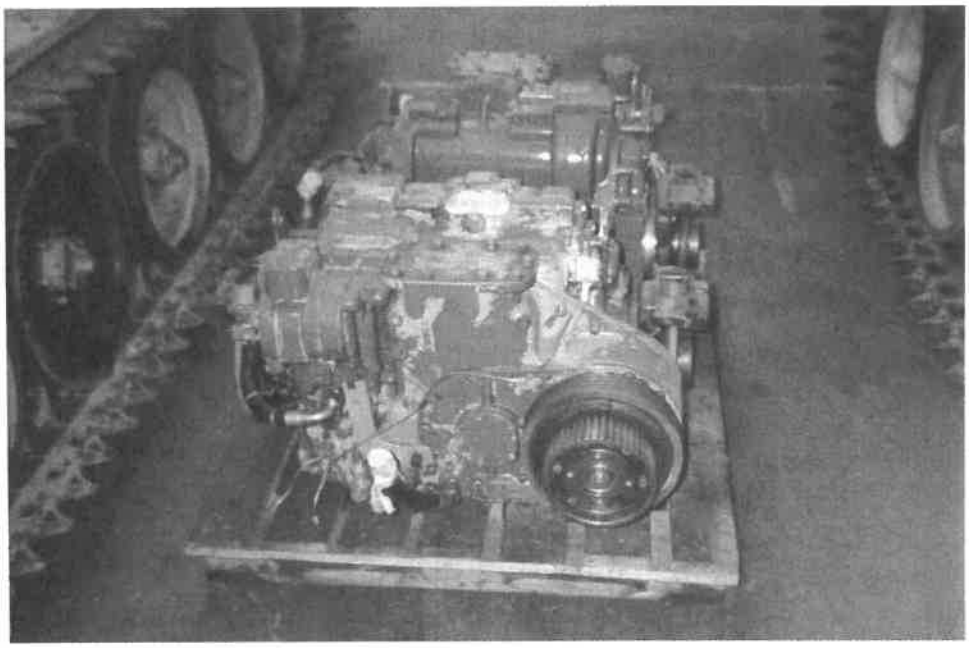
607 A complete Scorpion consists of thousands of assemblies and components, and the reliability of each affects the overall reliability of the vehicle.

608 To assess the reliability of the Scorpion, we focused on:

- the vehicle as a whole;
- the transmission (see Figure 3 on page 22), because of known problems in the British Army Scorpions;
- the engine, as the main motive item; and
- the power traverse, because it was a non-standard item.

609 For each, we attempted to determine the probability of successful performance and the average time or distance between failures, and then to compare these figures against the Army's EMPS requirements for the Scorpion.

FIGURE 3
TWO SCORPION TRANSMISSIONS, AWAITING REPAIR IN AN ARMY WORKSHOP



Findings

610 It was not possible to assess the reliability of the Scorpion or its components because:

- there are no reliability standards; and
- even if there were standards, the information gathered by the Army is not adequate to monitor or determine reliability.

611 Nonetheless, some observations about the reliability of the Scorpion are still valid.

- Inherent quality and reliability affects the number of vehicles that are operational. To date, the Scorpion has a poor record.
- Frequent transmission failures resulted in the Army commissioning a study into them. That study concluded there was a design flaw in the transmission. It is notable that transmission failures had occurred in British Army Scorpions which the Army knew about before it decided to purchase the vehicle.
- The vehicle state data shows that, when Scorpions are not operational, only 5% of the reasons for being non-operational are due to the engine.
- Since the Scorpion's introduction into service, the turret power traverse device has had continual serviceability problems. At the time of our visit to Queen Alexandra's Squadron, five Scorpions were without power traverse.

612 In an attempt to redress its information deficiencies, the Army is currently developing a logistic management information system which it believes will allow it to monitor, among other things, the reliability of its equipment.

Conclusions

613 The reliability of the Scorpion directly affects its ability to perform in combat, yet its reliability is neither specified nor known. Furthermore, systems do not exist to monitor reliability. Given that the format of, and the requirement to generate, an EMPS are the same for all equipment, we believe that the lack of reliability information applies to all Army equipment.

614 In our opinion, therefore, the Army does not yet attach enough importance to assessing the reliability of the Scorpion or its other equipment.

615 In the case of the Scorpion, this lack of attention resulted in the Army purchasing a vehicle that has had problems, and this is reflected in the number of vehicles that are operational at any one time.

616 In mitigation, the Army appears to have recognised some of its deficiencies and is taking positive steps to redress them.

7

OVERHAUL

Introduction

701 Until recently, it was usual practice to overhaul armoured vehicles after a fixed period of time in order to sustain operational capability. Increasingly, overseas armies are assessing their need for overhauls based on reliability and costs.

702 The costs of keeping equipment in operation are directly related to its reliability. Unreliable equipment incurs repair and other costs.

703 An overhaul is only justified when an item of equipment no longer performs as required, and where:

- the cost of keeping equipment in operation is greater than the cost of an overhaul; and
- the cost of replacing that equipment is greater than the cost of an overhaul.

704 In 1988, the Army undertook a study on the need to overhaul the Scorpion because it was nearing the Army's fixed period for an overhaul. The study concluded that hull components were in an advanced state of deterioration, but that the turret was considered maintainable and not worthy of overhaul before 1992.

705 On the basis of that study, the Army proposes to overhaul its Scorpions.

706 Arising from its stated need to overhaul the engine, along with the other hull components, the Army assessed the economics of various alternatives. The most cost-effective of these alternatives was to replace the existing petrol engine with a diesel engine. The overhaul will cost around $10.5 million.

707 We reviewed the justification and merits of the proposed overhaul.

Findings

708 Except for the engine and transmission, where partial information exists, information does not exist for us to determine the reliability of vehicle components. Hence, we could not assess the overall impact an overhaul might have on reliability or costs, nor whether there were grounds for an overhaul based on performance. Accordingly, we find it difficult to understand how the Army has justified the overhaul.

709 Some information does exist about the engine's performance and reliability. The engines have been in service for an average of approximately 8,150 kilometres. Distances for individual engines range between 950 kilometres and 17,500 kilometres.

710 Army calculations show that the whole-of-life costs for a diesel engine replacement are less than those for the existing petrol engine over the remaining life of the vehicle, provided the existing engines require overhauling.

711 However, we examined the information that is available on engine reliability and found that their failure rate is low. Since 1983, 23 engines have been replaced due to faults requiring more than eight hours' work. That failure rate means that an engine will need to be replaced, on average, once every eight years.

712 Additionally, the engine does not appear to be a significant contributor to a lack of operational Scorpions (see Paragraph 611).

713 It is also curious to note that the Army considered an unproven diesel engine too risky when purchasing the Scorpion, but that an unproven diesel is now acceptable for the overhaul. However, we recognise that this time the Army is trialling the unproven diesel engine in the Scorpion.

Conclusions

714 Due to the lack of critical information we are not convinced of the need for the proposed overhaul.

715 Certainly, the current replacement rate of engines due to failures does not justify their overhaul and, therefore, a diesel replacement is not economically viable.

716 Even so, there may be other valid reasons for changing to a diesel engine stemming from improvements to military capability. For example:

- increasing the distance a vehicle can travel between refuelling through better fuel consumption;
- the ease of transporting one fuel type into a combat zone;
- diesel is less volatile than petrol and hence safer; and
- a diesel engine is not as easily visible to infra-red detectors at night.

717 Our view is, therefore, that the only valid justification for replacing engines would be to increase combat effectiveness. Accordingly, the Army should re-examine the diesel alternatives.

718 In any event, the future of the whole overhaul should be the subject of further consideration.

8

THE ARMY'S ATTENTION TO RELIABILITY

Discussion

801 We have no reason to doubt that the repair and maintenance work undertaken by the Army is of a high standard. Nor do we question the Army's ability to detect and remedy minor and major defects as they occur.

802 However, assuring and assessing reliability requires greater effort from the Army. In general, reliability is influenced by the inherent quality of the equipment. No amount of repair or maintenance will increase the reliability of poorly designed equipment. It can only limit deterioration. The key to assuring reliability is, therefore, in the design. Where procurement does not involve actual design work, as in the case of the Scorpion, considerations of reliability should be covered through warranties and standards. After all, it is the totality of features of the equipment that determine its quality.

803 Assurance of reliability demands rigorous attention, including the establishment of reliability standards or requirements. The Army does not currently state such requirements or standards.

804 A reliability standard or requirement does not, by itself, assure reliability. Assessment of in-service performance is necessary in order to determine actual reliability and to feed back into improved equipment design. The Army states that it places a high premium on the reliability of its equipment.

805 At present, the Army can determine the number of failures for some components when a workshop lodges a defect report. Otherwise, it may be possible for the Army to track the number of failures from supply records. However, even if the Army could determine the number of failures, it cannot in most cases determine the amount of work done by the failed part, and cannot, therefore, calculate a failure rate.

806 For example, replacements of power traverses in the Scorpion are not documented, and it is not possible to determine the distance or time between failure for individual units, let alone the number of times the unit was actually used.

807 Basic information is, therefore, generally lacking for the Army to assess the reliability of its equipment.

808 Furthermore, in exchanges between ourselves and the Army, we noted that the Army did not appear to understand how to determine reliability, even if the information was available.

809 For example, partial information exists for the Scorpion engines recording failures requiring more than eight hours to repair. Using this information, and internationally-accepted methods, we calculated a mean distance between failure of 13,700 kilometres. The Army, using the same data, calculated the figure to be around 5,500 kilometres. Due to the large discrepancy, we analysed the Army's figure to discover that it had not calculated a mean distance between failure as stated.

810 We are concerned that the Army is unable to correctly calculate and use even a basic measure of reliability.

Conclusions

811 Inadequate technical understanding of reliability, combined with a lack of reliability standards and reliability information, indicates to us that the Army cannot assure or assess the reliability of its equipment. Inadequate attention to reliability directly affects operational capability. Furthermore, unreliable equipment costs money through downtime, repairs and overhauls. The Army's financial systems are not adequate to estimate the costs associated with unreliable equipment.

812 Given these factors, we can only conclude that the Army does not yet pay adequate attention to the reliability of its equipment.

9

LESSONS ARISING

901 Our audit revealed concerns which are specific to the Scorpion. Even though other Army equipment is different from the Scorpion, there are, we believe, some lessons that could be generally applicable.

902 In the procurement process, the Army should identify and fully document all the alternatives that could fulfil the required role. Assessment of each alternative should cover:

- military requirement and capability;
- range of possible roles;
- technical performance;
- quality and reliability;
- quantification of risks in financial terms; and
- whole-of-life costs.

903 The single most critical measure of whether the performance of an item of equipment is adequate is its ability to perform its operational role. For each item, the Army should identify those features which affect its expected performance and be able, therefore, to ascertain the operational state of the equipment. These details should be recorded in the Equipment Management Policy Statement for that equipment, including an expected level of performance and operational numbers.

904 Similarly, the Army should develop reliability standards for each equipment item and document these in existing Equipment Management Policy Statements.

905 Both the availability and reliability actually achieved could then be monitored and the reasons for variance noted. Where problems arose, the Army would be able to assess the causes and take remedial action. In any event, the Army should be able to report its operational capability, a key indicator of its management performance.

906 By monitoring reliability, the Army would have information available to determine when deterioration occurs and for it to justify overhaul or replacement.

907 Overall, we believe the Army should invest some effort in assuring and assessing the quality and reliability of its equipment. United States Defence Department experience shows that an investment on reliability alone of around 2% of the purchase price gives a financial return of better than 1:7 in saved operating costs. However, the greatest benefit for the Army through increased quality and reliability would be in improved availability of equipment and, therefore, increased operational capability.

APPENDIX
DEFENCE FORCE RESPONSES

Throughout the preparation of this report, the Army were given opportunities to comment. It became apparent that the Army had some major concerns with the content of the report, and, in spite of numerous attempts to address those concerns, substantial disagreement still exists.

In the interests of fairness and balance, therefore, we are including a summary of the outstanding concerns as provided by the New Zealand Defence Force. At no stage have we found any reason to modify the substance of the report in light of the comments we received.

We have added some italicised comments below the Army's, where necessary, to clarify our position.

ARMY COMMENTS—AUDIT OFFICE REPORT ON SCORPION PROCUREMENT

(Chapter 4)

Comparison of Alternative Vehicles (refer paragraphs 412–417)

1 In its report the Audit Office makes statements regarding the evaluation and selection processes which led to the decision to purchase Scorpion as a replacement fire support vehicle for the Army. Criticism is levelled at the comparative process used to assess Scorpion against the other potential vehicles. Army maintains that full consideration was given to all reasonable options in the selection of a replacement fire support vehicle and in discussions the Audit Office acknowledges that it has been unable to find evidence to the contrary.

2 Three vehicles (Sheridan, Scorpion and the Australian fire support vehicle) were evaluated in the process of selection of a fire support vehicle for the Army. These three vehicles, in the circumstances of the time, were the only realistic and sensible options available for evaluation.

3 The information for the evaluation of Sheridan, an American fire support vehicle, was drawn from trials carried out by the Australian Army. The process of pooling equipment information is common among allied armies as a means of ensuring standardisation of equipment and to prevent repetition of costly research and development, and/or trial procedures. The prime reason for rejection of Sheridan was the unacceptability of its main armament due to its sophistication and cost. Neither of these factors were significantly altered in the five years between the Australian trials and the time that the decision was made by the New Zealand Army to purchase Scorpion.

4 The decision by the Australian Army to reject Sheridan as a fire support vehicle had a significant bearing on the selection of a vehicle for the New Zealand Army. Compatibility with allies and the economics of supporting equipment after purchase are considerations of major significance as recent major Defence equipment procurement decisions show.

5 Having raised the questions of compatibility/interoperability, we must then answer the question as to why New Zealand did not follow the Australian solution entirely. The Australian fire support vehicle considered during the evaluation process was a Scorpion turret fitted to an M113 Armoured Personnel Carrier hull. The decision by the Australian Army to adopt this vehicle was based primarily on the larger numbers of M113 hulls available after the Australian withdrawal from Vietnam. As surplus vehicle hulls were not available to the New Zealand Army this option was not a sensible solution.

AUDIT OFFICE COMMENT: *We expected that evidence would have existed to demonstrate that the Army had considered all militarily feasible options. For example, a French fire support vehicle existed at the time and it was (and still is) widely used. We*

would have expected this vehicle to have been considered, at least in preliminary material, relating to the selection of the Scorpion.

Whole of Life Costs (refer paragraphs 418–420)

6 The decision to purchase the Scorpion with a petrol engine rather than a diesel alternative is highlighted in the report as an example of the Army's failure to assess the impact of whole-of-life costs on the procurement of the Scorpion. This criticism does not take full account of the factors prevailing at the time the decision was made.

7 Although a diesel engine option was being developed by the manufacturer of Scropion at the time of the evaluation, its significant disadvantages and the lack of trial data led to a decision to opt for the petrol engine on the basis of proven realiability. A further important factor is that deferral of a decision until a proven diesel engine was available would have resulted in a delay in the supply of vehicles until after the existing fire support vehicle had gone out of service with a consequent major reduction in Army combat capability.

AUDIT OFFICE COMMENT: *The example of the diesel engine was used to illustrate the value of whole-of-life costings. (Whole-of-life costs are the total costs associated with an asset for the duration of its life. They include both the purchase price and the operating and maintenance costs.) In the case of the Scorpion, the whole-of-life costing process was not carried out in, or prior to, 1980. The various disadvantages referred to by the Army would have been taken into account in such whole-of-life costings. We are encouraged that the Army now does these costings.*

Number of Vehicles (refer paragraphs 421–429)

8 Cabinet agreement for the purchase of Scorpion was given in May 1980. The Audit Office draws attention to changes to distribution of the vehicles after Cabinet approval was given to purchase the Scorpion. Proposals for numbers of vehicles and their distribution were amended a number of times within the total numbers of vehicles approved, as a result of changes to priorities, required capabilities and force structure. While a number of draft distributions were produced between October 1980 and mid-1982 the definitive distribution for Scorpion was not issued until September 1982. The suggestion that the decision not to issue Scorpion to the cavalry squadron made in July 1986 represents abandonment of commitment to separate armoured reconnaissance and direct fire support capabilities a "short time" after securing Cabinet agreement is incorrect.

9 To imply that once Cabinet had approved the number and distribution of Scorpion they should never had been changed fails to take account of the changing requirements imposed on a Defence Force as a result of doctrinal changes and resource management requirements. At all times there was a commitment to providing the required number of vehicles to Queen Alexandra's Squadron in time of operational need regardless of where the vehicles were physically located.

AUDIT OFFICE COMMENT: *We have good reason to believe that the advice to Cabinet was different from the Army's intent at that time. Thus, we believe more vehicles*

were purchased than could be justified. The average cost of replacing the Scorpions is around $2 million per vehicle.

Vehicle Specification (refer paragraphs 430–434)

10 The contract for the sale of Scorpion specified that the Ministry of Defence in the United Kingdom was responsible for quality assurance on an agency basis and for ensuring that all vehicles were built to specification and properly modified. Vehicles received in New Zealand were subject to inspection prior to their acceptance. Warranties given by the manufacturer for the New Zealand vehicles were the best which could be negotiated at the time and were more generous than those normally incorporated in a commercial sale of this nature. They are far superior to those applying to British Army vehicles some six years later. The New Zealand warranty covered faults to all components, critical or otherwise, with none of the exclusions contained in the British Army warranty. Where justified the New Zealand Army submitted claims against its warranty.

11 The extent of known problems was a factor in the initial selection of Scorpion in relation to its competitors. An extensive New Zealand trial would undoubtedly have only repeated findings of trials conducted by other Armies and would have been an expensive duplication of effort.

Conclusions

12 In summary the procurement of Scorpion necessitated:

a) adequate consideration of all sensible alternatives available, as a fire support vehicle for the New Zealand Army;
b) purchase of the most cost effective and proven engine available at the time;
c) purchase of the number of vehicles approved by Cabinet and the distribution of those vehicles to provide the best management of the resource at any particular time; and
d) purchase of the vehicle with adequate knowledge of and protection against known defects in the vehicle while mindful of the expense of conducting a full scale trial.

13 In view of the circumstances prevailing at the time, purchase of a vehicle which was in service with 14 other Armies, with a good warranty and United Kingdom Ministry of Defence supplied quality assurance, seemed to provide sufficient precautions to minimise the risks associated with the purchase.

OPERATIONAL STATE OF VEHICLES

(Chapter 5)

14 Each Scorpion fire support vehicle has a log book which is used to record major activities associated with that vehicle. Despite the difficulties of interpretation encountered by the Audit Office, a correctly completed log book, in conjunction with regular technical inspections, provides a realistic assessment of vehicle serviceability. In contrast the weekly vehicle state which is recorded when vehicles are in Camp does not allow an accurate assessment to be made of the total operational state of the Scorpion fleet.

15 Difficulty experienced by the Audit Office in interpretation of data contained in weekly vehicle states appears to have lead to misinterpretation of factors affecting the classification of vehicles as "off-road" or "on-road". This serves to reinforce the point that weekly vehicle states are intended as a means of monitoring internal repair priorities and are not indicative of the operational availability of a vehicle fleet.

16 Similarly, despite advice given a number of times to the Audit Office, there is a misunderstanding in the report of the effect of power traverse and elevation gear faults on vehicle availability. Further, the validity of analysis of a vehicle's availability for operations on the basis of serviceability of sights, communications gear and engines is suspect.

17 Availability of vehicles refers to their serviceability, not their location, and classification of a vehicle as unavailable because it is located at a training school pro tem, ignores the fact that these are all servicable vehicles and can be made available to meet operation requirements.

18 The effect of the difficulties encountered by the report's authors in the interpreation of data results in a much lower claimed operational availability than is actually the case. Queen Alexandra's Squadron experience indicates that real operational availability is in the vicinity of 70 to 90% of the 16 vehicle fleet, with a consequent operational availability of 75 to 92% over the Squadron vehicles plus the Repair and Maintenance Pool. The requirement for a Repair and Maintenance Pool to provide backup vehicles was identified in the Army's original vehicle submission to the Defence Council in 1978.

Conclusions

19 Significant differences exist between the Audit Office and Army regarding the assessment of vehicle availability. These are based primarily on the methodology employed. Army's experience is that vehicle availability is far greater than is indicated by the Audit Office. Consequently deductions regarding the quality of the Scorpion and the Army's ability to maintain its vehicles in a serviceable condition differ quite significantly between the two organisations.

AUDIT OFFICE COMMENT: *Our analysis showed that log books were not correctly completed and were an unreliable source of information. Weekly vehicle state records are the squadron commander's assessment of his repair priorities and are, therefore, indicative of the operational state of vehicles. Our analysis was conservative, in the Army's favour, on the operational state of vehicles and does not support the Army's contention of 70–90% availability.*

RELIABILITY

(Chapter 6)

20 Reliability standards adopted for Scorpion are based on operational and technical guidance provided by the United Kingdom Ministry of Defence's trials establishment. This information is incorporated into the New Zealand Army's Equipment Management Policy Statements and forms a basic realiability standard. While it is accepted that this process does not conform with current engineering standard procedures it does form a basis against which vehicle reliability can be assessed.

21 Reliability of individual components is monitored through documentation in the vehicle log book as well as technical inspections and defect reporting. Information provided by this process has to be extracted manually and recognition of the limitations of this procedure, inter alia, has lead to development of the Logistic Management Information System currently being introduced into the New Zealand Army.

Conclusion

22 Army some time ago accepted that its reliability and reporting criteria did not conform with current standard engineering procedures, although they did provide a basis against which vehicle and component performance could be assessed. The introduction of the new equipment management system will permit closer monitoring of reliability standards.

OVERHAUL

(Chapter 7)

23 Overhaul of military equipment is undertaken so as to maintain a reasonable standard of operational readiness throughout expected life, and to decrease the changes of critical failure occurring at or soon after any deployment is required. Along with Allied armies, we still conform with the procedure of performing overhauls at a fixed mileage so as to maintain a satisfactory residual life in all equipment at all times. This means that overhauls are not left right until the end of useful component/vehicle life. The Army is cognisant of the whole-of-life cost benefits which must result from an overhaul of equipment, but neither the fact nor the timing of an overhaul can be equated too closely to an equivalent commercial decision on say production or other equipment.

24 Data on the reliability of vehicle components which could form the basis for overhaul justification does exist. However the process of extracting this information is currently slow. Considering the relatively short period over which Scorpion has been in service with the New Zealand Army and the small number of vehicles in service in New Zealand, it is doubtful whether this local information would provide a statistically reliable basis on which to make overhaul decisions. The New Zealand Army has proposed its overhaul programme on the basis of information provided by the British Army (which has been operating a larger number of vehicles over a longer period), as well as on advice provided by New Zealand Army technical advisers and the manufacturer. None of this advice is conflicting and taken in total provides a sensible basis for a decision to overhaul Scorpion, as a means of ensuring its continuing reliability. New Zealand operating conditions, which are harsher than those experienced by the British Army, have been taken into account in determining overhaul policy.

25 In contrast to the impression given by the Audit Office on the contribution made by engine faults to unserviceability of vehicles, Army's assessment based on more detailed examination of vehicle documents is that over a 27-month period, 13% of all vehicle faults were engine-related.

26 Reference to Army's acceptance of an unproven diesel engine for installation in the Scorpion during overhaul is misleading. The engine currently being trialled as a

possible replacement is in use in a large number of military and civilian vehicles throughout the world. Only its use in Scorpion is unproven, hence the curent trial!

Conclusion

27 Audit Office criticism of the need for overhaul of the Scorpion is based primarily on economic grounds. The main criterion for the overhaul of military equipment is the need to reduce the risk of failure, and to maintain adequate residual life at all times. They are clearly not the same criteria as would be applied in a pure commercial sense.

28 Whole-of-life costs have, however, had a significant impact on the proposal to fit vehicles with a diesel engine. Analysis of current engine failure rates, together with anticipated performance for diesel engines, makes a decision to replace the existing petrol engines with diesel economically viable. The advantages of diesel engines mentioned in the report, together with others such as fuel cost savings, greater range, commonality of fuel for logistic resupply, reduced maintenance costs and safety, make the diesel alternative an attractive option as a means of improving both the economic performance of the vehicle and its combat effectiveness. No decision will be made on the installation of a diesel engine, however, until the results of the current trial are known.

AUDIT OFFICE COMMENT: *The Audit Offices of the United States of America and Britain have had considerable experience in non-financial reviews of defence forces. They have indicated, in recent reports, that defence forces in their countries are changing, or have already changed, to the same methodology as we describe in our report.*

Our analysis was not based on economic grounds alone. If the main criterion for an overhaul is to reduce the risk of failure then that risk of failure must be known beforehand. The Army's information is inadequate to quantify that risk.

ATTENTION TO RELIABILITY
(Chapter 8)

29 Army agrees with the contention in the Audit Office report that reliability is influenced by the inherent quality of the equipment. As the New Zealand Army was not involved in the design of Scorpion, adequate safeguards were necessary to ensure that the required standards were met by the manufacturer. For this reason care was taken in the Scorpion procurement process to incorporate quality assurance into the contract and warranties were included to allow for repair of failed components.

30 Reliability standards against which the performance of the equipment has been assessed since is introduction are, it is acknowledged, not as well developed as those in current practice. Despite this every attempt has been made by Army to ensure that the vehicles perform to an adequate level by measuring the performance of New Zealand vehicles against the standards specified for vehicles in service with the British Army.

31 The Army's recognition of the difficulties associated with the system currently in place to assess in-service performance of its equipment, is well illustrated by the decision made last year to develop and introduce the new Logistic Management Information System.

32 The report highlights the discrepancy in calculating the "mean distance between failures" (MDBF) of Scorpion engines, as undertaken by the Audit Office on one hand

and the Army on the other, and has cited this discrepancy as evidence of Army's inability to determine reliability. Both parties have quoted a variety of experts in support of their method of calculation, which has the Audit Office claiming an MDBF of 13,700 km, and the Army a figure of 5,500 km. However, both methods suffer to varying degrees from the relatively small sample available for the calculation. For this reason the Army has investigated the MDBF arising from the British Army's exper-eince (using the same failure criteria) and finds that based on in-service use of 2,500 Scorpions (or Scorpion variants with the same engine), the British Army calculates an MDBF of 4,800 km. The manufacturer has also been asked for a view on engine MDBF and claims it is 5,000 km. Both these figures, based on a very large statistical sample, would seem to suggest that it is unwise of the Audit Office to state "the Army is unable to correctly calculate and use even a basic measure of reliability".

Conclusions

33 Army acknowledges that there are areas in which improvement can be made to its equipment management system and is taking steps to implement new systems. In the absence of recently developed equipment management systems Army has, however, implemented control systems and practices to ensure a reasonable measure of equipment management in the prevailing circumstances.

AUDIT OFFICE COMMENT: *Our calculations use the methods and mathematics prescribed by the international standard IEC 271 for determining the observed (actual) reliability of components. At the time of our calculations, the Army's 26 Scorpions had travelled a total of around 315,000 kilometres and there had been 23 engine failures since 1983. This shows that the mean distance between failure is around 13,700 kilometres as we reported.*

LESSONS ARISING
(Chapter 9)

34 Army is satisfied that, during the procurement process of Scorpion, all reasonable and sensible alternative fire support vehicles were assessed as part of the initial evaluation, with particular emphasis on the ability of each alternative to perform its operational role in the physical and economic environment then applying.

35 The Audit Office report rightly stresses the role of reliability standards as a means of assessing equipment performance. Basic as they are by modern standards, reliability criteria (currently being phased out) are incorporated in existing Army Equipment Management Policy Statements.

36 Systems are in place to assist unit commanders and to ensure that adequate monitoring of availability occurs. Detection of failures in Scorpion transmissions and the process by which the fault was isolated and rectified is evidence of this. These systems will be improved with the introduction of the Logistic Management Information System.

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