Aspects of Defence Equipment Support Volume 2— Technical Documentation

Report

263

Joint Committee of Public Accounts

Parliament of the Commonwealth of Australia 1987

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

JOINT COMMITTEE OF PUBLIC ACCOUNTS

REPORT 263

ASPECTS OF DEFENCE EQUIPMENT SUPPORT

VOLUME 2 - TECHNICAL DOCUMENTATION

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>
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>
> and include such other duties as are assigned to the Committee by Joint Standing Orders approved by both Houses of the Parliament.

PREFACE

This Report presents the findings of the Committee's inquiry into two aspects of Defence equipment support:

- the supply of spares and ammunition (supply support); and
- the provision of technical documentation for equipment operators and maintenance personnel.

The Report has been presented in two volumes, the first on spares and ammunition and the second on technical documentation.[1]

The inquiry was begun in April 1986 as a follow-on investigation to the Committee's earlier Review of Defence Project Management. The Report on Defence Project Management, tabled in February 1986, noted shortcomings in the provision of initial spares and technical documentation and in equipment handover procedures in a number of major Defence projects. These findings suggested significant deficiencies in the ability of the Services to support equipment after it had been introduced into service.

The Committee decided to assess the adequacy of present stocks of spares and ammunition to meet authorised operations and training objectives and the timeliness, completeness and utility of technical documentation in the hands of equipment operators and maintenance personnel. Options for improving the effectiveness and efficiency of spares and ammunition supply and of the production of operating and maintenance handbooks or manuals were examined.

The Committee collected a great deal of its evidence from a detailed examination of the supply and technical support of six major Defence equipment items.

This volume contains several recommendations, additional to the 29 recommendations of Volume 1, related to:

- the timeliness of supply of technical documentation,
- the adequacy of documentation, and
- the revision and updating of technical documentation.

1 Joint Parliamentary Committee of Public Accounts, Aspects of Defence Equipment Support Volume 1 - Spares and Ammunition, Report 263 (tabled 28 November 1986, Parliamentary Paper 340/86), AGPS, Canberra, 1986.

This volume also contains reports from the Committee's specialist adviser, Mr R J Parkinson, on :

- a toxic gas and accident on HMAS Stalwart, and
- Navy shipboard fire and gas control systems.

These documents, together with responses from the Department of Defence, have been included in the Committee's Report because of public concern about accidents on HMAS Tobruk and HMAS Stalwart. The recommendations of four recent reports of the Committee (PAC Reports 223, 227, 243 and 263 Volume 1), and the findings herein, have been directed towards improving the operation and efficiency of the Department of Defence. The Committee hopes that one of the outcomes of this process will be the avoidance of any recurrence of accidents similar to those experienced on HMAS Tobruk and HMAS Stalwart.

Throughout the inquiry the Committee received extensive co-operation and assistance from the Department of Defence. The Committee thanks the Department of Defence and other Commonwealth agencies for their efforts. The Committee also thanks Mrs Helen Mayer, MP who chaired the Sectional Committee which conducted the inquiry, the Committee's specialist advisers and the members of the Secretariat for the considerable support given to the reference.

For and on behalf of the Committee.

R E Tickner, MP
Chairman

M J Talberg
Secretary
Joint Parliamentary Committee of Public Accounts
Parliament House
CANBERRA
25 March 1987

TABLE OF CONTENTS

VOLUME 2

TECHNICAL DOCUMENTATION

- Introduction
- Timeliness of Supply
- Adequacy of Documentation
- Revision and Updating of Technical Documentation
- Navy Shipboard Fire and Gas Control Systems

Introduction

1.1 Technical documentation is an important element of equipment support. The term 'technical documentation' covers engineering and operating data. This includes specifications, drawings, test procedures, training, operating and maintenance manuals, and instructions. In this inquiry, the Committee was interested only in documentation 'in the hand of the users' (i.e., the equipment operators and maintainers). The inquiry has therefore focussed on operating and maintenance manuals.

1.2 The Committee's interest in technical documentation stems from the results of its earlier inquiry into HMAS Tobruk, from the fatal gasing of sailors' on HMAS Stalwart, and from the Auditor-General's review of major problems associated with the Army's M113A1 Light Armoured Vehicles.

1.3 In its Report 223 on HMAS Tobruk, the Committee noted the many serious problems with the design, installation, modification, quality control, quality assurance of the ship's sewerage system.[1] This led to poisonous gases filling a lavatory and resulted in the death of Naval Reserve Cadet Dax in December 1981.

1.4 In October 1985, three sailors from HMAS Stalwart died as as result of inhaling poisonous gases which were generated in the ship's sullage tank. A Naval Board of Inquiry found that the accident could have been avoided had a non-return value been fitted to the transfer pump.[2]

1.5 In his September 1985 Report the Auditor-General reported on a number of major problems associated with the serviceability, lack of technical data, poor resolution of technical problems, unsatisfactory maintenance and the supply of spare parts for the Army's M113A1 Light Armoured Vehicles.

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1. Joint Parliamentary Committee of Public Accounts, Report 223, HMAS Tobruk, AGPS, Canberra, February 1984, p.136.
2. The Australian, 5 March 1986.

1.6 Given this background the Committee wished to know whether:

- technical documentation, in the hands of operators and maintainers, is adequate when supplied for the:
  - (a) safe, and
  - (b) effective use of equipment; and
- technical documentation used by operators and maintainers, is kept accurate throughout the service life of the equipment it covers, by incorporating:
  - (a) current user experience i.e. Australian Defence Force and foreign users; and
  - (b) the latest expert technical advice: for example, from the designer/manufacturer, Australian technical authorities, and overseas technical authorities.

1.7 The Committee began its inquiry into technical documentation by submitting two sets of questions to the Department of Defence. The first sought details of the Services' technical documentation acquisiton and revision procedures, and of the history of technical documentation associated with six selected equipment items. The second sought details of RAN shipboard fire and gas control systems and procedures, and a report on the recent incidents on HMAS Stalwart.

1.8 The Committee discussed the Services' response to the questions on technical documentation procedures at a public hearing held in Canberra on 10 June 1986. Unfortunately, the Department directed its initial written response to technical documentation relevant to equipment manufacture and modification, and not to operating and maintenance handbooks. The Committee then addressed more questions in writing to the Department.

1.9 The Committee referred the Navy response to questions on RAN shipboard fire and gas control systems to a specialist adviser appointed for the task, Mr R J Parkinson. He prescribed a number of questions for answer by RAN authorities (refer Appendix C). These questions together with his report were referred to the Navy for comment and response (refer Appendix D).

1.10 The Committee notes that no matters appear to be materially at issue or in conflict in the Department's response to Mr Parkinson's report.

Timeliness of Supply

1.11 The Committee wished to determine whether the acquisition of technical documentation was timely so as to allow the Services to deploy equipment effectively when the equipment was introduced into service. Report 243 on Defence Project Management noted significant delays in the delivery of hand books, maintenance manuals and spare parts lists for the Army's Medium Truck Project. [3]

1.12 The Committee selected six equipment items for detailed investigation: the FFG Guided Missile Frigates, the Humpty Doo Transmitting Station (Navy), the M113A1 Light Armoured Vehicles, Rapier Surface to Air Missile System (Army), F-111 Strike and Reconnaissance Aircraft and P3C Orion Long Range Maritime Patrol Aircraft (Air Force). For each of these items (or their major components), the Committee sought answers to the following questions:

- whether operating and maintenance manuals, handbooks and instructions were delivered to users before the delivery of equipment;
- whether that documentation was complete and up to date; and
- the source of any delays in the supply of complete documentation.

1.13 In its response to the questionnaire, the Department provided details of twelve equipment items. These items are listed in Table 1.1.

TABLE 1.1

List of Selected Equipment Items - Technical Documentation

Navy	Humpty Doo Naval Transmitting Station	
	FFG Frigate	Mk 92 MOD 2 Fire Control System
		Mk 13 MOD 4 Guided Missile Launching System
		LM 2500 Marine Gas Turbine Propulsion System
Army	Rapier	missile
	M113A1	light armoured vehicle
Airforce	F 111C	engine
		stabilised platform unit
		hydraulic spoiler
	P3C	engine
		infra-red receiver
		propellor

3. Joint Parliamentary Committee of Public Accounts, Report 243, Defence Project Management, Volume 2, AGPS, Canberra, February 1986, paragraphs 13.35 - 13.36.

1.14 Technical documentation for nine of the twelve equipment items was supplied, over the life of the projects, on time and complete. Records were insufficient to indicate whether documentation for six of the items was complete on delivery.

1.15 Very significant deficiencies were experienced in the case of technical documentation for the Navy's Humpty Doo Transmitting Station. The Station lacked twenty percent of its technical documentation, on arrival of the prime equipment in Australia. Ninety two percent of this documentation was complete and up to date. However, a twenty percent increase in overhaul time was experienced due to these deficiencies.

1.16 All technical documentation for the FFG was supplied on time, complete and up to date.

1.17 The Army had no data available for the Rapier, and therefore could not reply to the Committee's questions. All technical documentation for the M113A1 vehicles was supplied on time, complete and up to date.

1.18 The Air Force's F111C engine lacked thirty per cent of its technical documentation on arrival of the prime equipment in Australia. Whereas the F111C stabilised platform unit and the F111C hydraulic spoiler was supplied on time.

1.19 The P3C infra-red receiver had no technical documentation available on arrival of the prime equipment in Australia. Technical documentation for the P3C engine and the P3C propellor was supplied on time.

1.20 Records for the F111C and the P3C do not indicate whether or not technical documentation was complete on receipt of the prime equipment. However at the time of the Committee's examination all technical publications were up to date and no delays in repair or overhaul times had been linked to a lack of technical documentation.

1.21 Generally where the receipt of technical documentation was delayed or publications were incomplete in Defence projects problems were attributed to:

- the inability to define technical documentation requirements;
- deficiencies in contractual provisions for technical documentation; and
- contractor performance.[4]

4. Minutes of Evidence, op cit, pages 281-452.

1.22 The Committee then examined the first two problems in relation to the F/A 18 Tactical Fighter Project. There were two ways of obtaining data relating to the F/A 18:

- a common foreign military sales contract,
- a contract data requirement list which is a contract with McDonnell Douglas.[5]

1.23 The latter method was employed for the F/A-18. Aeronautical Research Laboratories (ARL) stated that scientific and technological support of military aircraft is dependent on the acquisition of data beyond that necessary for immediate operation and maintenance of equipment.[6] However, at the time contracts were entered into for the F/A-18, data requirements were not defined in a contractable form.[7]

1.24 In a submission to the Committee ARL stated :

> It is the experience of personnel in these Laboratories that the data they require is often not available in a timely and efficacious manner, so jeopardising their ability to provide the support required.[8]
>
> The contract for supply of the F/A-18 via a Foreign Military Sale (FMS) managed by the US Navy calls for the generation of a sequence of Contractor Data Requirements Lists (CDRL) for the F/A-18 supplied by McDonnell Douglas Aircraft Company and the F404 engines supplied by General Electric Company. ARL personnel involved in the evaluation were given to understand that the specified data requirements would be included in the CDRLs. Following the selection of the F/A-18, ARL provided a sequence of lists of information required. Very little of this has been supplied.[9]

1.25 ARL officers explained that :

> We have found that we can obtain data cost effectively only if it is included in the contract, or more realistically, if provision to acquire it is included in the contract, since it is difficult to specify in the contract exactly what it is that we require. Much depends on the provision within the contract and the actual mechanisms under the contract by which the documents that meet our requirement are firstly identified and then released.[10]

5. Minutes of Evidence, op cit, page 709.
6. Ibid, page 708.
7. Ibid, page 709.
8. Ibid, page 10.
9. Ibid, pages 11-12.
10. Ibid, page 15.

> A CDRL is a fairly complex document. The items listed there have to be specified very precisely. It is this problem of converting our broad requirements into a precise requirement that can be included in the CDRL that seems to have been one of the problems here. We specified at that early stage the broad requirement and there seems to have been a problem of converting that into the format required for the CDRL.[11]

1.26 A source code version ('one that is written in a language that makes it possible to transfer the code from one computer to another computer relatively easily'[12]) of the performance program for the F404 engine existed prior to the signing of the F/A 18 contracts in 1981. This was not included in any data listings received from the manufacturer or the US Department of Defense. The ARL request dated 13 May 1986 and the extract from the engine specification document, provides a sufficient statement of requirement for a source program. This information should enable procurement of the data through an FMS Case.[13]

1.27 The Committee believes that the Department of Defence can improve the timely and adequate supply of technical documentation by:

- better liaison with engineering and other technical specialists in defining technical documentation requirements;
- improving contractural provisions for technical documentation; and
- better monitoring of contractor performance in this regard.

1.28 The Committee recommends that the Department of Defence :

> promulgate instructions to the Services to ensure that the appropriate technical authorities (such as the Areonautical Research Laboratories) are closely involved in the specification of contract data requirements (including mechanisms to ensure the timely acquisition of relevant data, for example source codes, not able to be specified at the time of contract negotiation but required over the life of the project); and
>
> develop revised 'pro-forma' contract clauses covering the provision of technical documentation.

11. Minutes of Evidence, op cit, page 22.
12. Ibid, page 20.
13. Ibid, page 1113, 115.

Adequacy of Documentation

1.29 The Committee sought information on the adequacy of technical documentation. By adequate the Committee meant that it allowed the safe and effective use and repair of equipment. By effective the Committee meant that technical documentation:

- was accurate,
- met all user requirements, and
- was provided in a 'user friendly' format.

1.30 In its response to the Committee's questions the Department of Defence provided the Committee, in confidence, with a copy of a recent report on technical publications. This report reviewed the efficiency of the procedures governing the supply, production and updating of equipment publications in each of the Services.

1.31 The report determined that current efforts to assess the content of technical publications and manuals were generally adequate in that technical specialists (engineers and trade specialists) were attached to project teams specifically for that purpose. However, it perceived that specialist publication expertise was lacking in Defence, given the increasing application of technology to the presentation of information.[14]

1.32 The Efficiency Review revealed that errors in technical publications have proven costly. RAAF figures indicate that about 8% of aircraft accidents and incidents can be linked to deficient technical publications. The Review also suggests that similar figures apply to the Army and RAN.[15]

1.33 Each Service has a unique requirement for technical documentation. Procedural differences are minimal between the RAAF and Army, while RAN has some systems which are not clearly defined.[16]

1.34 The Committee found that the Department is behind in using computers for document management. Quality assurance procedures for technical documentation need to be devised and implemented by staff who are trained in technical writing. Senior staff lack training in information management and are unversed in the documentation problems associated with today's complex equipment. The Services are currently using terminology which is often loose, non-standard and incomplete. The language used is frequently over complicated and needs to be simplified by using the principles of plain english. The Committee notes the comment

14. Department of Defence, Answers to Questions on Notice, 1986, Q.17.
15. Department of Defence, Efficiency Review of Procedures for the Acquisition, Production and Updating of Technical Publications, Canberra, March 1986.
16. Minutes of Evidence, op cit, page 532.

of its specialist adviser (at section 2(C.1) of Appendix C) that :

> Subject to normal courtesies of address it is always advantageous to couch documents, particularly Service documents, in straight forward language, most particularly those destined for use in training programmes. A serving sailor could be excused for not recognising an 'Olfactory Apparatus' as his nose.

1.35 The Air Force procedures for the supply of technical documents encompass project control, editing and approval. The Army makes no provision for quality assurance of manuals which are used for equipment operation; and unqualified engineers advise on maintenance procedures. The Navy has no adequate quality assurance procedures to vet handbooks prior to the supply of equipment.

1.36 The Committee believes that documentation should be available to ensure that equipment is properly used and maintained by those expected to operate such equipment. Thus the Committee recommends that the Department of Defence formulate guidelines to :

> determine the minimum standard for technical publications in every instance;
>
> implement universal procedures ensuring that documentation will be made available in time to meet these standards;
>
> establish suitable training courses for technical writers;
>
> expand existing training programs to encompass technical documentation;
>
> ensure that qualified professional staff (and/or technical writers) write, compile and regularly review engineering instructions; and
>
> encourage operational staff to verfiy technical documentation and report those matters described in handbooks etc which are ambiguous or not accurate.

Revision and Updating of Technical Documentation.

1.37 Revision and updating of technical documentation is performed both by the manufacturer and the user of equipment. The RAAF and Army arrangements for the implementation of these

processes are similar, while Navy procedures are different and more complex. All the Services have an:

- amendment proposal,
- acceptance,
- draft,
- check,
- print, and
- distribution to the user.[17]

1.38 For the six examples cited by the Committee, Navy and Army did not identify deficiencies in the present arrangements. The Air Force cited the time delay between issue of amendments by the US service and the ensuing incorporation of these into maintenance publications in the field.[18]

1.39 The Auditor-General found that the operational capability of the Army's M113A1 Light Armoured Vehicles had been adversely affected by Army not acquiring up to date technical information. Technical Data Package (TDP) revisioning services from the manufacturers of the Vehicle and the Scorpion Gun Turret of the Fire Support Vehicle version of the M113A1 had either not been acquired, or had not been renewed. Technical problems had arisen with both equipments, and Audit believed that had TDP revisioning services been maintained, Army would have been advised of the necessary equipment modifications by the manufacturers and would have been able to take timely action. Instead costly remedial action was necessary.

1.40 Audit stated that :

> an up to date TDP revisioning service is an important and relatively cheap engineering and safety requirement.[19]

1.41 The Committee found that while existing procedures have been followed, their form and adequacy is questionable.

1.42 The Committee recommends that for major projects :

> publication and training provisions not be reduced to make savings in a project;
>
> the Department ensure flexibility in funding to accommodate rapid changes in publications requirements and costings;
>
> technical documentation be part of the integrated logistic support plan;

---

17. Department of Defence, Questionnaire Response to the Joint Parliamentary Committee of Public Accounts, May 1986, Annex 1.
18. Department of Defence, Additional Answers to Questions, 1986.
19. Report of the Auditor-General, Canberra, AGPS, September 1985, pages 18-19.

dedicated staff on project teams be responsible for technical documentation;

contractural arrangements include technical documentation; and

involvement of technical authorities e.g ARL, from the onset of projects, and including support for contract negotiations.

1.43 The Committee recommends that the Department implement technical documentation procedures which :

use computerized equipment for document management and revision ;

arrange for the electronic distribution of material where possible;

include proper project evaluation and review techniques;

ensure quality assurance;

train staff in information management;

as far as possible, simplify and standardise terminology;

ensure complete documentation; and

supply user handbooks to all relevant equipment maintainers.

Navy Shipboard Fire and Gas Control Systems.

1.44 The Committee's examination revealed significant deficiencies in Navy procedures governing the operation of shipboard fire and gas control systems.

1.45 The Committee requested its specialist adviser, Mr R J Parkinson, to:

- analyse the HMAS Stalwart Toxic Gas Accident Summary of Board of Inquiry Report and Navy Office Review of the Report of Board of Inquiry, and

- examine:
  - the extent of usage/installation of systems capable of generating toxic gases and the use of combustible materials,
  - current approved RAN Standards covering systems capable of generating toxic gases and the use of flammable materials especially polycarbons in RAN vessels, and
  - current RAN Instructions in the event of fire or the release of toxic gases aboard ship.

1.46 In his report Mr Parkinson advised the Committee that:

> things which are not perceived to directly impinge on the fighting qualities of vessels receive inadequate consideration. Consideration should be given to widening the terms of reference of a Board of Inquiry and/or Accident Evaluation Committee to include the consideration of preventative measures independent from Service disciplinary considerations.
>
> On HMAS Tobruk and on HMAS Stalwart, malodourous smells persisted and were tolerated for months. Nauseating and putrid odours are not normal and some procedure should be established to encourage the reporting of same and after repeated reports, proper inquiry into their cause, source and cure instituted. Such a procedure could have prevented both accidents. In view of the findings of the Tobruk inquiry, knowledge of the presence of sewerage in the sludge tank of HMAS Stalwart, should have been sufficient warning to treat the contents of the tank prompty and with care.

1.47 Mr Parkinson's reports have been reproduced in Appendices A and C. The Department of Defence's responses have been reproduced in Appendices B and C respectively.

1.48 The Committee notes that no matters appear to be materially at issue or in conflict in the Department's responses to Mr Parkinson's reports.

1.49 The Committee believes that publication of these reports and responses is important in this instance because of public concern about accidents on HMAS Tobruk and HMAS Stalwart. The Department's current general position on these matters should be accounted for publicly.

APPENDIX A

Report by Mr R J Parkinson,

PAC Specialist Adviser, on a Toxic Gas

Accident on HMAS Stalwart.*

*Appendices A-G referred to in the following Report by Mr Parkinson have not been reproduced herein.

Report on

Inquiry into Aspects of Defence Equipment Support

SECTION C.(2)(c)

HMAS 'STALWART'

Toxic Gas Accident 22.October 1985

Notes and Questions
for further enquiries following study of:-

(a) The Summary of Board of Inquiry Report

(b) Navy Office Review of the Report of Board of Inquiry

8th August, 1986

ERRATA

Errata No.1

Page 14 - Question 28)
)
Page 14 - Question 29) These questions are considered to be partially
) answered in Briefing Notes Part 1.
Page 15 - Question 33)

Errata No.2

Please refer to Page 16 - Remark 21

Errata No.3

Please refer to Page 17 - Remark 22 (ii)(c)

Please note additional copy of Section 2 of Report is included herewith upon which these corrections have already been completed.

1 INTRODUCTION

Approximately sixty percent of the Defence Department's response to the Committee's request comprises the Board of Inquiry Report and the Navy Office Review of the toxic gas accident aboard 'Stalwart' and for this reason a separate section has been devoted thereto. This section was also completed first and for this reason some of the questions proposed may be answered in the earlier documentation relating to Section C(1)(2)(a) and (2)(b).

In the interests of progressing the task within a restricted time this is unavoidable and should be taken into consideration during the hearings.

As far as possible where questions outlined in this section have been subsequently answered an asterisk so indicates. They have not been deleted because the responses may still require further amplification. Retention may therefore serve as a prompt.

To facilitate appraisal the report follows the same sequence as the Documents.

Notes to amplify or explain appear opposite the relevant text and *paragraph reference with suggested questions appended.*

2 COMMENTS ON SUMMARY OF BOARD OF INQUIRY REPORT

Quote	Remark 1
para 7 - The waste had been retained on board to conform with International Maritime Organisation (IMO) regulations concerning non dumping in inshore water.	The vessel's refit had apparently taken place at HM Dockyard. Garden Island, Sydney, NSW, from March to September 1985. Setting aside IMO regulations, commercial dockyards but more particularly Naval dockyards should have slops, sullage and waste oil disposal facilities. Not infrequently and particularly so in cases of damage repairs, it may be necessary to discharge fuel and/or lubricants ashore for storage or disposal. Tankage should be available, or facilities exist within convenient reach. Aqueous effluent from chemical cleaning of boilers or degreasing of engine cooling systems etc. would normally be disposed of directly to a road tank vehicle and the nearest approved industrial waste tip or, subject to satisfactory dilution, directly into the town sewerage system.

Q.1 Who would have taken the decision to retain the "sullage" on board 'Stalwart' and under the circumstances prevailing during a refit, whose wishes would be paramount?

Q.2 Who drew up the specification for and who was "in charge" during the refit, i.e. who commissioned work, accepted it on completion, carried out inspections and testing, made day to day modifications as necessary and could be deemed to be the responsible officer/ authority?

Q.3 Was that authority absolute or if not how were important decisions taken during the refit?

CONTENTS

Quote

Remark 2

IMO anti-pollution regulations were promulgated at the IMCO conference on Marine Pollution 1973, the International Convention for the Prevention of Pollution from Ships (publication 77.14./) and specifically Regulation 9 Appendix No.1 1

which defines the maximum oil content of the effluent as less than 100 ppm,

Regulation 12 Appendix No.2 2

which defines the requirement for reception facilities,

Regulation 16 Appendix No.3 3

which defines the requirements for oil discharge monitoring and control system and oily water separating equipment.

18

'Stalwart' is understood to be a 15,500 tonne Destroyer Tender. It probably has a ship-to-ship refueling capability and the fact that the Department of Defence consider the applicable IMO regulations to be a maximum oil content in overboard discharge effluent of 100 ppm (parts per million) and an instantaneous maximum oil discharge rate not exceeding 60 litres per nautical mile indicate the vessel is intended to comply with the IMO regulations for tankers.

Translating the above rates into tonnes per hour at various speeds gives :

Knots Speed	Oil Content at 100 ppm/hour	Total Effluent Vol. (water plus oil/hour
10	0.6 tonne	6000 tonne
15	0.9 "	9000 "
20	1.2 "	12000 "
25	1.5 "	15000 "

Quote

Remark 2 (cont.)

Clearly the 60 litre/nautical mile limit may be ignored by 'Stalwart' and assuming the transfer pump capacity is 30 tonne/hour, the limit of 100 ppm oil content provides a permissible 3 litres per hour oil content discharge rate and because the pump capacity is constant at higher speeds the instantaneous oil discharge rate would be very low indeed. For example, at 20 knots it should not exceed 0.15 litres per nautical mile.

Article 3 (3) Appendix No.4 .....
Defines the scope of the convention and specifically excludes naval vessels except as a voluntary act.

Note also from Regulation 16 that it is not mandatory for existing vessels until 3 years after the entry into force of the Convention. For 'Stalwart' this is 2.October 1986.

19

Q.4 Has the efficiency of 'Stalwart's' separator been tested and is it capable consistently of maintaining at the water discharge an oil content of less than 100 ppm?

Q.5 It was known the contents of the sludge tank was an oily/chemical/water mix but the tank was being discharged directly overboard and not through the separator. Given the desire to conform with IMO regulations (although not yet applicable to 'Stalwart') had any guidance instructions been issued to the vessel in this respect?

Q.6 IMO regulations for tankers also require an oil discharge monitoring and control system. The Inquiry states (11.1 "but ships have no ready measure of oil concentration) which indicates an absence of the specified monitoring equipment. Is it the Department's intention to comply with this aspect of the IMO regulations?

Q.7 The alternative to oil monitors would be to retain all oily water on board and pump out to shore installations. Is this being implemented?

Quote

Q.8 Are copies of the relevant IMO Regulations or abbreviated interpretations carried aboard RAN vessels and specifically what general instructions apply concerning compliance with and implementation of IMO pollution prevention regulations?

Remark 3

para 7 - The ship's programme had been a busy one since the ship had completed engineering sea trials on 27.September 1985.

The accident occurred on 22.October 1985 or 25 days later during which the vessel had been at sea for a total of 21 days which seems a long time to ignore the presence of over 80 tonnes of unwanted waste products. Presumably during this period machinery space bilges had been regularly pumped, including the Stern Gland Compartment.

Q.9 What division of departmental responsibility for:-

(a) pumping machinery space bilges etc.
(b) pumping from other tanks or spaces?

Q.10 Given that there had not been a suitable opportunity or perception to discharge the sludge tank before 22.October 1985, what was the change in circumstances which caused A.B. Oliver to seek and be granted permission to pump out at 18.00 hours that day?

Remark 4

para 8 - The sludge tank had an air vent on the ship's quarterdeck. Under certain conditions an offensive smell had been noted, but it was regarded as a "normal" sludge tank smell and had aroused no particular interest.

Only a limited number of the ship's personnel would be aware that the air pipe came from the sludge tank or possibly that the smell came from that particular air pipe.

The 'Tobruk' incident had alerted the Service to the dangers of hydrogen sulphide gas and test equipment had been issued. Doubtless the offensive smell had the characteristic "rotten eggs" odour which was instantly recognised by the Dental

Quote

Remark 4 (cont.)

Officer on board (Navy Office Review 9.12) from the respirators being returned after the accident.

Given the above:-

Q.11 For how long had the "offensive" smell been noted? Had it been reported? Why had the odour not been recognised, the potential danger appreciated and the source traced and eliminated long before 22.October 1985?

(The above applies more particularly to technically knowledgeable and higher ranks of the Ship's company).

Remark 5

para 14 - (Regarding pumping out the stern gland compartment).

It must be assumed that he noted the transfer pump already running but believed it safe to have the pump taking suction from two places at once. This practice, termed 'stealing a suction' is often used but in this case was inherently dangerous since the controlling valve for the flexible hose was not a non-return valve. As soon as it was opened there was a direct path from the sludge tank (liquid level about 20 feet above bilge) to the bilge.

As appears later in the Report (14.1.d.) 'stealing a suction' depends upon throttling or reducing the flow in one suction pipe to induce a suction in another, which involves the simultaneous manipulation of at least two valves which therefore must be in fairly convenient proximity. This was not the case in this instance. What was being done was attempting to pump from two sources at the same time which is quite different.

Q.12 Does training include instructions on the inherent difficulty of pumping from two places with a single pump?

(a) That at best the system with the lesser resistance will be favoured to the detriment of that with the higher resistance up to the latter remaining totally unpumped unless steps are taken to balance resistance by valve manipulation?

Quote	Remark
Q.12 (cont.) (b) That at worst there could be a cross flow of liquid from the compartment with the high head to that of the lower via the suction lines, byepassing the pump entirely, which is what occurred and caused the Accident?	
Q.13 Are there any standing instructions to cover the situation that a pump required for use is found to be already operating?	Remark 6 What happened was that two operatives used the same pump for differing purposes at the same time: (a) The operative properly authorised did obtain permission but that was not passed further up the chain of command. (b) The other operative, unauthorised except by custom and usage may not have consciously registered that the pump was already being used. He may have been mentally distracted or even have pressed the starter button as he approached the pump and then merely thought someone had left open the pump valves. Adjacent noises and vibrations of other operating machinery could be factors. It is probable the operatives were from different departments with separate chains of command which broke down. To eliminate recurrence it would be logical for only one department to be authorised to start machinery and/or pumps.
Q.14 Has any thought been directed to adjusting the duties of departments as indicated above?	

Quote	Remark
para 52 - The Board considered that had permission been sought of the Engineering Officer of the watch for both pumping actions to occur simultaneously, the potential for cross-connection flooding might possibly have been appreciated.	Remark 7 The above indicates recognition that machinery/pumping operations would be more efficiently regulated as suggested in Remark 6.

3 COMMENTS ON BOARD RECOMMENDATIONS

Quote

para 69a - that all Naval personnel be made aware of the characteristics and dangers of H_2S in particular.

Remark 8

Following the earlier 'Tobruk' incident Draeger portable gas detection kits were issued to vessels indicating an awareness of the danger of hydrogen sulphide.

Q.15 Guidelines/instructions concerning the lethal properties of hydrogen sulphide were distributed to the fleet following the 'Tobruk' incident. How far down the command structure was that information disseminated - to all Ranks, Petty Officers or Officers only?

Remark 9

para 69c - that HMAS 'Stalwart's' engineering personnel be made aware of the dangers of attempting to pump with one pump from more than one suction.

It is suggested that this recommendation be amended to include engineering personnel on all ships.

4 COMMENTS ON NAVY OFFICE REVIEW OF THE BOARD OF ENQUIRY

Quote

para 6.5 - In late July through to 14.August, ship's staff chemically cleaned the main engine cooling system..... The initial operations entailed dumping the considerable quantities of effluent into the engine room bilges from where it was pumped to the sludge tank, which was used as a holding tank.

Remark 10

The effluent quantity quoted appears large in comparison with the probable content of the engine cooling system. It is self-evident that 228 tonnes cannot be accommodated in a 90 tonne capacity tank.

para 6.6 - Large quantities (228,000 litres = 228 tonnes approx.) of sullage were removed in the period after completing the engine clean and before sailing.

Q.16 What is the combined capacity of the engine cooling system in metric tonnes?

Q.17 What was the source of the 228 tonnes referred to?

Q.18 Some of the material must have been disposed of ashore. How was this disposed of and why was it not all disposed of?

Remark 11

para 6.7 - The opportunity had nor arisen ..... for the treatment and discharge of the accumulated bilge washings, chemical solutions and contaminated fuel (water and cladisporium fungi growth) stripped from several fuel tanks.

The above are the first stated contents of the sludge tank to which must be added per Enclosure 9, Department of Science and Technology, para 3.

"In this respect it should be noted that the information provided to myself by officers of your Department indicated that the sullage (sludge) contained a considerable sewerage component".

Quote

Remark 11 (cont.)

It is obvious that if oily and aqueous waste are mixed their eventual disposal becomes more difficult. As a first step they have to be settled and passed through a separator. The work load on the separator would be reduced if, so far as possible, aqueous and oily wastes were kept separated.

Q.19 'Stalwart' is equipped with alternative tankage such that aqueous and oily wastes could be kept separate. Why was this not used?

Q.20 Have such instructions been issued for the future?

Remark 12

26

Later in the Report (11.23) the point was made that the sewerage system on board was drained down prior to the refit which may have been the source of the faecal coliform count reported in the analysis of sludge (AMDEL Report No.224/86 page 2) but that this was in any event very slight. Enclosure 9 however states that microbiological assays were not attempted because the samples had not been taken in the correct type of containers, kept at the correct temperature or analysed within the necessary time scale and hence quantitive data would not be valid.

Q.21 What were the circumstances which caused Officers of the Naval Department to comment that there was "a considerable sewage component"?

Q.22 Having in mind 'Tobruk', was it not obvious that such wastes should be disposed of ashore to the city sewerage system or by tank car to the nearest sewage farm and why was this not done?

Quote

Remark

Fleet Comments

page 4 - 'Stalwart' had not used the tank cleaning compartment or facilities since before refit. By using pump out facilities there was no requirement to process oily waste until the ship went to sea. There is no evidence to indicate that the separator or system was defective after refit and could not be used.

Q.23 If the tank cleaning facilities had not been used, how was the sludge pumped to the sludge tank?

Q.24 If the normal procedure using the separator would have been to return washings to the settling tank, why had not this policy been followed, aqueous waste to settling tank, oily wastes to sludge tank?

27

Q.25 Pump out facilities had been used during the refit therefore at which point had it been terminated and why?

Remark 13

para 6.9 - The practice had developed to use the hose suction from the transfer pump in the tank cleaning compartment, with a flexible 3 inch hose passing through the manhole to the stern gland compartment to pump the stern gland bilges. The hose was "normally there" preventing quick closure of the manhole. By this method the sterm gland bilges could be drained almost completely. The main suction was not preferred because of the inconvenience

The report also comments that using the TCC transfer pump for bilge pumping was against standing orders because the pump could be expected to be contaminated with oil. Additionally that to use the Hull and Fire Pump would have necessitated drawing storeroom keys to the compartment and returning them afterwards (7.3 Fleet Comment).

It appears that the irregular system in use was of long-standing and almost certainly long enough for:-

(a) The irregular practice to have been legitimised by changing standing orders and fitting a permanent steel

Quote

para 6.9 (cont.) - in opening the system and having to start the hull and fire pump located in an adjacent compartment..... Additionally because of the level of the strainers on the main suction lines more frequent pumping was necessary.

Remark 13 (cont.)

suction pipe to the stern gland compartment with normal screw down non-return suction valves which would have maintained convenience and, by eliminating the flexible hose, restored watertight integrity.

(b) To have improved the convenience and efficiency of the main system by lowering the suction strainers and eliminating the necessity to draw a key for access to the pump.

Q.26 Has it been established for how long the irregular practice had been in use?

Q.27 Were proposals to modify the arrangement submitted at any time and, if so, why was it not carried out?

28

para 7.5 - A.B. Oliver on the quarterdeck ..... noted the foul smell over the side and suspected something was wrong. He left the quarterdeck to shut down the transfer pump.

Remark 14

This was fortuitous and independent from the fact that inadvertently the sludge tank was draining to the steering gear compartment. Stopping the pump prevented much more gas from escaping.

para 7.5 - Navy Office Comment

If Oliver's shut down of the system is placed at 18.08 IK, then more than 8 minutes had elapsed since the start time.

Remark 15

Assuming the restriction to flow was the $2\frac{1}{2}$" fire valve SDSL screw down screw lift) valve in the tank cleaning compartment lower level, the driving head between it and the nearly full sludge tank would be about 10 feet (say 3 metres) permitting water/effluent to escape at the following rate:

$(2.5 \times .0254)^2 \times .7854 \times 60 \times .6\sqrt{2 \times 9.81 \times 3} \times 1000$

= 875 litres/minute approximately

= 875 x 8 = 7000 litres in 8 minutes (about 1540 gallons)

Quote

para 9.5 - Navy Office Comment

The theoretical volume which would flow through an unrestricted 3 inch orifice given the head in the sludge tank and the available time is about 5000 gallons.

Remark 16

For the reasons given in Remark 17, the above seems somewhat overstated.

Remark 17

para 9.12 - The information of the identification of the gas was passed to the Commanding Officer "many hours after the accident".

The statement is surprising in view of the characteristic odour of hydrogen sulphide, the number of different personnel involved including P.O. Ledger shortly after 18.22 hrs IK who commented "there was obviously gas" in 2H (12.20) when opening the large port and starboard doors in the ship's side as agreed by the C.O.

29

Q.28 Have any steps been taken subsequently to ensure that all personnel are familiar with the odour of low concentrations of hydrogen sulphide and its lethal propensity in higher concentrations? *

Remark 18

para 10.9 - Fleet Comments

Use of the Draeger tubes is of minimum assistance if operators are not well trained. It is doubtful if L.S. Smith was - and it is understood that there were several leaks in the equipment which would have made the readings meaningless.

It is understood that the distribution of Draeger test kits commenced following the 'Tobruk' incident and Report 223, latest early 1984. If this is so it is somewhat surprising that the Draeger pump had deteriorated so rapidly on the one hand and that there were not at least several well trained operators on the other hand.

Q.29 How many Draeger test kits have been distributed throughout the fleet and when? *

Q.30 How many personnel have been trained in their use?

Q.31 What arrangements have been made for routine regular inspection of the pumps and changing "time expired" test capsules?

Quote

para 10.31 - LCDR Lemmey states he noted the smell of hydrogen sulphide emanating from the Oxy-Vivas which had been returned from the steering gear compartment ..... He further stated that he was aware of the dangers of hydrogen sulphide and assumed other people know what it was. He could not pass on his awareness as "there was no-one ..... of significance to report to".

Remark 19

LCDR Lemmey happened into the Sick Bay fortuitously about 19.35 and in retrospect it is unfortunate that he did not appreciate that others did not share his own awareness of the identity of the gas and pass the information by messenger to the bridge. Whilst it is very doubtful that at that stage the knowledge would have affected the outcome in any way, it is obviously essential that any asphyxiating or toxic gas should be identified as soon as possible.

Q.32 Have any arrangements been made to familiarise personnel (tehnical and medical at least) with the odours and characteristic effects of the gases one might experience on shipboard and specifically those gases listed in the Departments's circulars?

30

Q.33 Have any standing orders been promulgated regarding requirements for personnel to report their knowledge or suspicion of the presence or proximity of any of the above gases on board?

Q.34 Irrespective of positively identifying any particular gas, have any standing orders been promulgated for personnel to report any bad, nauseous or putrid odour whether identified or not?

Remark 20

Whilst at first sight the above may appear to be too obvious, the facts are that putrid/nauseous odours are not normal but abnormal and were ignored or at least accepted for long periods both on 'Tobruk' and 'Stalwart', whereas recognition that something was wrong and needed investigation could have prevented both Accidents.

Quote

para 11.1 - 'Stalwart's' installed system for handling oily waste water should well cope with the requirements that the maximum rate of discharge be 60 litres per nautical mile of an oil/water mixture no greater than 100 parts per million.

Navy Office Comment:

The discharge rate needs to be converted by ships into tons per hour at so many knots, but ships have no ready measure of oil concentration ..... The recent IMO regulations applicable to the RAN in relation to retention of sullage on board until it can be safely discharged at sea, could be a possible factor.

Remark 21

The regulations adopted are applicable only to tankers. After the 2.October 1986 the lack of a ready measure of oil concentration (i.e. an oil monitoring and recording device) will be an infringement of Regulations unless all slops are disposed of ashore.

NOTE:- See IMO Publication "Oily Water Separators & Monitoring Equipment" Sales No. 608.82.15.E - Appendix No.5

31

Q.35 Have the Department of Defence anticipated the IMO Regulations?

Q.36 Which regulations do they deem apply to 'Stalwart' and other RAN vessels?

Q.37 Because ships have no ready measure of oil concentration, is it intended to fit monitoring or additional oil filters and maintain oil record books, as per Regulation 20?
Appendix No.6 6

para 11.19 - Generation of hydrogen sulphide in the sludge tank:-

(b) Release during the decay of sulphur containing materials by the action of sulphate reducing bacteria (Desulphovibrio Desulphuricans)

Remark 22

At the time of the commencement of discharge of the sludge tank it was said to contain about 82 tonnes of liquid comprising:

(i) Accumulated bilge washings including about 35% sea water (Encl. 9)
(ii) Chemical solutions

Quote

Remark 22 (cont.)

(iii) Contaminated fuel water and cladisporium fungi stripped from several fuel tanks

(iv) Some faecal coliform content.

(i) 35% seawater amounts to 28.7 tons which contains about 3% by weight of dissolved solids of which about 10% comprise Magnesium Sulphate 6% and Calcium Sulphate 4%, thus total available sulphate would have been approximately

$$28.7 \times 1000 \times 0.03 \times 0.1 = \underline{86\ Kg}$$

(a source of Oxygen for Desulphovibro Desulphuricans)

(ii) Chemicals included:-

(a) AMEROL HDE 777 - A heavy duty emulsifier containing Alifatic and Aromatic hydrocarbons and surfactants (low foaming detergents) (phenols, aliphatic and aromatic compounds were detected in the Engineering and Water Supply Department Analysis Encl.9)

(b) ALFLOC 707 - A mildly alkaline aqueous liquid cleaning chemical. The major active component is a polyphosphate. Minor components include a synthetic organic dispersant, an organo sulphur compound and a synthetic surfactant.

(Phosphates are a source of oxygen. The presence of organo sulphur compounds should also be noted).

(c) NALFLEET 9-111 - An aqueous multicomponent sodium nitrite inhibitor for use in closed cooling water systems. Alkaline (neat product pH 12.7).

(It is improbable that there was much of this material as the pH of the sludge was about 6.5) See Appendix No.7

(d) GAMOSOL D - A solvent emulsifier detergents similar to HDE 777.

32

Quote

Remark 22 (cont.)

(iii) Some waste oil and contaminated fuel (would have floated on the liquid surface and sealed off atmospheric oxygen thereby assisting in the development of anaerobic con conditions).

(iv) Faecal Coliform content.

(It is conjectured that presence of this material was accidental. Also that it may have resulted from draining down the sewerage system during refit. If so it is possible the material was partially septic. Whilst dirt, warm water and hydrocarbons could have been the source of the sulphate reducing bacteria as commented in 11.19, faecal coliform may have provided the original seeding material).

The sludge tank therefore contained all the necessary materials and the warm stagnant conditions favourable for anaerobic cultures and the formation of hydrogen sulphide which did occur.

33

Q.38 Were the contents of the sludge tank a matter of common knowledge or restricted to a few dockyard/ overseers/ship's staff?

Q.39 Is it a common practice to leave sludge resulting from refit activities on board vessels?

para 11.21 - Navy Office Comments:

"Further research will be needed into determining whether the wastes in this instance comprised detergents etc. which may lower pH".

Remark 23

The report states that the engine cooling system was cleaned using HDE 777 and afterwards passivated using ALFLOC 707. In fact HDE 777 is a degreasant and emulsifier and does not require subsequent passivation. ALFLOC 707 is designed for the same purpose as HDE 777.

GAMOSOL D is also an emulsifier and detergent similar to HDE 777.

All three materials contain detergents, (usually phosphates).

Quote

para 11.22 - Fuel contaminated by Cladisporium fungi had been stripped and pumped to the sludge tank.

Navy Office Comment:

The Board of Inquiry have not produced evidence to justify the statement that fuel contaminated by Cladisporium fungi had been pumped to the sludge tank.

34

Q.40 From where did the statement originate?

Remark 23 (cont.)

The pH of the material 6.3 - 7.0 would have enabled sulphur reducing bacteria to flourish and Methane to be evolved in anaerobic conditions.

para 11.23 - It is possible these organisms (faecal coliform) equivalent to contaminated sea water, resulted from washing through bilges, contaminated prior to refit when cleaning out the sewerage system.

Remark 24

This is unlikely because the sludge tank was shot blasted to white metal and recoated with epoxy resin paints as part of the refit. Therefore any content prior to the refit would have been removed and on completion of painting the tank would have been clinically clean and inert. It hence follows that the contamination must have occurred as a result of activities during the refit and after the painting of the sludge tank. Furthermore the profferred explanation does not explain who and why information was given to the sludge analysts that there was a "considerable sewerage content".

Quote

para 11.24 - (AGAL 5/2/4 dated 8.November - Encl.9) which shows high sulphides in the sullage (sludge) compared with typical sewage and greatly reduced sulphates compared with typical sewage or sea water.

Navy Office comment:

The BOI reference to "typical sewage" as a term is an ill advised statement and it is assumed that the BOI intended to refer to "typical sullage wastes".

Remark 25

The BOI reference is taken directly from the AGAL analysis - Encl. 9 - see Appendix No.8 8
It is not understood why Navy Office consider it "ill advised".

Q.41 Do Navy Office accept that the BOI statement is perfectly reasonable and accurate under the circumstances?

35

Q.42 If the answer to 41 is negative, what levels of sulphides or sulphates would they expect in "typical sludge (sullage) wastes"?

Remark 26

The above Navy Office comment is either a misreading/ misunderstanding of the BOI evidence and understandable or suggests a hypersensitivity to references to sewage for an unknown reason which suggests a need for further questions on the subject.

Remark 27

Here is confirmation that sludge wastes were pumped ashore during the refit and "before sailing".

para 11.25 - Garden Island Dockyard investigated those chemicals used in the cleaning of the main engine coolant system and when considered in conjunction with the quantities of sludge pumped ashore before sailing, it is concluded the chemicals did not directly produce H_2S.

Quote	Remark
Q.43 Was the cessation of pumping sludge ashore in any way connected with time constraint and the requirement for the vessel to sail to take part in exercise "Coral Sea"?	
Q.44 Is it known how much sludge remained in the sludge tank on sailing?	
Q.45 Was the sludge tank content in any way increased due to any activities after the 'Stalwart' sailed on 24 September 1985?	
para 11.27 - In this incident, had only oily sludge been in the sullage (sludge) tank, limited generation of H_2S would have occurred. The correct use of the sludge and settling tanks in concert with the oily water separator should enable "safe" sludge to be stored until such time as it could be pumped ashore.	
Q.46 Why was not the above procedure followed during the refit of 'Stalwart'?	
Q.47 A piece of equipment in increasing use since the mid 1970's is a waste incinerator. Has the Defence Department considered fitting such equipment on RAN vessels to enable the total disposal of all wastes generated including oily wastes, sludges, toxic solids and chemicals (subject to temperature control and, of course, plastic, kitchen and galley wastes?	
para 11.27 - Within sewerage systems where H_2S generation is common it is often controlled by the addition of measured quantities of Hydrogen peroxide H_2O_2.	Remark 28 With an efficient aerobic sewage system H_2S is not generated but CO_2. H_2S generation indicates a septic condition in the sewage system. Any soluble alkali which will raise the pH above 8 will halt the generation of H_2S and advice concerning

Quote	Remark
	Remark 28 (cont.) the most suitable cost effective material would be of value to all ships for use when necessary (possibly Borax (Sodium Borate)).
para 11.27 - Navy Office Comments It is unlikely that the oily water separator can ever be 100% efficient and although "sludge" following separation will be oil predominantly, a small proportion of water and chemicals will remain. Potentially this will still support bacterial growth and H_2S generation.	Remark 29 The above material would be well within the capability of a well designed incinerator to dispose of thus eliminating any risks.
para 11.28 - To monitor a combined area or space with difficult access would be awkward and without any other signs of gas require the assumption of danger before monitoring commenced.	Remark 30 The above is a valid assessment and on the basis that prevention is better than cure steps should be taken to eliminate conditions whereby gas generation can occur: (a) By ensuring healthy aerobic sewage systems. (b) Not leaving mixed oil and waste water to stagnate but separating and burning off the oil fraction. (c) If resultant aqueous waste was not suitable for overboard discharge then increase its pH to more than 8. (d) As a final precaution carriage of an electronic gas detector would appear to be desirable.

Quote

para 12.20 - P.O. Ledger described bending down whilst opening the doors and inhaling a pocket of foul smelling gas in 2H Flat.

Navy Office Comments:

While the smell of H_2S (hydrogen sulphide) in the TCC and 2H Flat was noticeable, it is not agreed that the concentration of H_2S was sufficient to cause any serious effect or symptomatology".

Remark 31

From the above it is surprising that positive identification of H_2S was not made until several hours later.

Q.48 Can it be confirmed that the above statement and Navy Office comment was made with the benefit of hindsight and that at the time no such knowledge existed other than that of a "foul smelling gas"?

38

para 13.8 - There were problems with the scientific method of collection and transport of samples which may have affected the validity of results. Liquids were not placed in correct containers and for the microbiological studies were not maintained at correct temperatures whilst in transit, which in some cases took several days to reach their destination. Nevertheless, the results provide some guidance.

Remark 32

The AGAL Analysis Report (Encl.9) commented:

(i) That microbiological analysis should take place within 2-6 hours of collection.
(ii) Because details of chemicals used had not been supplied at the time of the analysis, no conclusions could be drawn.
(iii) Due to the lapse of time it was possible the H_2S concentration was not representative.

Hence results would be indicative and not qualitative and in particular it would not be possible to draw firm conclusions concerning the apparently low faecal coliform content.

para 11.23 compared the faecal coliform count 2800 ppm with city stormwater 5000 ppm, the inference surely being that it was minimal and fortuitous. This is not supported by the AMDEL REPORT D.224/86.

Quote

Remark 32 (cont.)

Attachment 2, page 3:

"Mr. Ian Grant of AMDEL analysed the sample for faecal coliforms and ammonia to determine if the sample was contaminated by sewerage"

Results:*

Faecal coliform count of organisms per 100 ml sample 2800.
Ammonia was detected in the sample.

*It should be noted that the sample was not sampled or supplied in a recommended sample container.

- These results indicate the presence of sewerage contamination.

Attachment 3, Report Q 346/86:

39

"The sample arrived in the laboratory several days after being taken, in a non recommended sample container and with no sample preservation, i.e. kept in Eskimo with Ice".

Results:

Microbiological Report Faecal Coliforms orgs/100 ml 2800
Ammonia - Present

Discussion:

"The results indicate that it is highly likely that the sullage sample contained or was contaminated with sewage".

This appears to be a positive assessment and in view of the fact the Navy originally alerted the analysts to the possibility there seems little doubt that the contamination was real and not fortuitous.

Hence the earlier questions on this topic require comprehensive replies.

Quote

para 14.1.C - Conclusions

A.B. Oliver was not aware that L.S.Gilbert was attempting to pump the SGC (Steering Gear Compartment) bilges via the flexible hose suction using the same pump he (Oliver) was using to pump the sullage tank.

Fleet Comments:

There is no reason why A.B. Oliver should have been expected to know that L.S. Gilbert was pumping bilges.

Remark 33

These comments rather miss the point. There was every reason why the Engineer Officer of the Watch should have been informed of the requirement and given the order to L.S. Gilbert and/or P.O. Purvis to pump the sludge tank and not that A.B. Oliver should have sought and been given independently permission to pump the tank. The indication is that the procedure needs revision.

para 14.1.d - Although L.S. Gilbert was aware the transfer pump was in use discharging overboard.

Remark 34

It is not certain that he was aware either that the pump was running or that it was pumping overboard nor from where. L.S. Gilbert reported the rising level of the SGC bilges twice. The balance of probability at least suggests that had he been conciously aware the pump was running when he went to use it, he would have mentioned the fact when reporting his own difficulty.

The conclusion that he was aware the pump was running is not proven. It is an assumption.

para 14.1.d - Fleet Amplifying Remarks:

This details precisely how the practice of "stealing a suction" is carried out.

Remark 35

For reasons already stated in NOTE 7 above there is no evidence that L.S. Gilbert was attempting to "steal a suction".

Quote

para 14.1.e - Operator error caused two suctions; one of positive static head from the near full sludge tank and the other negative static head from the SGC bilges, to be opened concurrently to the transfer pump.

Remark 36

This is so, but does not address the real problem, namely the defect in basic procedure.

5 COMMENT ON FLEET COMMENTS WHEN FORWARDING BOI REPORT

Quote

6. Contributory causes to the incident can also be identified:

b. ..... The ship was still setting-to-work evaporators, the auxiliary boiler and some diesel generators at the time of the incident. 'Minor' systems such as the oily water separator would take second place.

Remark 37

The ship was on sea trials between 24-27.September 1985, the purpose of which would be to test equipment after refit and the period should have been adequate for all equipment to be tested. If the vessel was still "setting-to-work" after 28 days, it suggests that the refit was not really complete when it sailed. With respect to the oily water separator, the tank was being pumped directly overboard so whether the separator had or had not been "set-to-work" was not relevant.

EXTRACT FROM STANDING ORDERS OF HMAS 'STALWART'

Bilges may be pumped in harbour and at sea if it can be clearly ascertained that oily water will not be discharged. Sentries are required at the point of suction, the point of isolation of the pump and on the upper deck within clear view of the discharge. This should normally be carried out during daylight hours. Good continuous communications are to be established and tested prior to commencing pumping also.

Remark 38

Standing Orders are a matter of Naval discipline and have not been considered in this appraisal of the circumstances. However, it is curious that sanction should be given to pump out a tank which would clearly take several hours at the end of a working day and at the onset of darkness.

Q.49 Enquiries should be directed to find out if A.B. Oliver initiated the move to pump out the sludge tank or was told to pump it out and then requested permission from his Regulating Chief.

ENCLOSURE 10 TO HMAS 'STALWART' BOARD OF INQUIRY

Quote

Garden Island statement on chemicals used in main engine cleaning

para 3 - Postulated Mechanism for Generation of Hydrogen Sulphide

Remark 39

This paragraph makes clear that persons presumably in responsible positions at Garden Island Dockyard where the 'Stalwart' refit took place were aware of the possibility of hydrogen sulphide generation in mixes of oily waste and bilge waters.

Q.50 Enquiries should be directed to clarify exactly who was responsible for the vessel during the refit - the dockyard, ship's staff or overseers department and thereafter the state of knowledge of the contents of the sludge tank and what, if any, advice was given.

6 SUMMARY

The following is an assessment of the principal causes of the toxic gas accident on 'Stalwart' identifying areas which appear to require changes of practice and/or additional attention by the Department of Defence.

6.1 Need for Change of Fundamental Procedure

6.1.1 Completion and Entry into Service

This relates to accepting new vessels or the re-entry into service of existing vessels after refit.

HMAS 'Tobruk' entered service on 11.April 1981 and the accident to NRC Dax occurred on 16.December 1981, 8 months later, the deficiency which caused the accident having existed for the whole of that time.

'Tobruk' was probably accepted and pressed into service earlier than would otherwise have been the case in order to participate in Exercise "Kangaroo 81".

HMAS 'Stalwart' was under refit from March to September 1985 and shortly after sea trials took part in Exercise "Coral Sea", the deficiency which caused the accident having existed since the vessel re-entered into service.

The parallel is probably not coincidental and suggests the vessels were pressed into service before they were really ready. In the case of 'Stalwart' the crewwere still setting-to-work machinery and pumping out sludge nearly one month after apparent completion of a refit.

This suggests that a decision is required as to whether the dockyard and/or General Overseers Department should be able to overrule the Operational Branch of the R.A.N. Events suggest that a case can be made out for such action at least during peace-time.

Any such contemplation would also involve assessment of the dockyards and Overseers Departments general commitment, efficiency and meeting of target dates and the attitude of R.A.N. in preparing for and committing vessels to refit.

6.1.2 Departmental Division of Responsibility

Two ratings were, independently and without knowledge of the other's actions using the same pump to try to discharge from different places at the same time.

Standing Orders are a purely service disciplinary matter; of concern is the procedure which could have a historical background.

In olden times shipwrights and carpenters built and repaired the vessels, sounded tanks, caulked seams, manned pumps and generally looked after the well-being of the hull. In service terms they probably still preserve some of their original duties over the engineering branch who only originated relatively recently.

Hence the Shipwrights' Department continue to sound and pump tanks, the concession to progress being to inform the Engineering Officer what they are doing, who, in turn, informs the Officer of the Watch. This system has long been superceded in Mercantile practice. Only the Engine Department start and stop machinery including starting cargo pumps on tankers and supplying power to, but not manoeuvring deck machinery such as winches, windlasses and capstans.

Thus, applied to 'Stalwart', the Shipwrights' Department, judging the sludge tank needed pumping, would request the Engine Department to pump it for them. This alone would possibly have prevented the accident because the Engineer-in-Charge would know at all times which machinery was running and for what purpose.

Consideration should be given to affecting this change.

6.2 Lack of Emphasis

6.2.1 Discharge of Sludge Ashore

The Report makes clear that large quantities of sludge/Aqueous wastes were disposed of ashore during the refit and that dockyard personnel at least most certainly were aware of the possibility of dirty mixtures of aqueous and oily waste to generate Hydrogen Sulphide but is silent on the subject of why the discharge ashore was stopped or why waste oil and water were pumped to the same tank when it would have been as easy to keep them separate.

The Report also apparently accepts at face value the fact that A.B. Oliver sounding the sludge tank found it nearly full, therefore considered it should be pumped, requested and was given permission to so do.

It seems very improbable that someone in authority on board did not know the level and content of the sludge tank and equally improbable that it had not been sounded before. Therefore questions which arise are - why had it not been pumped before,
- why should this activity commence in the evening at approaching nightfall.

A cogent case could certainly be made out that someone on board decided it was time to dispose of the rubbish and instructed the rating to so do commencing with approaching darkness so the vessel would be well clear of the area before daybreak!!

6.2.2 Ignoring Odours

In the case of 'Tobruk' malodourous smells persisted and were tolerated, ignored or camouflaged for months.

In the case of 'Stalwart' the odour was also of some standing hence "6.8 This mixture generated, under certain conditions, offensive odours..... This was generally regarded as a 'normal' sullage tank smell".

This may also be related to naval discipline and possibly a conditioning that - if you ignore it, it doesn't exist.

The facts are, however, that nauseating putrid odours are not normal and some procedure should be established to encourage the reporting of same and after repeated reports, proper inquiry into their cause, source and cure instituted.

Such a procedure could have prevented both accidents.

6.2.3 Completion of Refit

One would normally understand that upon completion of refit a vessel would be in a state of refurbishment and general cleanliness ready to resume a prolonged period of continuous service. Therefore it is illogical to first shot blast to white metal and then recoat the sludge tank then contaminate it with sewage, oil wastes and dirty bilge water allowing that material to remain on board upon departure.

6.3 Incorrect Emphasis

6.3.1 Retention of Waste on Board

It was stated that the waste had been retained on board to conform to IMO Regulations concerning non dumping in inshore waters.

Had the vessel been cleaning oil tanks at sea and possibly chemically cleaning the cooling system in port but under normal commission (such procedures could certainly occur with merchant ships), then the above statement might have validity.

However, because the vessel was under refit in a Naval Dockyard the inescapable conclusion must be that the permitting of sludge to accumulate and remain on board upon sailing had nothing to do with IMO but everything to do with expediency.

6.3.2 Sewerage Content of Sludge Tank

Although this is played down the references in the report and particularly the letters and analyses of AGAL and AMDEL make it clear this was a fact and they had been originally alerted to it by the Navy Department. Therefore, in view of the findings of the 'Tobruk' enquiry, as it was known by somebody that sewerage was contained in the 'Stalwart' sludge tank, the fact that there was not a similar awareness concerning aqueous waste and oil is less relevant. Knowledge of the presence of sewerage should have been sufficient warning to treat the contents of the tank promptly and with care.

APPENDIX B

Department of Defence Response to Report

by Mr R J Parkinson, PAC Specialist Adviser, on a Toxic

Gas Accident on HMAS Stalwart.

ANSWERS AND COMMENTS ON THE QUESTIONS AND REMARKS

MADE BY THE CONSULTANT TO THE JOINT PARLIAMENTARY

COMMITTEE OF PUBLIC ACCOUNTS ON THE INQUIRY INTO THE

TOXIC GAS ACCIDENT IN HMAS STALWART - 8 AUGUST 1986

REMARK 1

The vessel's refit had apparently taken place at HMA Dockyard, Garden Island, Sydney, NSW, from March to September 1985. Setting aside IMO Regulations, commercial dockyards, but more particularly Naval dockyards should have slops, sullage and waste oil disposal facilities.

Not infrequently and particularly so in cases of damage repairs, it may be necessary to discharge fuel and/or lubricants ashore for storage or disposal. Tankage should be available, or facilities exist within convenient reach.

Aqueous effluent from chemical cleaning of boilers or degreasing of engine cooling systems etc. would normally be disposed of directly to a road tank vehicle and the nearest approved industrial waste tip or, subject to satisfactory dilution, directly into the town sewerage system.

COMMENT

Unfortunately Garden Island Dockyard has very limited facilities for handling waste oil and other sullage. Liquid waste requires the use of contractor road tankers until holding and treatment facilities are installed as part of the modernisation programme.

QUESTION 1

Who would have taken the decision to retain the "sullage" onboard 'STALWART' and under the circumstances prevailing during a refit, whose wishes would be paramount?

ANSWER

The decision whether or not to retain sullage onboard is that of the ship. In the latter stages of the refit arrangements to discharge sullage ashore proved very difficult for administrative reasons, and the existing tank contents were retained for later stripping at sea.

.../228K litres

228K litres (approx. 20 tons) was removed in the last stages of the refit. This was a routine ship decision.

QUESTION 2

Who drew up the specification for and who was "in charge" during the refit, i.e. who commissioned work, accepted it on completion, carried out inspections and testing, made day to day modifications as necessary and could be deemed to be the responsible officer/authority?

ANSWER

The ship raised the main Defect List, which is a specification of work to be carried out. It is made up of three parts:

a. repair and overhaul work;

b. planned maintenance - i.e. overhaul, testing and inspection of equipments and structure based on either elapsed time or hours run; and

c. configuration changes, replacement of obsolescent equipment, improvements to facilities, and so on.

The main Defect List is submitted in work priority order to the Fleet Engineering Staff. The work requests are checked and confirmed and the priority order validated. The work to be done is sanctioned by the Chief Staff Officer (Technical) (CSO(T)), an engineer Captain who is the chief engineer in the Fleet. CSO(T) authorises the work package within financial and time guidelines provided by the Director General of Fleet Maintenance (DGFM) in Canberra. It should be noted that configuration changes to be implemented are selected by DGFM. CSO(T) does not control the configuration change package.

CSO(T)'s authority is quite clearly laid down in Regulations and Instructions for the RAN which states:

> "When ships under his superintendence are refitting, docking or maintaining, he is to be responsible for sanctioning the work to be undertaken".

Day-to-day matters during the refit, including work assistance, are handled by the ship's Marine Engineer Officer (MEO) or Weapon and Electrical Engineer Officer (WEEO), as appropriate. More significant matters

.../affecting finance,

affecting finance, resources and time are submitted to CSO(T) for decision.

There appears to be a theme recurring through these questions which implies that the operators are able to overrule the engineers. In particular, it is implied they did so in TOBRUK and STALWART.

CSO(T) in practice often restricts ships from going to sea or curtails their activities for engineering reasons. These decisions are rarely even questioned by the "operational arm". They are never overruled in peacetime.

QUESTION 3

Was that authority absolute or if not how were important decisions taken during the refit?

ANSWER

Within the broad guidelines of money, time and required configuration changes provided by DGFM, the authority of CSO(T) is absolute.

REMARK 2

IMO Anti-Pollution Regulations were promulgated at the IMCO conference on Marine Pollution 1973, the International Convention for the Prevention of Pollution from Ships (publication 77.14.) and specifically

Regulation 9
Appendix No. 1 1

which defines the maximum oil content of the effluent as less than 100 ppm

Regulation 12
Appendix No. 2 2

which defines the requirement for reception facilities

Regulation 16
Appendix No. 3 3

which defines the requirements for oil discharge monitoring and control system and oily water separating equipment.

.../'STALWART' is understood

'STALWART' is understood to be a 15,500 tonne Destroyer Tender. It probably has a ship-to-ship refuelling capability and the fact that the Department of Defence consider the applicable IMO Regulations to be a maximum oil content in overboard discharge effluent of 100 ppm (parts per million) and an instantaneous maximum oil discharge rate not exceeding 60 litres per nautical mile indicate the vessel is intended to comply with the IMO Regulations for tankers.

Translating the above rates into tonnes per hour at various speeds gives:

Knots Speed	Oil Content at 100 ppm/hour	Total Effluent Vol. (water plus oil/hour)
10	0.6 tonne	6000 tonne
15	0.9 tonne	9000 tonne
20	1.2 tonne	12000 tonne
25	1.5 tonne	15000 tonne

Clearly the 60 litre/nautical mile limit may be ignored by 'STALWART' and assuming the transfer pump capacity is 30 tonne/hour, the limit of 100 ppm oil content provides a permissible 3 litres per hour oil content discharge rate and because the pump capacity is constant at higher speeds the instantaneous oil discharge rate would be very low indeed. For example, at 20 knots it should not exceed 0.15 litres per nautical mile.

Article 3 (3) Appendix No. 4 4

Defines the scope of the convention and specifically excludes naval vessels except as a voluntary act.

Note also from Regulation 16 that it is not mandatory for existing vessels until 3 years after the entry into force of the Convention. For 'STALWART' this is 2 October 1986.

COMMENT

Nil.

QUESTION 4

Has the efficiency of STALWART's separator been tested and is it capable consistently of maintaining at the water discharge an oil content of less than 100 ppm?

.../ANSWER

ANSWER

Yes, it has been tested and meets the standard. However, it will not separate at least one GAMLEN biodegradable product which emulsifies. This matter is under investigation.

QUESTION 5

It was known the contents of the sludge tank was an oily/chemical/water mix but the tank was being discharged directly overboard and not through the separator. Given the desire to conform with IMO Regulations (although not yet applicable to 'STALWART') had any guidance instructions been issued to the vessel in this respect?

ANSWER

The separator was not set to work at the time. However, the ship was in open water and was discharging what was reasonably expected to be water under oil. The guidance given to all ships is covered by Fleet Operational Orders and the Marine Engineering Manual.

QUESTION 6

IMO Regulations for tankers also require an oil discharge monitoring and control system. The Inquiry states (11.1 "but ships have no ready measure of oil concentration) which indicates an absence of the specified monitoring equipment. Is it the Department's intention to comply with this aspect of the IMO Regulations?

ANSWER

Most equipment fitted and being introduced has automatic monitoring arrangements, but no recorders. Yes, it is Navys intention to meet, if not better, IMO regulations.

QUESTION 7

The alternative to oil monitors would be to retain all oily

.../water onboard and pump

water onboard and pump out to shore installations. Is this being implemented?

ANSWER

Generally it is preferred to pump overboard except in confined waters to allow space for any further sullage and to avoid pumping out on return to harbour. Given the more extensive knowledge Navy now has of the dangers of H2S this preference is expected to continue.

Pumping for treatment ashore normally requires the use of road tankers as covered at Remark 1.

QUESTION 8

Are copies of the relevant IMO Regulations or abbreviated interpretations carried aboard RAN vessels and specifically what general instructions apply concerning compliance with and implementation of IMO Pollution Prevention Regulations?

ANSWER

No. IMO Regulations are monitored by both Fleet and Navy Office staff. When necessary they are introduced by Fleet or Navy Directives or Instructions.

REMARK 3

The accident occurred on 22 October 1985 or 25 days later during which the vessel had been at sea for a total of 21 days which seems a long time to ignore the presence of over 80 tonnes of unwanted waste products. Presumably during this period machinery space bilges had been regularly pumped, including the Stern Gland Compartment.

COMMENT

The ship sailed with about 30 tonnes of liquid sullage and operated in confined waters until the incident. The remaining approximate 50 tonnes built up over the period.

QUESTION 9

.../What division of

What division of departmental responsibility for:

a. pumping machinery space bilges etc.; and

b. pumping from other tanks or spaces?

ANSWER

The Marine Engineering Department in both cases.

QUESTION 10

Given that there had not been a suitable opportunity or perception to discharge the sludge tank before 22 October 1985, what was the change in circumstances which caused AB Oliver to seek and be granted permission to pump out at 1800 hours that day?

ANSWER

The ship was just out of confined waters, hence AB Oliver sought and was granted permission.

There was no particular changed circumstance except that the ship was out of coastal waters and the tank was nearing full capacity. A normal and proper precaution would be to ensure capacity in the settling and sludge tanks to accommodate an unforeseen circumstance such as an oil spill in a machinery space requiring washing through, or stripping a fuel tank of water.

REMARK 4

Only a limited number of the ship's personnel would be aware that the air pipe came from the sludge tank or possibly that the smell came from that particular air pipe.

The 'TOBRUK' incident had alerted the Service to the dangers of hydrogen sulphide gas and test equipment has been issued. Doubtless the offensive smell had the characteristic "rotten eggs" odour which was instantly recognised by the Dental Officer onboard (Navy Office Review 9.12) from the respirators being returned after the accident.

.../QUESTION 11

QUESTION 11

For how long had the "offensive" smell been noted? Had it been reported? Why had the odour not been recognised, the potential danger appreciated and the source traced and eliminated long before 22 October 1985?

(The above applies more particularly to technically knowledgeable and higher ranks of Ship's Company).

ANSWER

The offensive odour had only been noted "under certain conditions", but this is only likely to have been for the previous 10 - 14 days as, prior to this, conditions would not have been as conducive to rapid bacterial growth. The "certain conditions" are likely to have been associated with ship movement, or when the tank content was being added to from the pump discharge. There is no record of the offensive smell being reported to higher authority or investigated. There are other sources of odours in the area, such as vacuum pump discharge filters and the general effect would be likely to be a combination of dirty oil, bilge, sea water, stale air and H_2S. It was not possible to clearly distinguish the component of the smell that was H_2S.

REMARK 5

As appears later in the Report (14.1.d) 'stealing a suction' depends upon throttling or reducing the flow in one suction pipe to induce a suction in another, which involves the simultaneous manipulation of at least two valves which therefore must be in fairly convenient proximity. This was not the case in this instance. What was being done was attempting to pump from two sources at the same time which is quite different.

COMMENT

This is an unsupported assumption. The two valves are in fairly convenient proximity, being within the same compartment approximately two metres apart.

QUESTION 12

.../Does training include

Does training include instructions on the inherent difficulty of pumping from two places with a single pump?

a. That at best the system with the lesser resistance will be favoured to the detriment of that with the higher resistance up to the latter remaining totally unpumped unless steps are taken to balance resistance by valve manipulation?

b. That at worst there could be a cross flow of liquid from the compartment with the high head to that of the lower via the suction lines, bypassing the pump entirely, which is what occured and caused the Accident?

ANSWER

Yes, especially at on-the-job training. Navy Office and Fleet Instructions highlighting this matter were promulgated following the STALWART incident.

QUESTION 13

Are there any standing instructions to cover the situation that a pump required for use is found to be already operating?

ANSWER

Not at the time. The Engineer Officer of the Watch (EOOW) keeps a stateboard which shows the system configuration at the time. It is a simple diagramatic model of the machinery system. It shows which machinery, tanks, etc. are in use and which major valves are open and shut. Any change to the system is required to be reported to the EOOW.

REMARK 6

What happened was that two operatives used the same pump for differing purposes at the same time:

a. The operative properly authorised did obtain permission but that was not passed further up the chain of command.

.../b. The other operative,

b. The other operative, unauthorised except by custom and usage may not have consciously registered that the pump was already being used. He may have been mentally distracted or even have pressed the starter button as he approached the pump and then merely thought someone had left open the pump valves. Adjacent noises and vibrations of other operating machinery could be factors.

It is probable the operatives were from different departments with separate chains of command which broke down. To eliminate recurrence it would be logical for only one department to be authorised to start machinery and/or pumps.

ANSWER

The sailors concerned were not from different departments, but with different responsibilities within it. Agreed, there was a breakdown in the communication chain.

QUESTION 14

Has any thought been directed to adjusting the duties of departments as indicated above?

ANSWER

No. Not applicable.

REMARK 7

The above indicates recognition that machinery/pumping operations would be more efficiently regulated as suggested in Remark 6.

COMMENT

See Remark 6.

REMARK 8

.../Following the earlier

Following the earlier 'TOBRUK' incident Draeger portable gas detection kits were issued to vessels indicating an awareness of the danger of hydrogen sulphide.

QUESTION 15

Guidelines/instructions concerning the lethal properties of hydrogen sulphide were distributed to the Fleet following the 'TOBRUK' incident. How far down the command structure was that information disseminated - to all Ranks, Petty Officers or Officers only?

ANSWER

The information regarding H2S production has been, and is, regularly disseminated to all ranks following the TOBRUK incident.

The TOBRUK incident prompted awareness of the possibility of H2S generation in sewerage systems, and the attendant danger. In this instance, it was not in the area of the sewerage plant, and H2S was not recognised or identified by the majority of personnel involved. It may have been 'disguised' by other smells such as oil.

REMARK 9

It is suggested that this recommendation be amended to include engineering personnel on all ships.

COMMENT

It was. Instructions to the Fleet have been issued.

REMARK 10

The effluent quantity quoted appears large in comparison with the probable content of the engine cooling system. It is self evident that 228 tonnes cannot be accommodated in a 90 tonne capacity tank.

COMMENT

.../This is a misunderstanding.

This is a misunderstanding. Removal was progressive.

QUESTION 16

What is the combined capacity of the engine cooling system in metric tonnes?

ANSWER

38.09 tonnes.

QUESTION 17

What was the source of the 228 tonnes referred to?

ANSWER

The 228K litres was removed from the ship in the period between completion of the engine cooling system clean (14 August) and the ship sailing (24 September). The source of the remaining waste was the result of normal refit activities and bilge pumping with some engine washing residues.

QUESTION 18

Some of the material must have been disposed of ashore. How was this disposed of and why was it not all disposed of?

ANSWER

See Remark 1 and Question 1.

REMARK 11

The above are the first stated contents of the sludge tank to which must be added per Enclosure 9, Department of Science and Technology, paragraph 3.

"In this respect it should be noted that the

.../information provided

information provided to myself by officers of your Department indicated that the sullage (sludge) contained a considerable sewerage component".

It is obvious that if oily and aqueous waste are mixed their eventual disposal becomes more difficult. As a first step they have to be settled and passed through a separator. The workload on the separator would be reduced if, so far as possible, aqueous and oily wastes were kept separated.

COMMENT

Noted, but not relevant to STALWART.

QUESTION 19

STALWART is equipped with alternative tankage such that aqueous and oily wastes could be kept separate. Why was this not used?

ANSWER

STALWART's system is designed with a settling tank in which waste is stored and settled and from which sludge is separated and stored elsewhere. There are no separate aqueous and oily waste systems.

QUESTION 20

Have such instructions been issued for the future?

ANSWER

Such instructions are not relevant in this case.

REMARK 12

Later in the Report (11.23) the point was made that the sewerage system onboard was drained down prior to the refit which may have been the source of the faecal coliform count reported in the analysis of sludge (AMEDEL Report No.

.../224/86 page 2), but that

224/86 page 2), but that this was in any event very slight. Enclosure 9 however, states that microbiological assays were not attempted because the samples had not been taken in the correct type of containers, kept at the correct temperature or analysed within the necessary timescale and hence quantitive data would not be valid.

COMMENT

The sewage system was not run down to bilges.

QUESTION 21

What were the circumstances which caused Officers of the Naval Department to comment that there was "a considerable sewage component"?

ANSWER

This statement is unfortunately erroneous, and resulted from some confusion by the Regional Director of AGAL following a discussion with the Director of Naval Medicine prior to delivery of the samples, when sewage was discussed as being one possible source of hydrogen sulphide.

QUESTION 22

Having in mind TOBRUK, was it not obvious that such wastes should be disposed of ashore to the city sewerage system or by tank car to the nearest sewage farm and why was this not done?

ANSWER

It was disposed of ashore. This question implies the ship was dealing with sewage, which was not the case, and known by the ship to be not the case.

QUESTION 23

If the tank cleaning facilities had not been used, how was the sludge pumped to the sludge tank?

.../ANSWER

ANSWER

The bilge pumping system can discharge directly to the settling tank.

QUESTION 24

If the normal procedure using the separator would have been to return washings to the settling tank, why had not this policy been followed, aqueous waste to settling tank, oily wastes to sludge tank?

ANSWER

This question indicates a misunderstanding of the system. The water separated from waste (bilge or tank) is discharged overboard and only the oil waste stored. It is not normal, nor would there be any point in storing the washings.

QUESTION 25

Pump out facilities had been used during the refit therefore at which point had it been terminated and why?

ANSWER

Pump out was terminated towards the end of the refit and before sailing as covered by Question 21.

REMARK 13

The report also comments that using the TCC transfer pump for bilge pumping was against standing orders because the pump could be expected to be contaminated with oil. Additionally that to use the Hull and Fire Pump would have necessitated drawing storeroom keys to the compartment and returning them afterwards (7.3 Fleet Comment).

It appears that the irregular system in use was of long

.../standing and almost

standing and almost certainly long enough for:

a. The irregular practice to have been legitimised by changing standing orders and fitting a permanent steel suction pipe to the stern gland compartment with normal screw down non-return suction valves which would have maintained convenience and, by eliminating the flexible hose, restored watertight integrity.

b. To have improved the convenience and efficiency of the main system by lowering the suction strainers and eliminating the necessity to draw a key for access to the pump.

COMMENT

Noted, but see Questions 26 and 27.

QUESTION 26

Has it been established for how long the irregular practice had been in use?

ANSWER

It was not established for how long practice had been in use, but certainly during the period of the refit.

QUESTION 27

Were proposals to modify the arrangement submitted at any time and, if so why was it not carried out?

ANSWER

No.

If a proposal had been submitted to modify the pumping arrangements as suggested by JPCPA consultant, it would have been disallowed for the very reason the practice of using the pump to pump bilges to sea is disallowed by orders, i.e. by its service for pumping oily waste it could contain oil which would be discharged to sea. Two other

.../points should also be

points should also be noted. The prime purpose of the main line suction system is to remove large quantities of water in the event of flooding. As such, the suction line must be clear of the ship's structure such that there is minimum interference with flow.

Suction is then lost by vortex and pressure differential as the level approaches the lip of the suction pipe. A hose laid directly in the bottom with a low suction head will therefore likely lower the bilges further than is possible with the main line suction. More sensibly, there is in train a modification (raised well before this event) to eliminate the source of water by changing the type of stern gland seal from a packed gland (which necessitates some leakage) to a mechanical seal type (which has minimal leakage).

REMARK 14

This was fortuitous and independent from the fact that inadvertently the sludge tank was draining to the steering gear compartment. Stopping the pump prevented much more gas from escaping.

COMMENT

It was not fortuitous that AB Oliver was on the Quarterdeck observing the discharge overboard. This is correct practice to ensure nothing other than water is discharged overboard, and is the normal course of action when pumping anything other than known clear water. It was fortuitous that he shut down the pump and tank suction when he did, thereby reducing the flow of effluent into the SGC bilge, hence limiting the H2S released within the compartment.

REMARKS 15 AND 16

Assuming the restriction to flow was the 2½" fire valve SDSL screw down screw lift valve in the tank cleaning compartment lower level, the driving head between it and the nearly full sludge tank would be about 10 feet (say 3 metres) permitting water/effluent to escape at the following rate:

$(2.5 \times .0254)2 \times .7854 \times 60 \times .6 \quad 2 \times 9.81 \times 3 \times 1000$

= 875 litres/minute approximately

.../ = 875 x 8 =

= 875 x 8 = 7000 litres in 8 minutes (about 1540 gallons)

For the reasons given in Remark 17, the above seems somewhat overstated.

COMMENT

Both the original Navy Office estimate and the consultant's estimate are based on over simplifications of the piping system. They neglect losses due to the effects of another valve in the system and due to friction losses caused by bends in the pipework. However, it is considered that the consultant's estimate is closer to the probable volume of sludge that flowed from the tank.

REMARK 17

The statement is surprising in view of the characteristic odour of hydrogen sulphide, the number of different personnel involved including PO Ledger shortly after 1822 hours IK who commented "there was obviously gas" in 2H (12.20) when opening the large port and starboard doors in the ship's side as agreed by the Commanding Officer.

COMMENT

The Commanding Officer knew there was toxic gas but its positive identification was not made until some time later.

QUESTION 28

Have any steps been taken subsequently to ensure that all personnel are familiar with the odour of low concentrations of hydrogen sulphide and its lethal propensity in higher concentrations?

ANSWER

Yes. Fleet Instructions have been issued.

REMARK 18

.../It is understood that the

It is understood that the distribution of Draeger test kits commenced following the TOBRUK incident and Report 223, latest early 1984. If this is so, it is somewhat surprising that the Draeger pump had deteriorated so rapidly on the one hand and that there were not at least several well trained operators on the other hand.

COMMENT

Remark 18 misunderstands the situation. LS Smith did the testing because he was familiar with the compartment and dressed in breathing apparatus. There would be other trained operators onboard, particularly those associated with maintenance of the sewerage system, probably including PO Ledger.

A Navy Instruction was issued on 31 August, 1983 for the awareness of the potential hazards associated with toxic hazards of gases produced in RAN Ships. The instruction was extensively promulgated to cover precautions, personnel protection, hazards of Hydrogen Sulphide, testing procedures and first aid procedures. Details of most common gases encountered in Sewage treatment plants were also listed in addition to authorised allowances of Draeger Multigas Measuring Kits.

The Draeger pump was found to be leaking, but not sufficiently to raise doubts beyond the accuracy of the reading. Agreed, it should not have deteriorated so rapidly and it should have been better maintained. This aspect is being monitored in all ships.

QUESTION 29

How many Draeger test kits have been distributed throughout the Fleet and when?

ANSWER

Kits were issued in 1983, one each to the following ships or establishments:

Garden Island Dockyard

Williamstown Dockyard

HMAS HOBART

HMAS BRISBANE

.../HMAS PERTH

HMAS PERTH

HMAS ADELAIDE

HMAS DARWIN

HMAS CANBERRA

HMAS SYDNEY

HMAS STALWART

HMAS PARRAMATTA

HMAS STUART

HMAS YARRA

HMAS DERWENT

HMAS TOBRUK

HMAS COOK

HMAS COONAWARRA DNB

HMAS WATERHEN

HMAS CAIRNS

HMAS CERBERUS - for training

HMAS STIRLING

QUESTION 30

How many personnel have been trained in their use?

ANSWER

Not known, but the inaugural course commenced February 1984, and is a pre-requisite qualification for sewage system maintainers on all ships. Part of the course syllabus involves detailed instruction in the use of gas detection equipment. Approximately 12 courses a year are held with an attendees figure of 6 to 8 a course. A total of 27 courses have been held up to 4 November 1986. In addition a 4 week course (water pollution control plant training) with the Metropolitan Water Sewage and Drainage Board, Liverpool, NSW has been attended by selected

.../personnel since July

personnel since July 1983. These personnel are instructors and Fleet and Navy Office Policy implementers.

QUESTION 31

What arrangements have been made for routine regular inspection of the pumps and changing "time expired" test capsules?

ANSWER

A Navy Instruction states the requirement to check the integrity of the Draeger test equipment and details checking procedures. The instruction supplements the Draeger Kit literature issued with the kit.

The pumps are used in regular toxic gas exercises and replaced when deterioration is noticed. The capsules have a time expired date on them. Pending incorporation of appropriate changes in the Planned Maintenance Schedule the Fleet Marine Engineer Officer and his staff carry out spot checks on the equipment during their routine inspection of ships.

REMARK 19

LCDR Lemmey happened into the Sick Bay fortuitously about 1935 and in retrospect it is unfortunate that he did not appreciate that others did not share his own awareness of the identity of the gas and pass the information by messenger to the bridge. Whilst it is very doubtful that at that stage the knowledge would have affected the outcome in any way, it is obviously essential that any asphysiating or toxic gas should be identified as soon as possible.

QUESTION 32 - 34

Have any arrangements been made to familiarise personnel (technical and medical at least) with the odours and characteristic effects of the gases one might experience on shipboard and specifically those gases listed in the Department's circulars?

Have any standing orders been promulgated regarding requirements for personnel to report their knowledge or

.../suspicion of the

suspicion of the presence or proximity of any of the above gases onboard?

Irrespective of positively identifying any particular gas, have any standing orders been promulgated for personnel to report any bad, nauseous or putrid odour whether identified or not?

ANSWER

Fleet and Navy Instructions are in existence, continually *stressed and updated as required.* Ships are warned of dangerous gases and are required to report any occurrences or suspected presence of them, especially those involved with sewage systems.

REMARK 20

Whilst at first sight the above may appear to be too obvious, *the facts are that putrid/nauseous* odours are not normal but abnormal and were ignored or at least accepted for long periods both on TOBRUK and STALWART, whereas recognition that something was wrong and needed investigation could have prevented both Accidents.

COMMENT

Agreed.

REMARK 21

The regulations adopted are applicable only to tankers. After the 2 October 1986 the lack of ready measure of oil concentration (i.e. an oil monitoring and recording device) will be an infringement of Regulations unless all slops are disposed of ashore.

Note: See IMO Regulations "Oily Water Separators and Monitoring Equipment" Sales No. 608.82.15.E - Appendix No. 5.

COMMENT

.../Agreed in principle

Agreed in principle. However, MARPOL Regulations have yet to be ratified by Australia. This should take place early in 1987.

QUESTION 25

Have the Department of Defence anticipated the IMO Regulations?

ANSWER

Yes. In 1975 the then Naval Board approved the policy of the adopting the IMO Regulations in RAN Fleet units. A project commenced in December, 1979 for the acquisition and fitting of waste disposal equipment to all major RAN vessels.

Oily water separators are presently fitted to approximately 80% of RAN Ships and will be fitted to the remainder during the earliest convenient refit period.

QUESTION 36

Which regulations do they deem apply to STALWART and other RAN vessels?

ANSWER

Although Article 2 of the Convention specifically states that Naval vessels and auxiliarys are exempt, the Government policy is that, to the extent possible, military vessels are required to conform to the requirements of the Act. The following regulations are therefore adopted:

a. HMAS STALWART. IMO Regulation, Annex 1, Chapter II, *Regulation 9(1)(b), Annex 1, Chapter II,* Regulation 16(2)(a) and (5) or alternatively Annex 1, Chapter II, Regulation 16(2)(b) (6) and (7).

b. Other RAN Ships in general. Annex 1, Chapter II, Regulation 9(1)(1) and if not fitted with water compensating fuel tanks regulation 16(1)(6). If fitted with water compensating fuel tanks regulation 16(2)(a) and (5) or regulation 16(2)(b) (6) and (7).

QUESTION 37

QUESTION 37

Because ships have no ready measure of oil concentration, is it intended to fit monitoring or additional oil filters and maintain oil record books, as per Regulation 20?

Appendix No. 6

ANSWER

It is intended to fit monitoring or additional oil filters. RAN ships need not carry Oil Record Books as adequate RAN ship's records are maintained in accordance with instructions for Ballasting and Oil Pollution Control in ABR 5225.

Discharge oil content of less than 15 ppm is expected to be achieved.

REMARK 22

At the time of the commencement of discharge of the sludge tank it was said to contain about 82 tonnes of liquid comprising:

(i) Accumulated bilge washings including about 35% sea water (enclosure 9).

(ii) Chemical solutions.

(iii) Contaminated fuel water and cladisporium fungi stripped from several fuel tanks.

(iv) Some faecal coliform content.

(i) 35% seawater amounts to 28.7 tons which contains about 3% by weight of dissolved solids of which about 10% comprise Magnesium Sulphate 6% and Calcium Sulphate 4%, thus total available sulphate would have been approximately:

$$28.7 \times 1000 \times 0.03 \times 0.1 = 86 \text{ kg}$$

(a source of Oxygen for Desulphovibro Desulphuricans)

(ii) Chemicals included:

a. AMEROL HDE 777 - A heavy duty emulsifier containing Alifatic and Aromatic hydrocarbons

.../and surfactants

and surfactants (low foaming detergents) (phenols, aliphatic and aromatic compounds were detected in the Engineering and Water Supply Department Analysis Enclosure 9).

b. ALFLOC 707n- A mildly alkaline aqueous liquid cleaning chemical. The major active component is a polyphosphate. Minor components include a synthetic organic dispersant, an organo sulphur compound and a synthetic surfactant.

(Phosphates are a source of oxygen. The presence of organo sulphur compounds should also be noted).

c. NALFLEET 9-111 - An aqueous multicomponent sodium nitrite inhibitor for use in closed cooling water systems. Alkaline (neat product pH 12.7).

(It is improbable that there was much of this material as the pH of the sludge was about 6.5) see Appendix No. 7.

d. GAMOSOL D - A solvent emulsifier detergents similar to HDE 777.

(iii) Some waste oil and contaminated fuel (would have floated on the liquid surface and sealed off atmospheric oxygen thereby assisting in the development of anaerobic conditions).

(iv) Faecal coliform content.

(It is conjectured that presence of this material was accidental. Also that it may have resulted from draining down the sewerage system during refit. If so it is possible the material was partially septic. Whilst dirt, warm water and hydrocarbons could have been the source of the sulphate reducing bacteria as commented in 11.19, faecal coliform may have provided the original seeding material).

The sludge tank therefore contained all the necessary materials and the warm stagnant conditions favourabe for anaerobic cultures and the formation of hydrogen sulphide which did occur.

COMMENT

This remark is rather misleading. To take the content

.../analysis of a sample

analysis of a sample obtained from either the top of the SGC bilge or from the remnants in the tank after pumping out is not representative of the entire 82 tons. There was no measure before the incident, but experience of testing bilge oily water has shown the normal concentration to be nearer 95% water. The 82 tons was mainly bilge, with some tank strippings, and would more likely be in excess of 75% water.

Otherwise, the statement is agreed except that the presence of faecal coliform has not been related to activities with the sewage system in STALWART.

QUESTION 38

Were the contents of the sludge tank a matter of common knowledge or restricted to a few dockyard/overseers/ship's staff?

ANSWER

The question implies that the contents were in some way a hazardous cocktail with a guilty few only knowing the ingredients. In reality, it was a normal collection of bilge washings and tank strippings, made hazardous by circumstance, the danger not being appreciated onboard STALWART, or indeed the Navy as a whole, until this incident. The contents, predominantly water with oil strippings and bilge washings, would be known by those in the Engineering department with any responsibility in this area. All other materials mentioned in the report (Amerol Alfloc, etc) were mentioned as they could be present in some proportion and may have contributed to ensuring the most beneficial conditions for bacterial growth.

The question appears to be based on the false premise that the ship sailed with 80 tonnes of sludge onboard.

QUESTION 39

Is it a common practice to leave sludge resulting from refit activities onboard vessels?

ANSWER

.../No, and this is not

No, and this is not desirable.

The additional tank contents were accumulated over the 25 day period after refit, and were obviously only collected at about 2 tonnes per day.

REMARK 23

The report states that the engine cooling system was cleaned using HDE 777 and afterwards passivated using ALFLOC 707. In fact HDE 777 is a degreasant and emulsifier and does not require subsequent passivation. ALFLOC 707 is designed for the same purpose as HDE 777.

GAMOSOL D is also an emulsifier and detergent similar to HDE 777.

All three materials contain detergents, (usually phosphates).

The pH of the material 6.3 - 7.0 would have enabled sulphur reducing bacteria to flourish and Methane to be evolved in anaerobic conditions.

COMMENT

The consultants remarks are agreed. However circumstances at the time of change of engine inhibitor called for the use of AFLOC 707 as a suppliers recommendation before NALFLEET 9-111 was introduced.

REMARK

"Fuel contaminated by Cladisporium fungi had been stripped and pumped to the sludge tank".

The Board of Inquiry have not produced evidence to justify the statement that fuel contaminated by Cladisporium fungi had been pumped to the sludge tank.

QUESTION 40

From where did the statement originate?

.../ANSWER

ANSWER

Evidence was informally gathered by the Board of Inquiry that fuel ready use tanks had been stripped of fungal growth, but this was not considered at the time to be of sufficient significance to recall the witness. It would have been entirely consistent with fuel remaining in these tanks for diesel generator ready-use during the refit.

REMARK 24

This is unlikely because the sludge tank was shot blasted to white metal and recoated with epoxy resin paints as part of the refit. Therefore any content prior to the refit would have been removed and on completion of painting the tank would have been clinically clean and inert. It hence follows that the contamination must have occurred as a result of activities during the refit and after the painting of the sludge tank. Furthermore the proferred explanation does not explain who and why information was *given to the sludge analysts that there was a "considerable* sewerage content".

COMMENT

This misunderstands paragraph 11.23, which merely states the possibility of contamination of bilges prior to refit, and subsequently at the end of refit washed through to the tank. *Sea water from Woolloomooloo Bay, in which* STALWART (and any other craft) would have been dumping sewerage, could easily have contained this level of contamination (noting it is about 3/100 of city stormwater run-off contamination), and therefore contamination may have been introduced along with normal sea water leakage. It was not 'considerable sewerage content'.

REMARK 25

The BOI reference is taken directly from the AGAL analysis - Encl. 9 - see Appendix No. 8

..... 8a

It is not understood why Navy Office consider it "ill advised".

COMMENT

.../Navy Office considered the

Navy Office considered the term ill advised on the grounds that the sewage plant had been emptied, cleaned and opened in August 1984 on departure of HMAS STALWART from Shanghai and not returned to service before refit. The plant was under repair in refit period and had been prepared to be lifted for structural base repair (gas free certified by GID). The lift was subsequently deferred but repair on the system was progressed. As the sullage and settling tanks were grit blasted and painted during refit, contamination of the sullage/settling tank by the sewage plant post refit is most unlikely. The physical location of the sewage plant and sullage/settling tanks are a half a ships length apart and no interconnection of systems exists. In summary, the sewage plant had not been in use for over 12 months prior to incident and no cross connection exists between sewage and sullage/settling tanks.

QUESTION 41

Do Navy Office accept that the BOI statement is perfectly reasonable and accurate under the circumstances?

ANSWER

No. AGAL analysis is not in dispute but the reference to typical sewage is questioned for reasons stated above.

QUESTION 42

If the answer to 41 is negative, what levels of sulphides or sulphates would they expect in "typical sludge (sullage) wastes"?

ANSWER

Sulphates in sullage wastes vary from normal levels in such compartments as gland spaces to very high levels on occasions in boiler rooms at times of boiler fireside cleaning by water washing; or in bilges adjacent to some distilling plants. Sulphide levels vary dramatically due to such factors as PH, heavy metal salts, bacteria amount, dissolved oxygen, presence of surfactants, bilge levels, washing action of bilges at sea, and temperature. Some typical readings taken in a submarine are:

.../PHD

PH	Chloride %	SO3	Bacterial Count	Anaerobic m.p.m.
7.6	2.7	0.4	less than 9.5 x 100	1.4 x 1000
7.7	trace	trade	less than 1 x 100	1.4 x 1000
7.2	0.3	0.3	less than 1 x 100	7.5 x 1000

REMARK 26

The above Navy Office comment is either a misreading/ misunderstanding of the BOI evidence and understandable or suggests a hypersensitivity to references to sewage for an unknown reason which suggests a need for further questions on the subject.

COMMENT

See answer to Question 41.

REMARK 27

Here is confirmation that sludge wastes were pumped ashore during the refit and "before sailing".

COMMENT

Agreed, but not immediately prior to sailing.

QUESTION 43

Was the cessation of pumping sludge ashore in any way connected with time constraint and the requirement for the vessel to sail to take part in exercise "Coral Sea"?

ANSWER

No.

QUESTION 44

.../Is it known how much

Is it known how much sludge remained in the sludge tank on sailing?

ANSWER

The best estimate available is about 30 tonnes.

QUESTION 45

Was the sludge tank content in any way increased due to any activities after the 'Stalwart' sailed on 24 September 1985?

ANSWER

See comment on Remark 3 and answers given to Questions 38 and 39.

QUESTION 46

Why was not the above procedure (correct use of sludge and settling tanks in concert with the oily water separator) followed during the refit of 'Stalwart'?

ANSWER

As stated in the report paragraph 6.5, considerable work was undertaken on the tank cleaning system fitted to STALWART. It would not have been possible to use the system during refit, nor desirable, as the intention would not be to accumulate and treat waste. Thence, it was pumped ashore. Paragraph 11.27 concerns treatment of material accumulated since refit completion.

QUESTION 47

A piece of equipment in increasing use since the mid 1970's is a waste incinerator. Has the Defence Department considered fitting such equipment on RAN vessels to enable the total disposal of all wastes generated including oily wastes, sludges, toxic solids and chemicals (subject to

.../temperature control and,

temperature control and, of course, plastic, kitchen and galley wastes?

ANSWER

Navy has considered the use of incinerators to enable the total disposal of all wastes to be carried out. However, incinerators can be difficult or impossible to retrofit in some ships. For the FFGs a change in operational requirements (viz increased payload and complement, and reassignment of some compartments in association with the helicopter fit) means that the incinerators will be removed and alternative garbage disposal equipment installed.

REMARK 28

With an efficient aerobic sewage system H2S is not generated but CO2. H2S generation indicates a septic condition in the sewage system. Any soluble alkali which will raise the pH above 8 will halt the generation of H2S and advice concerning the most suitable cost effective material would be of value to all ships for use when necessary (possibly Borax (Sodium Borate)).

COMMENT

Agreed, however, Navy is replacing biological sewage treatment systems and holding tank systems with an electrocatalytic flow-through sewage treatment system. With this system sewage is treated as it is generated, and since it is not retained onboard it has no time to become anaerobic. This approach has been influenced in part by the following overseas naval experience:

a. The RN has found biological sewage treatment plants to be inherently labour intensive, oversensitive and prone to failure.

b. The USN has had a number of serious accidents with installed CHT systems, one of them fatal.

Paragraph 11.27 appears to have not been understood or fully quoted. H202 is used to control H2S in "sewerage systems" in total, in particular large city sewers. Paragraph 11.27 notes while it would control H2S in "sullage or dirty oil tanks" - it may not be the preferable course.

.../REMARK 29

REMARK 29

The above material would be well within the capability of a well designed incinerator to dispose of thus eliminating any risks.

COMMENT

Agreed, however, as discussed in answer to question 47, incinerators can not always be retrofitted to ships and in some cases must be removed in order to achieve changed operational requirements. Navy is investigating using an improved filtration method so that the requirements for a clear effluent and effective dewatering of the contents of the waste oil tank can both be satisfied. It is considered that effective dewatering of the contents of the waste oil tank will impose a population strain on the bacteria and thus control the generation of hydrogen sulphide.

REMARK 30

The above is a valid assessment and on the basis that prevention is better than cure steps should be taken to eliminate conditions whereby gas generation can occur:

a. By ensuring healthy aerobic sewage systems.

b. Not leaving mixed oil and waste water to stagnate but separating and burning off the oil fraction.

c. If resultant aqueous waste was not suitable for overboard discharge then increase its pH to more than 8.

d. As a final precaution carriage of an electronic gas detector would appear to be desirable.

COMMENT

Navy's current course of action includes the following:

a. Installing electrocatalytic flow through sewage treatment plants which will not retain sewage in tanks. This will eliminate the danger of sewage becoming anaerobic.

.../b. Investigating the

b. Investigating the installation of improved filtration equipment which will achieve a clean effluent and remove the aqueous phase from the waste oil. This will put a population strain on the bacteria and control the generation of hydrogen sulphide.

c. Navy's investigations (GID laboratory) have revealed that sulphate reducing bacteria can continue producing hydrogen sulphide although the pH is in excess of 8.

d. Electronic gas detectors are being procured for all ships.

REMARK 31

Quote Paragraph 12.20 - P.O. Ledger described bending down whilst opening the doors and inhaling a pocket of foul smelling gas in 2H Flat.

REMARK

From the above it is surprising that positive identification of H2S was not made until several hours later.

COMMENT

Agreed.

Quote Navy Office Comments:

"While the smell of H2S (hydrogen sulphide) in the TCC and 2H Flat was noticeable, it is not agreed that the concentration of H2S was sufficient to cause any serious effect or symptomatology".

QUESTION 48

Can it be confirmed that the above statement and Navy Office comment was made with the benefit of hindsight and that at the time no such knowledge existed other than that of a "foul smelling gas?"

.../ANSWER

ANSWER

Yes, the Navy Office comment was made with the benefit of hindsight, and assumed - not unreasonably - that the smell was H2S. The basis took account that no serious sequelae were detected in personnel present in the vicinity.

REMARK 32

The AGAL Analysis Report (Enclosure 9) commented:

(i) That microbiological analysis should take place within 2-6 hours of collection.

(ii) Because details of chemicals used had not been supplied at the time of the analysis, no conclusions could be drawn.

(iii) Due to the lapse of time it was possible the H2S concentration was not representative.

Hence results would be indicative and not qualitative and in particular it would not be possible to draw firm conclusions concerning the apparently low faecal coliform content.

Paragraph 11.23 compared the faecal coliform count 2800 ppm with city stormwater 5000 ppm, the inference surely being that it was minimal and fortuitous. This is not supported by the AMDEL REPORT D.22t/86.

Attachment 2, page 3:

"Mr. Ian Grant of AMDEL analysed the sample for faecal coliforms and ammonia to determine if the sample was contaminated by sewerage".

Results

Faecal coliform count of organisms per 100 ml sample 2800. Ammonia was detected in the sample.

It should be noted that the sample was not sampled or supplied in a recommended sample container.

These results indicate the presence of sewerage contamination.

Attachment 3, Report Q 346/86:

.../"The sample arrived in

"The sample arrived in the laboratory several days after being taken, in a non recommended sample container and with no sample preservation, i.e. kept in Eskimo with Ice".

Results

Microbiological Report Faecal Coliforms orgs/100 ml 2800
Ammonia - Present.

Discussion

"The results indicate that it is highly likely that the sullage sample contained or was contaminated with sewage".

This appears to be a positive assessment and in view of the fact the Navy originally alerted the analysts to the possibility there seems little doubt that the contamination was real and not fortuitous.

Hence the earlier questions on this topic require comprehensive replies.

COMMENT

As the sewerage system was cleaned and shut down prior to the refit, and the sullage tank was cleaned and repainted during the refit, and further as the two systems are not cross connected, it would seem self evident that if in fact the contents of sullage tank were contaminated by sewage then the contamination must have been fortuitous.

REMARK 33

These comments rather miss the point. There was every reason why the Engineer Officer of the Watch should have been informed of the requirement and given the order to LS Gilbert and/or PO Purvis to pump the sludge tank and not that AB Oliver should have sought and been given independently permission to pump the tank. The indication is that the procedure needs revision.

COMMENT

The EOOW of the watch should have been aware of both operations. Paragraph 11.5 applies.

REMARK 34

.../It is not certain

It is not certain that he was aware either that the pump was running or that it was pumping overboard nor from where. LS Gilbert reported the rising level of the SGC bilges twice. The balance of probability at least suggests that had he been consciously aware the pump was running when he went to use it, he would have mentioned the fact when reporting his own difficulty.

The conclusion that he was aware the pump was running is not proven. It is an assumption.

COMMENT

LS Gilbert in the course of attempting to pump, and reporting his difficulties by phone, and reporting his difficulties by phone, passed the pump 6 times. If the pump was not running, he would hardly report he was having difficulty getting a suction. The inference from this report is the fact that the pump was running.

REMARK 35

For reasons already stated in NOTE 7 above there is no evidence that LS Gilbert was attempting to "steal a suction".

COMMENT

The BOI have attempted to establish the most likely sequence of events. It is agreed that there is no direct evidence, but this remains the most likely explanation.

REMARK 36

This is so, but does not address the real problem, namely the defect in basic procedure.

COMMENT

There is no defect in procedure, only that it was not observed.

REMARK 37

.../The ship was on sea trials

The ship was on sea trials between 24 - 27 September 1985, the purpose of which would be to test equipment after refit and the period should have been adequate for all equipment to be tested. If the vessel was still "setting-to-work" after 28 days, it suggests that the refit was not really complete when it sailed. With respect to the oily water separator, the tank was being pumped directly overboard so whether the separator had or had not been "set-to-work" was not relevant.

COMMENT

The ship carries a series of systems which are fitted to enable her to carry out her primary role of Escort Maintenance Ship. These include five diesel generators, evaporators, cranes, oily water separator and many machine tools and workshops. There is no reason why she should not sail with a number of these systems awaiting setting to work. Those that were outstanding were not seen as critical to the safe operation of the ship. In retrospect it would of been prudent to have had the oily water separator serviceable from the time of sailing. Navy has learned from this experience and is revising its procedures for testing ships equipment during and after a refit.

REMARK 38

Standing Orders are a matter of Naval discipline and have not been considered in this appraisal of the circumstances. However, it is curious that sanction should be given to pump out a tank which would clearly take several hours at the end of a working day and at the onset of darkness.

QUESTION 49

Enquiries should be directed to find out if AB Oliver initiated the move to pump out the sludge tank or was told to pump it out and then requested permission from his Regulating Chief.

ANSWER AND COMMENT

Theres is nothing sinister about the timing, which follows the normal timing for tank dipping and the ship reaching open water.

.../REMARK 39

REMARK 39

This paragraph makes clear that persons presumably in responsible positions at Garden Island Dockyard where the 'Stalwart' refit took place were aware of the possibility of hydrogen sulphide generation in mixes of oily waste and bilge waters.

COMMENT

A Garden Island Dockyard Laboratory chemist was aware of the possible method of H2S generation, but this was not common knowledge among engineering personnel.

QUESTION 50

Enquiries should be directed to clarify exactly who was responsible for the vessel during the refit - the dockyard, ship's staff or overseers department and thereafter the state of knowledge of the contents of the sludge tank and what, if any, advice was given.

ANSWER

Questions 1 and 2 apply. The responsibility is that of the ship. No advice was sought, and the request to discharge sullage was not satisfied.

6.1 Need for Change of Fundamental Procedure

6.1.1 Completion and Entry into Service

This relates to accepting new vessels or the re-entry into service of existing vessels after refit.

HMAS 'TOBRUK' entered service on 11 April 1981 and the accident to NRC Dax occurred on 16 December 1981, 8 months later, the deficiency which caused the accident having existed for the whole of that time.

'Tobruk' was probably accepted and pressed into service earlier than would otherwise have been the case in order to participate in Exercise "Kangaroo 81".

.../HMAS 'Stalwart' was under

HMAS 'Stalwart' was under refit from March to September 1985 and shortly after sea trials took part in Exercise "Coral Sea", the deficiency which caused the accident having existed since the vessel re-entered into service.

The parallel is probably not coincidental and suggests the vessels were pressed into service before they were really ready. In the case of 'Stalwart' the crew were still setting-to-work machinery and pumping out sludge nearly one month after apparent completion of a refit.

This suggests that a decision is required as to whether the dockyard and/or General Overseers Department should be able to overrule the Operational Branch of the RAN. Events suggest that a case can be made out for such action at least during peacetime.

Any such contemplation would also involve assessment of the dockyards and Overseers Departments general commitment, efficiency and meeting of target dates and the attitude of RAN in preparing for and committing vessels to refit.

COMMENT

These remarks appear to be based on the premise that the operators can overrule the engineers and "press ships into service" in peacetime. They cannot and do not.

The setting to work referred to in STALWART was of non-critical systems except, as now understood, the oily water separator (See R. 37). Had the specialised knowledge of a GID Laboratory Chemist been common knowledge then as it is now, the incident would not have happened. However, the best engineering advice available at the time did not indicate the possible implications of adherence to the IMO regulations.

6.1.2 Departmental Division of Responsibility

Two ratings were, independently and without knowledge of the other's actions using the same pump to try to discharge from different places at the same time.

Standing Orders are a purely service disciplinary matter; of concern is the procedure which could have a historial background.

.../In olden times

In olden times shipwrights and carpenters built and repaired the vessels, sounded tanks, caulked seams, manned pumps and generally looked after the well-being of the hull. In service terms they probably still preserve some of their original duties over the engineering branch who only originated relatively recently.

Hence the Shipwrights' Department continue to sound and pump tanks, the concession to progress being to inform the Engineering Officer what they are doing, who, in turn, informs the Officer of the Watch. This system has long been superceded in Mercantile practice. Only the Engine Department start and stop machinery including starting cargo pumps on tankers and supplying power to, but not manoeuvring deck machinery such as winches, windlasses and capstans.

Thus, applied to 'Stalwart', the Shipwrights' Department, judging the sludge tank needed pumping, would request the Engine Department to pump it for them. This alone would possibly have prevented the accident because the Engineer-in-Charge would know at all times which machinery was running and for what purpose.

Consideration should be given to affecting this change.

COMMENT

This section is based on a premise that there are two departments as in "olden times". The recommended change was carried out years ago in the RAN.

LACK OF EMPHASIS

6.2.1 Discharge of Sludge Ashore

The Report makes clear that large quantities of sludge/Aqueous wastes were disposed of ashore during the refit and that dockyard personnel at least most certainly were aware of the possibility of dirty mixtures of aqueous and oily waste to generate Hydrogen Sulphide but is silent on the subject of why the discharge ashore was stopped or why waste oil and water were pumped to the same tank when it would have been as easy to keep them separate.

.../The Report also

The Report also apparently accepts at face value the fact that AB Oliver sounding the sludge tank found it nearly full, therefore considered it should be pumped, requested and was given permission to so do.

It seems very improbable that someone in authority onboard did not know the level and content of the sludge tank and equally improbable that it had not been sounded before. Therefore questions which arise are: - why had it not been pumped before,
- why should this activity commence in the
- evening at approaching nightfall.

A cogent case could certainly be made out that someone onboard decided it was time to dispose of the rubbish and instructed the rating to so do commencing with approaching darkness so the vessel would be well clear of the area before daybreak!!

COMMENT

There is evidence that a chemist in GID Laboratory knew the probability of H2S production. The engineers, whether uniformed or civilian, in concert with their colleagues elsewhere did not.

The conspiracy theory which the consultant advances is refuted by the comments already made. The tank in question had been sounded regularly It accummulated waste over a period of time. The need to separate oil and water was not perceived. The tank was not pumped earlier because the ship was in restricted waters.

6.2.2 Ignoring Odours

In the case of 'Tobruk' malodourous smells persisted and were tolerated, ignored or camouflaged for months.

In the case of 'Stalwart' the odour was also of some standing hence "6.8 This mixture generated, under certain conditions, offensive odours ..... This was generally regarded as a 'normal' sullage tank smell".

This may also be related to naval discipline and possibly a conditioning that - if you ignore it, it doesn't exist.

The facts are, however, that nauseating putrid

.../odours are not normal and

odours are not normal and some procedure should be established to encourage the reporting of same and after repeated reports, proper inquiry into their cause, source and cure instituted.

Such a procedure could have prevented both accidents.

COMMENT

It is agreed that the significance of the odours was underestimated. To imply, however, that this is a direct result of Naval Discipline is absurd.

6.2.3 Completion of Refit

One would normally understand that upon completion of refit a vessel would be in a state of refurbishment and general cleanliness ready to resume a prolonged period of continuous service. Therefore it is illogical to first shot blast to white metal and then recoat the sludge tank then contaminate it with sewage, oil wastes and dirty bilge water allowing that material to remain onboard upon departure.

6.3 Incorrect Emphasis

6.3.1 Retention of Waste Onboard

It was stated that the waste had been retained onboard to conform to IMO Regulations concerning non dumping in inshore waters.

Had the vessel been cleaning oil tanks at sea and possibly chemically cleaning the cooling system in port but under normal commission (such procedures could certainly occur with merchant ships), then the above statement might have validity.

However, because the vessel was under refit in a Naval Dockyard the inescapable conclusion must be that the permitting of sludge to accumulate and remain onboard upon sailing had nothing to do with IMO but everything to do with expediency.

COMMENT

.../This section is based

This section is based on the premise that the ship sailed with 80 tonnes of waste onboard. It did not.

6.3.2 Sewerage Content of Sludge Tank

Although this is played down the references in the report and particularly the letters and analyses of AGAL and AMDEL make it clear this was a fact they had been originally alerted to it by the Navy Department. Therefore, in view of the findings of the 'Tobruk' enquiry, as it was known by somebody that sewerage was contained in the 'Stalwart' sludge tank, the fact that there was not a similar awareness concerning aqueous waste and oil is less relevant. Knowledge of the presence of sewerage should have been sufficient warning to treat the contents of the tank promptly and with care.

COMMENT

Nobody onboard STALWART had any reason to suspect that sewage was contained in the sludge tank, nor was this ever proved. As covered at Question 48, discussion with AGAL gave sewage as a possible source of H_2S, based on the TOBRUK incident.

APPENDIX C

Report by Mr R J Parkinson, PAC Specialist Adviser, on RAN Toxic Gases and Fire Fighting*.

*Appendices 1-6 referred to in the following Report by Mr Parkinson have not been reproduced herein.

Report on

Inquiry into Aspects of Defence Equipment Support

Sections C(1), C(2)(a) and C(2)(b)

(1) The extent of usage/installation of systems capable of generating toxic gases and the use of combustible materials.

(2)(a) Current approved RAN Standards covering systems capable of generating toxic gases and the use of flammable materials especially polycarbons in RAN vessels.

(2)(b) Current RAN Instructions in the event of fire or the release of toxic gases aboard ship.

Instructed by

The Commonwealth of Australia
Joint Parliamentary Committee
of Public Accounts
Parliament House
CANBERRA A.C.T. 2600
Australia

13th August 1986

CONTENTS

1 PREAMBLE

Instruction 3(b) in the Statement of Tasks requests identification of Standards (Public or Private Sector, Australian or International) with which to assess the relevant Defence policies and procedures.

Some of the Organisations which set and/or apply Standards in the Marine Industry are:-

1. American Bureau of Shipping
   45 Eisenhower Drive
   Paramus
   New Jersey USA

2. Bureau Veritas
   31 Rue Henri-Rochefort
   BP710 75821 Paris Cedex 17
   France

3. Germanischer Lloyd
   Vorsetzen 32
   Postfach 111606
   D-2000 Hamburg 11
   Federal Republic of Germany

4. Lloyds Register of Shipping
   71 Fenchurch Street
   London EC3M 4BS

5. Det Norske Veritas
   Veritasveien 1
   P.O. Box 300
   N-1322 Høvik
   Norway

6. The British Ship Research Association
   Wallsend Research Station
   Wallsend
   Tyne & Wear NE28 6UY

7. The British Standards Institution
   2 Park Street
   London W1A 2BS

8. The College of Maritime Studies
   Warsash
   Southampton SO3 6ZL

9. The Department of Transport
   Marine Directorate
   Sunley House
   90-93 High Holborn
   London WC1V 6LP

10. Electric Cable Makers Confederation
    56 Palace Road
    East Molesey
    Surrey KT8 9DW

11. General Council of British Shipping
    30-32 St.Mary Axe
    London EC3A 8ET

12. Institute of Marine Engineers
    76 Mark Lane
    London EC3R 7JN

13. Institute of Petroleum
    61 New Cavendish Street
    London W1M 8AR

14. The Institution of Mechanical Engineers
    1 Birdcage Walk
    London SW1H 9JJ

15. International Chamber of Shipping
    30-32 St.Mary Axe
    London EC3A 8ET

16. International Maritime Organisation (IMO)
    4 Albert Embankment
    London SE1 7SR

17. Lloyd's of London Press Ltd. (Shipping Information Service
    Sheepen Place
    Colchester
    Essex CO3 3LP

18. The Royal Institution of Naval Architects
    10 Upper Belgrave Street
    London SW1X 8BQ

19. United States Coast Guard
    400 7th Street S.W.
    Washington D.C.
    20590 U.S.A.

20. The Health and Safety Executive
Baynards House
1 Chepstow Place
London W2 4TF

The above are a small random selection of organisations concerned in this field.

Taking only The British Standards Year Book and Catalogue of Publications, this contains more than 1100 pages on each of which appear 10-15 standards. Thus any attempt at carrying out a comprehensive listing and cross reference of standards would be an enormous undertaking and it is concluded is not required. Therefore only the specific information contained in the Department Response will be considered and appropriate references given, if known. The minimum of time has been spent on researching the existence of references.

At the same time, note should be taken that all the Technical Institutions have comprehensive Technical Libraries available for reference purposes; the Classification Societies an enormous accumulation of knowledge relating to equipment and system performances including specialised departments related to safety, IMO regulations and various International Conventions.

Application at appropriate level to some of the above organisations could save considerable time and effort.

2 STANDARDS RELATING TO TOXIC GAS & FIRE FIGHTING

2(C.1) The Installation of Systems capable of of generating toxic gases

The subject headings in this document are repeated in the listing of all current approved RAN standards which comprise the response to Question 2(a).

It is convenient to offer a combined comment on the Department's response to both these questions. Because the reply to Question 2(a) is essentially a list of documents, there is little indication of the contents. It is, therefore, possible that some of the following comments are superfluous and this fact should be borne in mind during the Inquiry.

Briefing Paper

Remark:

The impact is spoiled by the use of complex terminology and some examples are appended:-

Briefing Paper	Alternative Text
1. Combustion of fossil fuel in a liquid form (8)	Fuel Oil (2)
2. The products of combustion in a gaseous form (8)	Combustion gases (2)
3. The penetration of these combustion gas systems from external causes would require either extreme shock or impacting by a fast-moving object (10)	either explosion or a direct shell strike (7)
4. The metallic structure of the gas system deteriorates due to heat, corrosion, and continuous flexing. Fastenings and joints at junctions also deteriorate. Penetration of the exhaust system can occur in peace or war due to wastage of components as outlined. (40)	The gas uptakes deteriorate due to heat, moisture and corrosion eventually resulting in holes (14)
5. The volume of liquids retained in oily waste tanks has the potential for significant reduction with the adoption of developing technology associated with membrane filters (25)	The volume of waste retained can probably be reduced by using special types of filters (15)

2(C.1)(cont.)

Remark (cont.):

Briefing Paper	Alternative Text
6. Navy has attached high priority to the urgent provision of suitable hand held instruments to ships so as to permit rapid monitoring assessment of hydrogen sulphide levels (27)	Navy are supplying rapid acting electronic detectors for hydrogen sulphide as matter of priority (15)
7. The ignition of hydrogen/oxygen mixtures can have catastrophic personal and structural effects if a sufficiently large accumulation is allowed to occur. The risk is controlled (26)	Because a hydrogen/oxygen explosion can be catastrophic, the risk is carefully controlled (13)
8. The initiation of combustion of fuel in a stored torpedo in a submarine could have immediate and fatal effects to personnel (21)	Combustion of fuel in a stored torpedo in a submarine could kill the crew (14)
9. Leakage of sea water onto the battery banks causes electrolytic breakdown of some of the constituents of sea water particularly chloride salts such as sodium chloride. One of the products of the electrolysis is chlorine, a pungent and respiratory irritant, which has fatal effects (43)	Leakage of sea water onto the battery banks causes the electrolytic generation of chlorine gas which can be fatal (18)

Subject to normal courtesies of address it is always advantageous to couch documents, particularly Service documents, in straight forward language, most particularly those destined for use in training programmes. A serving sailor could be excused for not recognising an "Olfactory Apparatus" as his Nose.

100

2(C.1.1) The Production of Power

5. Fuel on burning in any of the three prime equipments (Boilers, Diesel Engines or Gas Turbines) generates carbon dioxide, carbon monoxide and water vapour from the prime constituents of the fuel and sulphur dioxide. These products of combustion have varying degrees of toxicity.

Remark:

(1) It may appear too obvious but the above does not include the fact that as Nitrogen comprises the main constitutent of air (79%) it remains by far the greatest constituent in the exhaust and although it does not contribute to the combustion process, being inert, it is the main reason why exhaust gas will not support life and is primarily an asphyxiant which will kill.

(2) In addition to the toxic gases referred to, the so-called "Nox" gases are generated. (These are the main gases subject to emission control regulations for automotive engines). They are oxides of nitrogen, as follows:

Nitric Oxide	NO
Nitrogen Oxide	NO_2
Nitrogen Trioxide	NO_3
Nitrogen Tetroxide	NO_4
Nitrogen Pentoxide	N_2O_5

generically expressed as NO_x - hence the name.

In tests carried out by the writer some years ago in connection with detecting and neutralising the corrosive constituents in Inert Gas Systems for Tankers, results showed that significant amount of NO_x could be produced.

Indications were that as combustion temperature increased, greater quantities of NO_x resulted. High combustion temperature is associated with high quality fuel having low sulphur content.

Fuel containing large sulphur content has a lower combustion temperature (sulphur is a low quality fuel) and much less NO_x is produced but commensurately a larger quantity of sulphur dioxide (SO_2).

Thus as one contaminant is reduced, the other tends to increase and vice-versa. SO_2 contents in exhaust gas of 1500 ppm were noted. NO_x content detected was up to 750 ppm.

101

2(C.1.1)(cont.)

Remark:

(2)(cont.) Reference to Appendix B indicates that Threshhold Limit Values (TLV) are low but because of their relatively low solubility in water, their warning power is low and dangerous amounts can be absorbed into the system before any real discomfort is experienced. Thereafter although the immediate symptoms may clear up on breathing fresh air, death may occur from 6 to 24 hours later, or pneumonia may develop.

The concentrations noted in the Exhaust Gas tests far exceed (TLV) acceptable limits and it should be recognised that it is inherently dangerous to attempt repairs to leaking exhaust gas uptakes with machinery/boilers in operation. It is understood that several otherwise inexplicable deaths amongst engine room crews of Scandinavian vessels in the 1960s were attributed to the mechanism described above. It is suggested this omission be rectified.

102

Q.1 How frequently are exhaust systems checked for leakage in HMA vessels due to both wastage and leakage at joints and provisions for expansion due to the large temperature changes which must be accommodated?

Q.2 Regulations exist concerning working on funnels when the machinery is in operation but does that include working on the exhaust trunking system generally?

Q.3 What provision is made to ensure, so far as this is possible, that in the event of exhaust ducting leakage air will leak into the casing and not exhaust gas leak out into the engine room space (for example by maintaining boiler room pressures higher than those inside the uptakes)?

Q.4 In the event that provisions suggested in Q.3 are impractical, what consideration has been given to improving positive air supply by ventilation to areas of greater risk, above boilers and restricted spaces in way of uptakes?

2(C.1.1)(cont.)

Q.5 Has specific training been directed to ensure that technical personnel at least are fully aware of the dangers of acid gases which can cause irreversible lung damage; such gases as NOX, Phosgene, Chlorine and Sulphur Dioxide?

Remark:

(3) The toxic gases referred to are generated and reference to Appendix A details their toxicity. Note that only sulphur dioxide is readily detectable by odour.

However a boiler exhaust gas can typically be expected to contain

Carbon Dioxide.	14%
Carbon Monoxide	Trace
Sulphur Dioxide	0.2%
Oxygen	4.0%
Nitrogen	(Balance 81.8%)

Diesel Engine & Gas Turbine Exhausts:

Carbon Dioxide	5%
Carbon Monoxide	Trace
Sulphur Dioxide	0.1%
Oxygen	15.0%
Nitrogen	79.9%

(Constituents vary with the particular fuel analysis and air/fuel ratio)

Clearly the most important asphyxiant is Nitrogen. It is suggested this fact be suitably emphasised.

103

Q.6 To what extent is the chemistry of combustion included in basic training courses to ensure that the most Junior personnel are made aware from the outset of the dangers inherent in exhaust systems both with respect to Asphyxiants and Toxic Gases?

2(C.1.1)(cont.)

8. It is possible for the products of combustion to be drawn into ship's ventilation systems and into the ventilation systems of ships in company.

Remark:

(4) The above is recognised and to an extent unavoidable. Whilst normally it is no more than a minor nuisance, there have been cases reported when it became more serious (usually by self-contamination). Whereas merchant vessels do not normally operate "in company", Naval vessels do so frequently.

Q.7 Is it the practice to carry out wind/smoke tunnel tests as an aid in detecting any propensity for self or cross contamination of ventilation systems so facilitating modifications?

2(C.1.2) Sewage Systems

14. "The RAN sewage policy now requires all ships to be fitted with a sewage system that meets IMO regulations. The RAN prefers a system which treats sewage by an electrocatalytic flow through method".

Remark:

(5) The above preference is understandable in that because of the small retention time the equipment is compact with a very high throughput capacity, both desirable, indeed possibly essential, on Naval vessels.

What is not emphasised is whether the preference has been maintained and strengthened by operational results.

The following should be considered:-

The Omnipure, Electrocatalytic System is a superficially impressive name, but it does not use a catalyst in the true sense of the word. A catalyst is a material which promotes and speeds up a chemical reaction, whilst itself remaining unchanged. On that criterion there is no catalytic action; it is rather better described as an accelerated process.

In fact the system is a macerator/chlorination system, the chemical oxidation and purification of the waste resulting from the electrolytic generation of Sodium Hypochlorite from the reaction of sea water in an electric cell (see later description of differing types of installation).

It is reminiscent of a system used some years ago which utilised such a cell to chlorinate the water at the inlet to ships' sea water circulating/cooling systems, the purpose being to prevent fouling by barnacles and marine growth. In that case the chlorine was used as a biocide. The system worked but suffered two problems:-

(i) Frequent electric cell failure,
(ii) Corrosion, particularly in way of differential metals.

Doubtless with time both deficiencies have been reduced or possibly eliminated.

2(C.1.2)(cont.)

Remark (5)(cont.)

Details of an Omnipure System have been studied and attention is directed to the following :

(a) Equipment operating towards its designed limits would tend to choke and/or block-up.
(b) The fact that a back flush is necessary suggests it could become blocked and the plant rendered ineffective at high throughput.
(c) The electric cell electrodes could become blocked and/or burn out. It is understood that plant being designed for the Canadian Navy includes multiple electric cells which can be used progressively whilst defective units are cleaned, replaced and/or renewed.
(d) Despite the fact that the solids would be comminuted and discharged in sterile condition, there would nevertheless be a tendency for the plant to accumulate sludge which would require blowing down from time to time.
(e) Overchlorination of the effluent can occur with adverse effects on the ecology of the local marine environment which could progressively be serious in fisheries areas.
(f) In fresh water, hydrogen and oxygen are evolved which provide an explosion hazard and it is understood some plants include a discharge fan. In fresh water conditions it is necessary to add salt to the unit to permit the generation of hypochlorite.
(g) In the event of electric cell failure anaerobic conditions would quickly ensue together with all the concomitant undesirable phenomena.
(h) Whilst the plant is regarded as well designed, unless considerably automated, it would potentially at least require considerable attention.

Whilst the above is to an extent 'devil's advocacy', it is not intended to be and should not be regarded as with destructive intent. The simple facts are that with Sewage Treatment Plants there is no simple road to salvation. In particular

106

2(C.1.2)(cont.)

Remark (5)(cont.)

selection and operation should in no way depend upon any understood inherent characteristics of the system but should rather depend upon:

(i) Need and capacity.
(ii) Design, quality of materials and reliability.
(iii) Ease of maintenance and amount of operational attention required.
(iv) Environmental acceptability.

15. The various methods of collection, holding, transfering and treatment of sewage in RAN ships are closely monitored. It is considered that regulations adequately cover operation and maintenance of these various systems.

107

(6) It is noted that under design and installation no specific reference has been identified from UK sources so far and the U.S. sources relate specifically to "Collection, Holding and Transfer" (CHT) systems. This suggests that concerned personnel may suffer from a basic lack of understanding of the real function of sewage plants.

Methods available for the treatment and purification of sewage are the same irrespective of whether the installations are land or ship based, any difference is that of scale. It follows that a large amount of reference material must exist in Australia via Institutes of Public Health, Sanitation etc. etc. and an obvious source for preparing a fundamental guidance document would seem to be Australian Government Analytical Laboratory (South Australia) or the Engineering and Water Supply Department of South Australia (or equivalents in other States).

In the interim, to facilitate a basic understanding of the subject, basic systems are:
(i) Anaerobic *
(ii) Sterilisation *
(iii) Macerator/Chlorination
(iv) Macerator/Electrochemical
(v) Aerobic-biological digestion. *

2(C.1.2)(cont)

Remark:

(6)(cont.)

(i) Anaerobic Systems are generally unsatisfactory and potentially dangerous.

Note from Appendix E:

"Another and better known term for 'anaerobic decomposition' is 'putrefaction' and this perhaps spells out more emphatically the foul, highly offensive conditions which arise as a consequence of this change. Hydrogen Sulphide, ammonia,mercaptans, and, eventually methane add their noxious odours to the blackening, bubbling water".

The above type of "System"was used during the war to convert animal sewage to methane as an alternate fuel for cars.

(ii) Sterilisation using chemical flocculents is an efficient process which greatly reduces the residual stored solids. However, it is generally considered suitable for only small installations such as patrol boats etc. This group includes the ELSAN System.

(iii) Macerator/Chlorinator Systems: The material is chopped into small comminuted pieces and purified by chlorination with Sodium or Calcium Hydrochlorite (or similar material). These systems are effective but may be unacceptable in some parts of the world due to the amount of and discolouration capability of the discharged solids. Further the residual chlorine content may be sufficient to adversely affect the ecology of the receiving water by destroying the normal bacterial flora. This group includes CHT Systems.

(iv) Macerator Electrochemical Systems are similar in effect to group (iii) above except that the chlorination is achieved by an electric cell which reacts with the salt content of sea water (Sodium Chloride) releasing chlorine at one electrode

2(C.1.2)(cont.)

Remark:

(6)(cont.)

(iv)(cont.) and Hydroxyl ions at the other. Because the electrodes are in close proximity Hypochlorite results which effectively purifies the effluent. A big advantage of these systems is the short retention time and consequently a high capacity compared to equipment volume. Potentially at least these systems suffer from the same drawbacks associated with those in group (iii) although careful design can doubtless be effective. This group includes the OMNIPURE system at present favoured by the RAN.

(v) Aerobic System: This is the system normally found in land based sewage farms. It harnesses the aerobic digestion processes of nature to break down the material into clear effluent and a small volume of residual waste sludge, both of which are rendered inert by mild chlorination. Environmentally this is perhaps the most acceptable process but is once again subject to design and throughput considerations. The material total retention time is about 24 hours and for this reason plants occupy more space and are able to cope with less crew capacity than group (iv). They do however require the minimum of attention.

Appendices C. D and E are appended being literature immediately available on the subject from the Library of the Institution of Marine Engineers in London and are couched in fairly straightforward language. They may assist in enabling a paper to be produced to provide the general guidance at present considered to be lacking in the Departments's response. Reading the appendices will indicate that they are far from recent.

Note also that Groups (i), (ii) and (v) are linked to possible final disposal of sludge using an incinerator.

2(C.1.2)(cont.).

Remark:

(7) Close Monitoring of CHT Systems:

It is a fact that study of the 'Tobruk' incident showed that quite apart from the unsatisfactory design features of the CHT system, the basic arrangement of the sanitary/toilet system malfunctioned.

This is a matter totally independent from any IMO regulations and equivalent to building an hotel with a deficient toilet/ sewage disposal system. It is not difficult to predict the response from a Public Health Department under such circumstances.

Q.8 Can the Defence Department confirm that since the 'Tobruk' accident all the sanitary/sewage systems on RAN vessels, including separate evaluation of the "standard provisions", i.e. those independent of any appended sewage treatment plant, have been thoroughly examined and proven satisfactory?

110

(8) Heads of Minimum Flush Design:

Toilet pans on 'Tobruk' were fitted with water/hygiene traps of reduced depth, the intent of which was to reduce the quantity of necessary flushing water. The desire to reduce the amount of flushing water on any CHT system is understandable but would have the incidental effect that the effluent was more concentrated and required a significantly higher (B.O.D.) Biological Oxygen Demand for its purification. Sewage systems on ships already tend to have effluents with higher B.O.D. than those found in land installations (see Appendix C pages 5 - 7). The effect of reduced liquid flow is to increase the purification load upon the sewage treatment plant, and at peak load periods, possibly to the point of overcoming its capacity for purification/sterilisation.

2(C.1.2)(cont.)

Q.9 Has this aspect of design been evaluated with the various equipment manufacturers involved?

Q.10 How have selections been made? What is the basis for the present expressed preferences?

Q.11 How far do preferences result from recommendations from other sources, other Navies, Passenger Ships or Offshore Oil Rig Operators etc.?

Q.12 How far do those preferences result from practical trials and if affirmative, the length of trials, methods used, loadings imposed together with documented results?

111

Remark:

(9) It must be emphasised that the above remarks do not refer particularly to any specific type or manufacturer but to all types and all manufacturers. In short, how widely and how deeply has the net been cast?

A final note on the subject is that merchant navy experience has shown, and no doubt Naval experience may confirm, that all too frequently personnel regard IMO safety regulations as "Just another Imposition!"

"Don't they think we have enough to do!"

"We are really not interested in meddling with these new-fangled contraptions!"

These attitudes will not change overnight and therefore it is important that personnel understand that increasingly ships are their own eco-system and crews have the same responsibility for their environmental well-being as everybody else. Training

2(C.1.2)(cont.)

Remark:

(9)(cont.) should therefore be thorough and repeated until acceptance of the new standards is automatic, total safety will not be achieved until this is brought about.

Q.13 Does present training reflect the above concept?

112

2(C.1.3) Incinerators

Remark:

(10) There is no reference to such equipment in the Department's response to the Committee. Whilst there is at present no legislation to require an incinerator for disposal of shipboard waste, the implications of the IMO Annex IV - Regulations for the Prevention of Pollution by Sewage from Ships and Annex 5 - Regulations for the Prevention of Pollution by Garbage from Ships, is indicative of general attitudes and the probability that such measures will be promulgated and become mandatory sooner rather than later.

The advantages of incinerators have long been recognised in the Merchant Marine and Appendix C confirms such equipment has been under development in the UK at least since 1974 (and doubtless earlier). Incinerators have been increasingly installed on new ships since the mid 1970s and now are almost standard equipment.

113

Advantages are the convenient and total disposal of:

Food and Galley Wastes
General Shipboard Rubbish
Plastic Materials in reasonable quantities
Oily Sludge Wastes
Sewage Sludge Wastes.

It is appreciated that space is frequently at a premium aboard Naval vessel's but this could be balanced against an improvement in safety and the ability to dispose of debris, which may otherwise lead to detection in time of war.

Q.14 Does the Department have any plans to install Incinerators on RAN vessels?

2(C.1.4) Oily Water Treatment and Oily Waste Tanks

22. Environmental demands have necessitated the fitting of oily water treatment systems to ships to reduce the oil content of bilge water which in earlier times might have been pumped directly overboard.

Remark:

(11) Paragraph 22 may be thought to refer to recent IMO regulations - this is not so. The writer originally went to sea in 1947 and even then vessels were fitted with oily water separators for bilge and/or ballast/oil tank contents. For many years many countries including Australia prohibited the discharge of oily bilge water into estuaries and harbours. There is nothing new about it. Regrettably there was a tendency to ignore or avoid the local regulations if possible and as enforcement was local and depended upon the vigilence of the harbour authorities, it was difficult, if not impossible, to identify a specific culprit in a busy harbour with the means then available. However, as tanker sizes increased in the 1960s, the extent of the problem magnified and with a growing awareness, regulations became more stringent and tankers increasingly used the B.P. originated system of "Loading on Top" which eliminated slop discharge at sea from tankers. Admittedly cargo vessels tended to lag behind but as port regulations became more stringent, considerable improvements in the quality and usage of separating equipment has taken place, one aspect being the increasing installation of Incinerators noted above.

114

Q.15 Is it accepted that there is nothing new about Oil Separating Equipment and that there can be no real excuse for personnel being unfamiliar with its operation?

(12) Apart from the ill advised admixture of aqueous and oily wastes during the refit of 'Stalwart', the possible unfamiliarity of personnel with the separator resulting in the waste being retained on board for nearly a month after sailing was a factor in the accident. This is underlined by the fact that even when the contents of the sludge tank were discharged, they were not discharged through the separator.

2(C.1.4)(cont.)

Remark:

(12)(cont.) It appears that general awareness of the dangerous propensities of oily waste/aqueous effluent is only recent within the Department.

Notwithstanding awareness of the dangers of Hydrogen Sulphide, the accident also owed at least something to accepting a known bad practice, i.e. the mixing of oily and aqueous waste, even if only considered from a general pollution standpoint.

Q.16 What is the extent of the installation of oily water separators aboard RAN vessels; the extent and depth of training into the use of the equipment and has any revision taken place since the 'Stalwart' Incident?

(13) Documentation from the UK clearly places regulations concerning oil water separators back as far as 1957, but that from the U.S. is less informative.

115

Q.17 How widely was the information which was available disseminated and used, or due to lack of emphasis, had it slowly declined in awareness?

24. In oily waste tanks conditions which reduce or eliminate the capability of such mixes to generate hydrogen sulphide can be created by aerating the contents vigorously with compressed air.

Remark:

(14) Aerating Waste Oil Tanks Vigorously:

Whilst the light fuel used in RAN vessels will probably have a flash point of more than 65°C, the above practice would probably be harmless enough. However, it is feasible that from time to time oily waste tanks may contain gasolene or Naphtha/Benzene from cleaning degreasing operations, in which case vigorous aeration could lead to the generation of static electricity at the oil/water interface causing spark discharge

2(C.1.4)(cont.)

Remark:

(14)(cont.) and resultant explosion and fire. It is suggested that increasing the aqueous content pH more than 8 would be safer and as effective. A useful reference in connection with the above is the International Chamber of Shipping Oil Companies International Marine Forum:

"INERT FLUE GAS SAFETY GUIDE"

Section 1.4.4 and 4.4.4 specifically.

The Oil Companies International Marine Forum:

"International Oil Tanker and Terminal Safety Guide"

Second Edition 1974

also contains useful data. However this is doubtless only one of many such available sources.

116

Q.18 Was the above considered when preparing paragraph 24?

(15) With respect to sewage treatment plant, oily water separating, filtering and oil content measuring and monitoring equipment, the Marine Environment Protection Committee (MEPC) of IMO regularly publish lists of approved manufacturers throughout the world as these are made known by member Governments. The latest such list is MEPC/Circular 166 dated 12.March 1986, attached hereto as Appendix F, which may be useful in obtaining additional data from Manufacturers to add to the technical library of the Department.

2(C.1.5) Materials Capable of Generating Toxic Gases

44. In further recognition of the risk to human health of burning undesirable combustible materials aboard HMA ships protection is available to the crew through the use of effective fire-fighting equipment and personal protection equipment.

Remark

(16) Training with Breathing Apparatus:

One sailor, A.B. Oliver, lost his life in the 'Stalwart' accident despite the fact that he was properly equipped with a self-contained air breathing apparatus when he entered the Stern Gland Compartment (SGC) to assist the others. It was speculated that:

(a) He may have removed his own mask as "Buddy Aid" to his shipmates.
(b) That his mask may have been knocked off by the obstruction of air trunk and 3 inch suction hose passing through the manhole.
(c) That his mask may have been incorrectly adjusted and leaked from the perifery of the face piece.

All of the above could also be accounted for by lack of familiarity with the equipment and/or lack of sufficiently frequent and in depth training.

117

Q.19 With relation to all Naval personnel, what is the extent of training using the various types of breathing apparatus, the training time in hours, how often repeated, what tests are applied to determine competance? Does any training take place in smoke filled or tear gas saturated atmospheres (with the deliberate intent to discover improperly fitted masks) and/or does any training take place in concert with Municipal Firefighting Services who could be expected to be very knowledgeable concerning respirators and gases of various types?

(17) In considering the above, it is also important to recall that if A.B. Oliver's mask had not been removed in some manner, the death toll may have been eliminated or, at worst, reduced to one.

2 (C.2)(b) Part 1 Toxic Gases

Current RAN Instructions governing action to be taken in the event of fire or the release of toxic gases aboard ship.

2 (C.2)(b) 1a Respiratory Hazards on Board HMA Ships - 6 December 1985

NHC40/85 ATTACHMENT 3A

Remark:

(18) The above is a general circular containing useful information and guidance and directed to all Health Services personnel.

The document is not a directive nor does it appear to call for any specific action or response and as it post dates the 'Stalwart' accident, it may be thought that additionally it should have called for a revision and/or intensification in training programmes.

118

Q.20 Were other directives prepared following receipt of NHC40/85 aimed at revising and/or intensification of training relating to hazards on HMA vessels?

2 (C.2)(b) 1b Understanding the Dangers and Causation of Hydrogen Sulphide (Supplements NHC40/85)

Dated: 25.February 1986 ATTACHMENT 3B

para 10: .....Because most bilge wastes (which may foster the growth of bacteria generating hydrogen sulphide) are channeled into one holding tank at a central plant, it is possible that this plant and the tank will become infected. For this reason, compartments which house such tanks should normally be treated cautiously, with

Remark:

(19) It would seem to be essential that air pipes should not terminate below decks from such tanks and/or equipment.

2 (C.2)(b) 1b (cont.)

particular attention being paid to the location of escape or vent pipes which terminate in below spaces. (Writer's emphasis)

para 11: .... The Oxygen of the air in the tank will allow the top layer, tank freeboard is thus depleted.

Remark:

(20) This appears to contain a typographical omission and the correct text can be derived from the previous circular, Tech. 31.August 1983 (Appendix 3C), namely:

"The Oxygen of the air in the tank is in contact with the untreated sewage which decomposes aerobically (using oxygen). Oxygen in the air in the tank freeboard can thus be depleted in this process".

119

para 12: .... It is primarily the task of Senior Sailors and Officers to educate their men in the hazards and safe practices in dealing with unventilated and confined compartments.

Remark:

(21) The Circular supplements NHC40/85 dated 6.December 1985 and to an extent para 12 supplies the earlier omission, namely a directive concerning education. Nevertheless the paragraph appears to delegate responsibility for the education to individual fleet units and in this sense can be said to lack emphasis indicative possibly of the order of priority.

Q.21 There appears to be a case for incorporating the safety training referred to into the central instruction programme and requiring proof by examination of increasing competence with seniority. Is such action in progress or planned?

The above two Circulars post date the 'Stalwart' accident.

2 (C.2)(b) 1c Sewerage Systems in RMA Ships - Dangers to Personnel - 31.August 1983 ATTACHMENT 3C

para 4: .... When sewage is aerated (i.e. has air blown through it) it decomposes aerobically but formation of the gases is inhibited.

Remark:

(22) The paragraph may have greater meaning if reworded as follows:

"When sewage is aerated (i.e. has air blown through it) it decomposes aerobically and carbon dioxide CO_2 is given off (this gas is heavier than air and toxic in high concentrations, i.e. 10%). However, the formation of dangerous toxic gas such as hydrogen sulphide is inhibited (hydrogen sulphide is rapidly lethal in concerntrations higher than 1 in 1000 or 0.001%)."

ANNEX A to DI(N) Tech 29-9 indicates:

	60 minute Safe exposure %	Max. 8 hour Exposure %
Chlorine	0.0004	0.0001
Hydrogen Sulphide	0.02 - 0.03	0.001

From APPENDIX G:

Chlorine	{0.00005 Dangerous for short exposure {0.001 May be fatal at brief exposure
Hydrogen Sulphide	0.0008/0.001 May be fatal in 30 mins.

The apparent difference in the concentrations of these gases with respect to tolerance and toxicity should be noted. It is desirable that standard nomenclature and uniformity of description be investigated and established as soon as possible.

(N.B. Annex A to NHC40/85 Hydrogen Sulphide 1000 parts per million (= 0.001%) single breath causes immediate respiratory arrest and unconsciousness).

120

Q. Are these apparent contradictions in dangerous concentrations of these gases being revised?

The above Circular post dated the 'Tobruk' accident.

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2 (C.2)(b) 3a Boards of Inquiry DI(N) Pers.5-2 31.December 1981 ATTACHMENT 3G

Remark:

(23) Circumstances requiring Boards of Inquiry and their terms of reference are clearly laid down. However, the document is silent with respect to any duty of the Board of Inquiry, having established causes, to address attention specifically to formulating recommendations for the avoidance of similar accidents in the future. It is recognised that the Fleet Comment and recommendations following the 'Stalwart' accident (10d) do require wide promulgation of the failure to promptly use the oily water separator, the general lack of knowledge that anaerobic activity in waste oil tanks can lead to dangerous gas accumulations and the inherent dangers of using a pump for two duties at the same time but these fall short of specifically addressing the task of trying to eliminate recurrence.

121

Q.23 Has consideration been given to the incorporation of such a post enquiry task into the BOI terms of reference?

Q.24 Has any thought been given for Boards to include a member who does not have a service background (i.e. an Academic or Lawyer) whose thinking may be less likely to be subconsciously conditioned by service procedure and discipline?

Q.25 As an alternative to the above, has consideration been given to the establishment of a permanent "Accident Evaluation Committee" with the task of identifying basic fundamental contributory causes, independent of any breaches of service discipline, which may help to prevent or indeed eliminate the possibility of recurrence of accidents?

2 (C.2)(b) Part II Fire

1a Precautions against Accidents, Safety of Personnel

Section 1 - Precautions ATTACHMENT 3H

para 0601.10:

In order to help prevent accidents, all accidents that occur or hazards that exist are to be reported to the ship's Hazard Survey and Inspection Team.

Remark:

(24) The above provides the means necessary to help prevent accidents.

Q.26 Do all ships have Hazard Survey and Inspection Teams?

Q.27 What is the composition of the team?

122

Q.28 Was such a team active prior to the accidents on 'Tobruk' and 'Stalwart'?

Q.29 What authority do the team enjoy, to whom do they make their reports and/or recommendations and does any provision exist for passing on recommendations without breaching service discipline in the event that corrective action cannot be taken promptly or is otherwise not acceptable to the Commander of any particular vessel?

Q.30 Does any centralised Authority exist to collect and disseminate the findings of individual Hazard Survey Teams throughout the service or perhaps function as Ombudsman in the event that recommendations of any Team were rejected?

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2 (C.2)(b) Part II (cont.)

para 0628.3:

When possible, compartments used as turret drain tanks, or as tanks to which oil, dirt, soapy water or other substances which can form gases have access, are to be flooded completely with sea water and pumped out immediately before opening. Air escape pipes or vent pipes from the compartments, if terminating in a living space, are to be fitted with temporary lengthening pieces so that the escaping gases may be discharged to the open air

Remark:

(25) It will be self-evident that vent pipes from any tank which may contain substances which can form gases should not terminate in living spaces at any time. Hence any necessary lengthening pieces should be permanent.

Q.31 Has any general survey been undertaken upon HMA Naval vessels to determine if there are any vent pipes of the type described in 0628.3? If so, how many, and is it possible to make the alterations suggested?

123

Q.32 If such vent pipes cannot be extended, what alternative means can be adopted to ensure the safety of personnel in the enclosed area involved?

ATTACHMENT 3H - Chapter 6

Precautions against Accidents

Safety of Personnel

Section 1 - Precautions

Remark:

(26) This document runs from Section 0601 to 0638 with many sub-paragraphs. Although included in the Department's Response relating to fire precautions, it is in fact a general document embracing amongst other things:

Prevention of Accidents, Hydraulic Hoses, Deep Fryers, Oxy/Propane Cutting Gear, Waste Polystyrene, Guards for Machinery and Grinding, Welding, Burning Acetylene, Fuelling Precautions, Thermometer Pockets,

2 (C.2)(b) Part II (cont.)

Remark:

(26)(cont.)

Gas Turbine Modules, Ventilation, Opening Unventilated Spaces, Gas Free Certificates, Tests for Flammable Gas/ Foul Air, Precautions When Using Breathing Apparatus, Asbestos Precautions, Dust Respirators, Medical Registers, X Rays, Synthetic Fibres and Dangers of Burning, Care of Hearing, Lead Paints, Inhalation of Smoke, Falls and Radiography.

Chapter 6 appears to be part of a Manual possibly a Training Manual and for example strict adherence to para 0601 could have prevented the accident aboard 'Stalwart'.

The date of origin of this Document does not appear.

124

Q.33 Of which volume does Attachment 3H form part and when was it issued?

Q.34 To what extent is the volume available down the Service command structure? Who has total access to the contents?

Q.35 To what extent could the contents of Attachment 3H and the other parts of the total volume be expected to be general knowledge in the Service?

Q.36 If the volume forms part of a training manual, to which Branches of the Service does it apply?

Q.37 Following the accidents on 'Tobruk' and 'Stalwart' has any attention been addressed to the possibility of extending the general awareness of the contents of Attachment 3H and similar accident preventative material?

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2 (C.2)(b) Part II (cont.)

Remark:

1b & 1c Firefighting - Precautions to be Observed

ATTACHMENT 3I,3J

The documents provide guidance for fire precautions aboard vessels when in commission, during repair/ refit and the varying responsibility of Service and Dockyard personnel.

(27) Circulars or instructions concerning the dangers of toxic gases are repetitive to a significant extent and all of fairly recent origin, say from 1981 onwards.

Comparable documentation concerning accident prevention and fire fighting, although they appear only to be selected extracts from Training Manuals, are approximately four times more voluminous and indicate a long standing careful and structured approach to the subject not present in the toxic gas data.

Doubtless at least part of the reason for the difference is that fire has always been a major shipboard hazard and vast experience has been accumulated both in peace and war. The dangers of toxic gases on the other hand are mainly of recent origin stemming in no small measure from the implementation of IMO regulations.

In the above connection three of the most significant IMO regulations concern:

(a) Inert Gas Systems for Tankers,
(b) Sewage treatment, retention and disposal,
(c) Oily waste and garbage treatment, retention and disposal.

Implementation of these regulations has led to accidents, more particularly associated with gas equipment, although overall accident rates are falling and the safety and pollution prevention regulations have led to a great improvement in the marine environment.

1d Firefighting - ATTACHMENTS 3K,3L

3K reviewsHelicopter transfer operations at sea and actions in the event of accidents. It reviews BCF portable extinguishers and fire-fighting means generally including the organisation and structure of firefighting crews, systems for attacking and extinguishing fires are also addressed.

3L is concerned principally with nuclear, biological and chemical defence courses and training.

125

Remark:

(27)(cont.)

There is ample evidence to suggest that insofar as the Merchant Marine is concerned accidents could be attributed to:-

(i) Poor training,
(ii) Indifference to the new regulations,
(iii) Resentment of the additional workload.

It was noted that the implementation of IMO regulations possible contributed to the accidents on both 'Tobruk' and 'Stalwart', concerning the latter, the Board of Inquiry so indicated.

Whatever the precepts are concerning IMO, implementation of any of its recommendations requires the acceptance of at least 15 maritime nations who between them control a majority of the world's merchant shipping and in that sense it is democratic *and should* be supported. In turn, as indicated elsewhere in these notes, this calls for greater awareness and better training. It is possible that a much more concerted effort is necessary from the Defence Department to improve the level of their documentation and training for IMO related requirements to that which has been long established with respect to fire precautions.

Q.38 How are IMO related matters dealt with in the Department and particularly the Construction Branch related to the Navy? Have separate specialist sections been established or does it remain on an 'ad hoc' basis?

Q.39 Are there any plans to change existing arrangements, extend and improve training or carry out a wider sweep of available systems and equipment to ensure only the most suitable and reliable are retained?

Q.40 Are there any intentions to extend the training of personnel to increase awareness and improve safety?

3 SUMMARY

The above notes and questions should be related to and considered with Section C(2)(c) being briefing notes on the Toxic Gas Accident about 'Stalwart'.

Additionally the evidence and notes prepared following the previous accident aboard 'Tobruk' must be taken into consideration.

It is unfortunate but regrettably true that an evaluation of all the above evidence points towards the possibility that things which are not perceived to directly impinge upon the fighting qualities of vessels receive inadequate consideration.

The objective is laudable but sight should not be lost of the fact that a ship is first a ship before being a warship, a tanker or a passenger liner and if it does not provide the solid basic requirement of reliability and a comfortable environment, then its performance with respect to its designed function is likely to be impaired not least because it would undermine the basic morale of the crew.

It is with this in mind that these notes have been prepared and it is suggested that in addition to the summary of the 'Stalwart' accident, other needs for change may be:-

3.1 Board of Inquiry and/or Accident Evaluation Committee

Consideration to be given to widening the terms of reference to include the consideration of preventative measures independent from Service disciplinary considerations.

Alternatively to create a special Accident and Safety Evaluation Committee to assess BOI reports with a view to improving basic procedures and preventing recurrence and to co-ordinate the activities of the Hazard Survey and Inspection Teams on individual vessels to ensure central and comprehensive distribution of improved safety concepts.

3.2 Award

There may be merit in instituting an annual award for the most significant contribution to vessel safety and efficiency.

APPENDIX D

Department of Defence Response to Report

by Mr R J Parkinson, PAC Specialist Adviser,

on RAN Toxic Gases and Fire Fighting.

APPENDIX 2 TO CNE MINUTE 77/87
OF 27 JAN 87

ANSWERS AND COMMENTS ON THE QUESTIONS AND REMARKS MADE

BY THE CONSULTANT TO THE JOINT PARLIAMENTARY COMMITTEE

OF PUBLIC ACCOUNTS ON TOXIC GASES AND FIRE FIGHTING

13 AUGUST 1986

PREAMBLE - NOTES ON SHIP DESIGN STANDARDS EMPLOYED BY THE ROYAL AUSTRALIAN NAVY

The Royal Australian Navy operates a number of different classes of ships, the designs for which have originated in other countries and the design standards for which are the standards required by the original overseas customers. For example, HMAS TOBRUK is basically a UK design to Lloyds commercial standards, HMAS SUCCESS is basically a French design to Bureau Veritas standards, and the FFG Guided Missile Frigates are to US Navy standards.

Design changes can be costly. Generally, in the interests of preserving the co-ordinated integrity of the design and in order to minimise cost and cost risks, changes to the design standards in an adopted overseas design would not be introduced where it can be demonstrated that the original design has been executed to an acceptable and recognised standard appropriate to the future utilisation of the ship. Rather, changes to the original designs would more usually be contained to those required to meet the RAN's operational requirements and to meet requirements for construction and through-life support in Australia.

For ships designed and built in Australia, there is of course much greater scope for the incorporation of RAN requirements in the design. Those requirements may include specific RAN standards, commercial classification society rules, or foreign navy standards, as may be appropriate to the vessel being designed.

International, national and naval standards and regulations may change during the life of a ship. Where these changes occur, it is encumbent upon the RAN to consider whether the changes should lead to modification of existing ships, having due regard to the competing demand of other operational requirements for the limited funds available for the modification of ships, the down-time necessary for the incorporation of modifications and the remaining life of the ships concerned.

.../In the case of SOLAS and

In the case of SOLAS and IMO Regulations, it is not compulsory for warships to conform with these Regulations, but it is RAN policy to conform wherever practicable.

REMARK 1 (BURNING OF FUEL)

It may appear too obvious but the above does not include the fact that as Nitrogen comprises the main constituent of air (79%) it remains by far the greatest constituent in the exhaust and although it does not contribute to the combustion process, being inert, it is the main reason why exhaust gas will not support life and is primarily an asphyxiant which will kill.

COMMENT

This remark is noted and it is recognised that significant quantities of NOX gases are generated during the combustion of Fossil fuels. Navy experience has proved that incidents of significant quantitites of NOX gases escaping from exhaust ducts are rare.

REMARK 2 (EXHAUST GAS CONSTITUENTS)

In addition to the toxic gases referred to, the so-called "NOX" gases are generated. (These are the main gases subject to emission control regulations for automotive engines). They are oxides of nitrogen, as follows:

Nitric Oxide	NO
Nitrogen Oxide	NO2
Nitrogen Trioxide	NO3
Nitrogen Tetroxide	NO4
Nitrogen Pentoxide	N2O5

generically expressed as NOx - hence the name.

In tests carried out by the writer some years ago in connection with detecting and neutralising the corrosive constituents in Inert Gas Systems for Tankers, results showed that significant amount of NOx could be produced.

Indications were that as combustion temperature increased, greater quantities of NOx resulted. High combustion temperature is associated with high quality fuel having low sulphur content.

.../Fuel containing large

Fuel containing large sulphur content has a lower combustion temperature (sulphur is a low quality fuel) and much less NOX is produced but commensurately a larger quantity of sulphur dioxide (SO2).

Thus as one contaminant is reduced, the other tends to increase and vice-versa. SO2 contents in exhaust gas of 1500 ppm were noted. NOX content detected was up to 750 ppm.

Reference to Appendix B indicate that Threshhold Limit Values (TLV) are low but because of their relatively low solubility in water, their warning power is low and dangerous amounts can be absorbed into the system before any real discomfort is experienced. Thereafter although the immediate symptons may clear up on breathing fresh air, death may occur from 6 to 24 hours later, or pneumonia may develop.

The concentrations noted in the Exhaust Gas tests far exceed (TLV) acceptable limits and it should be recognised that it is inherently dangerous to attempt repairs to leaking exhaust gas uptakes with machinery/boilers in operation. It is understood that several otherwise inexplicable deaths amongst engine room crews of Scandinavian vessels in the 1960s were attributed to the mechanism described above. It is suggested this omission be rectified.

COMMENT

The generation of SO2 (Sulphur dioxide) has been observed by the Royal Navy circa 1976, who found that low sulphur content distillate fuels generate no less gaseous sulphur oxides than sulphur containing fuels such as FFO.

The substance of the precautionary advice suggested by the consultant will be amplified in Navy Instructions.

QUESTION 1

How frequently are exhaust systems checked for leakage in HMA vessels due to both wastage and leakage at joints and provisions for expansion due to the large temperature changes which must be accommodated?

.../ANSWER

ANSWER

The main potential source/cause of gas leaks from the exhaust system into funnel casing and machinery compartments are as follows:

- Short Term
  - Expansion Joints
  - Expansion Glands
  - Pressure Tappings
  - Drain Connections
  - Flanged Joints
- Long Term
  - Corrosion
  - Fatigue
  - Cracking

To minimise the risk of failure from the above sources, extreme care is taken during the design stage to ensure that compatible materials are used.

The expansion pieces are selected to satisfy the design requirements with regard to temperature and vibration/pulsation.

As a generality, running machinery including boilers, diesels and gas turbine is inspected hourly by Watchkeepers, every four hours by the Marine Engineer Officer of the Watch and daily by the Marine Engineer Officer or his Deputy. These examinations would include routine examination of accessible exhaust systems, more formal examinations are prescribed in various planned maintenance schedules with, in some cases most detailed emphasis on periodic tests to assess integrity/leakage. Typical preventive maintenance schedules relating to exhausts and uptakes are detailed below. Ship main propulsion boilers are examined:

a. Weekly - externally for evidence of leaks, cracks, corrosion, sliding feet lubrication.

b. Monthly - sliding feet movement.

c. 4½ Monthly for:

   1. Casing uptake and uptake drainage condition.

   2. Support and Stay condition.

d. 9 Monthly, which includes inter alia repitition of 4½ monthly items.

e. 18 Monthly - inspection of inner and outer funnels.

.../f. Three - Four

f. Three - Four Yearly:

   1. Dockyard survey of air casings.

   2. Conduct of air and gas casing leakage tests if preliminary tests so indicate need.

   3. Structure and pressure part durability examinations.

   4. Dockyard survey of outer funnel and deck plating between inner and outer funnel.

Boiler Funnels/Uptakes for Auxiliary Boilers are examined at the following intervals:

a. Monthly:

   1. Rain catchments, drainage, and drain soot filters.

   2. Uptake Shutters (where fitted) for freedom of movement and functioning.

b. 4½ Monthly - Condition of expansion gland, and gland cover plates where fitted.

c. 2500 Hourly - In conjunction with uptake clean, and subsequent oiling down on completion, examination of funnel for corrosion and security of internal fittings.

d. 18 Monthly - Examination and check of uptake expansion joint freedom.

e. 3-4 Yearly - Survey of uptakes.

PFG Gas Turbine exhaust ducts and baffles are examined 6 monthly and are also examined more frequently in the course of other gas turbine module examinations which include quarterly inspections of module interiors, and ducts.

For Diesel Engines, the following exhaust/funnel examinations are required:

a. Daily - Silencer drainage.

b. Weeky - Funnel drains and bottom section of funnel, exhaust manifolds, drainage clear.

c. 4½ Monthly - Clean funnel, check funnel drains clear.

d. 18 Months:

.../1. Exhaust flexibles for

1. Exhaust flexibles for cracks.

2. Take down, clean (certain) exhaust pipes, drains.

3. Generators, exhaust pipes for deterioration.

e. 3-4 Yearly - Scrubber clean.
3-4 Yearly/during engine change/overhaul, clean exhaust system, examine for wear and cracking.

QUESTION 2

Regulations exist concerning working on funnels when the machinery is in operation but does that include working on the exhaust trunking system generally?

ANSWER

Generally no, and it is intended to clarify Navy instructions to emphasise this hazard.

QUESTION 3

What provision is made to ensure, so far as this is possible, that in the event of exhaust ducting leakage air will leak into the casing and not exhaust gas leak out into the engine room space (for example by maintaining boiler room pressures higher than those inside the uptakes)?

ANSWER

RAN ships are 'closed front' (open stokehold) in which combustion air from fans/blowers is trunked to the boiler air casings and thence to the furnaces, and the exhaust trunking (funnel) and boiler casing are recognised potential sources of gas leakage.

It is often impractical to pressurise the machinery spaces with the present ship compartment configuration. It is normal practice to subject the machy spaces to operate under a slight depression (created by the exhaust ventilation system) to allow air to enter the compartment and avoid heat transfer to other compartments.

.../QUESTION 4

QUESTION 4

In the event that provisions suggested in Q.3 are impractical, what consideration has been given to improving positive air supply by ventilation to areas of greater risk, above boilers and restricted spaces in way of uptakes?

ANSWER

The machinery space ventilation design in RAN warships provides for the introduction of fresh air at a low level in each space and for exhaust at or near the deckhead. The capacities of the supply and exhaust fans are arranged so that there is a positive air flow from the space. This arrangement ensures the best habitability conditions and that any uptake/exhaust gas leakage is removed quickly.

The supply and exhaust ventilation systems currently fitted in HMA ships are considered adequate, and presently there are no known significant proposals to improve/change them.

QUESTION 5

Has specific training been directed to ensure that technical personnel at least are fully aware of the dangers of acid gases which can cause irreversible lung damage; such gases as NOX, Phosgene, Chlorine and Sulphur Dioxide?

ANSWER

All new entry personnel before going to sea attend a Standard Nuclear, Biological and Chemical Defence and Damage Control (NBCD) Course during initial training. This course makes students aware of accidental gases e.g. toxic, exhaust, and acid gases, how to identify them and the associated problems with these gases.

The course subject areas are also covered with the NBCD Requalification Course prior to a sailor going to sea, and the Advanced NBCD Course for promotion to Petty Officer. The Advanced and Requalifying courses have additional instruction where the instructor builds an exercise scenario for the students.

The above can be summarised as:

.../All Personnel:

1. Exhaust flexibles for cracks.

2. Take down, clean (certain) exhaust pipes, drains.

3. Generators, exhaust pipes for deterioration.

e. 3-4 Yearly - Scrubber clean.
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The above can be summarised as:

.../All Personnel:

All Personnel:

1. Basic NBCD training prior to sea posting.

2. Basic first-aid training at entry.

3. Basic firefighting at entry.

4. Advanced first-aid for first-aid parties and coxswains.

5. Advanced first-aid prior to promotion to Petty Officer.

6. Refresher first-aid training before each promotion.

Medical Personnel:

1. Basic medical training.

2. Advanced clinical training before promotion to PO.

3. Clinical updating by formal Naval Health Circulars.

REMARK 3 (ENGINE EXHAUST)

The toxic gases referred to are generated and reference to Appendix A details their toxicity. Note that only sulphur dioxide is readily detectable by odour.

However a boiler exhaust gas can typically be expected to contain

Carbon Dioxide	14%
Carbon Monoxide	Trace
Sulphur Dioxide	0.2%
Oxygen	4.0%
Nitrogen	(Balance 81.8%)

Diesel Engine and Gas Turbine Exhausts:

Carbon Dioxide	5%
Carbon Monoxide	Trace
Sulphur Dioxide	0.1%
Oxygen	15.0%
Nitrogen	79.9%

(Constituents vary with the particular fuel analysis and air/fuel ratio).

.../Clearly the most

Clearly the most important asphyxiant is Nitrogen. It is suggested this fact be suitably emphasised.

COMMENT

The consultant's remarks are noted and are being considered. However the only significant problems with exhaust gases Have been associated with CO which may reach toxic levels insidiously. Problems were experienced in the past with FFO burning boilers and SO2. All ships will soon have the ccapability to measure O2 and CO levels.

QUESTION 6

To what extent is the chemistry of combustion included in basic training courses to ensure that the most Junior personnel are made aware from the outset of the dangers inherent in exhaust systems both with respect to asphyxiants and toxic gases?

ANSWER

All NBCD Courses cover toxic gases and asphyxiants under accidental gases. Whilst the chemical content is not taught the dangers and actions to be taken in the event of an accidental gasing are covered.

The New Intake First Aid Course contains subjects on asphyxiation - various types and their treatment, toxic gases, confined spaces procedures and cardiac arrest.

Accidental gases are also covered in Occupational Health and Safety lectures on Management courses.

Medical sailors are instructed that CO results from combustion of organic matter and that oxygen is consumed in the reaction. This is emphasised also in the basic firefighting course.

REMARK 4 (SMOKE INGESTION)

The above (ingestion of funnel smoke to other ship ventilation systems) is recognised and to an extent unavoidable. Whilst normally it is no more than a minor nuisance, there have been cases reported when it became

.../more serious (usually)

more serious (usually by self-contamination). Whereas merchant vessels do not normally operate "in company", Naval vessels do so frequently.

COMMENT

Not required, but see Question 7 below.

QUESTION 7

Is it the practice to carry out wind/smoke tunnel tests as an aid in determining any propensity for self or cross contamination of ventilation systems so facilitating modifications. (By products of combustion)

ANSWER

In recent years it has been the practice of the Naval Design Branch to conduct wind/smoke tunnel tests on funnel designs of new construction ships and those undergoing modernisation. The tests not only address the problem of ventilation contamination by combustion gas but where appropriate its effect on weapons and electronic systems.

Tests were conducted on the funnel design of the following ships:

HMAS COOK
HMAS TOBRUK (funnel height raised by 4.27m as result of test)
DEs (during modernisation)
FFGs (by US class design authority)
ATTACK CLASS (tests conducted and funnels modified after ships entered service as a result of exhaust gas problems)

Exceptions to this practice are FREMANTLE class patrol boats and the minehunter catamaran *HMAS RUSHCUTTER*. Both of these classes have water injected exhaust systems which in the FREMANTLE class exit below the waterline and in RUSHCUTTER above waterline between the hulls.

It is not known if the funnels of the "DURANCE" class of replenishment ships, of which HMAS SUCCESS is a copy, were tested by the French designers, however exhaust gas problems have not been reported.

.../Contamination of a ships

Contamination of a ships ventilation system by exhaust gases of another when in close company is at times unavoidable. It is not a significant problem and is not considered when conducting smoke/wind tunnel tests of funnels.

REMARK 5 (SEWAGE TREATMENT SYSTEMS)

The above preference is understandable in that because of the small retention time the equipment is compact with a very high throughput capacity, both desirable, indeed possibly essential, on Naval vessels.

What is not emphasised is whether the preference has been maintained and strengthened by operational results.

The following should be considered:

The Omnipure, Electrocatalytic System is a superficially impressive name, but it does not use a catalyst in the true sense of the word. A catalyst is a material which promotes and speeds up a chemical reaction, whilst itself remaining unchanged. On that criterion there is no catalytic action; it is rather better described as an accelerated process.

In fact the system is a macerator/chlorination system, the chemical oxidation and purification of the waste resulting from the electrolytic generation of Sodium Hypochlorite from the reaction of sea water in an electric cell (see later description of differing types of installation).

It is reminiscent of a system used some years ago which utilised such a cell to chlorinate the water at the inlet to ships' sea water circulating/cooling systems, the purpose being to prevent fouling by barnacles and marine growth. In that case the chlorine was used as a biocide. The system worked but suffered two problems:

a. frequent electric cell failure; and

b. corrosion, particularly in way of differential metals.

Doubtless with time both deficiencies have been reduced or possibly eliminated.

Details of an Omnipure System have been studied and attention is directed to the following:

.../a. Equipment operating

a. Equipment operating towards its designed limits would tend to choke and/or block-up.

b. The fact that a back flush is necessary suggests it could become blocked and the plant rendered ineffective at high throughput.

c. The electric cell electrodes could be come blocked and/or burn out. It is understood that plant being designed for the Canadian Navy includes multiple electric cells which can be used progressively whilst defective units are cleaned, replaced and/or renewed.

d. Despite the fact that the solids would be comminuted and discharged in sterile condition, there would nevertheless be a tendency for the plant to accumulate sludge which would require blowing down from time to time.

e. Overchlorination of the effluent can occur with adverse effects on the ecology of the local marine environment which could progressively be serious in fisheries areas.

f. In fresh water, hydrogen and oxygen are evolved which provide an explosion hazard and it is understood some plants include a discharge fan. In fresh water conditions it is necessary to add salt to the unit to permit the generation of hypochlorite.

g. In the event of electric cell failure anaerobic conditions would quickly ensue together with all the concomitant undesirable phenomena.

h. Whilst the plant is regarded as well designed, unless considerably automated, it would potentially at least require considerable attention.

COMMENTS

The consultant states in remark number 5:

> "In fact the system is a macerator/chlorination system, the chemical oxidation and purification of the waste resulting from the electrolytic generation of Sodium Hypochlorite ..."

This is only partially true, because in addition, the presence of a current field in the effluent stream breaks down the molecules or organic material into smaller units enhancing the oxidation process.

.../The following comments are

The following comments are made in amplication of the sections a to h of the Consultant's remarks.

Comment 5. a.

Any piece of equipment operating towards its designed limits is likely to give trouble. If the Omnipure plant, as installed in RAN ships, receives an excessive hydraulic loading the high level alarm will sound and excess liquid will be diverted overboard via an overflow line. If an excess organic loading is received partial treatment of the sewage will take place with a reduction in effluent quality. Omnipure units fitted in RAN ships have been selected to ensure that they are not operating near their design limits.

Comment 5. b.

Backflushing is a preventative maintenance routine carried out daily. Its purpose is to remove any particles of organic material which cling to the cell electrodes and which would in time block the cell. It takes approximately 5 minutes to carry out this routine.

Comment 5. c.

Cell failure is a possibility as is failure of any of the mechanical components. Omnipure units being supplied to the USN have duplicate macerators and discharge pumps but one cell. It would be possible to duplicate all of these items however it would add enormously to the cost and complexity of the plant. In addition, RAN experience has shown that equipment which lies idle, even for a short time, in salt water or sewage systems deteriorates rapidly. RAN policy is to carry onboard spare sub assemblies such as macerators, air compressors and discharge pumps, complete with motors which can quickly be fitted in the event of failure of the unit on the plant. It should be noted that these items and others are standard throughout the range of Omnipure plants thereby simplifying spares support. If in the future operating experience indicates that a particular component is more prone to failure than others then duplication of that component will be considered.

Comment 5. d.

It is a design feature of the Omnipure plant that unoxidised particles of organic material settle in the bottom of V2 tank. These particles or sludge is returned daily, during the blow-down routine, to V1 tank for further treatment. This routine in conjunction with backflushing of the cell takes approximately 5 to 10 minutes

.../Comment 5. e.

Comment 5. e.

Chlorination is one of the most efficient means of disinfecting sewage or wastewater. It is widely used in both land based and marine sewage treatment plants. Accurate dosing with chlorine to suit the effluent strength is practiced in large land based plants but overchlorination is common on land base "package" plants and marine plants. Dechlorination is sometimes used where overchlorination will be harmful to receiving waters, however excess dechlorination can deplete the dissolved oxygen of the receiving water. Although in theory chlorine residuals of low concentrations may be toxic to fish and marine life, when it enters the receiving waters dilution and degradation takes place and in addition fish and other free swimming organisms avoid the area of irritation.

Comment 5. f.

The Omnipure plant requires salt water or brackish water with a minimum salt content of 1.5% by weight for successful operation. Small quantities of gas are generated in the cell, mainly carbon dioxide and hydrogen. These gases are drawn off either by an extractor fan or a compressed air driven air eductor. Both these gas extraction systems dilute the hydrogen with air to below the lower explosive level.

Comment 5. g.

In the event of cell failure an alarm will be activated and the plant shut down. Even with the cell unserviceable sewage in the plant can be macerated, pumped overboard and the tanks flushed with clean salt water to prevent the onset of anaerobic conditions.

Comment 5. h.

The plant is fully automated and requires approximately 10 minutes routine maintenance per day.

Consultant's Remark 5 (Continued)

Whilst the above is to an extent 'devil's advocacy', it is not intended to be and should not be regarded as with destructive intent. The simple facts are that with Sewage Treatment Plants there is no simple road to salvation. In particular selection and operation should in no way depend upon any understood inherent characteristics of the system but should rather depend upon:

a. Need and capacity.

.../b. Design, quality of

b. Design, quality of materials and reliability.

c. Ease of maintenance and amount of operational attention required.

d. Environmental acceptability.

Comment

Navy is well aware of the fact that there is no simple solution to sewage treatment. The RAN sewage treatment policy may be summarised as follows:

a. Every HMA ship, submarine or support craft having a crew of 6 or more shall have a self contained means of:

   1. discharging sewage to a shore connection;

   2. discharging sewage directly overboard when more than 12 nautical miles from land; and

   3. treating sewage so that the resulting effluent may be discharged into any waters at any time in accordance with IMO requirements.

b. The means of treating sewage shall not require the carriage onboard of hazardous substances for treatment of sewage or cleaning and disinfecting the plant under normal operating conditions.

c. If practicable the sewage treatment plants fitted throughout the Fleet shall be of one common type.

d. The installation of sewage systems to existing ships, submarines or support craft is subject to the availability of funds and wherever practicable this work should be carried out during normal refits or modernisations.

In addition to the above policy it is desirable if not essential that the plant is as light and compact as possible, does not retain or store large quantities of sewage or sludge, is simple to operate and maintain and is safe and reliable.

The electrochemical system of which Omnipure is the only known IMO approved plant, fulfils these requirements although a satisfactory standard of reliability is yet to be achieved. It is considered that the problems experienced thus far can be overcome and an acceptable level of reliability achieved.

.../REMARK 6

REMARK 6 (METHODS OF SEWAGE TREATMENT)

It is noted that under design and installation no specific reference has been identified from UK sources so far and the US sources relate specifically to "Collection, Holding and Transfer" (CHT) systems. This suggests that concerned personnel may suffer from a basic lack of understanding of the real function of sewage plants.

In the interim, to facilitate a basic understanding of the subject, basic systems are:

a. Anaerobic.

b. Sterilisation.

c. Macerator/Chlorination.

d. Macerator/Electochemical.

e. Aerobic-biological digestion.

a. Anaerobic Systems are generally unsatisfactory and potentially dangerous.

Note from Appendix E:

"Another and better known term for 'anaerobic decomposition' is 'putrefaction' and this perhaps spells out more emphatically the foul, highly offensive conditions which arise as a consequence of this change. Hydrogen Sulphide, ammonia, mercaptans, and eventually methane add their noxious odours to the blackening, bubbling water".

The above type of "System" was used during the war to convert animal sewage to methane as an alternative fuel for cars.

b. Sterilisation using chemical flocculents is an efficient process which greatly reduces the residual stored solids. However, it is generally considered suitable for only small installations such as patrol boats etc. This group includes the ELSAN System.

c. Macerator/Chlorinator Systems. The material is chopped into small comminuted pieces and purified by chlorination with Sodium or Calcium Hydrochlorite (or similar material). These systems are effective but may be unacceptable in some parts of the world due to the amount, and discolouration capability, of the discharged solids. Further the residual

.../chlorine content may

chlorine content may be sufficient to adversely affect the ecology of the receiving water by destroying the normal bacterial flora. This group includes CHT Systems.

d. Macerator Electrochemical Systems are similar in effect to group c above except that the chlorination is achieved by an electric cell which reacts with the salt content of sea water (Sodium Chloride) releasing chlorine at one electrode and Hydroxyl ions at the other. Because the electrodes are in close proximity hypochlorite results which effectively purifies the effluent. A big advantage of these systems is the short retention time and consequently a high capacity compared to equipment volume. Potentially at least these systems suffer from the same drawbacks associated with those in group c although careful design can doubtless be effective. This group includes the Omnipure system at present favoured by the RAN.

e. Aerobic System. This is the system normally found in land based sewage farms. It harnesses the aerobic digestion processes of nature to break down the material into clear effluent and a small volume of residual waste sludge, both of which are rendered inert by mild chlorination. Environmentally this is perhaps the most acceptable process but is once again subject to design and throughput considerations. The material total retention time is about 24 hours and for this reason plants occupy more space and are able to cope with less crew capacity than group d. They do however require the minimum of attention.

Appendices C, D and E are appended being literature immediately available on the subject from the Library of the Institution of Marine Engineers in London and are couched in fairly straightforward language. They may assist in enabling a paper to be produced to provide the general guidance at present considered to be lacking in the Department's response. Reading the appendices will indicate that they are far from recent.

Note also that Groups a, b and e are linked to possible final disposal of sludge using an incinerator.

.../Comment

Comment

Before the TOBRUK accident, other than in a few specialised areas, there was a general lack of understanding of sewage treatment methods and in particular a lack of appreciation of the dangers of holding sewage in an anaerobic condition. Since then the Navy has introduced a general sewage treatment course at HMAS CERBERUS which is attended by all naval personnel involved in operating or maintaining shipboard sewage systems. This will be supplemented shortly by a similar course at HMAS NIRIMBA which will cover the same ground but in addition provide detailed instruction on the operation and maintenance of the Omnipure equipment.

Sewage course instructors and key personnel at Fleet Headquarters, Fleet Maintenance Branch and Design Branch attend courses run by the Metropolitan Water Sewerage and Drainage Board of Sydney or the Department of Water Resources, Victoria.

Consultant's Remark

Methods available for the treatment and purification of sewage are the same irrespective of whether the installations are land or ship based, any difference is that of scale. It follows that a large amount of reference material must exist in Australia via Institutes of Public Health, Sanitation etc and an obvious source for preparing a fundamental guidance document would seem to be Australian Government Analytical Laboratory (South Australia) or the Engineering and Water Supply Department of South Australia (or equivalents in other States).

Comment

The first sentence above, oversimplifies the problem, scale is not the only difference, in fact there are many successful land based package plants which are little bigger than marine units. Environmental operating conditions such as ship motion, vibration, fluctuating loadings and salt water flushing of WC are probably more significant than size.

Many of the problems with existing sewage treatment systems can be traced to the attempt to adapt land base treatment principles to marine use. For example, biological plants require a reliable food supply for their "bugs". When a Naval ship returns to port up to 80% of the crew may be given leave and the bugs starve and die. In addition land based plants have staff whose only duty is to operate and maintain the plant whereas naval ships, especially with the current minimum manning policy, do not have the manpower resources to dedicate staff solely to the sewage system.

.../QUESTION 8

QUESTION 8

Can the Defence Department confirm that since the 'TOBRUK' accident all the sanitary/sewage systems on RAN vessels, including separate evaluation of the "standard provisions", i.e. those independent of any appended sewage treatment plant, have been thoroughly examined and proven satisfactory?

ANSWER

Subsequent to the TORBUK accident all sewage treatment and retention systems were reviewed by the Design or Fleet Maintenance Branch staff. Problem areas were identified and remedial action taken. Where unsafe conditions existed which could not be corrected in a reasonable timeframe plants were shut down and sewage diverted directly overboard. Rectification work is still in progress e.g. removal of holding tanks and installation of Omnipure on HMAS SUCCESS and recently completed on HMAS TOBRUK. All plants now in operation are considered to be safe provided they are operated in accordance with instructions and standing orders.

REMARK 8 (HEADS OF MINIMUM FLUSH DESIGN)

Toilet pans on TOBRUK were fitted with water/hygiene traps of reduced depth, the intent of which was to reduce the quantity of necessary flushing water. The desire to reduce the amount of flushing water on any CHT system is understandable but would have the incidental effect that the effluent was more concentrated and required a significantly higher (B.O.D.) Biological Oxygen Demand for its purification. Sewage systems on ships already tend to have effluents with higher B.O.D. than those found in land installations (see Appendix C pages 5 - 7). The effect of reduced liquid flow is to increase the purification load upon the sewage treatment plant, and at peak load periods, possibly to the point of overcoming its capacity for purification/sterilisation.

COMMENT

Although it was reported that the depth of the water seal traps on the WC pans of HMAS TOBRUK were of reduced depth this was not borne out by measurements taken after the

.../accident. Apart from

accident. Apart from WC pans which were obviously affected by inadequate soil pipe venting the depth of the seals varied from 40 to 60mm. The original toilet flushing valves were intended to provide a low flush of 3.5 litres. These have long since been replaced with valves which provide a nominal flush of 9 litres. However, in service, quantity tends to increase with valve wear.

QUESTION 9

Has this aspect of design been evaluated with the various equipment manufacturers involved?

ANSWER

Suppliers of sewage treatment equipment to the Navy are advised of the type of wastes to be treated and also the nominal quantity of water supplied by the flushing valves. It should also be noted that an additional measured quantity of salt water is supplied to the Omnipure plant at all times when it is in operation. This dilutes the influent and also ensures that the plant cycles at regular intervals during periods of low usage ensuring that sewage is not retained in the plant for more than 30-40 minutes.

QUESTION 10

How have selections been made? What is the basis for the present expressed preferences?

ANSWER

Prior to the installation of the Omnipure plant on HMAS FLINDERS in November 1983 the following sewage treatment systems had been installed in ships built in Australia for the Royal Australian Navy.

SHIP	SEWAGE SYSTEM
STALWART	Biological (extended aeration) 4 units fitted
TOBRUK	CHT - 2 holding tanks 6 collecting tanks
COOK	CHT - 1 holding tank 2 collecting tanks

.../PARRAMATTA

PARRAMATTA YARRA STUART	) Macerator/chlorinator 2 units per ship) each with small collecting tank)
FLINDERS	Solid separation, recirculated flush system

None of these units could be considered successful.

The biological system on STALWART required approximately two weeks to achieve full treatment from start up. Fluctuations in loading due to leave and weekends ashore caused starvation of the "bug" population in spite of artificial "feeding". The plant was large, heavy and maintenance intensive. The CHT systems of COOK and TOBRUK wee mechanically unreliable, required shore reception facilities and had insufficient storage capacity to allow the ships to operate within the Great Barrier Reef for a reasonable period of time.

It should be noted that, from the point of view of pollution control regulations, the outer edge of the Great Barrier Reef is considered to be "nearest land" and distances relating to discharges are measured from this line. RAN ships regularly transit and exercise within these waters consequently unless the ship has the capability of treating sewage to a standard which permits discharge within the reef it is faced with severe operational restrictions.

The macerator/chlorinator system fitted to the PARRAMATTA, YARRA and STUART experienced similar problems to the CHT system.

The plant fitted on FLINDERS, in which solids were separated from the influent and the liquid disinfected and used as the WC flushing medium, proved to be difficult to operate, unreliable and the flushing medium unsightly and malodorous.

In 1981 the unit was considered to be beyond economical repair and investigations were carried out to find a suitable replacement system.

Initially a solid separation unit made by MARLAND appeared to be suitable, however reports from the Royal Navy indicated that this unit was little better than the original equipment.

In 1982 details of the Ominipure system became known to the RAN. It appeared to offer the following significant advantages:

a. Compact, light weight for given capacity.

.../b. Quick start up and

b. Quick start up and shut down.

c. No additional chemicals required.

d. Flow through system.

e. Plant can self disinfect prior to shut down.

f. Few moving parts.

g. No shore facilities required.

h. Treated sewage can be discharged into harbour and inshore waters.

An Omnipure unit was installed in HMAS FLINDERS in November 83 on a trial basis.

QUESTION 11

How far do preferences result from recommendations from other sources, other Navies, Passenger Ships or Offshore Oil Rig Operators etc?

ANSWER

During the selection process advice was sought from USN and RN sources regarding their experience with sewage systems. The USN advised that having tested various types of treatment plant it had decided on the almost universal fitment of CHT systems. The inherent dangers of the CHT system together with the operational restrictions mentioned previously made this system unacceptable to the RAN. The RN had operated various types of treatment plant, with little success and in fact it was reported that they were considering converting the biological units fitted on HMAS INVINCIBLE, to holding tanks.

The answers to a questionnaire circulated throughout NATO Navies, regarding their pollution control equipment, was available to the RAN. This failed to provide any real guidance as to proven systems. A list of customers was provided by Omnipure and their opinions sought. Response was poor but where a reply was received it was in general favourable.

QUESTION 12

.../How far do those

How far do those preferences result from practical trials and if affirmative, the length of trials, methods used, loading imposed together with documented results?

ANSWER

An Omnipure plant was trialed onboard HMAS FLINDERS between December 83 and December 84. The plant was in operation whenever the ship was within 12 miles of nearest land. Loading was providing by the normal ships company. Results of the trial are documented.

REMARK 9 (ATTITUDES)

It must be emphasised that the above remarks do not refer particularly to any specific type or manufacturer but to all types and all manufacturers. In short, how widely and how deeply has the net been cast?

A final note on the subject is that merchant Navy experience has shown, and no doubt Naval experience may confirm, that all too frequently personnel regard IMO safety regulations as "Just another Imposition!"

"Don't they think we have enough to do!"

"We are really not interested in meddling with these new fangled contraptions!"

These attitudes will not change overnight and therefore it is important that personnel understand that increasingly ships are their own eco-system and crews have the same responsibility for their environmental well-being as everybody else. Training should therefore be thorough and repeated until acceptance of the new standards is automatic, total safety will not be achieved until this is brought about.

COMMENT

Whilst there is a degree of truth in paragraph 2 of the above, these attitudes are changing and ships companies do in general make every effort to comply with the spirit of the regulations.

QUESTION 13

.../Does present training

Does present training reflect the above concept?

ANSWER

Yes. HMA Ships with Sewage Treatment Plants or Collection holding and Transfer Systems carry out on-the-job training, which is complemented by a 2 day Sewage Systems Training Course at HMAS CERBERUS. All Engineering Junior Sailors are required to have a good working knowledge of operating and safety procedures of sewage plants as part of their shipborne training.

REMARK 10 (INCINERATORS)

There is no reference to such equipment in the Department's response to the Committee. Whilst there is at present no legislation to require an incinerator for disposal of shipboard waste, the implications of the IMO Annex IV - Regulations for the Prevention of Pollution by Sewage from *Ships and Annex 5 - Regulations for the Prevention of* Pollution by Garbage from Ships, is indicative of general attitudes and the probability that such measures will be promulgated and become mandatory sooner rather than later.

The advantages of incinerators have long been recognised in the Merchant Marine and Appendix C confirms such equipment has been under development in the UK at least since 1974 (and doubtless earlier). Incinerators have been increasingly installed on new ships since the mid 1970s and *now are almost standard equipment.*

Advantages are the convenient and total disposal of:

Food and Galley Wastes
General Shipboard Rubbish
Plastic Materials in reasonable quantities
Oily Sludge Wastes
Sewage Sludge Wastes

It is appreciated that space is frequently at a *premium* aboard Naval vessels but this could be balanced against an improvement in safety and the ability to dispose of debris, which may otherwise lead to detection in time of war.

ANSWER

Navy concur with this remark.

.../QUESTION 14

QUESTION 14

Does the Department have any plans to install incinerators on RAN vessels?

ANSWER

Pollution control equipment to deal with sewage, garbage and oily wastes is being installed progressively in RAN. The following extracts from project documentation shows *current status and proposed future developments.*

EXISTING POLLUTION CONTROL EQUIPMENT IN RAN SHIPS

SHIP OR CLASS	SEWAGE SYSTEM	GARBAGE EQUIPMENT	OILY WATER SEPARATOR
ADELAIDE	CHT	INCIN. & COMPACT .	YES
CANBERRA	CHT	DO DO	YES
SYDNEY	CHT	DO DO	YES
DARWIN	CHT	DO DO	YES
PERTH	NONE	NONE	NOT YET OPERATIONAL
HOBART	NONE	NONE	NOT YET OPERATIONAL
BRISBANE	NONE	NONE	NOT YET OPERATIONAL
SWAN	NONE	NONE	YES
TORRENS	NONE	NONE	YES
PARRAMATTA	MAC/ CHLOR	INCINERATOR	NONE
STUART	MAC/ CHLOR	INCINERATOR	TO BE FITTED 87 REFIT
DERWENT	NONE	INCINERATOR	TO BE FITTED 89 REFIT
FREMANTLE CLASS	CHT	NONE	YES
TOBRUK	OMNIPURE	INCINERATOR	YES
FLINDERS	OMNIPURE	NONE	YES
MORESBY	NONE	NONE	TO BE FITTED 89 REFIT
COOK	CHT	INCINERATOR	YES
JERVIS BAY	NONE	NONE	YES
STALWART	BIO-LOGICAL	NONE	YES
SUBMARINES	COLLECT-ING TANK	GARBAGE EJECTOR	NONE
SUCCESS	CHT	COMPACTOR	YES
MHC	OMNIPURE	NONE REQUIRED	NONE REQUIRED
WFL'S	NONE	NONE REQUIRED	YES

.../TAMAR CHT

TAMAR	CHT	NONE	NONE (WASTE OIL RETENTION TANK FITTED)
LCH'S	NONE	NONE	NONE

Note: Of the incinerators fitted only those on the FFGs ADELAIDE, CANBERRA SYDNEY and DARWIN are designed to burn waste oil.

PROPOSED FUTURE INSTALLATIONS OF POLLUTION CONTROL EQUIPMENT

SHIP	AVAILABILITY	EQUIPMENT
ADELAIDE	APR 88 MOD	O'PURE & OILY WASTE EQUIPMENT
CANBERRA	FEB 89 MOD	" " " " "
SYDNEY	SEP 90 REFIT	" " " " "
DARWIN	FEB 89 REFIT	" " " " "
PERTH	FEB 87 MOD	O'PURE & COMPACTOR
PERTH	FEB 91 ID	OILY WASTE EQUIPMENT
HOBART	SEP 88 MOD	O'PURE & COMPACTOR & OILY WASTE EQUIPMENT
BRISBANE	NOV 90 REFIT	O'PURE & COMPACTOR & OILY WASTE EQUIPMENT
SWAN	JAN 89 REFIT	O'PURE & INCINERATOR OR COMPACTOR & OILY WASTE EQUIP.
TORRENS	FEB 90 REFIT	AS FOR SWAN
DERWENT	SEP 89 REFIT	O'PURE & OILY WASTE EQUIPMENT
WARRNAMBOOL	MAR 87 REFIT	O'PURE & GARBAGE EQUIPMENT
WARRNAMBOOL	APR 90 REFIT	OILY WASTE EQUIPMENT
TOWNSVILLE	JUL 87 REFIT	O'PURE & GARBAGE EQUIPMENT
TOWNSVILLE	JUN 90 REFIT	OILY WASTE EQUIPMENT
WOLLONGONG	1986 REFIT	O'PURE & GARBAGE EQUIPMENT
WOLLONGONG	JUN 89 REFIT	OILY WASTE EQUIPMENT
WHYALLA	JAN 88 REFIT	O'PURE & GARBAGE EQUIPMENT & OILY WASTE EQUIPMENT
LAUNCESTON	AUG 88 REFIT	AS FOR WHYALLA
IPSWICH	SEP 88 REFIT	AS FOR WHYALLA
FREMANTLE	JAN 89 REFIT	AS FOR WHYALLA
BENDIGO	JUN 89 REFIT	AS FOR WHYALLA
GAWLER	OCT 89 REFIT	AS FOR WHYALLA
GERALDTON	DEC 89 REFIT	AS FOR WHYALLA
DUBBO	JAN 90 REFIT	AS FOR WHYALLA
GEELONG	MAY 87 REFIT	OILY WASTE EQUIPMENT
GLADSTONE	OCT 87 REFIT	O'PURE & GARBAGE EQUIPMENT
GLADTSONE	OCT 90 REFIT	OILY WASTE EQUIPMENT
BUNBURY	JAN 88 REFIT	O'PURE & GARBAGE EQUIPMENT & OILY WASTE EQUIPMENT
FLINDERS	MAR 89 REFIT	COMPACTOR & OILY WASTE EQUIP.

.../MORESBY AUG 89

MORESBY	AUG 89 REFIT	O'PURE & OILY WASTE EQUIPMENT
COOK	SEP 88 REFIT	O'PURE & OILY WASTE EQUIPMENT
JERVIS BAY	FEB 88 REFIT	O'PURE & INCINERATOR & OILY WASTE EQUIPMENT
STALWART	JUN 87 ID	OILY WASTE EQUIPMENT
STALWART	MAR 89 REFIT	O'PURE
TAMAR	OCT 89 REFIT	O'PURE
WARRIGAL	1990 REFIT	O'PURE
WALLABY	1989 REFIT	O'PURE
WOMBAT	1988 REFIT	O'PURE
WYULDA	1988 REFIT	O'PURE
BRUNEI	JUL 90 REFIT	O'PURE & OILY WASTE EQUIPMENT
BETANO	OCT 89 REFIT	O'PURE & OILY WASTE EQUIPMENT
LABUAN	FEB 91 REFIT	O'PURE & OILY WASTE EQUIPMENT

REMARK 11 (OILY WATER TREATMENT)

Paragraph 22 may be thought to refer to recent IMO regulations - this is not so. The writer originally went to sea in 1947 and even then vessels were fitted with oily water separators for bilge and/or ballast/oil tank contents. For many years many countries including Australian prohibited the discharge of oily bilge water into estuaries and harbours. There is nothing new about it. Regrettably there was a tendency to ignore or avoid the local regulations if possible and as enforcement was local and depended upon the vigilence of the harbour authorities, it was difficult, if not impossible, to identify a specific culprit in a busy harbour with the means then available. However, as tanker sizes increased in the 1960s, the extent of the problem became more stringent and tankers increasingly used the B.P. origined system of "Loading on Top" which eliminated slop discharge at sea from tankers. Admittedly cargo vesels tended to lag behind but as port regulations became more stringent, considerable improvements in the quality and usage of separating equipment has taken place, one aspect being the increasing installation of incinerators noted above.

COMMENT

No comment required.

QUESTION 15

Is it accepted that there is nothing new about Oil Separating Equipment and that there can be no real excuse for personnel being unfamiliar with its operation?

.../ANSWER

ANSWER

Not all RAN ships are fitted with oil separating equipment and this may have had a bearing on this matter.

It is noted that oily water separators have been available for ship installation for 20-30 years and that as more stringent limits on oil content of discharge water have been imposed, so the development of some units has reflected these tightening limits.

Navy believes that appropriate personnel are familiar with the operation of Oily Water Separators in their ship.

REMARK 12 (MIX OF OILY/AQUEOUS WASTE)

Apart from the ill advised admixture of aqueous and oily waste during the refit of 'STALWART', the possible unfamiliarity of personnel with the separator resulting in the waste being retained onboard for nearly a month after sailing was a factor in the accident. This is underlined by the fact that even when the contents of the sludge tank were discharged, they were not discharged through the separator.

It appears that general awareness of the dangerous propensitites of oily waste/aqueous effluent is only recent within the Department.

Notwithstanding awareness of the dangers of Hydrogen Sulphide, the accident also owed at least something to accepting a known bad practice, i.e. the mixing of oily and aqueous waste, even if only considered from a general pollution standpoint.

COMMENT

If the contents of the machinery space bilge are such that it cannot be pumped directly overboard (i.e. contravening regulations) then there is no alternative to pumping it to the settling or sludge tanks aft. The ships vacuum tank cleaning system also discharges into these tanks consequently the mixture of aqueous and oily wastes appears unavoidable.

Although a general awareness of the dangers of Oily Water/Aqueous effluents is recent within the Department, most Engineering personnel have been aware that open bilge

.../sullage degenerates.

sullage degenerates. The dangers of such mixtures have now been promulgated by the RAN and by the Australian Department of Transport.

QUESTION 16

What is the extent of the installation of oily water separators aboard RAN vessels; the extent and depth of training into the use of the equipment and has any revision taken place since the 'STALWART' Incident?

ANSWER (see also QUESTION 14)

Oily Water Separators are fitted in:

a. Fremantle Class Patrol Boats (15).

b. HMAS TOBRUK.

c. HMAS STALWART.

d. HMAS JERVIS BAY.

e. HMAS SWAN, TORRENS & DERWENT.

f. HMAS ADELAIDE, CANBERRA, SYDNEY & DARWIN.

g. HMAS COOK & FLINDERS.

h. WATER FUEL LIGHTERS (4).

i. HMAS SUCCESS.

j. HMAS PERTH.

When the equipment is fitted it is provided with an operational and maintenance handbook, and the intended operators participate in the set-to-work of the equipment.

Although the STALWART incident provided some impetus to the search for modern oil water separation equipment, the RAN was already investigating this subject.

The Project Directive for Pollution Control has been revised to include the provision, on a Fleet wide basis, of modern Oily Water Separation Equipment of the membrane type. This project is expected to be completed in the early 90s.

.../REMARK 13

REMARK 13

Documentation from the UK clearly places regulations concerning oil water separators back as far as 1957, but that from the US is less informative.

COMMENT

No comment required.

QUESTION 17

How widely was the information which was available disseminated and used, or due to lack of emphasis, had it slowly declined in awareness?

ANSWER

It is unclear as to what information is being referred to. If the question is related to UK regulations then these would be of no effect in Australia and would have no effect in HMA Ships and support craft.

If the question is related to distribution of maker's equipment manuals as provided to the then prevailing commercial standards, or Naval publications, then these are distributed to ships fitted with oily water separators, e.g. HODGE/VICTOR/CUB; SAREX.

Should the question be alluding to the need to emphasise the safety features of all machinery operation on a frequent periodic basis, the administrative effort and expenditure of resources would be prohibitive. However, where safety features are identified in machinery operations, these are included in the relevant technical supporting documentation for that machine. In addition basic technical courses provide personnel with a knowledge of many common occupational health hazards, and these are re-iterated during subsequent promotion courses, pre-joining training and in NBCD courses. Fleet post refit inspections also encompass an assessment of ships' ability to control these hazards.

REMARK 14 (AERATING WASTE OIL TANKS VIGOROUSLY)

Whilst the light fuel used in RAN vessels will probably have

.../a flash point of more than

a flash point of more than 65 degrees celsius, the above practice would probably be harmless enough. However, it is feasible that from time to time oily waste tanks may contain gasolene or Naphtha/Benzene from cleaning degreasing operations, in which case vigorous aeration could lead to the generation of static electricity at the oil/water interface causing spark discharge and resultant explosion and fire. It is suggested that increasing the aqueous content pH more than 8 would be safer and as effective. A useful reference in connection with the above is the International Chamber of Shipping Oil Companies International Marine Forum:

"INERT FLUE GAS SAFETY GUIDE"

Section 1.4.4. and 4.4.4. specifically.

The Oil Companies International Marine Forum:

"International Oil Tanker and Terminal Safety Guide"

Second Edition 1974

also contains useful data. However this is doubtless only one of many such available sources.

COMMENT

Copies of reference documents have been obtained to enable consideration to be given to this aspect.

Navy is not aware of any Naptha or Benzene type cleaning agents that are used in RAN ships. Although some low flashpoint materials are used in ships they are normally stowed in purpose built comaprtments or on the upper deck, and are used in very minute quantities.

QUESTION 18

Was the above considered when preparing paragraph 24?

ANSWER

No.

REMARK 15 (SOURCE OF SYSTEM/EQUIPMENT MANUFACTURERS)

.../With respect to sewage

With respect to sewage treatment plant, oily water separating, filtering and oil content measuring and monitoring equipment, the Marine Environment Protection Committee (MEPC) of IMO regularly publish lists of approved manufacturers throughout the world as these are made known by member Governments. The latest such list is MEPC/Circular 166 dated 12 March 1986, attached hereto as Appendix F, which may be useful in obtaining additional data from Manufacturers to add to the technical library of the Department.

COMMENT

Noted.

REMARK 16 (TRAINING WITH BREATHING APPARATUS)

One sailor, AB Oliver, lost his life in the 'STALWART' accident despite the fact that he was properly equipped with a self-contained air breathing apparatus when he entered the Stern Gland Compartment (SGC) to assist the others. It was speculated that:

a. He may have removed his own as "Buddy Aid" to his shipmates.

b. That his mask may have been knocked off by the obstruction of air trunk and 3 inch suction hose passing through the manhole.

c. That his mask may have been incorrectly adjusted and leaked from the perifery of the face piece.

All of the above could also be accounted for by lack of familiarity with the equipment and/or lack of sufficiently frequent and in depth training.

ANSWER

Noted.

QUESTION 19

With relation to all Naval personnel, what is the extent of training using the various types of breathing apparatus, the training time in hours, how often repeated, what tests

.../are applied to determine

are applied to determine competence? Does any training take place in smoke filled or tear gas saturated atmospheres (with the deliberate intent to discover improperly fitted masks) and/or does any training take place in concert with Municipal Firefighting Services who could be expected to be very knowledgeable concerning respirators and gases of various types?

ANSWER

All RAN personnel complete a 5 day Standard NBCD Course during initial entry. A module of this course is related to Breathing Apparatus (Self Contained Breathing Apparatus - (SCBA) and Open Circuit Compressed Air Breathing Apparatus - (OCCABA)). This instruction is about 3 - 3½ hours long and covers the operation, wearing and re-charging of both types of units.

All personnel negotiate the Smoke Tunnel and complete exercises whilst inside the tunnel. Breathing apparatus are also worn by personnel at the East Australian Fire Fighting Facility (EAAFFF) as a component of the Standard, Advanced and Requal NBCD Courses.

Before posting to sea personnel complete the NBCD Requal Course which is similar to the Standard NBCD Course.

The Advanced NBCD Course contains the same breathing apparatus content as the Standard NBCD Course.

Duty watch onboard ships exercise fires daily in harbour and the Standing Sea Fire Brigade exercises daily at sea. Smoke canisters are rarely used in harbour but are used frequently at sea to create effect.

Damage Control exercises are conducted periodically at sea where fires are fought.

In all fire exercises on ships, nominated personnel wear BA and lectures are given at these musters by senior sailors on the use of this equipment.

Naval Police presently train with civil fire fighting authorities as will the Fire Fighting Category personnel in the future.

Personnel are formally trained in the use of SCBA, DCBA and OCCABA at the EAAFFF, RAN NBCD School HMAS PENGUIN, NBCD School HMAS CERBERUS. The extent of training in any of the above BA units is dependent upon:

.../Ship type - fitted

Ship type - fitted equipment
Course type - Standard/Advanced/Refresher/Fire-fighter.
PJT/PWT - where dedicated firefighting crews (SSFB) and instructors are given specialised training.

In addition, onboard continuation training is regularly conducted (Daily Fire Exercises, Emergency Exercises, Briefs and Sea-going Exercises).

Formal training involves instruction in the use, donning and maintenance of the BA borne by the ship concerned, following theoretical training, the trainee, accompanied by an instructor must carry out a 'smoke-walk'. This involves negotiating a darkened chamber/passageway which has been filled with smoke (diesel fire) or CS (tear) Gas, and cluttered with a number of physical obstructions. During this smoke-walk, the trainee is wearing BA and carrying a hand-held firefighting applicance. At the EAAFFF, the trainee must locate and extinguish a pre-set fire and finally activate his reserve air by pulling the D-ring.

The above sequence is repeated until the instructor considers the trainee competent in the safe use of this equipment.

Testing of the face seal is carried out by shutting off the air supply momentarily to create a pressure differential. Once the mask is adjusted to suit the user, it is left in that configuration for the duration of the exercise. This enables the trainee to remove and replace the mask inside the smoke/gas filled chamber and effect a good seal without further adjustment. All evolutions are fully supervised at all times and the SAFEGUARD Rule applies.

With the introduction of OCCABA (positive pressure) BA into service, the requirement for a face seal check is less important than that required by SCBA (Negative pressure) - as used aboard STALWART.

Time taken in training differs from course to course but the following are indicative of an average group of trainees:

duration of a successful 'smoke-walk' is approximately 10 - 12 minutes;

dedicated Shipboard users and controllers spend a full working day at RAN NBCD School operating BA in a smoke environment; and

dedicated users also spend ½ a training day at EAAFFF (during PWT) operating and wearing BA.

.../No trainee is

No trainee is considered competent until he/she is confident and relaxed in the use of all Breathing Apparatus in which training has been given.

General training is undertaken by sailors and officers prior to initial sea positing and during regular refresher/PWT courses.

No liaison or training interface takes place between RAN units and civil firefighting Authorities, however, EAAFFF conduct practical firefighting training on behalf of Sydney Technical College (TAFE) during civilian maritime training courses.

It is worthy of note, however, that RAN BA is different in construction, and has a different concept of use than that of civilian fire brigades, therefore liaison between the schools and civilian users of BA is not considered appropriate.

REMARK 18 (NAVAL HEALTH CIRCULAR 40/85)

The above is a general circular containing useful information and guidance and directed to all Health Services personnel.

The document is not a directive nor does it appear to call for any specific action or response and as it post dates the 'STALWART' accident, it may be thought that additionally it should have called for a revision and/or intensifiation in training programmes.

COMMENT

NHCs have the status of a Directive issued by the Chief of Naval Staff.

QUESTION 20

Were other directives prepared following receipt of NHC 40/85 aimed at revising and/or intensification of training relating to hazards on HMA vessels?

ANSWER

A general message was sent to all ships and shore

.../establishments

establishments concerning confined spaces and unventilated compartment safety precautions. All Divisional Officers and Senior Sailors were directed to inform their Divisions of its contents and include the subject in future lecture periods.

REMARK 19 (VENT TERMINATIONS)

It would seem to be essential that air pipes should not terminate below decks from such tanks and/or equipment.

COMMENT

Concur.

The remark relates to holding tanks which contain bilge waters. It is normal practice to terminate the air escapes from such tank above the weather deck. It is thought that the Navy Office response which prompted the consultants remark may have been made in error.

The air escapes from some small waste oil storage tanks may terminate in machinery spaces and in view of current problems with toxic gases this practice should be reassessed.

REMARK 20

This appears to contain a typographical omission and the correct text can be derived from the previous circular, Technical 31 August 1983 (Appendix 3C), namely:

> "The Oxygen of the air in the tank is in contact with the untreated sewage which decomposes aerobically (using oxygen). Oxygen in the air in the tank freeboard can thus be depleted in this process".

COMMENT

Concur.

REMARK 21

.../The Circular

The Circular supplements NHC 40/85 dated 6 December 1985 and to an extent paragraph 12 supplies the earlier omission, namely a directive concerning education. Nevertheless the paragraph appears to delegate responsibility for the education to individual fleet units and in this sense can be said to lack emphasise indicative possibly of the order of priority.

COMMENT

The safety and welfare of each ship's company is ultimately the responsibility of the Captain of the ship. Safe working practices are the responsibility of each individual. It is up to the Captain to ensure that by appropriate delegation (i.e. to officers and senior sailors) that all individuals on the ship are aware of the hazards and safe practices.

QUESTION 21

There appears to be a case for incorporating the safety training referred to into the central instruction programme and requiring proof by examination of increasing competence with seniority. Is such action in progress or planned?

The above two Circulars post date the 'STALWART' accident.

ANSWER

It is a requirement for all technical engineering personnel to be familiar with the rules and regulations concerning confined spaces and unventilated compartments. The subject is covered by junior sailors in the task book, senior sailors by Fleet Technical Boards and officers for their Certificate of Competence and Charge Qualification. Current instructions are regarded as essential core knowledge which is examinable for promotion.

REMARK 22

The paragraph may have greater meaning if reworded as follows:

> "When sewage is aerated (i.e. has air blown through it) it decomposes aerobically and carbon dioxide CO_2

.../is given off (this gas

is given off (this gas is heavier than air and toxic in high concentrations, i.e. 10%). However, the formation of dangerous toxic gas such as hydrogen sulphide is inhibited (hydrogen sulphide is rapidly lethal in concentrations higher than 1 in 1000".

ANNEX A to DI(N) TECH 29-9 indicates:

	60 minute Safe exposure %	Max. 8 hour Exposure %
Chlorine	0.0004	0.0001
Hydrogen Sulphide	0.02 - 0.03	0.001

From APPENDIX G:

Chlorine	(0.00005 Dangerous for short exposure (0.001 May be fatal at brief exposure
Hydrogen Sulphide	0.0008/0.001 May be fatal in 30 mins.

The apparent difference in the concentrations of these gases with respect to tolerance and toxicity should be noted. It is desirable that standard nomenclature and uniformity of description be investigated and established as soon as possible.

(N.B. ANNEX A to NHC 40/85 Hydrogen Sulphide 1000 parts per million (= 0.001%) single breath causes immediate respiratory arrest and unconsciousness).

COMMENT

DI(N) TECH 29-2 has been revised and now agrees with NHC 40/85.

QUESTION 22

Are these apparent contradictions in dangerous concentrations of these gases being revised?

The above Circular post dated the 'TOBRUK' accident.

ANSWER

.../See comment above.

See comment above.

See also Remark 22.

REMARK 23 (BOARDS OF INQUIRY)

Circumstances requiring Boards of Inquiry and their terms of reference are clearly laid down. However, the document is silent with respect to any duty of the Board of Inquiry, having established causes, to address attention specifically to formulating recommendations for the avoidance of similar accidents in the future. It is recognised that the Fleet Comment and recommendations following the 'STALWART' accident (10 d) do require wide promulgation of the failure to promptly use the oily water separator, the general lack of knowledge that anaerobic activity in waste oil tanks can lead to dangerous gas accumulations and the inherent dangers of using a pump for two duties at the same time but these fall short of specifically addressing the task of trying to eliminate recurrence.

COMMENT

Noted, but see below.

QUESTION 23

Has consideration been given to the incorporation of such a post enquiry task into the BOI terms of reference?

ANSWER

The procedures and scope of BOI's are governed by the Defence (Inquiry) Regulations (Statutory Rules 1985 No 114) and *General Instructions*. The regulations provide that a BOI may be empowered to make recommendations to the appointing authority (regulation 25), and regulation 67 provides that a BOI shall continue in existence until the expiration of 2 months after it has completed its inquiry. A BOI has no executive power as such, rather it is the prime function of a BOI to ascertain the facts of a particular issue and if empowered, to make recommendations to the appointing authority. It is then a function of the apppointing authority to take whatever action is necessary

.../on the BOI

on the BOI recommendations. In cases involving major policy considerations or which otherwise have Navy wide implications, it will be necessary for such matters to be referred to Navy Office for staffing by the appropriate functional areas.

QUESTION 24

Has any thought been given for Boards to include a member who does not have a Service background (i.e. an Academic or Lawyer) whose thinking may be less likely to be subconsciously conditioned by Service procedure and discipline?

ANSWER

The constitution of BOI's is governed by D(I) R 26(1) which provides that "A Board of Inquiry shall be constituted by 2 or more persons who include at least one officer". It is therefore open to an appointing authority to include non-Service persons as members of a BOI. However, observing that a BOI is an inquisitorial fact finding tribunal, it would appear to be more logical to appoint expert Service officers who have an intimate knowledge of the matters relevant to the particular issue under investigation. In appropriate circumstances, however, consideration could be given to including a specialist to a Board; under D(I) R 51 the appointing authority may also appoint a legal practitioner to assist a Board of Inquiry.

QUESTION 25

As an alternative to the above, has consideration been given to the establishment of a permanent "Accident Evaluation Committee" with the task of identifying basic fundamental contributory causes, independent of any breaches of Service discipline, which may help to prevent or indeed eliminate the possibility of recurrence of accidents?

ANSWER

The RAN has a standing Occupational Health and Safety Committee which is responsible for ensuring that:

a. the RAN formulates policy in all areas of OH and S;

.../b. RAN policies are

b. RAN policies are consistent with recognised and acceptable standards; and

c. potential hazards are detected and appropriate preventive actions are taken.

The terms of reference for the OH and S Committee are set out in a Navy Instruction and provide for a comprehensive reporting system to the Director of Naval Safety for injuries sustained, or near misses following unsafe practices or equipment failure. Other relevant instructions cover Safety - Accident Prevention Policy and Safety - Ship's Safety Team.

QUESTION 26

Do all ships have Hazard Survey and Inspection Teams?

ANSWER

Yes. Hazard Survey and Inspection Teams (HSIT) are formed from personnel within the ships' company, normally under the guidance of the Executive Officer, who is President of the Committee which the members form.

This is covered by a Navy Instruction.

QUESTION 27

What is the composition of the team?

ANSWER

Minium of 3, maximum of 5 depending on complement.

The Chairman is normally the Executive Officer but in larger ships or Establishments, the task may be delegated to an officer of Lieutenant rank.

Personnel must be drawn from all branches to ensure unbiased outlook and overall safety coverage.

QUESTION 28

.../Was such a team active

Was such a team active prior to the accidents on 'TOBRUK' and 'STALWART'?

ANSWER

Yes.

QUESTION 29

What authority do the team enjoy, to whom do they make their reports and/or recommendations and does any provision exist for passing on recommendations without breaching service discipline in the event that corrective action cannot be taken promptly or is otherwise not acceptable to the Commander of any particular vessel?

ANSWER

It advises the Command and they report directly to the Commanding Officer. All personnel have the right to make representation to the Commanding Officer and the ships Administrative Authority should they identify a safety hazard.

QUESTION 30

Does any centralised Authority exist to collect and disseminate the findings of individual Hazard Survey Teams throughout the Service or perhaps function as Ombudsman in the event that recommendations of any Team were rejected?

ANSWER

The Directorate of Naval Safety (DONS) is the coordinating authority of the results and recommendations of Hazard and Safety committees.

QUESTION 31

Has any general survey been undertaken upon HMA Naval vessels to determine if there are any vent pipes of the

.../type described in

type described in 0628.3? If so, how many, and is it possible to make the alterations suggested?

ANSWER

A survey has been carried out and there were no vent pipes found terminating in living spaces.

QUESTION 32

If such vent pipes cannot be extended, what alternative means can be adopted to ensure the safety of personnel in the enclosed area involved?

ANSWER

Not applicable.

REMARK 26 (ABR 5225 MARINE ENGINEERING MANUAL)

This document runs from Section 0601 to 0638 with many sub paragraphs. Although included in the Department's Response relating to fire precautions, it is in fact a general document embracing amongst other things:

> Prevention of Accidents, Hydraulic Hoses, Deep Fryers, Oxy/Propane Cutting Gear, Waste Polystyrene, Guards for Machinery and Grinding, Welding, Burning Acetylene, Fuelling Precautions, Thermometer Pockets, Gas Turbine Modules, Ventilation, Opening Unventilated Spaces, Gas Free Certificates, Tests for Flammable Gas/Foul Air, Precautions when Using Breathing Apparatus, Asbestos Precautions, Dust Respirators, Medical Registers, X Rays, Synthetic Fibres and Dangers of Burning, Care of Hearing, Lead Paints, Inhalation of Smoke, Falls and Radiography.

Chapter 6 appears to be part of a Manual possibly a Training Manual and for example strict adherence to paragraph 0601 could have prevented the accident aboard 'STALWART'.

The date of origin of this Document does not appear.

COMMENT

.../Chapter 6 is

Chapter 6 referred to is Chapter 6 from ABR 5225 "RAN Marine Engineering Manual" issued under the authority of the Chief of Naval Staff. The regulations in ABR 5225 RAN Marine Engineering Manual govern the duties and responsibilities of officers and sailors borne for marine engineering duties in *HMA Ships and Establishments*. They are supplementary to Regulations and Instructions for the Royal Australian Navy.

QUESTION 33

Of which volume does Attachment 3H form part and when was it issued?

ANSWER

Chapter 6 to ABR 5225 was first published in October 1976, it was last amended in July 1983 (Change 6).

QUESTION 34

To what extent is the volume available down the Service command structure? Who has total access to the contents?

ANSWER

ABR 5225 is held by all HMA Ships, Establishments and Commands and forms part of an outfit of Naval Publications held by Commanding Officers and Heads of appropriate departments. In very small ships - e.g. Patrol Boats, one copy to be held onboard; in larger ships, e.g. HMAS SUCCESS four copies would be held. Training Establishments having a significant Marine Engineering training commitment have much larger holdings - e.g. HMAS CERBERUS 37 copies, HMAS NIRIMBA 80 copies. The book is available as an office "Loan" item from the Departmental Office in the ship concerned. Access to and a knowledge of various chapters is required to be demonstrated by candidates for the award of Watchkeeping Certificates, Certificates for promotion, and of Task Book completions. Specific reference is made to ABR 5225 as a study document in many of the syllabi outlines. The book is maintained as a single volume with unrestricted access to its total contents.

QUESTION 35

.../To what extent could

To what extent could the contents of Attachment 3H and the other parts of the total volume be expected to be general knowledge in the Service?

ANSWER

ABR 5225 is widely known within the Marine Engineering Branch of the RAN but is not so well known by other branches of the Service.

QUESTION 36

If the volume forms part of a training manual, to which Branches of the Service does it apply?

ANSWER

The volume does not form part of a training manual.

QUESTION 37

Following the accidents on 'TOBRUK' and STALWART' has any attention been addressed to the possibility of extending the general awareness of the contents of Attachment 3H and similar accident preventative material?

ANSWER

Yes. A letter to all Ships and Commands of December 1985 has amplified the dangers of toxic gases.

REMARK 27 (INSTRUCTIONS ON TOXIC GASES)

Circulars or instructions concerning the dangers of toxic gases are repetitive to a significant extent and all of fairly recent origin, say from 1981 onwards.

Comparable documentation concerning accident prevention and firefighting, although they appear only to be selected extract from Training Manuals, are approximately four times more voluminous and indicate a long standing careful and

.../structured approach to

structured approach to the subject not present in the toxic gas data.

Doubtless at least part of the reason for the difference is that fire has always been a major shipboard hazard and vast experience has been accumulated both in peace and war. The dangers of toxic gases on the other hand are mainly of recent origin stemming in no small measure from the implementation of IMO regulations.

In the above connection three of the most significant IMO regulations concern:

a. inert gas systems for tankers;

b. sewage treatment, retention and disposal; and

c. oily waste and garbage treatment, retention and disposal.

Implementation of these regulations has led to accidents, more particularly associated with gas equipment, although overall accident rates are falling and the safety and pollution prevention regulations have led to a great improvement in the marine environment.

There is ample evidence to suggest that insofar as the Merchant Marine is concerned accidents could be attributed to:

a. poor training;

b. indifference to the new regulations; and

c. resentment of the additional workload.

It was noted that the implementation of IMO regulations possibly contributed to the accidents on both 'TOBRUK' and 'STALWART', concerning the latter, the Board of Inquiry so indicated.

Whatever the precepts are concerning IMO, implementation of any of its recommendations requires the acceptance of at least 15 maritime nations who between them control a majority of the world's merchant shipping and in that sense it is democratic and should be supported. In turn, as indicated elsewhere in these notes, this calls for greater awareness and better training. It is possible that a much more concerted effort is necessary from the Defence Department to improve the level of their documentation and training for IMO related requirements to that which has been long established with respect to fire precautions.

.../COMMENT

COMMENT

The RAN has had a knowledge of toxic gases and taken precautions against such gases through the confined spaces regulations, for many decades. It is therefore untrue to say that all regulations regarding toxic gases are of fairly recent origin. The consultant's comment about the greater shipboard hazards are noted and generally accepted.

In implementing IMO regulations, it is agreed that there is potential risk in installing new equipment in ships, and particularly war ships. Every endeavour is made to reduce this potential for accident by the implementation of the Integrated Logistic Support concept of Project Management. Navy believes that as IMO regulations become more stringent and more widly accepted, it will continue to adopt measures to meet those requirements where ever possible.

QUESTION 38

How are IMO related matters dealt with in the Department and particularly the Construction Branch related to the Navy? Have separate specialist sections been established or does it remain on an 'ad hoc' basis?

ANSWER

With relation to IMO matters the Training Directorate responds to advice/direction given by the Functional Directorate who assess the requirement for training and detail what training is necessary for RAN personnel.

Navy maintains a specialist section of the Naval Design Branch which has responsibility for advising on and implementing International Standards and Regulations as they apply to RAN warships.

QUESTION 39

Are there any plans to change existing arrangements, extend and improve training or carry out a wider sweep of available systems and equipment to ensure only the most suitable and reliable are retained?

.../ANSWER

ANSWER

The Navy, and Departmental Procurement organisations continue to develop and refine procedures to ensure that Capital Equipment provides the best value and meet the Australian Navy requirements. These procedures are bound by Government Policies such as the open tendering system, either within Australia or on a world wide basis for major acquisitions. These systems are under continual review.

The matter is ongoing - Gas Detection Equipment, OCCABA and Emergency Life Support Respiratory Devices (ELSRDs) are all current equipment acquisition projects.

The Director of Naval Ship Design has recently become Project Director for pollution control in the RAN. Feedback of equipment performance is sought from ships companies. Market surveys will be conducted before new items of pollution control equipment are obtained.

QUESTION 40

Are there any intentions to extend the training of personnel to increase awareness and improve safety?

ANSWER

Both the training of personnel and the improvement of Safety in the RAN are subjects which are under continual review at all levels. Results of such reviews are approved and implemented as far as scarce resources allow.

All NBCD training courses now include a module on toxic gas incidents and rescue operation, (introduced as a result of the STALWART BOI).

Training of personnel has improved since the TOBRUK accident and additional training will be provided to cater for each new type of pollution control equipment installed. Provision for this training has been made in the scope of the relevant Project.

Board of Inquiry and/or Accident Evaluation Committee

Consideration to be given to widening the terms of reference to include the consideration of preventative

.../measures independent

measures independent from Service disciplinary considerations.

Alternatively to create a special Accident and Safety Evaluation Committee to assess BOI reports with a view to improving basic procedures and preventing recurrence and to co-ordinate the activities of the Hazard Survey and Inspection Teams on individual vessels to ensure central and comprehensive distribution of improved safety concepts.

Agreed. It is considered that the role of the investigative body in providing recommendations to prevent reoccurrence of an accident is absolutely vital. These recommendations should be considered independently of any possible disciplinary measures, and assessed in context with other BOI reports for central co-ordination and dissemination. See also Answers to Questions 25-30 inclusive.

There may be merit in instituting an annual award for the most significant contribution to vessel safety and efficiency.

Agreed. The concept of providing an annual award for Safety is tried and proven and is in fact already in existence in some areas of Naval Operations (ie, Flight Safety). Official recognition in the form of an award will increase competition and identify those units that have an aggressive and successful safety policy. For this reason the concept of a General Safety Award is supported, although it is considered that the award should be presented to the ship or unit that has displayed the best safety record for that year, rather than an award for one significant incident or contribution.