

**Ship-generated Marine Pollution in
Nine Ports in the Pacific – Identification and Prevention**

By

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**A Thesis Submitted in fulfillment of the Requirements
for the degree of Doctor of Philosophy in Development
Studies at the Pacific Institute of Advanced Studies in the
Development and Governance, Faculty of Arts and Law,
The University of the South Pacific, 2008**

TABLE OF CONTENTS

I.	Abstract	i - iii
II.	Acknowledgements	iv
III.	Table of Contents	v - x
IV.	List of Abbreviations and Acronyms	xi – xii
V.	List of Tables, Figures and Appendices	xiii - xvi
1.0	Introduction and Methodology	1 - 53
1.1	The Pacific Region	1
1.2	Historical Development of Shipping in the Region	12
1.3	Rationale and Framework	14
1.4	Methodology	20
1.4.1	Establishing the SMPI	21
1.4.1.1	Calculating the Sub-Indices	33
1.4.1.2	Data Gathering	33
1.4.2	Internal Factors	42
1.4.3	External Factors	46
1.5	Expected Results	47
2.0	Physical Features, Economies, Trade and Shipping - Overview of Pacific Island Countries and Territories (PICTS)	54 – 98
2.1	Physical Features	54
2.1.1	Introduction	54
2.1.2	Geological Formation and Structural Features	57
2.1.3	Islands	58

2.1.4	Ocean	61
2.1.5	Wind Systems	63
2.1.6	Climate	64
2.1.7	The Nine PICTs	65
2.2	Economies	76
2.3	Trade	83
2.3.1	Exports	85
2.3.2	Imports	87
2.4	Shipping	91
3.0	International Instruments and Measures for the Prevention of Ship-generated Marine Pollution (SMPI)	99 - 166
3.1	Introduction	99
3.1.1	The History of Safety at Sea	107
3.1.2	History of Oil Spills	110
3.1.3	History of Noxious Substances Spillage	112
3.1.4	IMO Conventions	113
3.2	International Conventions on Maritime Safety	115
3.2.1	International Convention for the safety of Life at Sea, 1974	115
3.2.2	Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972	122
3.2.3	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978	124
3.2.4	International Convention on Load Lines, 1966	126
3.2.5	International Convention for Safe Containers, 1972	127

3.3	International Convention for the Prevention of Marine Pollution	128
3.3.1	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related thereto (MARPOL 73/78)	130
3.3.2	International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (AFS)	144
3.3.3	International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC)	145
3.3.4	Oil Pollution Act of 1990 (OPA) of the United States	147
3.4	New International Conventions for Pollution Prevention	148
3.5	The United Nations Convention on the Law of the Sea, 1982 (UNCLOS)	150
3.6	Flag and Port State Control	152
3.6.1	Flag State Control	153
3.6.2	Port State Control	156
3.7	Classification Societies	159
4.0	Internal and External Factors in the Ship-generated Marine Pollution Index (SMPI)	167 - 257
4.1	Internal Factors	167
4.1.1	Ships	167
4.1.1.1	Vessel Types	169
4.1.1.2	Safety Issues	177
4.1.1.3	Marine Pollution Issues	191
4.1.1.4	Ship Registration	195
4.1.1.5	Security	200
4.1.1.6	Ships' Impacts on the Marine Environment	202
4.1.1.7	Summary of Ship Pollution risk Factor	212

4.1.2	Cargoes	213
4.1.3	Management of Ships	218
4.1.4	Security Issues	220
4.1.5	Anti-fouling Systems (AFS)	221
4.1.6	Summary of the Internal Pollution Risk Indicators	222
4.2	External Indicators	224
4.2.1	Meteorological Events	224
4.2.2	Accuracy of Navigation Charts	229
4.2.2.1	Classification of Hydrographic Surveys	231
4.2.2.2	Positioning	233
4.2.2.3	Depths	234
4.2.2.4	Data Attribution	236
4.2.2.5	Nautical Charts in the Nine PICTs	236
4.2.3	Coastal Sea routes and Port Passages	239
4.2.4	Skills of Port Workers	243
4.2.5	Port Infrastructures and Conditions	245
4.2.6	Regulatory Framework	246
4.2.7	Emergency Procedures and Equipment	250
4.2.8	Summary of the Nine External Pollution Risk Indicators	252
5.0	Analysis of Findings	258 - 295
5.1	Identifications Relating to the SMPI	258
5.2	The SMPI	259
5.2.1	Strengths and Weaknesses of the SMPI	261

5.3	Current Policies and Legal Framework	265
5.4	Trade and Shipping	270
5.4.1	Impacts of Shipping on Trade	271
5.4.1.1	Impact of Total Shipping on Total Cargo	271
5.4.1.2	Impact of Total Ships (excluding fishing vessels) on Total Cargo of Imports and Exports	273
5.5	Impacts of Pollution on the Marine Environment	276
5.6	Economic and Social Impacts	279
5.7	International Conventions and Regional Agreements	282
5.8	Recent Developments	286
5.8.1	Safety Conventions	286
5.8.2	Marine Pollution Prevention Conventions	289
5.9	Issues Identified	290
6.0	Summary, Conclusion and Recommendations	296 - 322
6.1	Review of Issues	296
6.1.1	Identification and Prevention	300
6.1.1.1	Internal Indicators	300
6.1.1.2	External indicators	301
6.1.2	Other Issues	301
6.1.2.1	Impacts of Pollution	301
6.1.2.2	Regulatory Framework	302
6.1.2.3	Security	303
6.1.2.4	Fishing Vessels	304

6.1.2.5 Nuclear Materials and Radio Active Wastes	305
6.2 Challenges in the Prevention of Marine Pollution	306
6.3 Conclusions	315
6.4 Recommendations	317
References	323 - 335
Appendix 1 Discussion of IMO conventions, their adoption, amending, ratification and implementation. Also covered are resolutions and non-binding instruments.	336 – 345
Appendix 2 Diagram of the Load Line Mark and the Plimsoll mark.	346
Appendix 3 Calculating the Navigation Safety Measure and harbour chartlets of the nine PICT ports.	347 - 356
Appendix 4 Status of international conventions in the nine PICTs.	357
Appendix 5 Calculation giving the approximate amount of fuel oil that ships carry onboard during their visits to the nine PICT ports.	358
Appendix 6 Proposal for the establishment of a regional maritime transport organisation in the Pacific.	359 - 368

ABSTRACT

This research identifies ship-generated marine pollution in ports of nine Pacific Islands Countries and Territories (PICTs) and related risks while a ship is visiting a port and the measures that could be put into place to prevent marine pollution from occurring. The ports are: Apra of Guam, Apia of Samoa, Honiara of the Solomon Islands, Majuro of the Marshall Islands, Nuku'alofa of Tonga, Pago Pago of American Samoa, Port Moresby of Papua New Guinea, Suva of Fiji, and Tarawa of Kiribati. Under the SPREP study (Marine Pollution Risk Assessment for the Pacific Islands Region) the author collected the basic data during country visits to the nine PICTs which was also used in the thesis but organised differently and presented from a different perspective to the study.

Chapter 1 provides a background to the topic, discussing an introduction to the Pacific region, historical development of shipping in the region, rationale and framework, methodology and the establishment of a ship-generated marine pollution index (SMPI) using risk assessment principles, to identify risks of marine pollution (as defined by GESAMP). Risk is defined as the likelihood of an event occurring and the consequence that would result. Likelihood can also be discussed as the threat multiplied by vulnerability. The latter part of this chapter discusses sources of information assessed and the five internal and seven external pollution risk indicators to the ship that are used to identify risks of marine pollution. Measures to prevent pollution of the marine environment will be based on the marine pollution risk indicators identified.

In Chapter 2, is the discussion of an introduction to the physical features of the Pacific region that include: geological background, formation of islands, the ocean, wind systems, climate, and a brief introduction to each PICT and each port. Discussed in the latter part of the chapter are the economies of each PICT, trade and shipping. The gross domestic products of each PICT are also discussed. Sea-borne trade in terms of tonnage

imported and exported by each PICT in order to determine the amount of cargo that may pollute the marine environment such as oil is also discussed. The number of ship calls to each PICT is investigated as the size and type of ships is important in the assessing of risks of pollution to the marine environment.

International instruments and measures for the prevention of ship-generated marine pollution is reviewed in Chapter 3, that also cover the history of safety of ships and oil spills at sea, and International Maritime Organisation (IMO) conventions. The provisions of IMO conventions dealing with safety, security and the prevention of marine pollution, and regional agreements under the auspices of the Secretariat of the Pacific Regional Environment Programme (SPREP), on the prevention of marine pollution are also discussed. PICTs that have adopted these IMO conventions and SPREP agreements are identified. The latter part discussed the United Nations Convention on the Law of the Sea (UNCLOS) and its impact on the prevention of marine pollution; the roles that flag States, port State control (PSC), and classification societies play in the safety and security of ships, and the prevention of marine pollution.

The SMPI, which use risk management principles, is the main tool for identifying ship-generated marine pollution. Chapter 4 investigates each of the 12 individual pollution risk indicators which are grouped into internal (five indicators) and external factors (seven indicators). Internal factors cover ships, the cargoes that ships carry, the management of the ships, security issues, and anti-fouling systems are discussed in some detail. Different types of ships, their construction, stability and other safety issues such as training and certification of seafarers, and the minimum number of crew onboard ships are discussed. Marine pollution issues are investigated and ships' impacts on the marine environment of each PICT port determined. Oil is the main cargo investigated as all nine PICTs kept complete and reliable records on oil imported and exported. Records kept in the nine PICTs regarding other dangerous cargoes have been found to be incomplete and unreliable. Cargoes imported to each PICT is then assessed for their potential to cause

marine pollution The management of ships is investigated and marine pollution risk scores for each PICT port is calculated. In the latter part of this chapter, external factors to the ship that comprised of seven pollution risk indicators, are also discussed in some detail and the marine pollution risk scores for each PICT port are calculated. The external factors are: meteorological events, accuracy of navigation charts, coastal sea routes and port passages, port infrastructures and conditions, regulatory framework, emergency procedures and equipment.

An Analysis of Findings is contained in Chapter 5 which established the SMPI from aggregating pollution risk scores of the 12 pollution risk indicators of each PICT port. Apra recorded the lowest total pollution risk score and was assigned a value of 1 and Tarawa recorded the highest with an index score of 2.36. The total pollution risk score of Apra was used as the base value of the SMPI and the total pollution risk score of each of the other eight PICT ports was divided by that of Apra to obtain each PICT port's index score. In the latter part of the chapter are the reviews of current policies, legal framework, trade and shipping, economic and social impacts, and the impacts of pollution on the marine environment. The chapter closes with the identification of issues that are critical to the well being of PICTs and the prevention of marine pollution.

A review of: issues identified in a regional and international perspective, the 12 pollution risk indicators, impacts of fishing vessels, ships carrying nuclear materials and radio active wastes is undertaken in Chapter 6. International and regional challenges in the prevention of marine pollution are investigated and discussed in some detail in the latter part of the chapter, followed with concluding remarks and 15 recommendations to assist PICTs in addressing the issues and challenges identified, and the prevention of marine pollution in the region.

ACKNOWLEDGEMENTS

I have benefited from the help of many people during the course of writing this thesis to which I owe special thanks to Doctor Mahendra Reddy, Acting Director of the Centre for Development Studies, Professor of Economics, and my thesis supervisor, University of the South Pacific, Suva, Fiji, for his advice and patience which were sources of strength that enabled me to successfully complete the thesis. Furthermore, Doctor Robin South, former Professor of Marine Studies, University of the South Pacific, Suva; Doctor Vijay Naidu, Professor and Head of the School of Social and Economic Development, University of the South Pacific; Doctor Peter Heathcote, Regional Maritime Legal Adviser, Secretariat of the Pacific Community, for their ideas and suggestions; the Australian Maritime Safety Authority, and the Government of the Kingdom of Tonga. Special thanks must also be given to my colleagues in the Marine Departments, Port Authorities and Departments of Environment of the nine Pacific Island Countries and Territories that provided port data, national trade statistics, economic data, environmental and shipping information when I visited those countries throughout the year 2000 under SPREP's Marine Pollution Risk Assessment for the Pacific Islands Region study. My special thanks are also extended to my colleagues Doctor Edward Anderson, Brad Judson and Batiri Thaman for their contributions to the above study.

I am particularly indebted to SPREP for the permission granted to me to use the data from the above SPREP study in my thesis. Furthermore, the scholarship that was awarded to me as a Ph.D student and the support that I have received from the Department of Environment, Tonga, during the writing of this thesis. I am also indebted to the University of the South Pacific for their deferment of my studies for the whole of the year 2003 as I requested, because of personal reasons. My special thanks go to Telusa Fotu and Popi Fotu who helped with the editing and final production of this document.

Finally, I wish to thank my family and friends for their advice and encouragement during the writing of this thesis. Without their strong support it would have been more difficult for me to complete this assignment.

LIST OF ABBREVIATIONS AND ACRONYMS

AFS '01	International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001
ASRM	Australian Standard Risk Management AS/NZ 4360:1999
BALLAST WATER	International Convention for the Control and Management of Ship's Ballast Water and Sediments
COLREGS '72	Convention on the International Regulations for Preventing Collisions at Sea, 1972
CSC '72	International Convention for Safe Containers, 1972
EEZ	Exclusive Economic Zone
GESAMP	United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution
IACS	International Association of Classification Societies
IHO	International Hydrographic Organisation
ILO	International Labour Organisation
IMDG Code	International Maritime Dangerous Goods Code
IMO	International Maritime Organisation
INF Code	International Code for the Safe Carriage of Packaged Irradiated Nuclear, Plutonium and High-Level Radioactive Wastes Onboard Ships
INTERCARGO	International Association of Dry Cargo Shipowners
INTERTANKO	International Association of Independent Tanker Owners
INTERVENTION	International Convention Relating to Intervention on the High Seas In Cases of Oil Pollution Casualties, 1969
ISF	International Shipping Federation
ISM	International Safety Management (Code)
ISO	International Organisation for Standardisation
ISPS Code	International Ship and Port Facility Security Code

ITF	International Transport Workers Federation
ITOPF	International Tanker Owners Pollution Federation
LC '72	London Convention (Dumping)
LL'66	International Convention on Load Lines, 1966
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973 (including Annexes I, II, III, IV & V)
MEPC	Marine Environmental Protection Committee
MSC	Maritime Safety Committee
OPA '90	Oil Pollution Act, 1990 (United States of America legislation)
OPRC '90	International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990
PICT	Pacific Island Country and Territory
PSC	Port State Control
Ro-ro	Roll-on/roll-off vessel where wheeled traffic is driven on/off
SMPI	Ship-generated Marine Pollution Index
SOLAS	International Convention for the Safety of Life at Sea, 1974
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
STCW'78	International Convention on Standards for Training, Certification and Watchkeeping for Seafarers, 1978
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environmental Programme
WTO	World Trade Organisation

LIST OF TABLES, FIGURES AND APPENDICES

TABLES

Table 1.0 - Contains information on land area, EEZ and population of selected PICTs	4
Table 1.1 – Vulnerability Scores for Internal Pollution Risk Indicators for The Nine PICT Ports	24
Table 1.2 – Harm to Living Resources in the Nine PICT Ports	25
Table 1.3 – Hazards to the Human Health in the Nine PICT Ports	26
Table 1.4 – Hindrance to Maritime Activities in the Nine PICT Ports	27
Table 1.5 – Impairment of Quality for use of sea water in the Nine PICT Ports	28
Table 1.6 – Reduction of Amenities in the Nine PICT Ports	29
Table 1.7 – Calculation of Consequences for the Nine PICT Ports	30
Table 1.8 – Summary of Defining Risk	31
Table 2.0 - Gross Domestic Products US\$ million	82
Table 2.1 - Selected PICTs’ Principal Export Destinations – 2000 (%)	86
Table 2.2 - Selected PICTs’ Principal Import Sources – 2000 (%)	88
Table 2.3 Cargoes Handled in Nine Selected PICTs	90
Table 2.4 - Selected PICTs – Ships’ calls per Year into Principal Ports 1998	94
Table 3.0 - Hydrocarbons Inputs into the Oceans due to Marine Transport Activities	102
Table 3.1 - Selected Oil Spillages into the Sea	111
Table 3.2 - Selected Spillage of Toxic Substances Other Than Oil	113
Table 4.0 - Classifying and Quantifying Oil Spills	203
Table 4.1- Pago Pago Ship pollution risk factor	204

Table 4.24– Summary of External Pollution Risk Indicators	252
Table 5.1 -Summary of Internal, External and Total Pollution Risk Indicators	258
Table 5.2 – Ship-generated Marine Pollution Index (SMPI)	260
Table 5.3 – If Security Issues pollution risk indicator is scored August 2004 in SMPI	263
Table 5.4 – Summary of Internal, External and Total Pollution Risk Indicators after taken into account the Security Issues pollution risk indicator in August 2004.	264
Table 5.5 – Comparisons of cargoes handled, value of the cargoes, and the number of ship calls into PICTs.	270
Table 5.6 – Relationship between Total Cargo and Total Vessels	271
Table 5.7 – Relationship between Total Cargo and Total Ships but excluding fishing vessels	274
Table 5.8 – Values of Imports and Exports vs. Population in Nine Selected PICTs	281

FIGURES

Map of the Region	xvi
Figure 1: Water Depths	235
Figure 2: Minimum Safe Design	242

APPENDICES

Appendix 1 – IMO Conventions	336
Appendix 2 – Load Line Mark	346
Appendix 3 – Calculating the Navigation Safety Measure	347
Appendix 4 – Status of international conventions in the nine PICTs	357
Appendix 5 – Fuel oil that ships carry	358
Appendix 6 – Proposal for the establishment of a regional maritime transport Organization	359

SHIP-GENERATED MARINE POLLUTION IN NINE PORTS IN THE PACIFIC - IDENTIFICATION AND PREVENTION

1.0 Introduction and Methodology

1.1 The Pacific Region

Oceans covered seventy percent of the earth's surface. They are now increasingly being recognised as the “common heritage of mankind” and over ninety percent of the world's trade is carried by ships plying the oceans (IMO:4). The oceans are vital for the well-being of the human race today in terms of source of food, mankind’s health and living standards in the context of the wide range of pollution threats, both natural and man-made, to which the earth’s ecosystem is now subjected. A large proportion of all polluting materials on land inevitably find its way to the sea, thus requiring strong commitment by every human being on this planet to keep the oceans clean and healthy.

The Pacific Ocean is vast and covers almost one third of the earth’s surface and is estimated to have an area of 166 million square kilometres. It contains more than half of the world's free water and it is substantially larger than the total land surface of the earth (Spiess, 2001:1). Furthermore, it is the largest and deepest of the four oceans of the world. The name 'Pacific' was given to this ocean in 1520 by Ferdinand Magellan, the

Portuguese navigator, which means peaceful in Latin (http://en.wikipedia.org/wiki/Pacific_Ocean). The Pacific Ocean is bounded in the north by the Bering Strait; on the east by the North and South American continents; on the south east it is generally recognised that the Drake Passage along longitude 68 degrees west separates it from the Atlantic Ocean and on the south by Antarctica (CIA. 2001 World Factbook). There is no official designation on the south west boundary that separates it from the Indian Ocean and on the west it is bounded by Asia, the Malay Archipelago, and Australia.

The area of the Pacific Ocean covered by this research extends from the Northern Mariana Islands to the north-west, through Micronesia and Papua New Guinea to New Caledonia and Tonga to the south, French Polynesia and Pitcairn Island to the east. This area is referred to in this research as “the region”. Irian Jaya (western half of New Guinea), Easter Island and the Hawaiian Islands are not included in the area of research. It is estimated that the size of this region is 30 million square kilometres ([www..spc.org/nc/AC/region.htm](http://www.spc.org/nc/AC/region.htm)), which is equivalent to the combined land areas of Canada, China and the United States of America. Only 551 400 square kilometres of this area is land, which is equal to 2 per cent of the region. This ocean is nearly 200 times more significant to the average Pacific islander¹ (footnotes are given at the end of the chapter) than it is to the average global citizen (Adams et al 1995), in terms of its size in relation to the region’s population.

Excluding Papua New Guinea, the total population of the region is 2.8 million which would result in at least 11 square kilometres of ocean for each and every Pacific islander. Papua New Guinea has a population of 4.8 million equal to 63 per cent of the region's total population, and a land area of 462 243 square kilometres that is equal to 83 per cent of the region's total land mass. The Exclusive Economic Zone² (better known as EEZ) of Papua New Guinea is 3.12 million square kilometres. Solomon Islands is the next country in size to Papua New Guinea with a total land area of 28 370 square kilometres equal to 5 percent of the total land area, and a population of 447 900 equal to 5 per cent of the total population of the region (Secretariat of the Pacific Community's Oceania Population

2000 as in Table 1.0 with author's calculations based on it). It has an EEZ of 1.34 million square kilometres. Two thirds of the region has land areas of less than 500 square kilometres and at least three of them - Nauru, Tokelau and Tuvalu have less than 30 square kilometres. Their corresponding EEZs in square kilometres are 320 000 for Nauru, 290 000 for Tokelau and 900 000 for Tuvalu (Fairbairn 1993:3,6-7).

The region is dotted with islands of 22 nations and territories that spread over what is generally classed as the South Pacific Ocean and stretches across three distinct geographic groupings - Melanesia, Micronesia and Polynesia. From an ethnic point of view these three groupings cannot be neatly defined as Polynesians can be found as inhabitants in the Lau Group in Fiji and Tikopia Island in the Solomon Islands. There are at least 1000 languages (Connell, 1988:1) spoken in the region. Of the total land area of the region - Melanesia, comprising of Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu, has 98 per cent; Polynesia, comprising of American Samoa, Cook Islands, French Polynesia, Niue, Pitcairn Islands, Samoa, Tokelau, Tonga, Tuvalu and Wallis and Futuna, has 1.4 per cent; and Micronesia, comprising of the Federated States of Micronesia, Guam, Kiribati, Marshall Islands, Nauru, Northern Mariana Islands and Palau, has 0.6 per cent. Furthermore, Melanesia has 84 per cent, Polynesia 9 per cent and Micronesia 7 per cent of the total population (author's calculations based on Table 1.0). Fourteen island States³ and eight territories⁴ from these three distinct ethnic regions, with Australia, France, New Zealand and the United States of America make up the Samoa based South Pacific Regional Environment Programme, better known as SPREP. These 22 countries are also members of the Secretariat of the Pacific Community (SPC), which is headquartered in Noumea, New Caledonia. The Pacific island countries⁵ and territories of SPREP are described throughout as PICTs and where the word "region" is used, it has the same meaning as the PICTs.

Table 1.0 contains information on land area, EEZ and population of selected PICTs.

Country	SPC Population Estimates (2000)	SPC Land Area (sq.km)	SPC EEZ (Sea Area) (000 sq.km)
MELANESIA	6 475 900	539 712	8 170
Fiji	824 700	18 333	1 290
New Caledonia	212 700	18 576	1 740
Papua New Guinea	4 790 800	462 243	3 120
Solomon Islands	447 900	28 370	1 340
Vanuatu	199 800	12 190	680
MICRONESIA	516 100	3 214	10 603
Federated States of Micronesia	118 100	701	2 978
Guam	148 200	541	218
Kiribati	90 700	811	3 550
Marshall Islands	51 800	181	2 131
Nauru	11 500	21	320
Northern Mariana Islands	76 700	471	777
Palau	19 100	488	629
POLYNESIA	612 947	8 133	* 9 819
American Samoa	64 100	200	390
Cook Islands	18 700	237	1 830
French Polynesia	233 000	3 521	5 030
Niue	1 900	259	390
Pitcairn Islands	47	39	N.A.
Samoa	169 200	2 935	120

Tokelau	1 500	12	290
Tonga	100 200	649	700
Tuvalu	9 900	26	900
Wallis and Futuna	14 400	255	300
<i>TOTAL PICTs</i>	7 604 947	551 059	* 28 592

Source: SPC's Oceania Population 2000

Notes :

SPC means the Secretariat of the Pacific Community

* denotes that Pitcairn Islands not included

EEZ is Exclusive Economic Zone

N.A. means not available

Most of the Pacific islands are basically of volcanic origin with the larger countries such as Fiji, New Caledonia, Papua New Guinea and Solomon Islands having complex geological formations characterised with rich in mineral resources, relatively high mountains and deep valleys. These features present formidable barriers to transportation and communication between inhabitants of the land creating isolated pockets of communities developing their own cultures and languages (Papua New Guinea has over 700 languages spoken)⁶. Some of the countries such as the two Samoas and Rarotonga in the Cook Islands have similar features as the first category but are of much smaller land masses. Other countries are coral atolls such as the Marshall Islands, Tuvalu and Tokelau which are characterised with small low lying islands and atolls, and poor land based resources. Some of these countries are raised coral atolls such as Niue and Nauru (Fairbairn 1993:4).

Although most PICTs are disadvantaged in terms of geography and resource endowment on land, they still have relatively huge EEZs that are rich in fisheries resources and non-living resources such as deep sea nodules (cobalt and manganese) which are yet to be fully exploited. Furthermore, pristine seas in island settings together with white sandy beaches, the mild climate experienced in many Pacific countries, are now being actively developed and promoted as tourist attractions and destinations by PICTs. This is done

with the view to accumulate much needed foreign exchange earnings for development purposes and raising the standards of living of PICTs. Fiji⁷ and French Polynesia now lead the way in tourism promotion and the development of the industry in the region. In some countries like Samoa and Tonga, tourism is potentially a major revenue earner of foreign exchange but is being developed at a slower pace than Fiji and Tahiti.

The geographical dispersion of small islands within each country creates a lot of problems in administration⁸ and transportation, especially the distribution of health and welfare services and economic development. Sometimes the vast distances involved in countries such as Kiribati, which has 33 low lying atolls spread over a distance of about 3 200 kilometres from East to West, exacerbate these problems. Many PICTs experience similar problems as Kiribati except Nauru, Niue and Pitcairn which are single island countries although they are also isolated islands themselves.

At the same time, due to the vastness of the region, international trade routes between the Americas, Europe through Panama, and Asia, Japan, Australia and New Zealand, cross many of the PICTs' EEZs. All of these trade routes are being serviced by foreign owned shipping companies and many ships do not call into a port in the region but are in transit only. This creates potentially huge problems for small PICTs in preventing pollution from occurring, as these ships are permitted, under the 1982 United Nations Convention on the Law of the Sea (UNCLOS 1982), the right of innocent passage through their waters without the knowledge of these countries.

In 1994, crude oil trade from South East Asia to North America was 12.8 million tonnes, with about half transported in oil tankers of more than 150 000⁹ tonnes capacity and half on oil tankers less than 150 000 tonne capacity (Wijnolst et al 1997:27). Furthermore, in 1998 the Transpacific Asia to US trade recorded overall 6896 ships with over 5.2 million tonnes of cargo east bound and 6896 ships and over 3.3 million tonnes west bound (UNCTAD 1999 :55). Therefore, PICTs waters are more likely to be polluted because of

the huge number of ships and cargoes transiting the region. Detection of marine pollution in PICTs waters is quite difficult given the lack of resources in PICTs to monitor and enforce national legislation or international conventions dealing with the prevention of pollution matters, such as IMO's International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78). This can cause problems in determining the true extent of marine pollution in these waters.

The location of PICTs is of strategic importance to any world power as evidenced by some of the largest naval battles ever fought in the history of mankind, such as the Battle of the Coral Sea during World War II. These great sea battles also produced marine pollution¹⁰ mainly from bunker fuel oil onboard the ships sunk or severely damaged. After World War II and the emergence of the Cold War, many countries had hoped that the end of the Cold War would reduce the levels of possible conflict in the region, which was dominated by the US/Soviet dichotomy. But the formation of regional economic and military power blocks in the Asia/Pacific region, and the emergence of China as a world power after the collapse of the old Soviet Empire, created conditions for re-militarisation in the Pacific/Asia region (Ratuva et al 1993:108). This will increase the chances of the region being drawn unwillingly in any future conflict between these powers. In the event of a regional or global war occurring, the marine environment of the region will be adversely affected as ships will be used for offensive or defensive and supply purposes across the vast Pacific Ocean, so they become legitimate targets. Ships will be damaged or sunk releasing oil and other hazardous substances such as nuclear fuel from warships and submarines into waters of PICTs.

In terms of trade, world sea-borne trade for 1998 recorded its 13th consecutive annual increase of 2.2 per cent. Similarly, the world merchant fleet expanded by 1.6 per cent over 1997 (UNCTAD 1999: xi). In short, shipping patterns always follow trade patterns. Taking the above statistics into consideration together with the huge population of Asia (including China) and the Americas means that more ships will transit PICT waters in

future increasing the potential risk of pollution of the waters of the region. So far, since the early 1970s only one major oil spill has been recorded by the International Association of Independent Tanker Owners (INTERTANKO)¹¹ to have occurred in the region. An estimated 99 000 tonnes of oil was spilled from the oil tanker *Hawaiian Patriot* into the sea (IMO News No.1/1997:14) about 555 kilometres off Honolulu. There is an increasing probability that a major oil spill will occur in the Pacific Ocean in the foreseeable future as more ships are expected to transit the region, in the light of the persistent growth during the last decade of the world sea borne trade and the world merchant fleet.

The post Cold War emergence of market economies as the dominant force in world commerce aggressively promoted globalisation and open economic policies to be pursued by countries world – wide. These policies would facilitate global trade and economic growth. Powerful financial institutions such as the World Bank, the International Monetary Fund and developed countries like the United States, Japan and the European Union, strongly supported these policies and their implementation. The negotiations in the Uruguay Round of the General Agreement on Tariff and Trade (GATT Talks) in 1986 - 1994 and the establishment of the World Trade Organisation (WTO) on 1 January 1995, were basically implementation measures in terms of facilitating freer trade between countries in the pursuance of globalisation goals. Proponents of GATT and later WTO see these measures as part of a process that would result in the dismantling of the entire system of international preference as well as other trade distortions. During the last two decades, developed countries and global financial institutions have actively encouraged PICTs to adopt growth enhancing policies. These policies were to be formulated and implemented by all countries (such as focusing more on exporting of goods and services, increased efficiency and the removal of Government subsidies) which would result in higher per capita income for the citizenry of these countries. This growth led policies create wealth and trade between countries and in conjunction with the huge population masses in East Asia (including China) and the Americas (estimated to be over 3 billion) create markets that will also increase trade between them. Furthermore, trade between

other parts of the world to the Americas and Asia cross PICT waters. More world trade means more ships will transit the region.

The recent ascendancy in importance of tourism receipts¹² in most PICTs' economies are now widely recognised as being an encouraging trend. Tourism is being actively encouraged and promoted to replace manufacturing and traditional agricultural products such as copra and in some countries like Fiji, sugar. Underpinning tourism is the maintenance of the aesthetic and recreational values of the marine and coastal environment of these countries by preventing any form of pollution. Receipts from tourism pay for goods imported from overseas. The imported goods are transported to the PICTs in ships which by their inherent nature, through bunker oil and cargoes they carry, are potential polluters of the marine environment.

For centuries and even up to this day, most Pacific islanders' lives revolved around the ocean for food such as fish and other marine life and also for transportation purposes. The ocean therefore has a special place and meaning in most Pacific islanders' culture and psyche. Although there is great diversity in the region by geography, resource endowment, culture and languages, most Pacific islanders are more united by their affinity to the ocean than they are divided by their separate identities. It is therefore imperative that pollution of the Pacific Ocean be prevented by whatever means available.

This research will contribute to the determination of the sources of marine pollution by developing a ship-generated marine pollution risk index and the formulation of policy measures and action plans to prevent marine pollution occurring in the region. The UN's Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) defined pollution (marine) as "the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to maritime activities including fishing, impairment of quality for use of sea water and

reduction of amenities” (GESAMP71: 130) and this definition will be adopted in this thesis.

Internal and external factors to a ship are two sub-indices that have been identified by the researcher as showing risks individually to cause marine pollution, and when combined would establish the ship-generated marine pollution index. Internal factors comprise **five** pollution risk indicators. Firstly, ships trading in or transiting the region will be identified, categorised, analysed to determine their probabilities to cause marine pollution, and is labeled as an indicator. An indicator is defined here as any variable posing a risk to cause pollution to the marine environment. International conventions dealing with the construction and safe operations of ships, and the prevention of pollution of the marine environment will also be discussed.

The second pollution risk indicator is the cargoes that the ships carry during their transiting or trading in the region. These cargoes will be categorised and analysed with the view of determining their potential to pollute the marine environment. The regulatory framework appropriate to these two indicators will also be identified and discussed.

Thirdly, the decisions by head office and its management of ships in terms of commitment to performing quality and safe operations at all times, and the quality of the shore staff at head office will be reviewed. It is quite difficult to access actual data concerning the last factor but it is possible to estimate and suggest some facts with regards to the country where the head office is located that may have some bearing on this matter. It is possible to hypothesize that a company in New Zealand is more likely to have a better quality staff than a company in Tonga, for example, due to various reasons. One reason being that companies in New Zealand have accepted and have implemented successfully the concept of providing a quality service or product for some years now, whereas Tongan companies have not. This pollution risk indicator is increasingly becoming important today as decisions by shore management greatly affect how a ship is being operated and maintained, whether their management practices are in accordance with international safety standards and industry wide generally accepted practices.

The fourth pollution risk indicator cover security of ships and ports as required by the ISPS Code under the Safety of Life at Sea Convention (SOLAS). Both ports and ships are required to have each security plans that are approved by the maritime administration of the country that the port is located, and the Flag State of the ship, respectively.

The last pollution risk indicator deals with the use of anti-fouling systems (paints) in ships as required under the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS) 2001.

External factors will also be examined to identify the pollution risk indicators that can affect and compromise the normal activities of a ship and will result in the polluting of the marine environment of PICTs. These pollution risk indicators include:

- meteorological events;
- accuracy of navigation charts;
- sea routes and coastal passages;
- skills of port workers;
- how safe are the port infrastructures;
- good regulatory framework;
- sound emergency procedures with appropriate equipment;

The pollution risk indicators will be analysed to identify and establish the risks that ships can cause to the marine environment in each PICT. Risk in accordance with the Australian Standard-Risk Management AS/NZ 4360:1999, is defined as the chance of something happening that will have an impact upon objectives. Basically, in terms of cost, it is a product of the probability of an accident occurring and the consequences of such accident (Boisson 1999:31).

A Ship - generated Marine Pollution Index (SMPI)¹³ will be developed to provide a relatively quick and inexpensive way of characterising the risks to each PICT when ships

call, using these indicators. The nine countries out of the potential twenty two PICTs used for the research may not be sufficient to provide a fully operational SMPI for PICTs. As for all summarising methods and modeling data, further testing and refinement of the SMPI may be required.

After having established the SMPI, prevention policies and measures will be formulated for each PICT to address any ship - generated marine pollution issue identified, then examined and consolidated to produce a general set of prevention guidelines that cover the PICTs used in the research.

1.2 Historical Development of Shipping in the Region

Historically shipping has played a critical role in PICTs in terms of transportation between islands in each country or between two countries for trading purposes, fishing, wars and exploration. PICTs have an impressive maritime heritage, as islands in the region were first populated by what are arguably the greatest mariners, the nationals of each country, in human history. Pacific islanders in canoes¹⁴ propelled by oars and sails migrated from South East Asia or from South America, centuries before the first contact with Europeans. The canoes were constructed using hollowed logs held together by ropes made from bark of trees or coconut fibre and probably using mats as sails. They navigated across thousands of kilometres of open seas basically using the stars and their intimate knowledge of the sea, wind (SPREP's PACPOL 1999:2) and currents as they settled throughout the region.

Europeans visited the region in their much bigger boats made of timber and propelled by sail since the 17th Century and up to the end of the 19th Century. Distinguished seafarers and explorers such as Tasman, Magellan, La Perouse and Cook made very valuable contributions in charting the waters of the region and paving the way for Europeans to

settle in PICTs and start trading with other parts of the world. In the late 19th Century steamers with coal fired engines visited the region but the potential to cause marine pollution was still low as coal does not float and spread like oil when it is spilled into the sea. Towards the end of the 19th Century and the beginning of the 20th Century ships that were fitted with engines using oil as fuel called into the region's ports. Today, some ships have been built for a particular purpose such as an oil tanker, a container ship, a cruise liner; others for carrying two or more types of cargoes such as a general cargo ship, a chemical product carrier and passenger/roll on-roll off vessels. Some ships¹⁵ in the mid 20th Century, including surface warships and submarines, were fitted with engines using nuclear fuel as propulsion means and have transited the region as part of their routine operation.

Even today, all PICTs are relying more and more on shipping for transportation, fishing and trade. The only difference is that ships are becoming bigger and faster and driven by engines using hydrocarbon fuels (bunker oil) such as diesel and heavy oil, instead of sails and oars. All ships used for trade use oil as fuel; only a few warships and submarines use nuclear fuel. Only ships using oil as fuel will be discussed as information is usually available whereas information on naval vessels and their activities is very difficult to obtain. Unfortunately, hydrocarbon fuels do pollute the marine environment if intentionally or accidentally released from the ship into the sea. Oily waters contained in ships' bilges and intentionally discharged from their engine rooms represented over 40% of the total hydrocarbon pollution of the oceans in 1989, whereas accidentally released oil - such as from grounding on a reef resulting in the ship holed at the bottom hull plating, collisions etc, represented over 20% (Drewry Shipping Consultants 1999:2). This illustrates the need for effective oil transfer and waste oil management onboard ships.

In today's global economy, ships are used to transport from one country to another, raw materials and the finished products to the final consumer. Over 90 per cent of the world's trade is carried by ships (IMO p.4) and they call into ports to load and discharge their

cargoes. The world sea-borne trade is dominated by three types of cargo which are crude oil, iron ore and coal¹⁸ (Wijnolst 1997:16).

Ships trading today routinely carry from one country to another dangerous cargoes (including oil), as defined under IMO's International Maritime Dangerous Goods Code¹⁹ (known with the acronym IMDG Code), which are potential polluters of the marine environment. This is especially so in PICTs' ports, during loading or unloading operations, or in the event of a shipping casualty. Oil tankers pose very high risks in polluting the marine environment because of the enormous quantities of petroleum products (thousands of tons) they normally carry at sea and during loading/discharging operations while in port.

Today, ships are built of steel and propelled by engines using different types of hydro-carbon fuels. They can carry huge amount of cargo such as the Japanese built *Happy Giant*²⁰, an oil tanker with a cargo carrying capacity of 564,763 tonnes, which is the largest oil tanker and one of the biggest ships ever built.

Cargo ships of approximately 100 metres length trading between PICTs, may carry up to 400 tonnes of fuel oil in special tanks onboard at the bottom part of the ship¹⁶. Cruise liners visiting PICTs, such as, the *Crystal Harmony* and *Crystal Symphony*, carry 2 500 tonnes of bunker oil onboard¹⁷. If these special tanks are holed due to some reason, the hundreds tons of oil (bunker fuel oil as compared to a cargo of oil) onboard these ships will be spilled into the sea causing major marine pollution.

1.3 Rationale and Framework

It is estimated that less than 20 per cent of pollution²¹ of the marine environment comes from ships and their cargoes (SPREP's PACPOL 1999:iv) but the impact can be

disastrous such as the spillage of oil from oil tankers *Torrey Canyon* in 1967, the *Exxon Valdez* in 1989 and the *Erika* in 1999, to name a few. The socio-economic development of any country is linked to the issues of safe, secure shipping and clean oceans and no country can afford to neglect its maritime sector. As ships carry over 90% of the global trade, any breakdown in the movement of ships can cause delays and add on costs, economic loss and uncertainty in the import and export of goods to/from a country.

After the oil tanker *Torrey Canyon* 1967 disaster in the south west coast of England spilling approximately 120 000 tons of oil into the sea, maritime nations through IMO started to focus more on the prevention of marine pollution issues. As this was the first major oil spill it drew a lot of publicity and interest worldwide in both the media and the public alike that resulted in the preparation by IMO and the adoption of the Marpol 73/78 Convention. This convention is an ambitious attempt to deal with not only oil pollution but pollution from chemicals, harmful substances carried in packaged form, sewage and garbage. The Convention also contained regulations relating to different types of ship-generated pollution and is provided for in six technical annexes²².

In 1969, following the *Torrey Canyon* disaster, maritime nations, through the IMO, prepared, agreed to and adopted an international convention - The International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969 (The Intervention Convention). This Convention allows a country to take pre-emptive actions where a ship or a shipping casualty threatened that country with oil pollution, although still outside its EEZ. In fact, the Convention gives the right to a Party to take such measures on the High Seas as may be necessary to prevent, mitigate or eliminate grave and imminent danger to its coastline or related interests from pollution or threat of pollution of the sea by oil. Today, a “threat” to a littoral State could mean a threat to its environment, a threat to its living resources, or a threat to the safety of shipping within its exclusive jurisdiction (Bernaerts 1988:28-29 and the Law of the Sea Article 19). In a country like Kiribati which has a huge EEZ, any action (like

surveillance of its sea areas and implementation of appropriate legislation) to address this problem can be quite difficult given the available resources.

World leaders, scientists and environmentalists²³ have repeatedly warned in recent years that nothing less than a global collective effort can save the planet's environment from irreversible damage by pollution, enhanced greenhouse effect, depletion of the ozone layer and other factors. An integrated, holistic and systemic perspective must guide these global collective efforts which are essential for two reasons. Firstly, everyone lives in the same place, earth. The earth is a fully integrated system and what happens in one area is likely to affect other areas, slow in some but rapid in others. An oil spill in a harbour basin will kill fish and other forms of marine life as soon as they come into contact with the oil, which in turn will cause sea birds feeding on them to move to other areas not affected. Secondly, the earth's environment must be preserved and maintained as healthy as possible for the benefit of future generations.

This research will contribute to the global collective effort in preventing pollution by ships in the marine area, but will not cover land based sources of marine pollution. Notwithstanding that, in order to give an overview or appreciation of the total pollution of the marine environment, and given that over 80 per cent of marine pollution are from land based/ non - shipping sources (SPREP's PACPOL 1999:iv), a brief discussion of this area is warranted.

The management of non-shipping sources of marine pollution became a real issue for PICTs in the latter half of the 20th Century (Improving Ships' Waste Management in the Pacific Islands Ports 2002: 13). Non-shipping wastes in PICTs, such as, garbage, oily water, sewage, chemicals (including washing detergents and dish washing liquids), waste water, are carried into the sea by rain water run-offs or storm-waters. Morrison and Munro (1999) identified a number of problems to effective waste management in PICTs, such as; lack of financial and skilled human resources, incomplete regulatory framework,

lack of political commitment, and lack of awareness of health and environmental impacts associated with inadequate waste management. Further research is required to determine the combined impact of shipping and non-shipping sources of marine pollution in PICTs. Maritime nations, especially those with developed economies, have for some years appreciated the negative impacts of ship-generated pollution on the environment and have taken steps to address this problem by way of international conventions such as MARPOL 73/78 and the London Convention, 1972²⁴. In addition, the training of officers and crew under the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended, and the safety standards required for construction of a ship and its equipment under the International Convention for the Safety of Life at Sea, 1974 (better known as SOLAS) have been formulated under the auspices of IMO with the same objectives in mind.

For centuries, ships were propelled by environmentally friendly means such as wind and oars, and have been used for harvesting of marine resources, trading and transportation between islands within a PICT or between PICTs. The advent of new technologies in marine propulsion systems, which use hydrocarbon fuels, and the increasing profit and/or existence driven thinking of ship owners in terms of lowering the cost of transporting one unit from one place to another, have meant that bigger and bigger ships can be built and operated more profitably. Unfortunately, in my experience, ship owners and shipping companies at the same time are not willing to pour money into ships to deal with such things as preventing marine pollution and preserving the marine environment, for these have no immediate benefit to them, unless they really have to. Governments legislate to ensure that ship owners comply with international regulations and standards in safety, security and the prevention of pollution in the marine environment, which also show their commitment to the implementation of these international instruments in their own countries.

Ships transiting PICT waters while steaming from North or South American ports to Asian or Australian and New Zealand ports without calling into a port (under the

innocent passage concept permitted under the Law of the Sea) pose a particularly difficult situation to the authorities in these countries as it is difficult to assess if a ship is a 'threat' without the physical presence of the ship. These ships are big, fast and may carry cargoes that are a threat to the marine environment if accidentally released. If one of these ships is involved in an accident and spills oil while transiting a PICT waters, there is nothing that a PICT can do to prevent oil pollution in its waters²⁵. Accidents have happened before: like that of the oil tanker *Amoco Cadiz* which grounded near the coast of France in 1978. The steering gear failed and it ended up on the rocks causing a massive oil spill of 230 000 tons of oil along the Atlantic coast of France. On 12 December 1999, the oil tanker *Erika* broke into two during bad weather in the Bay of Biscay, spilling 14 000 tonnes of heavy oil into the sea some 60 miles from the coast of Brittany, France. Oil reached the coast with devastating effects on marine life, birds and the tourism industry with hundreds of millions of dollars in clean up costs. Cargoes of both vessels were not destined for France, they were just transiting the coast of France.

Many PICT governments or citizens do not own ships²⁶ that are used for trade between PICTs or between PICTs and countries outside the region. If a PICT government or one of its citizen owns ships, it is more likely to be well informed about trends and developments in ships on matters concerning the marine environment than would otherwise be the case. Ships report to their owners and not to the country or countries they operate in. PICTs do not have the resources to own and operate ships, so overseas shipping companies provide the shipping services as required. Controlling the compliance to international standards under various conventions by overseas ships calling into PICTs' ports requires adequate manpower with specialised knowledge that is lacking in these countries²⁷. A 'Port State Control'²⁸ regime has been introduced to the region for surveillance purposes and to expedite the enforcement of maritime legislation, including the prevention of marine pollution. For vessels registered in PICTs, a 'Flag State Control' regime ensures that these vessels comply with national legislations and also international conventions requirements.

Ships operating within the EEZ of a PICT are mostly owned by local companies or individuals that have political clout due to the importance of shipping to local communities for trade and transport. Ships operating locally, such as, the *Olovaha* and *Tautahi*, still have up to 100 tons of fuel oil (mainly diesel oil) onboard and also carry dangerous or harmful substances. The impact of ship-generated marine pollution from these ships is the same as any other ship size but the effect will be more quickly felt as they sail inside sheltered waters and close to reefs and populated areas.

Ports that ships call into also play an important complementary role in preventing marine pollution while they are on passage to wharves or jetties in a port and during the time cargo operations are being conducted. The adequacy and safety of navigation aids and cargo handling equipment, skills and experience of local workers, contingency response plans in the event of oil or hazardous cargo spills are major factors in minimising risks of a marine pollution from occurring. In addition, the availability of adequate equipment such as oil booms, absorbent pads for cleaning and preventing oil from spreading. An oil spill in a port will be a major disaster to that country²⁹ as that port will be closed to shipping for some time (losing millions of dollars in port revenue). Furthermore, the cost of clean up, degradation of coastal eco-systems³⁰, rehabilitation and compensation will be immense as happened with the oil tanker *Exxon Valdez* pollution disaster in Alaska in 1989. The cost of clean up and compensation was estimated to amount to over US\$3 billion and punitive damages of US\$5 billion (Boisson 1999:42).

In an economic perspective, tourism receipts in many of the PICTs have taken over from the export of manufacturing and agricultural products as the main revenue earner in each country. Due to the remoteness, massive geographic span, limited natural resource base and small but densely populated areas with little employment opportunities, that characterise many PICTs, especially Polynesian countries, a large number of their nationals emigrated to New Zealand, Australia, and the United States (Appleyard et al 1993:11). It has been estimated for the 1980s to be approximately 60 per cent of Samoa's population and 44 per cent of Tonga's population. These migrants remit a

substantial amount of money back home that helped to pay for the importation of goods (Fairbairn 1993:5) in each country. All PICTs exported and imported goods to the value of approximately US\$ 1735.3 million and US\$ 2236.8 million (Heathcote 1997:41-42) respectively per annum in the early 1990s. It is the volume of general imports which tend to determine the level of shipping services in the islands of the region (Touche Ross & Co. 1985:7)

The economic principle of 'where there is a demand there will be a supply' applies to trade between PICTs and countries outside the region, between PICTs, and between islands in each PICTs (except Nauru, Pitcairn and Niue) as well. Ships³¹ are the main tools for the conducting of trade due to the vastness of the sea areas and the small land areas of PICTs. Aircraft are used only by some PICTs (Fiji, Solomon Islands, Tonga, Samoa, and Vanuatu) for the exporting and importing of goods of very high value and special in nature such as fresh fish to Japan and laptop computers from the US respectively.

1.4 Methodology

The overall aim of the research is, firstly, to identify ship- generated marine pollution and related risks in the Pacific, and, secondly, the preventative measures that could be put in place to minimise or eliminate those risks. The SMPI, comprising of five internal and seven external factors that this researcher, at the time of the country visits, assessed to be the most important and relevant to the aim of the research, is used to determine ship - generated marine pollution in each of the nine PICTs that the researcher visited and collected data during the middle part of the year 2000. Data collected from the nine PICTs and used are for the year 1998, as it was the most complete data available from port authorities' and government statistical records during this researcher's visits to those countries. After calculating each indicator, this researcher then formulates strategies to

eliminate or minimize those risks, and they are submitted as recommendations at the end of this thesis.

1.4.1 Establishing the SMPI

In order to identify risks of marine pollution in the nine PICT ports used in this research, risk assessment principles are adopted that would enable calculations to be made to produce the SMPI, the main tool for identifying the risks of marine pollution. . The SMPI is a multi-item index comprised of twelve indicators grouped into two sub-indices, namely internal factors which comprised of five pollution risk indicators, and external factors which are made up of seven pollution risk indicators. The indicators incorporated into the SMPI are heterogeneous in nature but no weightings will be used in the calculations of the SMPI. Instead, the calculations will be based on the assigning of numerical values to the elements used in the assessment of risk under the Australian Standard Risk Management AS/NZ 4360:1999 (ASRM). Basically, risk under the ASRM can be expressed as the product of the likelihood (measured by probability) of an incident occurring and the consequences (or impacts) arising from such as incident that will have an impact upon objectives.

$$\text{Risk} = \text{likelihood} \times \text{consequences}$$

Likelihood can also be expressed as the product of a threat and the vulnerability of a system or thing to the threat. Risk therefore, can be assessed as the product of a threat, vulnerability and consequences.

$$\text{Risk} = \text{threat} \times \text{vulnerability} \times \text{consequences}$$

Each of the three variables of risk is discussed below.

Threat

Threat means the ability of any pollution risk indicator to cause damage to the environment, life and property or any other thing of value. The assessment of threat will be carried out in a scale of 1-3, and these threat levels are the same ones used by IMO under the ISPS Code:

3 = high (Part A, section 2.1.11 of the ISPS Code)

2 = medium (Part A, section 2.1.10 of the ISPS Code)

1 = low (Part A, section 2.1.9 of the ISPS Code)

Threat levels are based upon the degree to which some combinations of the following factors are present:

- damage to the environment;
 - economic impacts; and
 - fatalities.
- A threat is high when all the above three factors are present. Medium threat occurs when damage to the environment and economic impacts are present. When neither damage to the environment nor economic impacts are present the threat is regarded as low. In assessing the ship pollution risk indicator to each PICT port, the actual ship calls are normalised to a scale of 3 which is used instead of the threat 1-3 scoring as there is no loss of information by using the actual ship calls.
 - For calculating threat in the Ship pollution risk indicator, the bunker oil carried by each ship is equated to the ITOPF scale (Tier 3 if oil carried is over 700 tonne (potential oil spill), Tier 2 if 7-700 tonne, and Tier 1 if less than 7 tonne) is multiplied by the actual ship calls, then normalized (dividing each with the highest value obtained) to a scale of 3 (see Tables 4.1 – 4.9).
 - The threat for the Cargo and Management pollution indicators are calculated using the scoring 1, 2, 3.

For assessing the seven external pollution risk indicators, the following threat criteria are used:

- The Cyclone Impact pollution risk indicator is also normalized and assessed using the number of cyclones that struck a port over a 10 year period instead of the threat scoring 1-3.

- Navigation Chart date of latest edition and survey order (degree of sea bed details in the chart) was used for the Navigation Chart pollution risk indicator.
- For Coastal Sea Routes and Port Passages indicator, the MSD was used so that there is no loss of information.
- There is some degree of control in Skills of Port Workers indicator as ship's officers may stop any operation, if in their judgment safety considerations are not being met by the workers. A score of 2 is entered for all ports.
- Port Infrastructure and Condition indicator are all scored with a 2 as wharves have been upgraded in the 1990s to accommodate container cargo handling.
- Acceding or not acceding to international maritime conventions is the main criteria for scoring 1, 2 or 3.
- Party to the OPRC Convention and oil spill response equipment are the main criteria in scoring under the Emergency Procedures and Equipment indicator.

Vulnerability

Vulnerability is the susceptibility of the marine environment to a threat or in other words the control on the threat. It will also be assessed in a scale of 1-3, which is as follows:

3=high

2=medium

1=low

High vulnerability is when there is very little or no control on a threat. Medium vulnerability is when there is some control on the threat. In a low vulnerability situation there are control measures in place to respond adequately to any threat in a timely manner. In assessing vulnerability of each of the five internal risk indicators, the following three factors are used:

- Safe port infrastructures include navigation aids, charts, type and condition of berths, and availability of tug boats for berthing assistance.
- Skills of port workers cover pilots, linesmen, tug boat crew and oil spill response teams.
- Adequate pollution control equipment available in the port that could deal with an oil spill up to Tier 2 as it usually require a local response.

There are some subjective assessments involved, such as, skills of linesmen and oil spill response teams as there are no regional or international standards established yet. All three factors would be added up and normalize to a scale of 3, that is, total score divided by 3 (see Table 1.1).

Table 1.1: Vulnerability scores for Internal Pollution Risk Indicators for the Nine PICT Ports (scores are rounded off if no whole number)

PICT ports	Safe Port Infrastructures	Skills of Port Workers	Adequate Pollution Control Equipment	Vulnerability score for 5 internal indicators
Apra	1	1	1	1
Suva	1	1	1	1
Port Moresby	1	1	1	1
Honiara	1	1	2	1.3
Majuro	1	1	2	1.3
Pago Pago	1	1	1	1
Apia	1	1	1	1
Nuku'alofa	1	1	1	1
Tarawa	2	1	2	1.7

Source: Author

(Note: Tarawa has no tug boat)

Consequence

Consequence is the impact or loss or damage caused to a PICT and port as a result of an incident as defined by threat multiplied by vulnerability. Marine pollution is the consequence of an oil spill. It will be assessed using a scale of 1-5 which are as follows:

5=extreme

4=high

3=medium

2=slightly less than average

1=low

Each of the five deleterious effects of marine pollution (as defined by GESAMP) will be discussed separately and an index for each effect would be calculated for each PICT port using a 1 – 5 score. The aggregated result (in Table 1.7) of the five deleterious effects are normalized to a scale of 5 and used instead of the score 1 – 5. These normalized scores calculated in Table 1.7 will be used in all consequence calculations in the Tables for all pollution risk indicators of the nine PICT ports.

Table 1.2: Harm to Living Resources in the Nine PICT Ports

PICT Port	Coral	Seagrasses	Mangroves	Sandy beaches	Sea birds	Deleterious Effects
Apra	Y	Y	Y	Y	Y	5
Suva	Y	Y	Y	N	Y	4
Port Moresby	Y	Y	Y	N	Y	4
Honiara	Y	Y	N	N	Y	3
Majuro	Y	Y	Y	Y	Y	5
Pago Pago	Y	Y	Y	Y	Y	5
Apia	Y	Y	Y	N	Y	4
Nuku'alofa	Y	Y	Y	Y	Y	5
Tarawa	Y	Y	Y	Y	Y	5

Source: Author

No oil spill is benign. Even a small spill at the wrong place (with current and prevailing wind in the wrong direction, that is, toward an area where coral reefs or sea grasses or mangroves or sandy beaches or sea birds habitat or any combination of these living resources exist) at the wrong time can result in significant damage to individual organisms or entire population (Oil in the Sea III 2003: 4), especially in the confined areas of any of the nine PICT ports. According to Oil in the Sea III, the long and short

term effects of an oil spill are still being debated by scientists. The author did not use a sensitivity map as there are no official maps found for the nine PICT ports but designed Table 1.2 as a proxy (information sheet obtained from information on actual British Admiralty charts, their copies are attached in Annex 3) to show the main living resources found in any of the ports.

Table 1.3: Hazards to Human Health in the Nine PICT Ports

PICT Port	Beach Activities	Location of nearest town	Reef flats for food	Water sports	Prevailing wind direction	Deleterious Effects
Apra	Y	N	Y	N	N	2
Suva	Y	Y	Y	Y	Y	5
Port Moresby	Y	Y	Y	N	N	3
Honiara	Y	Y	Y	N	Y	4
Majuro	Y	Y	Y	Y	Y	5
Pago Pago	Y	Y	Y	N	Y	4
Apia	Y	Y	Y	Y	N	4
Nuku'alofa	Y	Y	Y	Y	N	4
Tarawa	Y	Y	Y	Y	Y	5

Source: Author

A yes (Y) or no (N) entry is made in each column for each port (Y equals score of 1, N equals score of 0), whichever is applicable, and totaled up in the Deleterious Effects (DE) column. The DE scores of each port (Tables 1.2 – 1.6) are then added together in Table 1.7 to give the consequence score for each port which will be used for all the calculations on each of the 12 pollution risk indicators.

The following is an explanation of the column headings in Table 1.3.

- Beach activities include beach volleyball (and similar games) and sunbathing.
- Location of nearest town means if the port is part of the capital city or not. Only Guam has a port which is not part of the main town.

- Reef flats for food cover reefs that people use to seek sea food, such as mollusks, small fish, crabs and sea weeds.
- Water sports include water skiing, swimming, diving and boating.
- Prevailing wind direction means the direction of the wind that blows towards a PICT for a majority time of the year. In the southern hemisphere the prevailing wind is from the south east and north east in the northern hemisphere. If a PICT port is located in a major town (or capital of a PICT) and the prevailing wind picks up fumes of oil spilled in the port and carried it into the town, people with respiratory diseases or problem, such as asthma, would probably suffer or die.

Table 1.4: Hindrance to Maritime Activities (including fishing) in the Nine PICT Ports

PICT Port	Vessels' movements	Search and rescue	Water sports	Fishing	Cargo movements	Deleterious Effects
Apra	Y	Y	Y	Y	Y	5
Suva	Y	Y	Y	Y	Y	5
Port Moresby	Y	Y	Y	Y	Y	5
Honiara	Y	Y	Y	Y	Y	5
Majuro	Y	Y	Y	Y	Y	5
Pago Pago	Y	Y	Y	Y	Y	5
Apia	Y	Y	Y	Y	Y	5
Nuku'alofa	Y	Y	Y	Y	Y	5
Tarawa	Y	Y	Y	Y	Y	5

Source: Author

In Table 1.4 the meaning of column headings are as follows:

- Vessels' movements cover the inward and outward movements of vessels from a PICT port.

- Search and rescue activities in areas where an oil spill is occurring, using rescue boats would be very difficult as water intakes of their engines will be contaminated with oil causing problems.
- Water sports would include swimming, water skiing, and diving.
- Fishing would cover fishing for food by locals using nets, lines or other means.
- Cargo movements would be stopped as oil spill response equipment would be deployed in the port area. Furthermore, a PICT's focus would be to contain the oil spill and clean it up as soon as possible before other maritime activities are permitted to go ahead.

Table 1.5: Impairment of Quality for use of sea water in the Nine PICT Ports

PICT Port	Water sports	Fishing	Sea food (mollusks, etc)	Intake for power stations	Vessel movements	Deleterious Effects
Apra	Y	Y	Y	N	Y	4
Suva	Y	Y	Y	N	Y	4
Port Moresby	Y	Y	Y	N	Y	4
Honiara	Y	Y	Y	Y	Y	5
Majuro	Y	Y	Y	Y	Y	5
Pago Pago	Y	Y	Y	Y	Y	5
Apia	Y	Y	Y	Y	Y	5
Nuku'alofa	Y	Y	Y	Y	Y	5
Tarawa	Y	Y	Y	Y	Y	5

Source: Author

The column headings in Table 1.5 are explained as follows:

- Water sports such as swimming and diving;
- Fishing by line or net;

- Sea food including small fish and mollusks;
- Intake for power stations will be contaminated with oil thus rendering it unusable causing it to be closed down; and
- Vessel movements would be affected as oil residue marks cover the hull of vessels thus fouling them, causing a rough surface along the water line that adversely affect the speed of vessels (from more friction between oil residue and sea water flow along the vessels' hulls).

All five bulleted points above are no longer possible to be carried out for some time until the spilled oil are cleaned up and the sea water in the port is tested by authorities to determine if it is safe to be used again.

Table 1.6: Reduction of Amenities in the Nine PICT Ports

PICT Port	Water sports	Fishing	Tour Vessel movements	Wharf cargo operations	Inter island passenger vessels	Deleterious Effects
Apra	Y	Y	Y	Y	N	4
Suva	Y	Y	Y	Y	Y	5
Port Moresby	Y	Y	Y	Y	Y	5
Honiara	Y	Y	Y	Y	Y	5
Majuro	Y	Y	Y	Y	Y	5
Pago Pago	Y	Y	Y	Y	Y	5
Apia	Y	Y	Y	Y	N	4
Nuku'alofa	Y	Y	Y	Y	Y	5
Tarawa	Y	Y	Y	N	Y	4

Source: Author

In the event of oil being spilled in one of the nine PICT ports, the use of amenities listed and discussed below and in Table 1.6, would be reduced because the oil would prevent their normal uses.

- Water sports such as swimming and diving in popular spots.
- Fishing by line or nets or traps would not be possible.
- Tour vessel movements for tourists would also be not possible.
- Wharf cargo operations would be stopped if vessels are prevented from entering the port for a week because of the spilled oil. Tarawa is the only port that has 31 vessel calls per year which would mean a ship approximately two weeks.
- Inter-island passenger vessels movements would not be possible.

Table 1.7: Calculation of Consequences for the Nine PICT ports

PICT ports	Table 1.2 scores	Table 1.3 scores	Table 1.4 scores	Table 1.5 scores	Table 1.6 scores	Total scores	Normalised scores
Apra	5	2	5	4	4	20	4.0
Suva	4	5	5	4	5	23	4.6
Port Moresby	4	3	5	4	5	21	4.2
Honiara	3	4	5	5	5	22	4.4
Majuro	5	5	5	5	5	25	5.0
Pago Pago	5	4	5	5	5	24	4.8
Apia	4	4	5	5	4	22	4.2
Nuku'alofa	5	4	5	5	5	24	4.8
Tarawa	5	5	5	5	4	24	4.8

Source: Author

The consequences of an oil spill in Majuro is extreme (5 score) and the other eight PICT ports would be high (4.0 to 4.8 scores) as shown in Table 1.7

Table 1.8- Summary of Defining Risk (risk=threat x vulnerability x consequences)

	Components	Measure	Comments
Threat	-Damage to the marine environment -Economic impacts -Fatalities	3 – all three factors present 2 - economic and environment 1 – Fatalities only	Calculated as Vessel calls per year for the five internal indicators, normalized to the highest number, then multiplied by 3 (see threat discussion. For the seven external indicators different methods are used for the calculations of threat.
Vulnerability	Control on a threat	3 – Little or no control 2,- Some control 1 – Adequate control, measures in place	Calculated using 3 factors for all indicators – safe port infrastructures -skills of port workers -pollution control equipment. (see Table 1.1) Vulnerability scores for each port is the same throughout Tables in Ch.4
Consequences	Damage to a PICT or port as a result of the incident defined by Threat X Vulnerability	5 deleterious effects of GESAMP definition of marine pollution: - harm to living resources; - hazards to human health; - hindrance to maritime activities (including fishing; - impairment of quality for use of sea water; and - reduction of amenities	Calculated by having a table each (Tables !.2- !.6} for each of deleterious effects (DE). Total DE are calculated and normalized to a 5 scale in Table 1.7 Consequence scores of PICT ports obtained in Table 1.7 will be used in every calculation throughout Ch 4.

Source: Author

When a ship enters a port of a PICT there are numerous threats to the marine environment posed by the ship which are represented by the five internal and seven external pollution risk indicators. The numeric values of the three elements (threat, vulnerability and consequences) of risk are given a subjective assessment and entered in the risk assessment formula and the risk score calculated for that particular port.

Calculations for each of the twelve marine pollution risk indicators (of each PICT) will be aggregated, ranked and the lowest risk score will form the base value of the SMPI which will be 1. Risk scores of other PICTs, as ranked, will be divided with the lowest risk score to produce the index values of each PICT.

The scales chosen for threat, vulnerability and consequences used in the assessment of risks have the following features built into the model:

- It is simple to use with high scores indicating more marine pollution risks.
- The indicators used are the appropriate main ones for each PICT and should produce unbiased measures of risks of marine pollution.
- The spread of their values is sufficient to highlight the differences among PICTs.
- As a composite index the SMPI could be broken down when needed to get a clear understanding of the nature of any indicator for specific comparison purposes and the identification of problem areas.
- The index could be easily upgraded by the deletion of an irrelevant indicator or the inclusion of a new and relevant indicator (water-ballast management).
- Non-numerical data can be quantified by the use of the 1–3 and 1-5 scoring as each has a central score that can satisfy the concept of averages and minimum/maximum values. In the 1-3 scoring the main reasons to why it was used is that a threat or vulnerability level does not need a reasonable spread on values for assessment purposes. A threat or vulnerability is assessed as either high, medium or low level, hence the compressed and direct scale of 1-3. The United States has five threat levels (5-extreme, 4-high, 3-elevated, 2-moderate, 1-low) but the international preference is 1-3 as adopted in the ISPS Code. The scoring of 1–5 was chosen for consequences as it allows for a reasonable amount of spread among the possible values of the consequences data; a scale too compressed would make the spread difficult to create.

In addition, a scale too wide would make the spread much more difficult to calculate and represent in the index resulting in it being a complex, not user-friendly and difficult to understand.

1.4.1.1 Calculating the Sub- Indices

An EXCEL worksheet or tables in Microsoft Words was used for calculating the values of each pollution risk indicator for each PICT as follows:

- The worksheet comprises of the twelve indicators with scores entered in the appropriate scale, in accordance with the data collected from each PICT.
- The risk scores are calculated by entering the numerical values for threat, vulnerability and consequences in the risk assessment formula:

$$\text{Risk} = \text{threat} \times \text{vulnerability} \times \text{consequences}$$

- By substituting for the highest value of threat (3), vulnerability (3), and consequences (5) the highest risk score can be calculated as follows:

$$\text{Risk} = 3 \times 3 \times 5 = 45$$

- Results of scoring of each pollution risk indicator are then calculated for each PICT port. The SMPI is now known. A breakdown of the sub-indices showing relative contributions of each indicator to the index, if needed, to highlight a specific problem area, can be done.

1.4.1.2 Data Gathering

This research is based on information and data that was collected by the author on field visits to nine³² of the twenty two island States/Territories of SPREP in 2000. They are -

Fiji, Papua New Guinea and Solomon Islands from Melanesia; Guam, Kiribati and Marshall Islands from Micronesia; American Samoa, Samoa and Tonga from Polynesia.

In addition, the following information is used :

1. A search and review of existing literature relating to the research including background information on the; geography and brief history of each country, maritime policies and the legal framework to implement those policies. Existing maritime legislations relevant for the research - especially those dealing with safety, training and certification of crew, carriage of goods, security, and prevention of marine pollution were obtained from IMO, SPREP and other web-sites cited. Furthermore, annual reports of marine departments, port authorities, customs departments, fisheries departments, oil companies and shipping schedules from shipping companies or agents will also be used in this research.

2. Dialogue with academic and research staff at various learning institutions in the maritime discipline, IMO and other international organisations, regional organisations such as SPREP, Forum Secretariat³², SPC and the Forum Fisheries Agency (FFA), and the Australian Maritime Safety Agency (AMSA), regarding journals and published papers relevant to the thesis topic.

3 This researcher used a questionnaire developed under SPREP's Marine Pollution Risk Assessment Study in 2000, for data collection. When this researcher started visiting the nine PICTs, SPREP requested beforehand, co-operation from port authorities, marine departments, environment departments and the US Coastguard by the completion of the questionnaire emailed to them, before his arrival. Most of the nine PICTs had already completed their questionnaires on our first meeting where a general discussion was conducted on the data presented. Usually, interviews were conducted with heads of these government agencies on the first day and data collected confirmed on the second day, and they are referenced in this thesis. Further information, such as, trade statistics, ships in

their ship registers, and port annual reports were requested and received promptly from the authorities. This researcher spent on average three days in each PICT, and still have the raw data collected from these PICT visits. After the county visits, this researcher also used email communications with the PICT authorities to clarify any issue identified later to be important.

4. Some of the previous shipping and related studies that have been conducted in the region are:

- *Ship Groundings in the Pacific Islands Region – Issues and Guidelines* by Preston G.L.; Gillet R.D.; McCoy M.A.; Murrel P.A.; Lovell E.R. for the South Pacific Regional Environment Programme, 1997.

The Study deals with ship groundings in ports and outside of ports, which is only one part of ship-generated pollution of the marine environment (by various types of ships and their impacts). It provides useful data and information on the issues involved including legal, salvage, social and economic. A set of 10 recommendations for national governments (7) and regional organisations (3) are included at the end of the Study. It covers only one area of marine pollution, ship groundings.

- *Shipping and Port Capacities in the Island Developing Countries (Policy Options for Replacing Ageing Ships in the Pacific Island Fleets)* by The United Nation's Economic and Social Commission for Asia and the Pacific (ESCAP), 1997.

This Study focused on domestic shipping issues (within EEZs of PICTs) especially the replacing of locally owned ships (mostly over 20 years old) which could not meet international standards on safety. The dilemma faced is that nearly all of the 615 locally owned ships trading within EEZs of PICTs will probably be scrapped and this was not socially, economically and politically acceptable within as trade will be just a trickle. These ships may sink in the foreseeable future and are potential polluters of the marine environment. Funding of new tonnages was identified as the main constraint and

recommendations were made to governments to that effect. Again this Study touched only on parts of the problem identified for the research.

- *Maritime Law in the South Pacific – Towards Harmonisation by Peter Heathcote, 1997.*

The thesis covers well maritime law and some policy areas but lacks treatment of the relationship between ships and the marine environment with related problems that this research will focus on.

The above publications are mainly statements and statistical data with no in depth analysis in the area of research.

5. IMO News reports, new developments in shipping technology, articles from journals and academics as well as practitioners in the maritime industry on a wide range of topics in the world scene. In addition, what IMO is doing, such as the discussion of technical issues, international conventions and also providing advice to Member States on safety and the protection of the marine environment from pollution. It is a very good reference source but it does not cover in one sweep the aim of the research.

The following articles from journals and published papers are reviewed as follows:

- *The framework protecting ports and ships from fire and pollution by A.M. Goulielmos and Angeliki Pardali, 1998.*

This article discusses the approach taken by the European Union (EU) with regards to the protection of ports and ships from fire and pollution within the EU, which the authors argued are not effective. Specifically on the protection of the port environment, the authors concluded that pollution in ports is caused by 'attitude' of stakeholders in the industry rather than lack of rules. From this researcher's experience in the maritime industry, the authors' premises are supported. Each player in the maritime industry should commit themselves to their responsibilities, as mandated by international and

national regulations, so that shipping is safe, secure and the marine environment is protected from pollution. This article covers only a small part of the thesis topic.

- *Marine accident prevention: an evaluation of the ISM code by the fundamentals of the complexity theory by A.M. Goulielmos and C.B. Giziakis, 2002.*

The authors highlighted the view that the world around us is not linear. Maritime disaster and management are better explained by the theory of complexity (four classes: stability; order; chaos; and complexity) than linear theories. The ISM Code (in a linear theory) has been accused of increasing the bureaucracy of the system by introducing different levels of responsibilities with the result that no substance work could be done at the end. In a maritime disaster, information needs to travel faster to key people so that decisions are made quickly to address the situation. The complexity theory suggests a flatter structure where information travels faster, and measures to prevent further damage to the environment could be designed and implemented much quicker. This researcher supports the use of the theory of complexity in the prevention and management of maritime disasters, as the world around us is not linear. Further research is required to determine the degree of linkage between the thesis topic and the theory of complexity.

- *The regional approach to management of marine pollution in the South Pacific by R.J Morrison, 1999.*

The author describes the marine pollution scenario in the South Pacific and the region's approaches that were adopted from 1988 to 1994 to address marine pollution problems. Given the limited financial and technical resources in PICTs, a regional approach is advocated by the author, outlining the methods adopted, describing the outcomes and discussing the problems and lessons learned. This paper covers many of the problems discussed and the findings in this research, although the research focuses on ship-generated marine pollution.

6. IMO international conventions were consulted with the relevant main conventions categorised as follows :

- Conventions related to safety at sea and establishing international rules and standards.
 - Safety of Life at Sea (SOLAS), 1974 and the SOLAS Protocol of 1978.
 - International Convention on Load Lines (Load Lines), 1966.
 - Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREG 1972).
 - Torremolinos International Convention for the Safety of Fishing Vessels, 1977 and the Protocol of 1993 (Torremolinos Convention 77/93). Not entered into force yet.
 - International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended.
 - International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessels Personnel, 1995 (STCW-F 95). Not entered into force yet.
 - International Convention on Maritime Search and Rescue, 1979 (SAR Convention 1979).
- Conventions related to the prevention and control of marine pollution from ships.
 - International Convention for the Prevention of Pollution from Ships, 1973 and its Protocol of 1978 (MARPOL 73/78).
 - International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990.

- The International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Intervention), 1969, and its Protocol of 1973.

- International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001.

- International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water), 2004.

- Conventions related to liability and compensation.
 - International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC 1969).

 - International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971 (Fund 1971 and its Protocols of 1992).

 - Convention on Limitation of Liability for Maritime Claims, 1976 (Limitation Convention 1976).

 - International Convention on Salvage, 1989 (Salvage Convention 1989).

 - International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 1996 (HNS Convention 1996).

- Conventions intended for encouraging and facilitating international maritime trade.

- Convention on Facilitation of International Maritime Traffic, 1965 (FAL Convention).
- International Convention on Tonnage Measurement, 1969 (Tonnage Convention)
- Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, 1988 (SUA Convention).
- Miscellaneous international conventions and regional agreements.
 - Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989. (United Nations Environmental Program)
 - Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, 1986. (SPREP)
 - Protocol concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region, 1986. (under the auspices of SPREP)
 - Protocol to SPREP for the Prevention of Pollution of the South Pacific Region by Dumping, 1986.
 - Agreement establishing the South Pacific Regional Environment Program (SPREP), 1993. (as an Intergovernmental Organisation)
- Marine Pollution Risk Assessment for the Pacific Islands Region by Edward Anderson et al in 2002 under a SPREP consultancy.

The study focused on classifying PICTs' waters into zones of high, moderate and low potential for collision and grounding incident at three scales: regional; country EEZs; and major ports. Whereas, this thesis focuses on the identification of the potential for a ship to cause marine pollution during a visit to a PICT port, and assessing the risks involved, by the use of five internal and seven external indicators. The risks identified under a SMPI are analysed and the findings were submitted as recommendations for PICTs. The study and the thesis cover ship-generated marine pollution from different perspectives.

- Risk of Marine Spills in the Pacific Islands Region and its Evolving Response Arrangements by Sefanaia Nawadra and Trevor Gilbert in Spillcon 2002.

This paper discussed SPREP's Pacific Ocean Pollution Prevention Programme (PACPOL) activities that included a regional risk assessment (summarizing Anderson et al 2002), establishing regional and national contingency plans, formulation of a regional oil spill response equipment strategy, and conducting regular workshops discussing oil spill issues.

- National Academy of Sciences. 2003. Oil in the Sea III: Inputs, Fates and Effects. National Academy Press. Washington, DC, USA.

Experts have recognized since the early 1970s that petroleum pollutants were being discharged into the sea worldwide, from oil spills, ships normal operations, and land-based sources. This book provides the best available estimate of oil pollutant discharge into marine waters. It discusses where the discharges come from; behaviour or fate how oil is affected by processes (evaporation, spreading etc) as it moves through the marine environment; and the effects of petroleum on marine ecosystems and organisms. This book provides valuable information on the thesis topic.

- Great Barrier Reef Shipping Review Steering Committee, 2001, Australian Maritime Safety Authority
<http://www.amsa.gov.au/SD/gbrreview/final/gbrprint.htm>

The Australian Government commissioned this review of ship safety and pollution prevention measures in the Great Barrier Reef and Torres Strait with the view to develop

strategies to address issues such as: extension of compulsory pilotage areas; effective monitoring of shipping operations; better traffic management and response arrangements; constraining certain ship types from operating in the area; and improving legislative powers of intervention and enforcement. Submissions were received from the public and recommendations were adopted as strategies which addressed the above issues.

The above publications provide background information and data that would be needed in the research as each provided only bits and pieces of this research topic.

1.4.2 Internal Factors:

The ship, cargo, management of the ship, maritime security issues and anti-fouling systems (paints) are the five indicators grouped under the sub-indices labeled Internal Factors. They are the primary indicators, for without the shipping company management's decision to buy then operate the ship and load with cargo, there will be no risk of marine pollution.

(a) The ship indicator will cover ships that are trading in PICTs' waters. This will include commercially operated ships of 200 Gross Tonnage (GT) ³⁴ or more, trading locally, in the region and internationally. Gross tonnage is defined as a measure of the internal capacity of a ship intended to give an idea of the earning capacity of that ship. Data for ships of less than 200 GT are very difficult to get and these ships carry about 40 tonnes or less bunker fuel. In addition, the researcher could not find in the region an oil tanker of less than 200 GT. Some of the issues to be discussed are as follows:

- If the construction of the ship and equipment onboard has been carried out in accordance with generally accepted international standards such as SOLAS or better,

otherwise the ship may break up at sea or experience equipment failure at critical moments such as during discharging oil.

- The age of the ship.
- The quality of general maintenance onboard could be identified by examining the Maintenance Book or by the general appearance of the vessel onboard.
- The amount of bunker fuel (fuel oil) onboard. Bunker oil may leak into the sea when fuel oil tanks onboard are holed or may spill overboard accidentally.
- Whether the training, qualifications and crewing of a ship are in accordance with international standards such as the STCW 95.
- Sulphur oxides create acid rain while nitrogen oxides create photo-chemical smog and carbon dioxide create the greenhouse effect. All of these chemicals are found in ships' exhaust emissions. Some estimates indicate that shipping contributes 4 to 5 per cent of nitrogen oxides emissions and 7 per cent of sulphur oxides emissions although they vary considerably from region to region (IMO News No.4/1994 :17).
- Normally, ballast water is pumped onboard into ballast tanks at the bottom part of ships for stability reasons (safety) in port and pumped out at the next port of call which may introduce new marine organisms into a country. The introduction of unwanted aquatic organisms in ballast water and sediment discharges into a country can cause immense damages to the local marine life such as the introduction of the American comb jelly into the Black Sea causing the near extinction of the anchovy and sprat fisheries. Faster and bigger ships of today (quite a few ships can load up to 500 000 tons of oil) can increase the survivability of unwanted marine organism onboard as it will take less time to sail from one place to another compared with slower and smaller ships few years ago.
- Untreated sewage is a health hazard and particularly so in harbour basins where there is little movement of water to disperse the sewage.

- The dumping into the sea of garbage and other solid wastes such as plastic materials pollute and kill marine life such as turtles and dolphins.
- Operational waste oil may overflow or may spill from holding tanks when they become full.
- Lubricating oil may leak into the sea from stern-tubes housing the ship's propeller shafts
- Most anti-fouling paints contain metallic compounds such as tributyltin (TBT) which kills barnacles and other marine life that have attached to the ship. Studies have shown that these compounds persist in the water and kill other sea life as well and harm the environment.
- Equipment failure like pump overflow alarms especially during cargo operations when oil is loaded or discharged may spill oil overboard or oil may spill to on hot surfaces causing fire and pollute the marine environment.

Scoring on some of these elements may have to be estimated as data on locally owned ships is usually non-existent and some international trading ship's data could not be obtained. Oil tankers will have the highest score as oil pollution poses the greatest risk to the marine environment.

(b) The cargo that a ship carries is the second indicator and oil usually pollutes a large sea area. Some cargo such as poisonous chemicals can heavily pollute the sea but usually in small areas, radio-active substances can cause serious pollution if they escape from their proper stowage containers or containment units. There is very strict control and monitoring in all phases of transporting radio-active substances including packaging, loading, carriage onboard ships and unloading activities. This is very important today due

to strong protests in port and at sea by environmental activists such as Greenpeace which can pose risks (collisions and/or groundings) to the safety of the ships involved and their cargoes.

Some ships were purpose built to carry a special type of cargo such as oil tankers and product tankers and those cargoes are classed as dangerous cargo under the IMDG code or not of dangerous cargo such as dry bulk carriers, reefer ships and so on. Other ships were built for carrying a mixture of cargoes (such as general cargo ships, supply ships). The IMDG Code covers every substance (each one allocated with a United Nations number) that have been identified by scientists throughout the years to have a dangerous nature. These dangerous substances may have one or more characteristics, which may appear in more than one class. The Code also states how it is to be contained, packaged and carried onboard or stowed. Other relevant information such as extra handling precautions, environment impact, medical treatment if a substance comes into contact with a person is also included.

(c) Management decisions have the greatest impact on how a ship has been built to suit a particular trade. If it is a second hand ship, how safe/good condition is that ship? The decision to buy and operate a ship is influenced mainly by the amount of money a prospective ship owner wishes to invest, his experience and capability. Ships operated by a company in a developed country are generally better managed than a company in a PICT due to various reasons including the regulatory regime, management practices and controls in the former. Shipping remains broadly an open market where ship owners have considerable flexibility in operating their ships. The result is huge disparities in safety management policies and subsequently practices. A study published by S.R.Tolofari ³⁵ in 1989 analysed casualties between 1975 and 1983 which showed that shipping casualty rates for traditional maritime nations are lower than for 'open registers'³⁶ .

(d) The entry into force on 1 July 2004 of the International Ship and Port Facility Security (ISPS) Code ensures that security of ships and ports are maintained. This is through the Code's requirement that ships and port facilities must comply with the

provisions of the ISPS Code before the 1 July 2004 and be issued with the appropriate Security Certificate; and

(e) Banning of use of organotin biocides (TBT) in anti-fouling systems commencing on 1 January 2003, as required under the International Convention on the Control of Harmful Anti – fouling Systems on Ships, 2001. The Convention also provides for the complete prohibition on the use of TBT paints on vessels by 1 January 2008. As on 31 December 2007, the Convention has not entered into force.

In recent years maritime nations have focused on addressing this matter through an International Safety Management Code (ISM Code)³⁷ under the auspices of IMO which came into force on 1 July, 2002 as Chapter IX of the Safety of Life At Sea Convention, 1974 (SOLAS). The ISM Code deals with safe operations of ships and prevention of marine pollution matters.

1.4.3 External factors :

It is in the best interest of every PICT to send a ship away from its waters as soon as possible. The longer a ship stays in its waters to complete its planned and legitimate activities (cargo operations or whatever), the higher the risk of a ship-generated marine pollution occurring. The indicator in this sub-indices can greatly impact the safety of ships and their cargoes and they are additional risks to cause marine pollution that have to be addressed too.

Issues to be examined under this indicator include:

(a) Meteorological events such as cyclones and rough seas have sunk ships, spilling fuel oil and dangerous cargoes into the sea and causing marine pollution;

(b) In ports, the accuracy of hydrographic surveying and navigation charts is very important as ships are getting bigger, if the entrance to a port is by way of narrow passages or channels. The adequacy and maintenance of navigation aids so that they are

functioning properly as ships enter and leave a port at any time of the day is also critical. Ships can be damaged or holed if they go aground in a shoal or reef if these are not charted accurately;

(c) If possible, the sea routes and coastal passages should not be near an environmentally sensitive area such as mangrove swamps with associated wild life or a tourism resort. Oil pollution near these areas will cause an environmental and economical disaster. In addition, surveys of these sea areas are not yet in sufficient details, with some navigation charts dating back to the 18th Century;

(d) The skills of shore workers used by ships including pilots, tugboats, mooring gangs and stevedores that will be involved in handling ships while they are in ports. Poor skills of shore workers can adversely affect the safety of ships and their cargoes;

(e) The regulatory framework in place in a country and the implementation measures to ensure that safety of ships are not compromised in any way. This includes proper Port State Control inspections and other surveillance measures inside and outside ports, which is a deterrent factor to a sub-standard ship planning to visit that port;

(f) The port infrastructures are safe, in good working order and are maintained properly to ensure that ships are not exposed to an unexpected risk;

(g) That contingency plans are in place and regularly reviewed after drills in the event of an oil or other marine pollution occurring. This is very important in the event of an accident occurring where prevention measures could be undertaken promptly to minimise damage to the marine environment;

1.5 Expected Results

There is currently no information available in consolidated form in the area proposed for this research, except a SPREP study “Marine Pollution Risk Assessment for the Pacific

Region” done in 2002 (Anderson et al). This situation can lead to subjective and unsubstantiated statements being made by various parties on the subject. It is hoped that this research will fill in this information gap for the benefit of the maritime industries, governments, the public and tourism related industries.

It is timely to carry out this research to determine if there are marine pollution risks when ships are in seas and ports of PICTs, and, if there are risks, to develop policies and prioritised actions to prevent ship-generated marine pollution occurring which are submitted as recommendations at the end of the thesis.

The data used in this research were collected during this researcher’s country visits to nine PICTs in 2000, were analysed and three internal and nine external indicators to the ship were identified to be relevant to the thesis topic. Each indicator was calculated using the formula: risk = threat x vulnerability x consequences. The SMPI for each PICT was calculated by aggregating the values of the risk indicators and ranked in a table. From the outcome of the risk assessments for each PICT, policies and strategies are proposed that would assist PICTs in reducing or eliminating ship-generated marine pollution risks.

The development and establishment of the SMPI should identify the risks involved and causes of ship-generated marine pollution in each of the nine PICT ports. By analysing the SMPI and considered together with issues and background information such as trade, shipping, economies, regulatory framework and international conventions, it is possible to formulate policies and prioritised actions to assist PICTs in preventing ship-generated marine pollution from occurring. It is then up to each PICT government to decide with the view to adopt in full or in part or reject the recommendations contained and submitted in this research.

The implementation of sound sustainable management of the marine environment remains the exception rather than the rule in PICTs. At times, critical information such as scientific, legal, economic and social goals are lacking, or that they are available but poorly communicated and not used, will make it the more urgent that governments have a

clear understanding of the sources, severity and distribution of environmental problems so that wise, realistic decisions are made.

New communication technologies increasingly empower individuals, organisations and governments to be better informed and also express their views in matters related to the marine environment, if they wish to do so to influence decisions on these matters. Given the increasing interest by the general public in preserving the environment for contemporary use and for future generations, and the past history of shameful misuse and abuse of it through greed and ignorance, it is timely to carry out this research that will provide meaningful conclusions to PICTs.

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- 1 Pacific islander is used in a general sense meaning the indigenous inhabitants and naturalised citizens of countries from Melanesia, Micronesia, and Polynesia including the nine PICTs used in this research.
- 2 Exclusive Economic Zone is the sea area a country is entitled to impose jurisdiction in the exploitation, exploration and management of the living and non-living resources on the ocean, above and below the sea bed, as prescribed under the United Nations Convention on the Law of the Sea, 1982 (UNCLOS). The sea area is determined by drawing 200 nautical miles out to sea from baselines determined along the coast of a country in accordance with criteria under UNCLOS. Where two countries' 200 miles meet then the median line is the boundary and this is usually agreed to between the two or more countries involved.
- 3 State as defined in The Concise Oxford Dictionary, an organised political community under one government. It is often referred to as a Sovereign State and is recognised as having equal status by other States.
- 4 Territory has the meaning a country that has not been granted full rights of a State by the metropolitan power ruling or looking after it since colonial times. In the Pacific, examples are French Polynesia, New Caledonia and American Samoa.
- 5 Country has the meaning the territory of a nation. A nation is defined by The Concise Oxford Dictionary as " large number of people of mainly common descent, language, history, etc. usually inhabiting a territory bounded by defined limits and forming a society under one government.
- 6 Over 700 vernacular languages and many more dialects spoken. English is the official language of Government, commerce and education. Widely spoken are pidgin and motu (Papua New Guinea : Shipping, Transport & Aviation, 1995 : 6) .
- 7 Fiji recorded tourist arrivals of 371 342 and French Polynesia 188 933 in 1998 (Tourism Council of the South Pacific : 1997 – 1998 Annual Report), with the rest of PICTs in smaller numbers.
- 8 Tuvalu has one Director of Marine and 1 assistant with a couple of clerical staff in support services to administer 900 000 square kilometres EEZ. Kiribati has one Director of Marine and 2 assistants with 4 support staff (personal discussion with A.Miteti, Director of Marine) to administer 3.55 million square kilometres EEZ (Fairbairn 1993 :6) .
- 9 Generally used shipping terminology on approximate size of oil tankers :
- | | |
|-----------------------------------|--|
| Ultra Large Crude Carriers (ULCC) | 300 000 tonne carrying capacity and over |
| Very Large Crude Carriers (VLCC) | 150 000 - 299 999 tonne |
| Suezmax | 100 000 - 149 999 tonne |
| Aframax | 50 000 - 99 999 tonne |
- (UNCTAD, 1999 :x)
- 10 Oil pollution from ships was first recognised as a problem during World War I but was not the same scale as those in World War II due to the fuel used and the sizes of ships involved in those wars. World War I ships were generally smaller and some still used coal and some oil as fuel but World War II ships were much bigger and all used oil for fuel. Furthermore, the merchant and naval fleets involved in World War II were the biggest in numbers in history.
- 11 International Association of Independent Tanker Owners was established in 1970 by oil tanker owners from all over the world to represent the interests of its members now comprises 259 member companies with 2000 oil tankers, equal to 161.4 million

tons deadweight or cargo carrying capacity. About 76 per cent of the current global tanker fleet is independently owned with 70 per cent of this are members of Intertanko. Its mission is that it is committed to working for safe transport, cleaner seas and free competition.

(web site <http://www.intertanko.com/about/mission/>)

- 12 Fiji's gross foreign exchange earnings, including "leakages", has exceeded those of sugar. Western Samoa's tourism receipts was nearly equal to total export earnings estimated at US\$14 million (Fairbairn, 1993 :47,55). In 1997 it was US\$294 million and US\$40 million respectively (Annual Report 1997 - 1998, Tourism Council of the South Pacific). Leakages is the amount of money paid for goods imported to cater for the needs of the industry such as food, drinks, etc., and is estimated to be as high as 75 % of foreign exchange earnings received from tourists (estimates from the Central Planning Department, Tonga).
- 13 The SMPI is designed to identify the risks to cause marine pollution in PICTs which is one part of the thesis topic i.e. identification.
- 14 Canoe sizes varied but it would reach about 100 feet in length for voyaging canoes (web site <http://tjunior.thinkquest.org/3542/Life/hokulea.html>). Canoes had two independent hulls - hollowed or solid and connected together by a wooden platform on which some kind of shelter (probably made of coconut leaves or leaves of other plants) was constructed. Probably fitted with one wooden mast and a triangular sail made from mats.
- 15 Prototypes of nuclear powered merchant ships were built in the United States (passenger/cargo ship *Savannah*), Japan, West Germany and the USSR (starting with the nuclear icebreaker *Lenin*) in the late 1950s to early 1960s. They were plagued by technical problems and there were no more nuclear powered cargo ships built for trading purposes ever since.
- 16 These special tanks are called double bottom tanks (DB tanks as they are normally called by seafarers). There were widely fitted in ships at the beginning of the 20th Century to provide increased safety in the event of bottom shell damage , and also provides liquid (such as oil) tank space low down in the ship's hull for stability purposes. The top parts of these tanks form the cargo hold floor.
- 17 Cruise liner *Fair Princess* carries 4168 tonne of bunker oil, the cargo vessel *Fua Kavenga* carries 593 tonne of bunker oil onboard are examples of the range of vessels operating and trading in the region.
- 18 Total tonnage of sea-borne trade in 1995 was 3385 million, including – crude oil and oil products of 1263 million; iron ore was 311 million; coal was 276 million.
- 19 Dangerous cargoes under the IMDG Code are classed as follows :
 - Class 1 : Explosives
 - Class 2 : Gases
 - Class 3 : Flammable Liquids
 - Class 4 : Flammable Solids
 - Class 5 : Oxidisers and Organic Peroxides
 - Class 6 : Toxic Substances
 - Class 7 : Radio-actives
 - Class 8 : Corrosives
 - Class 9 : Miscellaneous or Multiple Labels

The IMDG Code is mandatory on 1 January 2004 but it also contains some recommendatory provisions. In the Code the use of “shall” indicates that the specific provision is mandatory but the use of “should” indicates that the provision is recommendatory.

- 20 In 1979 the *Happy Giant* was built in Japan and also other similar sized oil tankers. This was necessary as global oil price increased by about 60 per cent in 1979 in real terms and the main source of oil was the Middle East countries. The development of the North Sea oil fields and other alternate energy sources such as coal made these Ultra Large Crude Carriers (such as the *Happy Giant*) uneconomical to operate due to decreased distances and the amount required to be transported (Wijnolst, 1997:67,339) and they were rarely used in the late 1980s and were later scrapped.
- 21 It has been estimated in 1990 that oil pollution from ships has decreased by 60 per cent since 1981 from 1.47 million to 0.59 tons per year due to IMO’s work in having safe ships and clean seas in many forms.
- 22 Marpol 73/78 technical annexes are -
 Annex 1 – Regulations for the Prevention of Pollution by Oil
 Annex 2 – Regulations for the Control of Pollution by Noxious Liquid Substances
 Annex 3 – Regulations for the Prevention of Pollution by Harmful Substances
 Annex 4 – Regulations for the Prevention of Pollution by Sewage
 Annex 5 – Regulations for the Prevention of Pollution by Garbage
 Annex 6 – Regulations for the Prevention of Pollution by Air {entered into force on 19 May 2005.
- 23 This is encapsulated in Agenda 21, Chapter 17 of the Rio de Janeiro declarations in 1992. Basically there were three important principles for the management and sustainable development of ocean resources which were integrated, precautionary and anticipatory.
- 24 The London Convention 1972 basically prohibited certain wastes from being dumped at sea, the other wastes require a permit to be dumped at sea, subject to certain criteria stated in the Convention.
- 25 An example – the bulk carrier *Oceanus* of 38 891 gross tonne (carrying capacity), speed 15 knots and carrying bunker oil of about 2 200 tonne went aground in the Federated States of Micronesia at Satawal Island with a cargo of phosphate in 1994 (Preston et al, 1997:67).
- 26 Kiribati owns the *Nei Matagare* a general cargo/container vessel, Samoa owns the ro-ro/container vessel *Forum Samoa*, and Tonga the *Fua Kavenga* that are used in international trade. The word ‘vessel’ is used interchangeably with ‘ship’ but a vessel includes a ship and other watercraft used for transportation on water.
- 27 See endnote 8 above.
- 28 Due to lack of control by some countries in implementing onboard ships registered in those countries of the provisions of international conventions to which they are Party to. And also ships of some countries not Party to those international maritime conventions when visiting a port of another country has to be determined by the authorities in that country if those ships are safe to visit its port and work there. The determination by authorities in that port, if a visiting ship is safe or not, is a Port State Control activity.
- 29 This is especially so in harbours with a fjord type of configuration or closely bounded by reefs such as Suva, Pago Pago, Apia, Papeete and Apra (Guam), to name a few.

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- 30 It has been reported that chemicals used to clean up the *Exxon Valdez* oil spill in Alaska did more damages to the eco-systems due to the toxicity of the cleaning chemicals used. This is an useful lesson for PICTs as a viable option in not using toxic cleaning chemicals in the event of an oil spill.
- 31 Examples are – Kiribati which has 5 passenger/cargo vessels, Solomon Islands has 23 passenger/cargo vessels operating in local routes (Data collected by researcher from marine and port authorities on country visits in 2000)
- 32 Country visits of average duration of 2 weeks for each group of countries by the researcher – to Polynesian countries in April, Melanesian countries in May and Micronesian countries in August 2000.
- 33 It was agreed by leaders in the Palau Forum Meeting in 1999 to change the name from South Pacific Forum to Pacific Islands Forum and the new name will be used beginning in the 2000 meeting at Tarawa, Kiribati.
- 34 Gross tonnage (GT), strictly speaking, consists of the sum of the following :
- (a)The under deck tonnage of vessel below tonnage deck.
 - (b)The tonnage of between deck space between second deck and the upper deck.
 - (c)The tonnage of permanently closed-in spaces, on or above the upper deck.
 - (d)The excess of hatchways.
 - (e)At owner’s option – engine light and ventilation spaces on or above the upper deck.
- Tonnage in relation to any space in a ship is measured in terms of cubic capacity, 100 cubic feet representing one ton. Charging of port fees are usually based on GT when commercially operated vessels call into a port. Commercially operated vessels means vessels not being a warship, naval auxiliary, Government owned ship or operated on non commercial service, yacht of less than 35metres long and of traditional built.
- 35 The objectives of the ISM Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular, to the marine environment, and to property. The safety management objectives of the shipping company are to be in accordance with the provisions of the Code.
- 36 The study also identified that fleets sailing under open registers account for 24 per cent of all shipping losses. Furthermore, an analysis over a longer period, from 1970 to 1983, indicates that the casualty rate is substantially higher than for regulated fleets and also the world average.

2.0 Physical Features, Economies, Trade and Shipping - Overview of Pacific Island Countries and Territories (PICTs)

2.1 Physical Features

2.1.1 Introduction

The Pacific region is characterised by its diversity in geological structures and the degree of dispersion of islands. There is no part of the ocean on this planet that has so many dangerous reefs, shoals and banks rising abruptly from great depths as in the Pacific Ocean. The region also has deep troughs, submerged volcanic mountains and oceanic volcanic islands and prone to frequent and sometimes severe earthquakes, mudslides and tsunamis. Interactions between tectonic plates caused basaltic lava to flow out of rifts to build huge dome-shaped volcanic mountains whose eroded summits form island arcs, chains and clusters. A detailed description of this process is contained in the next section and its main link to the subject of the thesis is to explain the physical characteristics of islands in PICTs and identify the potential risks to ships when navigating at sea and in entering their ports. For example, a shoal¹ about 1 mile long was only discovered and charted approximately 42 miles westward of Late Island in Tonga in the 1993 (see nautical chart NZ 82 – Tonga) which is located in waters used by ships trading between the United States west coast and Australia and New Zealand. The Late and Tofua Islands area, including Metis shoal, have active volcanoes on land and at sea. Furthermore, formulating of a contingency plan would be tailored to the

physical characteristics of an island or port of a PICT in the event of an oil spill occurring.

Physical – geological features of PICTs could be viewed as belonging to one of the following three categories (Fairbairn 1993:3):

- (1) Complex serpentine formations such as those found in Papua New Guinea, Solomon Islands and New Caledonia. These islands are big and contain river systems and natural resources such as gold and tropical forests.
- (2) High volcanic structures such as the two Samoas and Rarotonga in the Cook Islands. These islands are similar to the first category but of smaller land masses.
- (3) Coral atolls such as the Marshall Islands, Tokelau and the Northern Cook Islands. These islands are mostly small, flat, low lying and lack land based resources.

The presence of physical resources like tropical forests, gold and copper in some PICTs such as Papua New Guinea, Solomon Islands and Fiji attract foreign investors to cut or mine them. Tropical forests are located inland far away from the main ports and logs are somehow transported from the inland areas to the most convenient and nearest coastal site with an anchorage area that are poorly charted, exposed and may be just inside breaks in the fringing reefs. This situation is a recipe for disaster such as when a vessel engaged in the transportation of logs running aground in these loading anchorages and spilling oil. On the other hand, main ports or properly constructed minor ports are used for handling copper and gold shipments which pose lesser risk of ships running aground and spilling oil causing marine pollution. Deep sea-bed minerals such as cobalt and manganese nodules have been discovered by scientists in PICTs' waters but the technology and cost of mining them is not yet feasible in the near future (SOPAC: 2000). However, the recent discoveries within PICTs' EEZs of cobalt-rich manganese modules (Cook Islands), cobalt-rich crust (Federated

States of Micronesia, Marshalls, Kiribati and Tuvalu), and of high grade, gold bearing massive sulfide deposits (on the sea floors of Fiji, Tonga, Papua New Guinea and Japan), the prospect of mining them is becoming closer to reality. In case that these minerals are developed, environmental problems are anticipated to occur. The complex and inter-dependent ecosystems associated with such development will have far reaching impact on each PICT, regional and international such as fisheries. Economical, social, sustainable responsibility issues on developing these minerals will also be assessed and monitored carefully and continuously to prevent any major adverse effects occurring. The Madang Guidelines have been developed by the South Pacific Applied Geoscience Commission (SOPAC) to assist member countries (that include the nine PICTs in the research) in dealing with the control of offshore mineral exploration and development.

In 1994 the United Nations Environmental Programme (UNEP) launched a Regional Seas Programme to address urgent environmental problems world wide. The reasons behind this programme were that although marine pollution is a global problem, it is best implemented through regional cooperative programmes. In addition, most of the marine pollution is caused by land based activities and sources. The Regional Seas philosophy embodies collective work in addressing trans-boundary issues concerning the marine environment and it was quickly adopted in the Pacific region, for example, the Forum Fisheries Agency Convention (fisheries management on a regional basis) and the Rarotonga Treaty (nuclear testing and radioactive waste disposal in the Pacific).

In the past decade, PICTs have consistently raised in international fora their concerns about their vulnerability to natural disasters such as cyclones/typhoons, drought, floods, volcanic eruptions, tsunamis and sea level rise. Furthermore, their interaction with other factors such as remoteness from markets, geographical

dispersion, limited natural resources and small internal markets would seriously inhibit their development. These concerns were recognised at the Global Summit on Small Island States held in Barbados in 1994, where the Barbados Plan of Action was agreed to, that an environmental vulnerability index be developed. The index was planned to be tabled in the UN General Assembly special session on Small Island Developing States of the world (including PICTs) in September 1999. These goals were achieved and further work are being undertaken SOPAC and the Forum Secretariat, to combine it with an economic vulnerability index to give a composite index that would greatly assist the formulation and implementation of development plans of PICTs.

2.1.2 Geological Formation and Structural Features

The earth is estimated to be approximately 4.5 billion years old and it is made up of five parts. The first is the atmosphere (gaseous) that surrounds the globe and has a thickness of more than 1100 kilometres with about half of its mass being concentrated in the lower 5.6 kilometres. In the second part is the hydrosphere (liquid) in the form of oceans and all water surfaces on earth cover 70.8 percent of the its surface. Average depth of the oceans is 3794 metres which is more than five times the average height of continents ("Earth (planet)", Microsoft Encarta Online Encyclopedia 2001). In the third is the lithosphere comprising of the cold, rigid, rocky crust of the earth that extends to depths of about 100 kilometres from its surface. The fourth and fifth are the mantle and core (at the centre of the earth) respectively that are largely solid.

The crust and upper mantle are divided into a dozen or so rigid tectonic plates². The crust consists of two parts; first the upper crust or sialic which contains

granite type rocks found in continents; the second is the lower crust or simatic contains igneous rock, such as basalt, forms the floors of the ocean basins.

A chain of dead volcanoes forms as a plate moves over a plume³ deep in the mantle. These plumes stay in one spot, and each one creates a hot spot⁴ in the plate above the plume. These hot spots can form into a volcano on the surface of the earth and may eventually evolve into a volcanic island. Alternately it can sink below sea level and becomes a seamount. Limestone can grow on the top part of the seamount if the temperature is right, and developing into a coral reef and then eventually into an atoll.

2.1.3 Islands

Oceanic islands⁵ (Nunn 1994:3) can be classified as plate boundary islands or intraplate islands. The former is composed of islands at the convergent or divergent plate boundaries and also along the transverse plate boundaries⁶. Islands in active convergent plate boundaries are generally volcanically and/or tectonically active and groups form in arc patterns which are widespread in the western Pacific. Islands in the divergent plate boundaries are usually volcanically active associated with tectonic movements in both a vertical and a lateral sense, Niuafu'ou in Tonga is an example.

Intraplate islands include linear or isolated or clustered group of islands. Linear island groups are thought to have been formed either at a fixed point or along the fissure and many islands change in size and age along the group, and Hawaii, Marquesas and Tuamotu groups are examples. Isolated islands may be part of a group which are forming or being destroyed, Easter Island is an example.

Clusters of islands may have been formed where new plate boundaries are either developing or disappearing, Galapagos is an example.

This general genetic classification of oceanic islands is based on the location of islands relative to the plate boundaries (Nunn 1994:10) and the geological activities in those boundaries. Grigor'yev (1971, as quoted by Nunn) identified six major types of island and nineteen subtypes within each and generalised about size⁷, geomorphology, climate, drainage development, fauna and flora. The problem with this explanation is that there is no clear link between the type of lithosphere underlying a particular island and many of these characteristics (Nunn 1994: 9).

Another descriptive classification of islands is atolls⁸, which have long been regarded as unique types of islands in the middle of the oceans. This is misleading as an atoll began as a fringing reef around a volcanic island. Over time, the volcano stopped erupting, and the island began to sink. It is believed that this fringing reef over time became a barrier reef as the island gradually sank and a lagoon formed between the reef and the island. Coral growth at the reef's outer edge would push the top of the reef above the water forming over time an atoll, as the original volcanic island sank.

Oceanic islands have different types of landscapes depending on the geological activities at or near the plate boundaries. Most of the oceanic islands can be identified with volcanic, limestone and composite⁹ island landscapes. A volcanic island formed from a newly extinct volcano has a cone shape feature which over time can be changed by erosion resulting in the development of radial drainage (rills, furrows), for example, Kao Island in Tonga. Where the volcanic island is small, marine erosion can cause high cliffs along the coast and giving rise to

volcanic plateau, for example, Savai'i Island in Samoa. Big volcanic islands may exhibit amphitheatre-headed¹⁰ valleys and calderas¹¹ characteristics, for example, Totoya Island in Fiji. .

Atolls are made primarily of limestone (of great thickness) accumulated over time, from mainly corals and coralline algae. The temperature of the ocean controls whether corals can grow or not and coral growth is confined to a broad band in the tropics. Small dunes are usually piled up in atolls by limestone broken up by waves and deposited there by the wind. Outer shore of most atolls is made up of a narrow fringing reef, often with a smooth rim, and a steep narrow beach of broken or wave rounded limestone fragments (sand). As one travels from the beach to the centre of small or low lying atolls, the sand changes to rubble, then gravel and then a mucky soil. Big or high atolls in its centre may have an overlying soil developed from volcanic ash, which is fertile. Any groundwater lies very near the surface in low lying atolls and are usually brackish or salty but in big atolls the water tends to be fresh.

Coral reefs are ecosystems with well-defined structures that involve both photosynthetic algae and other forms of marine life higher in the food chain. Living polyps of coral live in the outer layer of a reef. Small coral photosynthetic animals¹² live together with the coral polyps and transfer some food energy to them. At night the coral animals feed on zooplanktons for scarce nutrients such as phosphorus. The coral animals excrete these scarce nutrients to the algae and they cycle the nutrients between them thus reducing nutrient loss to the water (Smith : 2001, Coral Reef, Encarta online). The productivity of the reefs and its microhabitats support a great diversity of marine life and also humans. Herbivorous fish, sea urchins, sea cucumbers and other species of mollusks feed on algae. Predatory marine animals such as crabs, moray eels and sharks live on mollusks and smaller fishes, and all of these provide as food for humans.

2.1.4 Ocean

The ocean and seawater are synonymous for the purposes of this research. Seawater is a dilute solution of several salts, mainly of sodium and chloride¹³, derived from erosion of continental rocks. The salinity of seawater¹⁴ is expressed in terms of total dissolved salts in parts per thousand parts of water, and is between 34 and 36 parts per 1000 in the high seas ([http://www.ocean98.org/fact .htm](http://www.ocean98.org/fact.htm)). Carbon, nitrogen, phosphorous, oxygen, trace elements, inorganic and organic nutrients are also present in seawater which are very important to marine life (<http://www.ocean98.org/fact .htm>).

The productivity for a given area of natural shallow estuary is similar to that of most productive land crops. A given area in an ocean upwelling zone or deep estuary is as productive as the same area in rain forests, moist crops and intensive agriculture which is between 150 to 500 grams of carbon per square metre per year (<http://www.ocean98.org/fact.htm>). In the open ocean the productivity is between 40 and 60 grams of carbon per square metre per year, which is similar to that found in deserts and grasslands.

Of all life on earth, about 80 percent is found under the ocean surface (about 275 000 ocean species known to man), and the oceans contain about 95 percent of the habitat space on earth (<http://www.ocean98.org/fact.htm>). The first plants on earth, the algae, developed in the sea 3.5 million years ago. They give off oxygen as they produce food, and they produce over half of the oxygen that we breathe. The tiniest sea creatures are the microscopic plankton and they form the basis of the ocean food chain on which all higher animals depend. The giant kelps are the

fastest growing plants in the world for they can grow up to two feet in one day, in warm water (<http://www.ocean98.org/fact.htm>).

Sound travels about five times faster in the ocean than in the air. The density of ocean water varies and it becomes denser as it becomes colder, right up to its freezing point of -1.9 degrees Celcius. Fresh water is most dense at 4 degrees Celcius, well above its freezing point. Seawater can reach very high temperatures in the deep ocean without boiling due to the enormous pressure involved. A water temperature of 400 degrees Celcius has been measured at one thermal vent but the average temperature of ocean water is about 3.5 degrees Celcius (<http://www.ocean98.org/fact.htm>).

Friction between wind, which supplies the energy (kinetic)¹⁵, and water create waves. Higher or bigger waves need more energy. Water is not replaced behind as waves move forward. The typical height of wind waves (sea state) is determined by the speed of the wind, the length of time the wind has been blowing steadily (duration), and the distance over the water that the wind blows in one direction (fetch). Ocean waves generated by wind continue to travel after the wind stops blowing. Longer waves travel faster than shorter ones, and also go farther before friction causes them to disappear. Waves usually break on reefs or on shoals if they are quite shallow.

Earthquakes, volcanic eruptions and tides also cause waves. Geologically generated waves called tsunami¹⁶, can move as fast as 800 kilometres per hour (<http://www.ocean98.org/fact.htm>). Seiche waves are formed by the rocking movement of water inside an enclosed harbour or bay. Sometimes underwater waves exist between two layers of water of different densities. Tides¹⁷ are not

waves but are caused by the gravitational attraction between the moon and the earth resulting in high waters and low waters.

Over the past 100 years the sea level has risen an average of 10 - 25 centimetres and scientists expect it to continue rising even if the climate has stabilised, as the ocean reacts slowly to change. It has been estimated that the sea level 10 000 years ago was about 110 metres lower than it is now, but the oceans would rise by about 66 metres if all the world's ice melted (<http://www.ocean98.org/fact.htm>).

The earth's rotation, wind friction at the surface of the water, and variations in seawater density due to differences in temperature and salinity are the driving forces for ocean currents. In the deeper areas of the oceans, currents are caused by the density differences between water masses and is known as thermohaline circulation (example is the Weddel Sea, off Antarctica). Climate is greatly affected by the interaction between wind and current which is also vital for long-range weather prediction and the routing or planning of sea passages.

2.1.5 Wind Systems

The northern and southern hemispheres (in the Pacific Ocean) from 30 to 60 degrees latitude have each a belt of westerly winds, that vary in seasonal patterns. The North Central Pacific has stormy and unpredictable westerly winds that researchers are now studying to determine if it has a controlling influence on global weather systems. Towards the equator are the steady trade winds that blow from the northeast in the northern hemisphere, and from the southeast in the southern hemisphere.

In the tropical areas of both hemispheres, sometimes violent tropical revolving storms are formed in early summer and late autumn, and they move away from the equator wreaking havoc in PICTs and shipping in the region, then weakened and disappear or join with other pressure systems in the higher latitudes. These tropical storms are called typhoons in the western Pacific, and hurricanes or cyclones in the southern and eastern Pacific. The equatorial doldrums are light winds with seasonal cyclonic activity at the equator.

In the northern hemisphere the wind belt associated with a tropical revolving storm or low pressure moves along the isobars in an anti-clockwise direction towards its centre or "eye". In the southern hemisphere the wind belt moves in a clockwise direction along the isobars towards its centre. In high pressure systems, the wind belt moves in a clockwise direction along the isobars and away from the highest pressure in the northern hemisphere but in an anti-clockwise direction in the southern hemisphere.

Wind direction and strength experienced in each PICT is influenced by the position of a pressure system relative to it and how fast the pressure system transits a PICTs' waters. When no definitive pressure system affect a PICT, sometimes localised light to moderate sea or land breezes occur in PICTs that have big islands but in low lying atolls the distinction is usually masked. Winds caused by pressure systems will replace any sea or land breezes.

2.1.6 Climate

Climates of PICTs are affected mainly by external influences such as ocean circulation and atmospheric circulation. The former is by ocean currents and upwelling and sinking of bodies of water; the latter by the wind system and

columns of rising and falling air. At times the normal variations of these four factors do not occur, tropical cyclones and those associated with the El Nino – Southern Oscillation (ENSO) phenomenon occur and severely affecting PICTs which in turn had serious impacts on their economies. For example, during the prolonged droughts in 1998, Fiji lost two-thirds of its newly planted sugar cane that had an equivalent to 3 percent of GDP (SPREP:2000, Pacific Island's Framework for Action on Climate Change, Climate Variability and Sea Level Rise).

2.1.7 The Nine PICTs

This research focuses on nine PICTs, comprising American Samoa, Samoa, Tonga, Kiribati, Marshall Islands, Guam, Solomon Islands, Fiji and Papua New Guinea gathered when the author made his visits to these countries during 2000. Each PICT's physical features, climate, some hazards to navigation and current environmental issues are briefly discussed. The principal ports in most cases, also capitals of PICTs, are discussed in some detail as their physical characteristics will form the basis for assessing some of the external indicators in determining the SMPI. Description of each PICT and ports, such as geographical position, port operations and infrastructure was based on the British Admiralty Sailing Directions Volumes I and II. Distances between wharves and also to other places inside a port were measured by the author using appropriate navigational charts.

American Samoa is an unincorporated territory of the United States of America and consisting of seven islands. Tutuila being the biggest island where the capital, Pago Pago, is located at the eastern side of the island in Latitude 14 degrees 17 minutes South and Longitude 170 degrees 40 minutes West. Manua Islands, consisting of four islands, lie 83 kilometres (km) eastward of Tutuila

Island. Both Tutuila and the Manua Islands are formed from remains of extinct volcanoes resulting in today's central mountain ranges with narrow coastal plains which are covered with rain forests. Rose Island is a circular atoll lying 117 km eastward of Manua Islands and it is not inhabited. The island is a wild life sanctuary and special permission is required to visit there. Swain Island, lying about 333 km northward of Tutuila Island, is an atoll 2.5 km diameter with a brackish lagoon inside. The climate of the group is tropical with high temperatures and humidity and has an average daily temperature range of 20 to 31 degrees Celcius. High annual rainfall of up to 3 000 millimetre, with the heaviest falls during the cyclone season (November to April). In December 1991, cyclone 'Val' caused damages in American Samoa of US\$80 million (American Samoa: Encarta ® Online Deluxe).

Pago Pago harbour is a natural deep-water harbour, with depths of up to 69 metres, some narrow fringing reefs and a narrow coastal plain backed by mountainous land. The town lies round the north, south and west shores of the harbour where some mangrove swamps are found. Entrance to the harbour is from the east through either side of Whale Rock passage which is 400 metres wide at its narrowest points. The harbour area at its longest and widest parts is approximately 3 km in an east-west direction and 1 km north-south respectively. The port area lies in the inner part of the harbour and navigation aids inside the harbour are good and adequate in numbers. The Main Wharf and Fuelling Wharf in the south of the inner harbour is each about 122 metres long with depths of up to 11 metres alongside which can accommodate cargo ships and oil tankers of up to 135 metres long. The pilotage distance from the entrance passage to the Main Wharf (the inner-most wharf) is 3 km. The Cannery Wharf in the northern part serves the two fish canneries and is smaller than the other two wharves. The inner harbour is safe for anchoring purposes and two tug boats are available for mooring and unmooring of ships.

Samoa (previously known as Western Samoa until 1997 when it became officially known as Samoa) is an independent island nation, made up of nine islands. The islands of Savai'i (land area of 1709 sq.km) and Upolu (1114 sq.km) comprise 99 percent of Samoa's land (Samoa: Encarta ® Online Deluxe) and both are of volcanic origin. Their interiors are mountainous and lie in an east/west direction (the highest peak is Mount Silisili (1858m) in Savai'i) and they are covered with dense rainforests that contain hardwood trees. Towards the sea are fertile plateaus and coastal plains with numerous rivers and streams. Out of the other seven islands only Apolima and Manono (which are located between Savai'i and Upolu) are inhabited. The climate is similar to American Samoa with little seasonal variation. There is heavier rainfall in the windward side (east and south) of Upolu. About two thirds of Samoa's population live in Upolu in ocean-side villages. The capital, Apia, is located on the northern coast of Upolu in Latitude 13 degrees 49 minutes South and Longitude 141 degrees 46 minutes West.

Apia Harbour is the principal port of Samoa and the town lies mostly round the south side of the harbour. A large area of mangrove swamps to the south of the harbour. The entrance to the harbour is a break between two reefs approximately 463 metres wide at its narrowest point and Pilots board 5 km north of entrance. The Main Wharf is about 300 metres from the entrance and the depth of water alongside is 9.4 metres. The harbour area is approximately 0.5 km north-south and 1 km east-west direction and navigation aids are good. Two tug boats are available for mooring and unmooring of ships. Cargo ships anchor 5 km or more northward of the entrance as it is not safe for big ships to anchor inside the harbour because of its small size. Oil tankers (of up to 30 000 dwt¹⁸) are anchored and moored to three mooring buoys in the western side of the entrance and oil is pumped ashore through a submerged pipeline tied to two smaller buoys located to the south. During the Northern Hemisphere's winter, northerly sea

swells could cause quite severe surges inside the harbour and ships had to leave the wharf quickly and anchor outside the harbour for one or two days.

Tonga, the only remaining Polynesian monarchy, is comprised of over 150 islands and are divided into four main groups – Tongatapu (including ‘Eua Island), Ha’apai, Vava’u and the Niuas (Niua Fo’ou and Niuatoputapu). Tongatapu is the largest island (280 sq. km) where the capital, Nuku’alofa, is located at the north coast in Latitude 21 degrees 08 minutes South and Longitude 175 degrees 11 minutes West. An extensive lagoon is in the interior of the island with an entrance from the north. Tongatapu, islands in the east of the Ha’apai Group and some islands in the Vava’u Group are of coral formations surrounded by extensive reefs. ‘Eua Island, islands in the west of the Ha’apai group, most islands in the Vava’u Group, and the Niuas, are of volcanic origin with fertile soil with some rainforests. Tofua Island, approximately 150 km northwest of Tongatapu has an active volcano in its centre and to the north at Metis Shoal there was volcanic activity in 1993 resulting in the creation of an island 80 metres high. Submarine volcanic eruptions have been reported in waters between Tonga and Fiji and extended fields of floating pumice have been encountered, as reported in 1984 (Pacific Islands Pilot Volume II 1984:2), which could foul a vessel’s sea water (cooling) inlets and damage the engine cooling systems onboard. A barrier reef to the east of the Ha’apai Group extends the length of the group in a north/south direction. Tongatapu, Ha’apai and Vava’u Groups extend for about 330 km in a north of north east/south of south west direction, and the Niuas about 420 km north west of the Vava’u Group. About 40 islands are inhabited. The climate is tropical, modified by the trade winds and the average daily temperature range is 16 to 29 degrees Celcius with an average annual rainfall of 1 610 millimetres (Encarta ® Online Deluxe). Cyclone season is from November to April which is summer and also the wettest season. ‘Waka’ is the last cyclone to hit Tonga was on 31st December 2001 causing damage of over Tongan \$100 million (Tonga Government estimates). The International Dateline was diverted

and it passes to the east of Tonga making the local time equal GMT +13 hours but should have been GMT –11 hours¹⁹ based on its actual longitude.

The principal port is Nuku'alofa which can be entered through Ava Lahi Passage (the main passage) from the north, Egeria Channel from the west, and Piha Passage from the east. Most ships use Ava Lahi Passage (depth of 12 metres) and the narrowest point is 0.5 km between reefs, and the pilotage distance is 20 km to Queen Salote Wharf (main wharf). Nuku'alofa is a natural harbour basin with deep water area about 8 km in an east-west direction and 5 km north-south with coral reefs and small low lying islands used for tourism purposes. A large area of mangrove swamps in the east and west parts of the harbour. Inside the harbour area there are good navigation aids and big ships can safely anchor in there. Ships of up to 244 metres long can berth at the main wharf. Small oil tankers of 2 000 gross tonnage use two dolphins on the fringing reef about 200 metres to the east of the main wharf for discharging purposes through a pipeline there. Strong north winds or sea swells may force smaller ships to leave the wharf and anchor off due to surging at the main wharf. One tug boat is available for mooring and unmooring purposes.

Kiribati (pre-independence name was the Gilbert, Line and Phoenix Islands) gained full independence from the United Kingdom in 1979 and its capital Bairiki is at Tarawa Atoll where the port (Betio Island) is located in Latitude 1 degree 21 minutes North and Longitude 172 degrees 56 minutes East. Kiribati is divided into three island groups – Gilbert Islands, Phoenix Islands and the Line Islands, and consists of 33 coral islands. Except for Banaba (formerly known as Ocean Island of phosphate mining fame until 1979, with an elevation of about 80 metres) all are ring- shaped atolls that seldom rise to more than 4 metres with a central lagoon. If the sea level rises, most of Kiribati's islands will be adversely affected due to its low elevation. It straddles the equator and 21 islands are inhabited,

mainly in the Gilbert Group. The islands of Kiribati stretch out to about 4 000 miles from east to west and about 2 170 km from north to south. The low atolls have infertile sandy soil which limits the growth of trees to mainly coconuts, pandanus and breadfruit. The primary source of fresh water is rain water collected in catchment systems although treated well water is available but of poor quality. Kiribati has a hot and humid tropical climate with average annual temperature range of 22 – 33 degrees Celcius, and with an average annual rainfall (falls from October to March) of 3 050 millimetres in the north to about a third of this in the south of the group. Most of Kiribati is out of the cyclone zone but some westerly gales occur from November to February.

Betio is the principal port in Kiribati and has a passage to the south-west that ships with a draught of 7 metres could enter at any state of the tide. The pilotage distance is about 7 km and the narrowest points in the passage are 0.2 km apart. Aids to navigation are satisfactory; the harbour area for big ships is 3 km in an east-west direction and 2 km north-south. The main wharf is 129 metres long with a depth alongside of about 5 metres. Small oil tankers with up to 4 metres draught normally anchor off the eastern part of the harbour and discharge through floating hoses. Liquid petroleum gas is imported in specially constructed containers. There are small wharves in the harbour for fishing boats and inter-island trading ships.

The **Marshall Islands** gained independence in 1986 but has a Compact of Free Association with the United States. It consist principally of two chains of atolls of about 30 and 1 152 (CIA:2000 World Factbook) low-lying coral islands and islets running parallel to each other in a northwest/southeast direction. These small islands lie on top of reefs and most of them encircle a lagoon. Majuro is the capital and principal port of the Marshall Islands and it is located at Majuro Atoll in Latitude 7 degrees 7 minutes North and Longitude 171 degrees 40 minutes

East. Most of the islands have elevations of 1.5 – 6 metres and the eastern side is usually steeper than the western side. Kwajalein Island is now being used as a United States missile testing range but it was a famous battleground during World War II. Enewetak and Bikini islands are former United States nuclear test sites from 1946 to 1962. Climate is hot and humid, and the wet season is from May to November. The group is located in the border of the typhoon zone. The types of vegetation are similar to Kiribati and lack of potable water is a problem. The runway of the international airport has drainages to collect rainwater in concrete catchments which are then treated and used.

The main entrance to the port of Majuro is through Calalin Channel to the north west of the lagoon, which is about 12 miles from the wharves. Calalin Channel is about 3 km long and 0.4 km wide at its narrowest points, with good aids to navigation. Ships can anchor safely in the lagoon and the harbour area is about 25 km in an east-west direction and 8 km north-south, with some shoals inside. The Main Wharf is 137 metres long with a depth alongside of 10.4 metres and it is located on the southern part of the harbour. Adjacent to the wharf is a turning basin dredged to a depth of 10.4 metres . There are also a number of smaller wharves for fishing boats and inter-island trading ships. A tug boat is available for mooring and unmooring of ships and the pilotage distance is about 22 km.

Guam is an unincorporated territory of the United States and the largest and most southern island in the Mariana Islands. It is the peak of a seamount located in the Marianas Trench surrounded by coral reefs. The northern and central parts are of relatively flat limestone plateaus with steep coastal cliffs and narrow coastal plains. This area is the source of most of the freshwater in the island from tributaries flowing from water collected in ancient fault-lines. The southern part is volcanic in origin and mountainous, rising to a height of about 400 metres. To the southwest at about 70 km from Guam, many dangerous shoals have been

reported in that sea area. The principal port is at Apra Harbour in the southern end of the island at Latitude 13 degrees 28 minutes North and Longitude 144 degrees 39 minutes East. There are big United States naval and airforce bases in Guam and surface, submarine and air exercises are often held up to 370 km from land. It has a tropical climate with average daily temperature of 24 – 30 degrees Celcius and high humidity. The rainy season is from July to early November with frequent squalls and at times a typhoon may hit the island during this period. Guam is highly vulnerable to typhoons, squalls and the low coastal plains may be affected by any sea level rise. About one-third of its total land area is occupied by United States military facilities (Guam – Country information-DFAT).

Apra Harbour is the only harbour in Guam that can be entered through a passage. It is 300 metres at its narrowest point in the southern part with a depth of about 20 metres. A north-south breakwater near the passage protects the port from strong winds and sea swells. Ships maintain a speed of 10 knots when they transit the passage because of strong cross currents. This natural harbour is divided into the Inner Harbour which is under the jurisdiction of the U.S. Navy (a restricted area), and the Outer Harbour which is the commercial port that includes a container terminal, several general cargo wharves and two tanker berths. There are four large shoals in the middle of the Outer Harbour but they are well marked with aids to navigation and the harbour is safe for anchoring purposes or tied to mooring buoys already laid there. Pilotage is compulsory on entering the harbour and the pilotage distance is 5 km. Ships of up to 100 000 tons could enter the harbour with 3 tug boats available to assist in berthing and unberthing operations.

The **Solomon Islands** gained its independence from the United Kingdom in 1978 and some of the bitterest fighting in World War II occurred in these islands. It consist of a double string of six large islands and a number of smaller islands spreading over a distance of about 1 500 km in a north-west/south-east direction

from the Santa Cruz Islands in the east and the Bismarck Archipelago in the west. Most of the islands are volcanic in origin and mountainous, rugged with dense forests and abundant undergrowth, with the larger ones having river systems. Some islands are coral limestone with extensive reefs. There are also mid-ocean reefs (Indispensable Reefs) with lagoons that extend up to 53 km long and isolated rocks on them could be seen from ships even in high water. Volcanic activities and sighting of emerged islands have been reported in the south side of New Georgia Group (Pacific Islands Pilot Volume I 1988:105) which poses a danger to navigation. The capital is Honiara and is also the principal port that is located at Latitude 9 degrees 25 minutes South and Longitude 159 degrees 58 minutes East. The climate is tropical monsoon with the highest temperature and rainfall from December to April, which is also the cyclone season. The range of daily average temperature in Honiara is 24 – 34 degrees Celcius with high humidity. The topography can cause modifications to local winds that could pose a danger to shipping; for example, significant increase in wind strength in a particular area by ‘tunneling’ effect when the wind passes through straits or headlands.

The port of Honiara is in a natural harbour in Guadalcanal Island with clear deep-water approaches at Lungga Roads except Pelope Shoal which is about 300 metres to the east of the Main Wharf. Pilotage distance is 1.5 km with one tug boat available for assistance to ships berthing and leaving the wharf. The Main Wharf is 120 metres long but ships of 200 metres long can berth at a depth alongside of 9 metres. Fuelling Wharf is located about 500 metres east of the Main Wharf. Yellow buoys mark the end of the submarine pipeline that are used for the discharging of various oil products ashore. Oil tankers of up to 14 metres draught can use this facility but they have to anchor out with both anchors in an east-west direction at a distance sufficient for their sterns to reach the yellow buoys.

Fiji became independent from the United Kingdom in 1970 and consists of more than 800 islands and islets (Fiji: Encarta ® Online Deluxe) with about 100 inhabited. The largest island is Viti Levu where the capital Suva is located in the south-eastern part, and the second largest is Vanua Levu; together they comprise more than 85 per cent of the total land area. The large islands are of volcanic origin, mountainous, rugged with dense forests and river systems, the largest is Rewa River in Viti Levu. Forests cover 46 percent (Encarta ® Online Deluxe) of the land especially in the windward side (eastern) while on the leeward side (western) have lush plains. Some of the smaller islands are coral formations and low lying with coconut trees. Many of the islands in Fiji are surrounded by fringing coral reefs but mid-ocean reefs also exist posing navigational hazards to ships trading in the area.

Fiji has a tropical climate with an average annual temperature of 25 degrees Celcius, but sometimes reaching 32 degrees Celcius, with high humidity. The cyclone season is December to April, which is also the hottest and rainy season. The windward side of Viti Levu receive rainfall of up to 3 300 millimetres annually, the leeward side about 2 500 millimetres.

During the years 1877 to 1977 Fiji has experienced 11 tsunamis, one was of 2 metres high in 1953 as a result of an earthquake which had an epicentre west of Suva and it took only a few minutes to reach Suva where three people drowned.

Suva is the principal port of Fiji and is located at Latitude 18 degrees 8 minutes South and Longitude 178 degrees 25 minutes East. Suva Harbour is a natural harbour, measuring about 1mile in a north-south and 3 km in an east-west direction, protected from the south by extensive coral reefs. Ships can enter the harbour from the south through the main channel, Daveta Levu, which is 0.6 km at its narrowest point, and the pilotage distance is about 5 miles. Navigation aids are good and the harbour is suitable for anchorage of ships of up to 20 metres draught although there are coral patches in the harbour area. Kings Wharf could

accommodate all types of ships, is 495 metres long with a depth alongside of about 12 metres, and the cruise liner Queen Elizabeth II (of 294 metres length and draught of 10 metres) is the biggest vessel to berth in this wharf. Lying in an east-west direction and adjacent to the north of Kings Wharf is Walu Bay Wharf, which is 183 metres long and a depth alongside of about 9 metres. The gas terminal, consisting of two mooring buoys, lies to the north of Walu Bay and there are other small wharves and jetties for local ships. There are three slipways – one of 1 000 tons capacity, one of 500 tons and one of 200 tons, that are available in Walu Bay for slipping and repair purposes.

Papua New Guinea, gained its independence from Australia in 1975. It consists of the eastern half of the island of New Guinea (referred to as the mainland) and several hundred smaller islands that extend from Latitudes 1 to 12 degrees South and from 141 to 156 degrees East. The western half is Irian Jaya which belongs to Indonesia. The mainland's central highland and some islands are of volcanic origin have rugged, high mountainous interiors with broad valleys and dense tropical rain forests. Some islands such as Trobriands are of coral formations and low lying. The coastline of the mainland is mostly low lying and is deeply indented by river mouths and bays. Many rivers flow out from the high mountainous interior to the sea such as the Fly River in the south-west, which is navigable upriver for about 830 km. Papua New Guinea lies along the 'Ring of Fire', a belt of active volcanic activities caused by movements of several tectonic plates producing mild to moderate earthquakes and about 40 active volcanoes in the country. In 1994, one of these active volcanoes erupted in the port of Rabaul, and capital of New Britain, causing the evacuation of about 90 000 people. Several under water volcanic eruptions (submarine volcanoes) have been reported in the Papua New Guinea/ Solomon Islands areas since 1960. The capital, Port Moresby, and one of the major ports in Papua New Guinea, is located in the mainland's south eastern part in about Latitude 9 degrees 29 minutes South and Longitude 147 degrees 8 minutes East. Papua New Guinea's climate is tropical

but is moderated by the mountains and the north-west monsoon (December to March) and the south-east monsoon (May to October). The lowland areas are hot and humid while it is cooler in the mountains. Average annual temperature in the lowlands is about 27 degrees Celcius while in the mountains about 20 degrees Celcius. The seasonal monsoons bring heavy rainfall ranging from 5 080 to 5 840 millimetres annually depending on topography and whether an area is north or south of the mainland or is in the island groups. In July 1998, the Sissano tsunami (cumulative amplitude of 15 metres) in the northern coast of the mainland left over 2 000 people dead and three villages obliterated, which was caused by a 7.1 magnitude earthquake in the Sissano area (Papua New Guinea: Encarta Online Deluxe).

Port Moresby Harbour is a natural harbour with the main entrance, Basilisk passage, which is about 8 km to the south of the main wharves. Aids to navigation are good although a few reefs exist in the harbour areas and two tugs available to assist in mooring and unmooring operations. Basilisk passage is about 0.7 km wide at its narrowest points and it is a break in an extensive coral reef systems that protect ships at anchor inside the harbour. The inner harbour area is 2.5 km in an east/west and 8 km in a north/south direction. There are three main wharves for large ships – No.1 of 106 metres long, water depth of 8.5 metres; No.2 of 107 metres long, water depth of 8.5 metres ; No.4 of 125 metres long, water depth of 10.6 metres used mainly by oil tankers and container ships; plus smaller wharves and jetties for local ships.

2.2 Economies

PICTs are not homogeneous due to the diversity of their geography, cultures and economies. This explains the difference in development prospects of individual

countries. The economies of many PICTs are dominated by some or all of the following: tourism receipts, investments by foreign owned companies, foreign aid, remittances from nationals residing overseas, and export earnings – particularly from the primary sector, such as agriculture, fisheries and forestry. In some PICTs, mining of minerals is also important, such as gold, copper and oil in Papua New Guinea, nickel in New Caledonia, and gold to a lesser extent in the Solomon Islands and Fiji, phosphate in Nauru but this is declining. Subsistence activities still play an important role in most PICTs' economies, especially in the agricultural sector. In some PICTs, the employment of seafarers is increasingly important in such countries such as Kiribati and Tuvalu, where up to 1800 and 700 seafarers are employed in European ships respectively, and contributing about 20 – 25 per cent of their GDP (Abete: 2000, personal interview) through remittances.

The potential for tourism is yet to be realised in most PICTs for it is still being developed but in some countries this potential has been fairly well developed. For example - Fiji, where gross foreign exchange earnings from tourism now surpass those from sugar, and Samoa where tourism is about half, by value, of the total export receipts (Tourism Council of the South Pacific: 1998 Annual Report). Tourism has also created employment opportunities in hotels and the supply of various ancillary services. It has been estimated in Tonga by the Central Planning Department that 'leakages' from tourism receipts is about 75 per cent but this figure is yet to be confirmed for other PICTs.

Major direct investments from overseas companies have been mainly on hotels and developing mineral resources or both, in such countries as Papua New Guinea, Fiji, New Caledonia and Solomon Islands. Many PICTs are actively trying to attract investment in manufacturing of import substitutes and processing of natural resources such as fishery and agricultural products. Direct assistance

and industrial incentives, including tax holidays and tariff assistance, are being offered in PICTs. Future potential investment areas include pearl farming (Cook Islands), mari-culture (Tonga) and deep-sea mining of minerals such as cobalt, manganese nodules and poly-metallic sulphides. A regional economic cooperation agreement has been established by governments of Pacific Forum Island countries with New Zealand and Australia, on the principle of non-reciprocal preferential access, with the goal to stimulate economic development. This agreement, known as the South Pacific Regional Trade and Economic Cooperation Agreement (SPARTECA), allowed progressive free market access of island exports into these metropolitan countries.

Foreign aid provides foreign exchange and also assists in development and budgetary needs of all PICTs. It has been estimated that official development aid to PICTs amounted, on average, to at least 40 per cent of total government revenue of each country, in total US\$1.176 billion (Fairbairn 1993:50,48) to the region. Present and former United States Trust Territories, French territories and Papua New Guinea received more than the average noted above due to their historical links. The total aid that has flowed into the region is composed of bilateral aid which represents approximately 90 percent, and multilateral aid 10 percent. The annual gross investment rates in PICTs is between 25-35 percent of GDP (World Bank data as quoted in Fairbairn 1999 : 48), and at this rate when combined with sufficient arable land and labour should have attained higher annual economic growth rates. This is what the World Bank has called the 'Pacific Paradox' and urgent actions have to be carried out by PICTs to address this important matter. For in the future, PICTs will still remain heavily dependent on foreign aid due to their narrow revenue bases, small physical sizes, saving capabilities and other constraints.

Cash remittances from overseas countries have become an important factor in the economies of some PICTs such as: Tonga which received in 1989/1990 A\$43.9

million or 59.6 per cent of Gross Domestic Product (GDP); Samoa in 1989 of A\$48.4 million or 35.1 percent of GDP; and Kiribati in 1988 of A\$3.4 or 7.2 percent of GDP (Appleyard et al 1995:33). These remittance statistics vary from time to time depending on the number of people overseas and the state of the economies of the metropolitan countries. The impacts of cash and non-cash remittances on a country's development are still being debated by researchers but it is a much needed source of foreign exchange to these countries to pay for their imports. It has been reported that about 76 percent of cash remittances to Tonga and Samoa (Brown 1995:10 as quoted in Appleyard et al) were received through formal channels that would provide the banking sector with funds to expand its loan portfolio and other investment purposes.

Most of the PICTs' exports are derived from the primary sector. Fisheries is important for local consumption and export. All PICTs have huge EEZs as compared to their land areas and they are well stocked with migratory species like tuna. Some PICTs such as Fiji, Tonga and Samoa export fresh or chilled tuna by air mainly to New Zealand, Japan and Hawaii where the prices are high. Frozen tuna is sold locally or sent to fish canneries in American Samoa, Solomon Islands or Fiji but at lower prices, and these three countries have a total production capacity of about 160 000 tons of canned tuna annually where 80 percent of the tuna catches are processed. Most of the tuna in PICTs' waters is harvested by technologically advanced fishing fleets from the United States, Japan, South Korea, Taiwan and the Philippines. These countries pay about 5 percent licence fees on gross catches for fishing in EEZs of PICTs except the United States which pays a lump sum annual fee under a multilateral agreement with the region. The total tuna catch in PICTs' waters annually is about 100 000 tons and if unprocessed it is valued at around US\$55 million (Fairbairn 1993:52). The Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Community (SPC) are two regional organisations that have coordinated fisheries activities of PICTs, the former on economic and financial matters such as the multilateral

treaty with the United States, the latter in research on stocks and migratory movement patterns.

Agriculture is important for local consumption and export in PICTs except small atoll economies that do not have adequate land for agricultural expansion. The large PICTs have success in planting and processing cash crops such as sugar cane in Fiji, coffee and cocoa in Papua New Guinea which have replaced some traditional crops such as coconut and banana. Low commodity world prices often affect the viability of these cash crops.

Forestry products of mainly logs and some timber are very important export items mainly in Melanesian countries and also in Samoa. Hardwoods (and pine in Fiji) are found in the large forest areas of these countries and are harvested mainly by companies from Japan, Taiwan and Malaysia. About one sixth of the region's total export earning is from forest products. Concerns are now being raised by knowledgeable people in these countries, that unregulated logging, without proper replanting schemes to replace the forests being cut down, is going to lead to future disasters. Local companies cut down hardwood trees for furniture making and other domestic uses.

The mining of minerals on land and possibly at sea is important to some PICTs, especially those that are located in the 'rim of fire' such as Papua New Guinea, Solomon Islands, Vanuatu and Fiji. Deposits of gold, copper, silver, titanium and bauxite have been found in commercial quantities on land in these countries. In fact, the mining gold by the OK Tedi companies in Papua New Guinea is among the largest mining operation in the world, and it dominates the local economy. However, most chemicals used for the processing of these minerals are poisonous to humans and harmful to the environment and these chemicals are imported and

transported on ships, for example, flotation agents for concentrating copper ore, dynamite and sodium cyanide for some gold extraction purposes especially in Papua New Guinea. Kutubu oil fields in Papua New Guinea commenced production of crude oil in June 1992 and is still producing 140 000 barrels per day, equivalent to about 20 000 tonnes of oil per day (Papua New Guinea:2001 Encarta Online Deluxe). Given the high vulnerability of Papua New Guinea to natural disasters such as earthquakes and volcanic activities that may occur near the oilfields and causing damage to the infrastructure, these disasters may cause an oil spillage thus polluting the environment.

All PICTs are developing nations and their governments' main aspiration is to improve the living conditions of the people by increasing national income levels, better income distribution, greater self-sufficiency, and conservation of the natural environment. However, geographic, economic and socio-cultural constraints have frustrated efforts by governments to achieve development goals. The socio-cultural constraint is arguably the most difficult to address as PICTs' values and communal practices, such as sharing of resources as in an extended family environment clashing with modern business principles. Many businesses in PICTs have failed because of this sharing mentality that often leads to debts not being paid in time or not at all by relatives or friends. Furthermore, the customary land tenure systems do not give clear title to a land and it is quite difficult to deal with this situation in many PICTs. These constraints pose huge challenges to policy makers in PICTs, complicated by their small physical and market sizes, and the great distances their products have to be transported to metropolitan markets. Furthermore, many of the PICTs' economies are highly vulnerable to weather related disasters such as cyclones and droughts, and non - weather related ones such as earthquakes and tsunamis, because of their small physical sizes and narrow resource base. In some countries poor Government policies and inappropriate macroeconomic management has also impeded economic growth.

Political instability in some PICTs affect economic performance as well, resulting in negative growth.

In Table 2.0, Gross Domestic Products (GDP) of the nine PICTs covered in this research are compared to show their economic performances over the years (1996-99). An increase in GDP translates into more economic activities in a PICT that would also mean more imports would be transported to the countries onboard ships. These imports would include dangerous and harmful goods (oil, oil-based paints, petroleum products, chemicals, etc.,) which would increase the likelihood of pollution to the marine environment.

Table 2.0 - Gross Domestic Products US\$ million

PICT	1996	1997	1998	1999
American Samoa #				500 ^
Samoa *	217	236	221	238
Tonga *	n.a	171.5	162.2	149.9
Kiribati *	50.3	48	45.3	48.1
Marshall Islands *	n.a	92.2	95.7	97.3
Guam #	3000 ^			
Solomon Islands *	409.7	393.1	303.4	302
Fiji *	2100	2100	1700	1800
Papua New Guinea *	5200	4900	3800	3600

Sources : * Compiled by the Market Information and Analysis Unit, Department of Foreign Affairs and Trade. September 2001 (Australia).

CIA- The World Factbook 2000

^ Estimates from different web-sites.

According to the United Nations, most PICTs fall within the low-income group of developing countries. Various studies have been carried out by the World Bank and showed that PICTs economic growth rates averaged at 2 percent which is about half of that achieved by the island countries in the Caribbean, Indian Ocean and Africa regions. PICTs are now putting into place corrective measures to improve their economic performances. These measures included: promoting of family planning to reduce population growth; reform the public sector by

identifying the core functions of governments with non-government functions being transferred to the private sector; encourage private sector participation in the economy and development activities; improve factor productivity; and human resources development to have the necessary skills for planning and implementation purposes in different sectors.

2.3 Trade

Trade is one of the important building blocks of a country's economy. The exporting and importing of goods creates economic activities and employment opportunities that would benefit the people, particularly the raising of their living standards. Freer trade is increasingly becoming important in the global economy and PICTs are being affected one way or another, whether trading in their domestic or overseas markets. International trade has been around for a few centuries now but it has accelerated greatly in the past decade due to modern day technological advances such as in computers, satellite communications, the Internet, improved transportation and growth of the world economy.

It can be argued that world trade and related policy regimes can be closely linked to the policies of a dominating nation and the part it plays in the world economy (Wijnolst et al 1997:41) at the time. For example, most of the 19th Century Britain dominated the world economy as it was the dominant world power, and it had also the largest merchant fleet at the time to carry out its trade policies. The United States, from after World War II up to now, dominates the world economy and trade but is being challenged by Japan, China and the European Union. Nearly all of PICTs were colonies of the major powers before the 1960s. When they became independent nations (or maintained free association) in the last three decades they still maintained special ties with their former colonial masters, notably in trade. For example, American Samoa is linked with the United States,

Papua New Guinea with Australia, Cook Islands with New Zealand, French Polynesia and New Caledonia with France, Fiji with the European Union.

In 1995, the World Trade Organisation (WTO) replaced the General Agreement on Trade and Tariffs (GATT) that was set up by the international community in 1947. The purpose of setting up these organisations is to reduce tariffs and non-tariff barriers to trade as countries recognised the huge benefits that free trade will bring. WTO provides an open and predicable set of rules that big or small countries must abide by in dealing with trade issues. This will enable them to negotiate better access to each other's markets and not being dictated to by the more powerful of the two countries, and their trade disputes will be settled based on facts and not by their economic size or power. Many PICTs have applied to be members of WTO as this will create more trading opportunities than they would have achieved individually or as a region because of their small sizes.

World trade, by value, more than doubled from US\$1.77 trillion in 1983 to US\$4.09 trillion in 1994 (Wijnolst et al 1997:13). Trade statistics are quoted in value terms (usually in US\$) but sea borne trade statistics are quoted in tons or cubic metres so the two statistics are always different. World sea borne trade recorded 5.064 billion tons in 1998 (the first time ever that it reached the 5 billion mark) and since 1995 it has increased consistently (UNCTAD 1999:xi), and is forecast to rise at a lesser rate of increase, approximately at 2 percent in future. The United States economy now leads the global economy and subsequently trade, and its economy is still growing and the rest of the world's economies follow this trend. PICTs economies will be influenced by the global economy and trade trends, and therefore, more trading activities are anticipated in the region.

Like any other region in the world, PICTs have domestic and foreign trade components. Domestic trade is comprised mainly of the distribution of imports by ships from major ports to minor ports and centres in a PICT. The goods transported are mainly food (flour, rice, tinned foods etc), building materials and other similar basic necessities of life. Unfortunately, dangerous goods such as kerosene, oil-based paints, chemicals, and similar inflammables are carried by small ships together with passengers. These practices are contrary to national laws in PICTs and international convention requirements but they are very difficult to control due to various reasons. Sometimes, these ships on their return voyages to major ports carry local foods (e.g., taro, fish, fruits and vegetables) and export cargoes such as copra and coffee. It can be seen that the volume of trade determines the level of shipping services internally in a PICT and also with other countries.

2.3.1 Exports

Principal export destinations from the nine PICTs selected for the thesis are shown in Table 2.1 which indicates that the United States and Japan received more than half of the total export from these countries. Australia, Asia, the United Kingdom, European Union and New Zealand are amongst the other principal export destinations. There are some exporting activities between PICTs such as Samoa with American Samoa, and Fiji with Samoa, Tonga and Kiribati.

American Samoa exports canned tuna from its two canneries (private sector) and handicrafts mostly to the United States, and fish meal to Australia. Canned tuna and fish meal totaled about 100 000 tonnes (Ports Administration Department : 1998), that represented 93 per cent of total exports, valued at about US\$500 million in 1998. Merchandise exports from Samoa were 31 611 tonnes (Ministry of Transport port statistics: 1998) amounted to 9.2 percent of GDP, equivalent to about US\$20.33 million - with Australia, Indonesia (timber products) and the

United States as the major destinations in this order. The principal exports to Australia are electrical equipment for vehicle wiring, food products – both fresh and processed ones, some sound and radio equipment. Other exports to other countries were fish, beer, coconut oil and cream and copra. Tonga's merchandise export was 7.3 per cent of GDP in 1998, equivalent to about US\$11.84 million – with Japan, United States and New Zealand the major destinations. Squash exported to Japan was 7 249 tonne in 1998, mainly fresh fish to the United States, vanilla and foodstuffs to other destinations. Total export tonnage was 12 999 tonnes (Ministry of Marine and Ports: 1998).

Table 2.1 - Selected PICTs' Principal Export Destinations – 2000 (%)

PICT	N.Z	Aust	U.S	Jap	U.K	Am. Sam	E.U	Asia *	Sth Am	Total
Am. Sam.		3 ^	95 ^							98
Sam	2.6	62.2	11.6			2.4		13.2		93
Ton	3.7	2.0	30.4	49.1			3.6	2.0		91
Kiri		1.2	6.5	65.0			3.8	12.3	5.3	96
Mar. Is										
Guam			25							25
Sol Is		2.8		22.0	7.2			40.3		72
Fiji	4.5	33.1	14.8	4.5	13.8					71
PNG		29.3		11.0			4.1	10.8		55

Source : Market Information and Analysis, Department of Foreign Affairs and Trade (DFAT) - Australia

Note : * indicates that the Asian country for Samoa is Indonesia, for Tonga it is Cambodia, for Kiribati it is Bangladesh, for Solomon Islands it is Korea (17.3%) plus China (12.7%) plus Philippines (10.3), for Papua New Guinea it is China (5.5%) plus Korea (5.3%)

^ indicates estimates from DFAT web-sites

The goods and services exports of Kiribati were about 6 400 or 12.9 per cent of GDP in 1998, equivalent to about US\$5.84 million – with Japan, Bangladesh and the United States the major destinations. Copra (62 per cent) and fishery products were the main export items. Goods and services exports of the Marshall Islands were estimated to be 8 200 tonnes or about 7.8 per cent of GDP in 1998 or about

US\$7.46 million. Copra, coconut oil and fishery products were the main exports. Guam exported goods totaling 48 711 tonnes (Port Authority of Guam: 1998), estimated value of US\$86.1million in 1992, mostly transshipments of refined petroleum products, construction materials, fish, food and beverages products totaling 274 466 tonnes in 1998. It exports about 25 per cent to the United States. In the Solomon Islands, the goods and services exports were 56 770 tonnes (Solomon Islands Ports Authority: 1998) estimated at 46.7 per cent of the GDP or about US\$141.69 in 1998, mainly to Japan, Korea and China. Exports included canned fish, forestry products, copra, palm oil and cocoa.

Fiji's total goods and services exports were 933 992 tonnes (316 915 tonnes went through Suva) estimated at 54.2 per cent of GDP in 1998, equivalent to about US\$921.4 million, the main destinations were Australia, United States and the United Kingdom. The main exports are sugar (32 per cent), garments, gold, vegetable oil, timber products, fish and food (Maritime and Ports Authority of Fiji: 1998 Annual Report). Goods and services exports of Papua New Guinea were 50.1 per cent of GDP in 1998, equivalent to US\$1.904 billion, mainly to Australia, Japan and China. Gold, copper, crude petroleum, coffee, forestry products, cocoa and vegetable oils are the main exports. Total export tonnage was 431 617 tonnes of general goods, 223 353 tonnes of vegetable oil, transshipment goods of 53 763 tonnes and 53 763 tonnes of petroleum products. General goods of 66 937 tonnes and 1133 tonnes of petroleum products were exported through Port Moresby (Harbours Board: 1997 Annual Report).

2.3.2 Imports

In most PICTs, foreign trade is dominated by imports including dangerous cargoes as defined in the United Nation's International Dangerous Goods Code (IMDG Code) in packaged forms and also in bulk liquids. All PICTs import their

petroleum products, vehicles, chemicals, medicines, machinery and sophisticated equipment such as computers, copiers, printers and others for communications purposes. Some import manufactured goods, construction materials, foodstuffs and other consumable goods.

Table 2.2 - Selected PICTs' Principal Import Sources – 2000 (%)

PICT	N.Z	Aust	U.S	Jap	Malay	Fiji	E.U	Sing
Am. Sam	7*	11*	62*	9*		4*		
Sam	14.0	27.4	26.2	8.9		11.5		
Ton	27.9	11.9	11.9	17.6		21.0		
Kiri		27.4	7.5	15.5		14.6	15.5	
Mar Is								
Guam			23	19				
Sol Is	5.5	27.1	5.1	5.3				24.7
Fiji	13.3	41.9	14.1	4.8				5.4
PNG	1.6	21.2		1.9	1.5			8.3

Source: Market Information and Analysis Unit, DFAT (Australia)

Note : * indicates CIA : 1996 World Factbook

The statistics in Table 2.2 show that PICTs' imports come mainly from the United States and Australia, followed by New Zealand, Japan, Fiji and Singapore. Imports from Singapore are mostly refined petroleum products, although Australia and the United States supply some PICTs too.

The main imports of **American Samoa** are materials for canneries 56 per cent, food 8 per cent, petroleum products 7 per cent, machinery and parts 6 per cent. Imported petroleum products in bulk was 200 000 tonnes, general goods including dangerous goods, machinery, foods and other consumables, about 200 000 tonnes (Ports Administration Department: 1998). Total value of imports was US\$471 million in 1996 (Table 2.3). **Samoa** imported 187 490 tonnes of goods, that included machinery and equipment, dangerous goods, foodstuffs and other consumable items, and petroleum products of 39 530 tonnes (Ministry of Transport: 1998). The total value of imports was US\$96.6 million in 1998 (Table

2.3). The general goods imported by **Tonga** totaled 74 160 tonnes that included machinery and equipment, dangerous goods, foodstuffs and other consumable items, and petroleum products of about 31 000 tonnes (Ministry of Marine and Ports :1998), with a total value of US\$69 million (Table 2.3)

Kiribati imported about 63 000 tonnes of goods, that included machinery and equipment, dangerous goods, foodstuffs and other consumable items, and 13 716 tonnes of petroleum products (Marine Department and Port Authority: 1998). The total value of imports in 1998 was US\$37 million (Table 2.3). The composition of the **Marshall Islands'** imports are similar to that of Kiribati, with 48 686 tonnes, the petroleum products amounted to about 39 000 tonnes, that had a total value of US\$58 million in 1997 (Table 2.3). There were about 2.05 million tonnes of general goods in containers, break-bulk cargoes of 274 155 tonnes, including dangerous goods, and petroleum products of about 1.75 million tonnes imported into **Guam** (Port Authority: 1998), but the total value in 1992 was US\$202.4 million (Table 2.3). Some of these imports were transshipment cargoes such as petroleum products, foodstuffs and construction materials.

Imports to the **Solomon Islands** were 180 870 tonnes of general goods, including dangerous goods, machinery and equipment, consumable items, and 70 160 tonnes of petroleum products (Port Authority: 1998), with a total value of US\$160 million estimated for 1998 (Table 2.3). Some of these imports are transshipment goods of frozen fish. **Fiji's** total imports amounted to about 2.5 million tonnes but Suva's share was about 1.355 million tonnes (Maritime and Ports Authority: 1998), the total value was US\$612 million (Table 2.3) and comprised mainly of machinery and transport equipment, dangerous goods, foodstuffs and other consumable items. In addition, also included were petroleum products totaling 727 762 tonnes with Suva's share of 242 250 tonnes. The **Papua New Guinea** imports included machinery and transport equipment, manufactured goods, chemicals, dangerous goods, food and other consumable items with an estimated

value of US\$1 billion (Table 2.3). Total import tonnage was about 1.71 million tonnes of general goods, 473 930 tonnes of petroleum products and 54 285 tonnes of transshipment goods. Port Moresby handled 553 959 tonnes of general goods, 57 321 tonnes of petroleum products and 49 323 of transshipment goods (Harbours Board: 1997)

Table 2.3 Cargoes Handled in Nine Selected PICTs

Country	Imports (I) tonnes/US\$	Exports (E) Tonnes/US\$	Total (I + E) tonnes	Total Value US\$
American Samoa	400 000t 471 mil \$	100 000t 500 mil \$	500 000	971
Samoa	187 490t 96.6 mil \$	31 611t 20.33 mil \$	219 101	116.93
Tonga	105 160t 69 mil \$	12 999t 11.84 mil \$	118 159	80.84
Kiribati	76 716t 37 mil \$	6 400t ** 5.84 mil \$	83 116	42.84
Marshall Islands	87 686t 58 mil \$	8 200t ** 7.46 mil \$	95 886	65.46
Guam	274 155t 202.4 mil \$	47 038t 86.1 mil \$	321 193	288.5
Solomon Islands	251 030t 160 mil \$	56 770t 141.69 mil \$	307 800	301.69
Fiji	2 500 000t 612 mil \$	933 992t 921.4 mil \$	3 433 992	1 533.4
Papua New Guinea	2 250 000t 1 000 mil \$	4 637 052 t 1 904 mil \$	6 887 052	2 904
Total	6 132 237t 2 706 mil \$	5 834 062t 3 598.66 mil	11 966 299	6 304.66

Source: Annual Reports of Port Authorities and Statistical Reports of the Nine PICTs for 1998.

Note ** indicates estimates

Table 2.3 shows that the nine PICTs imported 298 175 tonnes more than they exported, but by value exports earned US\$892.66 million more than the value of imports. American Samoa and Fiji have less export tonnages than imports but the value of their exports exceeded those of imports. Only Papua New Guinea has more export tonnages than imports, and by value exports also exceeded that of the

imports. The other six PICTs have far less exports than imports in terms of tonnages and by value. The implication is that trade will be severely affected in these PICTs if their economies do not improve, therefore less ships will be used for transportation/trading purposes, thus in that context marine pollution is less likely to occur in their waters unless they have large EEZs used by transiting vessels.

2.4 Shipping

Ships can be grouped into three types :

1. Ships that carry persons and/or cargo. This category can be sub-divided into three groups. The first group (Group 1) includes passenger ships on short or long distance voyages, ferries, hovercrafts and hydrofoils. The second group (Group 2) includes those that carry general cargoes or goods in break-bulk such as conventional ships, heavy lift ships and refrigerated ships, and also unit loads such as container ships, roll on–roll off ships (ro-ro), barge carrying ships and tug barge systems. The third group (Group 3) includes those ships that carry bulk cargoes such as liquid bulk cargoes (oil tankers, chemical and product carriers, and liquid petroleum (LPG) and natural gas (LNG) ships), combination carriers (ore/oil carriers, ore/bulk oil carriers), and dry bulk cargo ships (log or timber ships, car carriers and wood chips carriers).
2. Ships which keep sea lanes open that include tug boats, dredgers, ice breakers, survey and research vessels.
3. Specialised ships which include weather ships, fishing vessels, salvage vessels, cable ships and off-shore supply vessels.

The UN's World Maritime University at Malmo, Sweden, also uses in its lectures the same grouping of ships.

Most of the different types of ships above engage in trading in PICTs' waters or are transiting the region. Small passenger ferries and conventional ships are commonly used for transportation of passengers and cargoes within PICTs waters. Furthermore, most PICTs use small containers (appropriate for the trade) onboard the roll on-roll off ferries for their domestic trade because of ease of pre-packing, loading and discharging. Ships trading within PICTs are mostly owned by local ship owners and they are operated under trading licences prescribed by national legislation. There are three main reasons for having such legislation. Firstly, to reserve the local trade to local ship owners due to various reasons, but foreign owned ships of specialised nature, such as oil tankers, that local ship owners could not supply might be allowed to trade within PICTs. Secondly, to prevent too many ships chasing too little cargo in a particular trade route (over-tonnaging) which would seriously affect the viability of these shipping services. Thirdly, to ensure that adequate shipping services are provided not only in the lucrative routes but also routes where there are not large volumes of passengers and cargoes. Otherwise, local ship owners may withdraw from unprofitable shipping routes and governments may be forced to provide these shipping services burdening the public purse.

The following types of ships engage in foreign trade or are transiting PICTs' waters. Bulk carriers carry raw cane sugar, molasses and wood chips from Fiji to overseas destinations, and from Papua New Guinea - copper ore concentrate and gold (ore) mainly to Australia. Most general goods, including dangerous goods, are packed today in containers and transported onboard container ships, ro-ro ships, tug barge systems or barge carrying ships. Conventional cargo ships have been modified to have a container cargo carrying capability and are also used in the region's trade, while some cargo ships are used to carry logs. Refrigerated ships are used for carrying squash from Tonga to Japan. Car carriers and heavy lift ships also frequent the region. Oil tankers, Liquid Petroleum Gas (LPG) and Liquid Natural Gas (LNG) carriers, chemical and product tankers bring oil, gas

and different chemicals into PICTs. Most of these overseas ships have onboard multi-national crew and are registered in an Open Register. IMO and safety of shipping commentators have expressed safety concerns on the use of substandard ships and untrained crews world wide including PICTs.

Tug-boats are used in many of the region's ports and in towing barge systems. Survey and research ships make frequent visits to the region to carry out research and investigations into deep sea minerals or to study the 'rim of fire' chain of seamounts and underwater volcanic activities. Hundreds of foreign fishing vessels are licenced to fish in PICTs' waters, especially in Kiribati/Solomon Islands area, with no real monitoring of what they do because of lack of both manpower and financial resources. In terms of tracking positions of fishing vessels that have been licensed in the Forum Fisheries Agency (based in Honiara, Solomon Islands) to fish in PICT waters, a Vessel Monitoring System (VMS) set is fitted onboard each licensed fishing vessel. Global positioning systems (GPS) are advanced satellite positioning technologies which are used in VMS. When a satellite (low-earth orbits at an altitude of about 780 km) passes overhead (about 25 passes per day over Nadi) a fishing vessel fitted with a VMS transmitter sends signals to the satellite which then routes them to land receivers and thus the position of a licensed fishing vessel is known and transmitted to FFA for information. FFA then inform Members of the fishing vessels positions but are not available to the general public. Refrigerated ships of up to 5 000 gross tonnage and small oil tankers meet fishing vessels in mid-ocean for transferring their catches and fueling purposes respectively. There is little or no control at all on their activities; for example, oil may have spilled overboard during fueling and not be reported to the authorities.

Nuclear fuels and wastes for power generation are transported on special cargo ships from the European Union to Japan passing through some of the PICTs' waters, probably between New Caledonia and Vanuatu, and Guam.

Shipping provides the means to conduct trade and ship calls into PICTs' ports are shown in Table 2.4 to identify the types of ships involved. The data show only foreign trade ships that called into a PICT port as reliable data to cover all domestic shipping is unavailable or non-existent in most PICTs. Furthermore, the small sizes of the ships (some with outboard motors only) will cause insignificant amount of pollution whereas the large ships data is comprehensible and reliable and they can cause major pollution. As a result this research was concentrated on the foreign trade shipping as records were found to be excellent in the nine PICTs used in the thesis. Oil is the most likely product that would causes a major oil pollution in the region as it is routinely carried into ports of PICTs in oil tankers or onboard ships as bunker fuel.

Table 2.4 - Selected PICTs – Ships' calls per Year into Principal Ports 1998

Ports	Type 1 ship			Type 2 ship	Type 3 ship	Total
	Group 1	Group 2	Group 3			
Pago Pago	56	110	24	0	144	334
Apia	62	144	36	0	0	242
Nukualofa	14	121	45	0	0	180
Tarawa	0	30	12	0	0	42
Majuro	0	62	19	11	385	477
Apra	22	301	88	0	2205	2616
Honiara	5	202	91	0	180	478
Suva	35	518	297	0	391	1241
Port Moresby	5	363	241	0	132	741
Total	199	1851	853	11	3437	6351

Source : Annual Reports of Ports Authority of the Nine PICTs for 1998

A container ship of 40 000 gross tonnage, owned by Matson Navigation Company, trading between the United States and Guam carries about 5 000 tonnes of heavy oil as bunker, compared to oil cargo onboard a smaller oil tanker used in the Fiji-Kiribati trade which carries about 2 000 tonnes of diesel oil. This

shows that these foreign trade ships where-ever they are can cause marine pollution. World wide accident data during the 1993-97 period showed that 40 per cent of marine pollution occurred in ports (Giziakis and Bardi-giziaki 2002: 110)

In the Pago Pago data, the Samoan ferry *Lady Naomi* has a weekly service (about 50 times per year) between Apia and Pago Pago which inflated passenger ship calls into both ports as reflected in Type 1 ship – Group 1 figures. The Type 1 ship Group 3 represents most of the oil tankers that have capacities of about 40 000 gross tonnage, sometimes called mid-range tankers (known in the industry as MR tankers). Oil tankers calling into Apia are a mix of MR tankers and smaller oil tankers of about 2 000 gross tonnage and it is the same for Apra, Majuro, Honiara, Suva and Port Moresby. Only the small oil tankers called at Nuku'alofa and Tarawa. LPG carriers of 2 000 gross tonnage capacity are used for the carriage and transportation of LPG mainly from Australia. PICT ports' records usually showed distilled products and diesel oil as oil or petroleum products. Petroleum products are imported mainly from Singapore, Australia and the United States. The Honiara data have also 22 oil tankers in Type 1 Group 3 and the rest are other liquid and dry bulk carriers. In addition, only 45 oil tankers in the Port Moresby data and for Suva it is only 117 and the rest comprised of other bulk carriers.

Type 2 ships are tug boats, used mainly in the United States to Marshall Islands trade that tow barges full of containers but this is not found in the other eight PICTs. Trans-shipment of fish catches by Type 3 ships show that Guam, Suva, Port Moresby and Majuro are the major ports involved in this activity.

The link between Table 2.4 with the thesis topic is that once the SMPI is established, policy makers in each PICT can see at a glance the potential magnitude of the marine pollution that could happen in their country. Marine

pollution risks can be assessed by internal factors to the ship such as the number of ship calls into PICTs' ports, the cargoes they carry and how they are managed. Furthermore, various external factors to the ship while the ship is in a PICT port, such as meteorological events (cyclones), accuracy of navigation charts that authorities in a PICT can have influence on. It may be possible for PICTs to cooperate in formulating policies to minimise marine pollution risks, perhaps by using and scheduling ships on regular schedules more efficiently. This is to prevent too many ships arriving at a port at the same time, or using bigger ships with fewer port visits per year, assuming that PICTs' cargo throughput remains the same.

-
- ¹ Shoal is basically a submerged reef and does not show above the surface of the sea at any state of the tide.
 - ² Plate Tectonics is a theory that near the surface of the earth it is made up of relatively thin, rigid plates that move relative to each other. Today scientists use this theory to explain geological events successfully such as earthquakes, volcanic eruptions, mountain building, formation of ocean floors and continents.
 - ³ Major cations or positive ions present per 1000 are : sodium, 10.5; magnesium, 1.3; calcium, 0.4; potassium, 0.4 parts. Major anions or negative ions are : chloride, 19; and sulphate, 2.6 parts per 1000.
 - ⁴ Salinity varies from zero in continental waters (lakes etc) to about 41 parts per 1000 in the Red Sea (a region of high evaporation), and more than 150 parts per 1000 in the Great Salt Lake.
 - ⁵ Carbon in the form of bicarbonate, nitrogen as nitrate, and phosphorus as phosphate.
 - ⁶ Kinetic energy, the energy of motion, in waves is tremendous and it has been calculated that an average 1.3 metre, 10 second wave striking a coast puts out more than 35 000 horse power per mile of coast. It has been reported that a block of cemented stone weighing 1350 tonnes was broken loose on the coast of Scotland.
 - ⁷ Tsunami is a Japanese word for seismic sea wave. It is usually generated by earthquakes but at times by volcanic eruptions or submarine landslides. Not all earthquakes generate tsunamis, and also, landslides may not be associated with volcanic eruptions or earthquakes. The largest tsunami on record was measured about 64 metres above sea level in 1737 in Siberia's Kamchatka Peninsula.
 - ⁸ The gravitational attraction pulls the water mass of the world's oceans so there is a relative high ocean surface in two places at the world surface, one on the side towards the moon and the other on the side away from the moon, both on a line drawn through the centre of the earth and the moon. There are 26 spring tides every year - 13 at full moon and 13 when there is no moon. Bay of Fundy, Nova Scotia, Canada, recorded the highest range (difference between high and low water) of tide about 16 metres.
 - ⁹ Imagine the earth is standing still, a particle of air in higher latitudes on both sides of the equator travels in a straight line towards the equator because colder air (associated with higher pressure as compared to warmer air at the equator that is associated with low pressure) is denser. If the earth starts to move (from west towards the east) the parcel of air is deflected to the right in both hemispheres. This motion is known as the Coriolis Force, which is the main cause of the two gyres or circular systems of winds and currents in both hemispheres. It moves clockwise in the northern hemisphere and counter-clockwise in the southern hemisphere.
 - ¹⁰ Winds are formed when a parcel of air moves from a high pressure area to a lower air pressure area until the pressure in those two areas are in equilibrium. The Coriolis Force influences wind direction (see endnote 29 above)
 - ¹¹ Sea breezes are formed during the day when the sun heats the island and the surrounding seawaters. Land becomes warmer much faster than the sea resulting

in a lower pressure created on the air above the land. The sea being cooler, and also the surrounding air, than the land has a higher pressure. A parcel of air (higher pressure) from the sea moves to the lower pressure area on land thus creating sea breezes that sometimes reach 10 - 15 knots. At night the land and the air above it becomes colder much faster than the surrounding seas thus have a higher pressure which will result in a parcel of air flowing from land to the sea or land breeze.

12 Pilotage distance is the distance from where the Pilot boards (usually at least 3 miles from an entrance to a port) to where a vessel berths in a wharf.

13 Dwt stands for deadweight which means the difference between the light displacement (weight of vessel as built, including boiler water, lubricating oil, and cooling water system) and the loaded displacement (mark in the Plimsoll line that the vessel is permitted to submerge to) i.e. it is the weight of cargo plus weights of fuel, stores, water ballast, freshwater, crew and passengers, and baggage.

14 Normally the International Dateline indicates the meridian (longitude) of 180 East or West. Zone times of the world are calculated using 15 degrees of longitude equals 1 hour. Greenwich Mean Time (GMT) is meridian 0 which runs through the English town of Greenwich. Places east of Greenwich have local times of GMT + the time equivalent of their longitudes, and those to the west have their local times GMT – the time equivalent of their longitudes, these time equivalents normally expressed as 1 or 2 hours etc. Reasons for Tonga's case or Kiribati is mainly for commercial reasons and to divert the International Dateline requires the approval of an international body controlling the allocation of time zones.

3.0 International Instruments and Measures for the Prevention of Ship-Generated Marine Pollution

3.1 Introduction

The expressions “maritime safety” and “safety at sea” are used interchangeably by people, and also in this research, to mean safety. One of the definitions of safety commonly used in the industry is “both the material state resulting from the absence of exposure to danger, and the organisation of factors intended to create or perpetuate such a situation” (Boisson 1999: 1). In the research, safety has the same meaning and is regarded as being a key to protecting the environment from being polluted by ships and their cargoes. The term “safety” has also been used in maritime law to mean health and safety; or safety of navigation; or in a national defence context.

Pollution knows no boundary and can often freely move between land, atmosphere and oceans if not restrained. The global environment that exists naturally is a sink for wastes and emissions generated by various human activities. Nonetheless, environmental scientists have recognised that the capability of the earth’s natural systems is finite and can only absorb so much pollution and waste generated by human activities over a period of time. Therefore, the preservation and protection of the global environment, including the sustainable use of resources, are of the utmost importance. Human activities play an important role

in causing changes to the natural environment in terms of resource consumption and generation of waste. For example, global energy consumption has been estimated to have grown by 48 percent from 1970 to 1990, releasing substantial amount of greenhouse gases and other gases harmful to the atmosphere (Drewry Shipping Consultants 1996:13).

Environmental scientists from the Inter-governmental Panel on Climate Change (IPCC) and other scientific research bodies have recently confirmed that global warming is taking place and that it is caused by environmental pollution¹ in the atmosphere caused by burning fossil fuels. There is a possible contribution to global warming caused by burning oil for ship's power

Marine pollution is one of the threats to which the global environment is subjected. Shipping is one of the industries being called upon to prevent environmental pollution as the industry operates globally and it has been, and is, a polluter of the environment, because of the huge amount of oil being transported by ships at sea every year and the high profile accidents reported in the media. One such case is the oil tanker *Exxon Valdez* in 1989 that ran aground and spilled thousands of oil into the sea in Alaska. This accident caused grave environmental damage to the coastal ecosystems and the United States introduced legislation in 1990, the Oil Pollution Act (OPA 90), to prevent future repetition of similar accidents in any area under its jurisdiction. However, over the years other types of marine pollution are becoming important such as those from ship-sourced toxic and noxious substances². It is often difficult to determine the extent of pollution from toxic and noxious substances because it is one of steady accretion. Whereas, pollution from oil is given a high profile in the media, due to the huge amount of oil seen floating in a very large area on the surface of the sea for days. The huge size of oil spills from oil tankers always attract the global media's attention, and subsequently the public at large, from live television and newspaper reports. Oil spills tend to overshadow spills from toxic and noxious substances, however, with

the increase in trade and commercial activities world wide in the last decades, the growth and combined impact of chemicals and cargo spillage on the marine environment is causing concern.

Ship-generated marine pollution may be divided broadly into two categories. Firstly, pollution caused during the normal operation of a ship every day such as the dumping of pollutants and wastes into the sea. Secondly, pollution that arise from casualties or accidents, caused mostly by the cargoes that ships carry or from ship's bunkers, as a result of human error or failure of equipment or machinery or hull, or any combination of these factors. Research³ has shown that human error is now being recognised as a crucial factor in causing shipping casualties and marine pollution. Furthermore, it also shows that 80 per cent is directly caused by human error and 20 per cent from technical failure. Many commentators have pointed out a serious contradiction in how the industry has gone about improving safety in terms of regulations: 80 per cent cover technical matters and only 20 per cent relate to people. In order to correct the situation, measures have now been put in place to address and minimise human error. They are as follows:

- The introduction, on 1st August 1998, of the International Convention on Standard of Training, Certification and Watchkeeping 1978, and amended in 1995 (STCW 95), and came into force on 1st February 2002. The Amendments to the Convention changed and strengthened the mechanisms to ensure that the standards for training, certification and watchkeeping are implemented in accordance with the Convention.
- The coming into force on 1st July 2002 of the International Safety Management Code (ISM Code) and formally included as Chapter IX of the Safety of Life at Sea Convention, 1974 (SOLAS) and its application to other cargo ships and mobile offshore drilling units of 500 gross tonnes and over. The ISM Code is a means of improving the level of safety within the industry. The safe management of ships should be the responsibility of everyone in the

company, from the Directors of the Board down to the lowest deck boy onboard.

- By increased cooperation between Flag States, IMO, ship owners, insurance companies and classification societies in ensuring that if a ship is to be used in international trade, it should meet the safety requirements prescribed in international conventions and rules. If not, then that ship must not be allowed to trade.

IMO has achieved a lot of success in preventing and reducing marine pollution in the last three decades by introducing new regulations, guidelines and procedures necessary to deal with any given situation arising from shipping operations accidents. For example; MARPOL 73/78 has been reported to reduce oil leaking from ships by 0.9 million tonnes in about eight years, from 1.5 million tonnes in 1981 to 0.6 million tonnes in 1989. This is a big improvement when one considers that about 2.35 million tonnes of oil (Drewry Shipping Consultants 1996: 21) enters the sea every year of which 15 per cent is from natural seepage (see Table 3.0). Although this trend is expected to go down further, much work needs to be done by all players in the industry to cause it to stay that way.

Table 3.0 - Hydrocarbons Inputs into the Oceans due to Marine Transport Activities

Estimated Hydrocarbon Inputs into the Oceans	1981 metric tonnes (million)	1989 metric tonnes (million)
Tanker Operations	0.7	0.159
Tanker Accidents	0.4	0.114
Bilge and Fuel Oil Discharges	0.3	0.253
Dry docking	0.03	0.004
Marine Terminals including Bunkering	0.022	0.03
Non tanker Accidents	0.02	0.007
Scrapping of Ships	-	0.003
Total	1.47	0.57

Source: United Nations and IMO, as quoted in Drewry p.21.

Safety is basically the control of accidental loss. This would involve specifying the safety requirements after taking into consideration past and present knowledge and experience, and also anticipating future risks. In order to ensure that the safety requirements are always relevant, it is important that performance complies with the requirements. Accidents⁴ are caused (they do not just happen), when safety requirements were not practiced onboard ships. This could be linked to human error/failure. For example: collisions are caused when ships' crew do not follow the COLREG 1972; accidents onboard ships are due to failure of the crew to follow safety requirements in operations such as cargo work or tank washing; groundings are due to poor navigation or short cuts to secure a berth such as happened in the *Torrey Canyon* disaster in 1967. By defining the safety requirements and measuring their compliance, it is possible for management and key personnel onboard ships to control its management of safety. This is a key aspect of the ISM Code that is based on the philosophy (of quality) that "What cannot be measured cannot be controlled and improved". In other word, the quality of the management of safety in an organisation is key to the prevention of accidents at sea and the pollution of the marine environment.

Over the years, some major maritime disasters such as the passenger ferry *Estonia* (1994), oil tanker *Torrey Canyon* (1967) and others have drawn heavy media attention worldwide. People see on television and the print media the same horrific scenes of dead bodies, wildlife dying and pristine coastlines blackened by spilt oil from these disasters. When one considers the number of lives lost at sea (average in 1999 was 140 deaths) due to accidents every year in European Union waters in terms of per passenger – kilometre, it is twenty five times higher as compared with aircraft accidents (Boisson 1999:507). Lives lost in roads and rail accidents are much higher than in shipping accidents. Commentators and scientists discussed and predicted it would take a long time for the environment and inhabitants to recover from the effects of the above disasters. People then started asking questions on why and what caused these disasters. Then the people

found out that the disasters should not have happened had the owners and the crew of the ship cared to safeguard life, property and the environment. Politicians were then pressured to act by having more regulations and better safeguards to prevent future disasters occurring. The adoption of stricter maritime regulations usually followed major disasters, for example:

<u>Vessel Disaster</u>		<u>Regulation</u>
Titanic in 1912	-	SOLAS in 1914
Torrey Canyon in 1967	-	MARPOL in 1973
Herald of Free Enterprise in 1987	-	IMO A.647(16) in 1989
Exxon Valdez in 1989	-	OPA 90 in 1990
Scandinavian Star in 1990	-	IMO A.680(17) in 1991

SOLAS, MARPOL and OPA 90 will be discussed in detail later in the Chapter. IMO resolution A.647(16) was issued in 1989 as “Guidelines on Management for the Safe Operation of Ships and Pollution and Pollution Prevention”. In 1991, after the *Scandinavian Star* disaster, IMO resolution A.680(17) was issued with the same title but with the added requirement of a Designated Person ashore to be appointed by the shipping company as the contact person on any matter related to a ship. These two IMO resolutions were to be adopted by the industry on voluntary basis and were superseded by later resolutions that were eventually incorporated in the ISM Code in 1994.

The United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) in its 1990 report on the ‘State of the Marine Environment’ restated four principles that have been recognised world wide as proper basis for the protection and management of the marine environment (as quoted in Drewry Shipping Consultants 1996: 17). They are: sustainable development; prevention of harm; avoidance of transfer of damage from sector to sector; and international cooperation. Marine pollution is only one of the environmental problems facing mankind today and due to high media exposure of pollution from spilt oil (caused

by accidents) at sea, it is relatively easy to push for changes to existing regulations and procedures than it is for other forms of environmental problems. Climatic change; ozone depletion in the stratosphere; loss of bio-diversity; major accidents; acidification; oxidants; management of freshwater; forest degradation; coastal zone management; waste management; increase urbanisation; and chemical risks (European Environmental Agency report as quoted in Drewry 1996:14) are other forms of environmental problems world wide.

Since human error is the major cause of accidents, adding more regulations alone cannot solve the problem. The solution has to include a change in attitude by every one in the industry. Also, the quality of management of safety has to be given the highest priority. IMO has started moving in this direction by initiatives such as the STCW 95 and the ISM Code. The proper and prompt implementation of these IMO initiatives and future improvements to them by the industry is a step in the right direction. The challenge now is for every player in the industry to cooperate and work together for 'real' safety but not just 'lip service' safety. It may be difficult for some people in the industry if one considers improvements in safety as additional costs. A far more realistic treatment of costs for improving safety and preserving and protecting the environment is to consider it as an investment. Based on the notion that the earth is a fully integrated system, pollution in one location will affect the environment of adjacent areas or the atmosphere that would in turn result in increasing the greenhouse gases or interfere with its bio-diversity. So improvements in safety and the environment are investments, not costs, in the long term. The human factor plays a vital role in deciding if improvements are investments or costs. Senior managers opting for short-term profits will surely be against improvements. Their attitudes need to be changed from being proponents of short-term profits to that of long-term benefits so that improvements to safety and protecting the marine environment are treated as investments. It is imperative that the long-term benefits view prevails over the

short-term gains one, for the sake of increased safety and the preservation and protection of the environment.

It has been forecast that the two per cent average growth of world trade in the last decade will be repeated during this decade, 2000 – 2010 (UNCTAD 1999:XI). This would indicate also that there will be growth in shipping. This in turn will require more effort by every one in the industry to ensure that safety remains the highest priority. Furthermore, as sea-borne trade volume increases, so will the sizes of ships will also increase. Trading patterns will change as well. These factors have significantly influenced existing measures that were designed to prevent marine pollution in the following areas:

- The increase in the size of ships: such as the German container ship *Hamburg Express* (320 metres long and 42.8 metres wide) that is capable of carrying 7 500 twenty feet equivalent units (TEU containers). It can also carry thousands of tonnes of fuel oil, as its fuel oil consumption is about 246 tonnes/day. Similarly, the P & O cruise liner *Galaxy Princess* with a gross tonnage of over 100 000 is capable of carrying 3 000 passengers and also carry thousands of tonnes of fuel oil. Due to their sizes alone, the probability of a marine pollution occurring increases if they are involved in a marine incident.
- An increase of the number of ships at sea will increase maritime traffic concentrations, especially in ports and coastal waters, raising the probability of pollution occurring from collision, grounding and from their normal operations.
- The continuing employment in world trade of old, poorly maintained, substandard ships together with sub-standard crews.

- Sub-standard management of ships, both ashore and onboard, has significant impacts on operational activities such as the improper packing of cargoes in a container, securing of cargoes before ships sail, and loading of ships such as bulk carriers.
- Toxic and harmful cargoes are increasingly being carried in ships.

The following issues are also very important for the prevention of pollution in future. Research and development of new technology onboard ships can and should be encouraged and strengthened with the view to minimise causes of pollution, such as engines to emit into the atmosphere levels of reduced carbon dioxide, sulfur dioxide and nitrogen oxide. Furthermore, ways to contain and recover high-density oil need to be developed. This was a major concern during and in the aftermath of the *Erika* casualty. Up to date information on the behaviour of new oil or toxic and harmful substances should be disseminated as quickly as possible to the industry so that oil spill contingency plans be adjusted accordingly, especially responses at sea. It is vitally important that other countries assist a country that lacks the resources to handle the situation, where an accidental oil spill is occurring, for example, in the containment, recovery and clean up of spilt oil. Decision makers in government and the industry should give their full support for all preventive and response activities being formulated and implemented in every country to prevent or reduce pollution for pollution knows no boundary.

3.1.1 The History of Safety at Sea

The sea has always been synonymous with uncertainty and danger since ancient times. It was thought of as something of a mystery, such as that which was recorded in the Book of Proverbs in the Bible, where the writer said he does not

know “the way of a ship in the midst of the sea”. Only adventurers dared to venture out into the sea and only by chance would they be able to return safely to their homes. The expression “maritime perils” probably was coined because this line of thinking was prevalent when people started to sail on ships to trade, travel or for military purposes. It seems that the need for safety was gradually recognised after accidents and disasters occurred for many years. Change of attitudes and behaviours followed in those engaged in maritime activities and new practices to improve safety were introduced. Ships used during this period were of decent size, made of wood, and propelled by oars or sails. They were frequently wrecked on the coast or sunk by heavy seas during storms as they were difficult to handle and thus could be tossed about easily by winds and currents. Sea voyages during Biblical times were extremely dangerous.

Over the centuries the size of various types of ships increased as adventurers venture out more from the coasts into other seas and oceans. The establishment of trade and trading companies in the Americas and the Far East meant that bigger and safer ships were needed by maritime powers at the time such as Spain, England and Holland. There were various improvements to the safety of ships introduced in their construction, loading and stowage of cargo and some standards were set by various maritime powers for the control of their merchant fleets. These safety standards were sometimes contradictory due to the fierce competition and self-interests of these maritime powers to gain competitive advantage that sometimes meant that standards were lowered when necessary. This caused great confusion in the industry. Ships in increasing numbers were routinely involved in maritime disasters, especially in winter, and it was soon recognised by the industry that collective safety procedures and standards setting globally must be improved to prevent further damages to its image in the eyes of the public. The first standard setting occurred in the Middle Ages. In 1255, the very first regulations appeared in Venice (Boisson 1999: 47)

The *Titanic* disaster in 1912, with the loss of 1 501 passengers and crew, had an enormous impact on public opinion and it accelerated the idea of collective safety procedures and standards-setting movement in the maritime powers of the day. In 1914, the first international conference on the safety of life at sea was held in London as a result of the *Titanic* disaster and the first SOLAS Convention was adopted. This was an important landmark in terms of internationalising safety in shipping. It is generally regarded in the industry that the SOLAS Convention, in its successive forms, is the most important of all international treaties concerning the safety of merchant ships.

A second version of the SOLAS Convention was adopted in 1929 and a third in 1948. The SOLAS Convention 1960 was the first major work that IMO did after its establishment by updating regulations in line with technical developments in the industry. Updates were made through periodic amendments, but it was a slow process in practice. It soon became obvious that these amendments took too long to come into force. Therefore SOLAS 1974 was designed to bring into force amendments within an acceptable short period of time that were specified therein.

Due to the variety of its sources and the legacies of maritime history, maritime safety laws are complex. As explained above, there were a number of promoters of regulations and standard-setting acting nationally and internationally. This is reflected in the scale and complexity of the issues discussed. Today, States are the principal movers in improving safety at sea and supported strongly by IMO, other international institutions such as the United Nations and its family of organisations (such as UNDP and ILO); private bodies such as the International Chamber of Shipping (ICS) and the International Shipping Federation (ISF), and classification societies. Safety standards are often categorised in three forms:

technical rules adopted at an international level such as in conventions; national legislation and regulations in accordance with the provisions of the Law of the Sea; and unilateral measures that break with generally accepted standards such as the Oil Pollution Act 1990 (OPA 90) of the United States.

3.1.2 History of Oil Spills

In 1996 the main causes of major oil spill incidents that were attributed to oil tankers were due to: stranding or grounding (32%); fire/explosions (24%); collision and structural failure (16% each); and mechanical failure resulting in subsequent loss of ship (12%) (Drewry 1996:50). These are representative figures only for one particular year as there may be variations in other years, but research has shown that the ranking of the causes remains the same. When the above figures are analysed, fires/explosions resulted for all collisions and about 50 per cent of stranding and structural failures. Furthermore, 64 per cent of all casualties involved fire/explosions (Drewry 1996:50). About two thirds of strandings and mechanical failures (as the main cause) occurred in Northern European waters, generally in heavy weather, and half of collisions occurred in Southern European waters. Drewry Shipping Consultants (1996) has reported that losses due to grounding and collision that are connected to human error represent about 50 per cent of all losses. This is in line with other studies and they point to repeated deficiencies in the management, operation, design and maintenance of ships. Technical design, those serving onboard ships, meteorological factors and commercial pressures also contributed to the causes of these accidents.

Oil pollution has decreased in total in the 1990s as compared with the two previous decades although this improvement is marred by few major spills. Table 3.1 shows the approximate amounts of total oil spilt into the sea and some major spillages distorting the statistics for these years.

Table 3.1 - Selected Oil Spillages into the Sea

Year	Major Oil Spillages (tonnes)	Other Oil Spillages (tonnes)	Total Oil Spillages (tonnes)
1970			280 000
1978	282 000	98 000	380 000
1980		210 000	210 000
1989	108 400	69 600	178 000
1990		61 000	61 000
1991	350 000	87 000	437 000
1992	72 000	90 000	162 000
1993	85 000	63 000	150 000
1994		71 000	71 000
1995		8 000	8 000

Source: Drewry Shipping Consultants

The substantial increase in the 1991 figure for major oil spillages into the sea is due to the oil tankers *ABT Summer* spilling 260 000 tonnes of oil, the *Agip Abruzzo* of 80 000 tonnes and the *Haven* of about 10 000 tonnes. When major oil spillages caused by accidents are not taken into account, the amount of oil spilled (in the Other Oil Spillages column) into the sea in the 1990s is about one third less than those in the 1970s. This improvement is to be credited to the success of MARPOL 73/78 and commitment by everyone in the industry, both ashore and onboard ships. However, a lot of hard work and diligence is still needed to ensure improved pollution prevention measures are achieved in future.

At times, oil spills of lesser volume incurred huge claims for compensation when compared to ones with much bigger volume but with little claims. This is often the case in the former where the pollution of fishing grounds, port areas and other environmental sensitive areas are included. For example, the oil tanker *ABT Summer* sank 700 miles off Angola spilling 260 000 tonnes of oil with no compensation claims lodged when compared to the *Exxon Valdez* which spilled only 37 000 tonnes into the sea has claims estimated to be up to US\$10 billion. The examples quoted here reinforce the idea that improving safety onboard ships are not costs *per se* but investments and the statistics speak for themselves. In

addition, someone has said “If you think safety is expensive, try accidents”. It is a true and sobering advice. This is also reflected in the payments made by the International Oil Pollution Compensation fund for total claims in the 1990s. For example – the amount paid out in US\$ was as follows - \$77 million in 1995, \$60 million in 1994, \$115 million in 1993, \$16 million in 1992 and \$40 million in 1991(Drewry 1996:46).

The only major oil spillage in the Pacific Ocean after World War II was caused in 1977 by the oil tanker *Hawaiian Patriot* when it sank 300 miles off Honolulu spilling 99 000 tonnes of oil into the sea. Luckily the oil drifted away from the islands. Most of the oil spilled in PICTs’ waters is less than 100 tonnes, mainly from fishing vessels’ groundings, with no report of any significant environmental damage. Nonetheless, in some ports such as Pagopago and Suva one often can see a thin oil slick in the harbour area adjacent to the wharves.

3.1.3 History of Noxious Substances Spillage

When any substance in quantity enters the sea it will affect the local environment somehow. In discussing substances other than oil, it is not easy to separate toxic and non-toxic substances. For example, normally wheat or any other type of grain is not toxic but if it spilled into the sea in quantity they can ferment, producing hydrogen sulphide (<http://www.atsdr.cdc.gov/tfacts114.html>), which is extremely toxic to plants, animals and humans. The process of fermentation takes time before the effects of hydrogen sulphide can be detected. It is also difficult to determine the extent of spillage of substances other than oil as they steadily accumulate rather than the spectacular scenes associated with oil spillage.

Table 3.2 shows that a variety of toxic substances other than oil are being carried in containers onboard container ships, in barges and in special purpose tankers. The spillages are fairly large and occurred in different parts of the world. Some of the toxic substances carried onboard ships are extremely toxic to any living creature or organism, such as cyanide and pesticides. Due to the increasing trend in world trade, more toxic substances are going to be transported throughout the world, which would increase the probability of pollution occurring. To date, no spillage of any toxic substances other than oil has been reported in PICTs' waters but it is only a matter of time before this type of spillage occurs.

Table 3.2 - Selected Spillage of Toxic Substances Other Than Oil

Year	Ships	Cause of Spillage	Toxic Cargo	Amount of Spillage in tonnes	Location
1993	20 barges	tug boats colliding	Liquid ammonium nitrate	700	Mississippi River
	Grape One	sank due to severe gale	xylene	2 500	off the UK
	Sherbro	lost containers	pesticides	1 container found in Normandy beach	English Channel
	Frontier Express	tanker grounded	naphtha	8 400 spilt	approach to Samsung
1994	Red Star	LNG/LPG tanker sank	butane	2 900 in spherical tanks	off Portugal
	Kamina	lost ten containers in rough weather	cyanide	3 containers	off Chile

Source: Drewry Shipping Consultants

3.1.4 IMO Conventions

It is useful to introduce and discuss the concepts of “hard law” and “soft law” as they could be helpful in understanding the present status of international law that regulates the maritime industry. Sometimes, agreements made under treaties

(conventions) are referred to as “hard law” as they set out rights and responsibilities to Parties under any particular convention, for example, IMO conventions. Furthermore, usually an adopted convention needs parliamentary approval before it becomes the law of any country. The Vienna Convention on the Law of Treaties, 1969, prescribed the steps in the treaty-making process. On the other hand “soft law” has no real legal authority and its power is based mainly on moral grounds, and from peer and public pressure to promote implementation and compliance. An example of this is Agenda 21 and the Rio Declaration adopted at the United Nations Conference on Environment and Development (UNCED), 1992. “Soft law” needs no parliamentary scrutiny before a country adopts a principle, such as the ‘polluter pays’ and the ‘precautionary’ principles, established in these multilateral meetings. It has a distinct advantage in that it could be implemented within a relatively very short time when compared to the time a convention normally takes to enter into force. Although it does not have the legal authority of “hard law”, it can serve as a forerunner to treaty law, and the development of national policy concerning the marine environment.

An international convention under the auspices of IMO is often suggested in one of the committees. It is sent to the Council, and as necessary to the Assembly with a recommendation that a conference be convened to consider the draft for formal adoption. The draft convention is circulated to Member States of IMO and invited organisations before the conference is held. Once the majority of governments approve the draft in a conference and adopt it, it is then deposited with the Secretary General of IMO and remains open for signature by States, generally for 12 months. It usually takes several years to complete the process from drafting to adoption of a convention. Many of the conventions are not the direct result of a major maritime accident; rather, it is a culmination of successive resolutions taken by IMO to ensure that the industry is more accountable for its actions. The date that a convention enters into force is stipulated in the

convention, together with other conditions that has to be met, for example, the number of countries and the percentage of world gross tonnage.

Once a State signs a convention and accedes to it, with or without reservation(s), it has to ratify the convention by depositing of an instrument of ratification to the depository of the treaty. If a Member State wishes to denounce a convention the procedure is stipulated in that convention but usually denunciation can only be made after the expiry of five years from the date on which the convention enters into force for that State. Detailed discussion of IMO and the process for the approval and adoption of a convention is to be found in Appendix 1.

3.2 International Conventions on Maritime Safety

Five international maritime safety conventions that will have impacts on shipping in PICTs will be discussed. They are the: International Convention for the Safety of Life at Sea (SOLAS), 1974; International Convention on Load Lines (LL), 1966; Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972; International Convention for Safe Containers (CSC), 1972; International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978. Five conventions that are normally included in maritime safety will not be discussed⁶.

3.2.1 International Convention for the Safety of Life at Sea, 1974.

The main purpose of the SOLAS 1974 is to specify minimum standards for the construction, equipment and operations of ships, congruous with their safety. It entered into force on 25 May 1980 and more amendments to the Convention have

been made to date. Special powers are extended to IMO, such as ‘tacit acceptance’⁷ procedure greatly speed up the entering into force of amendments, thus avoiding the holding of full-scale conferences. SOLAS 1974 also tightened up responsibilities of a flag State by specifying requirements for it to supply to IMO and other States concerning its laws, certificates and authorised non-governmental agencies acting on its behalf, in addition to ensuring that ships flying its flag comply with its requirements. Furthermore, control provisions allow a flag State to inspect ships of another State if those ships are clearly not complying with the requirements of the convention. The following is a brief discussion of the provisions of SOLAS 1974 :

Chapter I - General provisions

It includes the application, definitions, exceptions, exemptions and equivalents in Part A. Survey and certification denoting that the ship meets the requirements of the Convention is contained in Part B, and this is the responsibility of the flag State. In addition, provisions for the control of ships in ports of other Contracting Governments if those ships and their equipment do not substantially comply with the requirements of the convention. This control procedure is known as port State control (PSC) and it will be discussed in detail later on. Each Administration⁸ undertakes to conduct an investigation of any casualty occurring to any of its ships and any findings that may improve safety be conveyed to IMO, is contained in Part C.

Chapter II – 1 - Construction- Subdivision and stability, machinery and electrical installations

Part A covers application and definitions. Outlined in Part B (subdivision and stability) and Part B 1 (subdivision and damage stability of cargo ships) are the subdivision of passenger ships into watertight compartments and they must be such that after a given damage to the ship’s hull the vessel will remain afloat and stable. Requirements for watertight integrity and bilge pumping arrangements for passenger ships are prescribed as well as those for stability for both passenger

and cargo ships. In Part C (machinery installations), D (electrical installations) and E (additional requirements for periodically unattended machinery spaces) are requirements covering the design of machinery and electrical installations to ensure that essential services for the safety of the ship, passengers and crew are continued under various emergency conditions. An important part of this chapter are the requirements for the main and auxiliary steering gears to ensure that a vessel's heading at sea remains controlled, especially in rough seas. The use of materials containing asbestos in new installations is prohibited from 1 July 2002.

Chapter II – 2 - Fire protection, fire detection and fire extinction

There are general provisions in Part A and Part B covers prevention of fire and explosion while in Part C the suppression of fire. Part D includes means of escape, Part E on operational requirements and Parts F and G on alternative design and arrangements, and special requirements respectively.

Basically the chapter stipulates detailed fire safety provisions for all ships and specific measures for passenger ships, cargo ships and tankers in seven Parts. A new Fire Safety Systems Code was introduced, containing 15 Chapters is made mandatory for all ships that include the detailed specifications for fire safety systems. The Chapter deals with the following principles:

- Division of the ship into main and vertical zones by thermal and structural boundaries including separation of accommodation spaces from the remainder of the ship.
- The use of combustible materials in ships is restricted.
- Detection, containment and extinction of any fire in the zone of origin.
- Means of escape or of access for fire fighting purposes are protected.
- Readily available of fire extinguishing appliances for use.
- Minimise the possibility of ignition of flammable cargo vapour.

Chapter III - Life-saving appliances and arrangements

The chapter covers three Parts. In Part A, there are general provisions. Part B stipulates passenger and cargo ship requirements, and Part C the life-saving appliance requirements.

A new Life-saving Appliance Code (LSA) introduced and made mandatory in the 1996 Amendments, on which all life-saving appliances and arrangements shall comply. This took into account technological requirements and advances since the last amendments in 1983 that includes the use of slides (similar to that used in an aircraft emergency escape system) as a marine evacuation system. The 1996 Amendments also took into account public concerns over safety issues raised as a result of major accidents in the 1980s and 1990s. Specific regulations were added on to ro-ro passenger ships and many of the passenger ship regulations apply to existing ships.

Chapter IV - Radiocommunications

Contains a general provisions in Part A and Part B covers undertakings by Contracting Governments while Part C deals with ship radio requirements. This chapter is closely connected to the Radio Regulations of the International Telecommunication Union (ITU). The Global Maritime Distress and Safety System (GMDSS) introduced new technologies in satellite radio communication was included in the chapter in 1988 through amendments that entered into force on 1 February 1999. Another important aspect of these amendments is that the Morse Code was phased out on this date too as the new technologies were more reliable and therefore improved the chances of a ship in distress being detected and rescued.

Chapter V - Safety of Navigation

It describes certain navigation safety services that Contracting Governments should provide and some operational requirements that apply to all ships on all

voyages. This is unique in the convention as other provisions apply only to certain types of ships on international voyages. These safety services for ships include the provision of meteorological services and search and rescue services, routing of ships and the Ice Patrol⁹. The December 2000 amendments entered into force on 1 July 2002 made mandatory the carriage of voyage data recorders (VDRs) and automatic ship identification systems (AIS) for certain ships.

The chapter also covers a general responsibility for masters to proceed to any ship in distress to assist. Furthermore, that Contracting Governments must ensure that all ships be properly crewed to meet safety requirements.

Chapter VI - Carriage of Cargoes

Contained three Parts – A (general provisions), B (special provisions for bulk cargoes other than grain) and C (carriage of grain). The chapter covers the carriage of all types of cargo, other than liquids and gases in bulk, and any special precautions that may be required to prevent any harm to the cargo and those onboard. These precautions include requirements for the stowage and securing of cargo or cargo units such as containers.

Grain was the only cargo covered in this chapter before 1991 because it has the inherent capability to shift if not properly stowed, trimmed and secured. Once the cargo of grain shifts it will flow to any side causing disastrous effects on the ship's stability even to the point of capsizing. A new IMO International Grain Code was adopted in the revised Chapter VI in 1991 and any cargo ship loading grain has to comply with this Code.

Chapter VII - Carriage of dangerous goods

The chapter covers three Parts and Part A discusses the carriage of goods in packaged form or in solid form in bulk. This part also covers the provisions for the classification, packing, marking, labeling and placarding, documentation and stowage of dangerous goods. Instructions on implementing these provisions are left to Contracting Governments. The chapter also refers to IMO's International Maritime Dangerous Goods (IMDG) Code that is used by the industry globally for the stowage and carriage of dangerous goods although it is not yet mandatory. The IMDG Code is contained now in two Volumes with a Supplement since 2000, and is regularly updated with new dangerous goods or revising existing ones. In Part B is the construction and equipment of ships carrying dangerous liquid chemicals in bulk and requires chemical tankers built after 1 July 1986 to comply with the International Bulk Chemical Code¹⁰ (IBC Code).

Part C covers the construction and equipment of ships carrying liquefied gases in bulk. Gas carriers constructed after 1 July 1986 to comply with the requirements of the International Gas Carrier Code (IGC Code).

Chapter VIII - Nuclear ships

Provide basic requirements for nuclear powered ships and giving particular attention to radiation hazards onboard or to the adjacent area. Special control, in addition to that in Regulation 19 of Chapter 1 (Control), shall be carried out before a nuclear powered ship enters into a port that includes the providing by the ship of a valid Nuclear Ship Safety Certificate.

Chapter IX - Management for the safe operation of ships.

The May 1994 Conference adopted amendments that accelerated amendment procedures to a number of Chapters in SOLAS including Chapter IX that makes mandatory the International Safety Management (ISM) Code with the following implementation schedule:

- Passenger ships including high speed craft, not later than 1 July 1998.
- Oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high speed craft of 500 gross tonnage and over, not later than 1 July 1998.
- Other cargo ships and mobile offshore drilling units of 500 gross tonnage and over, not later than 1 July 2002.

The ISM Code consists of 16 clauses, focuses on the management of human performance and not just a technical inspection as some people think. It requires the establishment of a management system that will improve safety practices and also prevent accidents. The responsibility for safety of a ship is clearly placed on the owner or operator of a ship, the master and crew. Their functions and responsibilities are clearly defined to ensure that the Code is complied with and safety objectives achieved. It also provides a framework that facilitates the management of technical inspections and requirements. Ships that do not meet the minimum required standards under the Code are going to find it quite difficult to operate from the dates of the implementation schedule stated above.

Chapter X - Safety measures for high speed craft

The chapter makes mandatory the International Code of Safety for High-Speed Craft (HSC Code) originally adopted in May 1994 and entered into force on 1 January 1996. There is a new HSC Code now that was adopted in December 2000 that applies to ships built on or after 1 July 2002.

Chapter XI - Special measures to achieve maritime safety

It was adopted in May 1994 and entered into force on 1 January 1996. The chapter was developed to clarify requirements relating to:

- Authorisation of recognised organisations that have been authorised by Administrations to carry out surveys and inspections on their behalf.
- Enhanced programme of surveys for tankers extended to bulk carriers.

- Ship identification number scheme for all passenger ships of 100 gross tonnage or more and also for cargo ships of 300 gross tonnage or more.
- Port State control on operational requirements deemed justified.

Chapter XII - Additional safety measures for bulk carriers

The chapter was developed to resolve structural issues after a number of bulk carriers disappeared without a trace or break up, in heavy seas. It was adopted in November 1997 and entered into force on 1 July 1999. It encompasses structural requirements for new bulk carriers over 150 metres in length built after 1 July 1999 carrying bulk cargoes with a density of 1 000 kg/m³. Furthermore, specific structural requirements for existing bulk carriers carrying bulk cargoes with a density of 1 780 kg/m³ and above, that include iron ore, pig iron, steel, bauxite and cement. Cargoes with a density between 1 000 and 1 780 kg/m³ include grains and timber.

Out of the nine PICTs, the Marshall Islands, American Samoa and Guam have acceded to SOLAS 74, SOLAS Protocol of 1978¹¹ and SOLAS Protocol of 1988¹², the last two countries by virtue of being Trust Territories of the United States. The following countries have acceded to SOLAS 74: Fiji; Papua New Guinea; Samoa and Tonga. Furthermore, Samoa has acceded to the SOLAS Protocol of 1978, and Tonga the SOLAS Protocol of 1988. Kiribati and Solomon Islands have not acceded to the SOLAS convention.

3.2.2 Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972

The COLREG Convention was designed as a code of good seamanship and related practices to prevent collision at sea rather than a legal code. This is evidenced in the wording of some rules such as ‘as far as practicable’; ‘special

conditions'; and 'existing rules of navigation'. Furthermore, Rule 2 outlined two important principles: firstly, 'any precaution which may be required by the practice of seamen, or by the special circumstances of the case'; secondly, 'all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from these Rules necessary to avoid immediate danger'. These expressions leave room for various interpretations to courts when evaluating a case by taking into account the prevailing circumstances rather than applying strictly the provisions of the Regulations.

This convention was adopted on 29 October 1972 and entered into force on 15 July 1977. It updated and replaced the COLREG of 1960 that was part of SOLAS 1960. All seven independent PICTs of the research have acceded to COLREG 1972, and also American Samoa and Guam as United States Trust Territories. There are 38 rules in the convention, divided into five Parts: A – General; B – Steering and Sailing; C – Lights and Shapes; D – Sound and Light Signals; E – Exemptions. In addition, four Annexes containing technical requirements for: lights and shapes and their positioning; sound signaling appliances, additional signals for fishing vessels when operating in close proximity; and international distress signals. The convention has been amended four times¹³ due to rapid changes in ship's navigating equipment, huge increase in ship sizes, specialisation of ships and the establishment of Traffic Separation Schemes (TSS).

Marine insurers have put collisions and contacts as third among total losses with 10.93 per cent; fires or explosions at 20.7 per cent; and bad weather at 32.58 per cent (Boisson 1999:481). Several reasons for the low collision statistics are: modern and reliable navigation equipment fitted onboard ships, such as radar, for safe navigation day or night in any weather; much improved navigation aids such as Global Positioning Systems (GPS), and the increasing use of traffic separation

schemes world wide. To date there is no traffic separation scheme operating in any of the PICTs' waters.

3.2.3 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended

The STCW Convention, 1978, was adopted on 7 July 1978 and entered into force on 28 April 1984. It is a first in establishing basic requirements on training, certification and watchkeeping for seafarers globally that member countries must meet or exceed. Prior to the convention, individual governments fixed the standards of training, certification and watchkeeping of seafarers. Therefore, standards and procedures varied widely world wide, although shipping is arguably the most international of all industries. The convention did not cover manning levels as it has been dealt with in Regulation 13 of Chapter V of SOLAS 1974. However, it deals specifically with the hours that a crewmember has to rest within a 24 hours period, as fatigue has been found to be a major contributor in many shipping casualties, such as the *Exxon Valdez* and the *Herald of Free Enterprise* disasters.

One prominent feature of the convention is that its provisions apply to ships of non-Party States when visiting ports of a State Party by the use of the 'no more favourable treatment' concept. This is reflected in Article X, that requires a State Party to apply the control measures provided by the convention to any ship of a non-Party State that visits one of its port. Many countries strongly supported the 'no more favourable treatment' concept and that is why by December 2000 there were 135 Parties to the convention representing 97.53 per cent of world shipping tonnage (<http://www.imo.org/Conventions/contents.asp?>).

STCW 1978 contained six chapters – Chapter 1 contains the general provisions; Chapter II deals with standards for master and deck department; Chapter III concerns standards for engine department; Chapter IV covers standards for radio personnel; Chapter V states special requirements for tankers; Chapter VI mandates proficiency in survival craft. The Convention was soon proved to be ineffective, mainly due to difficulties in verifying compliance that led to a major revision in mid-1994. The amendments were adopted in 1995 and entered into force on 1 February 1997. However, a transition period of five years was approved for States Party to comply fully with the provisions of the 1995 amendments, that is until 1 February 2002. Due to compliance problems in upgrading and re-certification another six months was allowed to States Party to IMO: that is until 1 August 2002. After that Port State Control officials may detain vessels not complying with the requirements of the Convention, as amended. Other amendments to the major revision in 1995 of STCW 78 have been made in later years.

The 1995 amendments added provisions to STCW 1978 in order to verify compliance with the Convention and to ensure standards of training and certification are achieved. Port State control issues and the communication of inspection results were addressed. A Code, Part A of which is mandatory has been incorporated in the Convention that covers the required minimum standards of competence, knowledge, methods of demonstrating them, and criteria for assessing competence. Furthermore, standards for qualification of assessors were established and the use of simulators for training purposes was also included in the Convention. Part B (Guidelines) of the Code is not mandatory and is intended to assist Parties in implementing the Convention. The amendments in 1995 add on two new chapters. Chapter VII (Alternative certification) is intended to ensure that safety and the environment are not endangered in any manner. The new chapter also permitted ships' crews certificated in one department to be certificated in another department onboard, provided they meet certain conditions

prescribed by the Convention. In addition, a new Chapter VIII (Watchkeeping) covers measures designed to maintain efficient watch systems onboard ships by preventing fatigue through mandatory rest periods.

Port State control provisions were included in the 1995 amendments on Chapter 1 that permitted authorities of a port in a State to detain ships in case of deficiencies identified onboard that would endanger persons, property or the environment. For example: in case if the ship's certificates are not in order or pollutants were discharged in the port area or the ship was involved in an accident.

IMO published a list (known in the industry as the 'White List') in the first half of 2001 of 94 State Parties that has been deemed to be giving 'full and complete effect' to the revised STCW Convention (known as STCW 95). The White List will be kept under review and State Parties may be removed or added on to it in future, depending on their meeting or not, of the requirements of the Convention. Ships of non-State Parties and those countries not on the White List are expected to be targeted by port State control inspectors of State Parties to ensure that the crews of these ships are properly certificated and that their training meets STCW standards. As from 1 February 2002 all crew employed on ships of White List countries should hold STCW 95 certificates or endorsements issued by the flag States. The nine PICTs of the research and the Federated States of Micronesia, Tuvalu and Vanuatu are on the White List. These PICTs have also acceded to the STCW Convention 1978, as amended.

3.2.4 International Convention on Load Lines, 1966

Since ancient times, many ships have sunk or lost at sea due to overloading of those ships by greed of their owners or masters. Seafarers have been aware for a

long time that there is a limit to which a ship may be loaded with cargo before that ship starts to sink. That limit is the loaded draught¹⁴. This loaded draught has a corresponding freeboard¹⁴ and this is marked at both sides amidships of the ship. Beside the freeboard disc are the load lines that indicate how deep a ship is permitted to be submerged. There are six load lines and they are illustrated in Appendix 2.

The Convention is about freeboard regulations and damage stability calculations. It also takes into account potential dangers existing in different zones and different seasons. In the technical annex are safety measures (such as doors, hatchways etc) to ensure the watertight integrity of the ship's hull below the freeboard deck¹⁵. The convention was adopted on 5 April 1966 and entered into force on 21 July 1968 and it contains three annexes. There are four chapters in Annex I: Chapter I with general provisions; Chapter II on conditions of assignment of freeboard; Chapter III covering freeboards; and Chapter IV outlining special requirements for ships assigned timber freeboards. Annex II covers Zones, areas and seasonal periods. Certificates such as the International Load Line Certificate are prescribed in Annex III. Two of the nine PICTs of the research have not acceded to the Load Line Convention and they are Kiribati and Solomon Islands.

3.2.5 International Convention for Safe Containers (CSC), 1972

Since the 1960s, there has been a rapid increase in the use of freight or cargo containers and the construction of specialised container ships to carry them. In order to ensure containers are safe to be used for the carriage of goods, loading and unloading purposes, the CSC Convention was adopted on 2 December 1972 and entered into force on 6 September 1977. The Convention has two goals, the

first is to ensure that a high level of safety to humans during transportation and when they are handled. Safety measures designed were to stipulate generally acceptable test procedures and related proven strength requirements. Second, to establish international safety standards to facilitate the use of containers internationally.

The scope of the Convention is limited to containers of a prescribed size having corner fittings for handling, securing or stacking purposes. Containers used in air transportation are not covered by the Convention. Procedures for the safety approval by Contracting Governments and for amendments are contained in the Convention. The technical Annex specifies various tests representing a combination of safety requirements of both the inland and maritime modes of transport. When dangerous goods are carried in a container it is very important that the requirements of the Convention are being met to prevent water damage and maintain the separation required under the IMDG Code. Only the Marshall Islands and the two United States Territories have acceded to the Convention.

3.3 International Conventions for the Prevention of Marine Pollution

IMO has adopted six international conventions that cover marine pollution. Four of these conventions will be discussed, the first two relate directly to the subject of the research in the internal indicators – ships and cargoes. They are the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78); and International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001. These two Conventions¹⁶ prescribe regulations that are designed to prevent the polluting of the marine environment by ships and/or cargo at the first instance. The other two conventions cover the contingency plan external factor - International Convention on Oil Pollution Preparedness, Response and Co-

operation (OPRC), 1990, and Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000 (HNS Protocol). OPRC 1990 is included in a regional version known as the Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region (SPREP Pollution Emergencies Protocol).

The United States' unilateral Oil Pollution Act, 1990 (OPA 90) will be discussed in this section as there are two United States Territories – Guam and American Samoa in the PICTs of the research. The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (Basel Convention), 1989, and its regional version, the Waigani Convention will not be covered in the research as they basically cover controls of trans-boundary movement and management of hazardous wastes.

Pollution arising from the operation of the ship and those from accidents and casualties usually originated from faults in navigation or operation, or in the construction and maintenance of ship or equipment, or a combination of two or more of these factors. These factors are sufficiently addressed by SOLAS, MARPOL, COLREG, STCW and Load Line Conventions. Furthermore, MARPOL 73/78 provides for design and other requirements that limit damage and outflow in the event of the hull being damaged as a result of a casualty. About 40 years of pollution control has focused on the design of ships and technical aspects. Only recently has the human input been tackled through the ISM Code and STCW 95 to ensure safety and protection of the environment are made more effective. Therefore, a more holistic approach must be taken in order to prevent and control pollution.

In the past, improving safety and preventing marine pollution internationally was done after major casualties. A more scientific method of ‘prevention is better than cure’ is now being increasingly accepted globally to prevent pollution, by analysing the risks involved in a particular situation. The risks identified are managed to avoid or minimise any adverse impact and this new method is known as the ‘precautionary principle’. IMO has used this risk assessment method in the following areas:

- In evaluating safety levels for alternative designs of the double hull for oil tankers.
- In improving the development of regulations and their implementations.
- In identifying areas to be included in the Enhanced Survey Programme¹⁷.

SPREP in conjunction with UNEP in 2000 published the Pacific Islands Handbook of International Marine Pollution Conventions that covered texts of major global and regional environmental conventions, agreements and protocols as part of a series on Environmental Law and Policy. Furthermore, the Handbook is an important tool for enhancing public awareness and the development and enactment of environmental law, including marine pollution law. The Handbook’s main value is that it is a reference and resource book on global and regional environmental conventions in a single volume. The main shortcoming of the Handbook is that global and regional environmental conventions are regularly amended and if these amendments are not regularly circulated to users then its value diminishes.

3.3.1 International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related thereto (MARPOL 73/78)

The Convention was adopted on 2 November 1973 and entered into force on 2 October 1983 after it was amended and incorporated into the Protocol of February

1978 (for Annexes I and II only). This was due to the fact that MARPOL 1973 had not entered into force by the time new amendments were ready to be adopted as a result of a number of oil tanker accidents in 1976 – 1977. The MARPOL 1973 Convention covered pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage. Tanker safety and pollution prevention was the main subject of the 1978 Protocol and the Convention has been updated by amendments through the years in the light of new technological developments and changing circumstances. Measures linked to tanker design and operation were included in a 1978 Protocol to SOLAS 1974 and it was related to the 1978 Protocol to MARPOL 1973. Annex V entered into force on 31 December 1988 and Annex III entering into force on 1 July 1992. Annexes IV and VI have not yet entered into force at the end of July 2002 as the required number of States and tonnage have not been achieved. MARPOL 73/78 is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The Marshall Islands, Papua New Guinea, Samoa, Tonga, Guam and American Samoa (the last two PICTs are through the United States) have acceded to MARPOL 73/78 (Annexes I – V). No PICT has acceded to Annex VI yet as of 31 May 2002.

Achieving of global standards for equipment in general is a problem common to both MARPOL 73/78 and SOLAS 1974. The regulations contained in both Conventions only prescribe operational standards, leaving much of the detailed interpretation to Administrations and manufacturers. IMO and members of the International Association of Classification Societies (IACS) have provided unified interpretation guidelines that cover some aspects. However, the huge number of players in the ship equipment industry world wide runs into thousands, consequently there is no way that every item of equipment peculiar to a region could be covered by international regulations. Therefore, IMO is looking into and encourages the use of regional standards for ship equipment based upon international standards and certified by recognised existing organisations.

Oil pollution of the marine environment had been recognised as a problem in the first half of the 20th century and some countries legislated to control the discharges of oil within their territorial waters. The United Kingdom organised a conference on oil pollution in 1954 that resulted in the adoption of the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954, and it entered into force on 26 July 1958. When the IMO was established in 1958 the depository and Secretariat functions were transferred from the United Kingdom to IMO. The Convention was amended several times to address pollution resulting from routine oil tanker operations and from discharge of oily wastes from machinery spaces that were, at the time, the major causes of oil pollution from ships.

OILPOL 1954 was an attempt to tackle the problem of pollution of the seas by oil¹⁸ generally in two ways. Firstly, it established 'prohibited zones' extending to at least 50 miles from the nearest land in which the discharge of oil or mixtures containing more than 100 parts of oil per million was prohibited. Secondly, it required Contracting Parties to provide or encourage the provision of reception facilities for oily water and residues. The Convention did deal with some oil pollution matters but the growth in oil trade and the increased industrialisation world wide meant that further action was required to cope with new pollution challenges, hence the development of SOLAS 1974.

The Articles of MARPOL 1973 cover administrative matters such as general obligations, application, violation, inspection, enforcement, reports on incidents involving harmful substances, settlement of disputes, communication of information, casualties to ships, entry into force, amendments, and the promotion of technical co-operation. In 1974 the Marine Environment Protection Committee

(MEPC) was established as part of IMO to oversee environment matters because Contracting Parties recognised the importance of keeping the environment clean and free from pollution. Contained in the Annexes, that have been amended quite often over the years, is the real muscle of the Convention. They are discussed in more detail in the next paragraphs. The provisions of the Convention are complex and have seen much change over the years, therefore requiring careful interpretation by shipbuilders, ship owners and also those responsible for enforcing them.

Annex I - Regulations for the prevention of pollution by oil

It contains four chapters and three appendices and in its original form, in MARPOL 1973, came into force on 2 October 1983. Chapter I cover the general provisions that include definitions, application, equivalents, surveys, issue or endorsement of certificates, form and validity of certificates, and port State control on operational requirements. Chapter II outlines the requirements for control of operational pollution that include control of discharge of oil, exceptions, reception facilities, segregated ballast tanks (SBT), dedicated clean ballast tanks and crude oil washing, prevention of oil pollution in the event of collision or stranding, retention of oil onboard, oil discharge monitoring and control system and oil filtering equipment, tanks for oil residues (sludge), pumping, piping, and discharge arrangements of oil tankers, Oil Record Book, and special requirements for drilling rigs and other platforms. Requirements for minimising oil pollution from oil tankers due to side and bottom damages are stipulated in Chapter III. It also outlines damage assumptions, hypothetical outflow of oil, limitations of size and arrangement of cargo tanks, subdivision and stability. In Chapter IV the prevention of pollution arising from an oil pollution incident is covered together with shipboard oil pollution emergency plan. List of oils is in Appendix 1, with the Form of IOPP Certificate and Supplements in Appendix II. The Form of Oil Record Book is in Appendix III.

In the context of preventing pollution from operations of ships, the Oil Record Book plays a crucial role in ensuring that every activity onboard involving oil or oily mixture is recorded and signed by the appropriate ship's crew and countersigned by the master. By inspection of the Oil Record Book, Contracting Parties can check and monitor compliance of any ship that visits any of its ports, and that will contribute to minimising or preventing of pollution. Every oil tanker of 150 tons gross tonnage and every ship of 400 tons gross tonnage and above other than an oil tanker is required to be provided with an Oil Record Book. Administrations are encouraged to develop an appropriate Oil Record Book for oil tankers of less than 150 tons gross tonnage. It is clear that the maritime community wants to eliminate pollution of the marine environment by all ships whenever there are operations in machinery spaces by recording in Part I of the Oil Record Book the: ballasting or cleaning of oil fuel tanks and the discharge of dirty ballast or cleaning water from those tanks; disposal of oily residues (sludge); discharge overboard or disposal otherwise of bilge waters which has accumulated in machinery spaces. The recording in Part II of cargo/ballast operations in oil tankers such as: loading and unloading of oil cargo; internal transfer of oil cargo during voyage; ballasting, cleaning and discharging of oily water; closing of applicable valves after discharging from tanks; and disposal of residues, are also measures put in place to control and prevent the polluting of the marine environment.

According to Drewry Consultants (1996: 33), in 1989, the largest single cause of ship generated pollution is bilge water from machinery spaces. This type of pollution is not as spectacular as major spills but it can cause major problems and adverse media reports when it occurs in an environmental sensitive area where birds and mammals that swim on the water surface may be oiled by floating oil slicks. All ships can cause bilge water pollution for some very large passenger or cargo ships carry more fuel oil than some small oil tankers carrying cargo of oil. Cleaning of cargo tanks in oil tankers can produce a fair amount of oily water that

may be accidentally spilled overboard, which can cause pollution problems. In order to address oily water from cargo tank cleaning problems, oil tankers are fitted and have in operation an oil discharge monitoring and control system and a slop tank arrangement approved by a State Party that comply with the requirements of Annex I, Regulation 15 of the Convention. New oil tanker designs in recent years have been fitted with segregated ballast tanks that eliminates the need of having ballast in cargo tanks thus prevent the creation of oily water onboard.

Another important consideration is the adoption of the double hull design for new oil tankers. This may play a crucial role in preventing pollution from accidents such as grounding and collision. The double hull design was introduced by the United States after the oil pollution disaster that was caused by the *Exxon Valdez* grounding in Alaska in 1989, spilling thousands of tonnes of oil into the sea. Since then the United States has insisted and legislated in OPA 90 that oil tankers calling at its ports must be double hulled, although there are other designs such as that relying on rapid oil transfer. Some of the other designs have been found not satisfactory in some aspects to prevent pollution. Although there is an ongoing furious debate on the rights and wrongs¹⁹ of the double hull design, the fact is it is here to stay. For example, Drewry has reported that in February 1996, double hull oil tankers were 251 out of 3 500, with another 106 new ones on order. IMO is now planning to phase out the use of single hull oil tankers for trading purposes by 2015.

The prevention of pollution arising from an oil pollution incident is largely dependent on immediate actions taken by the master and the ships crew. Procedures are laid out in the shipboard oil pollution emergency plan as required under Chapter IV of Annex I. One of the most important features of the plan is that it should be written in the working language of the master and officers. The

plan also includes: the procedure to be followed in reporting an oil pollution incident; the list of authorities or persons to be contacted; detailed description of action to be taken on board to reduce or control discharge of oil; procedures and point of contact on the ship for coordinating shipboard action with national and local authorities in combating the pollution. This plan will also form part of the safety management system required under the ISM Code and it should be compatible with other plans, such as those covering chemicals. It is very important that the oil pollution emergency plan takes into account and be acceptable under OPA 90, as well as MARPOL 73/78.

Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk

The Annex entered into force on 6 April 1987 and applies to all ships carrying noxious liquid substances in bulk except as provided otherwise. It details the discharge criteria and measures for the control of pollution by the noxious liquid substances carried in bulk. There are about 250 substances that has been evaluated and included in a list attached to the Convention. The discharge of their residues is allowed only to reception facilities ashore or at sea more than 12 miles from the nearest land, subject to a prescribed residual concentration. Noxious liquid substances are categorised according to their effect when discharged into the sea from tank cleaning or deballasting operations. They are as follows:

- Category A – Noxious liquids presenting a major hazard.
- Category B – Noxious liquids presenting a hazard.
- Category C – Noxious liquids presenting a minor hazard
- Category D - Noxious liquids presenting a recognisable hazard.

The carriage of chemicals requires expert detailed analysis to determine the type of ship and equipment suitable to carry a particular Category cargo. Special care is required in respect of Category A cargoes.

Chemical tankers built before 1 July 1986 must comply with the BCH Code. After this date they must comply with the IBC Code. The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) covers design and equipment requirements for gas carriers and it also lists liquefied gases. Liquid cargoes carried in ships can be divided into three groups: liquefied gases; oils; and noxious and non-noxious liquid substances or chemicals. An increase of about 5.1 per cent in the global shipment of chemicals has been reported between 1992 and 1994 (Drewry 1996: 35).

Annex III - Regulations for the Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form.

This Annex is the first of the four optional Annexes (that is III, IV, V, VI) and that is why it took so long to enter into force, on 1 July 1992. Annexes I and II must be accepted by States once they ratify the Convention. General requirements for the issuing of detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances, are contained in this Annex. The provisions of the Annex do not apply to ships' stores and equipment. Existing international regulations on dangerous goods may be divided into two categories: safety of ships and the protection of the marine environment. SOLAS 74 covers the safety aspect in Chapter VI and Chapter VII. Chapter VII prohibits the carriage of dangerous goods by sea, except when they are carried in accordance with the provisions of the SOLAS Convention. The IMDG Code was published separately in 1970 by IMO, based on Assembly Resolution A.81 adopted in September 1965. Resolution A.81 approved an international maritime code for dangerous goods, and it advised member governments to adopt the code and use it for their national regulations. Most of the provisions of the IMDG Code are mandatory since 1 January, 2004.

In 1985, IMO made a major amendment to the IMDG Code to facilitate the implementation of Annex III of the MARPOL Convention. The main objective was to incorporate provisions for the transport of substances or objects harmful to the environment and identified as “marine pollutants”. Annex III defines “harmful substances” as those identified as marine pollutants in the IMDG Code. The Annex III does not contain a list of substances involved, but an appendix prescribing the criteria for identifying marine pollutants. Dangerous goods are those substances incorporated and defined under the IMDG Code and may include harmful substances. For example: Distress signals, UN No.0194 is classified as Class 1.1G but with no subsidiary risk (marine pollutant) as in column 4; Chlorine, UN No.1017 is classified as Class 2.3 that has a subsidiary risk as a marine pollutant (or harmful substance).

Briefly outlined below are the provisions of Annex III of MARPOL 73/78:

- Regulation 1 - Application

‘Harmful substances’ is defined as those substances identified as marine pollutants in the IMDG Code, and their carriage is prohibited unless they are in accordance with the provisions of the Annex. Contracting Governments are required to issue detailed guidelines to supplement the general provisions of the Annex. Empty packagings that have been used for the carriage of harmful substances shall be treated as harmful substances until they have been properly determined to be otherwise.

- Regulation 2 - Packagings

Packagings shall be adequate to minimise the hazard to the marine environment, having regard to their specific content.

- Regulation 3 - Marking and Labeling

Requires durable and correct marking on packages with technical name of the substance together with the IMO number where possible, and shall be identifiable after they have been immersed at sea for at least three months.

- Regulation 4 - Documentation

Documents are to refer to technical name with 'Marine Pollution' added on. A shipper has to supply a signed certificate that the shipment offered for carriage is properly marked, etc and in proper condition to minimise hazard to the marine environment. When carrying harmful substances a ship shall have a special list, or detailed stowage plan, of such substances and the location thereof. Copies of such documents to be retained by the owner or his representative ashore, and a copy be made available to the port State authority or the designated person or organisation before departure. Where a special list is carried in accordance with SOLAS 1974, the list required under this regulation may be combined with it provided that a clear distinction is made between dangerous goods and harmful substances.

- Regulation 5 - Stowage

Harmful substances are to be properly stowed and secured.

- Regulation 6 - Quantity Limitations

Certain harmful substances may only be carried in limited quantities, taking into consideration the size, construction and equipment of the ship, the packaging and nature of the substance.

- Regulation 7 - Exceptions

Jettisoning of harmful substances in packaged form is prohibited except in cases of safety of the ship or saving life at sea.

- Regulation 8 - Port State control on operational requirements

A ship may be inspected by officials and detained when in a port of another Party if it does not comply with the provisions of the Convention, but the inspection and detention must be in accordance with the procedures prescribed in Article 5.

- Appendix - Guidelines

It is for the identification of harmful substances in packaged form with references to source materials.

The safe securing of packages and containers containing dangerous goods onboard ships is very important as in recent years some of them have been lost overboard in heavy seas. They present danger in coastal waters and on beaches. Examples are given in Table 3.2 of this chapter. IMO has recently proposed recommendations to improve safe securing of these dangerous goods.

Annex IV - Regulations for the Prevention of Pollution by Sewage from Ships

It is one of the optional annexes of the Convention. The Annex covers requirements to control pollution of the sea by sewage and is summarised as follows:

- Regulation 1 - Definitions of new and existing ships, sewage, holding tank, and nearest land.
- Regulation 2 - New ships of 200 gross tonnage and over or carrying more than 10 persons shall comply immediately but for existing ships 10 years after the Annex enters into force.
- Regulation 3 - Surveys and related requirements.
- Regulations 4 to 7 - Issuance, validity and form of certificates.
- Regulation 8 – Discharge of sewage into the sea is prohibited except when discharging comminuted and disinfected sewage using an approved system. The discharge shall be made at a distance of more than four nautical miles from the nearest land. Or, if sewage not comminuted and disinfected, the discharge shall be made at a distance of more than 12 miles offshore. In any case, the sewage must have been stored in holding tanks. The sewage must be discharged at an approved moderate rate while the ship is en-route and proceeding at not less than four knots. Furthermore, as an alternate, the ship has in operation an approved and certificated sewage treatment plant.

- Regulation 9 is exceptions.
- Regulation 10 contains provisions for shore reception facilities.
- Regulation 11 covers specification, description and dimensions for standard discharge connections.
- Appendix shows the Form of International Sewage Pollution Prevention Certificate (1973).

Although the Annex is not yet compulsory, the United States and many countries have domestic regulations prohibiting the discharge of raw sewage into their waters. Ships without sewage treatment systems²⁰ are increasingly facing difficulties operating in most parts of the world.

Annex V - Regulations for the Prevention of Pollution by Garbage from Ships

Annex V is one of the optional annexes and it entered into force on 31 December 1988. This Annex deals with different types of garbage and specifies the distances from land and the manner that they may be disposed of, but it is much stricter in ‘special areas’²¹. The complete ban put on the dumping of all forms of plastic into the sea in Regulation 3 is a very important feature of the Annex. It is made up of seven Regulations, supplemented by a set of Guidelines that are summarised as follows:

- Regulation 1– Definitions: Garbage is defined as all kinds of victual, domestic and operational waste with some exceptions²².
- Regulation 2 – Application: Annex applies to all ships.
- Regulation 3 – Disposal of garbage outside special areas: The disposal of the following garbage shall be made as far as possible from the nearest land, but not less than 25 nautical miles from nearest land for dunnage, lining and packing materials which will float. It is 12 nautical miles for food waste and all other garbage including paper, rags, glass, metal, bottles, crockery and

similar refuse, three miles if it has been passed through a comminuter or grinder with less than 25 millimetres or less holes.

- Regulation 4 – Special requirements for fixed or floating platforms and ships calling at them.
- Regulation 5 - Disposal within special area: Requirements for disposal stipulated.
- Regulation 6 – Exceptions: In the event of emergencies or accidents.
- Regulation 7 – Reception facilities: Governments endeavour to provide garbage reception facilities and that IMO be advised of such.
- Regulation 8 – Port State control on operational requirements: Permits port State inspections of another Party's ships and the procedures to be of that prescribed in Article 5 of the Convention.
- Regulation 9 – Placards, garbage management plans and garbage record-keeping. Every ship of 12 metres or more in length shall display placards in the working language of the crew that notify the crew and passengers of the disposal requirements of regulations 3 and 5 of this Annex, as applicable. Furthermore, every ship of 400 tons gross tonnage and above, and every ship which is certified to carry 15 persons or more shall carry a garbage management plan and a Garbage Record Book. I have serious reservations that ship owners in PICTs can meet the requirements of this regulation.
- Appendix covers the Form of Garbage Record Book.

Garbage disposal can create problems depending on ship type, nature of cargo carried, size of crew and similar factors. The following also contribute to the problems onboard such as the: limitation of waste generated; separation and processing of different types of garbage and storage; disposal of garbage according to type; and the keeping of appropriate records. Good management by senior staff and appropriate training of crew to understand the concept behind this activity is important to successfully implement the requirements of the Annex.

The dumping of plastic waste at sea is prohibited and it may be difficult to implement this requirement. Three ways could be used to dispose of plastic waste onboard such as:

- (a) putting them in a storage locker or garbage drums until they could be disposed of ashore; or
- (b) compress the plastic with a plastic waste processing (PWP) unit then disposed ashore; or
- (c) use an approved incinerator onboard.

Annex VI - Regulations for the Prevention of Air Pollution from Ships

It was adopted in September 1997 but the Annex has entered into force on 19 May 2005. The Annex set limits on sulphur dioxide (SO_x) and nitrogen oxide (NO_x) emissions from ship exhausts. Furthermore, it prohibits the use and deliberate emissions of ozone depleting substances such as compounds of Halon and CFC²³. The goal was to halve SO_x emissions from marine sources by the year 2000 and an international limit of five per cent of sulphur content in fuel oil has been initially set, well above the existing estimated world average of two to three per cent. One method to reduce SO_x content in fuel oil is to fit expensive exhaust gas desulphurisation equipment to engines onboard. Another method is to produce lower sulphur content fuel oil by refineries but this is also expensive. NO_x exhaust emissions are a function of engine design and speed. Emission limits will be measured using rated engine speed or fuel consumption or other means of verification. Engines exceeding the required NO_x emission limits will have to be fitted with an approved exhaust cleaning system. The aim is to reduce SO_x and NO_x emissions in the next ten years and it is claimed that significant cost savings may be achieved in wear and tear of the engine that would compensate for the increased capital and lubricating oil costs. The use of CFCs will be strictly controlled and prohibited in new equipment. Any disposing of equipment containing CFCs will have to be made into a recognised reception facility. An International Air Pollution Prevention Certificate will be issued by an

Administration after a ship has been surveyed and found to comply with the provisions of this Annex.

3.3.2 International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS) 2001.

The Convention was adopted on 5 October 2001 but it has not entered into force yet as of 31 December 2007. The goal of the new Convention is to prohibit the use of harmful organotins in anti-fouling paints on ships by 1 January 2003, and total ban by 1 January 2008. It also establishes a framework to prevent the potential use in future in ships of other harmful substances in anti-fouling paints. By 1 January 2008 ships shall not bear such compounds on their hulls or external parts or surfaces, or shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems. Parties to the Convention are also required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag or under their authority, and all ships entering their ports, shipyards or offshore terminals. The disposal of removed materials from ships is the responsibility of the owner and master. In a shipyard, the responsibility for disposal of removed materials from ships is the owner of the shipyard.

Prohibited or controlled anti-fouling systems are listed in Annex 1 of the Convention that will be updated as and when necessary. The Convention states in Article 12 that a ship shall be entitled to compensation if it is unduly delayed or detained while being inspected for possible contravention under the Convention. It also provides for the establishment of a 'technical group' consisting of appropriate experts to review proposals for other substances to be prohibited or restricted. "Anti-fouling systems" is defined in the Convention as a coating,

paint, surface treatment, surface or device that is used on a ship to control or prevent attachment of unwanted organisms.

Organotin tributyltin (TBT) anti-fouling paints were developed in the 1960s.

Anti-fouling paints are used to coat the bottom parts of a ship's hull to prevent marine life, such as algae and molluscs, attaching themselves to the hull. If the marine organisms attached themselves to the hull the flow of water along the hull will be interrupted causing resistance to the forward motion of the ship thus reducing its speed, with subsequently increased fuel consumption and add costs. In the days of sailing ships, lime and later arsenic were used to coat ship's hulls until more effective metallic compounds were developed and included in anti-fouling paints. These compounds slowly leach into the sea, killing barnacles and other marine life that have attached to the ship's hull. Studies have shown that these compounds persist in the water, killing sea life and harming the environment, possibly entering the food chain.

3.3.3 International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) 1990.

The Convention was adopted on 30 November 1990 and entered into force on 13 May 1995. PICTs that have acceded to the Convention are the Marshall Islands, Tonga and the two United States Trust Territories – American Samoa and Guam. Its purpose is to provide a global framework for international co-operation in combating threats of marine pollution involving ships, offshore units, ports and oil handling facilities. Key points covered in the Convention include:

- Ships to have onboard an oil emergency plan.
- Oil pollution reporting procedures to be followed.
- Parties to take appropriate action when a pollution report is received.
- Parties to establish national and regional plans, bilateral and multilateral agreements on preparedness and response to pollution incidents.

- Parties to co-operate internationally in response to pollution incidents.
- Parties agree to co-operate in research and development through IMO.
- Support and training should be provided to Parties requesting technical assistance.
- The Convention should be evaluated and amended as necessary.

Conditions for the reimbursement of costs of assistance are provided in an Annex. An additional ten resolutions containing annexes cover the implementation, establishment of stockpiles of oil spill combating equipment, training, promotion of technical assistance, improving salvage services, co-operation between States and insurers. These resolutions also cover the expansion of the scope of the Convention to include hazardous and noxious substances. The Protocol on Preparedness, Response and Co-operation to pollution incidents by Hazardous and Noxious Substances, 2000 (HNS Protocol), address the concerns in dealing with hazardous and noxious substances. The requirement for ships to have oil pollution emergency plans under OPRC and HNS Protocol parallel a similar requirement in MARPOL 73/78 (as amended) and this is recognised in OPRC. Under OPA 90 the requirement is slightly different.

A regional agreement known as the SPREP Pollution Emergencies Protocol (SPREP Protocol) has been adopted under the auspices of SPREP and it covers only the Pacific Region. PICTs acceding to the SPREP Protocol are Fiji, Marshall Islands, Papua New Guinea, Samoa, Solomon Islands, American Samoa and Guam through the United States. OPRC 90 encourages the establishment of regional plans for preparedness and response to pollution incidents. Such response could only be carried out successfully by PICTs as a region. The SPREP Protocol covers oil pollution threats, similar to OPRC 90, as well as other hazardous substances that are now included in the HNS Protocol 2000. A number of similarities and differences can be found when one compares the OPRC 90 and

the SPREP Protocol. Both of them are compatible in that they encourage the establishment of bilateral or multilateral agreements for oil pollution preparedness and response. It remains to be seen which one a PICT will invoke when a pollution incident occurs if it has acceded to both. Perhaps it will be dependent on what type and where the pollution occurs.

3.3.4 Oil Pollution Act of 1990 (OPA 90) of the United States

Although OPA 90 is not an international regulation, a brief discussion is warranted due to the fact that two of the PICTs of the research, American Samoa and Guam, are Trust Territories of the United States. Furthermore, OPA 90 is one of the unique manifestations of unilateralism that relegates IMO's standing to the back in matters related to international law. It also shows the United States' power and ability to ignore the rest of the world when it decides to pursue its own interests. However, IMO has sponsored amendments to MARPOL 73/78 including Regulations 13f and 13g to take into account double hulls and other structural designs²⁴ that incorporate OPA 90 requirements. The United States has not withdrawn OPA 90 to date yet and it will run parallel to MARPOL 73/78, as amended.

Briefly OPA 90 demands that:

- Ship owners and operators shall be jointly and severally liable for oil spills and liable for meeting clean-up costs.
- Unlimited liability if negligence or breach of regulations can be proved. This has created a lot of difficulty in the industry as compared to IMO international conventions on liability and compensation such as the CLC and Fund 1992 Conventions.

- Individual states can override federal law and can impose unlimited liability. This can result in fragmentation of maritime law both within the United States and internationally due to different liability regimes.
- A Certificate of Financial Liability (COFR) is required for every vessel that enters United States' waters, and all vessels are to comply with United States Coast Guard regulations.
- Every new vessel must have a double hull, and this will increase the cost²⁵ of building a new one.
- Single hull vessels will be phased out according to a timetable provided by the United States, but by 2015 all vessels are to be double hulled.

An oil tanker is required to have an approved Vessel Response Plan (VRP) under OPA 90 as compared with MARPOL 73/78 Regulation 26 of Annex 1, where a Shipboard Oil Pollution Emergency Plan (SOPEP) is required. The OPA 90 requirement is more stringent than the MARPOL one in that an operator of an oil tanker is required to demonstrate that he has considered the consequences and related matters that will be implemented to minimise spillage. Furthermore, proof must be provided that the crew has the appropriate training in implementing the VRP. Included in SOPEP is the procedure to be followed by the master to report an oil pollution incident, the list of authorities or persons ashore to be contacted when a spillage occurs, and a detailed description of the implementation of the plan to reduce or control any oil spillage.

3.4 New International Conventions for Pollution Prevention

The International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water), 2004, has been developed for over 10 years by IMO. On 1 February 2004, a diplomatic conference adopted the Convention at

IMO. A number of countries (including Australia) have already used the voluntary Guidelines for the control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens that were approved in IMO (MEPC) Resolution A.868(20). The proposed Convention advocates: that ballast water is not to be taken onboard generally in shallow waters; that accurate records be kept of where ballast was taken and disposed of; ballast to be exchanged at sea; and ballast to be discharged in an approved manner in a port.

Studies in several countries have found that ballast water and sediments carry many species of bacteria, plants, and animals and they can also survive there in a viable form after several months. Subsequent discharge of the ballast water or sediments in another country's waters may result in the transfer of harmful aquatic and pathogens that may pose threats to indigenous human, animal life, plant life and the marine environment. For example, more than 170 exotic species have been introduced into Australia threatening the shellfish industry, such as the Northern Pacific Seastar (IMO News 1999: 18-19), and altering the feeding habitat for native fish. The World Health Organisation is also concerned that ballast water may be a medium for the spreading of epidemic disease bacteria (Ballast Water News, Issue 8, 2002: 4-5). Any risk management method used to reduce transfer of harmful organisms and chemicals will depend on several factors, including the type or types of organisms being targeted, the economic costs, ecological costs and the safety of ships. The use of a ballast water management plan in a ship provide safe and effective procedures for ballast water management that will assist in minimising the transfer of harmful organisms and/or chemicals.

In February 2004 the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) was adopted by IMO, but has not yet entered into force yet. There are 11 guidelines referred to in this

Convention for its implementation. The following six guidelines has been developed to date by the MEPC-

- Ballast water exchange design and control standards (G11);
- Design and construction to facilitate sediment control on ships (G12);
- Designation of areas for ballast water exchange (G14);
- Sediment reception facilities (G1); and
- Ballast water reception facilities (G5).

3.5 The United Nations Convention on the Law of the Sea (UNCLOS)

Safety of shipping, the preservation of the marine environment and compensation for pollution damages can be discussed under prevention of pollution, which is one of the four main subjects covered by UNCLOS. The other three subjects are States and organisations, zones and areas, and activities on the oceans.

A “ship” and “vessel” have identical meanings, although they are not defined in UNCLOS. The reason being that the large range of topics covered by the Convention, would have made a definition difficult and inadequate. Furthermore, other conventions’ specific laws and regulations define ‘ship/vessel’ within their context such as the COLREG 72 – “The word ‘vessel’ includes every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.” At times, UNCLOS mentions a type of ship as in warship (Article 29) and other times to the function or activity of the ship such oil tankers (Article 22), and fishing vessels (Article 62). UNCLOS does not refer to their sizes, cargoes or other normal operational distinctions but focused on vessels to be registered by a State, the granting to it of a nationality and the right to fly its flag.

Sea transportation by ships should be made as safe as possible for if ships are not safe they can easily cause or be involved in accidents that will result in the pollution of the marine environment. The Convention also tried to reconcile the different interests of flag States to maintain the mobility of their ships and coastal States who would like to regulate movement of ships in waters under their jurisdictions (especially straits), in favour of greater safety. A new concept of 'transit passage' was established in the Convention and defined in Articles 38 to 44 applies only to straits that would allow freedom of movement of international vessels through it.

UNCLOS is in 17 Parts and nine Annexes, and the focus of this discussion will be on Part I (Introduction) and Part XII (Protection and Preservation of the Marine Environment). It was adopted in 1982 and entered into force in 1994. The following PICTs have acceded to UNCLOS as at 31 May 2002: Fiji, Marshall Islands, Papua New Guinea, Samoa, Solomon Islands, and Tonga (see also Appendix 4 for other conventions acceded to by PICTs).

It would appear that the Convention highlights the central provision which is that flag States are required to exercise control in administrative, technical, and social matters to ensure the safety of ships at sea. Furthermore, various measures such as the construction of ships, training of crew, prevention of collisions, sea-lanes and traffic separation schemes, and search and rescue systems are the responsibility of the flag State. These measures are included as regulations in various safety conventions such as SOLAS 74 and Load Line 66.

In matters dealing with the preservation of the marine environment, the Convention defines pollution and prescribes a general duty by States to protect the

marine environment, methods of co-operation and other measures such as adopting legislation and its enforcement. It also deals with the two major divisions of marine pollution – land based sources and those from pollution by vessels, except warships and other government vessels in non-commercial services. No prevention of land based pollution convention has been adopted yet. Only conventions dealing with pollution generated by ships have been adopted and entered into force, such as MARPOL 73/78.

3.6 Flag and Port State Control

A country (whether a landlocked country or one with a sea port) that maintains a Ship Register, where all ships flying its flag are registered, is called a ‘flag State’. The exclusive jurisdiction of the flag State is stated in Article 92.1 of UNCLOS – “Ships shall sail under the flag of one State only and, save in exceptional cases expressly provided for in international treaties or in this Convention”. Further, Article 92.2 states that a ship with two nationalities may be regarded as a ship without a nationality. A country that has a sea port is called a ‘port State’. A coastal State is a country that has a coast.

In maritime trade, a ship owner is principally responsible for the safety of a vessel that an individual or a company owns, as well as the prevention of pollution of the marine environment. A flag State is mainly responsible in ensuring that a vessel flying its flag is operated in accordance to required standards and generally accepted practices, either nationally, regionally or internationally, and that safety and the prevention of marine pollution is being maintained. At times when the ship owner and the flag State do not carry out their responsibilities with care and competence, the port State must ensure that a ship is deemed safe during the time that the ship is in its jurisdiction. UNCLOS and most of the Conventions

discussed above entrust control of ships mainly to the flag State but at the same time allow port States some control measures to be taken when appropriate and in accordance with the provisions of these Conventions.

3.6.1 Flag State Control

It is a condition that when a vessel is registered in a State, that vessel must obey its laws. Many States today have acceded or ratified international conventions, on which their national maritime laws are based. The laws of a flag State describe the relationships between the vessel, the owner, procedures for effecting financial instruments, the crew, management, other States and other parties related to the commercial and operational activities of the vessel. These laws confer rights to a State with regards to a vessel flying its flag and at the same time impose duties/responsibilities on that State. However, without these laws maritime transportation will be in complete chaos. The special prerogative of a State with regards to its control of ships flying its flag is based on two concepts:

- Territoriality – A ship is regarded as a floating portion or extension of the national territory.
- Jurisdiction – The ship as a floating territory of the flag State must comply with the provisions of its laws where ever it is.

The duties/responsibilities of the flag State are stipulated in Article 94 of UNCLOS, and include:

- (a) The effective control of the administrative, technical and social matters over ships flying its flag.
- (b) The establishing and maintaining a Register of Ships containing the names and particulars of ships flying its flag. The ships registered are those required by law to be registered.

- (c) That every State shall take the appropriate measures to ensure that safety at sea is being maintained with regard to the construction of ships, its equipment, manning, training of crew, communicating and the prevention of collision.
- (d) The measures taken by a State include the carrying out of surveys in accordance with its law, the master and crew are appropriately qualified and that they could operate safely any one of its ships.
- (e) That States are to ensure that its ships comply with generally accepted international regulations, procedures and practices.
- (f) A State may report any deficiency found on a ship to the flag State who shall investigate and direct that ship to remedy the deficiency as soon as possible.
- (g) Each State shall hold an inquiry into any marine casualty or incident of navigation. If the casualty or incident involve a flag State and another State they shall co-operate in the conduct of an inquiry.

States may register ships in either its national register or an international/open register. The open register and other similar ship registry variations such as the dependent register, second register, and the bare-boat charter register have been established in various States due mainly to competitive terms being offered to ship owners that are mostly related to flexible crewing and tax exemptions. In a flexible crewing system the ship owner or operator choose officers and crew members of any nationality. The reduction in crew cost has been reported to be as much as one third of a crew from a developed country. However, language and cultural problems are causing concerns among maritime nations as recent accidents such as the *Scandinavian Star* pointed to language problems. In this accident the poor knowledge of English by the Portuguese catering staff was a contributing factor to the high number of fatalities.

Every State has the right to fix the conditions for the grant of its nationality to ships (UNCLOS Article 91.1) and this may be regarded as the establishment of a

legal relationship between the State and the ship. This relationship is known as the 'genuine link' principle and it is not defined under UNCLOS but is left to each State. Article 91.1 also states "There must exist a genuine link between the State and the ship" so, genuine link is not a condition of nationality but a simple consequence of such attribution. The establishment of a competent maritime administration and how the flag State controls its ships and their owners are key factors in establishing a genuine link.

Ships are registered in the national register of a State if owned by a citizen or company registered in that State. Here the genuine link is quite clear. Ship owners are required to comply with rigid maritime and taxation laws of the State as any other business within its jurisdiction. In an open register the owner and the ship itself usually have not yet been in the State yet and the place of trading of the ship can be anywhere in the globe. An agent or lawyer usually register a ship in an open register, acting on behalf of the owner (who is normally a non-national of the State). The choice of the nationality of the crew of a ship registered in an open register creates a very distinct advantage over a ship registered in the traditional register as the ship owner can shop around in developing countries for a crew that usually are poorly trained and cost much less to employ. Furthermore, the number of crew required to man a ship in the open register is also less than a traditional register. In recent years some unscrupulous ship owners have abandoned crew of their ships in ports of other States and this is increasingly becoming a problem world wide. Open registers have often been associated with sub-standard ships, but this could be misleading as standards in some open registers are better than some national registers. Boisson (1999:428) pointed out that many of the new shipbuilding tonnage have been registered in an open register, especially cruise liners, and therefore it is not fair to regard open registers as the only ones with unsafe ships.

In international law, all States have equal sovereignty and this prevents any State being held liable before the jurisdictions of another State. The sovereign immunity of a State is drawn from this concept. However, the immunity rule applies only to acts of public power (*jure imperii*) and not those of private management (*jure gestionis*). A flag State is responsible for ensuring that ships flying its flag are safe and this is an act of public power. For example, inspecting and surveying of ships, the issuance of certificates are by their very own nature are not commercial activities. This immunity prevents any legal action against a State. Some traditional maritime States have expressed serious concerns about States that operate open registers with sub-standard ships and hide behind their sovereign immunity. Various proposals have been put forward by them to change this immunity privilege but there are practical difficulties of implementing these proposals given the equal sovereignty concept. The only possible solution is for all players in the industry (including flag States, ship owners, insurers, crew and port States) to properly carry out their own individual responsibilities to promote and ensure safety of ships and the prevention of marine pollution.

3.6.2 Port State Control

Port State control (PSC) came into being when coastal States resolved to play an active role in improving safety at sea in their waters and protecting the marine environment. This is the result of their experiences and perceptions that flag States and ship owners have not carried out their responsibilities satisfactorily to ensure the safety of their ships. It is not a new concept as the following international conventions provide for control procedures to be observed by a Party, such as in Load Line 66 (Article 21), Tonnage 69²⁶ (Article 12), MARPOL 73/78 (Article I Articles 5 and 6, regulation 8A; Annex II regulation 15; Annex III regulation 8; Annex V regulation 8), SOLAS 74 (Chapter I regulation 19; Chapter IX regulation 6.2; Chapter XI regulation 4), UNCLOS 82, with regard to foreign

ships visiting its ports. In maritime law, traditionally it has been recognised that in internal waters, especially in ports, foreign merchant ships are subject to the laws of the coastal States. Two reasons are usually put up to justify the exercise of control procedures as follows:

- The “right of self-protection” in which the port State protects its own citizens and environment against the dangers of sub-standard ships.
- “International policing of navigation” that would require a port State to enforce provisions of international conventions and prevent a ship in poor condition sailing from its territory. In no way would it be viewed as port States taking over the responsibilities of flag States but it be regarded as the final safety net to ensure that international regulations are being complied with by ships.

Although port States control measures normally conform to international regulations, the interpretation and application of these regulations has been found to differ slightly from State to State. Some States place great importance on PSC inspections and provide the necessary resources to support them, while in other States the resources are not available or in various degrees of availability and PSC inspections are not a priority. The lack of skilled personnel and adequate financial resources represent the status in PICTs today although training and awareness programmes on PSC are being conducted by the Maritime Programme of the Secretariat of the Pacific Community and neighbouring metropolitan countries, are starting to have a positive effect on the situation. A key to the success of any PSC activity is to have appropriately qualified and experienced inspectors well informed in safety aspects of shipping. In the developing and setting up of regional cooperating bodies, such as the ‘Paris MOU’ in the European Union, and the ‘Tokyo MOU’²⁷ in the Asia-Pacific region, it has been

shown to be an effective way that PSC contributes to ensuring that ships are safe to operate in the region.

The effectiveness of PSC inspections do depend also on the motivation of the maritime authorities, if inspectors are properly trained and also their commitment to prevent sub-standard ships from operating in the region. Single ports could not provide an effective PSC, a regional approach is needed where information and other resources are shared to identify and prevent sub-standard ships trading in the region. However, due to high membership fee only Papua New Guinea and Fiji have joined the Tokyo MOU. On behalf of other PICTs, the Maritime Programme of the Secretariat of Pacific Community has approached the secretariat of the Tokyo MOU to reduce its membership fee so that these PICTs can afford the cost of joining it. So far, this proposal has not been successful and the gap of knowledge and experience continue to widen between PICTs that are Tokyo MOU members and the PICTs who are not members. As a consequence there is a potential danger that the PSC efforts in the region might not be as effective as one would have preferred it to be. American Samoa and Guam are adopting the United States' PSC regulations which is slightly different to the ones used by the other PICTs.

An international approach has been proposed to provide an effective PSC as there is no single international organisation today capable of supervising or regulating PSC and implementing such a global PSC scheme. It would provide some advantages such as worldwide standards that could be easily enforced and information exchanged, but this proposal would face political and legal problems. The adoption of a new convention specifically for PSC would result in the amendment of all IMO and ILO instruments on PSC. It will probably take a long time for countries to denounce the existing instruments and then adopt a new convention. Furthermore, PSC will probably be institutionalised in the new

proposal. Therefore, the two most important players (the flag State and the ship owner) in ensuring safety of ships at sea would be less committed than at present, given the voluntary and temporary nature of the present system where they are encouraged to take the leading roles.

3.7 Classification Societies

Classification societies came into existence in the late 17th Century as a result of the needs of marine insurers and ship owners. A classification society is an independent non-profit organisation earning income from fees for surveys and other services rendered. Information received from a classification society on the condition of a ship and whether it is seaworthy or not, was very useful to a marine insurer in terms of bringing any risk under control. This method of risk management was based on the award of a “rating” to each ship after surveyed by a surveyor of a classification society. Ship owners soon realised the benefits that they would get from their ships having good ratings from classification societies. These benefits are in the form of less insurance premiums and better values for their ships if they wanted to sell them.

For their mutual benefits, classification societies and ship owners extended issuing ratings to include issuing certificates that would be valid for a fixed period of time. Ship owners paid classification societies for these services. Detailed regulations called “rules” were drawn up which were used to determine the safety of vessels. These rules prescribe the standards to which the ship or structure can be approved or classed as fit structurally and mechanically, for its intended purpose. Classification does not cover the crewing or operation of a particular vessel. The traditional duty of a classification society has been to develop and administer standards covering the design, construction and condition of ships and

marine structures. Today, classification societies are being authorised by flag States to conduct inspections or surveys, and issue certificates in accordance with the various international maritime conventions.

It is not compulsory for a ship owner to have his ship classed with a classification society. However, it is nearly impossible nowadays for the ship owner to provide the trading certificates required by ports of call if his ship is not classed. In addition, most charter parties require chartered vessels to be classed. There are now fifty classification societies, many do not meet the minimum conditions to perform their role properly. In recognition of these difficulties the largest classification societies have established the International Association of Classification Societies (IACS) on September 1969 to regulate the work of classification. A lot of image promotion has been conducted by IACS to regain the confidence of the industry and also play a more active role in improving the safety of ships. IACS currently has ten members and they are as follows:

- American Bureau of Shipping (ABS)
- Bureau Veritas (BV)
- Germanischer Lloyd (GL)
- Lloyd's Register of Shipping (LRS)
- Nippon Kaiji Kyokai (NKK)
- Det Norske Veritas (DNV)
- Registro Italiano Navale (RINA)
- China Classification Society (CSS)
- Korean Register of Shipping (KRS)
- Russian Maritime Register of Shipping (RMRS)

There are also three associate members and they are as follows:

- Croatian Register of Shipping
- Indian Register of Shipping

- Polish Register of Shipping

IACS members class: 95 per cent of world shipping in tonnage (about 400 million gross tonnage); 50 per cent in number of ships (about 40 000). They undertake more than half a million surveys a year in about 1 200 offices throughout the world, with more than 6 000 frontline surveyors. Classification is a billion-dollar industry that employs over 10 000 people world wide, including surveyors (Boisson 1999:123-124). Classification societies have played a pivotal role in improving safety of ships and the prevention of marine pollution but recent changes in the industry as a result of oil tanker accidents pose serious challenges. These challenges include: rapid advances in technology; the risk of legal claims arising from accidents; and the fees for services rendered.

In recent years, the IACS is taking unprecedented abuse from many sources in the industry culminating after the *Erika* disaster. For example, the claims asserted by various litigants may bring about RINA's bankruptcy. It may be possible to consider some form of internationally agreed upon indemnity to be available to classification societies, perhaps along the lines of the 1992 CLC and Fund Conventions. The role played by the IACS in ships' safety and pollution prevention is so critical that it would be foolish to keep bashing it unnecessarily. Instead, the industry should be more willing to work with IACS to help it to survive and also improve its performance, given the technical knowledge, experience and the number of its members' surveyors world wide.

Most of the SOLAS sized ships (500 gross tonnage and above) trading in the region is classed by an IACS member or associate member. Non-SOLAS ships trading inter-island in a PICT are not classed as many of them have self insurance or insured after being surveyed by the marine department or marine safety authority. Expatriate non-exclusive surveyors are used by classification societies

for surveying purposes for there is a lack of qualified and experienced locals in the region.

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- ¹ Environmental pollution may be defined as the undesirable effect of human activities which manifests itself as degradation of the land, rivers, lakes, oceans, and the atmosphere.
 - ² Toxic and noxious substances are those substances other than oil such as liquid ammonium nitrate, cyanide, pesticide, butane, xylene etc.
 - ³ A message from Mr. William A. O'Neil, Secretary General of IMO in World Maritime Day 1997 referred to Institute of London Underwriters statistics and concluded that the majority of shipping losses in recent years attributed to human error.
 - ⁴ Accident is defined by the Oxford English Dictionary as 'anything that happens without foresight or expectation; an unusual event, which proceeds from some unknown cause, or is an unusual effect of a known cause'.
 - ⁵ They are: Special Trade Passenger Ships Agreement (STP), 1971, for it was intended for the carriage of pilgrims mainly to holy places in the Middle East; The Torremolinos International Convention for the Safety of Fishing Vessels (SFV), 1977, and the International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel (STCW-F), 1995, have not come into force yet and it is doubtful (e.g. up to 31 May 2002 only three countries have signed the STCW-F convention) that they will enter into force in the near future; the International Convention on Maritime Search and Rescue (SAR), 1979, Convention on the International Maritime Satellite Organisation (INMARSAT), 1976, for they do not deal with any matter specifically related or of great relevance to the subject of the research. In any case only Papua New Guinea, Guam and American Samoa (the last two countries through the United States) have acceded to SAR.
 - ⁶ Tacit Acceptance is generally confined to technical provisions and it is a new procedure to speed the adoption of new amendments that became popular since the 1970s. The principle is simple, instead of stipulating that an amendment comes into force after being accepted by two thirds of the contracting parties (the traditional way of Express Acceptance), the new procedure provides for it to enter into force on a specified date, unless a certain number of Parties raise objections before that date.
 - ⁷ Administration is defined in the SOLAS Convention 'means the Government of the State whose flag the ship is entitled to fly'.
 - ⁸ Ice Patrol – Regulations 5, 6 and 7 of Chapter V of SOLAS covers the provision of this service (ships and aircrafts study, observing ice conditions and disseminate to users) in the North Atlantic down to the Grand Banks of Newfoundland. The US is currently managing the ice patrol service and the cost of it is being funded from contributions by Contracting Governments based on the total gross tonnage of the ships of each government using the service.
 - ⁹ International Bulk Chemical Code (IBC Code) means the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted in 1982 and comprises the provisions of the ten series of amendments to the original Bulk Chemical (BCH) Code that was adopted in 1971 for ships built after 12 April 1972. The BCH Code is based on the

principle of categorising all chemicals on the basis of the danger they present and that determine the type of ship to carry them depending on the degree of danger they pose. The more dangerous the chemical, the higher is the degree of the protection of the cargo and the survivability of the ship. The Code also take into account the five major type of risks: cargo fire; health hazards; water pollution; atmospheric pollution; and product reactivity.

- ¹⁰ SOLAS Protocol of 1978 dealt with safer tanker designs and pollution prevention measures that were also included in MARPOL 73 resulting in MARPOL 73/78.
- ¹¹ SOLAS Protocol of 1988 covers a new harmonised system of surveys and certification (HSSC) with Load Lines and MARPOL 73/78 Conventions. The required surveys are to carried out at the same time thus reducing costs to ship owners and in administration.
- ¹² The COLREGs Amendments were in the following years: 1981 when Rule 10 was amended to exempt vessels such as cable laying and survey ships operating in a traffic separation area; 1987 when several Rules dealing with ships of special construction or constraints by their drafts were classified in terms of the application of the convention; 1989 intended to stop unnecessary use of the inshore traffic zone; 1993 that mostly concerned with the positioning of lights.
- ¹³ Draught marks is the waterline marks showing how deep the keel of the vessel is in the water at forward, amidships and aft.
- ¹⁴ Freeboard is the distance from the waterline to the top of the weather deck at the ship's side amidships (middle) which is denoted by a circle 300 mm in diameter on both sides. A freeboard performs five functions: to provide sufficient reserve of buoyancy and stopping water from entering exposed decks; to protect crew members moving around on deck; it provide extra strength to the hull as it floats in the sea especially when loaded with cargo; it provides sufficient intact stability; and it ensures sufficient buoyancy and stability in case of damage. The first two functions cover 'geometric freeboard' that is covered by international load line regulations. The third function defines the 'scantling freeboard' that stipulate rules dealing with material strength such as those put out by classification societies. The last two functions deal with 'subdivision and stability freeboard' that SOLAS focuses on.
- ¹⁵ Freeboard deck is the uppermost complete deck exposed to weather and sea which has permanent means of closing all openings.
- ¹⁶ The other two international conventions: International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION), 1969; and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972. The first Convention deals with the right of a country to take preventive measures before an oil spill reaches its EEZ, and it does not cover any of the internal or external factors discussed in the research. LDC in the original form regulates the dumping and incineration of wastes and other matter at sea. The 1996 Protocol deals with prohibition of the dumping of wastes etc into the sea. LDC 1972 (now known as the London Convention) has a regional version known as the Protocol for the Prevention of Pollution in the South Pacific Region by

Dumping (SPREP Dumping Protocol). This Convention is not discussed as it does not cover the factors included in the research.

¹⁷ Enhanced Survey Programme (ESP) was first initiated by the International Association of Classification Societies (IACS) in its Unified Rule Z.10.2 for bulk carriers on 1 July 1993. In November 1993 IMO adopted the IACS initiative as Resolution A.744 and expand it to include oil tankers as well. ESP is intended to ensure that drawings and documents are examined properly and structural surveys are conducted during the periodic, annual and intermediate surveys as required under MARPOL and SOLAS Conventions. Resolution A.744 generally target corrosion of tanks (anti-corrosive paints and systems) and careful examination of plate thickness. This is to detect any defects in paint works and serious corrosion in tanks and structures so that remedial works could be carried out before a major failure occurs and cause the ship to break up and sink. Surveyors use historical data of maintenance schemes, previous repairs and other structural surveys when ESPs are carried out to assess the safety status of a ship. ESP is one of the survey tools that contributes to maintaining safety of ships at sea.

¹⁸ Defined as crude oil, fuel oil, heavy diesel oil, and lubricating oil.

¹⁹ A double hull provides a measure of safety and protection against oil spillage when a ship sustains grounding and collision damage(s). Furthermore, the double hull protects oil containment and prevents fire/explosion. Some of the flaws identified by critics of the double hull are: the void spaces between the inner and outer hulls (plates) are prone to accumulations of gas that may cause fire or explosion (the Aegean Sea explosion has been attributed to this possible cause); the double hull carries with it more maintenance; cracks can form in certain areas not yet thought of as some structural members of the ship are reduced or rearranged to minimise added weights of the double hull; stability problems anticipated due to raised centre of gravity of the ship resulting from the higher location of the double hull and cargo as compared with a single hull ship, in addition, increased free surface effects due to the removal of centre line bulkheads.

²⁰ The types of sewage treatment systems available include:

- Biological systems – similar to land based plants. It is based on cultivation of aerobic bacteria. The main disadvantages are that they are large and their bacteria have a limited lifespan. Furthermore, they cannot be turned off and can be affected by the introduction of certain chemicals.
- Physical/chemical sewage treatment systems are able to be turned on or off according to location of ship. These can be fitted on individual toilet basis and are popular with small ships.
- Electrochemical systems capable of total disposal overboard of all effluent through electro-catalytic action. It can be made automatic and they are popular with passenger ships and offshore oil rigs.

²¹ Special areas means a sea area where for recognised technical reasons in relation to its oceanographical and ecological condition and to the particular character of its traffic the adoption of special mandatory methods for the prevention of sea pollution by garbage is required. They are listed in

Regulation 5 such as Mediterranean, Baltic, Black Sea, Red Sea, the Gulf area, the North and Antarctic Seas, and the wider Mediterranean but none in the PICTs' waters.

- ²² Exceptions are fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention.
- ²³ Halon compounds are: Halon 1211, Halon 1301, and Halon 2402. CFC compounds are: CFC-11, CFC-12, CFC-113, CFC-114, and CFC-115.
- ²⁴ An alternative design to double hulls is the mid-height deck tankers. In 1992 IMO conducted a study that evaluated these two designs and both of them could be regarded as equivalent, and it is reflected in Regulations 13f and 13g of MARPOL 73/78. However, OPA 90 allows only double hull tankers to be used in U.S. waters by 2015, and not other designs.
- ²⁵ A new Very Large Crude Carrier (VLCC) with a double hull costs 15-20% more to build under OPA 90, than a conventional one. Maintenance and repair costs estimated to be 20% more than a conventional one.
- ²⁶ Tonnage 69 means the International Convention on Tonnage Measurement of Ships 1969.
- ²⁷ "Tokyo MOU" means the PSC Memorandum of Understanding between Asian and Pacific countries, based in Tokyo.

4.0 Internal and External Factors in the Ship-generated Marine Pollution Index (SMPI)

4.1 Internal Factors

The three internal indicators of the SMPI are ships, the cargoes that ships carry, and the management of the ships by the ship owners or ship operators in relation to generally accepted practices adopted world-wide. Assessment of risk has been discussed in Chapter I using Australian and New Zealand risk assessment standards. A summary of the three indicators will be discussed at the end of this chapter.

4.1.1 Ships

Marine pollution occurs at sea from anti-fouling paints, operational wastes and oil or chemical spillages from the ship as it is used in trade during its economic life until it is no longer operated and scrapped ashore. Ships also pollute the marine environment if they sink, especially if oil or any dangerous cargo or both were carried onboard such as which is being experienced now in the Marshall Islands and Federated States of Micronesia resulting from World War II wrecks leaking oil.

Ships are built of different materials, in different shapes, and for different commercial purposes. Materials used are mainly steel, wood, composite and aluminium. Their shapes and commercial purposes vary from Ultra Large Crude Carriers (oil tankers), bulk

carriers, liquid gas tankers to big modern passenger ships, ro-ro ships, container ships, smaller vessels such as tugs, ferries and fishing vessels. Means of propulsion (sail, propeller, water-jet etc) are very important to achieve the commercial purposes that ships were designed for. Most ships of steel or aluminium or composite construction use propellers as a means of propulsion driven by engines using hydrocarbon fuels. Fuel oil for ships' engines is normally stored in special tanks in the lower part of a ship's hull called double bottom tanks¹.

Synonymous with the safety of a ship is its seaworthiness, which relates to the degree of fitness of the ship as to structure, equipment (including plants and machinery) and manning. It is prescribed in statutes. A ship is also seaworthy, in marine insurance, when she is reasonably fit in all aspects to meet the ordinary perils of the sea that the intended voyage was insured for. In contracts of afreightment, seaworthiness has an even wider application and will include cargo-worthiness. Statutory seaworthiness is different from implied or express warranty seaworthiness in marine insurance or contract of afreightment. Their difference is that statutory seaworthiness is a criminal offence when breached whereas a breach of warranty is not, although the latter is actionable if loss or damage arises resulting in losing its benefits under the "exception clauses". In some cases a ship owner's only defence would be to prove that he has exercised due diligence in providing a seaworthy ship.

In terms of promoting safety at sea, the adoption by IMO and the entry into force of the ISM Code on 1 July 1998 is a major contributing factor. This new approach in preventing accidents at sea is holistic and it deals with both the management of the ship and the shipping company. Together, the ship's crew and the shore management must each play their part to ensure that safety onboard is achieved and maintained. The principles of the Code had been discussed at IMO committees in the 1980s but the shipping casualties involving the passenger ferry *Herald of Free Enterprise* and the cruise vessel *Scandinavian Star* in the early 1990s highlighted the need for adoption of

this Code. A Safety Management System (SMS), for which the shipping company is responsible for establishing, is the means to achieve the goals of the Code which are to provide an international standard for the safe management and operation of ships and for pollution prevention. An SMS should ensure “compliance with mandatory rules and regulations, and that applicable codes, guidelines and standards recommended by the organisation, administrations, classification societies and maritime industry organisations are taken into account” (ISM Code paragraph 1.2.3.).

The ISM Code also has a profound and long lasting effect on how things are done, by encouraging and supporting a safety culture in all stakeholders in the industry. Ship owner associations such as INTERTANKO and INTERCARGO took a leading role in the drafting of the Code, incorporating in it their best practices. A ship owner who does not comply with the Code today would find it very difficult to do business. Insurance companies now stipulate that they will only cover ships that are in compliance with the Code. Furthermore, shipbrokers would require compliance with the Code before they would fix a charter for any ship. Ships could be detained by Port State Control inspectors if they do not comply with the Code. These measures have forced out of business many operators of substandard ships and at the same time reward owners of ships complying with the Code. Many ship-owners today who comply with the Code sleep better, knowing that their investment in their ships is as safe as it could be. This is a much needed and exciting development in the shipping industry that would contribute to the elimination of sub-standard ships from being used in international trade.

4.1.1.1 Vessel Types

The construction of some vessel types will be briefly discussed here; they are passenger ships², passenger ro-ro (commonly known as passenger ferries), oil tankers, bulk carriers,

and general cargo vessels. These vessel types call into PICTs' ports every year and they are also used for local transportation purposes.

(a) Passenger ships

SOLAS applies to all passenger ships of any tonnage engaged in international voyages unless provided otherwise under the Convention. A *passenger ship* is defined under SOLAS as “a ship which carries more than twelve passengers”, and a *cargo ship* is also defined as “any ship which is not a passenger ship”. To ensure passenger ships are safe, special considerations have been given under SOLAS to the following:

- Subdivision and Stability – Passenger ships are subdivided into water-tight compartments in accordance with established rules and regulations, so that after a hypothetical accident to the hull, they will remain afloat in a stable condition. Water-tightness of doors and openings of these compartments, and the bilge pumping arrangement are the keys for a ship to remain afloat in a stable condition after an accident. Regulation 8 of Chapter II – 1 provides damage stability standards that consider various hypotheses in the event that the ship is flooded.
- Fire Protection – Regulation 2 of Chapter II – 2 prescribes the division of the ship to the fullest practical degree for fire protection, fire detection and fire extinction. This regulation lays out the requirements for implementing these three objectives such as the use of bulkheads, fire resistant materials and location of detection equipment. IMO focussed its attention more on fire protection after fires onboard the Danish cruise vessel *Scandinavian Star* and Iranian car ferry *Moby Prince* that caused 158 and 144 fatalities respectively (Boisson 1999:215).
- Life-saving Appliances and Amendments - Chapter III deals with life saving appliances which is the most important equipment onboard a ship when the “abandon ship” order is given. Such equipment was used to save 486 lives from the *Jupiter* in

October 1988 off Piraeus Greece; 544 lives from *Oceanos* in August 1991 off South Africa; and 900 lives from the *Achille Lauro* in December 1994 off the Somalian coast (Boisson 1999:217). Life saving appliances include lifeboats, life rafts, life jackets, life buoys and other flotation equipment. The quantity of these life saving appliances and their location are provided for in Chapter III.

(b) Passenger Ro-Ro Vessels

These vessels are used on short sea trade routes. They are characterised by large vehicle decks, often occupying the whole length and width of the ship, to facilitate fast loading and unloading of vehicles. Platform decks also allow vehicles to be loaded on several levels. Passenger cabins are located on top of these platform decks. Centre of gravity of the weights of vehicles and passengers at these heights could cause poor stability. The large open vehicle decks also contribute to poor stability in the event that these spaces are flooded. Liquid in partially filled compartments or tanks tends to move horizontally to the side that the ship heels to (known in the industry as free surface effect) resulting in the reduction of the ship's stability. Two shipping accidents, the *Herald of Free Enterprise* in 1987 and the *Estonia* in 1994, drew attention to the serious flaws in these vessel designs. To ensure that lessons learned from these shipping casualties are implemented, passenger ferries are now designed so that the vehicle deck must not be flooded. This is achieved by the installation on the navigating bridge of indicators for all vehicle loading doors (including the bow door) so that the ship's crew could check if they are all properly closed. Furthermore, a system for detecting infiltration of water through these doors that could lead to major flooding of any vehicle deck. The fitting of television cameras in cargo spaces, capable of detecting any movement of any vehicle during bad weather is another design requirement. In the event that the ship is damaged and heeled to one side a vehicle stowed on a vehicle deck must not be able to move to that side for it would affect the stability of the ship by having too much weight on that side.

(c) Bulk carriers

By tonnage, dry bulk cargoes transport by sea with about 1 103 million tonnes (Boisson 1999:227), rank second only to liquid bulk cargoes (hydrocarbons) in 1995. Bulk carriers can be grouped into four dedicated ship types³: bulk dry carriers; combination carriers (Oil/Bulk/Ore carriers or known as OBO); self-discharging bulk dry carriers; and other more specialised bulk dry carriers. Iron ore, coal, grain, bauxite and phosphate are the main dry bulk cargoes carried by these bulk carriers. The transportation by sea of all these bulk dry cargoes, except grain, is increasing due to the liberation of trade world wide resulting in a 2-4 per cent annual growth of the world economy in the last decade. The growth in the world economy has created more demand for mineral resources, especially by Asian countries such as China and Japan. East Asia recorded a 6.1 per cent growth in 2003 but only 1.8 per cent growth in Latin America (<http://www.worldbank.org/prospects/gep2003/index.htm>). Australia is an important supplier of iron ore and coal to Japan and other Asian countries such as China. For coal, Japan imported 16.5 per cent from Australia (Wijnolst and Wergelund 1997:32)

In the late 1980s, bulk carrier accidents rose sharply causing deaths of hundreds of seafarers. These accidents caused concerns world wide when bulk carriers vanished, such as, the *Derbyshire* in 1982, with all forty-four people onboard (off the east coast of Japan). Furthermore, the loss of *Leros Strength* (off the Norwegian coast) and the *Albion Two* (near the coast of Brittany) in February 1998 with a total of 45 crew perished really disturbed the maritime community. From May 1988 to April 1991, thirty eight bulk carriers sank causing 328 deaths and more than 2 million tons of cargo lost (Boisson 1999:229). It was learned from various studies (by INTERTANKO and IACS) of these accidents that they have been caused when the ship takes water in bad weather and plate failure.

Bulk carriers are subjected to excessive structural stresses once they are in operation due to the nature of the bulk cargoes they carry, especially ores, are robust and heavy. During

loading and discharging operations, localised stresses are created and damage to the ship's structure by cargo grabs are common. As the ship gets older, corrosion sets in quickly, worsening if the ship carries high sulphur coal or similar corrosive cargoes. The sulphur content reacts with the moisture and cargo hold condensation that comes into contact with it to form sulphuric acid. For other bulk cargoes, the water condensation will cause rapid corrosion in the ship's structural members, especially steel parts exposed to the marine environment that could affect its structural integrity and weaken them. From the Donaldson inquiry into the loss of the *Derbyshire* (1972), technical experts suspected that it may be the frames amidships that were damaged during the cyclone (by heavy seas impacts) causing the vessels to break into two and sank. This made bulk carriers prone to damage by extreme sea conditions. After the second formal inquiry on the loss of the *Derbyshire* twelve years later, the report concluded that the initial cause was the destruction of some or all of the ventilators and air pipes located on the fore deck by heavy seas. Over about two days, water was able to enter the bosun's store (locker), machinery spaces and probably the ballast tank causing the bow to sink deeper exposing the vessel to more heavy seas that smashed No.2 hatch cover and the hold was filled with more water. The vessel eventually sank when it could not remain afloat due to the flooding of the forward holds (<http://www.mv-derbyshire.org.uk/report>). It could then be concluded, that some bulk carrier losses are the result of the combination of low freeboard, little forward end protection of air pipes and ventilators, and the susceptibility of hatch covers to wave impact damage.

Many of the risks associated with bulk carriers are now known and maritime nations, classification societies, in conjunction with IMO, have provided rules and regulations to improve the design and construction of ships including bulk carriers. IMO was also aware of the risks involved in the cargoes carried by these bulk carriers and adopted in 1965 the Bulk Cargo Code (commonly known as the BC Code) which was incorporated later into the SOLAS Convention. The BC Code gives guidelines to the characteristics of bulk cargoes except grains which is covered under the Grain Code. The BC Code guidelines deal with certain types of coal that may liquefy during carriage, some ore

cargoes that release flammable gases when in contact with water or other substances, and some with particular risks such as coal or sugar (spontaneous combustion). Amendments and resolutions adopted by IMO over the years, the support from classification societies and other major players in the maritime industry, have contributed to minimising the risks to bulk carriers. The new measures put forward include a corrosion protection scheme in seawater ballast tanks, shell plating and other structural parts, minimum thickness for cargo hold frames, and enhanced (more frequent, more stringent, or both) hull surveys. The inspection of cargo holds is a problem due to the size of bulk carriers. Amendments adopted by IMO to SOLAS in December 2002 require the fitting of permanent access to cargo holds, cargo and ballast tanks to bulk carriers of 20 000 gross tonnage and above, so that the inspection of bulk carriers could be carried out safely. The new measures apply to bulk carriers constructed on or after 1 January 2005.

(d) Oil tankers

Oil was transported at sea in barrels before the *Gluckhauf* was built in England in 1886. It was the first vessel in the world to be built and fitted with tanks for the carriage of oil. *Gluckhauf* was classed by Bureau Veritas. Since then, these vessels became known as oil tankers and their sizes have reached 500 000 gross tonnage in the 1970s after the price of oil was significantly raised by OPEC in 1973. Ship owners built these very large vessels so that the unit (barrel) costs of oil transported from the Middle East to Europe are minimised. The *Torrey Canyon* disastrous oil spill in 1967 and later high profile spills such as the *Amoco Cadiz* in 1978, *Exxon Valdez* in 1989, *Erika* in 1999, and *Prestige* in 2001 showed the inadequacies of preventive measures adopted in place at the time. In response to these disasters IMO Member States developed regulations to address the issues involved in order to improve safety of life at sea and protect the marine environment from pollution. This resulted in numerous complex regulations and standards for oil tanker construction and operations that are in existence today. Oil tankers represent about 36 per cent of total cargo capacity in global shipping today.

Many of the very large crude oil carriers (VLCC) today are up to 500,000 tons gross tonnage, 300 metres long and constructed of 25 millimetre thick steel plates.

Concerns have been raised on about the structural stresses and inherent weaknesses that exist merely by the fact that these vessels are very large and float freely in the sea. Their lack of manoeuvrability and the great difficulties in being manoeuvred during the attempted rescues of *Torrey Canyon*, the *Braer* and the *Amoco Cadiz* are characteristics of these very large vessels. Their low buoyancy margin is also a major concern when compared with other types of ships. The *Torrey Canyon* bow was under the level of the sea in the second day and it may have already lost its buoyancy, therefore, it was only a matter of time before it sank. Another concern is that towing these vessels is very difficult during high seas. Furthermore, their anchoring systems are usually inadequate in the event of an emergency. This was the case in the *Amoco Cadiz* and the *Braer* disasters when the crew tried to use the anchors for manoeuvring purposes. The Salvage Association has also raised the difficulties of inspecting oil tankers, especially VLCCs, and they have claimed that these vessels are virtually incapable of proper inspection. To support their claim, the Salvage Association said that a VLCC contains 50 000 square metres of external plate and 100 000 metres of main welding. Ultrasonic testing of the whole exterior plate would take 50 000 man-hours, inspecting the main welds for cracks would take 20 000 hours of visual examination or 100 000 hours by magnetic particle examination (Boisson 1999:246). The age of these vessels is causing considerable concerns, as about half of the 386 VLCCs of more than 250,000 gross tonnage are over 15 years old (Boisson 1999:247). Commentators have said that the 15 to 19 year age group of these vessels are more likely to be involved in an accident when the 1985 – 1995 shipping casualties data is considered (Boisson 1999:247).

Oil tankers face mainly two risks when oil is being transported from one place to another. Internally, the crew will be exposed to danger when there is a fire or explosion onboard. Externally, the huge quantities of oil onboard will be spilled overboard in the event of an

accident. The marine environment will be polluted and the marine ecosystems will also be damaged, especially if the oil spillage occurs in a sensitive area in or near the coast or a port where fish and other marine life hatcheries or habitats are usually found in mangrove swamps.

MARPOL 73/78 was adopted which sets limits on the amount of oil that may be released during routine operations. A number of requirements were also prescribed to reduce accidental pollution in the event of side or bottom damage to oil tankers. The *Argo Merchant* disaster in December 1976, off Cape Cod, causing pollution to the Georges Bank fishing ground and the popular beaches of Massachusetts, United States. The US threatened to take unilateral measures to improve the safety of oil tankers and forced IMO to promptly amend existing regulations although MARPOL 1973 was not actually in force. A protocol was adopted by IMO in 1978 that introduced stricter regulations for the survey and certification of ships. The 1978 Protocol absorbed the parent convention (the 1973 MARPOL Convention) and is usually referred to as MARPOL 73/78.

(e) General cargo vessels

Early designs for cargo vessels propelled by engines evolved from those of sailing ships that had flush decks with the machinery openings protected by only low coamings and glass skylights. Innovations in technology and new construction methods, new demands for passengers and crew safety and comfort, etc., that led to the changes in the design of these ships and being fitted with double bottom tanks for the carriage of fresh water, ballast water and fuel oil when coal was no longer used for fuel. In recent years, many types of ships carrying large quantities of cargo have their navigating bridge and engine room aft in order to have shorter propeller shafts, maximise the use of the ship's cargo spaces and faster cargo operations. Cargo ship designs have been modified to carry specialised cargoes of one or more types such as oil tankers, oil/bulk/ore (OBO) carriers, reefer, timber, gas, chemical, container, and passenger ships, and so on. The roll on/roll

off and container ships are specialised designs that radically changed the carriage of general cargoes in packaged form or in bulk. New cargo handling equipment, such as heavy forklifts and gantry cranes, were designed to load/unload containers and other cargoes from these specialised designed ships.

In the 1960s, the use of containers for the carriage of goods at sea had just started in the United States and Europe. By the beginning of the 1970s, containers were extensively used for the carriage of general cargo world wide because of faster turn around in ports. Container ships now carry more than 8 000 containers, with service sea speed of 26 knots that would improve turn around time per voyage, therefore more cargoes are carried in a year resulting in more revenue to shipping companies. In the early development of container ships the designs were basically cell guides for stowage of four high containers below deck and two containers stowed on deck using twist-locks. Container ships now have innovative hull designs that enable these vessels to carry the same number of containers on deck and below deck and still have adequate stability for the completion of a voyage from one country to another. Modern container ships carry more containers than a ship of the same size a decade ago. Containers are now stowed on deck in many tiers above the hatch cover with still adequate stability for safety purposes. Many of the big container ships are not fitted with cargo gears as gantry cranes ashore conduct cargo work much faster than ships' cranes. Only smaller feeder container ships have some cranes sited above the bulwark of a ship to maximise the carriage of containers onboard a ship. General cargo vessels are still in use today for tramp purposes, such as, voyage charters, but their sizes are not as big as container vessels.

4.1.1.2 Safety Issues

- (a) Construction and Safety

If a ship was constructed in accordance with the provisions of international conventions (as amended), such as SOLAS 74 and Load Lines 66, it is more likely that its structural strength will withstand better the operational stresses⁴ endured during the normal working life of the ship. In other words, that ship is deemed to be safer than one not constructed to standards of the above conventions, therefore the risks of causing marine pollution are minimised. There are two types of basic knowledge used in building ships: naval theory⁵ and naval architecture⁶. Many rules have been drawn up to cater for the building of a variety of types of vessels in order to provide sufficient strength and prevent accidental failures. Each ship type has rules for its construction that takes into account the type of cargo and how it is carried (oil/liquid or general/container or solid bulk cargo) or its propulsion system. When oil is used in engines for fuel, its propulsion system, plants and machinery are constructed to MARPOL 73/78 standards to prevent pollution of the marine environment by accidental or operational spillages of oil into the sea.

The strength of a ship's structure is dependent on two major factors: the materials used and material fatigue⁷. It is imperative that the scantlings used in a ship design can withstand tensile, compressive, shearing, torsional, bending and various other local structural stresses such as pounding and panting. Furthermore, any load on the material must not exceed the permitted load for that material. Also, any material deformation must remain within acceptable limits as prescribed by rules determined from experience by marine administrations or classification societies. The ship must also be built with adequate strength to withstand the hydrostatic⁸ and hydrodynamic⁹ forces to which it is subjected at sea. When a ship is being designed, architects make sufficient allowances for fatigue stresses acting on the hull and other structures of the ship, such as the longitudinal and the transverse parts. These longitudinal parts include longitudinal bulkheads and frames, keels and side plates. Transverse parts include transverse bulkheads and floor plates.

Once a ship is launched into the sea and starts operation it is subjected to various risks. The most serious of these risks are: complete or partial structural failure, causing the ship to sink rapidly; water flooding the ship after a collision or grounding, after the hull and bottom plating being holed; and fire onboard which is usually extinguished by the crew. These risks are minimised by sub-dividing the ship into water-tight and fire compartments giving the ship adequate buoyancy¹⁰ and stability¹¹ to survive such incidences. The following is a brief discussion of two of the most important factors affecting the safety and construction of a ship:

- SOLAS Convention and Construction and Stability

The SOLAS Convention of 1974, as amended, deals with the safety of ships at sea in three broad areas. They are construction and equipment, operation and navigation. Provisions covering passenger ships are quite stringent (such as Chapter II-2 Part B and Chapter III Part B Section II). Standards for the construction of cargo ships and their equipment are covered in Chapters II – 1 and II – 2 of the Convention. Briefly, Chapter II – 1 covers construction standards: that reinforces the water-tightness and stability of a ship (Part B); for plant and machinery (Part C); for electrical installations (Part D); and for unattended (by crew) machinery spaces. In Chapter II – 2, standards are prescribed to prevent, detect and fight fires onboard a ship. Stability factors play a critical role in safety, especially when the ship is in operation. When the ship is being designed, one of the major considerations is the stability calculation of that ship, usually contained in a Stability Booklet. It describes the stability corresponding to various conditions of the ship. This assists the crew in determining that the ship will not capsize (when too much weight is on the top part of the ship) or create excessive stresses on structures of the ship (when too much weight is at the bottom part of the ship). The Stability Booklet may be amended after the ship undergoes a trial (or test) soon after it has been launched. Ship's officers use the stability booklet to calculate and determine the stability of the ship before or during or after loading of the ships, and also during its passage from one port to another. Maritime authorities would also like to check the stability conditions of a ship during loading or discharging in a port to ensure that the ship does not capsize. Every

passenger ship (of any size) and cargo ships of 24 metres or more in length must undergo the stability trial.

- Load line and Safety

Load lines indicate the maximum depth to which a ship may be loaded in the prevailing circumstances in respect of Zones, Areas and Seasonal Periods. Appendix 2 has a load line diagram for the starboard side of a ship. The Load Lines Convention 1966 prescribes rules about freeboards¹², buoyancy and intact stability¹³ to ensure safety of a ship is maintained. It also divides ships into two types, A and B, which are defined in Regulation 27 of Chapter III of the Convention. Type A ships include all ships carrying liquid cargoes in bulk, such as oil tankers, gas and chemical carriers, and incinerator ships. Type B ships are all ships not in Type A ships. The Load Line Convention is currently being under review in IMO, for there are new developments that have to be taken into consideration today such as multi-hulls, high speed crafts, the use of new information technology and other new concepts.

(b) Classification Societies and Safety

A ship that has been classed by a classification society, especially by one of the IACS members, indicates that the construction, condition of the ship's hull, fittings and machinery are in accordance with generally accepted international standards prescribed under its rules or that of international conventions and/or national legislation. Furthermore, IMO Resolution MSC.47(66) dealing with Chapter II-1, Part A-1, Regulation 3-1 (Structural, mechanical and electrical requirements for ships) of SOLAS 74, was adopted on 4 June 1996 and entered into force on 1 July 1998.

Very recently, concerns have been raised by some IMO Member States and dissatisfaction expressed on the role that classification societies have played in the

design, construction and surveying of vessels. These countries proposed that IMO take over from classification societies the prescribing of rules and standards for the design, construction and surveying of vessels. It was claimed that classification societies have a conflict of interests, as they are basically dependent on ship-owners for their businesses. In one way, the use of classification societies is a good thing, because classification societies compete which would ensure that they provide a good service to ship owners and insurance companies. Another issue that has to be addressed in the new proposal is the practicality of how IMO would provide the surveyors required for implementing its rules and standards. IMO would be struggling to perform in this one area only and may not be able to focus on other areas in safety, such as the human factor. It should be pointed out that, in my opinion, IMO has been doing a great job in promoting safety in ships through international conventions such as SOLAS, Load Lines, STCW and COLREGS, and the promoting of conventions dealing with the prevention of marine pollution such as MARPOL and AFS. The proposal should not be considered and adopted by IMO until the issues raised above have been addressed.

(c) Age and Safety

When a ship becomes older, corrosion problems increase and its structural members are also weakened due to operational stresses that they have been subjected to over the years. The main causes of oil tankers and bulk carriers breaking up in heavy seas have been linked to corrosion and structural fatigue (Boisson 1999:239). Furthermore, plant and machinery require more maintenance and repair work as a ship gets older. Age and unreliability increases the risk of a machinery breakdown during a critical phase, say, during loading oil that may result in an oil overflow and causing spillage into the sea. Age is not the sole cause of shipping or pollution accidents, but some insurance companies in the Institute of London Underwriters, have commented that few ships of less than ten years old have been involved in total losses as compared to older ships. These insurance companies see age as a major factor in ship losses. But many ship-owners, that have maintained their vessels properly since they were built, would dispute with insurance companies. Many ship owners today buy new ships, operate them for

about two to three years, then sell them. Their strategy is to do very minimum or no maintenance on their new ships while they operate them and thus maximise their profits. On the other hand, some ship-owners, such as Columbus Line and Hamburg Sud, have taken out the original engines of some of their ships and fitted with new economical engines after their ships were 20 years old. The reason for keeping the original hull was that they are in very good conditions as they were maintained properly since they were built and launched. The savings in using the original hull has been estimated by Hamburg Sud to be tens of million of dollars, as compared to the construction of a new ship of similar size with the same new engines.

Another dimension to a ship being regarded as “old” is captured in IMO technical conventions by the use of grandfather clauses that were first introduced in the SOLAS 74 Convention and repeated in various forms in later amendments. The application of new amendments was only to new ships, “ships the keels of which are laid or which are at a similar stage of construction” (SOLAS Chapter I, regulation 2k).but not to existing ships. This non-retroactivity of new standards was justified due to the cost of complying with them. However, in recent years, the high profile pollution incidents at sea and the ageing of the world fleets have changed the thinking of the industry. From 1992, the changes made in SOLAS and MARPOL introduced major modifications in design that required compulsory compliance for existing as well as new ships, for example, damage stability of ro-ro passenger ships and double hulls for oil tankers. The phasing out of the use of grandfather clauses would result in new ships built because the cost of converting existing ships to comply with new regulations far outweighs the benefits for the ship-owner.

Calling a ship “old” on the basis of its age (from the time that it was built) could be misleading because its present condition is dependent on various factors, with the main one being the goal of the ship-owner. Firstly, the ship-owner may maximise his profit in the short term, then sell his ship after about three years operation or properly maintain his

ship as a long-term investment. Many ships of 30-years old that were properly maintained may be in much better shape than ships of 10 years old that were not properly maintained. Secondly, the cost of compliance to a new amendment to an international convention affecting an existing ship may be acceptable to a ship-owner. After the required upgrade is carried out, that ship could be regarded as having the same standards as a new ship built after the entry into force of that amendment. It would be legitimate not to call that ship old. For the purposes of the research, the age of a ship would mean the number of years from when it was built to the present, the reason being that it would require this researcher to actually see the ships contained in the PICTs' port data to make an assessment and comparison of those ships. This would be a very difficult, if not impossible exercise, as some of the ships that were trading in 1998 (base year of data) are not trading today. On the other hand, the date that a ship was built is readily available in port authorities' records.

(d) Maintenance and Safety

Timely and good quality maintenance and repair on the structural parts and machinery installations of a ship generally shows a good attitude by the crew, and assumed to be with the full support of the shore management, to make the ship safe at all times. The proper application of paint to inside parts of tanks and structural members of a ship protect those parts from being corroded. Engines are overhauled when servicing hours are due, to ensure that machinery problems do not occur during critical times such as berthing operations. A shipping company's policy on repair and maintenance of its ships is of major significance to the condition of those ships, given the intense competition in the market. The current repair and maintenance undertakings are carried out during survey dry-dockings to satisfy the requirements of classification societies and flag States concerning safety and the protection of marine pollution. Recently, maritime authorities and classification societies have closely scrutinised repair and maintenance policies of shipping companies with the view to improving the conditions of ships and more control, including the adopting of new regulations. The proper enforcement of the ISM Code by

Flag States with the strong support of ship owners and classification societies is the key to ensuring that ships are safe. .

(e) Training, Certification and Safety

The main purpose of the International Convention on Standards of Training, Certification of Watchkeepers (STCW), 1978, was to provide a platform for the standardisation of maritime qualifications in all States that have adopted this Convention. This Convention was adopted because Member States of IMO had already recognised in the 1960s the importance of the role that humans play in preventing accidents and the safe operation of ships. IMO then began to focus more of its resources in ensuring that seafarers are properly trained and certificated. The Convention left to individual Member States to develop their own syllabi and examination procedures that resulted in many standards being adopted and used world wide. A decade after the adoption of this Convention, the rate of shipping accidents was still climbing. Member States then agreed in 1995 to a major overhaul of the Convention to rectify the problem areas in the Convention.

Amendments to the STCW Convention agreed to by Member States in 1995 required that States must submit to IMO by 1 August 1998 the following minimum information:

- The name of the government organisation responsible for administering the Convention, with its full address and organisation chart.
- A concise explanation of the legal and administrative measures undertaken to ensure compliance, especially those in regulation I/6 (training and assessment) and regulation I/9 (medical standards) and the issue and the registration of certificates.

The above requirements are summarised as follows:

- A clear statement of policies adopted relating to training, education, examination, competency assessment and certification;

- A concise summary of the courses, training programmes, examinations and assessments designed for each certificate issued under the Convention;
- Provide clear procedures for the authorisation, accreditation or approved training and examinations, medical fitness and competency assessments, required by the Convention. In addition, a list of authorisations, accreditation and approvals already granted;
- A concise summary of the procedures followed in granting any dispensation under the Convention in article VIII;
- To determine the present level of standards of competence with the STCW Code and the concise outline of the refresher and upgrading courses required to meet the standards of the Convention.

In order for Member States to remain in the “White List” external audits must be made at least once in every five years. The results of external audits are transmitted to IMO reporting that the maritime administration and/or maritime training institute have complied with the requirements of the STCW Convention, and if not, then that Member State is removed from the “White List” by IMO.

It remains to be seen if the provisions of the Convention, as amended, would be able to provide a framework (in practice) to deal with the problems prevalent in STCW, 1978. Two main problems are discussed here. The first problem is related to short courses being conducted by training centres that are supposed to be meeting required standards of the Convention for training and assessment. In fact they are not, but certifications are still being issued. Secondly, the forgery of certificates and other documents such as medical fitness certificates by organised fraudsters involving Administration officials, businesses, training centres, ships’ crew and crewing agents, have been known to exist (IMO MSC 81/14/2). These practices have been reported to be predominant in South and South East Asia, and to a lesser extent in East Europe, the Middle East/Mediterranean areas, and South America. IMO has to develop anti-forgery and anti-fraud measures and guidelines

together with Administrations' proactive actions in ensuring that training and assessment are conducted in accordance to the Convention's requirements, before these problems could be addressed.

(f) Manning and Safety

Since the 1960s, there has been a marked decline in the number of seafarers required onboard to safely crew ships. A ship manned with 30 seafarers in the 1960s would require half or less seafarers today to safely crew a similar size ship. The drastic reduction in the number of seafarers onboard ships today has been made possible by the increasing reliability of automation technology in their engines, plant and equipment. Determining how many seafarers are required to safely man a ship rests with the flag State, as international organisations have not been successful in agreeing on manning standards.

The International Labour Organisation (ILO) adopted Convention 109 (the original convention was adopted in 1958 but was revised in 1996) in which, amongst other things, the following measures provide guidelines for the safe manning of ships:

- Article 21 states that “ every vessel ...shall be sufficiently and efficiently manned for the purposes of:
 - (a) ensuring the safety of life at sea;
 - (iv) giving effect to the provisions of Part III of this Convention” (dealing with hours of work onboard);
 - (iii)“preventing excessive strain on the crew and avoiding or minimising as far as practicable the working of overtime”.
- Furthermore, Article 10 of Convention 109 (dealing with manning matters) states that “a sufficient number of officers and men should be engaged so as to ensure the avoidance of excessive overtime and to satisfy the dictates of safety of life at sea”.

The new Convention 109 has been included in the 1996 Protocol to Convention 147.

IMO also deals with the manning issue in SOLAS 74, Regulation 13 (a) of Chapter V, states that “The Contracting Governments undertake, each for its national ships, to maintain, or if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned”. The 1988 Protocol, which entered into force on 1 February 1992, required that ships of 500 gross tonnage or more keep onboard a document specifying the flag State’s minimum safe manning requirements, in other words, the minimum number of seafarers and their positions onboard a particular ship.

Prior to the 1988 Protocol, the IMO in Resolution A.481 of 19 November 1981 laid down nine guidelines to follow in deciding on safe manning, and it includes the following:

- maintaining a safe navigational watch on the bridge and general surveillance of the ship;
- operating all watertight closing arrangements and maintaining them in effective condition;
- deploying a competent damage control party;
- operating all onboard fire equipment and lifesaving appliances;
- carrying out maintenance as is required at sea; and
- maintaining a safe engineering watch at sea of main propulsion and auxiliary machinery,

with the objective of successful completion of the intended voyage.

These guidelines are not compulsory but IMO is now looking at giving greater importance to the connection between actual workload, qualification of seafarers and their numbers onboard. This would also take into account the advances and reliability in ship equipment and machinery automation technologies.

Another aspect of manning relating to safety is the prevention of fatigue in watch keepers that is being dealt with in the STCW Convention Regulation VIII, Section A-VIII and Section B-VIII. These provisions deal with guidelines on fitness for duty and watch-keeping arrangements onboard ships. Regulation VIII/1 states that each Administration is to “establish and enforce rest periods for the purpose of preventing fatigue” and also “that the efficiency of all watch-keeping personnel is not impaired by fatigue”. This researcher has identified, after talking informally to at least two masters and crew of inter-island trading vessels in six PICTs, that fatigue is the major problem facing those masters and crew, because most of small ports they called into are less than 24 hours steaming from one port to the other. Furthermore, cargo operations are conducted from arrival in a port until departure. Masters and crew of ships used on trading between PICTs have more time to rest as steaming time at sea are two days or more between ports. The only exception is between Samoa (Apia) and American Samoa (Pago Pago) where the steaming time between them is about 12 hours. The IMO recognises fatigue as a major contributor to causing shipping accidents and it adopted the ISM Code to encourage ship owners to identify causes of fatigue and design procedures to eliminate them. In particular, issues relating to the environment, stress, psychological, and cultural conditions.

IMO has recognised the critical role that fatigue has played in an accident. The *Exxon Valdez* disaster in 1989 is a reminder and classic example of how fatigue caused a navigation error that led to the accident (Boisson 1999:288). In order to prevent fatigue onboard ships the ISM Code was developed and adopted by IMO in 1993 highlighting the need for ship-owners to design policies and measures that would ensure fatigue is eliminated onboard ships, and also that safety is the main goal of every person in the organisation.

During the seafaring career of this researcher, many ships trading internationally and between PICTs employed mixed crew onboard. Many ship-owners employ only masters and chief engineers from developed countries, the rest of the crew from developing countries. Some ship-owners prefer whole crew on a ship from a developing country such as the Philippines, Poland and Tonga, but this is not as prevalent as the mixed crew option. The main reasons for employing a mixed crew are that:

- they are cheaper, with some estimates stating that a third of the original sum in personnel costs (The ISF Year 1995/96: 15);
- there is very little union problem;
- open registers normally permit such arrangements;
- nationals of developed countries do not wish to go to sea anymore due to various reasons;
- there is a good and credible base from which to argue that the quality of qualifications of seafarers from “White List” developing countries are the same or similar to those of developed countries; and
- shortage of officers world wide is expected to be about 10 per cent short of demand around 2005 if the growth in world shipping is 1.5 per cent annually. If the world shipping growth rate is 3 per cent annually the shortage would be about 25 per cent of demand for 2005 (BIMCO/ISF 1995 Manpower Update Summary as quoted in Boisson 1999: 315).

There is some downside on the use of a mixed crew, and they would include the following:

- Crews comprising various nationalities would involve different cultures and food. Cultural differences were identified as a contributory factor in the *Baer* disaster where it was manned by Greek officers and Filipino ratings (Boisson 1999:315);
- Concerning wages, some ill feeling between two or more nationals has been experienced by this researcher due to different rates used in a ship. In some cases, wage differentials for the same job creates resentment: for example, when an East

European seafarer is being paid more for the same job with the same qualification than is a seafarer from an African country or the Philippines;

- Communication is quite difficult onboard, if some of the seafarers do not speak or understand the English language. This was identified in the *Scandinavian Star* shipping casualty that the poor knowledge of English among the Portuguese catering staff was a contributory factor to the high number of fatalities; and
- The abandonment of seafarers by shipowners of mixed crew in overseas ports is increasing. IMO is now quite concerned about this issue and is conducting committee meetings to address this problem. Owners of ships in some of the open registries have been reported to cause most of these problems.

(g) Quality and Safety

High profile oil tanker and bulk carrier accidents resulting in loss of life have highlighted some serious deficiencies in the maritime industry. There is a perception by the public that there are many substandard ship owners/operators and sub-standard ships currently in existence today world wide. Commentators have said that it is estimated that about one third of the world fleet comprises sub-standard ships (APMI - ISM Introductory Course, 1996, Module 1 p.12).

The ISM Code has been developed and adopted by IMO as a means of improving the level of safety within the maritime industry. Sometimes it is regarded as a licence to operate in the industry. Basically, the ISM Code deals with how a shipowner or operator manages his ship in relation to prescribed safe operation systems and procedures. Its main effect on the maritime industry is that it encourages the cultivation and adoption of a safety culture by every person in the organisation, from those in the boardroom ashore to the lowest position onboard the ship. The Document of Compliance (DOC) is issued by a flag State (or an authorised entity, such as a classification society) to the relevant ship-owner or operator certifying that a safety management system (SMS) has been satisfactorily established onboard and ashore. The Safety Management Certificate

(SMC) is issued by the flag State to a ship following the initial verification that it complies with the requirements of the ISM Code. Both of these two documents have a validity of five years, subject to further verifications by the flag State or an authorised entity.

It has been estimated that safety management comprises of 80 per cent of a quality management system (Asia Pacific Maritime Institute 1996:module1, p.12). However, there is a distinction between the two: basically, safety is control of accidental loss whereas quality is meeting a specified or implied need. Ships trading in the Pacific region having a valid SMC should be regarded as safer ships than those who do not have onboard such a document. Safer ships in this context would mean that these ships will have a lower probability to cause marine pollution or be involved in an accident.

4.1.1.3 Marine Pollution Issues

Ships complying with the requirements of MARPOL 73/78 are issued with an International Oil Pollution Prevention Certificate. The Convention applies to all tankers over 150 gross tonnage and all other vessels over 400 gross tonnage, except warships, naval auxiliaries, and government-owned vessels on non-commercial service. In the Pacific region, many ships trading locally in a PICT do not comply with MARPOL 73/78 due to their size, but they are more likely to cause marine pollution than international trading ships, though only of a minor nature due to their size and the amount of oil they carry. Ensuring the safety of local trading ships is a difficult exercise for the maritime authorities in many PICTs, given the age of these ships and the competing interests of safety and the pressure from politicians to provide regular sea services to coastal or island communities. It is miraculous that there has not been any shipping casualty to date involving high fatalities, when one considers the age and general poor condition of many local trading ships.

(a) Pollutants Emitted from Ship's Engines

Ship's engines burn fuel oil and emit gases that include sulphur oxide (SO_x), nitrogen oxide (NO_x) and carbon dioxide (CO₂). These gases occur in the natural world but the increase in use of hydro-carbon fuels world wide resulted in excesses of these gases. New engine types and low sulphur fuel oil have been designed for new ships under construction to minimise the generation of these gases.

(b) Ballast Water Management

Ballast tanks are tanks provided in different locations (usually in the bottom or lower part of the ship) onboard the ship for holding/storage the ballast water. The location of ballast tanks in the lower part of a ship contributes positively to its stability. Some ballast tanks are located in the forward or aft part of a ship and they are used at times to "trim" the ship (that is, the ship to be inclined more towards the forward or aft part as required by the crew). Recent research has shown that ballast water can carry viruses and bacteria such as *V.cholerae* and *Escherichia coli* from one port to another port around the world (Ballast Water News, 2002, Issue 8 p.4). Furthermore, the amount of bacteria and viruses in the ballast water of ships, as well as the bio-film that lines the ballast tanks, is substantial. This bio-film is a tough impermeable polymeric matrix that attached itself to the inner surfaces of the ballast tanks (Ballast Water News, 2002, Issue 8 p.4). Exchanges at sea do not affect much of the bio-film and it is also resistant to most methods of removal being proposed. The water in many ports of the world is highly contaminated with sewage, household chemicals and agricultural run-offs (Drewry 1996:19). When a ship takes in ballast water in these ports, high concentrations of pathogens can also be taken in and can be transported from discharging port to loading port. Ballast water can also transfer a range of species of micro-algae, including toxic species that may form harmful algae bloom or sometimes known as "red tides". Severe illness and death in humans from shell-fish poisoning often followed when there is an outbreak of harmful algae bloom in that area (Drewry 1996:17).

IMO has recognised the danger of spreading exotic organisms through the discharge of ballast water and has taken measures to control it. International regulations have been developed in the last decade and adopted by IMO on 1 February 2004. Proposals from IMO member countries have been discussed in various IMO committees and they have agreed in principle to focus on a two-tiered application regime. One tier requiring certain basic precaution to apply to all ships, the other tier as further control mechanism, is to apply when the ship entered certain defined areas and allowing for bilateral or multilateral agreements. Ballast water management schemes have been developed to facilitate the implementation measures in the new IMO convention dealing with the transfer of exotic organisms world wide through ballast water exchanges onboard ships (Ballast Water News, 2002, Issue 8 p.4).

(c) Pollution Effects of Paints

Paints used to protect a ship against corrosion or marine growth pollute the marine environment when they enter into the sea through spillages, discharges or application to the hull. Some paints, such as those used in anti-fouling systems; especially those that use organotins such as tributyltin (TBT); used on the underwater part of the ship's hull, are quite toxic to some marine organisms such as oysters and whelks.

(d) Type and Quantity of Bunker Oil (fuel oil)

The quantity and type of fuel oil carried onboard ships (of any size) trading in the Pacific region are similar to any region of the world in terms of the amount and type of fuel carried onboard. Many ships also trade internationally including those ships transiting the Pacific region. The bigger the ship, the more power it requires to propel it through the water. The higher the speed of a ship, the more fuel is required by the engine to attain the desired speed. Another important factor that has to be taken into account is the maximum range of the ship before it has to be refuelled.

When a ship is designed, the space for accommodating fuel oil is calculated, taking into account the amount of oil required to be used by the engines to achieve the desired speed of the ship and its maximum range without refuelling. In the Pacific region, vessels of about 50 metres long, trading locally in each PICT, carry onboard approximately 150 tonnes of fuel oil. Each vessel of about 120 metres long trading between PICTs carries onboard approximately 420 tonnes of fuel oil. Container vessels, each of about 190 metres long, used in the Pacific region, carry more than 2,500 tonnes of fuel oil and this oil is more than that carried by small oil tankers used in the region.

Small ships used for trading between PICTs carry only diesel oil for fuel. Ships trading between PICTs usually carry approximately 20 tonnes of diesel oil for harbour use and 400 tonnes of heavy oil for steaming at sea (for example, *Forum Samoa* and *Fua Kavenga*). Big container vessels normally carry a couple of hundred tonnes of diesel oil and the balance in heavy oil. This ratio is dependent on the type of engine and its manufacturer.

The International Convention on Civil Liability for Bunker Oil Damage (Bunkers) 2001 has not yet entered into force. However, the Convention establishes a liability and compensation regime for damage resulting from spills of oil, when carried as fuel in ships' oil tanks. The 1992 CLC and Fund Conventions cover only liability and compensation on oil spills from oil tankers. IMO modelled the Bunkers Convention on the 1992 CLC Convention where a key requirement was for the registered owner of a vessel to maintain compulsory insurance cover. Another key provision for the Bunkers Convention is the requirement for direct action, which would allow a claim for compensation for pollution damage to be brought directly against an insurer. The Bunkers Convention does not have any top-up provision (like the Fund Convention does for the CLC Convention), therefore there is no requirement for Coastal States or receivers of oil to contribute to a fund.

4.1.1.4 Ship Registration

Registration is the act by which a ship is granted nationality by a State after it meets the relevant national requirements. As a consequence the State has authority and responsibility over that ship. The ship is entitled to fly the flag of that State, and the State is known as the “Flag State”. In international law, without nationality a ship in the high seas would not be able to prove its existence because there is no document to show that it belongs to a State. Furthermore, it does not have any protection against any action of another State or individual. By having a nationality, a ship would be operated in accordance to the laws of the Flag State and its protection.

Ships are usually registered in a State under three types of registration. Firstly, under the traditional registry which requires the owner to be a national or registered company of that State. Secondly, the bare-boat charter registry where the bare-boat charter of a ship is registered in one State (for the benefit of the charterer) and flying the flag of that State, but with an underlying (or original) registry in another State that the ship-owner also benefits financially. Once the bare-boat charter is terminated, the ship immediately reverts to its original or underlying registry. This is a European concept with no precedent in English law, but this principle was adopted in the UNCTAD’s Convention on Conditions for Registration of Ships, 1986, that has not yet entered into force. The third form is the open registry (or well known as Flag of Convenience or with the acronym FOC) where the owner is not a national or company registered in the flag State. Many of the high profile oil tanker accidents, such as the *Amoco Cadiz* in 1978 and *Exxon Valdez* in 1989, were registered in Liberia, the second biggest open registry in the world. The biggest open registry is Panama.

There is an ongoing debate world wide on the pros and cons of open registries. Most of the high profile accidents have been associated with open registers and the public

therefore has a negative perception of open registries. Several statistical studies have been carried out over the years to establish the relationship between accidents and losses of ships with registries. These studies have concluded that the number of sub-standard ships and casualty rates were higher for open registries than for (a) traditional registries and (b) the world average.(Tolofari 1989:71). In 1996, Manaus Consultants carried out a study in France (as quoted by Boisson 1996:427) that showed a clear intensification of risks on new open registries of Cyprus, Malta, Saint Vincent and Grenadines, Antigua and Barbados, and the Bahamas.

Several maritime commentators agree that criticism of open registers on safety grounds is unproven (Boisson 1999:428), due to the following reasons:

- A number of the most modern ships are registered in open registries;
- Many open registries have taken steps to ban registration of old ships. The limit is 20 years for Liberia, Panama and Vanuatu, between 17 and 23 for both Cyprus and Bahamas;
- Most of the open registries are Parties to the main international conventions on safety at sea and prevention of marine pollution; and
- There is a new consciousness and understanding between many flag States operating open registries and ship-owners (especially those from developed countries) that complying with international regulations and standards are good investments that would prevent expensive mistakes and accidents in the long term. The adoption and entry into force of the ISM Code greatly contributes to the development of this new thinking. Furthermore, ship-owners have to meet the European Union's tough new legislation relating to safety at sea and prevention of marine pollution after the oil tankers *Erika* (December 1999) and the *Prestige* (December 2002) disasters, off the French and Spanish Coast respectively. IMO is developing new amendments along the same lines as the European Union has done.

It would appear that there is a strong link between accidents and certain open registries, but it is unfair to make a generalisation condemning open registries as a whole. There is a long history of open registries since the Roman Empire, when Roman vessels were registered under the Greek flag for convenience so as to avoid being attacked by enemies of Rome. British companies have registered their ships from the 17th to the 19th Centuries under the French and Spanish flags to avoid Spanish trade restrictions with the West Indies (Ozcayr, 2001:25). American companies in the 20th Century continued the practice of registration of their ships under open registries set up by them in Panama and Liberia during the Prohibition era to avoid government decrees including the carriage of alcohol onboard US ships. Ship owners changed flags for a variety of reasons, including avoiding government protectionist policies and protection from piracy. Open registries are well established now and they will not disappear completely, as the International Transport Workers Federation (ITF)¹⁴ has hoped for in the past 50 years, but without success because more than half of the world shipping fleet is registered under open registries. The open registries totalled 204 million gross tons in 1995 (Boisson, 1999:426). Furthermore, governments in developed countries have tried to force ship owners through legislation to register their ships in their own countries without success because international shipping operates under free market principles. Some of these countries have second registers to cater for their ship owner needs and compete with open registries. This scheme has had some success in the United Kingdom, Denmark and Norway.

Port State control will further make life more difficult today, if not impossible, for substandard ships to operate, whether registered under an open registry or a traditional registry. The registry is only one component of the safety issue and the flag State has to ensure that ship-owners flying its flag fully implement the provisions of conventions to which it is a Party. This is stated in Article 94.1 of the Law of the Sea Convention that “every State shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag”. Article 94.2 requires that Flag States maintain a register of ships flying its flag and assume jurisdiction on the ships and

their crew. Furthermore, Article 217 describes Flag State powers for protection of the marine environment. It is the ship-owner that is the most important component of safety as he is the key person that would have to decide either to support or not support any safety consideration or requirement.

From the discussions above, one might deduce that certain open registries have poor safety records and do not have a good reputation in the industry. Some open registries have good safety records, which are often better than some traditional registries. For example, the US Coast Guard stated in 1994 that six open registries had the worst safety records; they were St. Vincent, Honduras, Malta, Vanuatu, Cyprus and the Bahamas (Boisson,1999:429). At the same time in Europe, only Honduras and Belize appear on the ten worst flags. The 2000 European Union (EU) annual detention ratio¹⁵ (Ozcayir 2001:521) from PSC inspections showed that the following flag States recorded higher than the overall average of 5.05 per cent – Belize (50.56%), Honduras (39.06%), Venezuela (13.95%), Saint Vincent and the Grenadines (11.43%), Turkey (11.41%), India (8.94%), Cyprus (8.19%), Vanuatu (7.84%), Thailand (7.23%), Panama (6.92%), Malta (6.70%), Russia (5.83%), Antigua and Barbuda (5.59%), Philippines (5.14%). It is worth noting that the following flag States in the 1999 detention list do not appear in the 2000 detention list – Cape Verde, China, Equatorial Guinea, Mexico, Netherlands Antilles, Pakistan, Romania, Taiwan, and the Ukraine. Furthermore, the annual detention ratio dropped from 6.00 per cent in 1999 to 5.05 per cent in 2000. There is improvement in the number of ships detained in this three-year averaged data. For the purposes of the research, the calculation of this internal factor will be based on the above 2000 list of detentions.

Recently, two new developments on the international maritime scene are important for the elimination of sub-standard Flag States. Firstly, is the IMO Voluntary Audit Scheme designed so that a Flag State could assess its own performance against a set of guidelines (comprising of internal and external criteria). The Flag State can determine whether or

not it carries out its responsibilities in accordance with the IMO guidelines. Deficiencies identified are rectified by the Flag State to ensure that its responsibilities are carried out to the required IMO standards.

Secondly, an initiative of the Round Table of the international shipping industry organizations (comprised of BIMCO, Intercargo, International Chamber of Shipping, International Shipping Federation and Intertanko) that published a “Shipping Industry Guidelines on Flag State Performance”. These guidelines are designed to assist shipping companies in assessing a Flag State’s performance with a view to determine the “respectability” of a flag they are using or planning to use. The guidelines issued by the Round Table list the responsibilities of a Flag State that a shipping company might reasonably expect of a Flag State. Appended to the guidelines is a table that shows how a Flag State performs in the light of 18 negative performance indicators against such criteria as Port State Control, ratification of major international treaties, use of Recognised Organisations complying with IMO resolution A.739 (this resolution contains a standard agreement format), and attendance at IMO meetings. Examples of negative performance indicator questions required of a Flag State are: “Paris MOU black list ?” and “Not on Paris MOU white list?”. A Flag State with a negative performance indicator of 12 or more out of 18 is thought of as excessive. The implication is that those Flag States are only operating to provide a refuge for sub-standard ships. This evaluation will be a blow to sub-standard shipping and the Flags not performing to international standards

Both the above initiatives are strongly supported by the industry, insurance companies and Flag States. There is an ongoing debate by Member States at IMO of a proposal to have the Voluntary Audit scheme made mandatory, similar to that of the civil aviation industry. Whatever is the outcome of the debate, one thing is for sure is that sub-standard shipping and Flags States registering them will find it difficult to carry on business as usual given the strong support by the industry and responsible Flag States.

4.1.1.5 Security

In December of 2002, Contracting Governments agreed and adopted at IMO, amendments to the SOLAS Convention, 1974, as amended, that included the ISPS Code. This was by way of renumbering the Convention and a new Chapter XI-2 was made dealing with special measures to enhance maritime security and safety. The International Ship and Port Facility Security (ISPS) Code was initiated by the United States at IMO, in the aftermath of the terrorist attacks on its soil on 11 September 2001. It entered into force on 1 July 2004. If more than one third of the Contracting Governments to the Convention, with a combined merchant fleets of which constitute not less than 50 per cent of the gross tonnage of the world's merchant fleet, have notified to IMO their objections, then the amendments would not entered into force on 1 July 2004.

Risk management principles are used in the Code to ensure that security is maintained on board ships and in port facilities. This involves the assessment of what security measures are appropriate to ships and port facilities and the interface between them. The Code, in effect, provides a standardised, consistent framework for assessment risk and enabling Governments to reduce vulnerabilities of ships and port facilities in the light of identified threats. Evaluation of risk is a process that involves three essential elements - criticality, threat and vulnerability. It must be recognised that perfect security can never be fully realised, so any security measure designed to address an identified risk must provide timely warning of an impending threat. Evaluation of risk must also be capable of removing that threat through an effective response. Obligations of Contracting Governments and responsibilities of companies and ships are prescribed in the Code so that the achievement of its objectives concerning security are assured . The Code applies to all passenger ships, cargo ships of 500 gross tonnage and upwards, mobile offshore drilling units engaged on international voyages and port facilities serving such ships.

In evaluating risk, the critical component is the impact or loss or damage caused to a port facility, ship or system such as offshore installations. The risk evaluation would identify important assets and infrastructures in a port facility that if damaged, could cause loss of life or damages to its economy or environment. An example in a ship would be the sabotage of the main engines or the deliberate setting fire to accommodation spaces. An extreme critical incident would result in substantial loss of life or significant damage to the ship or port facility or nation. A highly critical incident would result in serious and costly damage to the ship or port facility but no loss of life. A medium critical incident would be disruptive to the ship or port facility operations for a moderate period of time but no loss of life or capability. In a low critical incident, only minor disruptions to ship or port facility operations.

The threat component identifies the actual threats to important assets and infrastructure in order to prioritise security measures. Threat is the ability and intent of an opponent to commit a crime or inflict injury or damage to your assets. These are the threats that affect ships and port facilities: pilferage and theft, smuggling illicit goods, piracy and armed robbery, stowaways and illegal immigrants, sabotage, and terrorism. The following factors are very important in assessing if there is a threat: past incidents; current situation, security environment, capability and intent of any opponent. Threat levels are based upon the degree to which some combinations of the factors are present. In the Code, threat levels are assigned as follows: 1 if the threat is low; 2 if the threat level is medium; and 3 if the threat level is high.

The vulnerability component covers the susceptibility of a ship or port facility to a maritime security threat. Factors determining the vulnerability of a ship or port facility are: the location of the facility (such as if it is near a motorway that many people use or is it pretty isolated); can the facility be accessed relatively easy; the adequacy of the physical protection; and the availability and adequacy of response forces. A significant,

if not prohibitive, amount of money and human resources is required to achieve effective security. Therefore, identifying areas of vulnerability by using risk management can be quite cost-effective. However, vulnerability and risk are not synonymous as explained in the following example. An oil tanker is vulnerable (due to its low freeboard; freeboard being the height of its main deck above the sea surface) to piracy when fully loaded but at low risk due to the fact that oil tankers usually steam far out to sea where the pirates could not get onboard easily.

One very important dimension of the Code that should be highlighted is described in Regulation 8 that provides for the master's discretionary power in matters related to safety and security onboard ship. This regulation gives unrestricted powers to the master to decide on any matter onboard a ship in order to maintain its safety and security, if in his professional judgement his decision is justified under the circumstances. The regulation also clearly states that in the event there is a conflict between safety and security requirements onboard a ship, the master shall deal with the safety ones first. The master may also implement temporary security measures commensurate with the prevailing security level.

4.1.1.6 Ships' Impacts on the Marine Environment

In Chapter 2 the categorisation of ships were established and included in Table 2.4. The explanations and definitions concerning ship types and ship groups apply also to the rest of this research in calculating the SMPI. The methodology for calculating the SMPI is discussed in Chapter 1.4 that included the scales to be used for threat (1-3), vulnerability (1-3) and consequences (1-5) to signify the ranking of pollution risk indicators in a descending order in each PICT.

Many countries world wide use Tier One, Tier Two, and Tier Three classifications that relate to the amount of oil or other pollutants spilt, or likely to be spilt, the resources required and the level of support available nationally, regionally or internationally. Oil spills (whether from bunker oil or cargo of oil) are linked to the consequences component of a marine pollution risk indicator when ships call into PICT ports. The tiered classification takes into account the quantity of oil estimated to have been spilt from a ship into waters of a PICT. Tier One is basically a small oil spill in a localised area, such as an oil terminal in a port, that could be dealt with within its available resources and in accordance to port specific response arrangements. The environmental and economic impact of the spill is low. It is only a small spill and is quantified in this research as a spill of less than seven tonnes. The tonnage used is designed to be in line with what is currently used by the International Tanker Owners Pollution Federation (ITOPF)¹⁶, in many countries and also has been used by SPREP as a guide for their oil spill response plans. A Tier Two oil spill has medium environmental and economic impact that could be dealt with within the national capability and resources of a PICT. It signifies spills of between seven and seven hundred tonnes. Major oil spills that could not be dealt with by the PICT alone are Tier Three spills, for they are of a magnitude and severity beyond national capability and resources. Neighbouring countries may also be affected by pollution damage and loss of resources. It is a spill of over 700 tonnes. These are shown more clearly in the following Table 4.0.

Table 4.0 - Classifying and Quantifying Oil Spills

Tier	Description	Quantity of Oil
1	Environment and economic impacts low	<7 tonnes
2	Medium environmental and economic impacts. Containment and clean up of oil is with the capability of the PICT	7-700 tonnes
3	Magnitude and severity of impact on environment and economy of a PICT is beyond capability and resources. Other nearby countries affected by oil pollution.	>700 tonnes

Source: ITOPF web-site

To determine the impact of any ship on the marine environment of each PICT would require examining any pollutant onboard the ship other than those of its cargo. The most

important and easiest to quantify pollutant is the fuel oil and lubricating oil for the ship's plant and machinery.

Pago Pago

The results of the analysis for Pago Pago are summarised in Table 4.1. There were 190 Type 1 ships (carrying persons or things) comprising of 56 Group 1 (passenger ships and ferries), 110 Group 2 (includes general cargo, container and ro-ro ships) and 24 Group 3 (bulk cargo in liquid or solid form) and 144 Type 3 ships (specialised ships such as off-shore supply ships and fishing vessels) recorded, as stated in Table 2.4. There was no Type 2 ship (tug boats, survey and research ships) recorded.

In Table 4.1 there is a special group (Group 1.2) that was inserted because the size of the passenger ferry *Lady Naomi* that travels between Apia (Samoa) and Pago Pago (American Samoa) is too small (48 metres) to be counted together with the normal cruise liners (230 metres). Type 3 vessels were all fishing vessels (long liners and purse-seiners) landing their catches to the fish canneries ashore and afterwards took fuel oil and provisions onboard.

Table 4.1- Pago Pago ship pollution risk factor

Ship Type	Fuel Oil in tonnes	ITOP F TIER (i)	Vessel Calls/ year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1.1	2500	3	12	36	0.33	1	4.8	1.6
Group 1.2	80	2	56	112	1.02	1	4.8	4.9
Group 2	1723	3	110	330	3.0	1	4.8	14.4
Group 3	1596	3	24	72	0.65	1	4.8	3.1
2	-	-			-			
3	200	2	144	288	2.62	1	4.8	12.6
Total								36.6

Source: PICT ports data obtained by author during country visits.

Note: - SPRI means Ship Pollution Risk Indicator throughout in Tables

- Threat calculation formula in Ch 1.4.1 discussions
- Vulnerability calculations see Table 1.1
- Consequence calculations see Tables 1.2 to 1.7

Apia

The results for Apia are summarised in Table 4.2. Only Type 1 vessels called into Apia during the year and they are - 66 Group 1 ships, 144 Group 2 ships, and 36 Group 3 ships. A special Group 1.2 was inserted to cater for the passenger ferry *Lady Naomi* that runs between Apia and Pago Pago.

All cruise liners (Type 1 Group 1), container ships (Type 1 Group 2) and mid-range oil tankers of about 30 000 gross tonnage (Type 1 Group 3) that called into Apia also called into Pago Pago. These oil tankers brought cargoes from Guam or Singapore or Australia to the two Samoas. Cargoes for these two ports are normally stowed/carried onboard ships in such a way that the ships could be discharged at Apia as a first port of discharge or Pago Pago first, without the cargoes being over-stowed for either port. The two ports are about 110 miles apart in an east/west direction, and to a ship that sailed from the U.S. West Coast or South East Asia both ports are in the same distance. Furthermore, if Apia is congested, a vessel could call into Pago Pago first or could be vice-versa. For container vessels, the steaming time between the two ports is about eight hours. This would not affect the ship's schedule as much as it would be, if the ship had to anchor outside a port, waiting for a berth for 12 hours and still had to call into the other port.

Table 4.2- Apia ship pollution risk factor

Ship Type	Fuel Oil in tonnes	ITOP F TIER (i)	Vessel Calls/ year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1.1	2500	3	12	36	0.33	1	4.2	1.4
Group 1.2	80	2	56	112	1.02	1	4.2	4.3
Group 2	1723	3	110	330	3.0	1	4.2	12.6
Group 3	1596	3	24	72	0.65	1	4.2	2.7
2	-	-			-	-	-	
3	-	-			-	-	-	
Total								21.0

Source: PICT ports data obtained by author during country visits

Apia has less ship risk factor than Pago Pago (36.6 versus 21.0) and this is due mainly to the 144 fishing vessels that visited Pago Pago as compared to none at Apia.

Nuku'alofa

The results for Nuku'alofa are summarised in Table 4.3. There were no Type 2 or Type 3 called into Nuku'alofa during the year. Of the Type 1 ships there were 14 Group 1, 121 Group 2, and 45 Group 3 vessels.

Cruise liners that called into Pago Pago and Apia also called at Nuku'alofa mostly on round-the-world cruises, starting from Europe through the United States to the Pacific island countries. The biggest container vessels from the U.S. West Coast called at all three ports. The number of oil tankers is higher for Nuku'alofa due to the use of much smaller Fiji based Dilmun oil tankers that carry about 2 000 tonnes cargo of oil. This is reflected in the lower ship risk factor of 18.1 for Nuku'alofa.

Table 4.3- Nuku'alofa ship pollution risk factor

Ship Type	Fuel Oil in ton	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	2500	3	12	36	0.33	1	4.8	1.6
Group 2	1723	3	110	330	3.0	1	4.8	14.4
Group 3	126	2	24	48	0.44	1	4.8	2.1
2	-	-	-			-	-	
3	-	-	-			-	-	
Total								18.1

Source: PICT ports data obtained by author during country visits

Tarawa

The results for Tarawa are summarised in Table 4.4. Bali Hai Line container ships called into the Port of Betio (Tarawa) on their way from Japan to other Pacific island countries.

Some other container ships also called from Australia. Dilmun oil tankers carried all oil cargoes into Tarawa mainly from Fiji.

Table 4.4- Tarawa ship pollution risk factor

Ship Type	Fuel Oil in ton	ITOP F TIER (i)	Vessel calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1								
Group 2	1494	3	2	6	0.38	1.7	4.8	3.1
Group 3	126	2	24	48	3.0	1.7	4.8	24.5
2	-	-			-	-	-	
3	-	-			-	-	-	
Total								27.6

Source: PICT ports data obtained by author during country visit

Although no cruise vessels visited Tarawa, there were some that visited Christmas Island thousands of kilometres to the east. There were no fishing vessel calls recorded at Tarawa. About 500 foreign fishing vessels have been licensed by Kiribati to fish in its rich fishing grounds (Abete 2000, personal interview) where the control of marine pollution is quite difficult because of lack of financial and human resources. This situation would continue into the foreseeable future because of the fees collected on the fishing vessel licences. The ship risk factor is 27.6 for Tarawa.

Majuro

The results for Majuro are summarised in Table 4.5. The container vessels and oil tankers that called into the Samoas also called into Majuro, which totalled 81 vessel calls. Container barges towed by sea-going tug boats (Type1.2 ships) from the U. S. West Coast called into Majuro and Kwajeleen Atoll where a big United States military base is located. There were no cruise vessel calls for the year, but 385 fishing vessel calls were recorded.

Purse-seiners and long line fishing vessels made up the 385 calls for Type 3 ships. Most of these fishing vessels called into Majuro after fishing in Kiribati waters.

Table 4.5- Majuro ship pollution risk factor

Ship Type	Fuel Oil in ton	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	-	-			-	-	-	
Group 2	1723	3	62	186	0.72	1.3	5	4.7
Group 3	1596	3	19	57	0.22	1.3	5	1.4
2	200	2	11	22	0.09	1.3	5	0.6
3	126	2	385	770	3.0	1.3	5	19.5
Total								26.2

Source: PICT ports data obtained by author during country visits

A Taiwanese fishing company based in Majuro owned many of the fishing vessels that called at Majuro. This company is planning to move its base out of Majuro and this will greatly reduce the ship risk factor for the port. While in Majuro these fishing vessels transfer their catches to special refrigerated ships, change crews, take fuel oil and provisions onboard then return to fishing in Kiribati waters. The increased fishing vessel calls pushed up Majuro's ship risk factor to 26.2.

Apra

The results for Apra are summarised in Table 4.6. One half of the Port of Apra belongs to the United States military and the other half, the western part, is used for commercial purposes. There is a big Navy base in the military part of the port but is excluded from the data in Table 4.6. Container ships with capacities of over 3000 TEUs called monthly from U.S. West Coast ports; some smaller ones from Japan, East and South East Asian countries, Palau, Chuuk and the Marianas. Tourism is quite important to Guam's economy and 22 cruise liners called into Apra from Japan, Asia, and the United States. Due to the big Navy base mid range oil tankers and smaller ones totalling 88 calls also called into Apra. Guam is a major transshipment port for much of Micronesia.

Table 4.6- Apra ship pollution risk factor

Ship Type	Fuel Oil in ton	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	2500	3	22	66	0.05	1	4.0	0.2
Group 2	2400	3	301	903	0.62	1	4.0	2.5
Group 3	1596	3	88	264	0.18	1	4.0	0.7
2	-	-			-	-		
3	126	2	2205	4405	3.0	1	4.0	12.0
Total								15.4

Source: PICT ports data obtained by author during country visits

Fishing vessels (Type 3 vessels) numbering 2205 calls have the most impact on the ship pollution risk factor, with three times the number of vessels compared to the other vessel types. These fishing vessels called into Apra for fuel oil, provisions, discharging their catches for transshipment to Japan, and other operational requirements. Most of these fishing vessels are purse-seiners and long liners. The ship pollution risk factor for the commercial part of Apra is 15.4.

Honiara

The results for Honiara are summarised in Table 4.7. Only five cruise liner calls was recorded in 1998. However, a variety of Type 1 Group 2 ships such as container ships, log ships, reefer ships for loading of fish catches had 202 calls. Mid range oil tankers that called into Honiara from Australian ports also called in Apia and Pago Pago later. Small Dilmun oil tankers deliver oil from Papua New Guinea to Honiara. Fishing vessel calls into Honiara were 180, and that consisted mainly of purse-seiners and long liners. Some of the container vessels are on round-the-world voyages (such as Bank Line ships), arriving from Papeete, Tahiti, and Apia. These vessels load coconut oil and palm oil in Honiara or other Solomon Islands ports.

Table 4.7- Honiara ship pollution risk factor

Ship Type	Fuel Oil in tonnes	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	4168	3	5	15	0.07	1.3	4.4	0.4
Group 2	3900	3	202	606	3.0	1.3	4.4	17.2
Group 3	1356	3	91	273	1.35	1.3	4.4	7.7
2	-	-			-	-	-	
3	452	2	180	360	1.78	1.3	4.4	10.2
Total								35.5

Source: PICT ports data obtained by author during country visits

Log ships call into isolated places all over the Solomon Islands for the loading of logs. There is usually no specific port, and these vessels anchor in out-of-the-way places where there is very little control and monitoring. This is of great concern to the Maritime Administration, as pollution from the operation of these ships could occur in environmentally-sensitive areas without the knowledge of the authorities. Usually, permits are issued by the appropriate forestry authorities in Honiara to Malaysian or Taiwanese logging companies without proper consultations with marine and environment authorities. These log ships are anchored at places nearest to the forested area in the permit and these areas often do not have the appropriate hydrographic surveys or adequate navigational charts. The ship pollution factor is 35.5.

Suva

The results for Suva are summarised in Table 4.8. In terms of cruise vessel calls, Suva recorded the highest in all the nine PICTs, a total of 35. Type 1 Group 2 and Group 3 ships show 518 calls and 297 calls respectively, which shows that Suva is the regional hub for shipping in the South Pacific. International and regional trading vessels have regular scheduled services to Suva. Mid-range oil tankers and small Dilmun oil tankers transported oil into Suva. Fishing vessel calls were 391 and this figure contributed to the high value of the ship pollution risk factor of 7514 for this port. Long liners were the biggest number of fishing vessels followed by purse-seiners that called into the port.

Table 4.8- Suva ship pollution risk factor

Ship Type	Fuel Oil in tonnes	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	2500	3	35	105	0.20	1	4.6	0.9
Group 2	3900	3	518	1554	3.0	1	4.6	13.8
Group 3	1356	3	297	891	1.72	1	4.6	7.9
2	-	-	-	-	-		-	
3	126	2	391	582	1.12	1	4.6	5.2
Total								27.8

Source: PICT ports data obtained by author during country visits

Many of the vessels below 2 000 gross tonnage called into Suva for dry-docking purposes in the two slip-ways. Table 4.8 covers vessels involved in trade and also vessels that called into port for dry-docking purposes. The ship pollution risk factor is 27.8.

Port Moresby

The results for Port Moresby are summarised in Table 4.9. For Type 1 Group 1 there were only five cruise vessel calls, but 363 Group 2 and 241 Group 3 calls. Log ships are included in the Group 2 ships that pose the same problems as that of Honiara and the Solomon Islands. Fishing vessel calls of 132, mainly purse-seiners and long liners, contributed to the high value of the ship pollution risk factor.

Table 4.9- Port Moresby ship pollution risk factor

Ship Type	Fuel Oil in tonnes	ITOP F TIER (i)	Vessel Calls/ Year (ii)	(i) x (ii)	Threat (a)	Vulnerability (b)	Consequences (c)	SPRI (a) x (b) x (c)
1 Group 1	4168	3	5	15	0.04	1	4.2	0.2
Group 2	943	3	363	1089	3.0	1	4.2	12.6
Group 3	1356	3	241	723	2.0	1	4.2	8.4
2	-	-	-	-			-	
3	126	2	132	264	0.73	1	4.2	3.1
Total								24.3

Source: PICT ports data obtained by author during country visits

The ship pollution risk factor is 24.3.

4.1.1.7 Summary of Ship Pollution Risk Factor

A summary of the total ship calls and ship risk factor in descending order for the nine PICT ports is shown in the following Table 4.10. There is no relationship between the total vessel calls and the total ship risk factor, that is, the rankings for total vessel calls in descending order - Apra, Suva, Port Moresby, Honiara, Majuro, Pago Pago, Apia, Nuku'alofa, Tarawa compared to SPRI which are also in descending order – Pago Pago, Honiara, Suva, Tarawa, Majuro, Port Moresby, Apia, Nuku'alofa, Apra. When only Type 1 vessel calls are considered, the following is the new ranking, in descending order – Suva, Port Moresby, Apra, Honiara, Apia, Pago Pago, Nuku'alofa, Majuro, Tarawa. Type 2 vessels called only into Majuro and not to any of the other eight ports. The relationship between Type 1 vessel calls to that of total vessel calls is as follows: Suva 68.5%, Port Moresby 82.2%, Apra 15.7%, Honiara 62.3%, Apia 100%, Pago Pago 56.9%, Nukualofa 100%, Majuro 19.3%, Tarawa 100%.

Table 4.10- Summary of ships' calls and pollution risk factor for the nine PICT ports

Ports	Fishing Vessels (Type 3) calls	Other Vessels (Types 1& 2) calls	Total Vessel Calls	Total ton bunker oil (from Annex 5)	SPRI
Apra	2205	411	2616	1195678	15.4
Suva	391	850	1241	2559698	27.8
Port Moresby	132	609	741	706577	24.3
Honiara	180	298	478	1013396	35.5
Majuro	385	92	477	187860	26.2
Pago Pago	144	190	334	291114	36.6
Apia	0	242	242	262314	21.0
Nuku'alofa	0	180	180	222554	18.1
Tarawa	0	42	42	13482	27.6
Total	=3437	=2914	=6351	=6452673	=232.5

Source: PICT ports data obtained by author during country visits

If only Type 3 vessels are discussed, the new ranking in descending order is: Apra, Suva, Majuro, Honiara, Pago Pago, Port Moresby, with Apia, Nuku'alofa and Tarawa recording no vessel calls. The impact of fishing vessel calls to that of total vessel calls in a PICT

port is as follows: Apra 84.3%, Suva 31.5%, Majuro 80.7%, Honiara 37.7%, Pago Pago 43.1%, Port Moresby 17.8%, with Apia, Tarawa and Nuku'alofa all recorded 0.

The impact of fishing vessels, although representing only 20.83 per cent of the total ship risk indicator (see Table 4.10), is quite significant when the actual numbers between fishing vessels and other vessels are compared. The total number of fishing vessel calls into the ports of the nine PICTs is 3437 as compared with those of 2914 of other vessels. Therefore, fishing vessels should be closely monitored and controlled properly by PICTs when they are fishing within their EEZs or calling into their ports. Apra is the most likely port to be affected by oil pollution due to fishing vessels. When the potential for oil pollution caused by vessels other than fishing vessels is considered, Suva comes out on top.

4.1.2 Cargoes

Trading between nations is conducted through the use of ships to carry goods from one nation to the other. When goods are loaded, carried onboard, and discharged from ships they are normally called the ship's cargo and "goods" and "cargoes" are used interchangeably in the research. In Chapter 1, a general discussion of the types of cargoes that may cause marine pollution was carried out but with no categorisation made. They may be categorised into three types – dangerous cargoes (with or without pollution impact on the marine environment) as covered by the IMDG Code; cargoes not normally regarded as dangerous but they can still pollute the marine environment (such as grain¹⁷); and general cargoes that produce insignificant marine pollution. The risk assessment formula will be used for scoring risks posed by cargoes. Threat, vulnerability and consequences are the main components in the calculation of risks and their applications have been discussed in Chapter 1.

Ships are sometimes designed and built to cater for a particular type of cargo. These specially built ships, which include oil tankers, bulk carriers, chemical carriers, container ships, passenger ships, have been constructed to IMO and classification societies' rules and standards for safety and the protection of pollution to the marine environment. Due to the nature of solid bulk cargoes such as grain, bulk carriers are required to be fitted with feed tanks to prevent the grain from shifting at sea that may capsize the vessel. Furthermore, bulk carriers carrying coal or other mineral ores are required to have extra strengthening to minimise the effects of longitudinal, bending, shearing and other structural stresses that may cause a fracture in the ship's hull resulting in the loss of the ship. Liquid cargoes such as oil or other petroleum products are carried in oil tankers that are designed and built to ensure their structural strengths are adequate. The prevention of these cargoes spilling into the sea by accident or the normal operations onboard or from a shipping casualty have been taken into consideration and incorporated in MARPOL 73/78 and the SOLAS Convention.

Unsafe practices in loading, stowage and unloading activities carried out by the ship's staff, especially in large oil tankers and bulk carriers, when not following recommended procedures on loading and unloading sequences can compromise the structural strength and stability of the ship. This may cause extra and substantial structural stresses that would result in the failure of the ship's structures (that is, breaking up of the ship into two or more parts). Alternate loading of cargo tanks to minimise shearing forces, such as, loading of odd numbered cargo tanks (1, then 3, then 5 etc) then followed by the even numbered cargo tanks (2, then 4, etc,) have been used successfully over the years. The employment of experienced and properly trained officers would go a long way in preventing unsafe activities from happening that might sink a ship during cargo operations.

In PICT waters, dangerous cargoes pose the greatest risk of causing marine pollution. Oil¹⁸ is the most likely dangerous cargo to cause significant amounts of pollution at sea

whether by accidental causes or from normal operations of a ship. This research will focus only on oil cargoes, as dangerous cargoes other than oil, are not recorded as separate items in records of Marine Departments or port authorities or Customs of PICTs. Only in very few PICTs are liquid minerals at times mentioned in their Foreign Trade Statistics, but by value only and not in revenue tonnes. In other words, the data on dangerous cargoes other than oil is negligible in PICTs or the quantities being imported are negligible as well, therefore, this research will not cover those cargoes. It is worth noting that although dangerous cargoes other than oil could not be quantified in the research, the potential to cause marine pollution is still real and ever present. For example, household goods such as bleaching liquids, disinfectants, cleaning liquids, and others such as pesticides and agricultural chemicals. Data on oil imports is properly recorded and readily available in each PICT. Suva is the only port, out of the nine PICT ports that recorded 150 467 tonnes of imported grain cargo in bulk from Australia (Maritime and Ports Authority of Fiji: 1998 Annual Report). This grain is for the flour mills in Fiji.

Oil, especially crude oil, spilled from a shipping accident is most likely to cause problems that are immediately seen by any person, such as oil-coated birds and animals from ingesting the oil that would die if not cleaned promptly. Pictures of the large oil slicks surrounding the ship are seen on TV all over the world, after the media arrived on the scene, and they make headline news for days. The oil will spread over large areas often continuing to cause damage to the ecosystem of the spillage areas for years, especially in the constraint areas of a port. Shallow reef environments, estuaries, mangrove forests, and wetlands in or adjacent to a port, are susceptible to environmental damages from an oil spill. Coral reefs, surrounding almost every island, are among the most sensitive of marine ecosystem types to oil and other forms of pollution. Thorhaug (1992), as quoted by Anderson et al (2002), gives the order of sensitivity to marine pollution as: 1, coral >2, fish >3, seagrasses > 4, mangrove forests. Effects on human populations are some potential health hazards, the loss of fisheries (food such as fish and shell fish) and tourism related incomes.

The total oil imports of the nine PICTs are estimated to be over three million tonnes for the year 1998. The amount of oil cargo imported into each port is a function of the:

- population of the PICT in which the port is located;
- per capita consumption of oil, which in itself is a function of GDP;
- number of ports in the PICT that import oil;
- ancillary activities – such as the US forces based in Guam.

Table 4.11- Summary of cargo pollution risk factor for the nine PICT ports

Ports	Cargo of Oil in tonnes imported	Percentage of oil imported via port to national Total oil imports	Threat (a)	Vulnerability (b)	Consequences (c)	Cargo Risk Factor (a) x (b) x (c)
Apra	1 750 000	100	3	1	4.0	12.0
Suva	221 057	39.7	3	1	4.6	13.8
Port Moresby	69 671	15	3	1	4.2	12.6
Honiara	69 160	85.2	3	1.3	4.4	17.2
Majuro	29 000	100	3	1.3	5.0	19.5
Pago Pago	200 000	100	3	1	4.8	14.4
Apia	39 530	100	3	1	4.2	12.6
Nukualofa	25 859	84.3	3	1	4.8	14.4
Tarawa	24 000	100	3	1.7	4.8	24.5
Total	2 428 277					141.0

Source: PICT ports data obtained by author during country visits

The United States military has a huge Navy and Airforce base in Guam and Apra is the only international port in Guam. The fuel oil for the military is all imported through Apra. Over 2 200 fishing vessels also called at Apra for fuel oil. These two activities account for most of the huge amount of oil imported into Guam, that is about eight times the amount of oil imported to Suva. In Fiji, oil is imported through three ports – Suva, Lautoka/Vuda Point and Levuka (total of 556 800 tonnes). Only 39.7 per cent of Fiji's oil import was discharged in Suva. In the case of American Samoa, the only deep-water port is Pago Pago that handled all oil imported into the country. The fish canneries and the hundreds of fishing vessels servicing the canneries absorbed most of the fuel oil imported. Papua New Guinea has 17 ports (including Port Moresby) under the control of

the Papua New Guinea Harbours Board, which is owned by the government. Only 15 per cent of the total oil (464 470 tonnes) imported into the country is discharged in Port Moresby as there are 16 other big ports in the country. In the Solomon Islands there are two major ports operated by the Solomon Islands Ports Authority – Honiara and Noro. Approximately 85.2 per cent (69 160 tonnes) of the total oil (81 200 tonnes) import was offloaded at Honiara, the rest (12 040 tonnes) at Noro. Apia is the main port of Samoa that oil imports were offloaded at and then distributed to other smaller ports by drums or in small coastal tankers when the demand warranted. In the Marshall Islands, Majuro is the main port where oil was discharged. Oil for the United States military base at Kwajalein Atoll does not come through Majuro but is imported direct to Kwajalein Island. In the 1980s and early 1990s, there was a lot more oil imported into Majuro where the Fungshin Fishing Company was based, for the bunkering of hundreds of their fishing vessels calling at the port. The fishing company has made a business decision to move out of Majuro before the turn of the century so the amount of imported oil is anticipated to decrease when this happens. Nuku’alofa is one of the three major ports in Tonga and it handles about 84.3 per cent of the total oil imports. Tarawa handled all the oil imported into Kiribati and then it was distributed mainly in containers or drums to other islands in the country by cargo vessels.

It is worth noting that the strategic importance of each of the nine PICT ports to their respective countries is illustrated in Table 4.11 in terms of the percentage of oil that goes through each port as compared to the total oil imports. If oil is spilled in any of the ports and the amount is over 700 tonnes, the following scenario is the mostly likely to occur.

Firstly, the port will be closed to shipping. From personal interviews, it is estimated that if a Tier 3 oil spill occur in each of the nine PICTs, their ports may be closed as follows: Apra and Pago Pago for over two weeks; Apia, Suva and Port Moresby for over one week; Majuro, Tarawa, Honiara, and Nuku’alofa, for less than one week. The immediate effect of this action is to the economy, for there will be no trade through the port, and it

will get worse as long as the port remains closed. Manufacturing, service and export industries will be adversely affected as raw materials could not get into the country, and exports could not get out of the country. Apra, Pago Pago, Apia, Majuro and Tarawa are the ports that will be the most affected, in descending order, for all oil imports (100 %) into their respective countries went through them. Therefore, the economies of Guam, American Samoa, Samoa, Marshall Islands and Kiribati are the most prone to be affected by the closure of shipping to any of their ports, when a significant oil spill occurs. Honiara is next (85.2 %), follows by Nuku'alofa (84.3 %), Suva (39.7 %) and Port Moresby (15%). This ranking, in other words, would make Papua New Guinea the country to be least affected by any closure of shipping to a major port, such as, Port Moresby. Secondly, the claims for compensation resulting from damage by oil attaching to structures, such as, boats, piers, wharves, fishing equipment, etc., could be substantial. Thirdly, the cost of containment or prevention of oil pollution and subsequent cleanup could be significant and this could put a significant strain on the financial resources of any PICT that it could not afford. Furthermore, the planning, physical and human resources for preventing or containing or cleaning up of an oil spill may be lacking in the PICT.

4.1.3 Management of Ships

World-wide concerns on the management of ships were raised by the public, the shipping industry, shipping industry commentators, government officials and inter-governmental organisations about the present practices in the boardrooms and on board ships. These concerns surfaced again after the report¹⁹ on the inquiry on the sinking in 1987 of the *Herald of Free Enterprise* was released by Mr. Justice Sheen. There were 188 lives lost. Members of management ashore and onboard the ship were charged and were convicted by the High Court with “unlawful killing of passengers”. Other shipping casualties soon followed, such as the 1990 fire onboard the passenger ship *Scandinavian Star* with 158 fatalities (Boisson 1999:215) which was also caused by sloppy management. Again,

senior shore and onboard ship management were charged with “causing death and risking lives of people onboard, whilst in the course of pursuing commercial gain”.

Table 4.12- Summary of Management of Ships pollution risk factor for the nine PICT ports

Ports	Fishing Vessels	Vessels Other than Fishing vessels	Threat (a)	Vulnerability (b)	Consequences (c)	Cargo Risk Factor (a) x (b) x (c)
Apra	2205	411	3 1	1 1	4.0 4.0	12.0 4.0 =16.0
Suva	391	850	3 1	1 1	4.6 4.6	13.8 4.6 =18.4
Port Moresby	132	609	3 1	1 1	4.2 4.2	12.6 4.2 =16.8
Honiara	180	298	3 1	1.3 1.3	4.4 4.4	17.2 5.7 =22.9
Majuro	385	92	3 1	1.3 1.3	5 5	19.5 6.5 =26.0
Pago Pago	144	190	3 1	1 1	4.8 4.8	14.4 4.8 =19.2
Apia	0	242	0 1	1 1	4.2 4.2	0 4.2 =4.2
Nuku'alofa	0	180	0 1	1 1	4.8 4.8	0 4.8 =4.8
Tarawa	0	42	0 1	1.7 1.7	4.8 4.8	0 8.2 =8.2
Total	3437	2914				136.5

Source: PICT ports data obtained by author during country visits

The oil tanker *Exxon Valdez* disaster in Alaska in 1989 was also caused by the “... failure of Exxon Shipping Company to provide a fit master and a rested and sufficient crew for the *Exxon Valdez*” according to the US National Transportation Safety Board (Boisson

1999:288). Although the *Exxon Valdez* spilled about 37 000 tonnes of oil in Alaskan, it was not a large spill as compared with the *ABT Sumner* (Drewry 1996:48), that sank 700 miles off Angola in 1991 with loss of 260 000 tonnes of oil, the whole incident turned into a media feeding frenzy. Had the same amount of oil been spilled in some obscure part of the world it would have been virtually ignored by the US press. These shipping accidents prompted Members of IMO to draft and agreed to the ISM Code and its subsequent adoption in 1993, in order to prevent further similar accidents at sea from happening.

The management of passengers ships is being accorded with the lowest risk, and in ascending order followed by oil tankers, tug boats, cargo vessels, and fishing vessels with the highest value possible.

The scoring of the risk factor due to management of a ship in descending order are: Majuro, Honiara, Pago Pago, Suva, Port Moresby, Apra, Tarawa, Nuku'alofa and Apia. It can be seen from Table 4.12 that fishing vessel calls have a high impact on the pollution risk factor of PICT ports.

4.1.4 Security Issues

Although this indicator is not relevant for consideration in the base year, 1998, the ISPS Code (under the SOLAS Convention) has entered into force on 1 July 2004 and now has a huge impact on the operations of ships engaged in international voyages and ports handling those ships. Ships and ports will find it extremely difficult to be involved in trading activities if they do not meet the requirements of the ISPS Code on 1 July. In the research this indicator will be accorded a “Not Applicable” or 0 score because of its entry into force later than the 1998 base year, but it is quite important to highlight it here so it could be included in the SMPI in future. Security and safety of ships (in addition to the prevention of marine pollution) are now the focus of the maritime sector world wide and will remain the case for the foreseeable future because of international terrorism. Since

9/11 in the United States, terrorist attacks all over the world are now on the increase and maritime security issues will be at the forefront of discussions at international forums. Terrorist attacks on ships and ports will have disastrous impacts on international trade and commerce.

One area of grave concern to PICTs is Distant Water Fishing Vessels (DWFV) (the usual term under Forum Fisheries Agency nomenclature for distant countries owned fishing vessels) operating in the Pacific and calling into PICTs' ports for unloading their catches, refuelling, provisioning and change of crew. The SOLAS Convention and the ISPS Code do not apply to fishing vessels. In Europe and other major maritime powers the above situation is not a problem, since fishing vessels do not call into other countries' ports but sail straight to their own fishing grounds and back to their own home ports. On every available occasion, PICTs should bring this situation to the attention of IMO and recommend that the SOLAS Convention's Security Provisions should be extended to fishing vessels to take into account the Pacific Region's concern in order that the security of Pacific ports is not compromised.

4.1.5 Anti-fouling Systems (AFS)

The International Convention on the Control of Harmful Anti-fouling Systems on Ships was discussed in Chapter 3.3.2. It will enter into force 12 months after 25 States representing 25 per cent of the world's merchant shipping tonnage have ratified it. However, IMO Member States should phase out the use of organotin biocides (TBT) paints by the 1 January 2003 when the ban on their use is imposed by the Convention. Furthermore, the removal or sealing of all TBT anti-fouling paints is required by 1 January 2008. No PICT, including US administered territories, has acceded to the Convention as at 31 December 2003. Furthermore, the Convention has not entered into force yet, since only five States have acceded to it, none of which is a PICT. The

adoption of the Convention on 5 October 2001 marked the achievement of the task set by Chapter 17 of Agenda 21 of the 1992 Rio Conference on Environment and Development, where States were called on to take measures to reduce pollution caused by organotin compounds used in anti-fouling systems.

Although the Convention was adopted later than the base year of the research (1998) it is discussed here because of its importance in preventing pollution caused by organotin based paints now and in the future. A “Not Applicable” or value of 0 is accorded to this indicator for each PICT, but it is important to include and highlight it in the research for a more complete SMPI when the Convention enters into force in the foreseeable future.

4.1.6 Summary of the Five Internal Pollution Risk Indicators

From Table 4.13, the PICT port with the highest probability of a marine pollution occurring (due to total internal pollution risk indicators) is Honiara followed by Majuro, Pago Pago, Tarawa, Suva, Port Moresby, Apra, Apia, Nuku’alofa, in descending order. The scoring of the indicators that have the potential to cause marine pollution in Table 4.13 resulted in the Management indicator (15.2 mean value) having the lowest value, followed by the Cargo indicator (mean of 15.7) and the highest is the Ship indicator (mean of 25.8).

It is important to note the impact of fishing vessels in the Ship and Management pollution risk indicators for there are large numbers of fishing vessels calling into PICTs’ ports for logistical purposes. The fuel oil they carry onboard when aggregated produced a large amount of oil that has the potential of being spilled into the sea through their normal operation or by accident such as collision or grounding. One consolation aspect of pollution from fuel oil carried by fishing vessels is that it will take a number of fishing vessel oil spills to equal a container vessel or worse, an oil tanker oil spill. This may be

only an academic consolation, as the prevention of pollution of the marine environment is the primary goal.

Table 4.13 Summary of the Five Internal Pollution Risk Indicators for PICT ports

PICT Ports	Ship Indicator	Cargo Indicator	Management Indicator	Security Issues Indicator	Anti-Foul Systems Indicator	Total Internal Pollution Risk Indicator
Apra	15.4	12.0	16.0	0	0	43.0
Suva	27.8	13.8	18.4	0	0	60.0
Port Moresby	24.3	12.6	16.8	0	0	53.7
Honiara	35.5	17.2	22.9	0	0	75.6
Majuro	26.2	19.5	26.0	0	0	71.7
Pago Pago	36.6	14.4	19.2	0	0	70.2
Apia	21.0	12.6	4.2	0	0	37.8
Nuku'alofa	18.1	14.4	4.8	0	0	37.3
Tarawa	27.6	24.5	8.2	0	0	60.3
Mean	25.8	15.7	15.2	0	0	53.3

Source: Author

In the Management indicator, it is clear that the exclusion of fishing vessels in the SOLAS and STCW Conventions poses significant problems to PICTs in terms of safety and security. There are implications that also have indirect negative impact on the prevention of marine pollution. Fishing vessels, to which many international conventions do not apply, pose a significant threat to maritime safety and security, as well as to the marine environment in most PICTs. One possible solution is to amend the SOLAS and STCW Conventions to apply to fishing vessels. Another action that could be taken by a PICT is to legislate that fishing vessels shall comply with the provisions of its Shipping Act which has already incorporated the SOLAS and STCW Conventions. Alternatively, a PICT may legislate under its Fisheries Management Act (or equivalent legislation) that a prerequisite for the issuance of a licence to fish in its EEZ is to comply with its Shipping Act. However, this approach may be in conflict with the provisions of the United Nations Law of the Sea Convention as fishing vessels are exempted under the SOLAS and STCW Conventions. The options discussed above concerning fishing vessels could easily be carried out by Sovereign States in the Pacific, but it may be difficult for

Territories as the final decision is made by the metropolitan powers (United States and France) that administer them.

4.2 External Indicators

In Chapter 1, an introduction of external factors was made that briefly discusses the pollution risk factors other than those attributed internal to a ship, its management, the cargo it carried, security issues and anti-fouling systems. 'External factors' is made up of seven external pollution risk indicators and they are: meteorological events; accuracy of navigation charts; coastal sea routes and passages; skills of port workers; port infrastructures and conditions; regulatory framework; emergency procedures and equipment. The seven external pollution risk indicators are important when a ship visits a PICT port for its safety is dependent on each one of them.

4.2.1 Meteorological Events

All of the nine PICT ports are located in the tropics of the North and South Pacific. Some PICTs are located in latitude 20 degrees or higher may experience fog once every number of years. Heavy rainfall and poor visibility are experienced in the region during tropical depressions but they do not affect the safety of ships in the same manner as do tropical revolving storms. So, the research will focus only on tropical revolving storms as the meteorological risk factor, for they tend to occur more frequently and can seriously affect ships caught in their paths.

Tropical revolving storms are low-pressure systems in the tropics that have well defined wind circulation, clockwise in the Southern Hemisphere and anti-clockwise in the Northern Hemisphere, with a centre, or eye, surrounded by gale force winds. When tropical revolving storms have sustained winds of 63 (and gusting to about 90) kilometres

per hour they are given a name, obtained from lists maintained by various meteorological organisations responsible to the area of concern (for example, for the South Pacific it is the Bureau of Meteorology, Australia).

Table 4.14 – Tropical Revolving Storms Severity Categories

Category	Strongest Gust (Km/hr)	Typical Effects (Indicative Only)
1 (TRS)	Less than 125. (gales)	Negligible house damages. Damage to crops, caravans, trees and boats may drag moorings
2 (TRS)	125 – 169 (destructive winds)	Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small boats may break moorings.
3 (severe TRS)	170 – 224 (very destructive winds)	Some roof and structural damage. Some caravans destroyed. Power failure likely.
4 (severe TRS)	225 – 279 (very destructive winds)	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures.
5 (severe TRS)	More than 280	Extremely dangerous with widespread destruction.

Source: <http://www.bom.gov.au/info/cyclone>

In the “eye” there are only light winds and usually clear skies. Eye diameters can range from 10 to 100 kilometres in diameter and they are surrounded by a dense ring of clouds about 16 kilometres high. It is also known as the eye wall that marks the belt of strongest winds and heaviest rainfall. These gale force winds can extend hundreds of kilometres from its centre. The intensity of tropical revolving storms does not necessarily correspond to their size. Their severity is described in terms of categories ranging from 1 – 5 (See Table 4.14 below) in accordance with their maximum winds, which is included in all tropical revolving storm advices or bulletins. The closer the isobars to each other towards the eye of a tropical revolving storm the more intense the wind systems are and the more severe and destructive the winds become.

From early summer to late autumn, that is November to March in the South Pacific and April to October in the North Pacific, tropical revolving storms²⁰ are formed. The sea surface temperature is highest during these seasons and warm waters are found in the

western parts of the tropical ocean. A deep, moist, unstable air is mostly found over a region of highest sea surface temperatures. Tropical revolving storms do not form unless the sea surface temperature is above 26.5 degrees Celsius (<http://www.bom.gov.au/info/cyclone>). This is one of the main factors for the development of tropical revolving storms, for most of their energy is derived from latent heat set free by condensation of water vapour in ascending currents of air. When a tropical revolving storm crosses a coast of a large land mass its intensity decreases rapidly. There is no record of a tropical revolving storm being formed or developed over a large area of land. Once a tropical revolving storm is formed, the rule of thumb is that it travels in a south westerly direction in the South Pacific then turns to a south to south east direction in latitude approximately 20 degrees south until it dissipates in the higher latitudes. In the North Pacific, once formed, it starts to travel in a north-westerly direction and then starts curving towards the north to north-east direction in approximately latitude 20 degrees north until it no longer exists in the higher latitudes. But the paths of some tropical revolving storms can be erratic and they can persist for many days until they dissipate over land or colder seas. A tropical revolving storm causes most damages when it crosses a PICT's land areas and small islands.

The intensity of tropical revolving storms does not necessarily correspond to their size. All nine ports of PICTs are susceptible to tropical revolving storm damage. Sometimes weather forecasts are not accurate in predicting the strength and direction of movement of a tropical revolving storm. Some ships, such as fishing and cargo vessels, are often caught not fully prepared to move to a safe and sheltered anchorage area or steam out to sea in a timely manner. For example, in 1982, tropical revolving storm *Isaac* was reported to be forming between the Vava'u Group and American Samoa and was not regarded as a strong one. About 24 hours later, and having travelled southwards for over 200 miles, it wreaked havoc in Tongatapu with destructive winds and seas. A couple of ships ended up in the reefs inside the harbour area and some lives were lost during the passage of *Issac* in Tonga.

Tropical revolving storms have a lowest wind speed of 63 km/hr gusting to over 170 km/hr are now known to occur during a strong El Niño. Recent scientific research has confirmed the El Niño²¹ and La Niña²² phenomena and their effects on the global weather, which are yet to be fully understood by scientists.

The probability of a cyclone striking a PICT port is used for threat calculations. Actual cyclones that struck PICTs from 1995 to 2004 were obtained from various websites. This 10 year data showed the PICTs with the number of cyclones that struck them, which are as follows: Pago Pago, 13; Apia, 13; Apra, 7; Honiara, 10; Nuku'alofa, 19; and Suva, 24. The cyclone data above are then normalised by dividing each figure by 24 and then multiplied by 3 and entered in the vulnerability column as shown in Table 4.15. Some PICTs may have experienced one category 5, others also one each of category 3 tropical revolving storms in the same time frame. Furthermore, tropical revolving storms may have developed in areas not yet known to have one before. In recent years the effects of El Niño and La Niña have been known to produce unpredictable weather patterns within and beyond the region (Murphree et al 2000). The vulnerability and consequences components are the same as to that discussed in Chapter 1.4.1.

Normally a port is closed to shipping once a tropical revolving storm warning is issued in a country. Damage to ships could be caused by inaccurate weather information or a bulletin that did not predict correctly the forecast movement of a tropical revolving storm. In either case, it may not leave sufficient time to permit a ship to leave the port and steam out to open seas. Or, the forecasted wind force was also inaccurate and was, in fact, greater or less, than that predicted. In this case, it would also produce undesirable judgments by the ships' staff in an affected port, such as still tying up to wharves and not steaming out to sea. By leaving port as soon as possible, the ship has the option of sailing away from the forecasted path of the tropical revolving storm, or heaves to and take shelter in the leeward side of a high island. Phenomenal seas²³ and storm surges²⁴ can capsize ships and are potentially the most dangerous phenomenon to ships out at sea. Alternatively, very strong winds, but not phenomenal seas, can cause ships moored in harbours to drag their anchors ending up grounded on reefs. Tropical revolving storms

are dangerous because they produce destructive winds, heavy rainfalls, flooding and dangerous storm surges that can cause inundation of low-lying coastal areas and also cause shipping casualties that would result in pollution of the marine environment.

Table 4.15 – Cyclone impact pollution risk indicator for PICT ports

Port	TRS Wind speed in Km/hr	Threat (Frequency over 10 yrs)	Vulnerability	Consequences	Cyclone impact risk indicator
Pago Pago	300	1.63	1	4.8	7.8
Apia	300	1.63	1	4.2	6.8
Apra	300	0.88	1	4.0	3.5
Honiara	300	1.25	1.3	4.4	7.2
Nuku'alofa	250	2.38	1	4.8	11.4
Suva	185	3.0	1	4.6	13.8
Majuro	-	-	-	-	-
Tarawa	-	-	-	-	-
Port Moresby	-	-	-	-	-
Total					50.5

Source: PICT ports data obtained by author during country visits and data for the threat column for: Pago Pago, Apia, Honiara, Nuku'alofa and Suva were obtained from <http://www.niwasceience.co.nz/pubs/mr/archive/2000-11-27-1>; Guam was from http://www.fema.gov/news/disasters_state.fema?id=66. Furthermore, the entries show the actual tropical cyclones that struck these ports for the years 1995-2004.

Suva has the highest risk to cause marine pollution followed in descending order by Nuku'alofa, Pago Pago, Honiara, Apia then Apra. As tropical revolving storms tend not to form between the equator and latitudes 6 degrees north or south, Tarawa, Majuro and Port Moresby do not normally experience them due to their geographical positions close to the equator. *Cyclone Val* with winds gusting to 300 kilometres per hour lashed both Pago Pago and Apia for about four days in December of 1991. It caused over US\$300 million of damage to both American Samoa and Samoa. *Cyclone Ofa*, of lesser severity, also struck the two islands about 18 months earlier causing about US\$200 million in damages. On 30 – 31 December 2001, *Cyclone Waka* tore through Tonga with winds gusting to 250 kilometres per hour and sinking yachts, destroying many homes, but causing no loss of life. *Super Typhoon Pongsona* pounded Guam on 8 December 2002 with wind gusts of more than 300 kilometres per hour and destroying houses and power lines and causing four deaths. Torrential rain flooded many villages and roads. On 28

December 2002, *Cyclone Zoe* devastated Tikopia of the Solomon Islands with winds above 300 kilometres per hour but there were no lives lost. The eastern islands of Fiji were lashed by *Cyclone Ami* on 14 January 2003, with winds of up to 185 kilometres per hour, which destroyed homes and torrential rain caused flooding. Two people were missing and feared dead. *Cyclone Ami* also passed close to Tonga a couple of days later, but with reduced intensity.

Six of the nine PICTs have been devastated by severe tropical revolving storms and the other three PICTs did not experience any. If any port of the six affected PICTs was not close to a cyclone's centre this year, it could well be devastated in the following months or years, as no one can predict yet where they will form or where they will strike. Sometimes, a cyclone can pass through two neighbouring PICTs causing devastations to both, such as *Val* and *Ami*. As each of the six PICTs has small land areas, their ports have always been affected by any cyclone or typhoon passing through them. So far, in recent years, no international trading vessel has been lost due to tropical revolving storms in any port of the PICTs. This is mainly due to improved and frequent weather forecasting produced from weather satellites, aircraft and other modern technologies that gave timely warnings allowing vessels to leave port and ride out the cyclone at sea, or escape its path. There is also a big global effort on climate research to understand and predict more accurately phenomena in the Pacific that cause tropical revolving storms and also have a big impact on weather patterns in other parts of the world.

4.2.2 Accuracy of Navigation Charts

Many navigation charts used today still contain the original hydrographic ²⁵ surveys made in the 19th Century. Most navigable waters of major port approaches and frequently used harbour charts have been resurveyed and new editions have been published. The original surveys made in the 19th Century were carried out using hand held lead lines for sounding of water depths. Celestial bodies were used to fix positions, or alternatively, three or more distinctive points on land or islands were used to fix the position of the ship where the soundings were taken. Measurement tapes and sextants

were used for fixing positions of soundings by triangulation²⁶. Spacing of a line of soundings are determined by the survey quality required. For example, in harbour charts the spacing of the line of soundings is three times the average depth or 25 metres, whichever is greater, as compared to four times the average depths if the water depths exceed 200 metres as in open waters. It is a very demanding and difficult task. It could take months or years to complete a survey of a harbour such as Suva. The commitment and great care for accuracy shown by the early explorers and hydrographic surveyors (e.g. Englishmen James Cook and Mathew Flinders) are legendary. After the surveys have been carried out it may take another two years or longer to prepare the charts for publication. New survey and navigation information received from ships and other sources, after being validated by hydrographic authorities of countries receiving those information, are disseminated to mariners and other users by means of Notices to Mariners, usually issued every week.

Hydrography plays an important role in ship safety and this is reflected in the adoption by IMO of the revised Chapter V of the SOLAS Convention that entered into force in July 2002. The new Chapter V of SOLAS requires Contracting Governments to maintain Hydrographic Services necessary to provide adequate hydrographic survey coverage and the production of nautical charts and publications. New editions of charts - even those that were published even a decade ago - have been produced, incorporating new survey data of greater accuracy and improved coverage. This provides more accurate hydrographic information for the following needs:

- the building and use of very deep draught ships such as Very Large Crude Carriers (VLCCs). This is important to both developing nations (where sparse surveys were done) as well as coastal waters and ports of developed nations because of deep draught ships in operation today;
- the increasing importance of protecting the marine environment from oil pollution in the event that a very deep draught ship runs aground and holed;

- changing maritime trade patterns resulting in new sea routes being used, necessitating the conduct of new hydrographic surveys and the subsequent publishing of new nautical charts;
- the advent of accurate satellite navigation has created problems to navigators, as many of today's nautical charts still incorporate the original surveys of the 19th Century. Modern satellite positioning systems have revealed that the position of islands in the original surveys can be out of position for up to three miles or more;
- the growing importance of seabed resources, such as manganese and cobalt nodules that could be mined through new technologies and techniques; and
- the determining of national jurisdictions under the United Nations Law of the Sea Convention.

Discussion of the following four important issues would assist in understanding hydrographic surveying and the production of nautical charts.

4.2.2.1 Classification of Hydrographic Surveys

There are four orders of hydrographic surveying standards (IHO Special Publication No 44), each depending on the accuracy requirement of a survey and are discussed below.

- **Special Order**

These are hydrographic surveys approaching engineering standards and the areas to be surveyed should be clearly defined by the agency responsible for survey quality. Their use is intended to be restricted to specific critical areas with minimum under-keel clearance and where bottom characteristics are potentially hazardous to vessels. Examples are harbours, berthing areas, and associated critical channels. This method uses a closely-spaced line of soundings in conjunction with side scan sonar, multi-transducer arrays or high resolution multi-beam echo sounders to obtain a 100 per cent

bottom search to ensure that all error sources are minimised. The sounding equipment must clearly identify cubic features greater than 1 metre. Side scan sonar may be used in conjunction with a multi-beam echo sounder in areas where thin and dangerous obstacles may be encountered.

- Order 1

The depth of water for this type of hydrographic survey is restricted to less than 100 metres. These surveys are intended for harbours, approach channels to harbours, recommended tracks, inland waters navigation channels, and coastal areas of high commercial traffic density where under-keel clearance is less critical than a special order survey. Furthermore, the nature of the sea-bed has to be determined, since soft silt and sandy bottoms, are less hazardous to vessels than coral or rocky sea-beds. A full bottom search is still required for areas where the risks of obstructions are potentially hazardous to vessels.

- Order 2

These hydrographic surveys are for areas with water depths of less than 200 metres and not covered by Special Order or Order 1 surveys. They are intended to show a general description of the bathymetry to ensure that there are no obstructions on the sea-bed that will endanger any vessel expected to transit or work like fishing in the area. A full bottom search is still required as in Order 1.

- Order 3

They are hydrographic surveys in water depths in excess of 200 metres and also are not covered by Special Order, Order 1 and Order 2 surveys. There is no full bottom survey required.

Surveys on nautical charts of ports covered by this research are of Order 1 ones and coastal charts are a mixture of Orders 2 and 3 depending on the water depth of the area surveyed. There is no information on a chart that would indicate which type of survey

was used. The surveying authority has to be consulted to advise the survey type that was carried out in a chart.

4.2.2.2 Positioning

Positions are determined within a geodetic reference frame and errors may occur and should be taken into account when the positions are recorded. Usually a statistical error method (position error), at 95% confidence level, is recorded with the survey data to determine position accuracy. The World Geodetic System 84 (WGS 84) is the geodetic reference system that has been adopted internationally and used by surveying authorities since 1984. Before WGS 84 there were various geodetic reference systems in use in different countries for their own hydrographic surveys. The various geodetic reference systems caused difficulties when a country with a different system wanted to use other countries' hydrographic surveys and these difficulties were addressed by the adoption of WGS 84 world wide. When positions are determined by celestial systems, standard calibration techniques are applied to the survey data. Satellite systems should be capable of tracking at least five satellites simultaneously for surveys of Order 1 or Special Surveys (International Hydrographic Organisation (IHO) Special Publication No.44, 1998:7).

For horizontal control purposes primary shore control points should be located by ground methods to a relative accuracy of 1 part in 100 000. If geodetic satellite positioning methods are used to determine such points, the error should not exceed 10 centimetres at 95% confidence level. The position of soundings and other submerged features should be at the following horizontal accuracy: 2 metres for Special Order; 5 metres + 5% of depth for Order 1; 20 metres + 5% of depth; and 150 metres for Order 3 surveys (International Hydrographic Organisation (IHO) Special Publication No.44, 1998:5). For positions of navigation aids and important features the accuracy stated in Table 4.16 is used.

Table 4.16 Type of Surveys

	Special Order surveys	Order 1 surveys	Order 2 and 3 surveys
Fixed aids to navigation and features significant to navigation	2 metres	2 metres	5 metres
Natural coastline	10 metres	20 metres	20 metres
Mean position of floating aids to navigation	10 metres	10 metres	20 metres
Topographical features	10 metres	20 metres	20 metres

Source: IHO Special Publication No.44

4.2.2.3 Depths

In a nautical chart, the depth of water shown there is the depth of the water column from the chart or survey datum to the surface of the sea bed/floor (see Figure 1 below). The measured depth is arrived at after the application of the tidal or water level height but should not be applied to depths of greater than 200 metres except if there is a special need for it. There are errors that must also be taken into account, so that depths appearing on nautical charts are as accurate and reliable as they could possibly be. This is very important in critical areas (such as navigable passages frequently used by ships and also alongside wharves) where the under-keel clearance is critical for ships to carry maximum cargo and still safely navigate in that area. These errors are due to the following factors:

- measurement system and sound velocity errors;
- tidal measurement and modelling errors;
- data processing errors.

Usually these errors are calculated and combined to obtain a Total Propagated Error (TPE) that should be applied and included in any depth shown in a nautical chart.

Hydrographic surveying basically determines the general seabed topography, tidal reduction, detection, classification and measurement of seabed hazards such as rocks and wrecks. The density or line spacing of soundings are determined by the users of a nautical chart and the surveying authority. Standards for sounding densities are

determined by the surveying authority. However, it should be noted that no hydrographic method is able to guarantee the reliability of a survey or disprove the existence of hazards to navigation, such as wrecks, that are between survey lines, with absolute certainty. Furthermore, where there is a wreck or obstruction with less water than 40 metres over it, a determination of the water depths should be made by high definition sonar or physical examination (diving). In some cases, mechanical sweeping may be used to guarantee a minimum safe clearance depth.

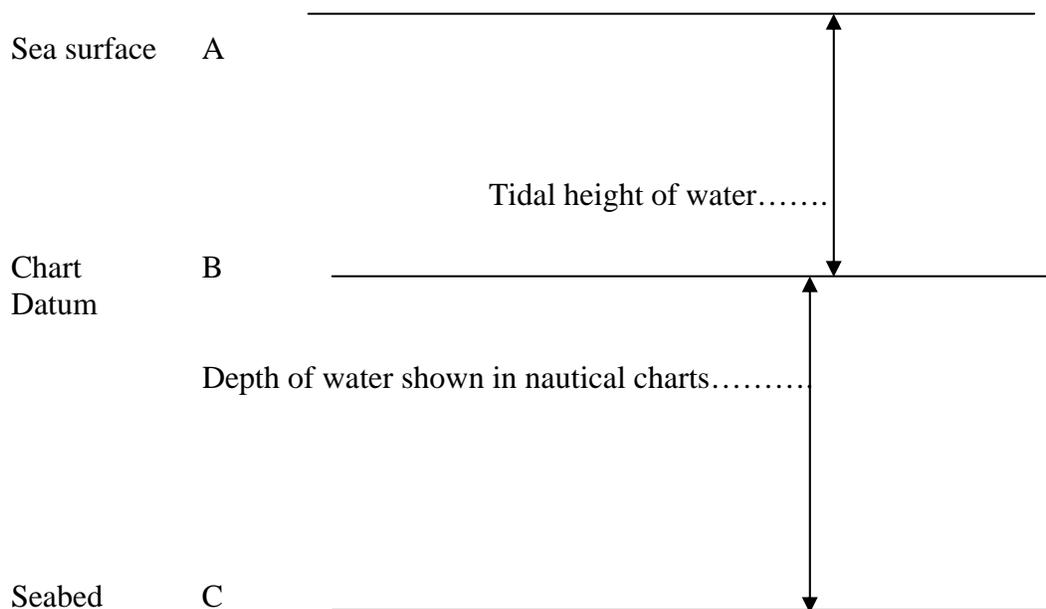


Figure 1.

Source: Author

Total or measured depth of water at any point in time in any area = $AB + BC$

Chart datum is usually the lowest astronomical tide (L.A.T) or sometimes the Lowest Low Water Spring (LLWS) tide. The concept is that it is supposed to be the lowest low water possible calculated at a place but an unusual meteorological event may cause lower than the predicted depth using the chart datum. An example is when tropical cyclone winds flow offshore in a coastal area, which pushes the sea away from land causing less water depth in that coastal area.

The British Admiralty Sailing Directions publication (Admiralty Sailing Directions 1984, 1988) contain details of chart datum and related information on any area in the world and must be consulted by mariners planning to navigate in a particular area. Other maritime powers such as the United States, France, Japan, Germany, Russia, issue similar information to that of the British Admiralty.

4.2.2.4 Data Attribution

As hydrographic surveys are critical for the safety of ships navigating in a certain location as well as for ensuring that cargoes loaded onboard those ships are maximised in the place of loading, it is necessary and important for surveyors/hydrographers to record certain information such as quality together with the survey data. By recording such information it would help other users (such as surveyors) that would like to check out the survey data for other uses. The process of documenting the data quality is called data attribution. The information on the data quality is called metadata that includes overall quality, data set title, source, positional accuracy and copyright.

4.2.2.5 Nautical Charts in the nine Pacific Island countries

Nautical charts are designed to be adequate for ocean and coastal navigation and for the entry to more important harbours. Charts for ocean navigation use small scale such as the natural scale 1:10 000 000²⁷ and 1:3 500 000²⁸ of the international series (abbreviated as INT). Much of the information from which these charts are made have been taken from lines of soundings taken by vessels on passage. Only few ocean charts have been surveyed systematically but they should all be used with caution in areas where there are charted banks, isolated dangers and vigias²⁹. For coastal navigation, a medium scale is used, such as 1:150 000³⁰ and 1:351 000³¹. For harbour charts, larger scales are used, such as 1:7 470³² and 1: 15 000³³. Many of these two types of charts have been published using information from modern surveys. It should be noted that no method of

hydrographic surveying guarantees by itself the reliability of a survey. Furthermore, a survey is acceptable when it has a 95 per cent probability or better that there is no hazard yet identified and included in the chart, as hazards may still exist between survey lines.

Coastal charts of the Solomon Islands are often based on surveys dating from the 19th Century but some are compiled from very good modern surveys such as BA 1750- Anchorages in Guadalcanal Island, a new edition that was published in June 1995. Papua New Guinea charts are based largely on old surveys but some are from very good modern surveys too such as the Australian (AUS) chart 621- Approaches to Port Moresby, that was published in March 1996. In Guam, United States Government charts based largely on Japanese surveys from the 1920s although some charts are from very modern surveys such as BA 1109- Guam and Apra Harbour, published in September 1993 by the British Admiralty. The Fiji, Kiribati, Samoa and Tonga charts are often based on old surveys with some dating from the 19th Century but there are exceptions. Very good modern surveyed charts are as follows: Fiji is BA 1673- Western Approaches to Suva Harbour, new edition in April 1985; Kiribati has BA 3269-Plans in the Gilbert Islands, new edition in November 1964; Samoa with NZ 8655-Apia Harbour, published in October 1993; Tonga is NZ 8275 – Nuku’alofa Harbour, published in July 1997. In the case of Marshall Islands, the charts are based on United States government surveys undertaken during World War II although with some exceptions such as BA 984-Islands and Anchorages in the Marshall Islands, a new edition in June 1987. American Samoa charts are based on old surveys from various sources and also of the United States Government modern surveys such as in BA 1729-Islands in American Samoa, published in April 1990.

In the assessment of risks related to the use of navigation charts the latest edition of the chart will be used. All nine PICT port charts have been surveyed to Order 3 . The appropriate navigation charts have been discussed in the previous paragraph.

- Threat will be discussed in three levels, which are as follows: Level 3 is when a navigation chart was surveyed and/or published before 1984 (the adoption of WGS 84 world wide).

- Level 2 covers when a navigation chart was surveyed and/or published between 1984 and 1998.
- Level 1 corresponds to a navigation chart that was surveyed and/or published after 1998. In April 1998, IHO published the Special Publication No.44 that specifies minimum standards for hydrographic surveys. The new standards does not invalidate charts and nautical publications based on previous standards, but sets the standards for future data collection to better respond to user (primarily mariners) needs. Furthermore, the new standards were designed to contribute to the production of more accurate navigation charts and any uncertainty of hydrographic data is adequately quantified so that any user of the charts knows of such information.

Table 4.17 – Navigation charts pollution risk indicator for PICT ports

Port	Navigation Chart date of latest edition	Survey Order	Threat	Vulnerability	Consequences	Navigation chart risk indicators
Pago Pago	1990	3	2	1	4.8	9.6
Apia	1993	3	2	1	4.2	8.4
Apra	1993	3	2	1	4.0	8.0
Honiara	1995	3	2	1.3	4.4	11.4
Nuku'alofa	1997	3	2	1	4.8	9.6
Suva	1985	3	2	1	4.6	9.2
Majuro	1987	3	2	1.3	5.0	13.0
Tarawa	1964	3	3	1.7	4.8	24.5
Port Moresby	1996	3	2	1	4.2	8.4
Total						102.1

Source : Author

The accuracy of a nautical chart depends mainly on what type of survey standard used – special order or order 1 or order 2 or order 3 as shown in Table 4.17.

Tarawa shows the largest risk indicator due to its port navigation chart BA 3269 being published in 1964, followed in descending order with their respective dates of publication: Majuro - BA 984 in 1987; Honiara BA - 1750 in 1995; Pago Pago - BA 1729 in 1990 and Nukualofa - NZ 8275 in 1997: and Suva - BA 1673 in 1985; Apia - NZ 8655 in 1993 and Port Moresby - Aus 521 in 1996; and Apra - BA 1109 in 1993.

4.2.3 Coastal Sea Routes and Port Passages

There are three Minimum Safe Design (MSD) methodologies that will be discussed with one chosen that is the most appropriate for this research: The European Radar Ocean Sensing (EuroROSE) that used a radar-based ocean monitoring system in support of safe navigation in port approaches and high shipping traffic density sea areas in Europe. Radar measured data were assimilated into a fine gridded numerical model with the aim of predicting currents and waves for a few hours. This system could be used by Vessel Traffic Service operators, harbour and coastal managers, to monitor and predict significant meteorological and ocean conditions with high time/spatial resolution in limited areas surrounding high density shipping traffic. Skills of the crew, manoeuvrability of the ship, and quality of navigation aids are not considered. Therefore, this system was dropped by this researcher.

The Canadian Coastguard's Marine Navigation Safety Systems (MNSS) and the U.S. Coastguard's Waterway Analysis and Management System (WAMS) are conceptually very similar (although some minor differences between them) and discussed below are basically how they both operate. This poses a problem in choosing the most appropriate system to be used in this research. The Institute of Risk Research (as quoted in Reid et al) made a comparison of MNSS and WAMS and concluded that MNSS has more variables and a wider range of possible input values for many of the variables. This researcher chose the MNSS methodology as the most appropriate for this research.

Basically MNSS is a Geographic Information System (GIS) for storage of geographic data and to provide a marine risk analysis interface to manage risk estimation for a particular waterway route segment. The GIS is combined with external pre- and post-processors used to modify predicted casualty rates and consequence magnitudes (Reid et al) respectively.

All nine ports of PICTs considered in this research have navigable passages leading to berths inside each port. The fringing reefs surrounding these islands are typical characteristics of oceanic³⁴ islands. In order for a ship to come alongside a berth, it has to pass through these passages. Many are narrow and pose a hazard³⁵ to navigation. Other factors such as: wind direction and strength; the strength and direction of currents; the range and direction of tidal movements; can all pose risks while ships are being navigated through narrow passages. No calculation was made to allow for the effect of each of these factors, but the application of the MSD³⁶ developed for the Canadian Coastguard to assist ships manage the risk (pre-possessors) on approaches to waters of ports or recommended tracks, as discussed above, will be used (see Appendix 3) which took into account the above-noted factors. This would involve designing and assessing worst-case scenarios for safe navigation of ships through these waters or sea areas.

In determining the MSD, risk factors such as physical constraints, current, wind, weather, tides, skills of the crew in ship handling and in fixing positions, the manoeuvrability of the ship, and quality of navigation aids are evaluated. When a ship is underway it needs room to manoeuvre, as the sea is a liquid and natural effects such as wind and sea can affect its motion in the water. Physical constraints include passage width at its narrowest points; dimensions and operational particulars of a ship such as speed, wind effect area, and draft. The direction and strength of current, wind, tide and the prevailing weather conditions are also important risk factors for safe navigation while a ship transits a passage. It is important that the quantum and effect of these risk factors be known, so that measures to counteract their effects can be taken into account, so that the ship is kept in the centre of the passage.

The concept of calculating MSD is similar to that of allowing a safe distance between a ship at anchor and the nearest hazard to navigation. In laying the course line through a narrow passage, the safe distances from hazards are taken into account, after allowing for effects of wind, sea and tidal conditions expected at the time. The collective skill of the crew in steering the ship and keeping it to the required track by accurate position fixing is critical for the ship to successfully transit a passage. When a ship is about to make an alteration of its course, its manoeuvrability is the key for successfully executing a turn,

especially when the wind, sea and tidal factors are strong. MSD, in effect, measures the residual hazards in a seaway and also reduces the potential harm to the ship by the risk management measures taken before it enters into or during its passage or sailing in restricted waters.

Identification of marine navigation hazards is not easy in PICTs due to the following reasons:

- It is difficult to construct models that deal with hazards that may change within a short period of time from the predicted data in a port. The hazards include strength and direction of wind, currents and passage widths (which are not parallel straight lines);
- The difficulty in ascertaining risk control options that are reliable, such as aids to navigation or GPS, that was established to reduce the effect of the navigation hazard;
- Commercial considerations to protect a company's technology makes it difficult for the analysis methodology to be transparent thus preventing the critical review of the methodology. A company's competitive advantage is ensured if it has no competition or very few competitors in the technology area where it is the market leader. Therefore, it makes commercial sense for a company to protect its technology from potential competitors.

Appendix 3 shows two chartlets of each of the nine PICT ports that would give mental pictures and orientation of the physical characteristics of passages of those ports. Furthermore, the safety measure of each PICT port (the particulars/characteristics used in the calculation) is as follows: Suva 3.9, Pago Pago 3.2, Apra 2.3, Majuro 2, Port Moresby 1.8, Nuku'alofa 1.8, Apia 1.7, Honiara 1.4, and Tarawa 1.3 (Anderson et al 2002:116,117). These ratios (representing the safety measure for each port) is over 1 and this means that the existing channel width at these ports is more than that required for the conditions and vessel size that called into these ports.

It is very useful to compare the hazards in one port with that of another port that could be calculated by finding out the Safety Measure of each port. The higher the value of the Safety Measure of a port, the better and more safe it is.

$$\text{Safety Measure} = \frac{\text{Channel width}}{\text{MSD}}$$

The following diagram (Figure 2) illustrates the principle of MSD.

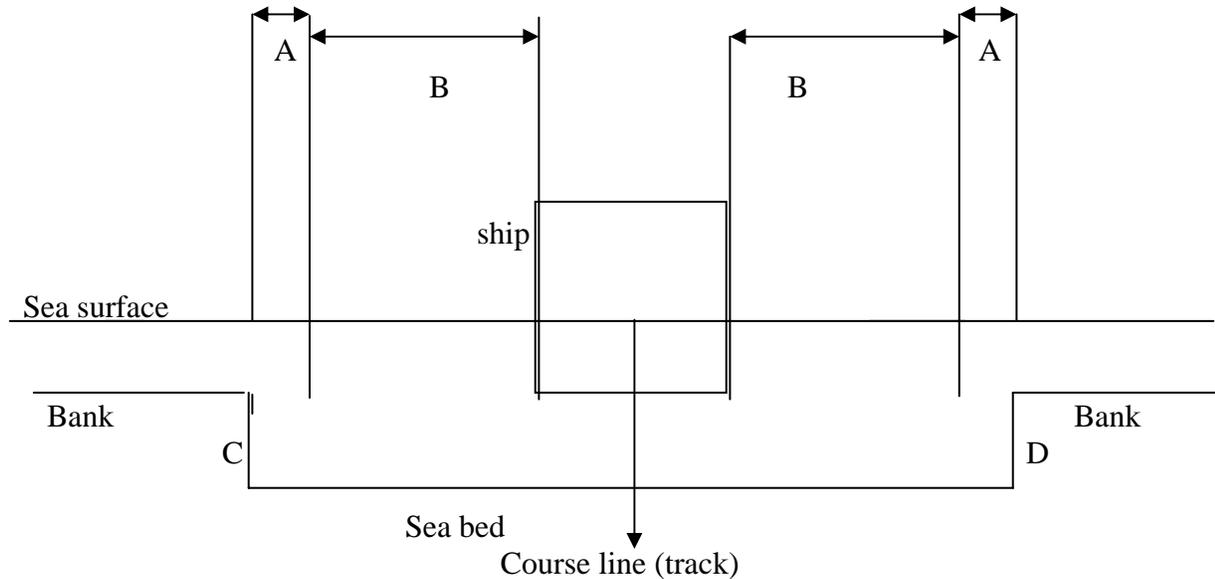


Figure 2

Note: A is the bank clearance in the passage or channel.

B is the beam of the ship, drift, ship handling and position width.

$\text{MSD} = A+B$ (for a single ship transiting a passage) i.e. width required for safe navigation.

CD along the sea-bed represents the passage width.

The ship is represented by the rectangle in the middle where the course line is drawn from as shown in the drawing above.

Source: Marine Pollution Assessment for the Pacific Islands Region

In assessing the threat component of risk, the scoring 1-3 will be used but the Safety Measure values are normalised by multiplying by 3 and divided by 3.9 (as in Table 4.18)

The vulnerability and consequences components are the same as to that discussed in Chapter 1.4.1.

Table 4.18 – Coastal Sea Routes and Port Passages Pollution Risk Indicator for PICT ports

Port	Values of Safety Measure	Threat	Vulnerability	Consequences	Coastal Sea Routes and Port Passages risk indicator
Suva	3.9	3.0	1	4.6	13.8
Pago Pago	3.2	2.46	1	4.8	11.8
Apra	2.3	1.77	1	4.0	7.1
Majuro	2	1.54	1.3	5.0	10.0
Port Moresby	1.8	1.38	1	4.2	5.8
Nuku'alofa	1.8	1.38	1	4.8	6.6
Apia	1.7	1.31	1	4.2	5.5
Honiara	1.4	1.08	1.3	4.4	6.2
Tarawa	1.3	1.0	1.7	4.8	8.2
Total					75.0

Source: PICT ports data obtained by author during country visits

Table 4.18 shows that the PICT ports with the least risk posed by this indicator lie in the following ascending order: Apia, Port Moresby, Honiara Nuku'alofa, Apra, Tarawa, Majuro, Pago Pago, and Suva.

Plan charts of each port of the nine PICTs are to be found in Appendix 3 that would assist a reader in visualising the physical characteristics of a particular port. The MSD of each port would be better understood.

4.2.4 Skills of Port Workers

This section deals with the skills of port workers of each of the nine PICTs ports in two main areas: seaward side; and shore-side of a berth.

(a) Seaward side

It covers pilots, pilot boat crew, tugboat crew, mooring launches and mooring gangs. All nine PICT ports in this research are operated commercially by port authorities established through legislation by their respective governments. This may be in the form of a port company under the Companies Act or a stand-alone legislation that sets out the objectives

of the authority, its powers and how it is to be managed. PICT governments are the owners of port authorities and governments appoint the Board of Directors to manage the ports on their behalf. Qualifications for seaward side personnel such as pilots and pilot boat crew are issued by the maritime administration of a PICT after attending courses in an approved training institution³⁷. Port officials in all nine PICT ports have informed this researcher during his country visits that the recruiting of new qualified pilots is increasingly becoming a problem and would become acute in five to ten years time.

(b) Shore side

This dimension includes stevedores, crane drivers, forklift drivers, wharf safety officers, cargo storage officers and Port State Control inspectors. Experience and qualification of shore side workers vary from PICT to PICT depending on the type of ship calling in to PICT port and the cargo that is to be loaded or unloaded in the port. A port such as Suva handles grain that requires a different set of skills than that for containers that are handled in all nine ports. All nine ports handled fuel oil and liquid petroleum gas in varying quantities, the port of Apra the biggest and Tarawa the smallest amount.

Table 4.19 – Skills of Port Workers Pollution Risk Indicator for PICT ports

Port	Threat	Vulnerability	Consequences	Skills of Port Workers pollution risk indicator
Suva	1	1	4.6	4.6
Pago Pago	1	1	4.8	4.8
Apra	1	1	4.0	4.0
Majuro	1	1.3	5.0	6.5
Port Moresby	1	1	4.2	4.2
Nuku'alofa	1	1	4.8	4.8
Apia	1	1	4.2	4.2
Honiara	1	1.3	4.4	5.7
Tarawa	1	1.7	4.8	8.2
Total				47.0

Source: Author

This researcher, on visiting the nine PICT ports, could not confirm or disprove the statements by senior managers of each of the port authorities that there were no stoppages recorded for accidents in each port for the base year 1998. Therefore, the assumption reached by this researcher is that seaward and shore side workers in each PICT port have

adequate qualifications and experiences for pilotage and cargo operations to be carried out safely. One area of concern raised in each PICT port is the future recruitment of qualified and experienced pilots after the current incumbents retire within the next 10 years, due mainly to the seafarer's higher salaries at sea.

The threat component of risk is regarded as low for there have not been any accidents reported in the nine PICTs and also that ships have been safely loaded and unloaded in their ports. Vulnerability and consequences are the same as discussed in Chapter 1.4.1.

4.2.5 Port Infrastructure and Conditions

Port infrastructure covers all navigation aids and wharves or berths or docks in the nine PICT ports. The conditions of wharves and navigation aids inside the ports are still satisfactory in 1998, but this researcher was told by senior port officials responsible for maintenance, that funds for proper maintenance of port assets (navigation aids and wharves) are not sufficient. Funds for maintenance either decrease every year or remain the same but the amount of maintenance increases every year. Therefore, port assets will be run down to an unsatisfactory state if proper maintenance is not carried out, and the risk of ships being involved in grounding or other accidents will increase substantially.

Some of the PICT ports have wharves upgraded in the 1990s to be able to handle container cargo operations without restrictions. The Asian Development Bank has funded the upgrading of the main wharves in Suva and Nuku'alofa. The main wharves in Apia and Tarawa have been upgraded with funds provided by the Government of Japan's Grant Aid. The main wharves in Apra, Majuro and Pago Pago have been upgraded with the assistance of the United States. The nine PICT ports' navigation aids have also been upgraded by various donor countries and fitted with solar panels and daylight switches. This arrangement is quite important for recharging of the special batteries (during daytime) that power the lights and increases the reliability of the lights burning during the night.

The risk that this indicator would cause marine pollution is low as all wharves used for international trading and navigation aids in the nine PICT ports have recently been upgraded. Vulnerability and consequences are the same as discussed under Chapter 1.4.1

Table 4.20 – Port Infrastructures and Conditions Pollution Risk Indicator for PICT ports

Port	Threat	Vulnerability	Consequences	Port infrastructures and Conditions pollution risk indicator
Suva	1	1	4.6	4.6
Pago Pago	1	1	4.8	4.8
Apra	1	1	4.0	4.0
Majuro	1	1.3	5.0	6.5
Port Moresby	1	1	4.2	4.2
Nuku'alofa	1	1	4.8	4.8
Apia	1	1	4.2	4.2
Honiara	1	1.3	4.4	5.7
Tarawa	1	1.7	4.8	8.2
				47.0

Source: Author

4.2.6 Regulatory Framework

In assessing the risks involved with this indicator, discussions will be carried out on two things - the adoption of international conventions on safety and marine pollution prevention, and whether the conventions have been incorporated into national law. Table 4.21 lists the PICTs that have acceded to or Party to the conventions at the end of 1998.

The fact that a PICT acceded to an international maritime convention does not necessarily mean that the provisions of these conventions are being properly enforced. Furthermore, United States and French territories will not accede to an international maritime convention in their own right. However, a PICT should have very good reasons why it has not acceded to the conventions stated in Table 4.21 for they are basic conventions dealing with safety, security and the prevention of marine pollution in a global dimension.

Table 4.21 – International Conventions acceded to by the Nine PICTs as at end of 1998

PICTs	SOLAS 74	LL 66	COLREG 72	STCW 78	MARPOL 73/78	OPRC 90
Fiji	x	x	x	x		
Guam *	x	x	x	x	x	x
Kiribati				x		
Marshall Is	x	x	x	x	x	x
PNG	x	x	x	x	x	
Samoa	x	x	x	x		
Solomon Is			x	x		
Tonga	x	x	x	x	x	x
Am. Samoa	x	x	x	x	x	x

Source: IMO

Notes:

* Convention entries for United States as Guam and American Samoa are both US administered territories.

• Convention abbreviations:

SOLAS 74 - Safety of Life at Sea 1974

LL 66 – Load Line 1966

COLREG 72 – Prevention of Collisions at Sea 1972

STCW 78 – Standards for Training, Certification and Watchkeeping for Seafarers 1978

MARPOL 73/78 – Prevention of Pollution from Ships 1973, and the 1978 Protocol

OPRC 90 – Oil Pollution Preparedness, Response and Co-operation

A PICT does not have to accede to a convention in order to fully comply with the convention's provisions. One option for a PICT to comply with the provisions of a convention is to incorporate the convention into its own national legislation, and once that has been done, it is only a small step to accede to the convention. Furthermore, a PICT does not have to be a member of IMO in order to accede to IMO Conventions, but again, membership entitles a PICT to input when a convention is being drafted or amended.

All nine PICTs acceded and ratified STCW 1978, as amended. The United States has acceded to all the conventions on behalf of some of its territories, including Guam and American Samoa. Marshall Islands and Tonga have also acceded to the same number of

conventions. Papua New Guinea has acceded to five conventions, Fiji and Samoa four each; Solomon Islands two; and Kiribati one, but the PICTs have not ratified them. Another important issue is the degree of enforcement by PICTs of conventions that they have acceded to and ratified. Guam and American Samoa are the only PICTs that have adequate financial and human resources to enforce the provisions of the conventions. The United States also provides financial assistance and human resources training on enforcement and compliance measures concerning conventions so that the two PICTs have the same standards as in the mainland United States. In the case of the Marshall Islands, enforcement of the conventions on its open register is dependent on contracted surveyors appointed by the United States company that operates the registry but not the Marshall Islands maritime administration. Therefore, the enforcement of Marshall Islands' laws and international conventions onboard ships on its open register is suspect. On the Marshall Islands domestic fleet, enforcement of conventions is similar to the other six PICTs (besides Guam and American Samoa) in the lack of financial and qualified human resources to properly enforce the conventions.

The threat is calculated in two parts, and they are conventions not acceded and conventions not ratified by a PICT (see Table 4.22). Threat is scored as follows:

- Conventions not acceded to –
 - 1 score if all 5 conventions acceded
 - 2 score if 1 – 2 conventions acceded
 - 3 score if 3 – 5 not acceded

- Conventions not ratified –
 - 1 score if all 5 conventions ratified
 - 2 score if 1 – 2 conventions ratified
 - 3 score if 3 – 5 not ratified.

Vulnerability and consequences are the same as discussed under Chapter 1.4.1.

Table 4.22 – Regulatory Framework Pollution Risk Indicator for PICT ports

PICT	Conventions Not Acceded	Conventions Not ratified	Threat	Vulnerability	Consequences	Regulatory Framework risk indicator
Am.Samoa	0	0	1 1	1 1	4.8 4.8	4.8 4.8 9.6
Fiji	2	5	2 3	1 1	4.6 4.6	9.2 13.8 =23.0
Guam	0	0	1 1	1 1	4.0 4.0	4.0 4.0 =8
Kiribati	5	5	3 3	1.7 1.7	4.8 4.8	24.5 24.5 =49.0
Marshall Is	0	0	1 1	1.3 1.3	5.0 5.0	6.5 6.5 =13.0
PNG	1	5	2 3	1 1	4.2 4.2	8.4 12.6 =21.0
Solomon Is	2	5	2 3	1.3 1.3	4.4 4.4	11.4 17.2 =28.6
Samoa	4	5	3 3	1 1	4.2 4.2	12.6 12.6 =25.2
Tonga	0	5	1 3	1 1	4.8 4.8	4.8 14.4 =19.2
Total						196.6

Source: PICT ports data obtained by author during country visits

The pollution risk ranking (in ascending order) for the regulatory framework indicator are - Guam, American Samoa, Marshall Islands, Tonga, PNG, Fiji, Samoa, Solomon Islands, and Kiribati.

It should be noted that some PICTs such as Tonga have incorporated in 1999 the five conventions other than the STCW Convention that would now rank Tonga equal to the Marshall Islands, Guam and American Samoa in the regulatory framework indicator as

least risk. Credit should be given to the Regional Maritime Legal Advisor for the assistance given to each PICT other than Guam and American Samoa, for the policy advice and the drafting of legislation that enabled PICTs to accede to the conventions and their incorporation into national legislation.

4.2.7 Emergency Procedures and Equipment

The two United States administered territories – American Samoa and Guam, are well stocked with oil spill prevention and oil spill cleaning equipment such as oil booms, pumps and skimmers. Furthermore, these two PICTs could access United States' federal stocks if the need arose. They also adopt the US Environment Protection Agency and Coastguard emergency regulations and procedures. Tiers 1, 2, and 3 oil spills can be handled in these two PICTs.

Fiji, Marshall Islands and Papua New Guinea have sufficient stockpiles of oil prevention and oil spill cleaning equipment to handle Tiers 1 and 2 oil spills. Their emergency procedures are not yet well developed and rely mainly on the oil industry's procedures. Kiribati, Samoa, Solomon Islands and Tonga have stocks of oil prevention and oil cleaning equipment to deal with Tier 1 oil spills only. SPREP is assisting all these seven PICTs to develop their emergency procedures using a SPREP generic oil spill contingency planning model provided that a PICT enacts the generic regional Marine Pollution Prevention Act (MPPA). To date, only Tonga and the Cook Islands have each enacted their MPPA and SPREP has assisted both PICTs in their oil spill contingency plans and also supplied the appropriate equipment worth thousands of dollars.

In the event of a Tier 2 or 3 oil spill, the Marshall Islands and Tonga can access international stockpiles of oil spill prevention and oil cleaning equipment for they are the only PICTs, except for the two United States administered territories, to have acceded to

the OPRC convention. A PICT could still request neighbouring States to assist with any oil spill prevention and oil cleaning equipment but due to lack of such resources in PICT, the best assistance would be from international stockpiles available by becoming a Party to OPRC. Within a couple of days, oil spill equipment could be flown from New Zealand to Tonga and deployed.

Table 4.23 –Emergency Procedures and Equipment pollution risk indicator for PICT ports

PICT Ports	Party to OPRC	Threat	Vulnerability	Consequences	Emergency Procedures and Equipment pollution risk Indicator
Pago Pago	Yes	1	1	4.8	4.8
Apia	No	3	1	4.2	12.6
Nuku'alofa	Yes	1	1	4.8	4.8
Tarawa	No	3	1.7	4.8	24.5
Majuro	Yes	1	1.3	5.0	6.5
Apra	Yes	1	1	4.0	4.0
Honiara	No	3	1.3	4.4	17.2
Suva	No	3	1	4.6	13.8
Port Moresby	No	3	1	4.2	12.6
					100.8

Source: Author

A PICT is accorded: a level 3 threat if it has not acceded to OPRC (such as Kiribati); a level 2 if the PICT has acceded to OPRC but it has insufficient oil cleaning and oil containing stock in the country (such as Tonga); a level 1 threat if the PICT has acceded to and also have adequate oil cleaning and oil containing stock in the country (such as Guam). Vulnerability and consequences are the same as discussed under Chapter 1.4.1.

Apra have the least risk from this indicator followed by Pago Pago and Nuku'alofa, Majuro, Apia and Port Moresby, Suva, Honiara and Tarawa.

4.2.8 Summary of the Seven External Pollution Risk Indicators

An overall summary of the external risk indicators is given in Table 4.24. Tarawa has the highest risk of being affected by the seven external risk pollution indicators, followed by Suva, Honiara, Apia, Nuku'alofa, Port Moresby, Majuro, Pago Pago, and Apra. The Regulatory Framework indicator has the highest score in the seven external pollution risk indicators. Apra has the lowest risk. Port Moresby, Tarawa and Majuro are not affected by cyclones to any great extent due to their geographic locations within the 6 degrees belt north and south of the equator.

Table 4.24– Summary of External Pollution Risk Indicators for PICT ports

PICT Ports	Met. Event	Accu. Nav. Chart	Coast Sea R.out & Port Pass.	Skills Of Port Work	Port Infra. & Cond.	Regul Fram	Emer Proc & Equi	Total Exter nal Indic.
	4.2.1	4.2.2	4.2.3	4.2.4	4.2.5	4.2.6	4.2.7	
Hon	7.2	11.4	6.2	5.7	5.7	28.6	17.2	82.0
Apia	6.8	8.4	5.5	4.2	4.2	25.2	12.6	66.9
Tara	0	24.5	8.2	8.2	8.2	49.0	24.5	122.6
Suva	13.8	9.2	13.8	4.6	4.6	23.0	13.8	82.8
Nuk	11.4	9.6	6.6	4.8	4.8	19.2	4.8	61.2
P.M	0	8.4	5.8	4.2	4.2	21.0	12.6	56.2
Apra	3.5	8.0	7.1	4.0	4.0	8.0	4.0	34.6
Pago	7.8	9.6	11.8	4.8	4.8	9.6	4.8	53.2
Maj	0	13.0	10.0	6.5	6.5	13.0	6.5	55.5
Mean	5.6	11.3	8.3	5.2	5.2	21.8	11.2	

Source: Author

Meteorological Events indicator showed Suva with the highest score followed by Nuku'alofa, Pago Pago, Honiara, Apia, Apra, and Tarawa, Port Moresby, Majuro last equals. With regards to the Accuracy of Navigation Charts indicator, Tarawa, Majuro, and Honiara needs to have some improvements and updates to their port charts such as better and more recent hydrographic surveying. There are variations in the Coastal Sea Routes and Port Passages indicator but for practical reasons such as their geological

configurations it is difficult to make any improvement except at very great costs in financial and environmental terms. On the Skills of Port Workers, the types of vessel introduced used for trading in the Pacific (such as the use of only shore cranes for loading and unloading vessels) may require new valuations on this indicator. The Port Infrastructure Conditions indicator may be re-evaluated after a period of time such as 5 – 10 years.

In this chapter, each of the five internal and seven external indicators was discussed and evaluated. The next chapter analyses the evaluations and the SMPI calculated.

¹ Double bottom tanks (known in the industry as D.B.tanks) are compartments or the tanks at the bottom of the ship between the outer (shell plating) and the inner bottom (tank top plating or cargo hold floor). The double bottom structure serves two important functions: it provides a buffer space that increased safety in the event of bottom plating damage: and also provides better stability by having weights (when they are full) low down in the ship. Its use started early last century although some smaller vessels have single hulls today such as tugs and ferries that trade within restricted waters.

² A passenger ship is defined in Regulation 2 of Chapter I of the SOLAS Convention as “a ship which carries more than twelve passengers”. A passenger is every person other than the master and other members of the crew or other persons employed or engaged in any capacity onboard a ship on business of that ship and a child of one year of age.

³ Within these four ship types are bulk carriers being categorised in their sizes as follows:

- Handysize 10 – 35 000 dwt
- Handymax 35 – 50 000 dwt
- Panamax 50 – 80 000 dwt
- Capesize 80 000 dwt and more

Dwt stands for dead weight, which means it is the difference between the lightweight (or sometimes known as light displacement) and load displacement of a ship. In other words, it is the weight of cargo plus weights of fuel oil, stores, water ballast, fresh water, crew and passengers, and baggage. Lightweight is the weight of the ship as built, including boiler water, lubricating oil, and cooling water system. Load displacement is the weight of the ship when loaded to the depth of its seasonal load line (mark). The load displacement at the depth of the summer load line (marked S in the load line diagram) in sea water is the figure normally quoted.

When carrying weight cargoes, such as ore, it is desirable to keep the lightweight as small as possible consistent with adequate strength. Since only cargo weight earns revenue, it is imperative that the other weight components in the load displacement be kept to the minimum as long as the ship fulfils its commitments.

⁴ Stress is a measure of the ability of a material to transmit a load, and the intensity of stress in the material, which is the load per unit area, is often stated e.g. kg/sq.mm.

⁵ Naval theory is the study of qualities of floating bodies and all factors that can affect those qualities.

⁶ Naval architecture sets out how the ship is to be constructed according to pre-drawn plans.

⁷ Material Fatigue is caused by low stresses which are applied to a structure repeatedly over a period of time that may result in a fracture in the material. Fatigue fracture occurs very slowly and can take years to propagate. It may grow unnoticed until the load bearing member is reduced to a cross-sectional area which is insufficient to carry the applied load. Fatigue failures are associated with sharp notches or discontinuities in structures, and are especially prevalent at hard spots (regions of high rigidity in ship structures).

⁸ Hydrostatic forces are forces (any act or pull exerted on a body) acting on a ship floating in water. The weight of cargo forces are acting downwards on the ship while buoyancy forces are acting upwards. Buoyancy and weight distributions are non-uniform along the whole length of a ship. Therefore, in some sections the weight of cargo is in excess

over buoyancy while in other sections the reverse may be true. However, the resultant of both forces are equal and opposite when the ship floats at a particular draft.

⁹ Hydrodynamic forces are forces that could incline a ship, such as a wave or wind at sea.

¹⁰ Buoyancy is the force considered to act vertically upwards through a point called the centre of buoyancy, which is the centre of gravity of the underwater volume. Archimedes' Principle states that when a body is wholly or partially immersed in a fluid it appears to suffer a loss in mass equal to the mass of fluid it displaces. The loss of mass is the force of buoyancy.

¹¹ Stability is the ability of a ship to return to an initial condition after it has been subjected to disturbing forces and moments.

¹² Freeboard is the distance between the water level at the top of the Summer load line mark to the top of the deck line mark (or freeboard deck), at mid-length of a ship. It serves the following functions:

- Provides sufficient reserve buoyancy (avoid water from entering the holds when water covers the exposed decks).
- Protects crew members working onboard by providing a proper deck height.
- Ensures that the hull is strong enough to withstand increase in water pressure due to loading of cargo up to the appropriate load line.
- Provides sufficient intact stability.
- Ensures sufficient stability and buoyancy when the ship is damaged.

Freeboard rules has a substantial financial cost to a ship owner in two ways. First, it puts a limit to the amount of cargo to be loaded to the appropriate load line, Second, it can impact the cost of building a new ship by meeting the requirements of the Load Line Convention.

¹³ Intact stability is basically the condition of a ship where there is sufficient stability is maintained for the ship not to capsize.

¹⁴ International Transport Workers Federation, was founded in 1896 on the initiative of British seamen and dockers. It has now over three million members from four hundred trade unions in more than a hundred countries. Since 1948, together with its main objective of improving welfare of seamen and dockers world-wide it also focused on driving ships from open registers back to their national flags. The former has been successful but the latter has not because it is very difficult to control the market if there is a demand for open registries. However, in 1998 at the Delhi 39th Congress ITF had a new policy of targeting sub-standard ships, whether they are FOCs or non-FOCs.

¹⁵ Annual detention ratios are based on data from the previous three years – 1997, 1998, and 1999.

¹⁶ ITOPF for some historical reasons, generally categorised spills by size (<7 tonnes, 7-700 tonnes, >700 tonnes) although the actual amount spilt is also recorded. Information is now held by ITOPF on nearly 10 000 incidents, the vast majority (84%) of which fall into the smallest category, that is, <7 tonnes.

(ITOPF is a non-profit making organisation, involved in all aspects of preparing for and responding to oil spills from tankers. This service is normally undertaken on behalf of members (tanker owners) and their oil pollution insurers (usually P&I clubs) or at the request of governments or international agencies such as the international Oil Pollution

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- Compensation Fund. It is based in London with a staff of 22 people of whom 11 are available to respond to spills).
- ¹⁷ The term “grain” includes wheat, maize, oats, rye, barley, rice, pulses and seeds.
- ¹⁸ Oil means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than petrochemicals) and includes also the substances listed in appendix 1 to Annex I of Marpol 73/78, as amended.
- ¹⁹ Mr. Justice Sheen said in the report “The Board of Directors did not appreciate their responsibility for the safe management of their ships. They do not apply their minds to the question... What orders should be given for the safety of our ships? ... Management from top to bottom was infected with the disease of sloppiness... Management from top to bottom share the responsibility for the accident”.
- ²⁰ Tropical revolving storms (TRS) are usually known as: *cyclones* in the Indian Ocean; *hurricanes* in the West Indies, North and South Pacific; *typhoons* in the China Seas and unknown to occur in the South Atlantic. Winds around the centre can be up to 200 km/hr. A fully developed TRS can pump up to 2 million tonnes of air per second. This is why it has more rain in a day than rain that falls in London in one year. No TRS have been reported to have existed between the equator and 6 degrees north or south latitudes.
- ²¹ El Nino means “Christ Child” which was coined by Peruvians to describe the warm current appearing off the western coast of Peru around Christmas time. Today El Nino is associated with the term El Nino Southern Oscillation (ENSO) that describes the warm phase of a naturally occurring sea surface temperature oscillation in the tropical Pacific Ocean. Southern oscillation refers to a seesaw shift in surface air pressure at Darwin, Australia, and Tahiti. When the pressure is high at Darwin it is low in Tahiti and vice versa. El Nino is the extreme phase of the southern oscillation that resulted in the warming of the eastern tropical Pacific.
- ²² La Nina is the extreme phase of the southern oscillation that resulted in the cooling of the eastern tropical Pacific. Both periods of El Nino and La Nina can be detected by measuring and monitoring changes in wind velocities, sea surface temperatures, surface air temperatures and sea level of areas between the eastern and western tropical Pacific Ocean.
- ²³ Phenomenal seas are estimated to be over 10 metres high and can have about 300 metres distance between two wave crests. They are associated with severe TRS.
- ²⁴ Storm surge is a dome of water about 60 to 80 kilometres across and typically about 2 – 5 metres higher than the normal tide level. If the surge occurs at the same time as a high tide then the area inundated can be quite extensive, particularly along low-lying coastlines.
- ²⁵ Hydrography (as defined by the International Hydrographic Organisation) is that branch of applied science that deals with the measurement and description of the features of the seas and coastal areas. It is carried out for the primary purpose of navigation and all other marine purposes and activities, including, inter alia, offshore activities, research, protection of the marine environment, and prediction services.
- ²⁶ Triangulation is a geometric method that uses three distinctive points to determine the position of water depth soundings. The use of triangles for calculation of distances and positions of soundings from reference points, the angles read off from sextants gave rise to the term ‘triangulation’.

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- ²⁷ Examples are: INT 4060 (Australasia and Adjacent Waters) and INT 4061 (South Pacific Ocean- Western Portion)
- ²⁸ Examples are: INT 4605 (New Zealand to Fiji and Samoa) and INT 4606 (Tonga to Archipel des Tuamatu).
- ²⁹ Vigia is a reported danger, usually in deep water, whose position is uncertain or existence doubtful and until disproved it must continue to be regarded as potentially dangerous. The most likely sources of vigia are shoals of fish and discolourations of water.
- ³⁰ Example: British Admiralty (BA) chart 744 (Suva Harbour to Koro Island)
- ³¹ Example: BA 440 (Fiji Islands-Eastern Group, Northern Portion).
- ³² Example: New Zealand (NZ) chart 8655 (Apia Harbour)
- ³³ Example: NZ 8275 (Nukualofa Harbour-Nukualofa Wharves)
- ³⁴ Oceanic islands have been discussed in section 2.1.3 of Chapter 2 of this research.
- ³⁵ Hazard can be defined as a thing likely to cause harm, injury or loss to lives, property, the environment and other things of value. It is possible that one or combination of lives, property and the environment can be harmed by a hazard. A narrow passage is a hazard to navigation which is a potential harm.
- ³⁶ The Minimum Safe Design (MSD) is the distance from where a vessel is or moving in the water to a hazard in that area i.e. width required for safe navigation.
- ³⁷ Approved training institution is a maritime training school that meets the requirements of STCW 78, as amended, and approved by the maritime administration to conduct maritime courses prescribed under the Convention. IMO is then informed of the approved training institution which confirms the status that it meets the requirements of STCW 78, as amended.

5.0 Analysis of Findings

5.1 Identification Relating to the Ship -generated Marine Pollution Index (SMPI)

This chapter includes a calculation of each PICTs' SMPI and ranked. Furthermore, discussions on the SMPI's impact on the economy, trade, shipping, marine environment, and civil society with key issues identified in the event of a shipping accident in a PICT port that would result in closure of that port.

In Chapter 4, summaries of the five internal and the seven external pollution risk indicators were discussed and ranked in accordance to their respective scores that are outlined in Tables 4.13 and 4.24 respectively. Table 5.1 shows the summary for total pollution risk indicators for the nine PICT ports.

Table 5.1 -Summary of Internal, External and Total Pollution Risk Indicators

PICT Ports	Total Internal Pollution Risk Indicators	Total External Pollution Risk Indicators	Total Pollution Risk Indicators for PICT Ports
Apra	43.0	34.6	77.6
Suva	60.0	82.8	142.8
Port Moresby	53.7	56.2	109.9
Honiara	75.6	82.0	157.6
Majuro	71.7	55.5	127.2
Pago Pago	70.2	53.2	123.4
Apia	37.7	66.9	104.6
Nuku'alofa	37.3	61.2	98.5
Tarawa	60.3	122.6	182.9
Total =	509.5 (45.3%)	615.0 (54.7%)	

Source: Author's calculations

The value of the summary and aggregate of internal and external pollution risk indicators, as depicted in Table 5.1 can be assessed by comparing the scores (in column number 4) of each of the nine PICT ports. Tarawa is ranked with the highest risk of having the potential to cause marine pollution, followed in descending order Honiara, Suva, Majuro, Pago Pago, Port Moresby, Apia, Nuku'alofa and Apra. One interesting point to note is that the impact of internal factors in the total pollution risk is approximately 45.3 per cent, as compared to that of 54.7 per cent for external factors.

Table 4.13 (Summary of the Five Internal Pollution Risk Indicators for PICT ports) and Table 4.24 (Summary of the Seven External Pollution Risk Indicators for PICT ports) show the value of each indicator used in the calculations of the SMPI. The Ship indicator is the most important internal pollution risk indicator. Regulatory Framework indicator is the most important external risk indicator (and also the highest score of all indicators), followed by the Accuracy of Navigation Charts and Emergency Procedures and Equipment indicators. Tarawa has the highest score on each of these three external indicators, and about twice the score for each of the other eight PICT ports. Kiribati has acceded to only one IMO convention (out of six), the lowest of all PICTs, while Guam has acceded to all six IMO conventions (through the US). Adopting and implementing international regulations, practices and standards will lower a PICTs' ranking under the SMPI.

5.2 The Ship-generated Marine Pollution Index (SMPI)

A SMPI is established by using Apra as a base with a value of 1 and the rest of the PICT ports are calculated by dividing the total pollution risk indicator score of a port by that of Apra (see values in Table 5.1).

The SMPI identifies the relative risks that ship based marine pollution may occur in the marine environment of the nine PICT ports used in this research. Although the SMPI is an environmental index it still has profound impacts on social and economic lives of citizens of each PICT, especially a port that handles 100 per cent of trade of a PICT.

The SMPIs of the other PICT ports are tabulated in Table 5.2, as follows:

Table 5.2 – Ship-generated Marine Pollution Index (SMPI)

PICT Ports	SMPI
Tarawa	2.36
Honiara	2.03
Suva	1.84
Majuro	1.64
Pago Pago	1.59
Port Moresby	1.42
Apia	1.35
Nuku'alofa	1.27
Apra	1

Source: Author's calculations

In the event of an oil spill that would necessitate the closure of a PICT port such as Apra for some weeks, trade could not be conducted to Guam and that would seriously affect the economy of the country and food supply to its people. Therefore, the SMPI could provide a number of benefits to the nine PICTs, including:

- the identifying of vulnerabilities of a number of PICTs and self assessment by a PICT when individual pollution risk indicators are examined;
- the fact that PICTs could identify any risk to cause marine pollution by ships and within a short time, formulate policies to address them; and
- the fact that donor countries and funding institutions have meaningful data at their disposal to assist them in their decisions to provide financial aid and technical assistance to address any marine pollution risk identified by the SMPI or an individual indicator.

In developing the SMPI, a simple formula style index (simple addition, subtraction, addition and multiplication with or without weightings) was aimed for and the researcher hopes that it would be easy to use by other researchers and decision-makers. A growing number of researchers world wide have developed indices that compares the relative vulnerabilities of countries in terms of risks to human economic and social systems but none in relation to the aims of this research. A study of selected countries in the Pacific, *Environmental Vulnerability Index to summarise national environmental vulnerability profiles* for SOPAC by Kaly et al (1999) developed an index that summarises the vulnerability of the environment of countries to natural and man made hazards. Again, it is different from the SMPI in that it covers three indicators that characterise the level of risk, resilience or environmental degradation in a country.

As discussed in Chapter 1, comparisons can be carried out for two or more ports by using the relevant pollution risk indicator or indicators and calculated as shown in the appropriate table in Chapter 4. This flexibility in the use of pollution risk indicators would provide for a new indicator deemed appropriate to be included in the SMPI in future, such as any pollution risk arising from ballast water exchanges when the Ballast Water Convention enters into force. Any pollution risk to a PICT's environment would affect humans, as human systems (economies, social systems and related activities) and the environment are dependent on one another. The environment provides natural resources for humans but the environment is also vulnerable to natural events and man made activities. Therefore, it is important to establish the SMPI and also discuss its impacts on human systems in general.

5.2.1 Strengths and Weaknesses of the SMPI

The SMPI developed is associated with a number of strengths and weaknesses that are characteristics of summarising and modeling data, which must be understood for its

proper application and use. The SMPI is based on a theoretical framework that identified the 12 pollution risk indicators that have been found to be common to the nine PICT ports. The strengths of the SMPI include factors such as:

- comprehensive and flexible, in that, it should also accommodate any future pollution risk indicator or remove any existing pollution risk indicator not considered relevant anymore;
- establishing a standard that could be used for comparing the vulnerability of PICTs to ship –generated marine pollution which could also be modified (the indicators) and used world wide;
- enabling PICTs to undertake self-assessments and adjustments to policies to address deficiencies identified and through a time frame, the SMPI could show changes in the risk indicators in response to new policies or new pollution risk indicators;
- highlighting the importance of recording and keeping data on the pollution risk indicators used here; and
- promoting awareness that there are internal and external risk factors contributing to the potential for marine pollution when a ship visits a port.

Data collected on ship calls, type of ships, quantities of oil cargoes were taken out of published annual reports and trade statistics of PICTs. The data is reliable and easily available. Other data such as on meteorological events, accuracy of navigation charts, coastal sea routes and port passages, regulatory framework, and emergency procedures and equipment were obtained from various published sources and the Internet. There has not been any data published yet on skills of port workers and port infrastructures and conditions but only subjective observations put forward by officials in each PICT that are of varying reliability. However, this situation does not diminish the values of these two

indicators, for in any instant, deficiency arising out from them, such as pilot error resulting in grounding, which would cause immediately a shipping casualty (a potential major marine pollution incident) in a port. Anti-fouling systems was included, as the AFS Convention's first implementation stage was on 1 January, 2003 (banning of use of TBT based paints), although no PICT has acceded to it (that is why this indicator was given a zero score). The ISPS Code entered into force on 1 July, 2004, and it is possible to calculate its impact on the ISPS Code today as many PICTs have acceded to SOLAS and some have not. If a PICT wishes to find out the SMPI in August 2004 then scoring of the security issues pollution risk indicator could be carried out as the ISPS Code has already entered into force on 1 July 2004.

Table 5.3 shows the effects of the Security Issues pollution risk indicator on the scores of each PICT in August 2004. The threat is derived from the status of a PICT in being a Party to SOLAS, a score of 3 for not yet a Party to SOLAS and a score of 1 if a PICT is a Party to SOLAS. Vulnerability and consequences are the same as discussed under Chapter 1.4.1.

Table 5.3 – If Security Issues pollution risk indicator is scored August 2004 in SMPI

PICT Ports	Party to SOLAS (Security Issues)	Threat	Vulnerability	Consequences	Security Issues Risk indicator	Total Risk Indicator from Table 4.13 (1998)	New Total Pollution Risk Indicator Aug 2004
Honiara	No	3	1.3	4.4	17.2	75.6	92.8
Apia	Yes	1	1	4.2	4.2	37.8	42.0
Tarawa	No	3	1.7	4.8	24.5	60.3	84.8
Suva	Yes	1	1	4.6	4.6	60.0	64.6
Nuku'alofa	Yes	1	1	4.8	4.8	37.3	42.1
P.Moresby	Yes	1	1	4.2	4.2	53.7	57.9
Apra	Yes	1	1	4.0	4.0	43.0	47.0
Pago Pago	Yes	1	1	4.8	4.8	70.2	75.0
Majuro	Yes	1	1.3	5.0	6.5	71.7	78.2
TOTAL						509.6	584.4

Source: Author's calculations

The greatest impacts of Security Issues are in the Solomon Islands and Kiribati, for both PICTs have not acceded to the SOLAS Convention.

Table 5.4 – Summary of Internal, External and Total Pollution Risk Indicators after taken into account the Security Issues pollution risk indicator in August 2004.

PICT Ports	Total Internal Pollution Risk Indicators	Total External Pollution Risk Indicators	Total Pollution Risk Indicators for PICT Ports
Apra	47.0	34.6	81.6
Suva	64.6	82.8	147.4
Port Moresby	57.9	56.2	114.1
Honiara	92.8	82.0	174.8
Majuro	78.2	55.5	133.7
Pago Pago	75.0	53.2	128.2
Apia	42.0	66.9	108.9
Nuku'alofa	42.1	61.2	103.3
Tarawa	84.8	122.6	207.4
Total =	584.4 (48.7%)	615.0 (51.3%)	1199.4 (100%)

Source: Author's calculations

When the total internal pollution risk indicator is considered, the overall effect is that the total score is increased by 74.8, that is, from 509.6 to 584.4. Tarawa has the highest score in this indicator followed in descending order by Honiara, Majuro, Nuku'alofa and Pago Pago, Suva, Apia and Port Moresby and Apra.

When the effect of the Security Issues pollution risk indicator is taken into consideration, the relationship between the internal and external pollution risk indicators changes from 45.3%:54.7% (see Table 5.1) to 48.7%:51.3% (see Table 5.4) respectively.

The following main weaknesses of the SMPI have been detected:

- The main drivers of the index are the indicators chosen and availability of data in PICTs. It is possible that if a different set of pollution risk indicators were used the result would be a different set of scoring and ranking of pollution risks of PICTs.
- Loss of detail may have occurred by the use of the three (for threat and vulnerability) and five point scales (for consequences) instead of using the numerical data directly.

- In some of the indicators, such as meteorological events, subjective assessments have been used as a cyclone may have been a hundred miles away from the selected port (in this research) but the maximum wind force in the cyclone warnings and weather forecasts have been adopted for the port too.
- It is very difficult to assess the relativity of complexity of operations in ports such as Apra (big) and Tarawa (small) given their actual sizes, the amount of ship calls and the numbers and diverse skills of port workers.

At some future point in time, when new data are available, or current pollution risk indicators found not relevant anymore, or new indicators have been identified, the SMPI may have to be tested to ensure that it still achieves its intended purpose. This is the identification and prevention of ship sourced marine pollution in the Pacific region.

5.3 Current Policies and Legal Framework

PICTs are facing major challenges in formulating policies, and the establishment of the subsequent legal framework required, that would meet the aspirations of the global maritime community relating to maritime safety, security and the prevention of pollution of the marine environment. Exceptions to this are American Samoa and Guam, for both countries can readily access resources available in the United States to assist them in formulating policies and put in place the legal framework to implement those policies in a timely manner. However, in the opinion of the researcher, the following issues characterise the situation in many PICTs:

- Lack of political commitment to provide mechanisms that will ensure that a PICT carries out its responsibilities under current international regulations, and participation in the discussion of upcoming issues, which will have an impact on a PICT's maritime

sector, that are being deliberated on in international forums. This could be explained by three main reasons.

- Many PICTs have a Ministry of Transport that manages the land, sea and air modes of transportation. The Director of Marine or his equivalent (in a separate office and at a distance from head office) reports to a Secretary of Transport, usually a non-maritime person, who clears submissions from the marine department and advises the Minister of Transport. It is a commonly accepted human trait that a person will do first the things he has knowledge about and last the things he knows little or nothing about. Often times, the maritime administration's submissions are left untouched for some time in the Secretary of Transport's "pending" files. Substantial time is lost in this way that usually frustrates the marine department's staff and also discourages them from initiating new measures or carrying out their functions and responsibilities under international conventions. The result is that the Minister is not aware (or not being properly briefed) on maritime issues, which in turn leads to non-commitment on his part. In order to improve on this situation, one option is that the Minister should specify a time frame or limit for a submission or briefing note to reach him from the time it left the desk of the Director of Marine.

- Lack of financial resources in PICTs creates an environment where all sectors in the country have to compete for the best deal in the national budget each year. If the Minister of Transport is not briefed properly and made aware of maritime issues, then the Minister could not fight for the best deal. This could result in maritime projects not being adequately funded and provided with the human resources required. It is a major problem in many PICTs to attract sea-going nationals with the right qualification and experience to return home and work in the marine administration. The shore based remuneration package is usually less than one half of what they get when employed at sea.

- The lack of physical resources to achieve goals is the consequence of not having adequate financial resources. Existing infrastructure cannot be maintained properly.

Critical new infrastructure, such as navigation aids, cannot be constructed. The recruitment of personnel qualified and experienced in maritime matters is made quite difficult, which would seriously affect safety surveys, marine pollution prevention, security and the drafting of the required legislation.

- There is very little dialogue between governments and the private sector (in shipping and ports) in PICTs, and also on the regional level, to promote efficiency and effectiveness of the maritime sector at both levels. There is a need for more consultation and interaction between the two in areas of institutional strengthening, rationalisation of shipping services and reducing costs in ports by taking measures to improve productivity. Governments would be in a better position to carry out their responsibilities under international conventions if they have very close working relationships with the private sector. It will be a win/win situation for everyone involved with the maritime sector.
- Lack of qualified staff, that have knowledge of current and future international regulations, practices and activities in the maritime sector. Specifically, adequate and experienced maritime lawyers, nautical and engineer officers with internationally recognised qualifications. The pressures and workloads that the PICTs' maritime administrations are facing are significant. For example, what is normally carried out in Australia and New Zealand by dozens of qualified nautical and engineer officers for implementation of international regulations, is being carried out by two similarly qualified persons in a PICT (for example, Kiribati). It is also a major problem when there are no qualified maritime lawyers in the Attorney General's department, which in most cases, also there are insufficient qualified lawyers to fill all the approved positions. The above situations create obstacles in many PICTs to carry out their responsibilities properly under a convention, such as Port State Control. They also make it very difficult for many PICTs to participate in any debate of any maritime issue in any forum.
- There is very little dialogue at ministerial level within the Pacific region concerning maritime issues except the Melanesian Spearhead Group Ministers' of Transport meetings when they do meet. Exchanging and sharing of maritime

information, experiences, problems and aspirations at the ministerial level is a “must” if there is going to be any real improvement in the maritime sector in PICTs, such as acceding to more international conventions with adequate financial and skilled human resources to implement the conventions. The ministers are the key people that have real influence in PICTs for they decide laws, budgets and the recruitment of the required staff for marine administrations. Therefore, it is vitally important that ministers are kept informed of what is going on and also be made aware of the critical role that the maritime sector plays in the national, regional and international economy, trade, and employment.

It seems that a good way of addressing this issue is to establish a regional maritime transport organisation with one of its main functions, is to have harmonised and coordinated maritime transport sector policies for all Member States. This would require the attendance of Ministers of Transport in these meetings that would create a golden opportunity for specialists in the organisation to explain and convince them of the importance of the issues under discussion, particularly when complex technical matters are involved. Peer pressure can play an important role in these meetings in terms of a PICT self-evaluating the performance of its maritime administration when compared with other PICT represented in a meeting. It is a natural thing to try and catch up with the perceived best PICT maritime sector performance. A little competition and rivalry is a healthy thing. This will result in improvements in the maritime sectors of PICTs. It will also solve the problem of maritime administrations’ submissions being held up in the Secretary of Transport’s office.

- Government instability is particularly important and is increasingly becoming a problem now in the Pacific region. For example, in June and July of 2004, the Opposition parties in Papua New Guinea tabled a vote of no confidence in the present Government with the aim of replacing the Prime Minister. Basically at the same period, snap elections in Vanuatu have resulted in a political vacuum, with no political party having enough seats to form a government, and the last Prime Minister losing his seat. Every time the Government changes, there is a knock on effect in the bureaucracy, as the politicians

want (in fact are expected in some cultures) to reward wontoks (friends and relatives) and political supporters with jobs and related benefits. It has been reported that one of the reasons that Papua New Guinea was not able to properly do the Port Security Assessments under the ISPS Code was that the executive management had been dismissed en masse. The members of the Board of Directors, most with no experience whatsoever, tried to take on the management roles, and failed abysmally (Heathcote: personal communications, 2004), requiring a team of consultants to come in at the eleventh hour and do a less than perfect job. This revolving door policy of politicians and bureaucrats means that the plans are perpetually changing.

- Another major issue is that many PICTs do not have a Maritime Sector Policy that would lay out what a PICT wants its maritime sector to do, determine its current status and then devise strategies that would best achieve what it wants. It is a process that would identify the issues, what is wrong, what needs fixing, how it is going to be done, who is going to be responsible, where is the money coming from and what is the time frame.
- Maritime policies in PICTs could be assessed by the number of basic safety and marine pollution prevention conventions they have acceded to and ratified as discussed in Chapter 4 (section 4.2.6 and Table 4.22). Kiribati and the Solomon Islands need to take a closer look at their maritime policies for the number of accession to conventions is one and two respectively. PNG, Fiji and Samoa have to review their maritime policies as soon as possible for they have acceded to four to five of the six conventions used in the assessment. On the other hand, American Samoa, Guam, Marshall Islands, Tonga and Vanuatu have all acceded to the six conventions that reflected good maritime policies are in place and they need only to maintain this status. It is true to say that PICTs would have struggled to accede to STCW 95 if it was not for the valuable assistance of the Regional Maritime Legal Programme at SPC. This would also reinforce the view that the establishment of a dedicated regional maritime transport organisation in the Pacific would positively contribute to the sector. Furthermore, it would facilitate the addressing of emerging requirements, achieving of national aspirations in PICTs and the addressing

of many of the problems discussed in this paragraph. A regional maritime transport organisation is envisaged to provide the support services to Member States in the following areas: legal, safety, security, prevention of marine pollution, training, port and shipping matters, and social issues such as employment, women affairs and occupation safety and health. Other areas could be added on later.

5.4 Trade and Shipping

Detailed discussions on trade and shipping were carried out in Chapter 2. A relationship between trade and shipping will be established here. The provision of shipping services in the Pacific region follows the trade patterns as discussed in Chapter 2. Trade is comprised of the export and import of goods and services between PICTs and other countries.

Table 5.5 – Comparisons of cargoes handled, value of the cargoes, and the number of ship calls into PICTs in 1998.

Country	Total exports and imports in tonnes	Total Value US\$ million of exports and imports	Number of ship calls from Table 2.3 *
Am. Samoa	500 000	971	334
Samoa	219 101	116.93	242
Tonga	118 159	80.84	180
Kiribati	83 116	42.84	42
Marshall Is	95 886	65.46	477
Guam	321 193	288.5	2616
Solomon Is	307 800	301.69	478
Fiji	3 433 992	1 533.4	1241
P.N.G	6 887 052	2 904	741
Total	11 966 299	6 304.66	6351

Note: * indicates the number of ship calls for the PICT ports but not for the whole country. In the case that there is only one PICT port in the country than the port data is also for the whole country. Single ports PICTs are in American Samoa, Samoa, Kiribati, Marshall Islands and Guam.

Source: Data from Annual Reports of port authorities for 1998.

The data in Table 5.6 show that the total amount of cargo imported and exported to the nine PICTs in 1998 was about 12 million tonnes worth over US\$6.3 billion. Total vessel calls of 6351 was recorded that comprised of 2914 cargo vessels/oil tankers (about 46% of total vessel calls) and 3437 fishing vessels (about 54%).

5.4.1 Impact of Shipping on Trade

The relationship between Total Cargo handled in a PICT port and the Total Ship Calls is examined and discussed first and then the Total Cargo handled with Total Ship Calls, but excluding fishing vessels, second.

5.4.1.1 Impact of Total Shipping on Total Cargo

The statistical analysis carried out in this section provides only a very rough guide as to the likely relationship of shipping and trade (total cargo). If correlation is below about 0.7 (Business Basics, 2000:231) predictions tend to be not reliable. In another dimension, the number of pairs of values (the five port variables) is less than the widely accepted 10 pairs of values, making the resulting estimates unreliable even if the correlation is high. Care should be taken in interpretation of data derived from these calculations.

Table 5.6 – Relationship between Total Cargo and Total Vessels

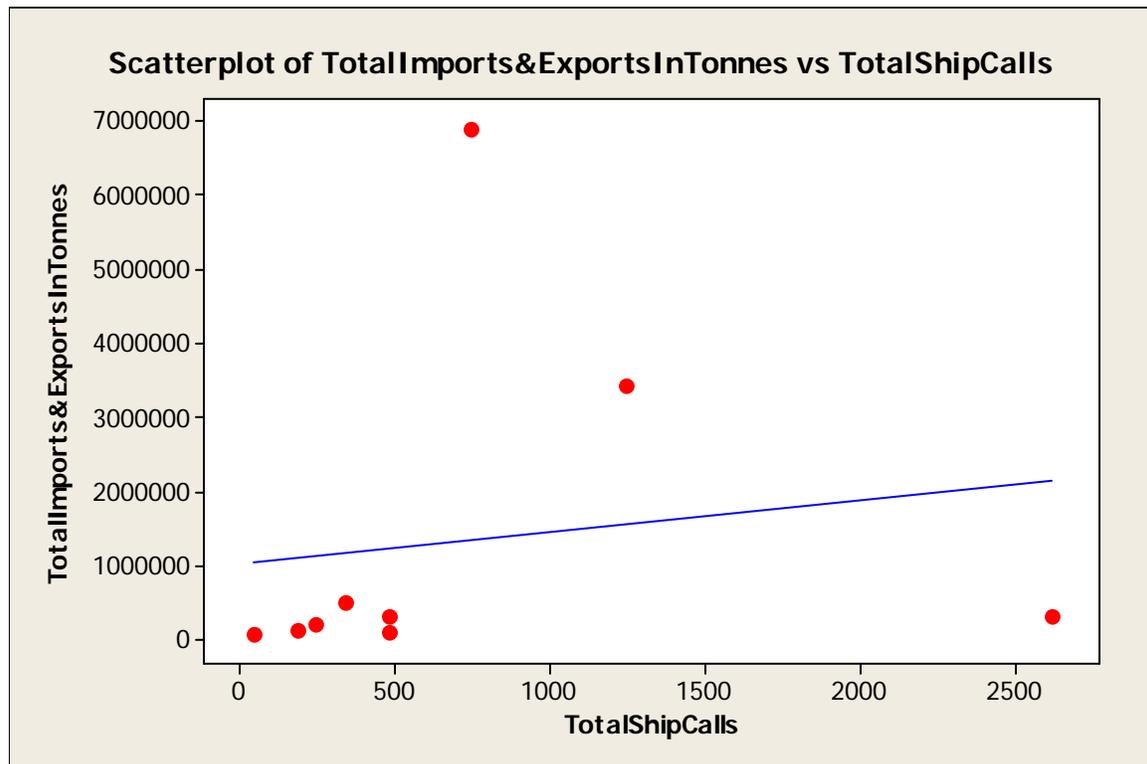
Country	y Total Exports and Imports in tonnes	x Total Ship Calls
American Samoa	500000	334
Samoa	219101	242
Kiribati	83116	42
Marshall Islands	95886	477
Guam	321193	2616
Solomon Islands	307800	478
Fiji	3433992	1241
Papua New Guinea	6887052	741
Tonga	118159	180

Source: PICT ports data obtained by author during country visits

Correlations: TotalImports&ExportsInTonnes, TotalShipCalls

Pearson correlation of TotalImports&ExportsInTonnes and TotalShipCalls = 0.147

P-Value = 0.706



Regression Analysis: TotalImports&ExportsInTonnes versus TotalShipCalls

The regression equation is

$$\text{TotalImports\&ExportsInTonnes} = 1026051 + 430 \text{ TotalShipCalls}$$

Predictor	Coef	SE Coef	T	P
Constant	1026051	1130420	0.91	0.394
TotalShipCalls	430	1095	0.39	0.706

S = 2475417 R-Sq = 2.2% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	9.45696E+11	9.45696E+11	0.15	0.706
Residual Error	7	4.28938E+13	6.12769E+12		
Total	8	4.38395E+13			

Obs	TotalShipCalls	TotalImports&ExportsInTonnes	Fit	SE Fit	Residual
1	334	500000	1169719	920033	-669719
2	242	219101	1130146	968811	-911045
3	42	83116	1044117	1099500	-961001
4	477	95886	1231229	862288	-1135343
5	2616	321193	2151306	2248549	-1830113
6	478	307800	1231659	861971	-923859
7	1241	3433992	1559859	1012140	1874133
8	741	6887052	1344787	826045	5542265
9	180	118159	1103477	1006048	-985318

Obs	St Resid
1	-0.29
2	-0.40
3	-0.43
4	-0.49
5	-1.77 X
6	-0.40
7	0.83
8	2.38R
9	-0.44

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large influence.

The variables are positively correlated (0.1469) in Table 5.6 but the correlation is very weak. It would appear that the number of fishing vessel calls into a PICT port is one major component of other factors affecting shipping/tonnage relationships. From Table 2.4 (Chapter 2) fishing vessel calls to the nine PICT port totaled 3437 which is about 54 per cent of the 6351 recorded for total vessel calls. The effect of fishing vessel numbers in the relationship between total vessel calls and total cargo handled in a PICT port could be significant and this is discussed in the following section 5.4.1.2.

5.4.1.2 Impact of Total Ships (excluding fishing vessels) on Total Cargo of Imports and Exports

When fishing vessels are excluded the variables are also positively correlated (0.7455) and the correlation is moderate to strong as shown in Table 5.7 below. The coefficient of determination is 0.5402, meaning that about 54 per cent of variation in total cargo could

be explained by variations in total vessel calls (but excluding fishing vessels), leaving 46 per cent to be explained by other factors such as cruise vessels calls. It is clear from the above data that fishing vessels distorted the relationship between total cargo handled and total vessels called.

As discussed earlier on in this section, fishing vessel calls into PICTs amounted to 54 per cent of total vessel calls. International maritime conventions such as SOLAS (including the ISPS Code) do not apply to fishing vessels and this situation creates a serious problem to PICTs in terms of safety, security and the prevention of marine pollution. PICT authorities now could not determine the condition of a fishing vessel, as international safety conventions do not apply to these vessels, so there are no means to assess if a fishing vessel is safe. . Another issue that is causing serious concern in PICTs is the entry into force of the ISPS Code on 1 July 2004, which does not apply to fishing vessels as well. Given that about 3400 fishing vessels (assuming that there is no big difference with the 1998 data of 3437 fishing vessels) will visit many of the PICT ports for bunkering, provisioning, crew exchanges and discharge of catch, the security of PICTs has a significant probability of being compromised. powers such as the United States, Japan, Singapore and China, have been of support.

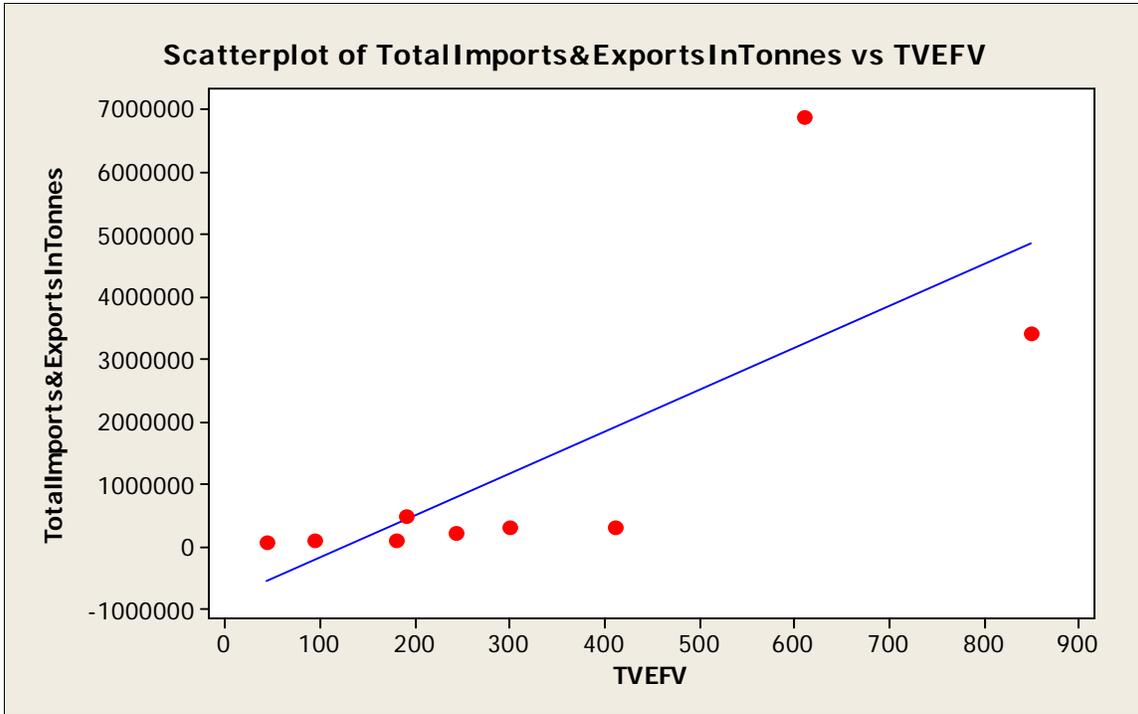
Table 5.7 – Relationship between Total Cargo and Total Ships but excluding fishing vessels

Country	x Total Exports and Imports in Tonnes	y Total Vessels but excluding Fishing Vessels
American Samoa	500000	190
Samoa	219101	242
Kiribati	83116	42
Marshall Islands	95886	92
Guam	321193	411
Solomon Islands	307800	298
Fiji	3433992	850
Papua New Guinea	6887952	609
Tonga	118159	180

Source: PICT ports data obtained by author during country visits

Correlations: TotalImports&ExportsInTonnes, TVEFV

Pearson correlation of TotalImports&ExportsInTonnes and TVEFV = 0.746
 P-Value = 0.021



Regression Analysis: TotalImports&ExportsInTonnes versus TVEFV

The regression equation is

$$\text{TotalImports\&ExportsInTonnes} = -835693 + 6688 \text{ TVEFV}$$

Predictor	Coef	SE Coef	T	P
Constant	-835693	918943	-0.91	0.393
TVEFV	6688	2260	2.96	0.021

S = 1668064 R-Sq = 55.6% R-Sq(adj) = 49.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	2.43725E+13	2.43725E+13	8.76	0.021
Residual Error	7	1.94771E+13	2.78244E+12		
Total	8	4.38495E+13			

Obs	TVEFV	TotalImports&ExportsInTonnes	Fit	SE Fit	Residual
1	190	500000	435001	632885	64999
2	242	219101	782770	585925	-563669

3	42	83116	-554803	845333	637919
4	92	95886	-220409	763853	316295
5	411	321193	1913019	589921	-1591826
6	298	307800	1157291	559064	-849491
7	850	3433992	4848991	1312679	-1414999
8	609	6887952	3237216	851211	3650736
9	180	118159	368123	643984	-249964

Obs St Resid

1	0.04
2	-0.36
3	0.44
4	0.21
5	-1.02
6	-0.54
7	-1.37
8	2.54R
9	-0.16

R denotes an observation with a large standardized residual.

Maritime officials from PICTs have tabled in various regional and international forums the above concerns on fishing vessels and requesting for their resolutions. The responses from big maritime

5.5 Impacts of Pollution on the Marine Environment

The identification and prevention of marine pollution in PICTs caused by the spillage of oil from ships into the sea is the main focus of the research. It is very important that oil does not leak or spilled into the sea for as soon as it enters the sea many physical, chemical and biological processes act on the oil. When oil enters the sea it floats (oil is lighter than water) and starts to move and spread as oil slicks, in the same direction and speed as the sea does. Within 12 hours, an oil spill can spread and affect an area of five square kilometres (Drewry Shipping Consultants 1996: 18). At the same time, environmental processes start changing its character as follows:

- a small percentage of oil dissolves in the sea water.
- some of the oil spreads and settles on the bottom due to the force of gravity. The spread diminishes over time.

- some of the oil evaporates into the atmosphere, the light more rapidly than the heavy oil .
- some of the oil is changed to carbon dioxide and water by marine micro-organism, bacteria and fungi that feed on its chemical compounds. This is known as “biodegradation”. The rate of biodegradation is dependent on the temperature of the mixture of oil and water.
- over time, the combined effects of physical, chemical and biological processes get rid of some oil (weathering effect), the lighter oils first.
- the upper layers of the water column is infiltrated by some oil through natural wave action.
- some of the oil is involved in oxidation (combined with oxygen) that is a slow process compared to other weathering processes.
- emulsification occur to some of the oil when it combines with another liquid. That is, water can be suspended in oil (such as butter) or oil can be suspended in water (such as milk) and both can occur only in specific oil compositions. Water in oil emulsions persist for months or years after an oil spill because of its very stable chemical composition. It contains about 50 to 80 percent water and has a reddish-brown colour. Oil spill specialists can estimate the amount of oil spilled in a sea area by the colour of the oil spill. For example, a brownish colour oil slick indicates a 0.1 millimeter to 1.0 millimeter thick layer of water in oil multiplied by its estimated width and the estimated length to give the estimated volume of oil in that sea area.

To date, no major oil spill has been reported inside ports of PICTs. But, from personal contacts between this researcher and officials in PICT ports it is clear that operational spills, such as from oily bilge waters, oil leaking from plant and machinery onboard, are happening in many PICT ports. This researcher, during his visits to PICT ports frequently noticed thin oil slicks floating around the port areas in most ports, with the worse ones being in Pago Pago, Suva and Port Moresby. Although no major oil spill has been reported in PICT ports, these thin oil slicks in sufficient concentration, through the environmental processes described above, can kill many marine organisms, mangrove

trees, sea birds and fish within the port areas. This is a major concern to every PICT and, if not addressed as soon as possible, could become a serious problem within the next decade.

An oil spill in a PICT port can cause the following marine environmental damage or degradation:

- sea birds, other marine organisms that fish and birds eat, fish themselves, mangrove trees, mollusks and other marine life will be adversely affected, possibly killed, by the chemicals and inherent characteristics of the oil (such as birds could not fly if covered with oil);
- it is possible that tidal streams will, within hours, spread the spilled oil from the port area into low lying coastal land areas where it will be deposited ashore (on sandy beaches, pebbled shores or cliff structures) during high water. Eventually, the oil (or the chemical compounds that make up the oil) leak through the soil to the fresh water lenses¹ thus affecting the quality of the coastal villages' water supply. This will be a problem in low-lying oceanic islands such as those in Tonga, Kiribati and the Marshall Islands;
- it will change the physical features of the port areas into a black mass, if the oil spilled is in the hundreds of tonnes, for oil will cling into rocks, beaches, trees and marine structures. PICT ports such as Apra, Pago Pago and Suva are the ones that will be mostly affected due to their geographical configurations, such as enclosed harbours of volcanic islands;
- if chemicals are to be used to clean up the oil on beaches and rocks, serious consideration should be given to their toxicity before they are used. In many cases, the most environmentally friendly solution is to leave the oil spilled well alone, but to monitor it and let nature take its course through biodegradation and other natural processes described above. However, the decision to use chemical or not will be a complex one when economic and social considerations are factored in.

In order to minimise environmental damages to a PICT in the event of an oil spill, an oil spill contingency plan should be in place. PICTs wishing to develop an oil contingency plan should consider either acceding to the global OPRC Convention 1990, or to the regional version of it known as the “SPREP’s” Protocol Concerning Cooperation in Combating Pollution Emergencies in the South Pacific Region 1987. Being a Party to OPRC would be more advantageous than the SPREP Protocol as a PICT can have access to assistance (equipment, experts etc) from other Member States in the world, whereas the latter is limited to PICTs and the United States. The next step to be taken by the government of a PICT wishing to address the prevention of damage from oil pollution should be to incorporate the more important environmental conventions into national law. This will provide the authority required to prepare the oil spill contingency plan. Only Tonga, Marshall Islands and the United States have acceded to OPRC 1990 and have enacted dedicated marine pollution prevention legislation. Furthermore, only the United States and Tonga have an oil spill contingency plan in place. Fiji, Marshall Islands, Papua New Guinea, Samoa, Solomon Islands have acceded to the SPREP Protocol but Kiribati and Tonga have not.

Other than the prevention of an oil spill occurring, its prompt containment and clean up should be the top priority in a PICT. PICTs should adopt, as a matter of policy, the dual approach of prevention of the marine environment from oil pollution, plus its protection from further oil pollution in the case of an oil spill. Accession by PICTs to marine pollution prevention conventions and enactment of appropriate national legislation would expedite the achievement of this dual policy

5.6 Economic and Social Impacts

If an oil spill occurred, of a sufficient magnitude, to close the ports of Pago Pago, Apia, Tarawa, Majuro and Apra, it would seriously affect the economies of American Samoa, Samoa, Kiribati, Marshall Islands and Guam respectively. These five ports are the only

ports in their respective countries that handle international trading vessels bringing in imports and taking out exports. Four other ports: Nuku'alofa, Suva, Port Moresby and Honiara handle a certain percentages of national imports and exports (See Chapter 4.1.2).

Table 5.8 shows, in columns (4) and (5), the total values of imports and exports and the total population of each PICT respectively. Column (6) shows the per capita values of imports and exports. In column (7) is the Gross Domestic Product (GDP)² for each PICT. Column (8) shows the comparison of column (4) to column (7) as a percentage. They indicate the impact of the total value of imports and exports in terms of GDP for each PICT.

The impact of a port closure on the imports and exports and the economy of a PICT can be assessed from the figures in column (8). If a PICT port is closed due to an oil spill or for any other reason, there will be no trade and the GDP of that PICT will be seriously affected. The Solomon Islands (99%) will be the most affected followed, in descending order, by Kiribati (95%), Fiji (90%), Papua New Guinea (76%), Marshall Islands (68%), Samoa (53%), Tonga (50%), and Guam (9%). If American Samoa's trade is stopped for any reason the researcher estimates that the economic impact on its GDP would be a reduction of over 95 per cent. The reason being, that there is little other economic activity in the country apart from the import of oil and the export of tinned fish.

The value, in US \$, of national GDP was as follows: Papua New Guinea (3.8 billion); Guam (estimated 3.2 billion); Fiji (1.7 billion); Solomon Islands (303.4 million); Samoa (221 million); Tonga (162.2 million); Marshall Islands (95.7 million); and Kiribati (45.3 million). There was no available GDP data for American Samoa.

Table 5.8 – Values of Imports and Exports vs. Population in Nine Selected PICTs

Country	Import (I) in US\$ million	Export (E) in US\$ million	Total (I+E) Values US\$ million	Popula-tion	Values I+E per capita	GDPs in US\$ million *	Column (4) as a share of Column (7) in % (8)
Column (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
American Samoa	471	500	971	64100	15148	N.A.	N.A
Samoa	96.6	20.33	116.93	169200	691	221	53
Tonga	69	11.84	80.84	100200	807	162.2	50
Kiribati	37	5.84	42.84	90700	472	45.3	95
Marshall Islands	58	7.46	65.46	51800	1264	95.7	68
Guam	202.4	86.1	288.5	148200	1947	3200**	9
Solomon Islands	160	141.69	301.69	447900	674	303.4	99
Fiji	612	921.4	1 533.4	824700	1859	1700	90
Papua New Guinea	1 000	1 904	2 904	4790800	606	3800	76
Total	2 706	3 598.66	6 304.66	6687600	943		

Source: National and Port Statistics of the Nine PICTs for imports and exports. SPC for population figures.

* Department of Foreign Affairs web-site September 2001

** CIA World Fact Book 1999

N.A. means data not available

When the per capita value of imports and exports are ranked (as in column (6) of Table 5.7), American Samoa (US\$15 148) was highest followed in descending order by Guam, Fiji, Marshall Islands, Tonga, Samoa, Solomon Islands, Papua New Guinea and Kiribati (US\$472). If a port in a PICT is closed, the ranking in column (6) holds true regarding the adverse impact of this event on the lives of peoples in that country. Therefore, it is of great strategic importance that a PICT should be aware of the economic and social costs that a closure of a port would cause in the event of a disaster in a port, such as an oil spill.

It is also important for an aid donor to be aware of the above information, if one of the PICT ports used in this research is closed to shipping because of its critical economic and social impacts on the country.

5.7 International Conventions and Regional Agreements

Various IMO conventions and regional agreements on the environment acceded to by PICTs as of 31 March 2004 and as at January 2000 respectively are shown in Appendix 4. The discussions in the following paragraphs will focus on the conventions appropriate for maritime safety and the prevention of marine pollution in PICTs.

- IMO maritime safety conventions

There are four IMO Conventions that deal with safety and should be considered for accession by PICTS.

- SOLAS 1974 and Load Lines 1966, both have been acceded to by Fiji, Marshall Islands, Papua New Guinea, Samoa, Tonga and the United States (representing American Samoa and Guam). Kiribati and Solomon Islands have not acceded to this convention.
- COLREG 1972 have been acceded to by Fiji, Marshall Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga and the United States. Kiribati has not acceded to this convention.
- STCW 1978 have been acceded to by all PICTs.

From the above information, it is clear that Kiribati and the Solomon Islands are quite slow in acceding to some of the main international safety conventions. Commitment to maritime safety by political leaders in these two PICTs may be lacking. This is an interesting situation given the importance of shipping to a PICT's economy and trade. A possible explanation is that maritime transport is a mature industry that is not high profile like civil aviation and therefore not a priority to politicians, despite the key role it plays in

the economy and trade in a PICT. Another possible explanation is that there is lack of qualified maritime lawyers and maritime officers in maritime administrations to prepare submissions to higher non-maritime officials in a Ministry of Transport

The adoption world wide of the above four main international conventions in general have shown a marked improvement in safety at sea. Improvements could be measured by looking at the number of ships lost, loss of life and accidental oil pollution.

- Shipping casualties

Marine insurers such as Institute of London Underwriters (ILU) and International Union of Marine Insurance (IUMI) estimated that in the 1987-1997 decade the total losses of ships (of over 500 GT) as a percentage of tonnage and the number of ships afloat have decreased. The former from about 0.4 of one per cent to 0.2 per cent and the latter from about 0.3 of one per cent to 0.15 per cent (Boisson 1999:506).

- Loss of life

For the 1990-1997 decade, total lives that was lost at sea was estimated to be about 770 in 1990 and about 170 in 1997. However, there were variations during the decade due to serious shipping casualties such as in 1994 when the *Estonia* casualty occurred and pushing the figures to about 1 400 fatalities. In 1996 the sinking of the *Bukoba* ferry in Lake Victoria resulted in nearly 1 200 deaths recorded for the year (Boisson 1999:507).

- Accidental oil pollution

Several reports have identified that accidental oil pollution has been reduced markedly. GESAMP reported in 1993 that accidental oil pollution has decreased over the last three decades (GESAMP 1993:5). In 1996 the International Tanker Owners Pollution Federation (ITOPF) reported in 1996 that the number of serious accidents has dropped significantly in the 25 years from 1970-1995, spilling oil approximately from 300 000 tonnes of oil to 15 000. There are some variations in between due to oil tanker accidents such as the *Atlantic Empress* (1979), *Castille de Bellver* (1983) and *ABT Summer* in 1991(Boisson 1999:507).

It could be deduced from the above statistics that the numbers of shipping casualties, loss of life and accidental pollution have decreased in the last decade. The reductions have been linked by some commentators to improvement in safety at sea through the adoption of the above four safety conventions. For example, in his report on safety aspects of ship design and technology, Lord Carver states, “Statistically, the sea would seem to be becoming a safer place. The rate of serious failures of ships in general has been steadily improving and the number of lives lost at sea is decreasing”

- IMO marine pollution prevention conventions

The main convention dealing with the prevention of marine pollution that is relevant to the topic of the research is MARPOL 73/78. PICTs that have acceded to the Convention (and the appropriate Annexes) are listed below (also see Appendix 4).

- The Marshall Islands, Papua New Guinea, Samoa and Tonga have acceded to Annexes I to V. Fiji, Kiribati and the Solomon Islands have not acceded to the Convention and these Annexes.
- Marshall Islands has acceded to Annex VI.
- The United States has acceded to Annexes I, II, III and V.

It is surprising that Fiji has not signed up to MARPOL 73/78 given that 1 241 ships have called into Suva alone in 1998, including 297 oil tanker calls. The Solomon Islands had 478 vessel calls at Honiara, including 91 oil tanker calls. Kiribati is at a much lower level with 42 vessel calls at Tarawa, including 12 oil tanker calls of much smaller size. Maritime officials in these three PICTs should bring to the attention of the political leadership as a matter of urgency the consequences of not adopting international standards and practices if these ports are closed due to a sub-standard ship visit. When a vessel calls into any of the three ports their Port State Control inspectors could not carry

out control measures for the prevention of marine pollution as they have not acceded to MARPOL 73/78 or have similar national legislation. So, the maritime authorities in these three PICTs could not really determine that the vessel is in a substandard condition or not. The risk to cause marine pollution in this situation is high and should be addressed urgently by their accession to MARPOL 73/78 or enact legislation by incorporating MARPOL 73/78 into their national legislation

In PICTs, there are no reliable data available that would confirm or not confirm the international trend of improvements in safety of ships. There has not been a ship (of 500 gross tonnage and above) that has been reported lost in the same period as the international data. Shipping casualties, loss of lives and accidental oil pollution in PICTs are from fishing vessels to which the safety conventions do not apply.

- Regional Conventions

The main regional convention dealing with the prevention of pollution of the marine environment is the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, 1986. It is a framework convention and SPREP is the Secretariat. The Convention covers a variety of environmental issues such as pollution from vessels, land based sources and sea-bed activities, disposal of wastes and testing of nuclear devices in the region. Article 6 of the Convention requires Member States to take appropriate measures to prevent, reduce and control pollution caused by discharges from vessels. Fiji, Marshall Islands, Papua New Guinea, Samoa, Solomon Islands and the United States (see Appendix 4) have acceded to the Convention. Kiribati and Tonga have not acceded to the Convention.

5.8 Recent Developments

As the main medium of conducting world trade today the shipping industry has evolved and adapted to its working environment successfully over the years. The success of the shipping industry rests on two main factors: technology and the human element. These two elements go hand in hand in order for the industry to function properly and safely. A vessel is sub-standard if it is of the best design and equipment but crewed by poorly trained seafarers living in poor accommodations and overworked with no adequate rests. And, since over 80 per cent of accidents at sea have been caused by human error the future of shipping lies mainly on the quality and expertise of the crew rather than the state of the art equipment in a vessel for the crew operate the equipment. The international safety conventions have been amended during the last decade, such as STCW 95 and the ISM Code, to reflect the new thinking and emphasis the industry has placed on the human element. Prior to the 1980s the maritime industry placed the emphasis (about 80 per cent) on regulating the technical/technology element but it was only about 20 per cent of the cause of shipping casualties whereas human error was about 80 per cent of the cause of the casualties. New amendments to IMO safety conventions are now focusing more attention on the human element than the technical element to instill a safety culture on all sectors of the maritime industry (Boisson 1999:316).

New developments in international safety and marine pollution prevention regulations adopted by IMO appropriate to the subject of the research will be discussed, starting from January 2001. The reason being is that the first write-up of the research was done in late 2000 based on 1998 data from PICTs.

5.8.1 Safety Conventions

The IMO new Conventions or Codes or important new amendments dealing with safety are as follows.

- The International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes Onboard Ships (INF Code) becomes mandatory as it enters into force on 1 January 2001. The INF Code was adopted in May 1999 following amendments to Chapter VII of SOLAS, that is, the carriage of dangerous goods. Ships carrying INF cargo are divided into three classes depending on the total radioactivity of the INF cargo carried onboard. Regulations controlling the carriage of INF cargo in ships vary slightly according to the class.

PICTs should take note of the INF Code as there has been serious concerns raised by many PICTs since the 1990s on the transportation of nuclear waste onboard ships that transit the Pacific Ocean on passage between Europe and the Far East. Calls were made by politicians, academics, environmentalists and even ordinary citizens to ban ships³ carrying packaged “nuclear”⁴ fuel from transiting PICTs’ waters, but there are no valid technical or legal grounds to justify such a proposal. A much better approach would have been to allow vessels carrying nuclear fuel in packaged form to transit the region, subject to some reasonable conditions that are negotiated and agreed to by the ship-owner and PICTs for the safe transit of vessels. To date no PICT has adopted the INF Code yet.

- Amendments to the IMDG Code was adopted at IMO in May 2000 that cover its complete reformatting, revisions to various sections of the Code and how specific substances are to be transported. The reformatting of the Code reduced the previous five volumes to two volumes but its use was still recommendatory. The Code entered into force on 1 January 2001 with a 12 months transitional period ending 31 December 2001.
- In May 2002, amendments to SOLAS chapter VII was adopted at IMO that the use of the IMDG Code mandatory. While the Code is now mandatory for the carriage of dangerous goods, certain provisions are of recommendatory nature and are editorially expressed (for example, using the word “should” instead of “shall”) to clarify their meaning. The amendments to the IMDG Code entered into force on 1 January 2004.

PICTs have not adopted the amendments or enact legislation to make the use of the IMDG Code mandatory in the carriage of dangerous goods. It must be pointed out that PICTs should make the mandatory use of the IMDG Code a top priority and legislate accordingly.

- The full implementation of the 1995 Amendments to the STCW Convention that entered into force on 1 February 1997. All PICTs have adopted and incorporated the STCW 1978 and the amendments into their national legislation. The amendments entered into force on 1 February 2002. Without the assistance of the Regional Maritime Programme of SPC some PICTs would not have achieved the IMO “White List” status as required under the STCW Convention. The implication is that qualifications of seafarers of PICTs would not have international recognition if the PICTs were not on the White List and would have lost their employment in foreign owned ships.
- The May 1994 amendments to SOLAS made mandatory the use of the ISM Code for dry cargo ships and offshore drilling units of 500 gross tonnage and above from 1 July 2002. The Code establishes safety management objectives and safety management system (SMS) requirements for shipping companies and onboard ships. The ISM Code first applied to passenger ships and oil tankers on 1 July 1998. Kiribati and Solomon Islands are the only PICTs that have not adopted the ISM Code as they have not acceded to SOLAS yet.
- The December 2000 Amendments to SOLAS revised SOLAS chapter V (Safety of Navigation) that made mandatory the carriage of voyage data recorders and automated identification system (AIS) transponders in certain ships. The amendments entered into force on 1 July 2002.
- In December 2002, amendments to SOLAS were adopted that provided measures to enhance maritime security onboard ships and at the ship/port interface areas. These amendments created a new SOLAS chapter (XI-2) dealing specifically with maritime security. One of the amendments was the introduction of the new International Ship and

Port Facility Security (ISPS) Code and it contains two Parts. The first is a mandatory Part A with detailed security related requirements for Governments, shipping companies and port facilities. Secondly, a Part B that contain guidelines on how to implement Part A but are recommendatory. The other amendments contain a series of resolutions designed to add weight to their implementation and encourage their application to ships and port facilities not covered by the Code. An audit regime has been put in place, similar to that under STCW, to ensure full compliance to the Code is achieved. The amendments have entered into force on 1 July 2004. All PICTs are committed to complying with the requirements of the Code as a PICT that does not comply will mean that vessels on international voyages, bringing in imports and taking out exports, will no longer call into its ports. There will be consequences such as economic, food and social problems similar to a scenario described above when a port is closed in the event of a major oil spill inside that port.

5.8.2 Marine Pollution Prevention Conventions

- Annex IV (Sewage) of MARPOL 73/78 entered into force on 27 September 2003. The Annex sets out in detail how sewage should be treated or held onboard a ship engaged in international voyages and the circumstances that discharge into the sea may be permitted. It also requires Member States to provide adequate reception facilities for sewage. The Annex apply to all ships (existing and new) of 400 gross tonnage and also to all ships of less than 400 gross tonnage but certified to carry more than 15 persons.
- The International Convention on the Control of Harmful Anti-fouling Systems on The adoption of the Convention achieved the task set by Chapter 17 of Agenda 21 under the 1992 Rio Conference on Environment and Development. Chapter 17 called on States to take measures to reduce pollution caused by organotin compounds used in anti-fouling systems. No PICT has acceded to this Convention.

- The International Convention for the Control and Management of Ship's Ballast The Convention is divided into Articles and an Annex that includes technical standards and requirements for the control and management of ships' ballast waters and sediments. Its objective is to prevent, minimise and eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. A ship can carry out ballast water exchange if it is at least 200 nautical miles (and in special cases at least 50 nautical miles) from land and in waters of at least 200 metres in depth. Parties are required to provide reception facilities ashore for ballast water where cleaning of ballast tanks occurs. Under the Convention, a ship is required to be surveyed and certified that it meets its requirements. It may be inspected by PSC officers to verify that the ship has also valid certificates and to inspect the Ballast Water Record Book, and/or take samples of the ship's ballast water for control purposes. No PICT has acceded to the Convention.

5.9 Issues Identified

The following key issues are very important and critical to the well being of the nine PICTs in terms of the adverse economic, environmental and social consequences that would occur in the event of a shipping accident, that would result in the closure of any port discussed in the research.

- After evaluating and ranking the total 12 pollution risk indicators for 1998, Apra has the lowest risk score followed in ascending order by Nuku'alofa, Apia, Port Moresby, Pago Pago, Majuro, Suva, Honiara and Tarawa with the highest risk score.
- The establishment of the SMPI will be of great value to PICTs as it will assist decision-makers in determining their vulnerabilities and thus enable them to formulate policies to address them. Furthermore, aid donors can access this tool (SMPI) that is transparent and readily available, and it will be easier for them to assist

in the event that an oil spill occurs, or any other cause such as a terrorist attack, that would result in the closure of a PICT port.

- Of the five internal pollution risk indicators, ship was the highest followed by cargo and the management last.
- Regulatory framework recorded the highest score in the seven external pollution risk indicators, followed by accuracy of navigation charts, emergency procedures and equipment, coastal sea routes and port passages, meteorological events, skills of port workers, and port infrastructures and conditions. There were no values recorded for security issues and anti-fouling systems as they have not yet adopted by IMO in 1998.
- The ship pollution risk indicator recorded the highest risk mean score of 25.8 which is about 2.3 per cent of the mean total (1124.5) of the 12 pollution risk indicators. Therefore, the main focus on any strategy devised by a PICT to prevent marine pollution should be the prevention of a bunker (fuel) oil spill from occurring.
- Tarawa has the highest total score followed in descending order by Suva, Honiara, Apia, Nuku'alofa, Port Moresby, Majuro, Pago Pago, and Apra the lowest for external pollution risk indicators.
- Approximately 45.3 per cent of total risk of causing pollution is attributed to internal pollution risk indicators of the vessel and only about 54.7 per cent for external pollution risk indicators.
- Lack of political commitment to provide mechanisms that will ensure that a PICT carries out its responsibilities under current international regulations.
- In the absence of a regulatory framework in line with international regulations and standards it is more likely that substandard ships will be used in trade to any PICT.

- The lack of financial resources in PICTs creates an environment where all sectors in the country have to compete for the best deal in the national budget each year. Maritime projects often times are not being adequately funded and provided with the human resources required.
- There is lack of dialogue between governments and the private sector (in shipping and ports) in each PICT and also on the regional level to promote efficiency and effectiveness of the maritime sector at both levels. There is a need for more consultations and interactions between the two in areas of institutional strengthening, rationalisation of shipping services and reducing costs in ports by taking measures to improve productivity.
- Very little dialogue at ministerial level within the Pacific region concerning maritime issues except the Melanesian Spearhead Group Ministers' of Transport meetings when they do meet. Exchanging and sharing of maritime information, experiences, problems and aspirations at the ministerial level is a "must deal" if there is going to be any real improvement in the maritime sector in PICTs.
- In assessing maritime policies in PICTs by using the number of basic safety and marine pollution prevention conventions that they have acceded to and ratified would give a result that the Marshall Islands, Tonga, Guam and American Samoa have the right policies in place. Fiji, Papua New Guinea and Samoa need some improvement. Kiribati and Solomon Islands should seriously consider acceding to the international conventions and ratifying them or incorporate them in their national legislation.
- Fishing vessel calls to the nine PICT ports totaled 3437 which is about 54 per cent of the 6351 recorded for total vessel calls. The impact of fishing vessel numbers in the relationship between total vessel calls and total cargo handled in a PICT port is significant. At present many international rules and regulations, including SOLAS, do not apply to fishing vessels and this is a serious concern to PICTs due to the huge number of fishing vessels calling into PICT ports and fishing in their EEZs.

- An oil spill in a PICT port can cause marine environmental damages or degradation to sea birds, marine organisms that fish and birds eat, fish, mangrove trees, mussels and other similar marine life will be adversely affected, possibly killed.
- In a low lying island such as Tongatapu in Tonga, if there is any oil spill in the Port of Nuku'alofa, the fresh water lens in the lagoon and coastal areas adjacent to the port area will be contaminated by the tidal movements. It is quite possible that the quality of fresh water in coastal villages' fresh water wells will be adversely affected which would result in a number of problems such as polluted water for drinking and also for cooking, personal hygiene and other sanitation requirements.
- A major oil spill that would necessitate the closing of Pago Pago, Apia, Tarawa, Majuro and Apra would seriously affect the economies of American Samoa, Samoa, Kiribati, Marshall Islands and Guam respectively. These five ports are the only ports in their respective countries that handle international trading vessels bringing in imports and taking out exports.
- The impact of the total of imports and exports on the economy of a PICT can be assessed when a PICT port is closed due to an oil spill or for any other reason, there will be no trade and the GDP of each PICT will be seriously affected.
- Although there are a number of new international conventions (such as the AFS 2001 and Ballast Water 2004) and amendments (such as the reformatting of the IMDG Code in 2002) that have been adopted or entered into force recently the ISPS Code is the most important. On 1 July 2004 if a port in a PICT does not comply with the requirements of the ISPS Code, in all probabilities no ship engaged on international voyages will call into that PICT port. If this situation is realised the impacts on the PICT involved will be the same as to that of a closure of that port as a result of an oil spill.

This chapter established the SMPI and reviewed current policies, legal framework, trade and shipping, economic and social impacts, and the impacts of marine pollution in the PICTs. The chapter closes with the discussion of issues that are important for the prevention of marine pollution in the PICTs.

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- ¹ Fresh water lens: The weight of rain water that percolates into the ground depresses the salt water beneath it forming a profile that has the appearance of a lens. Fresh water is lighter than salt water and it will float on top of the salt water but the boundary between the two is not clearly defined. The boundary is a transition zone of brackish water.
- ² GDP is the total monetary value of the goods produced and services provided by an economy over a specified period, usually for one year. The real rate of change of GDP gives a better measure of the performance of an economy rather than its absolute value.
- ³ Such as the two British merchant ships, the *Pacific Pintail* and *Pacific Teal*, that was approved by the authorities to carry this type of cargo.
- ⁴ Many people connect the word “nuclear” with atomic bombs dropped in Hiroshima and Nagasaki during World War II resulting in the devastation of these two cities with many of their citizens killed. Therefore, many people fear the word “nuclear” and all materials that are radioactive are viewed the same.

6.0 Summary, Conclusions and Recommendations

6.1 Review of Issues

- *International Background*

For centuries, shipping has developed and evolved inextricably and inexorably linked with human development in terms of technology, trade, and exploration, conquering and settling of new lands. Shipping also helped the spread of diseases and invasive aquatic species from country to country. Advances in shipping technology have resulted in the carriage of oil in bulk onboard and the use of hydrocarbon fuels in propulsion systems of ships instead of sails and oars. The technological advances in shipping brought challenges in terms of huge volumes of bulk oil being transported at sea and the fuel oils' potential to cause marine pollution.

Shipping is one of many industries being called upon by the world community to tackle environmental protection problems for pollution knows no frontier and, if unrestrained, can often freely pass between land, atmosphere and oceans. The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 served as a stimulus to world wide environmental protection and cleanup. Agenda 21 Chapter 17, covering prevention of marine pollution issues, was one of the important instruments produced by UNCED.

The international regulatory regime for shipping is based on IMO conventions, protocols and other instruments, and the United Nations Convention on the Law of the Sea 1982 (UNCLOS). Conventions such as SOLAS 74 and MARPOL 73/78 and other instruments adopted at IMO deal with safety, security and the prevention of marine pollution respectively. Safety conventions such as SOLAS 74, COLREG 72, Load Lines 66, and STCW 78 were adopted to prevent shipping accidents that would result in accidental spillage of oil into the sea. Prevention of marine pollution conventions such as MARPOL 73/78, AFS 2001 and Ballast Water 2004 deal mainly with the prevention of operational pollution spillages (oil, ship wastes and TBT paint systems) entering into the sea. The preamble to MARPOL 73 sets out its desire to “achieve the complete elimination of intentional pollution of the marine environment by oil and other harmful substances and the minimisation of accidental discharge of such substances”. UNCLOS created a “constitution for the oceans”, establishing a new global philosophy and general principles of managing the oceans. It established the rights and obligations of States and also provides a comprehensive and universal framework for governing the use of the oceans and the prevention of marine pollution (Part XII of UNCLOS). The implementations of the above conventions have contributed to a decrease in accidental and operational oil spills in the last two decades but there is still room for improvement in preventing and reducing marine pollution.

Shipping plays a critical role in the global economy as ships carry more than 90 per cent of world trade and thus underpins the continued economic development of nations. It has been estimated that there are 85 000 commercial ships of various types registered in Ship Registers of flag States (Lloyds 2000) transporting about 5 400 million tonnes of cargo across the oceans each year (Fearnleys 2002). Despite the huge number of ships plying the oceans of the world every year the adoption of safety and prevention of marine pollution conventions at IMO and their proper implementation by Member States, have contributed to an improvement in safety and the prevention of marine pollution worldwide. In support of this premise is the fact that the casualty rate for all types of vessels and the oil spilt into the world’s oceans has dropped dramatically over successive

decades. For example, the average number of significant oil spills over 700 tonnes dropped from 24.2 per annum in the 1970s through 8.9 per annum in the 1980s to 7.3 per annum in the 1990s. In the years 2000 to 2002, the annual figure did not go over five (ITOPF figures as quoted in IMO News No.3, 2003:18). Despite reductions in the number of pollution incidents, there is still concern world-wide in respect of their harmful effects on the environment and the adverse publicity that arises from an oil pollution incident. The improvement in oil pollution incident figures can be credited mainly to the adoption at IMO of MARPOL 73/78 and SOLAS 74, and the commitment by all players in the maritime industry in implementing the provisions of the conventions.

The use of ships to conduct global trade is unavoidable due to the fact that when one unit of cargo is transported from one location to another location the lowest cost is through shipping when compared with by road, railway or aircraft. This is the main reason why over 90 per cent of global trade are conducted through shipping. Furthermore, according to the World Bank (2004 World Development Indicators) global trade (exports plus imports) expanded by 6.7 per cent per year in 1990-2001 and the world economy grew below the 2.7 per cent in the 1990s. This would mean that more shipping tonnage would have to be built to meet the increase in the global trade demand thus increases the likelihood of a marine pollution incident occurring. Therefore, the most prudent way of preventing marine pollution is to identify the factors that have the potential to cause marine pollution and then strategies are devised accordingly to prevent marine pollution. The establishment of the SMPI would identify the marine pollution factors involved and also assist in the designing of measures to prevent marine pollution.

- *Regional Background*

In Chapter I the general description of the Pacific region was discussed where it is characterised by small island States with lack of mineral resources, small economies, small populations and significant diversity of languages, remoteness from markets, great diversity of physical features and geology, and vast EEZs. Over 90 per cent of trade

between PICTs have been conducted through the use of ships which is similar to the world trade statistics. The only difference is that some of the ships used for trade in the region are smaller in size as compared to other parts of the world. For example, oil tankers used in the region are approximately 40 000 gross tonnage or less, whereas hundreds of thousand gross tonnage oil tankers are used from the Middle East to Japan. Container ships used in the region have capacities of up to 3 000 containers whereas from the west-coast ports of the United States to Singapore, 8 000 capacity container ships are used. Cruise liners is the only type of ship on scheduled voyages to the region that are using the same ships that are deployed on their round the world cruises. Between 4 000 to 5 000 tonnes of fuel oil are carried onboard the cruise liners (see Chapter 4). The sizes of fishing vessels are the same as to those operating anywhere in the world.

The most intensive use of the seas by humans is through ships used for trading purposes between countries of the world. Fishing vessels is another intensive human use of the seas. There were 2914 cargo vessels and 3437 fishing vessels of various sizes (see Table 4.10) that have plied the trade routes and seas of the nine PICTs in 1998. In some PICTs, such as Guam and Fiji the volume and frequency of ship calls into Apra (see Table 4.6) and Suva (see Table 4.8) indicate virtually a continuous presence of ships in the two ports, thereby constituting a potentially unceasing source of pollution. Other PICTs have less ship calls but the potential to cause marine pollution is not diminished. All ship types have their own advantages and disadvantages in relation to their potential to cause marine pollution. For example, cruise liners carry thousands of people and generate huge quantities of sewage and garbage each day but present relatively less threat in terms of oil or chemical pollution. Very large oil tankers on the other hand, with 15 crew members onboard, generate negligible sewage and garbage but can devastate an entire port area or coastal regions if these ships are holed in an accident.

Ships with oil onboard as fuel or cargo, while at sea anywhere in the world, have the potential to cause marine pollution if oil is accidentally spilt or released from operational

activities. This researcher has identified from records and reports in the nine PICTs that ships in all three ship types have called into the nine PICT ports in 1998, the base year of the research. In order to determine the impacts of ships that have called into each of the nine PICT ports, a ship-generated marine pollution index has been designed to identify the pollution risk factors that would have the potential to cause marine pollution while a ship is in a PICT port.

6.1.1 Identification and Prevention

In PICT ports, or in any location on the planet, internal and external factors to the ship have the potential to cause marine pollution.

The SMPI is the indexing of the total score of the 12 pollution risk indicators of each of the nine PICT ports, the least PICT total score will serve as the base of the index. By dividing any of the other eight PICT total score with the base score the relative positions of PICT ports in the SMPI is obtained. Apra has the lowest, and Tarawa the highest, total pollution risk indicator score.

6.1.1.1 Internal Indicators

A ship owner decides what type of ship that is going to be built after considering market opportunities and funding available. Naval architects designed the ship and a ship-building company is contracted to build the ship. It is the decision of the ship owner or a management company whether to comply or not with international or national regulations that the crew of the vessel will follow. Ships owned by ship owners not adopting accepted practices or complying with international conventions are often detained by port State control (PSC) inspectors of a State. Ships routinely detained under PSC inspections are sub-standard ships. Most of the major accidents and marine pollution incidents and many smaller ones world-wide have been caused by sub-standard ships.

Fishing vessels have been exempted from the provisions of safety conventions. This is a serious shortcoming as fishing vessels are not required to comply with international safety requirements.

6.1.1.2 External Indicators

There are seven external pollution risk indicators that may affect a ship during its visit to a PICT port and they represented 54.7 per cent of the total score of the 12 pollution risk indicators.

6.1.2. Other Issues

The discussion of identification and prevention issues with regards to ship-generated marine pollution in the Pacific have been carried out in the previous paragraphs and there were emerging issues emanating that will be discussed in the following paragraphs.

6.1.2.1 Impacts of Pollution

- **Economic**

Table 5.8 shows the total values of exports (US\$3.6 billion) and imports (US\$2.7 billion) of the nine PICTs in 2001 was approximately US\$6.3 billion. If a PICT is closed to shipping in the event of an oil spill there will be a direct loss of government revenue (from taxes and duties), hardships to the populace and possibly have adverse effects on tourism receipts as foodstuffs and other goods required to service tourists' needs are imported. In the event of port closure the impacts of total values of imports and exports when compared with that of GDPs of PICTs (see Table 5.8, column 8) Guam is the lowest affected. This seems contradictory to the previous statement that the effects of a

port closure of a PICT are greatest on single port countries such as Guam. The GDP of Guam is approximately 11 times (US\$3.2 billion) more than the total value for imports and exports (US\$288.5 million), would explain the low impacts of a port closure in the economy of Guam.

- Health and environmental degradation

When an oil spill occurs in a port, the oil spreads to the beaches and other areas adjacent to the port, the areas covered is dependent on the amount of oil spilt, sea current, tidal flows and wind strength and direction (ITOPF's Response to Marine Oil Spills 1997: I.6). Sea wild life such as birds, fish, mollusks and other marine life get killed or their health affected by the toxicity of oil when they come into contact with the oil (Oil in the Sea III: Inputs, Fates, and Effects 2003: 29). Beaches, mangrove trees, boats, wharves and other similar structures will be covered with oil that would be very difficult and costly to clean. In atolls and low lying islands in PICTs, fish and mollusks are the main source of food of inhabitants and if they have been polluted by oil then the people cannot eat them or if they are eaten then they will get sick (GESAMP Reports and Studies No.66: 1998).

6.1.2.2 Regulatory Framework

The reduction in the scores of the 12 pollution risk indicators could only be achieved by PICTs adoption of basic international conventions on safety and marine pollution prevention and rigorously enforcing them. A ship calling into a PICT that has adopted an international convention is more likely nowadays to be inspected by the authorities (Port State Control officers) in that PICT to determine if the ship complies with standards set by the international conventions on safety and pollution prevention. Once deficiencies have been identified by authorities a ship may be detained by the PICT until the ship rectify the deficiencies. If the ship is registered in a country not a Party to the above conventions, the ship does not have any more favourable treatment by authorities than a ship registered in a Party State. Most shipping casualties in the world involve sub-standard ships. So, it is vitally important that sub-standard ships are prevented from being used in PICTs for trade, and that could only be achieved by the PICTs' adoption of

the basic safety and prevention of marine pollution conventions. Regulatory Framework has the highest score of the nine external pollution risk indicators (see Table 4.24) and therefore policy makers in PICTs should, as a matter of urgency, adopt the basic international conventions on safety and the prevention of marine pollution and implement them properly.

Kiribati and the Solomon Islands have not acceded to basic safety international conventions such as SOLAS (see Table 4.21). Fiji, Kiribati, Samoa and the Solomon Islands have not acceded to the basic environmental international conventions such as MARPOL 73/78. American Samoa and Guam through the United States, Marshall Islands, Papua New Guinea and Tonga have all acceded to these two international conventions.

6.1.2.3 Security

Since the terrorist attacks on 11 September 2001 in the United States the world maritime community joined the international effort in combating terrorism. This has led to the adoption at IMO of measures to enhance maritime security by amending SOLAS with a new Chapter 11-2 and the ISPS Code that entered into force on 1 July 2004. They apply to ships of 500 gross tonnage and above, the exceptions are naval and fishing vessels. Furthermore, Chapter 11-2 and the ISPS Code also apply to port facilities that handle vessels on international voyages. Appropriate port facilities and ships registered in PICTs have been reported to comply with the provisions of Chapter 11-2 and the ISPS Code. That is a remarkable achievement given the costs involved and the time frame of about 18 months that every country has to implement the new SOLAS amendment requirements. A PICT port or ship not complying with Chapter 11-2 and the ISPS Code by 1 July 2004 would have faced the risk of having no trade with the outside world until they comply. Security is an ongoing process and audits by PICTs or port State control officers of other countries may result in the issuance of non-compliance documents by a

PICT or detention of ships in overseas ports. The detention of ships involves a lot of money to the ship owner in lost income and possibly litigation with cargo owners.

6.1.2.4 Fishing Vessels

About 3 400 foreign fishing vessels called into the nine PICTs in 1998 for provisioning and discharging their catches. Hundreds are fishing in PICTs' EEZ with very little monitoring by authorities. SOLAS, which includes the ISPS Code, does not apply to fishing vessels. Fishing vessels is increasingly a serious problem to PICTs as their safety conditions and security could not be determined. PICTs may legislate to include fishing vessels in their Shipping Acts which would require domestic and foreign fishing vessels to comply with its safety and security standards. This measure does not pose any problem with a PICT registered fishing vessel but it will be challenged by owners of foreign fishing vessels on the ground that SOLAS does not apply to fishing vessels. PICTs, except the United States administered territories of American Samoa and Guam, are small countries and they do not have the resources to enforce any such legislation on foreign fishing vessels. Terrorists may use fishing vessels to travel from one country to another in the Pacific without much risk of being intercepted and arrested as fishing vessels are not covered yet by international regulations. If fishing vessels are covered by international regulations, PICT authorities will routinely inspect them as soon as they call into a PICT port.

Probably the only way to address the above concerns with regards to fishing vessels is for PICTs to table this issue at every opportunity in regional and international forums, including IMO. In Europe and the Americas when SOLAS was being drafted and discussed at IMO, fishing vessels was not a problem as each European nation had a fishing fleet that went out to fish mainly in its EEZ and then return to their homeport located in the same country. Today fish stocks in these countries are nearly depleted so fishing vessels have to steam farther out to sea to fish in international waters or even fish in another countries EEZ (such as the PICTs) under licence. PICTs must be able to

control fishing activities in their EEZs that would require all fishing vessels to comply with internationally accepted standards such as those provided under SOLAS. Therefore, every maritime nation should benefit from the inclusion of fishing vessels in SOLAS.

6.1.2.5 Nuclear Materials and Radio Active Wastes

Merchant ships in the last decade have carried reprocessed nuclear fuel from France or the United Kingdom to Japan but do not call into any of the nine PICT ports. These ships may have sailed through some of the PICT's EEZ but their passage plan is not known or made public. The purpose of including the above subject in the research is to discuss the safety issues and the risks involved in the event that a ship carrying reprocessed nuclear fuel or highly radio active waste or spent fuel, is forced to enter a port or place of refuge in a PICT. An unexpected visit of a ship like this is only for the purpose of effecting urgent repairs or other extraordinary circumstances. There will be no discussion on the politics of the 'pros and cons' of the nuclear issue debate that is still raging in the Pacific region.

A situation may arise that a ship carrying reprocessed nuclear fuel or highly radio active waste while transiting a PICT waters may experience a serious engine problem. This would force the master of the ship to sail to a PICT port (as a port of refuge) to carry out the urgent repairs to the engine which is sanctioned under international customary law. The PICT authorities may find out too late that the ship¹ has onboard reprocessed nuclear fuel or highly toxic waste. Authorities should not panic or start pointing fingers as the nuclear cargo may have been packed, loaded, stowed onboard in France or the United Kingdom and transported in accordance with the IMDG Code and the International Code for the Safe Carriage of Package Irradiated Nuclear Fuel, Plutonium and High Level Radioactive Wastes Onboard Ships (both are part of SOLAS Chapter VII). Furthermore, the ship may have been specifically designed to carry this type of cargo and it is wise for the authorities to isolate the ship at a remote area of the port, far from any residential area. Then, station a small armed patrol boat to enforce a 'no approach or security' clear area, perhaps a one mile radius from the ship. Every effort then should be directed to

have the engine repaired so that the ship can continue on as soon as possible with its voyage. As soon as the ship's engine is repaired the ship must leave immediately and should be escorted by a Pacific Class patrol boat until it leaves the PICT's EEZ. Other PICTs may also be advised of the nuclear cargo of the ship so that the ship's movement can be monitored by the PICTs until it leaves their EEZs.

6.2 Challenges in the Prevention of Marine Pollution

Safety, security and the prevention of marine pollution are intertwined and they are the key issues for the global maritime community to be always mindful of. Their importance is reflected on IMO's role which may be summarised by the catch phrase 'Safe, Secure and Efficient Shipping on Clean Oceans'. The international regulatory regime for shipping is covered mainly under two sets of United Nation's instruments: UNCLOS and the Conventions and other instruments of IMO. At the end of March 2004, IMO had 163 Members and three Associate Members and it is quite a challenge for every Member to agree on a maritime issue being discussed in a meeting. There are always diverse interests expressed at an IMO meeting such as from a national, regional perspectives or different groups within the maritime industry. However, IMO Members have always risen to the challenges over the years to agree and adopt conventions to regulate the industry. Ratifying the conventions and their proper implementation by each Member is a key to a safe, secure and clean marine environment. The following issues are also challenges to the maritime industry, some on an international perspective and some on a regional perspective.

International

- The entry into force of conventions and implementation.

An IMO convention enters into force after certain conditions laid down in the convention have been met such as a specific number of countries with a certain percentage of the world's shipping gross tonnage (see Appendix 1, paragraph 3) acceding. This would lead to a number of years before a convention enters into force. The traditional method

(express acceptance procedure) briefly outlined above may have been suitable two to three decades ago when the world's shipping gross tonnage was evenly distributed across a number of European countries that think alike. Today, over 50 per cent of the world's shipping gross tonnage are distributed in a relatively smaller number of countries with open registers and traditional registers, such as Panama, Liberia, Japan and Greece, that gives rise to concern when considering existing entry into force mechanism. It takes about five to seven years between the date of adoption of a convention at IMO and the date of entry into force (Boisson, 1999:145). The entry into force of a convention does not signify its effective enforcement. A convention can only be enforced when a Party State incorporates the convention in its national legislation. Once the convention becomes law of a State, effective enforcement of the convention's provisions is very important so that its objectives are achieved. In the process from adoption of a convention to its effective enforcement, external pressures such as financial, skilled human resources and technical requirements, legal procedures and private interests delay the adoption and implementation of conventions

A new method for adoption of technical conventions such as SOLAS 74, called the tacit acceptance procedure (see Appendix 1 paragraph 5) was agreed to by Member States at IMO that would fast track the adoption of the convention before its technical provisions become outdated. The principle is simple in that instead of the traditional method, the new procedure provides for the convention to come into effect on a given date, unless a certain number of contracting parties raise objections before that date. Recently, SOLAS Chapter 11-2 and the ISPS Code were adopted in December 2002 and entered into force on 1 July 2004, used the tacit acceptance procedure and it took only about 18 months from its adoption to entry into force.

- International Concern With Too Much IMO Regulations

The international community is continually demanding improved measures to protect the global environment, including the marine environment, from pollution. However, there is general consensus in the international maritime community, particularly ship owners and ship masters, that a greater effort should be made in implementing and enforcing existing

regulations for there are sufficient rules and regulations that are now in place. Developing new conventions and the amending of existing regulations at a faster rate at IMO pose a danger that the implementation of the overall objectives of safe, secure shipping and clean marine environment will not be achieved. Many nations such as PICTs, experience great difficulties trying to keep pace with new legislation and the amendments to existing regulations produced at IMO due to lack of skilled human and financial resources. Furthermore, many ship owners and ship masters will experience the same difficulties. These concerns have merit but it should be pointed out that whenever new regulations is deemed necessary then the development of new regulations should be allowed to continue but with very clear objectives and priority basis. New regulations that are being planned to be adopted in future may be designed to involve elements of self-regulation by the industry where appropriate, in order to demonstrate its ability to achieve the objectives of a convention. This would encourage a strong partnership arrangement and the convention currently developed for ship scrapping or recycling is an opportunity to try out the self regulation approach.

Existing international safety regulations have been devised usually after a shipping accident or incident at sea. This approach is now been criticised as being permanently out of date and reactive, therefore, inadequate to meet the overall challenge of safety at sea. New methods have been devised to address these shortcomings and to be more proactive. Formal Safety Assessment (FSA), based on risk assessment techniques, is one of the new approaches which assigns responsibility to the person taking the risk, encouraging that person to attain safety goals. Many sectors have used FSA successfully for decades now, such as the nuclear and aviation industries. This new approach will have impacts in the maritime industry such as IMO will have to review its strategies so that it focuses on performance standards rather than the technical requirements, as is the case today. Ship owners will also assume greater responsibility, particularly ensuring that their ships offer a minimum level of safety or the level recommended by the maritime administration of a country.

- Unilateralism and Regionalism

Unilateral action on safety at sea is when a single State or several States (regionalism) decide to adopt regulations that go beyond generally accepted international standards prescribed under a convention. Usually a State takes a unilateral action because it feels that the international standards are inadequate to deal immediately with a maritime disaster. Often times unilateral action takes the form of official declarations by a single State or several States followed by physical actions such as boarding, intercepting, inspecting or detaining ships. The United States, after the *Exxon Valdez* oil pollution disaster in Alaska in 1989, enacted the OPA 90 that establishes certain conditions for oil tankers (such as double hulls) that enter United States waters or ports to comply with, but these conditions were not required under any international convention. After the *Prestige* oil spill in 2002, Spanish and French warships were stationed off the Spanish and French coasts to warn oil tankers to sail outside Spain's and France's 200 miles EEZs. The United States, Spanish and French unilateral actions were not in line with the freedom of the sea provisions of UNCLOS or international customary law. The three States claimed that their actions were based on natural justice (humanitarian or ecological considerations) rather than on solid legal arguments. Unilateral actions are only ad hoc measures and would weaken efforts by States to set international standards, for if every State decides to take a unilateral action of some sort it would create chaos in the industry and global trade. One way of preventing unilateral actions is for IMO to be given more executive power to speed up the implementation of conventions or to launch amendments much quicker. IMO has been given more power in conventions, such as, the STCW Convention, that provide for IMO to issue a "White List" of countries that have demonstrated to IMO² of their compliance with provisions of the Convention. Other conventions such as MARPOL do not grant IMO such power. Due to the global nature of shipping and the critical role it plays on trade, international standards and regulations is the best way, perhaps the only way, to ensure that ships are safe, secure and the pollution of the marine environment is prevented.

- Sub-standard Ships

The often cited general definition of a sub-standard ship is “a ship whose hull, machinery, equipment, or operational safety are substantially below the standards required by the relevant convention, or whose crew is not in conformance with the safe manning document”. IMO resolution A.787 of 23 November 1995 first put out the above general definition to facilitate the work of safety inspectors in identifying sub-standard ships. These factors, as a whole or individually, make the ship unseaworthy, and would endanger the ship or those onboard if it were authorised to sail. A sub-standard ship is more likely to be unseaworthy. However, an unseaworthy ship is a legal concept (for contracts and insurance purposes) and not a question of fact, and therefore, unseaworthiness is not sufficient in itself to prove that a ship is sub-standard³. This could be explained in that unseaworthiness covers the factors in the general definition of a sub-standard ship, but in addition also covers cargo factors such as the condition of holds and the preservation of the cargo, which has nothing to do with the safety of the ship.

Sub-standard ships cause most high profile oil spills such as the *Erika* and *Prestige* oil spills. These oil tankers were registered in open registries. Donagis et al reported in their study that there is clearly a distinct relationship between casualty rates and flag of registry. Furthermore, that casualty rates on ships registered in open registries as a whole are significantly higher than those of regulated fleets (or traditional registries). The elimination of sub-standard ships is a key to improved maritime safety, security and the prevention of marine pollution world wide. All players in the maritime industry must work together to achieve the objectives for elimination of sub-standard ships and not finger pointing as is happening today. Governments, ship owners, ship’s crew, classification societies and IMO all have a role to play and must cooperate to implement vigorously existing preventive regulations or the developing of new ones so that sub-standard ships are not used in trade anywhere in the world. Effective enforcement by States of standards established by conventions is critical to the implementation of the requirements of conventions by ships flying its flag.

Regional

SPREP has reported that the prevention of pollution is the major environment concern in PICTs. Pollution is increasingly a major problem and is threatening PICTs' struggle to sustain healthy communities, encouraging investment and maintaining sustainable future for their peoples. Shipping related pollution is one of the potential major sources of pollution in PICTs. Effective prevention of pollution produces many benefits. Tourism is one of the main ones because PICTs' have a competitive advantage in promoting their clean seas, plenty of sunshine and white sandy beaches of small low lying islands.

Common to PICTs are the following challenges that must be addressed in order for the maritime industry to comply with international standards set by conventions, in order to achieve the goals of the maritime industry with regards to safe and secure shipping, and a clean marine environment. The following issues may have existed in PICTs individually or in combinations:

- Lack of Political Commitment

The maritime sector is the only sector in the Pacific region that does not have a regional Ministerial meeting. Given that ships carry over 90 per cent of regional and international trade, and the key role that shipping plays in every PICT's economy, the importance of having a Ministers of Transport meeting at least once a year is strongly emphasised here. SPC is sponsoring and convening every year a meeting called the Association of Pacific Islands Maritime Training Institutions and Maritime Administrations (APIMTIMA) where officials from PICTs discuss current international and regional issues that are important and also require prompt decision and implementation. Most of the officials attending the APIMTIMA meetings have at least one or two layers of senior officials above them in a multi-faceted Ministry of Transport in their own PICTs that a submission of any maritime issue has to go through before reaching the Minister. These senior officials usually have no maritime experience and therefore are slow in recognising how critical some of the issues that a maritime official has submitted to the Minister after returning from an APIMTIMA meeting. The end result is usually that the submission does not reach the Minister in time or the Minister does not have time to develop a full

comprehension of what the submission is all about. If a human being does not understand something the most likely action taken is that whatever is required for him to decide on is relegated to be of the least priority. Consequently, there will be lack of political will for the Minister to push for approval of a maritime submission in Cabinet. Therefore, that PICT will not achieve regional maritime targets agreed to in an APIMTIMA meeting.

There are two options available that can address the above issues:

- (i) Establish a maritime transport organisation for the region with various functions that would focus only on maritime issues, as discussed in detail in Appendix 6. By establishing a new maritime transport organisation, Ministers of Transport attend its meetings which is not the case now. Maritime officials in PICTs can accompany the Ministers to meetings and therefore have direct access to them which can be difficult in their own countries. Specialist staff in the new organisation can assist PICTs wherever needed within a short period of time and at no extra costs
- (ii) As an interim measure, Ministers of Transport can meet during APIMTIMA on the third day after officials meet on the first two days. The only problem is that the Articles of Association of APIMTIMA have to be changed so that the meeting of Ministers of Transport (as a Council) becomes the Annual General Meeting instead of maritime officials as representatives of PICTs. Any of these changes has to be approved by the SPC Council of Minister's meeting as these maritime activities are currently under the jurisdiction of SPC. This may pose some protocol problems as some PICT's Minister of Transport is the Prime Minister and the Minister attending SPC Council of Minister's meetings is a junior Minister.

- Lack of financial resources

PICT's financial resources are small and there are always fierce competitions for funds by every sector or within every sector, such as Marine, Civil Aviation and Road Transport in a Ministry of Transport. A sector that is under a Minister who has been well briefed by senior officials usually has advantage in the allocation of funds in Cabinet as

the Minister argues passionately for his case. It is vitally important that a Minister has the political will to obtain a successful funding allocation in the national budget.

The maintenance and repair of maritime assets such as navigation aids, monitoring of compliance with international conventions require funds. Safety of shipping is compromised if navigation aids are not in good working order. PICTs are unable to fulfill their obligations under international conventions that they have adopted and ratified if there are no funds available to obtain the required resources. The lack of financial resources to meet basic safety, security and the prevention of marine pollution needs is increasingly a problem in PICTs. Prioritisation of needs may help temporarily but in the long term adequate funding of what are required in the maritime sector is the only solution. A PICT could not afford one of its ports to be closed as a result of a safety or security or pollution accident or incident that will create further economic hardships by having no more trade with the outside world.

- Lack of Skilled Human Resources

This issue is a consequential effect of lack of political will and lack of funding. Skilled seafarers are required to enforce maritime law in a PICT. It is currently difficult for a highly qualified deck or engineer officer to work in a maritime administration ashore in a PICT because they are getting paid at sea of an amount at least twice of what they are paid ashore. Some sea going officers only search for employment ashore due to 'family' reasons. To get an idea of the pressures that PICT's maritime officials are currently being subjected to are to compare with what our metropolitan neighbours have. For example, Kiribati has three maritime officials to manage its maritime sector, in New Zealand about one hundred and Australia about over two hundred. On a population size basis, this is always going to occur. Safety, security and the prevention of marine prevention are compromised if there are inadequate skilled human resources in post to enforce national legislation or international regulations. The lack of skilled human resources in PICTs has the potential to cause a maritime disaster that would have an adverse impact on their economies when ports are closed. There is no easy solution but for the economy of a

PICT to grow so that funds become available for recruiting the appropriate skilled human resources.

- Lack of dialogue between Government and the private sector and also between Ministers of PICTs.

At present there is very little dialogue on maritime issues between Government and the private sector of PICTs. Usually PICT Governments, other than the two United States administered territories of American Samoa and Guam, adopted international conventions and drafted legislation incorporating those conventions without much input from the private sector, including the maritime industry. American Samoa and Guam adopt the American system of the public discussing a proposed legislation in committees before it is processed for enactment by the legislature. Often times, the maritime industry is not properly consulted and the result is that there is lingering doubt and skepticism in some quarters of the industry when the legislation is enacted. Some ship owners in PICTs are Members of Parliament and they may lobby Ministers against the adoption of international conventions or other similar issues which would also explain the lack of political commitment by Ministers in some instances where their support is required.

Dialogue by PICT's Ministers of Transport on regional or international maritime issues is non-existent. All of the maritime issues are currently discussed at the officials level that may also explain the lack of political commitment in many PICTs. In order to improve the commitment of PICTs' political leaders such as Ministers of Transport, they must meet and discuss maritime issues so that they can understand them. Experts may be hired to brief Ministers in a meeting before they are asked to decide on an issue. Ministers, as Cabinet officers, can give a PICT's support to a regional or international maritime issue discussed in a regional or international meeting with more authority and certainty when compared with officials who have to process to Cabinet for a decision of the issues approved in a meeting.

It is important that a Ministers of Transport regional meeting be held every year for there is much change in international regulations and standards every year. As an interim

measure, SPC hosts the Ministers of Transport meeting which must be designated as the highest authority on any maritime issue. Alternatively, the establishment of a regional maritime transport organisation as discussed in Appendix 6 should be implemented.

6.3 Conclusions

Maritime transport arguably is the most influential factor in the history of mankind due to its contribution to exploration, trade, international in scope and the projection of maritime power. Today over 90 per cent of global trade is transported from one country to another on ships. But ships carry oil as fuel (bunker) or as cargo. Oil contains toxic chemicals that pollute the marine environment when oil is spilled into the sea from normal operational activities or as a result of a shipping accident or incident. Accidents are caused mainly by human error and the recent focus by the global maritime community on reducing this risk is a step in the right direction. Shipping accidents or incidents cause marine pollution so the safe management of ships is a critical component of the measures to prevent marine pollution. The adoption of safety management systems in the shipping company and onboard its ships ensure that human error is minimised to an acceptable level. Factors external to the ship such as cyclones, accuracy of navigation charts and others, can cause adverse impacts on the safety of a ship that would increase the risk of a marine pollution incident occurring. Oil spilled in a PICT port can damage the surrounding shoreline and marine structures. Tidal flows can spread oil to fish and mollusk habitats, and wild life sanctuaries causing devastation. Furthermore, oil leaches into the soil and the fresh water lens in adjacent low lying areas contaminating the fresh water and thus affects the preparation of clean and healthy food and other basic domestic uses. Further research is needed to determine the extent of oil pollution effect on the coastal area, wild life habitats and the lives of people living in any affected area.

Identifying the effects of internal and external pollution risk indicators on the marine environment using risk management techniques and statistical analysis produced the

SMPI. Each of the selected nine PICT ports used in the research has a pollution risk score and comparisons of these scores which are in ascending order determine their rankings in the SMPI. Tarawa has the highest value and Apra recorded the lowest value in the SMPI. After assessing the 12 pollution risk indicators, the value of each indicator in a PICT port can be calculated. PICTs can design marine pollution prevention strategies, after reviewing their current SMPI scores, to address identified shortcomings. The importance of proper identification of a marine pollution risk indicator is critical for the prevention of marine pollution from occurring. If a port is closed for a week due to an oil spill in a PICT port the economic consequences can be catastrophic. It is therefore of the utmost importance that prevention of marine pollution be one of the top priorities of every PICT.

PICTs must adopt international conventions and standards if they are going to trade with the outside world. Shipping is a global industry. Lack of financial and skilled human resources in PICTs to implement international conventions and standards are ongoing problems common to most PICTs. It has been argued in this research that a regional approach provides the best solution in meeting obligations under international regulations on a sustainable basis because of their small sizes and lack of resources. SPC may be strengthened in the maritime sector as an interim measure but the establishment of a new regional maritime transport organisation provides the best long-term way to address the common maritime problems of PICTs. As a regional organisation dedicated to maritime affairs, consultations and meetings of PICT Governments and other players in the maritime industry is enhanced.

Lastly, it is submitted that this research has identified ship-generated pollution of the marine environment in the nine PICTs by calculating the 12 indicators of the SMPI. PICTs could formulate policies and action plans to eliminate or minimise the risks identified in the SMPI.

Measures adopted worldwide to prevent pollution of the marine environment by ships include international regulations and standards on safety, security, and the prevention of the marine environment. It is worth noting that ship-sourced marine pollution is caused mainly through attitude rather than lack of rules (Goulielmos and Pardali 1998: 286). The nine PICTs, considered in this research and others, should adopt the international regulations and standards and enforce them effectively to ensure that PICTs' waters remain clean, healthy and free from pollution as it has been in the past centuries. Furthermore, future generations can still live and feed on the resources of the Pacific Ocean and also enjoy the white sandy beaches of the beautiful islands of PICTs. Therefore, it is of the utmost importance that PICTs take stock of the status of pollution in their marine environment by the use of the risk management tools discussed in this research. However, further research should be undertaken to identify non-shipping marine pollution in ports of the nine PICTs as only 40 per cent of shipping accidents resulting in marine pollution occurred in ports (Giziakis and Bardi-Giziaki 2002: 110). Having determined their pollution status, PICTs must formulate strategies in a holistic dimension to prevent marine pollution, which may include various preventative options offered in this research and also in the following recommendations.

6.4 Recommendations

Recommendation 1

Governments of PICTs as a regional initiative take a bold step and declare “War on Pollution” and that pollution in any form is Public Enemy No.1 in the region. Furthermore, that they are committed to provide adequate resources to enforce vigorously the pollution prevention measures adopted to achieve the goal that within a decade the environment of PICTs should be at least equal to pre-1960 levels.

Recommendation 2

PICTs should adopt the principles of good governance as crucial in the “War on Pollution” and committing of adequate funds and skilled personnel so that pollution prevention measures are relevant, viable and sustainable.

Recommendation 3

Measures adopted to prevent the pollution of the marine environment are best implemented and coordinated through a regional organisation such as SPREP and SPC or a dedicated maritime transport organisation such as the one discussed in Appendix 6.

Recommendation 4

PICTs should make use of the Ship-generated Marine Pollution Index (SMPI) and the information derived from the calculations for each marine pollution risk indicator in this research for determining the status of pollution (although the SMPI will only assist in partly determining the status) in each PICT’s marine environment.

Recommendation 5

PICTs should pay particular attention to the adverse impacts on the economy, trade, health of the populace, and the pollution of the environment, in the event of a PICT’s port being closed to shipping as a result of a major oil spill (that is, a Tier 3 oil spill or oil spill of 700 tonnes and over). Measures to prevent an oil spill in a PICT must be in place to minimise the risk of a port closure due to an oil spill.

Recommendation 6

Ship-generated marine pollution can be prevented by PICTs’ adoption of international conventions (or the regional equivalents if a PICT has not acceded to an international convention) and standards on safety, security, and the prevention of marine pollution in their national legislation and also the effective enforcement of their provisions.

Recommendation 7

Donors should be encouraged to provide funds and technical assistance for institutional strengthening and capacity building in PICTs so that Recommendation 6 could be implemented effectively.

Recommendation 8

Formal dialogue between Ministers of Transport or with non-government organisations in the maritime industry should be held once every year at a regional forum where important maritime issues are discussed, debated, decided and agreed upon for the overall benefit of the industry.

Recommendation 9

A regional pool of resources such as oil pollution equipment and skilled personnel on pollution prevention should be established, so that each PICT does not have to stock these expensive equipment but buy only what each PICT has been agreed to stock.

Recommendation 10

All PICTs should be members of IMO so that they can input on any international maritime issue being discussed, and vote as a block to influence the decisions on those issues. It is important for the world maritime community to take note of small PICTs' concerns and they should be considered during the drafting stages, such as any over regulation proposals or the adoption of new conventions.

Recommendation 11

As one of the strategies to prevent marine pollution, PICTs should play their roles by focusing on the eight (meteorological events not included) external pollution risk indicators discussed in this research. Furthermore, as a high priority, to take the necessary measures to prevent marine pollution or improve the current situation of the marine environment of each PICT as indicated in the calculations of each pollution risk indicator.

Recommendation 12

A regional MOU on Port State Control inspections should be established in an existing regional organisation or an organisation such as proposed in Appendix 6 or an independent body, so that PICTs can share information and experiences in order to prevent sub-standard ships from being used in trade in the region.

Recommendation 13

PICTs need to comply with new SOLAS amendments to enhance maritime security, including the ISPS Code, in order to be able to trade with other countries of the world.

Recommendation 14

PICTs should raise the issue of fishing vessels being exempted under SOLAS in every regional and international forum with the view of amending SOLAS to apply also to fishing vessels. Many foreign owned fishing vessels are fishing in PICTs' waters and also visit PICT ports that may affect the security of other ships and the ports they visit.

Recommendation 15

In the context of ships carrying dangerous cargoes, PICTs should ensure that any ship carrying nuclear materials and radio-active wastes seeking a place or port of refuge in a PICT should be isolated in a safe place and then send away as soon as the emergency situation is rectified. The ship be escorted by a patrol boat until it leaves the PICT's EEZ and other PICTs must be advised of the ship and its cargo for monitoring purposes.

In concluding, the answer to the hypothesis "Can ship-generated marine pollution in the Pacific be identified?" is "Yes it can". There is adequate, reliable data in 1998, the base year of the research, that have enabled this researcher to construct a simple risk assessment model (SMPI) utilising scores on pollution risk indicators internal and external to the ship that identified the extent of risk of marine pollution in each PICT. It has also been shown in the research that new pollution risk indicators may be added on or existing ones deleted from the SMPI whenever the need arises, but the SMPI could still

be used in identifying any risk from a ship to cause marine pollution in each PICT. The answer to the supplementary question raised in the research, “Can prevention of the ship-generated marine pollution in the Pacific be achieved?” is again “Yes”. PICTs are currently adopting and implementing international regulations and standards on ships’ safety, security and the prevention of marine pollution despite experiencing problems such as lack of financial and skilled human resources. A regional approach as discussed in the research may be a viable option for PICTs to consider in addressing the lack of resources and other issues such as lack of political commitment and consultations between players in the maritime industry, including Governments and the private sector. The above recommendations, if followed and implemented, will ensure the sustainable use of PICTs’ marine resources and promote growth and development of their economies in the longer run.

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- ¹ A merchant ship (*Bouguenais*) has been used to transport spent fuel into France to prevent media exposure and legal injunctions by Greenpeace. This is quite different from the use of specifically built ships of the Pacific Nuclear Transport Ltd such as the *Pacific Teal* and *Pacific Pintail*.
- ² IMO appointed “competent persons” or maritime experts from Member States to vet submissions of other Member States to determine if they comply with the requirements of STCW 1978, as amended. The competent persons worked in groups of four or five people from 1998 to 2001 and the White List was completed by 1 February 2002 when the 1995 amendments entered into force.
- ³ A wide range of case law decisions have supported this statement.

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 - International Safety Management Code (ISM)
 - International Code of Safety for High-Speed Craft (HSC)
 - International Ship and Port Facility Security Code (ISPS)
 - Bulk Cargo Code (BC)
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APPENDIX 1

1. Conventions

A convention is an international agreement between States, and it is legally binding on any State as soon as it ratifies the convention. IMO uses the term “convention” in most of the international agreements (treaties) adopted under its auspices. “Agreement” is the term used for pledges between States with a more restricted scope than a convention. “Protocol” is an instrument amending the provisions of a convention that has not yet entered into force.

2. Adopting a Convention

IMO has no power to adopt international conventions and it can only recommend, incite or persuade States to adopt a draft convention. Only member States of IMO may all or in some cases, the majority agree in a diplomatic conference to adopt a draft convention. Procedural steps have to be undertaken by IMO before a diplomatic conference is convened to adopt it. This would involve IMO’s six main bodies on matters related to conventions and their implementation:

- The Assembly is the governing body of IMO and comprises of all member States. Each State is accorded one vote each. Decisions are taken either by a single majority or a qualified majority of two thirds of the members present, depending on the issue under debate. It meets once in every two years but extraordinary sessions can be held when necessary.
- The Council contains 40 members: eight members elected from ship owning States; 12 from chartering States; and 20 States to ensure fair geographical representation. It

meets whenever and wherever it wishes, as convened by the Chairman or at the request of at least four members. It takes care of IMO's functions between Assembly sessions, except for maritime safety questions. Furthermore, it can refer to the four technical committees any matter that it wishes to be advised on.

- The Maritime Safety Committee (MSC) is the highest technical committee in IMO. It deals with any matter directly related to maritime safety. Its membership is open to all IMO members and it meets at least once a year or when at least five members so wish. At each annual session, its officers are elected and its rules of procedure established. Specialised subcommittees are sometimes set up by the MSC to look into a particular safety issue. Subcommittees may set up working groups, in practice usually ten delegations, to study particular problems.
- Legal Committee is responsible for any legal matter within the jurisdiction of IMO. It operates the same way as the MSC.
- Marine Environment Protection Committee is charged with considering any matter concerned with the prevention and control of pollution from ships. It also operates the same way as the MSC.
- Facilitation Committee was set up to eliminate unnecessary paperwork and red tape to international shipping.

A State or a group of States or an international organisation may make proposals for a new convention or amendments to existing conventions. Any proposal is usually submitted to the relevant Committee where it is vetted and at times referred to subcommittees or working groups for detailed perusal. Once a Committee is satisfied with a draft proposal it is then submitted to the Council or Assembly, as the case may be, which gives authorisation to seek from States or other organisations any advice or opinion to draw up a draft instrument. The draft convention that is agreed upon is

reported to the Council and the Assembly with a recommendation that a conference be convened to consider the draft for formal adoption. If the Council and the Assembly clears the holding of a diplomatic conference, the draft convention is circulated to member governments and relevant organisations for their comments. A date is then set for a diplomatic conference and member States are invited to send representatives and from other international organisations, observers. The draft convention and government comments are tabled in the conference. When a final draft is agreed upon it is adopted by the conference and deposited with the Secretary General who sends copies to governments. The convention is then open for signature by States, usually for a period of 12 months. It may take several years from drafting to adoption, for example, STCW 1978 took five years, but it may take a shorter period if the case warrants.

3. Entry into Force

The adoption of a convention is the first step in the process of it becoming accepted as international rules and standards. In order for the convention to become enforceable it must be accepted formally by each government and, in addition, certain conditions laid down in the convention for it to come into force must also be met. These conditions vary but generally speaking, the more important and more complex the convention the more stringent are the conditions for its entry into force. For example, SOLAS 1974 required acceptance by 25 States whose merchant fleets comprise not less than 50 per cent of the world's gross tonnage; as compared to the Special Trade Passenger Ships Agreement, 1971, that came into force six months after three States (including two with ships or nationals involved in special trades) have accepted it. When the appropriate conditions have been fulfilled, the convention enters into force for the States that have accepted it. For the important technical conventions it is critical that as many States as possible have accepted them as they enter into force to prevent a confusing situation where only few States implement them but the majority of States do not.

Accepting a convention does not end when a formal instrument is deposited but the beginning of a process of implementation measures required under the convention. A State has to enact laws or change national laws to enforce the provisions of the convention. Often times special facilities have to be provided; personnel trained for implementation purposes; and adequate notices must be given to ship owners, ship builders, and other interested parties for their information and necessary actions.

4. Signature, ratification, acceptance, approval and accession

The above terms refer to some of the ways that a State can express its consent to be bound by a treaty. A brief discussion of the terms is as follows:

- Signature – Consent may be expressed by signature where: the treaty provides that signature shall have that effect; it has been established that negotiating States have agreed that signature should have that effect; the intention of the State to give that effect to signature of its representative during the negotiations.

A State may also sign a Treaty “subject to ratification, acceptance or approval”. In such case, signature does not express the consent of a State to be bound by the treaty. However, the State is obliged to abstain from acts that would defeat the intent of the treaty until such time that it has made its intention clear not to become a Party. Many States today choose this option, especially multilateral treaties, as it gives them an opportunity to ensure that any necessary legislation is enacted and other constitutional requirements fulfilled before entering into treaty commitments.

- Acceptance, approval, and ratification - Basically, acceptance and approval mean the same as ratification but they are less formal and non-technical and might be preferred by some States that might have constitutional difficulties with the term ratification.

The Vienna Convention of the Law of Treaties provides in Article 14.2 that “the consent of a State to be bound by a treaty is expressed by acceptance or approval under conditions similar to those which apply to ratification”. Ratification is done by a State following the incorporation of a convention into national law, after being subjected to parliamentary scrutiny.

- Accession – Most multinational treaties are open for signature by a specified time. Accession is the method used by a State to become a Party to a treaty that it did not sign during the time the treaty was open for signature. Usually, accession requires a State to deposit an instrument of accession with the depository.

5. Amendment

As new technologies are increasingly being used in the maritime sector the provisions of existing conventions need to be changed to incorporate the changes. Furthermore, the present provisions need regular revision to keep them up to date with today’s thinking and needs. The updating involves the amendment of existing conventions by means of protocols or amendments. A protocol is generally used to amend instruments that have not yet enter into force, or to change the provisions of an existing treaty which cannot be covered by the tacit acceptance procedure. Amendments are commonly used when small changes are required to conventions as they could be implemented in a relatively short time than protocols, using either the express or tacit acceptance or accelerated methods.

- Express (some people use the word ‘explicit’ instead of express but they have the same meaning) acceptance provides for two procedures of amending non-technical parts of the text: firstly; amendments after being considered within IMO (as in SOLAS Article VIIIb). A contracting State may submit an amendment to the MSC and it is adopted by a two third majority present and voting. Amendments are then circulated to contracting governments for acceptance and they come into effect on the

date they are accepted by the governments. Secondly, amendments after being considered by a conference and agreed upon by at least one third of the contracting States, as done in SOLAS Article VIIIc. An international conference is then convened by IMO to consider the amendments and adopted by a two third majority of the States present and voting. The express acceptance procedure was working well before the Sixties but as new independent States greatly increased so was the corresponding rise in States that were parties to multilateral conventions. The result was that an amendment by the express acceptance method proved almost impossible to achieve. Amendments to the SOLAS 1960 did not come into force as the two third majority could not be fulfilled, so, IMO devised a new amendment procedure (tacit acceptance) in 1974 to address this problem and it was approved by the Assembly to be used. Many of IMO conventions have an express acceptance component in the Articles and a tacit acceptance component in the Annexes and Appendices, especially in the technical conventions.

- Tacit acceptance method is more simple than the express acceptance method and it is most suitable for amending technical conventions to keep pace with new technologies. This new procedure provides for it to come into effect on an agreed date stipulated in the convention. If a certain number of contracting States (usually with a provision such as that these States constitute not less than 50 per cent of the gross tonnage of the world's merchant fleet) raise objections before that date, then the convention is not accepted. The tacit acceptance procedure renders several advantages: firstly, the date that an amendment will enter into force is known to all interested parties as soon as it is adopted. Secondly, all State parties are invited to the amendment conference where a convention is adopted by consensus or by a single majority. Thirdly, amendments come into force much quicker than the express acceptance method. For example, after the Herald of Free Enterprise capsized, IMO in April 1988 adopted amendments that came into force by 22 October 1989 and this was not possible in the express acceptance method. The tacit acceptance method is used mainly in amending of technical conventions.

- In recent years IMO is trying to reduce further the time needed for amendments to SOLAS Convention to enter into force. The practice now is to circulate to contracting States the proposed amendment six months before adoption and cannot enter into force until at least eighteen months has elapsed. At its 62nd session the MSC agreed to reduce only in exceptional cases that the circulation period be reduced from six to three months, the waiting period from eighteen to twelve months, and the time between publication of the convention and implementation from twenty four to fifteen months. Contracting States in the conference in 1994 agreed to adopt the accelerated amendment method only in exceptional circumstances, and a conference can reduce from twelve to six months the period that must elapse before an amendment to technical chapters of SOLAS is deemed to have been accepted.

6. Implementation

The implementing of international conventions is the responsibility of the States that have ratified them and should be done in good faith. States should provide enforcement provisions, by creating offences and fines, when a convention is incorporated into national law to give it a 'teeth'. Each convention defines the content and exact obligations of contracting States. Incorporating conventions into national legislation is the key to success of implementing them. Furthermore, to ensure that the provisions of conventions are being implemented with adequate resources to achieve the designed goals and also in line with interpretations of other contracting States. Many contracting States do not carry out their obligations under a convention and those States that do sometimes face different interpretations.

IMO conventions on average, take five to seven years from date of adoption to that of entry into force. The coming into force of a convention does not necessary mean that it is enforced right away. Administrative matters have to be addressed such as processing it

through the official channels up to enacting of legislation that would take some time to accomplish. Furthermore, some countries such as Tonga requires the English version to be translated into Tongan before it is tabled in parliament and this process takes at least one year to complete.

When a convention enters into force many States do not apply fully and consistently its provisions due to a number of reasons. Translation problems arose from the large number of languages involved and inaccurate translations may give different and divergent interpretations of the same standards. Technical conventions sometimes give some leeway to contracting States in approving equipment or material to be used onboard ships that are equal or better than those prescribed in the conventions. This would open the door to wide interpretations and different standards. Since there is no international court or international case law the interpretation of judges create case laws that reflect the national interests of a contracting State and this may change in future. Contradictions in case law decisions can occur in national law and it is therefore assumed that it will be worse in an international law context.

Ship owners and shipyards can experience serious problems when there are differences in interpretations and enforcement of international technical conventions. The technical conventions apply to different types of ships in different time frames depending on when an amendment or a new convention entered into force. When a contracting State does not apply the provisions of an international convention to its ships properly it creates a lower standard than is required. Although control of ships still remain with a State, other States that ships of the State in question is visiting, has the right to control and ensure that those ships have at least the same standards as required by the conventions. IMO has initiated these control measures in various IMO conventions.

7. Resolutions and non-binding instruments

Two other sources of regulations exist beside conventions and treaties: they are regulations passed by diplomatic conferences, and other instruments adopted by international organisations.

- Diplomatic conference resolutions is being increasingly used by IMO for various reasons. It offers a way for States to reach an agreement on a controversial technical standard that is needed by the industry to be implemented as soon as possible. Furthermore, they contain important ideas expressed by States' representatives that were not included in the convention but are increasingly important. Resolutions is part 'soft law' and they have certain legal weights and are usually included in an amendment or a revision of a convention.
- Recommendations made by IMO can be divided into three categories:
 - Codes and technical regulations, containing standards, inspection procedures, rules of conduct and studies covering every aspect of safety at sea.
 - Resolutions that do not create standards but explaining and commenting about existing standards.
 - Guidelines that define goals to be achieved but leave the means of achieving them to each State.

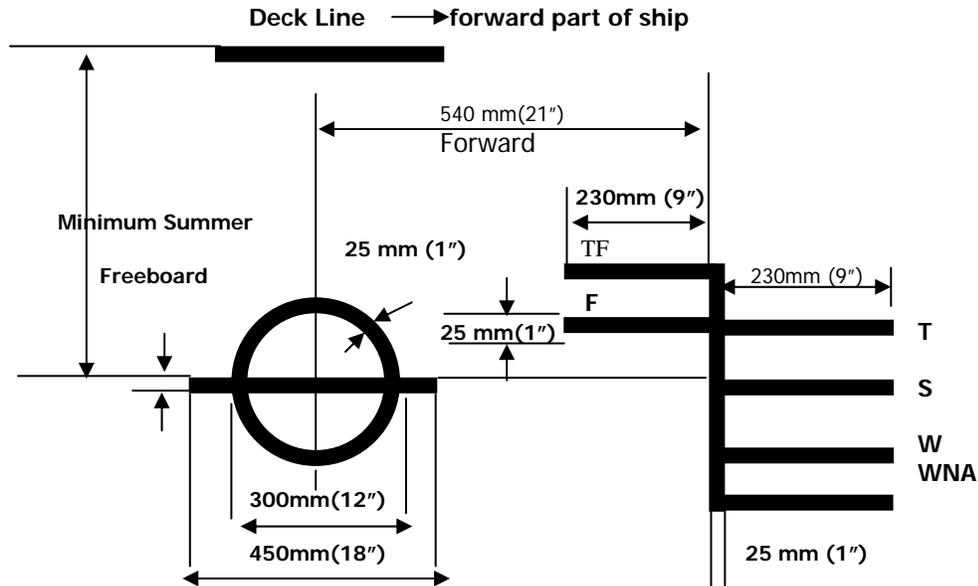
The words "recommendations", "resolutions", "codes", "manuals", "practices" and "guidelines" have no element of legal obligation attached so States are not bound to implement them. States are only required, as a moral obligation, to incorporate the resolution to the degree that is possible and reasonable (but their effects are not blocked) under their legal systems. In other words, the State remains in absolute control of the standard setting process. Despite their lack of enforceability, IMO recommendations are useful in three ways:

- They can give legal weight to some private rules or practices or facilitate their practical implementation.

- They may serve as basis to future mandatory regulations or for establishing amendments.
- The effectiveness of resolutions depends largely on the trust placed by States on the organisation promulgating them and its moral authority, such as that of IMO concerning safety at sea.

Most of IMO's recommendations deal with safety and security at sea and the protection of the marine environment. Three of IMO's bodies often times issued recommendations that are usually advice to States to adopt certain regulations or amendments. Many States adopt IMO recommended regulations or amendments and incorporate them in their national laws. The Assembly has been granted this power in Article 15 of the 1948 Convention. Since Resolution A.736 of 1977, the MSC has been granted the same power especially in dealing with traffic separation schemes, and similarly with the MEPC in Articles 38 and 39 of the 1948 Convention.

APPENDIX 2



Load Line Mark (Plimsoll mark) and lines to be used with this mark

Symbols

Summer (S); Winter (W); Winter North Atlantic (WNA); Tropical (T); Fresh Water (FW); Tropical Fresh Water (TFW). These load line symbols indicate the maximum allowable draft in the concerned zones and seasonal conditions and the upper part of the respective lines must not be submerged. Load line marks are placed at the forward and aft side of the Plimsoll mark on the port and starboard side respectively.

Source: International Convention on Load Lines, 1966

APPENDIX 3

1. Calculating the Navigation Safety Measure

The following calculations were originally carried out under the Marine Pollution Risk Assessment for the Pacific Islands Region study sponsored by SPREP (acknowledged in the References part) and it is reproduced here to explain the MSD data used in the Coastal Sea Routes and Port Passages (Paragraph 4.2.3). For detailed information, including the environment for simulation consult Part 7 (Risk Analysis at the Ports Scale) of the above study.

PICT Ports	Physical Constraints	Ship Handling Characteristics	Positioning	Minimum Safe Design (MSD)	Channel Width (CW)	Safety Measure (CW/MSD)	Ship size used in simulation (in DWT)
Apra	160 ft	179 ft	50 ft	389 ft	900 ft	2.3	46475
Majuro	136	163	100	399	800	2.0	46475
Tarawa	79	329	50	458	600	1.3	10553
Port Moresby	155	504	50	709	1300	1.8	31950
Honiara	198	65	50	313	450	1.4	31950
Suva	128	154	50	332	1300	3.9	46475
Apia	200	145	75	420	700	1.7	31950
Nuku - 'alofa	161	369	547	1077	1980	1.8	13320
Pago Pago	91	142	50	283	900	3.2	31950

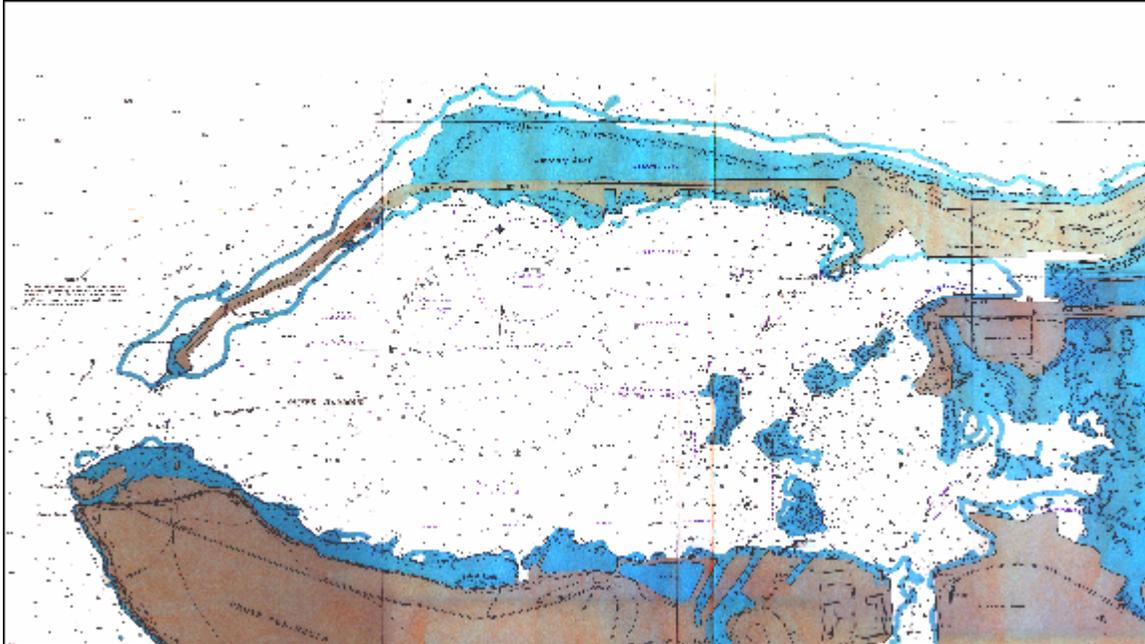
Source: SPREP's Marine Pollution Risk Assessment for the Pacific Islands Region

Note: The Security Measure used in the above Study has been renamed by the author as Safety Measure to prevent confusion when Security Measure is used under the ISPS Code.

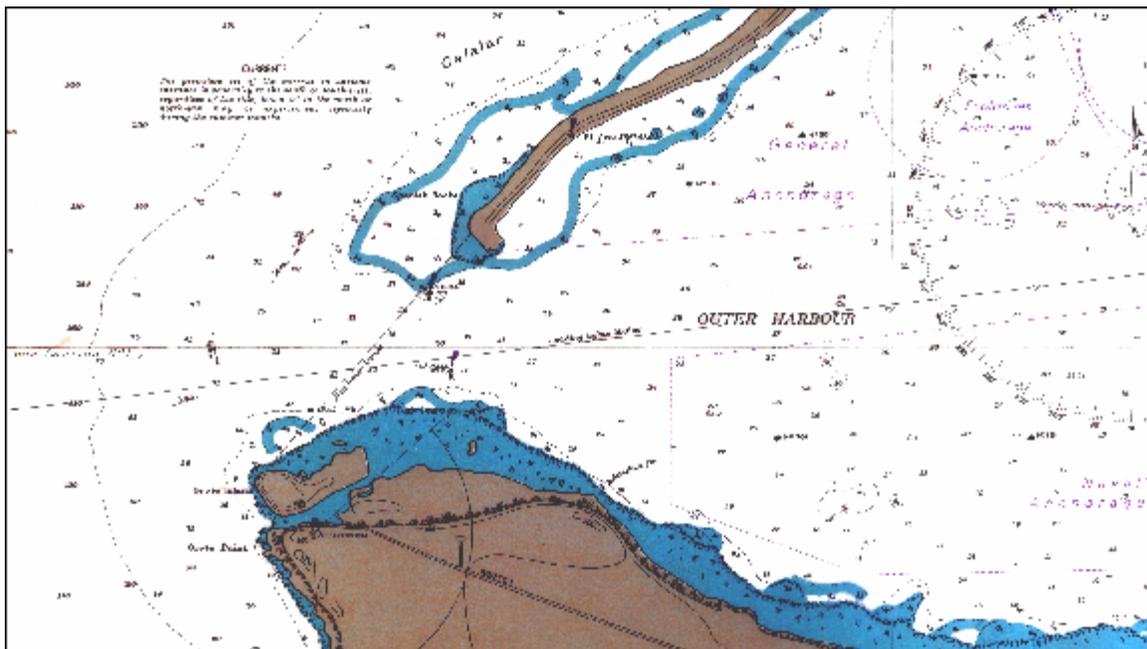
2. Nine PICT Ports and Appropriate Navigation Charts

The copies of the nine PICTs port charts are attached. They were reproduced from the appropriate charts appearing under Part 7.2 of the above study.

COUNTRY	Guam
PORT	Apra Harbour
HIGH RISK WATERWAY	Outer Harbour entrance

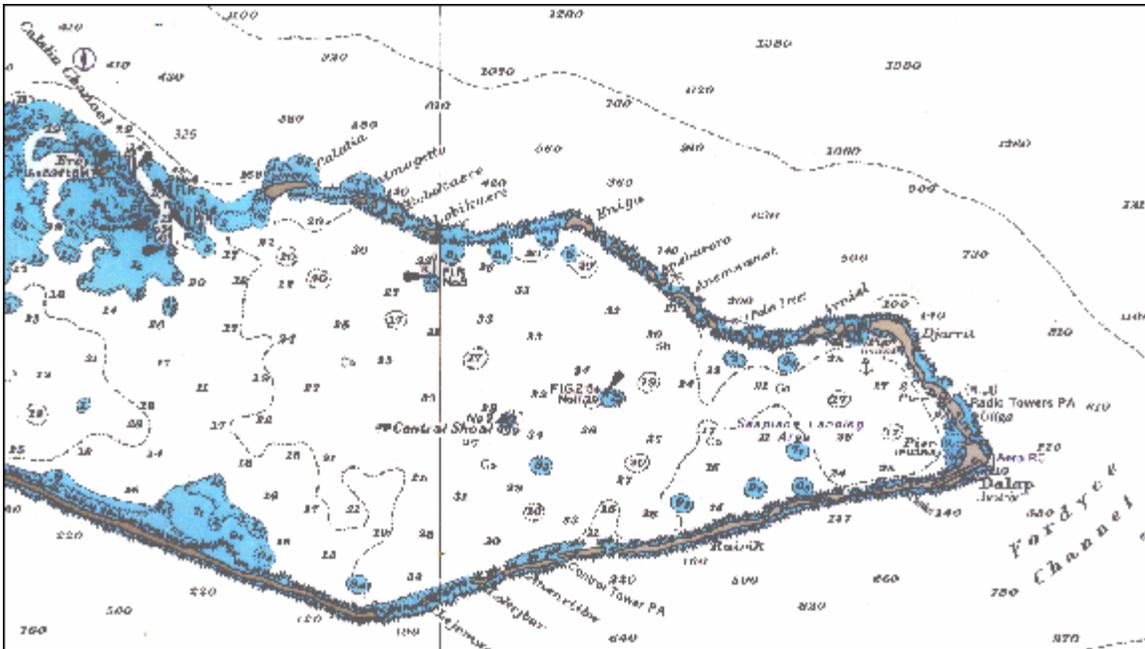


Apra Harbour

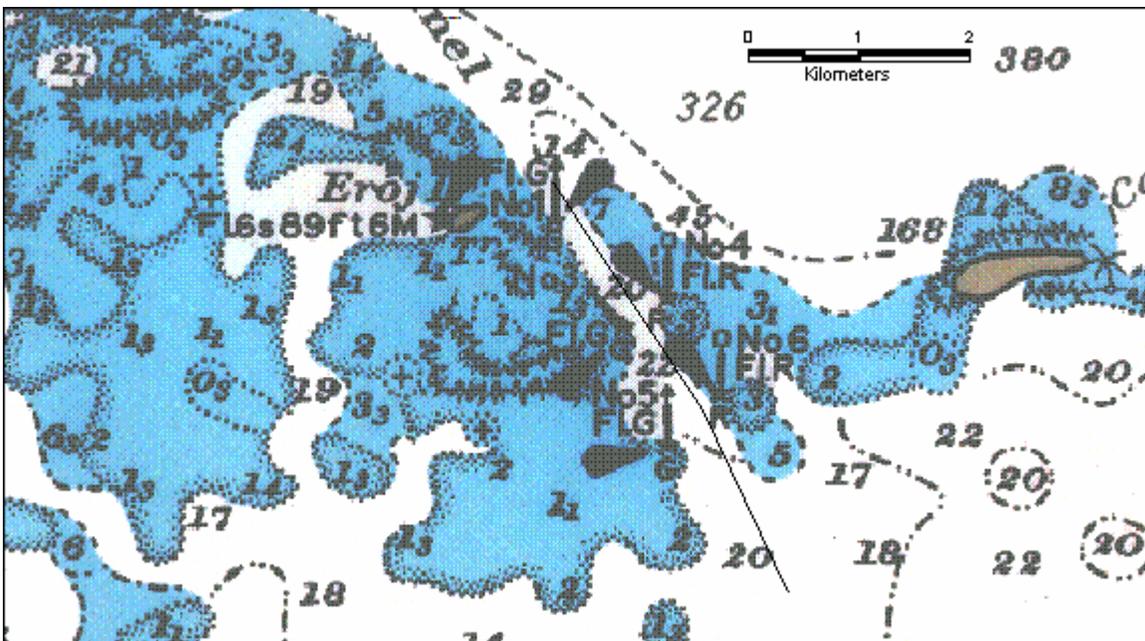


High risk waterway: Outer Harbour Entrance

COUNTRY	Republic of Marshall Island
PORT	Majuro
HIGH RISK WATERWAY	Calalin Channel

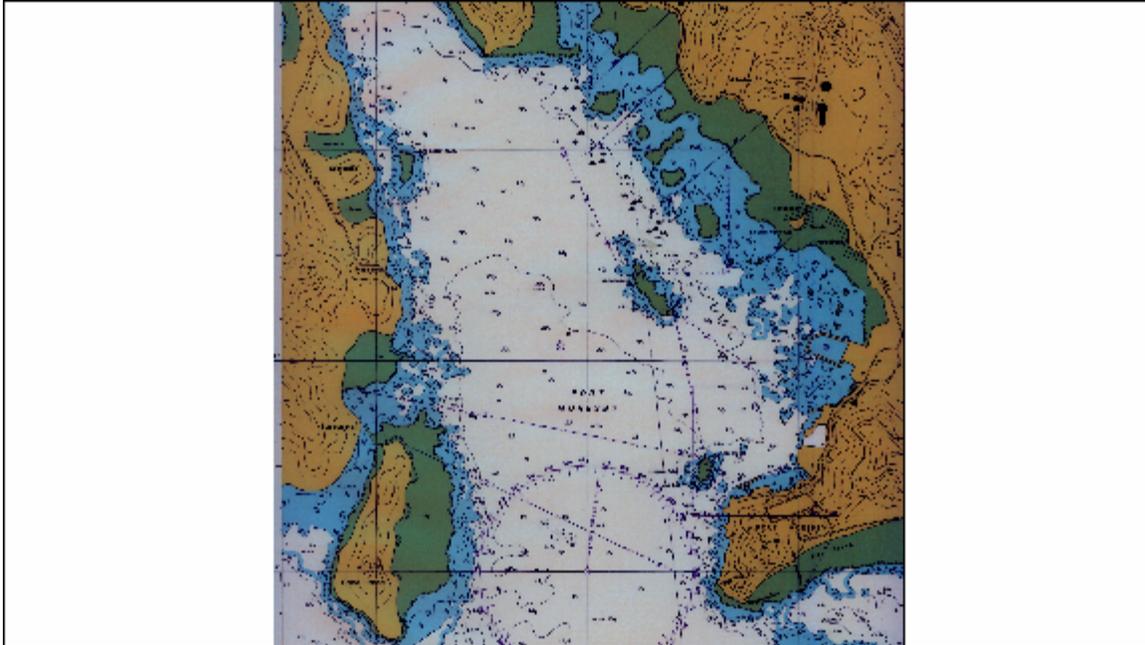


Majuro Atoll.

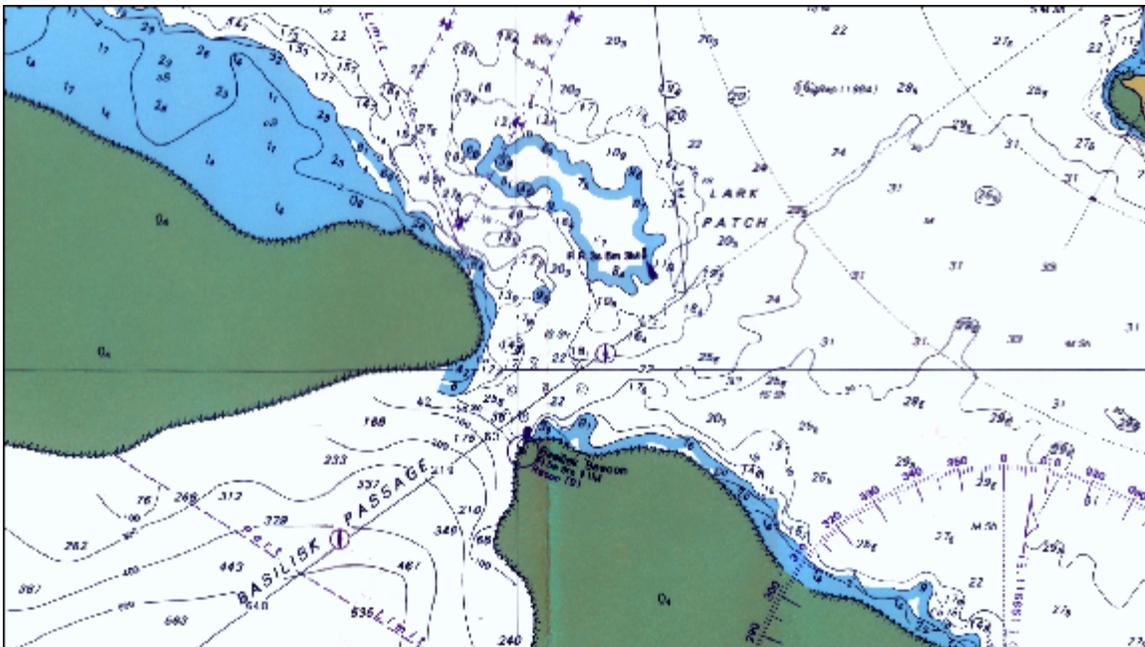


High risk waterway: Calalin Channel

COUNTRY	Papua New Guinea
PORT	Port Moresby
HIGH RISK WATERWAY	Basilisk Passage—Lark Patch Turn

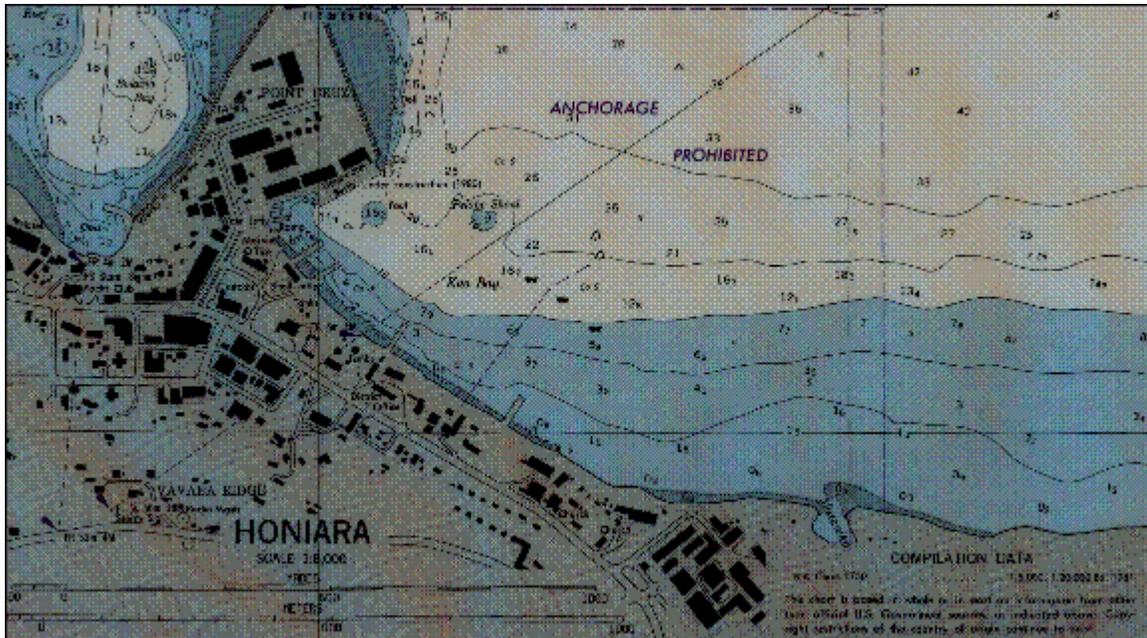


Port Moresby.

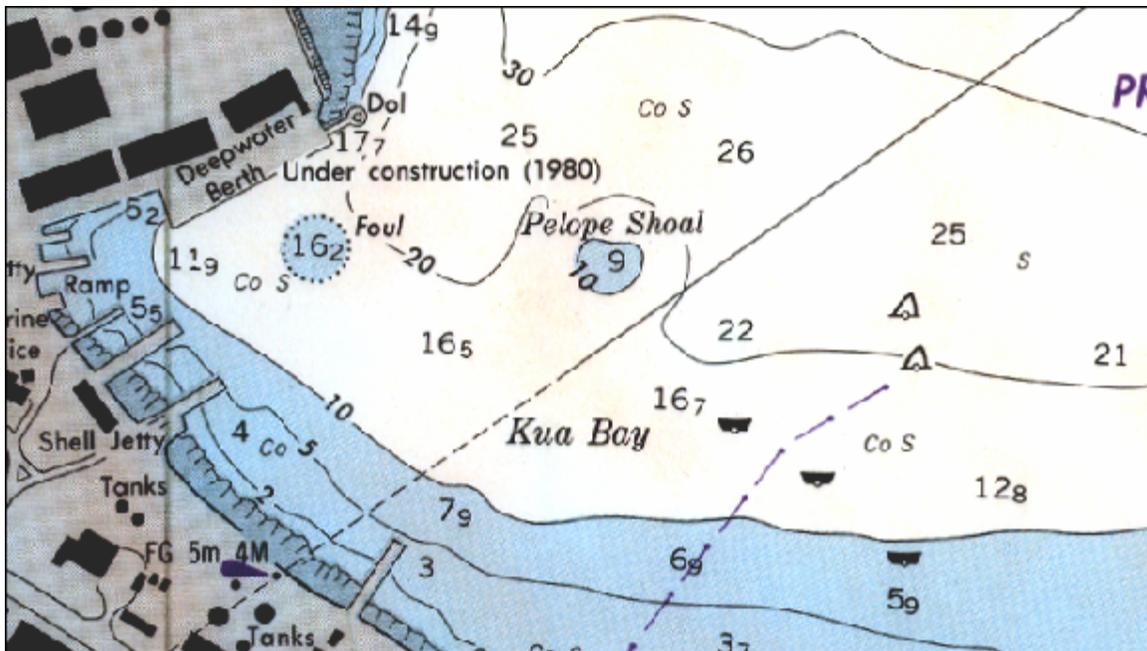


High risk waterway: Basilisk Passage, Lark Patch.

COUNTRY	Solomon Islands
PORT	Honiara
HIGH RISK WATERWAY	Approach to tanker moorings

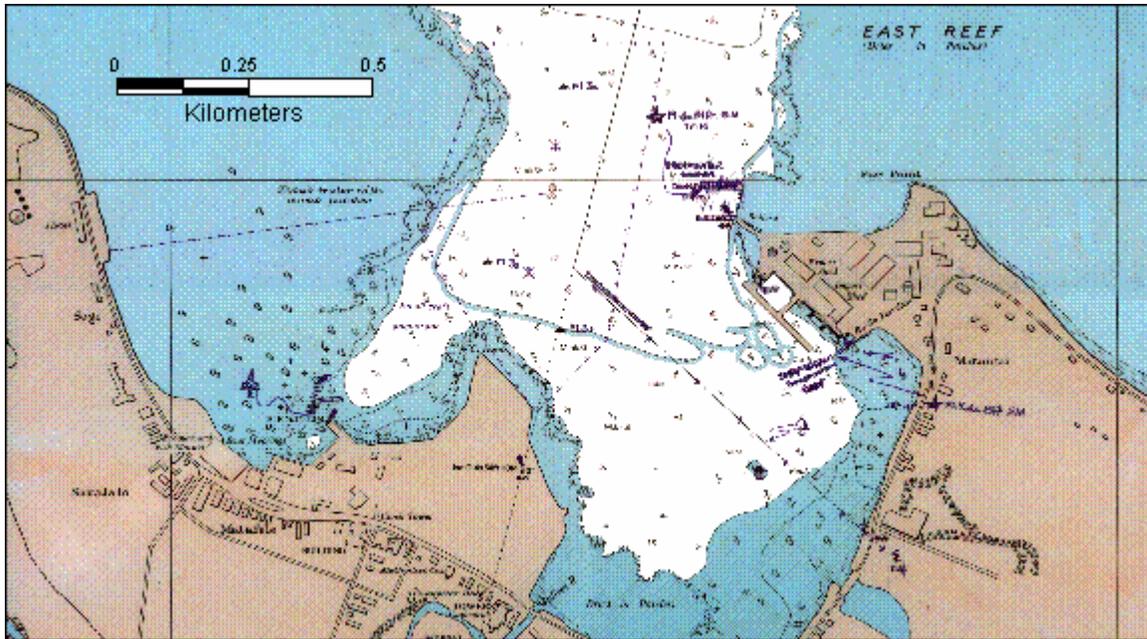


Honiara.

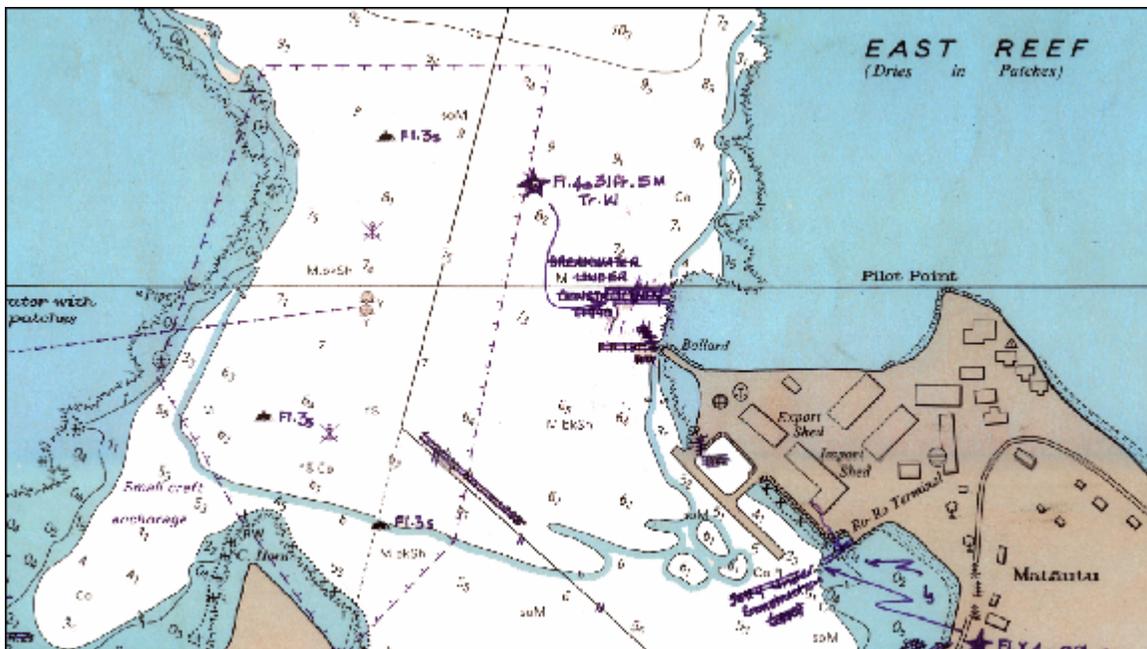


High risk waterway: Approach to tanker moorings.

COUNTRY	Samoa
PORT	Apia Harbour
HIGH RISK WATERWAY	Reef passage to mooring buoys

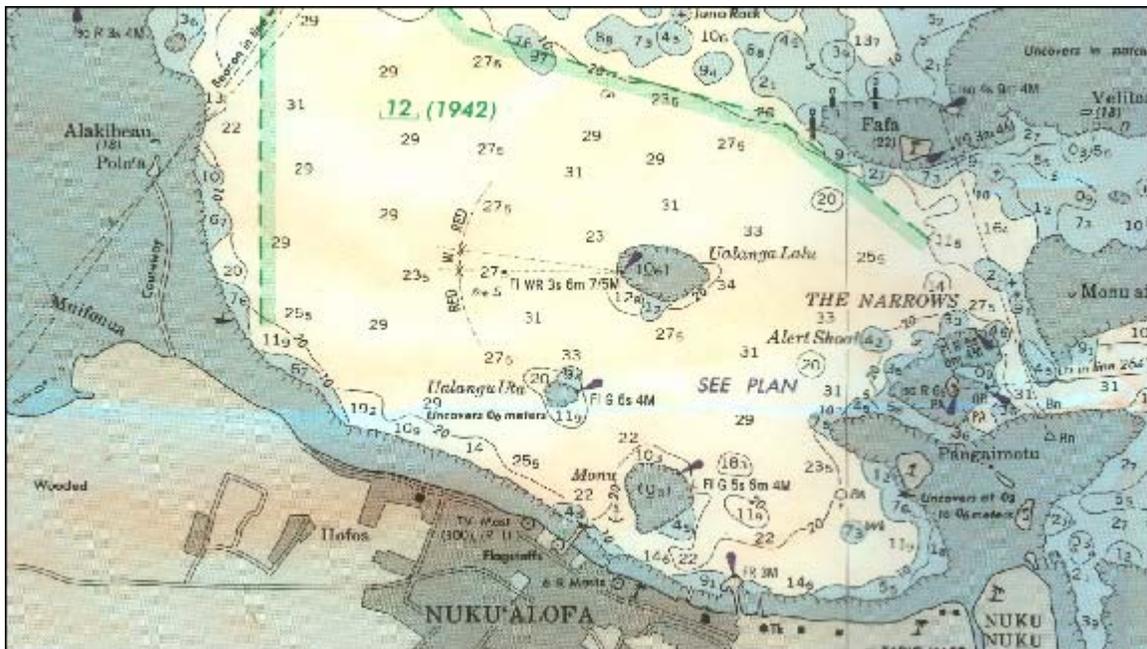


Apia Harbour.

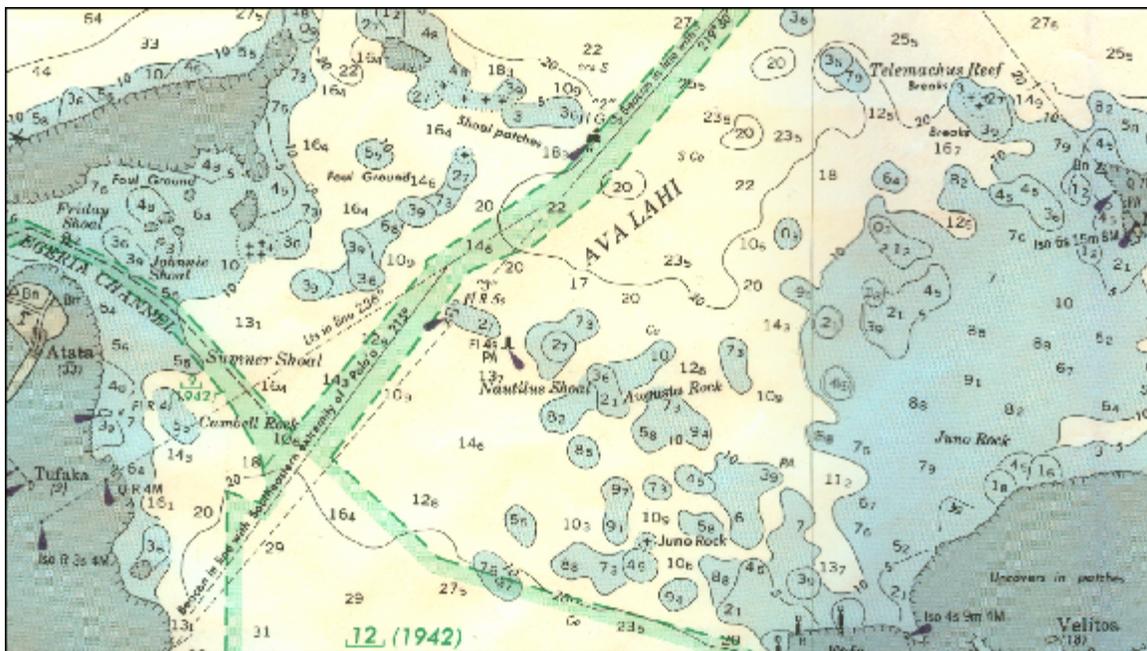


High risk waterway: Reef Passage.

COUNTRY	Kingdom of Tonga
PORT	Nuku'alofa
HIGH RISK WATERWAY	Ava Lahi Passage—turn to 215°

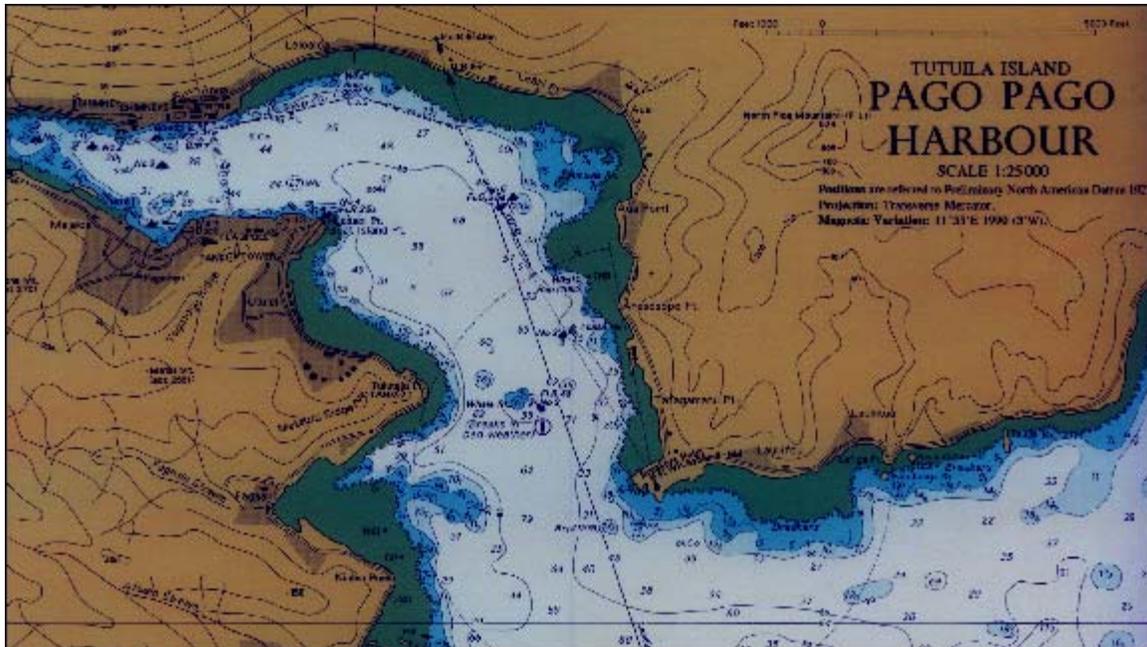


Nuku'alofa Harbour.

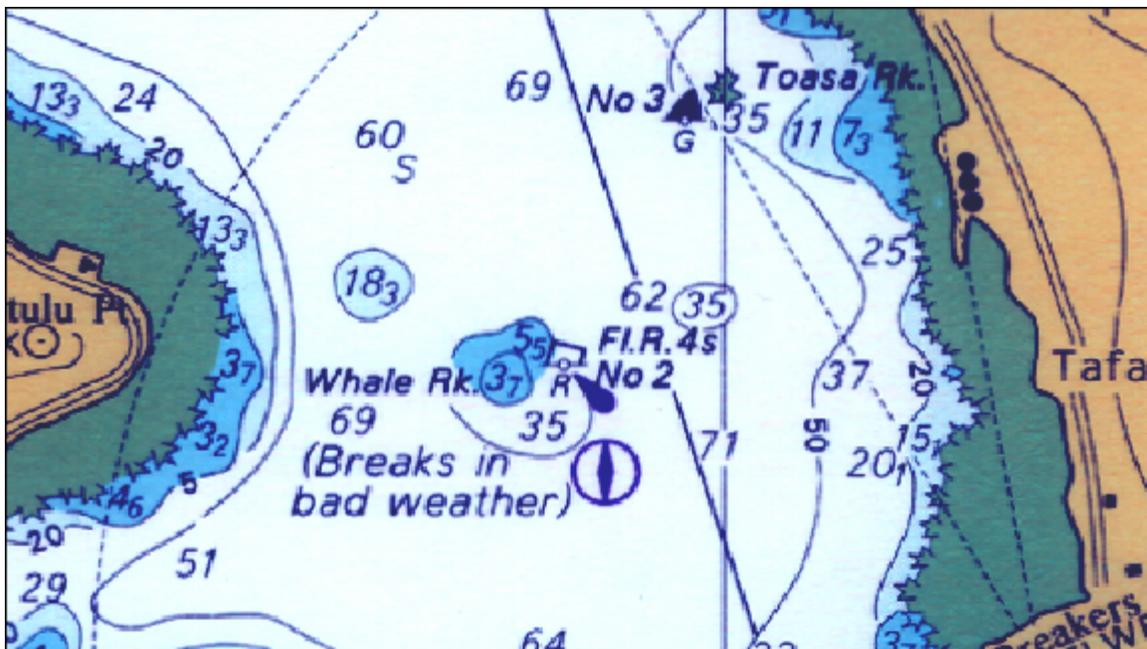


High risk waterway: Ava Lahi Passage—turn to 215°

COUNTRY	American Samoa
PORT	Pago Pago Harbour, Tutuila Island
HIGH RISK WATERWAY	Harbour entrance

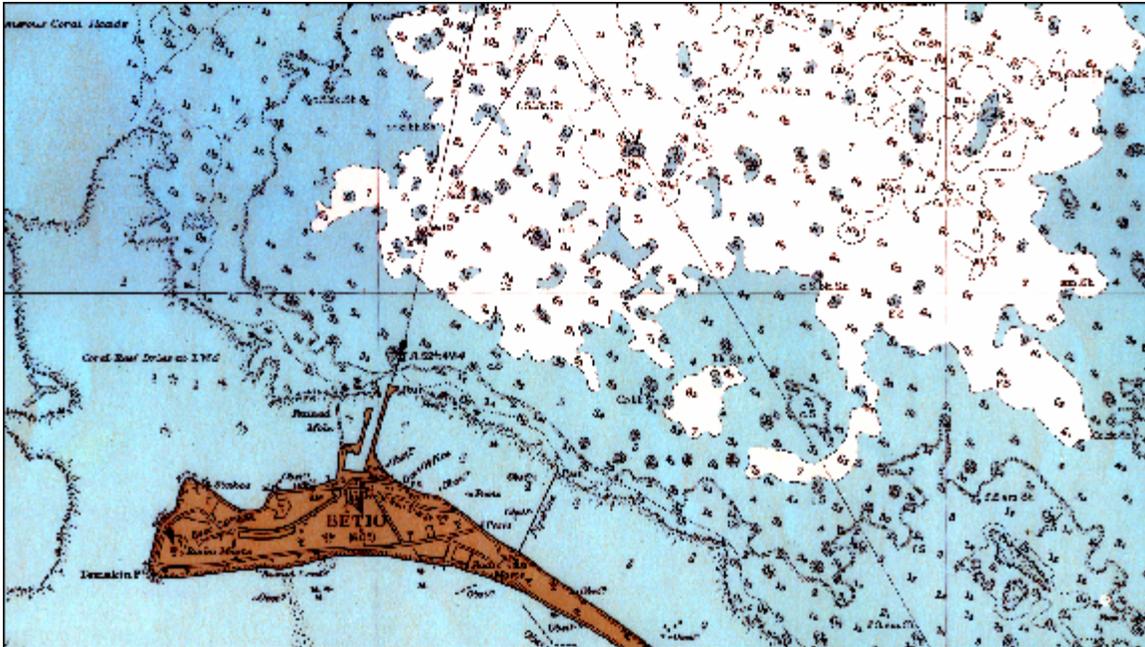


Pago Pago Harbour.

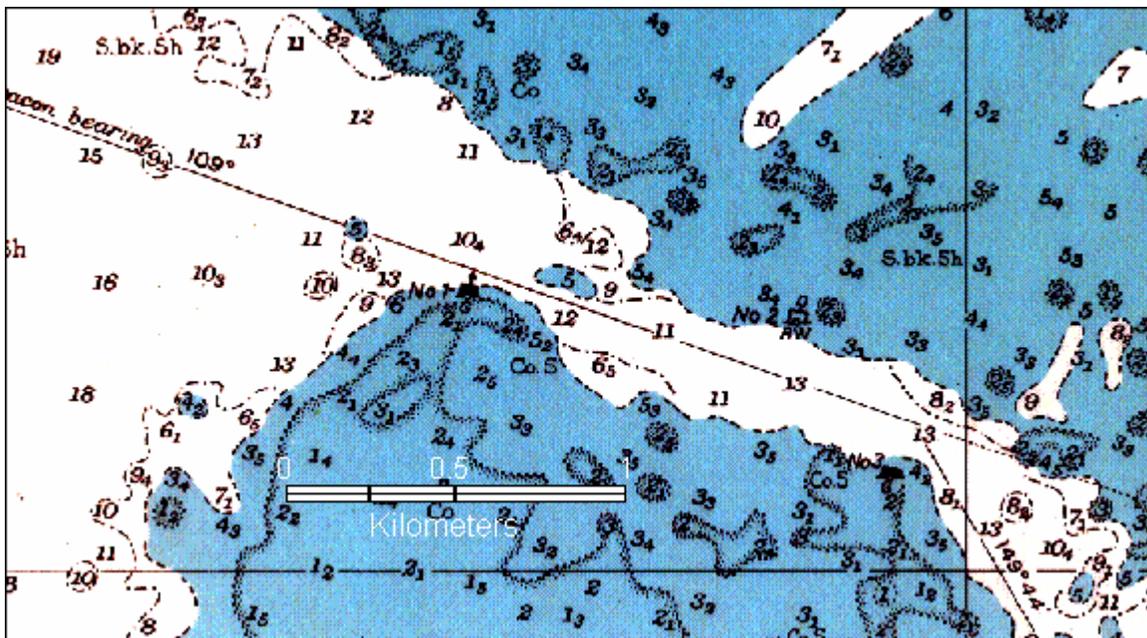


High risk waterway: Entrance to Pago Pago.

COUNTRY	Republic of Kiribati
PORT	Betio Island, Tarawa Atoll
HIGH RISK WATERWAY	Betio Entrance



Betio Anchorage.

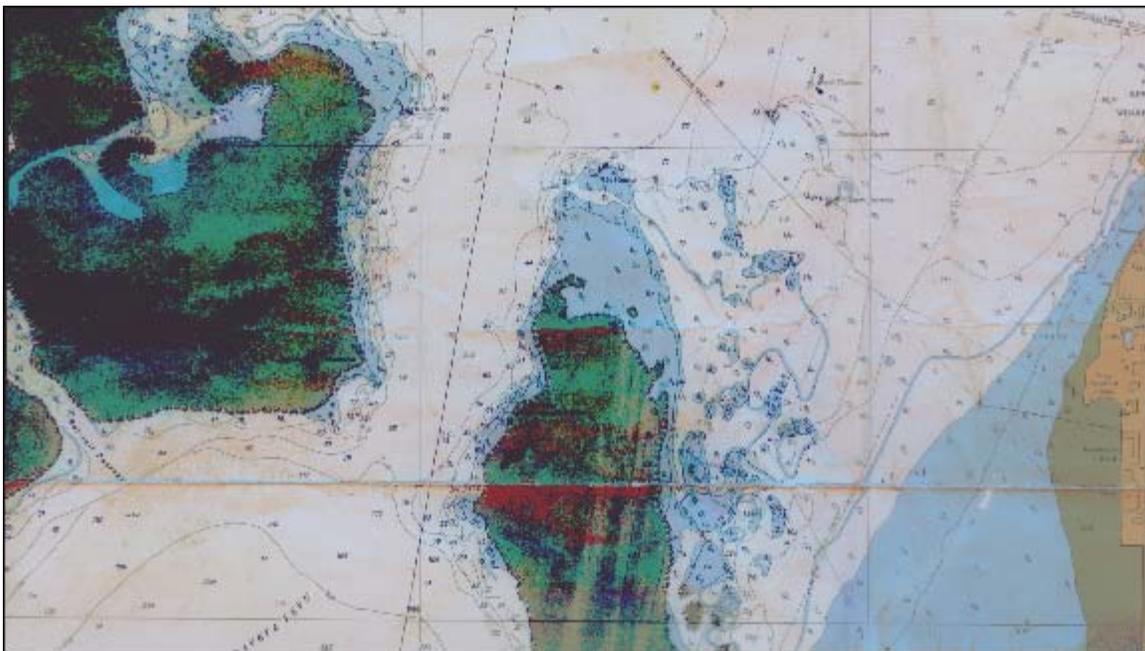


High risk waterway: Betio Entrance

COUNTRY	Republic of Fiji
PORT	Suva
HIGH RISK WATERWAY	Levu Pass



Suva.



High risk waterway: Levu Pass.

Port	Ship Type	Bunker		Ship	Appendix 5	
		Length	oil in tonnes		Total Bunker oil in tonnes	Each Port Total B/ oil in ton.
Pago Pago	1 Group 1.1		230 2500	12	30000	
	Group 1.2		48 80	56	4480	
	Group 2		163 1723	110	189530	
Apia	Group 3		178 1596	24	38304	
	2					
	3	70	200	144	28800	291114
Nuku'alofa	1 Group 1.1		230 2500	12	30000	
	Group 1.2		48 80	56	4480	
	Group 2		163 1723	110	189530	
Tarawa	Group 3		178 1596	24	38304	262314
	2					
	3					
Majuro	1 Group 1		230 2500	12	30000	
	Group 2		163 1723	110	189530	
	Group 3		75 126	24	3024	222554
Apra	2					
	3					
	1 Group 1		230 2500	22	55000	
Honiara	Group 2		200 2400	301	722400	
	Group 3		178 1596	88	140448	
	2					
Suva	3	75	126	2205	277830	1195678
	1 Group 1		220 4168	5	20840	
	Group 2		170 3900	202	787800	
Port Moresby	Group 3		195 1356	91	123396	
	2					
	3	70	452	180	81360	1013396
Grand Total	1 Group 1		230 2500	35	87500	
	Group 2		170 3900	518	2020200	
	Group 3		195 1356	297	402732	
Grand Total	2					
	3	75	126	391	49266	2559698
	1 Group 1		220 4168	5	20840	
Grand Total	Group 2		180 943	363	342309	
	Group 3		195 1356	241	326796	
	2					
Grand Total	3	75	<u>126</u>	<u>132</u>	<u>16632</u>	<u>706577</u>
	Grand Total		52585	6278	6452673	<u>6452673</u>

Note: Type 3 Vessels (fishing vessels) total fuel oil onboard for six PICT ports = 502 398 tonnes which is equivalent to about 7.8% of total amount of fuel oil onboard all for all vessels i.e 6 452 673 ton

APPENDIX 6**Proposal for the Establishment of a Regional Maritime Transport
Organisation in the Pacific****1. Introduction****(a) Background**

It has been estimated that over 90 per cent of the global trade and over 95 per cent of the Pacific Region trade is conducted through the maritime transport sector. The Pacific region covers a sea area of approximately 32 million square kilometers and 0.55 million square kilometers of land area, and a total population of approximately 7.6 million. From the above information, the importance of the maritime transport sector in the global and regional economies stands out. The sea to land ratio of 58:1 tells the story of the Pacific region – its small islands, remoteness, and the vastness of the Pacific Ocean that stretches from the extremities of the Northern Hemisphere to that of the Southern Hemisphere.

The maritime transport sector has served as the lifeline to Pacific island countries since time immemorial in terms of trade, food supply and protection from marauding enemies. Today the critical roles that the maritime transport sector traditionally contributed to in the Pacific region have not diminished in value but are facing new challenges. Some of the challenges are to comply with international regulations that involve institutional, structural, technological and regulatory changes. These changes require sufficient trained human and financial resources, both of which are grossly inadequate and underdeveloped.

(b) Proposal Rationale

Having discussed above the constraints in the maritime transport sector in the Pacific region, the only logical measure to be adopted is to create a regional maritime transport sector organisation to assist individual Pacific island countries in - complying

with international regulations and adopting global standards. At the present time, maritime transport sector activities are spread over a number of existing regional organisations, maritime training and legal programmes are being conducted through the Secretariat of the Pacific Community (SPC). Marine pollution prevention programmes is run by SPREP. ESCAP provides some consultancy assistance. These are ad hoc arrangements that dilute the importance of the maritime transport sector in the region.

When one looks at the global scene, the International Maritime Organization (IMO) is the United Nations specialised agency that looks after the maritime transport sector. It has five committees that reflected the key issues that maritime nations world-wide are concerned about. They are the Maritime Safety Committee, Marine Environment Protection Committee, Legal Committee, Technical Co-operation Committee and Facilitation Committee. By having these functional requirements operating under one body, plans will be better coordinated and more focused resulting in better implementations and the achievement of objectives. In Africa, the Carribean and the Mediterranean regions, regional organisations are set up to facilitate the emerging requirements and reaching of national aspirations of the maritime transport sector in the countries in those regions. Improvements have been experienced in sub-sectoral activities such as in shipping and port safety, maritime security, and the prevention of marine pollution.

2. Principles for Regional Cooperation

The following principles are proposed to be taken into account in the setting up of a regional maritime transport organisation :

- a) preservation of the sovereignty of independent Member States.

- b) harmonized and co-ordinated maritime transport sector policies for all Member States, so that all activities in the sector become more efficient and more effective.
- c) solidarity of Member States in pursuing issues of concerns in international fora.
- d) efficient and effective delivery of maritime services that are appropriate to the needs of Member States.
- e) sector activities are geared towards meeting requirements of international regulations, the promotion of economic and social developments.

3. Strategic Objectives

- a) To ensure that the integrity of Member States sovereign rights are maintained.
- b) To define maritime sector policies for the region that:
 - (i) promote safety at sea, maritime security and the prevention of marine pollution;
 - (ii) ensure that cooperation and harmonization between Member States;
 - (iii) enhance the development of sustainable and efficient shipping and port services in the region; and
 - (iv) integrate all activities in the maritime sector to provide efficient, effective and economic delivery of services to the maritime community and to the broader public/users. This would eliminate ad hoc decisions involving ports, shipping services, employment of seafarers, safety of shipping,

search and rescue, hydrography, aids to navigation, facilitation of maritime traffic, pilotage, ports administration and port productivity.

- c) To hold annual (or regular) meetings with a view to decide on a common position by Member States on international issues of concern, including:
 - (i) consultations on proposed international maritime conventions, to determine the impact on Member States.
 - (ii) the decision and response of Member States to the proposed conventions.
 - (iii) the best means of implementation of international maritime conventions that Member States are parties to
 - (iv) the development of policies and measures in international fora that will benefit and promote the interests of Member States.
- d) To formulate strategies to promote the efficiency and effectiveness of the maritime sector in Member Countries, including:
 - (i) collaboration with other sectors that have interest in the maritime transport sector, such as tourism and trade.
 - (ii) implementation or adoption of internationally recognised best practices in shipping and port services that are efficient and viable, and at the same time affordable to citizens of Member States.
- e) To improve the effectiveness of the maritime transport sector in Member Countries in order :

- (i) to contribute to the improvement and expansion of trade, investment, tourism and the economy in general.
- (ii) to create employment opportunities for each Member States' citizens.
- (iii) To assist in assessing of viability of development projects and their implementation, as requested by Member States.

4. Benefits

a) Regional perspectives

- (i) Improve the efficiency and effectiveness of the maritime transport sector in the region and also improve the role that the sector plays in the economy of each Member State. There is a need for governments and the private sector to consult and interact in shipping and ports in areas of institutional strengthening, rationalisation of shipping services and reducing costs in ports by taking appropriate measures to increase productivity.
- (ii) Promote bilateral and multilateral cooperation between the maritime administrations of Member States in areas such as training and implementation of conventions.
- (iii) Provide a more effective collective input into international maritime policy issues that will have a better chance of Pacific Island countries' interests and values being taken into account.
- (iv) Co-ordinate and implement activities in the maritime transport sector to achieve safety at sea, maritime security and the prevention of marine pollution. The existing situation is that SPC is providing training and legal

assistance in its Regional Maritime Programme while SPREP is dealing with pollution prevention issues.

- (v) Better manage and utilize aid funds as maritime transport activities will be co-ordinated under one organisation. At the moment, most senior managers in SPC and SPREP do not have much knowledge in maritime transport matters. This situation may have disadvantaged the maritime transport sector, since it is a well known human characteristic that a person will focus more on the things he/she knows or is familiar with.
- (vi) Provide political commitment to promote and implement urgent maritime transport matters as Cabinet Ministers do not always understand complex international regulations or technical standards. At present there is no Ministers of Transport meetings. SPC and SPREP meetings are normally attended by non-transport Ministers.
- (vii) Promote an Agreement of Cooperation between IMO and the new organisation so that any issues of concern will be expedited for consideration by either party, (an example is the Agreement between the Caribbean Community and IMO, known as CARICOM).

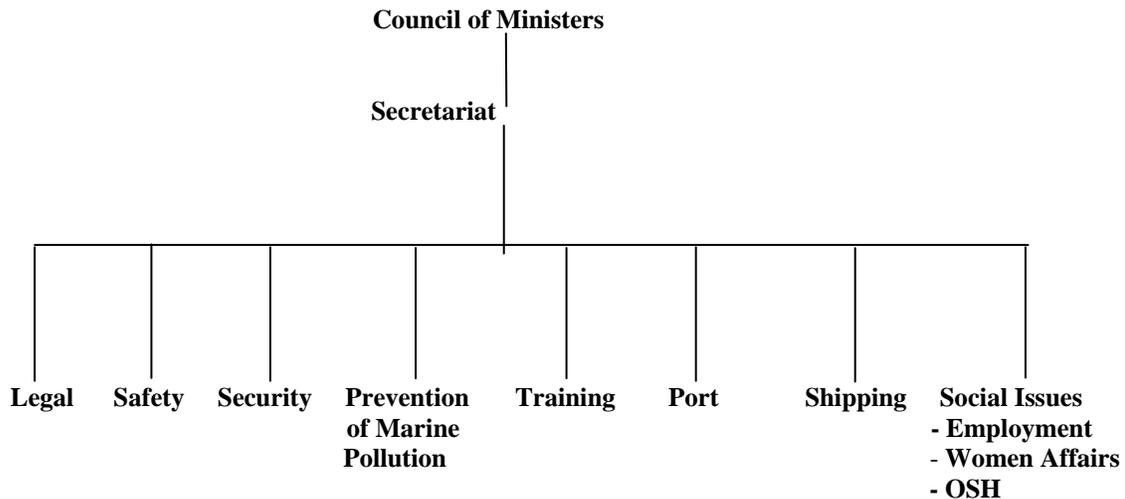
b) National perspectives

- (i) By establishing a dedicated regional organisation on maritime transport, Member States can access more easily to assistance on maritime matters from qualified, experienced and dedicated persons.
- (ii) Member States can exchange knowledge and disseminate information during meetings of the Member States of the organisation.

- (iii) National projects linked to approved regional projects have a greater chance of being funded and implemented.
- (iv) The harmonisation and coordination of policies, procedures, legislation and regulations between Member States will cut out unnecessary bureaucracy in Member States, thus improving efficiency and creating certainty for users.
- (v) Implementation of international conventions and regulations will be much easier with assistance of the secretariat of the regional organisation.

5. Structure

A similar structure to existing regional organisations is proposed as depicted in the following diagram.



The Secretariat will comprise of contract and support staff similar to other regional organisations and headed by a Director.

A name suggested for the new organisation is the Pacific Islands Maritime Transport Organisation (PIMTO).

The following is a brief description of the functions shown in the above diagram.

- a) Safety - deals with maritime safety conventions requirements such as SOLAS, Load Line, STCW and Collision Regulations and their implementation by Contracting States.
- b) Security – focuses on the Amendments to SOLAS and ISPS Code requirements.
- c) Prevention of Marine Pollution – deals with marine pollution prevention conventions such as MARPOL 73/78, Anti – Fouling Systems, OPRC, Intervention, London. Upcoming conventions dealing with Ballast Water and amendments to some of the above conventions.
- d) Training – This covers various training requirements under any convention or as required by Member States.
- e) Ports – Deals with issues to improve port administrations in the region. The Secretariat may provide coordination functions such as secretariat for the Pacific Ports Association.
- f) Shipping – Similar functions to Ports. There is very little coordination or contact between ship owners of Member States at the moment. So, there is room for improved communications, consultation and co-operation in shipping in the region.
- g) Social Issues – This covers seafarers’ employment and welfare, women’s affairs in the sector, occupation safety and health (OSH) issues, and other appropriate issues.

- h) Legal – provides legal advice and assist drafting legislation in Member States and the implementation of limitation of liability and compensation conventions such as LLMC, CLC, FUND, HNS and Bunker Conventions. Other functions may be added on in the final structure of the organisation.

Each main function in the proposed structure requires about two contract staff and one support staff. Some of the contract staff may be transferred from existing programme in SPREP or SPC if the new organisation is approved to be established.

Membership should be open to those countries that are members of the Pacific Islands Forum.

6. Costs

- a) Establishment costs would be in the form of contributions by Member States and other sources of funds available. The contribution formula is the same as any other regional organisation.
- b) Operational costs to be from Member's contribution and from other funding sources such as IMO, UNEP, UNDP, EU, Canada and the US.

Someone in one of the Pacific island countries may ask an appropriate and legitimate question of “What will be the benefit that the new organisation will give us?”. The answer to this question is as follows. Given the historical, current and future importance of the maritime transport sector to the lives of Pacific islanders a specialised regional organisation (as proposed) will ensure that the role of the maritime sector in the national economy and the national transportation network is enhanced.

At present, Member States of SPC and SPREP pay contributions for membership. It would seem that a new regional organisation would put extra financial burdens on Member States. This is correct, but the question to ask is, “Are the Member States getting the best value for their money under the present arrangement?”. The answer is to the contrary, as the

Regional Maritime Programme in SPC Suva, the Fisheries Training Section of SPC Noumea, and the Marine Pollution Unit in SPREP do not fit in well with the mandates of their respective regional organisations. In this context it seems that Member States do not get their money's worth on maritime transport matters from these organisations. However, the new maritime transport regional organisation has the potential to get much better results and value for money on their member's financial contributions to it. The mandate of the new organisation will be focused on maritime transport, staffed by maritime transport specialists, and will have a critical mass that will produce results in excess of the investment made. It will have an added benefit, in that it will free up the resources in SPC and SPREP to better carry out their functions and focus on achievement of their core functions.

7. Implementation Strategy

The following implementation steps are suggested;

- a) Decision by leaders of PICTs.
- b) Preparatory work.
- c) Agreement for establishment of organisation is signed.
- d) Establishment of organization and commencement of operations.
- e) Appointment of key personnel.
- f) New organisation starts functioning.