A review of aspects of the marine transport of radioactive materials

A REPORT TO GREENPEACE INTERNATIONAL

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WITH PARTICULAR REFERENCE TO THE ACTIVITIES OF THE PACIFIC NUCLEAR TRANSPORT LIMITED [PNTL] FLEET

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Executive Summary

In the 30 years since the nuclear industry started shipping highly radioactive materials around the globe, no detailed, comprehensive critique of the hazards or risks of this trade has been published. This document seeks to rectify that situation.

For the first time all the relevant information concerning the ships used in transporting nuclear cargoes, the routes used, weather patterns of the oceans travelled and the international planning arrangements have been brought together in one document.

This report sets out the background to the international regulatory framework that the International Maritime Organisation (IMO) uses to direct the sea transport of irradiated nuclear fuel (INF), plutonium and high-level nuclear wastes.

Those shipments, intensely radioactive spent nuclear fuel and high level wastes and long-lived radio-toxic mixed oxide fuel (MOX), present unique risks to the marine environments they travel through - and to the countries whose shores they pass.

Evidence presented demonstrates that the assurances on safety given by the companies involved in the shipment of nuclear materials, most notably Pacific Nuclear Transport LTD (PNTL), the UK state owned British Nuclear Fuels Ltd, and the French state company COGEMA, are underestimating the real risks. COGEMA, the company that transports spent nuclear fuel from Australia to France uses the same approach to hazard analysis as PNTL.

This report has found that:

- PNTL's vessels are not among the top ranked vessels in the world merchant fleet that carry hazardous materials - those carriers are fully double hulled. PNTL's claim that its Pacific Fleet is made up of double hulled vessels is quite inaccurate because the double hulling feature only extends around the cargo hold, leaving the fore and aft sections of the vessels with only a single skin. PNTL vessels are structurally inferior to many hazardous cargo carriers and as such are as vulnerable in accident situations;
- PNTL routinely routes its Pacific fleet through a number of regions classed by Lloyds of London as "Marine High Risk Areas". Those Marine High Risk Areas have weather conditions, sea states, vessel numbers and route congestion which give rise to high shipping casualty numbers;
- British Nuclear Fuels Ltd, one of the main owners of PNTL, has written a set of "Special Arrangements" for responding to at sea emergencies involving INF Code materials. A small number of senior executives of national maritime agencies, senior civil servants and senior government ministers are permitted access to these Special Arrangements, which are "commercial in confidence", the sole property of BNFL and not available to members of the public or their elected representatives;
- BNFL's statement that an emergency team is on standby "at all times" and on a "24 hour emergency standby system" should be of significant concern to Australia as this report has revealed the optimum "window of opportunity" for incident management

and control occurs within the first 24 hours. If BNFL emergency teams cannot arrive on scene within the first 24 hours the possibility of the emergency escalating to very significant or total casualty status (with attendant escalating radiological emergency) increases;

- PNTL's submission to the IMO claims that the emergency team is a "fully trained and equipped team of marine and nuclear experts." However, other documents explain that such a team actually consists of one marine expert, four nuclear experts, two head office staff and one public relations officer;
- Statements by BNFL that there "would be no reason for concern and no consequences which could significantly affect persons or the environment" in the transport of nuclear materials are not referenced or substantiated by empirical evidence that might support such a claim;
- Australia has acknowledged its rights and responsibilities under international conventions in respect of marine pollution incidents involving oil and chemicals. Australia has not done so in respect of radioactive materials classified by the IMO as IMDG Class 7 materials or as INF Class 1, 2 and 3 materials. These categories include shipments of plutonium (MOX) fuel, spent nuclear fuel and high level waste;
- The Australian Commonwealth Disaster Plan (COMDISPLAN), although it covers a range of emergencies, does not fully provide for mounting an effective and rapid response to an emergency involving the maritime transport of nuclear materials. It is unclear what jurisdiction and responsibility the COMDISPLAN has over the waters of the territorial sea, the EEZ and the adjacent High Seas.
- In contrast to Australia's detailed and subject specific maritime oil and chemical spill plans, COMDISPLAN contains no detailed, subject specific arrangements and plan for at sea spills of radioactive materials. COMDISPLAN does not identify either players or resources specifically relevant to a response to spills of radioactive materials at sea;
- Within the COMDISPLAN there is no clear division of responsibilities and jurisdiction between State and Commonwealth Agencies. Up to eight different agencies could be involved in any emergency response. These are the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), the Australian Nuclear Science and Technology Organisation (ANSTO), Dept of Science & Resources, Dept of Defence, Australian Maritime Services Agency (AMSA), Emergency Management Australia (EMA), Dept of Foreign Affairs, and the relevant State Emergency Services.

PNTL, COGEMA and other nuclear industry agencies deny that there is any serious risk of a breach of containment of INF flasks and packages. Surprisingly, a number of government agencies have uncritically accepted this denial. This review warns that the repeated downplaying of the likelihood of an INF Cargo means that there is a risk that resources, energy and funding directed towards response planning have been reduced because it is perceived as a minimal threat. This is a dangerous approach to adopt in the face of a mounting number of shipments through this region.

Authorities of en-route states need to fully examine the claims of the industry over the safety of nuclear transport.

Nuclear accidents pose a threat not only to the well being of people and the environment. They also pose significant risk to economies. Beyond the direct impact of contamination, even if a nuclear container is not breached and no radioactive material is released, the economic effect and damage to reputation of fisheries and coastal recreation and tourism is likely to be enormous.

1. The Irradiated Nuclear Fuel (INF) Code

1:1 INTRODUCTION

The maritime transport of high level nuclear wastes and irradiated nuclear fuel (INF) began in the 1960s. At this time there were no specific international requirements for the safety or security of INF carried at sea under the 1974 International Convention of Safety of Life at Sea (SOLAS) which regulated activities likely to cause damage or harm or loss of life as a result of shipping accidents.

It was not until 1985 that Italy raised the issue of the safe carriage of INF by sea at the 52nd session of the Maritime Safety Committee (MSC) of the International Maritime Organisation (IMO). The Italian concerns centred on the adequacy of fire protection of the cargo holds used for INF transport and for the adequate damage stability of the ships carrying INF. These concerns were particularly strong in the case of vessels which were not purpose built, but which could be freely used to carry any type or quantity of radioactive material (subject to the IMO's IMDG Code class 7 and the IAEA regulations: see below). These concerns were intensified by the anticipated growth in the frequency and volume of INF transport.

1:2 THE EVOLUTION OF THE INF CODE

a. The concerns raised by the Italians were considered by various sub-committees of the IMO. By this time there were a number of purpose built INF vessels in existence, so it was decided to widen the scope of the discussions and include vessels (both purpose built and non-purpose built) as well as cargo space and INF cooling, ventilation and radiation protection.
b. The IMO sub-committee on ship design and equipment (DE) was requested to develop what was to become the INF Code. The IMO sub-committee on the carriage of dangerous goods (CDG), which had produced the IMDG class 7 code, provided a definition of the quantities of INF which could be carried on various types of vessel. By 1990 the sub-committee had arrived at a division of three types of INF and relevant classes of ship to carry it.

1:3 IAEA INVOLVEMENT

a. The IAEA became aware of the IMO work during the later phase of the evolution of the INF code.
b. The IAEA had always been primarily concerned with the safety and integrity of the packaging of radioactive material. The IAEA position was, and is, that because their regulation and design of packaging provides for adequate safety in transport, there is no need, on safety grounds, to design or provide purpose built ship designs or fire protection equipment for the maritime carriage of INF.
c. The Director of the IAEA rapidly invited the IMO's Marine Safety Committee to establish a Joint IAEA/IMO Working group on the Safe Carriage of INF by sea. At a later date the United Nations Environment Programme (UNEP), with a specific interest in certain sea areas, joined the working group.

1:4 THE JOINT IAEA/IMO/UNEP WORKING GROUP.

a. The Joint Working Group met in December 1992 (IMO HQ: London) and April 1993 (IAEA HQ: Vienna). A major decision of the first meeting was to include nuclear materials of similar potential hazard to INF (including Plutonium and High Level Radioactive wastes) in the Code.
b. As a result of the meetings of the Joint Working Group a draft INF Code was drawn up. This draft code was subsequently approved by the IMO's Marine Safety Committee (MSC) and Marine Environment Protection Committee (MEPC). The decisions were taken by a strong majority of each Committee. Only three of 64 governments present at the MSC reserved their position and eight of 53 governments present at the MEPC reserved their position.
c. In 1993 the IMO's draft INF Code was subsequently formally adopted by resolution A.748 at the 18th Assembly of the IMO and became part of the SOLAS Convention by amendment. The relevant meeting was attended by 131 Member and two Associate Member delegations of which only seven members reserved their position until the INF Code had been augmented and improved.

1:5 SUBSEQUENT AUGMENTATION AND IMPROVEMENT OF THE INF CODE

a. Having adopted the INF Code the IMO concluded it should be the subject of continuing review and amended as necessary. The Code, as originally conceived, dealt principally with matters of vessel design, construction and equipment. During it's later stages of development, especially during the two sessions of the Joint IAEA/IMO/UNEP Working Group (December 1992, IMO HQ: London and April 1993, IAEA HQ: Vienna), some member states of the IMO and Observer Organisations raised issues which were complementary but not originally scheduled for inclusion in the Code.
   These included:
   - preparation of a Voyage Plan which should include specific packaging information;
   - emergency response plan for packages, and emergency response plans for INF vessels;
   - the notification of en-route coastal states and specific routing for ships carrying INF, Plutonium and High Level Waste (HLW);
   - positive tracking and equipment of transport containers for INF 2 and 3 materials with devices assisting their location and recovery if lost at sea;
   - liability issues.
b. The IMO's MSC and MEPC, and their subsidiary bodies, commenced work on these and other issues complementary to the INF Code. A progress report was submitted to the IMO's 19th Assembly which requested the committees to continue their work, endorsed a proposal for a Special Consultative Meeting and identified a number of specific issues to be addressed at that meeting.

1:6 SPECIAL CONSULTATIVE MEETING

a. An IMO Special Consultative Meeting of bodies involved/concerned with the maritime transport of INF materials was held (in consultation with the IAEA and UNEP) over a three day period in March 1996. The meeting was attended by representatives from 34 member Nations, two UN agencies and four non-government organisations (NGOs).

A summary of the meeting's outcome was submitted to the IMO's MSC and MEPC.

b. As a result of the 1996 Special Consultative Meeting, the 66th sitting of the IMO's MSC agreed the following specific issues should be considered:
   - specific hazards associated with the marine transportation of INF flasks, and the consequences of severe accident scenarios (by IMO committees and also the IAEA);
   - ship structural design requirements for securing flasks to the vessel in order to avoid separation from the ship in an accident (by IMO committee);
   - the adequacy of arrangements for marking, labelling and placarding the transport flasks (by IMO committee);
   - route planning, notification of coastal states and availability of information on the type of cargo being carried and its hazards (IMO committee);
   - restriction or exclusion of INF carriers from particularly sensitive sea areas (by IMO committee);
   - adequacy of existing emergency response arrangements (by IMO committee);
   - measures to locate, identify and salvage a sunken ship or lost flasks (by IMO committee);*
   - tracking of INF carriers throughout the voyage, by a shore based authority (by IMO committee);
   - adequacy of existing liability regimes covering accidents with INF materials. (This subject had been considered by the 1996 Hazardous and Noxious Substances Conference, which resolved that radioactive materials should not be dealt with by the HNS Convention: also to be considered by the IAEA.);
   - environmental impact of accidents involving INF (by IMO committee, the GESAMP EHS Working Group and UNEP);
   - materials being transported under the INF Code (by IMO committee);
   - mandatory application of the INF Code (by IMO committee);*
   - adequacy of flask design and testing (by the IAEA).
   - MSC decided to invite member governments to submit proposals to the 67th meeting for consideration.

   The 66th meeting of the IMO's MSC noted that no further action was required in regard to the notification of en-route States because existing reporting requirements under the SOLAS Convention and the MARPOL Convention were adequate.

c. Noting that the mandatory application of the INF Code might have difficulty because there was a difference of opinion about what a mandatory Code should contain, the MSC decided that future discussion of this matter should address which items might be clarified as mandatory.

d. The MSC agreed to include and retain in the work of its sub-committees an item labeled "Development of measures complementary to the INF Code" with a target completion date of 1997, and instructed the sub-committees to deal with the remaining issues on the list above. In the event this work was delayed and further amendments to the INF Code were not completed until 1999.

e. The most recent version of the International Code for the Safe Carriage of packaged Irradiated Nuclear Fuel, Plutonium and High Level Radioactive Wastes on board Ships (INF Code) was finally agreed and published in May 1999.

1:7 THE INF CODE DEFINITIONS

The majority of the text of the 1999 INF Code does not differ from the 1993 version. Chapter 1 concerns itself with definitions, the most important of which are:

- INF Cargo means packaged irradiated nuclear fuel, plutonium and high level radioactive wastes: (irradiated nuclear fuel is defined as material containing uranium, thorium and/or plutonium isotopes which has been used to maintain a self-sustaining nuclear chain reaction);
- Plutonium means the resultant mixture of isotopes of that material extracted from irradiated nuclear fuel from reprocessing;
- High level radioactive wastes means liquid wastes resulting from the operation of the first stage extraction system or the concentrated wastes from subsequent extraction stages, in a facility for reprocessing irradiated nuclear fuel, or solids into which such liquid wastes have been converted.

1:8 SHIPS CARRYING INF CARGO ARE ASSIGNED TO THREE CLASSES, DEPENDING ON THE TOTAL ACTIVITY OF THE INF CARGO CARRIED ABOARD:

- Class 1 INF Ships are certified to carry INF cargo with an aggregate activity of less than 4,000 TBq (Class 1 INF material is generally carried on normal merchant vessels such as cargo ships/freighters, Ro/Ro and passenger ferries);
- Class 2 INF Ships are certified to carry irradiated nuclear fuel or high level radioactive wastes with an aggregate activity less than 2 X 10^6 TBq or ships carrying plutonium with an aggregate activity of less than 2 X 10^5 TBq.(Class 2 INF material is generally carried on normal merchant vessels such as cargo ships/freighters, Ro/Ro and passenger ferries.)
- Class 3 INF Ships are certified to carry INF, or high level radioactive wastes and ships which are certified to carry plutonium with no restriction of the maximum aggregate activity. (INF Cargo required to be carried on Class 3 INF ships shall not be allowed on passenger ships.)

1:9 SURVEY OF VESSELS

Chapter 1 of the INF Code also lays out requirements for the survey of all vessels intended for the carriage of INF cargo. This survey is to be carried out before the carriage of INF cargo takes place. Such a survey shall include a complete examination of the vessel's structure, equipment, fittings, arrangements and material "in so far as the ship is covered by this Code" (i.e. it shall be inspected to check that it fulfils the conditions of the INF Code). If the vessel passes this survey it shall be issued with an International Certificate of Fitness for the Carriage of INF Cargo.

The International Certificate of Fitness for the Carriage of INF Cargo ceases to be valid if the relevant surveys are not carried out, or if the vessel fails to comply with Code survey requirements.

1:10 DAMAGE STABILITY

Chapter 2 deals with damage stability(or accident resistance/survivability) and stipulates:

a. "the damage stability of a Class 1 INF ship shall be to the satisfaction of the administration" (i.e. national government of the state where the vessel is registered);
b. A Class 2 INF ship must comply with the same standards (for passenger or cargo vessels) as those applying to another vessel of that type under the SOLAS Convention regulations;
c. A Class 3 INF ship must comply with the damage stability requirements for Type 1 ship survival capability and location of cargo as set out in the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk. (The IBC Code applies only to Chemical Carriers built after June 1986)
   Furthermore, regardless of its length, an INF Class 3 ship must comply with the damage stability requirements in part B-1, Chapter 11-1 of the SOLAS Convention.

1:11 FIRE SAFETY MEASURES

Chapter 3 deals with fire safety measures and stipulates:

a. for a Class 1 INF ship, such measures shall be to the satisfaction of the national administration;
b. Class 2 & 3 INF ships of any size must be fitted with a water fire extinguishing system, fixed fire extinguishing arrangements in important machinery spaces; a fixed fire detection and alarm system in machinery spaces, accommodation and service spaces; and fixed cargo space cooling arrangements. All of these features must comply with SOLAS Convention regulations;
c. In addition Chapter 3 stipulates that in a Class 3 INF ship, accommodation spaces, service spaces, control stations and important machinery spaces shall be fitted either forward or aft of the INF cargo spaces.

1:12 TEMPERATURE CONTROL

Chapter 4 deals in greater depth with the issue of temperature control of the cargo spaces and stipulates:

a. in all classes of INF ships ventilation or refrigeration of enclosed cargo spaces must be such that the average temperature within the space does not rise beyond 55C at any time;
b. such ventilation/refrigeration systems shall be independent of those serving other areas/spaces of the vessel;
c. essential operational items like fans, compressors, heat exchangers, cooling water supplies, shall be provided in duplicate for each cargo space and spare parts shall be available (to the satisfaction of the administration).

1:13 STRUCTURAL CONSIDERATIONS

Chapter 5 deals with structural considerations and stipulates:

a. The structural strength of deck areas and support arrangements shall be sufficient to withstand the load which is to be sustained. (N.B. There is no stipulation under the INF Code for any form or degree of double hulling or collision reinforcement in any class of INF ship.)

1:14 SECURING INF CARGO

Chapter 6 deals with the arrangements for securing INF cargo and stipulates:

a. such devices shall prevent movement of the "packages" within the cargo spaces. When permanent devices are designed due consideration must be given to the orientation of the packages and to ship acceleration levels;
b. where packages are carried on open or vehicle decks they should be secured in accordance with safe stowage principles already in place for rolling (unitised and wheel-based) cargo which are based on guidelines developed by the IMO and approved by the national administration;
c. any collision chocks used shall not interfere or prevent the flow of cooling/ventilation air.

1:15 ELECTRICAL POWER

Chapter 7 deals with the supply of electrical power and stipulates:

a. electrical power supplies in a Class 1 INF ship shall be to the satisfaction of the administration;
b. in Class 2 & 3 INF ships there must be alternative power supplies which comply with international standards acceptable to the IMO and which can operate even when the vessel's main supply is damaged;
c. alternative power source(s) must be sufficient to supply all flooding and cooling systems and all emergency systems for at least 36 hours;
d. in a Class 3 INF ship such alternative sources must be located outside the extent of any damage envisaged under Chapter 2.

1:16 RADIOLOGICAL PROTECTION

Chapter 8 deals with radiological protection and stipulates that, if necessary, radiological protection commensurate with the characteristics of the INF cargo and the design of the ship must be provided to the satisfaction of the administration.

1:17 MANAGEMENT AND TRAINING

Chapter 9 deals with management and training and stipulates that management and training for a ship carrying INF cargo shall be to the satisfaction of the Administration and must take into account any developments in the IMO.

1:18 SHIPBOARD EMERGENCY PLANS (SEPs)

Chapter 10 deals with Shipboard emergency plans and stipulates:

a. every ship carrying INF cargo shall carry on board a shipboard emergency plan that is based on the guidelines developed by the IMO and as a minimum must consist of:
   - procedures to be followed by the master, or other person in charge, to report any incident involving the INF cargo;
   - a list of the authorities and/or other persons to be contacted in the event of such an incident;

- a detailed description of the immediate action to be taken by persons on board to prevent, reduce or control the release, and mitigate the consequences of the loss, of INF cargo following an incident;
- a detailed description of the procedures and points of contact on the ship for coordinating shipboard action with national and local authorities.

1:19 REPORTING INCIDENTS

Chapter 11 deals with procedures for the notification in the event of an incident involving INF cargo and stipulates:

a. reporting requirements of the SOLAS Convention apply to the loss, or likely loss, of INF cargo overboard and to any other incident involving a release or probable release of INF cargo, whatever the reason (including for the purpose of securing the safety of the ship or saving life at sea).

b. reporting requirements of the SOLAS Convention also apply to any damage, failure or breakdown of a ship carrying INF cargo which affects the safety of the ship (including but not limited to: collision, grounding, fire, explosion, structural failure, flooding and cargo shifting) or results in the impairment of navigational safety (including but not limited to: failure of steering gear, propulsion system, electrical generating system and essential navigation aids).

2. The International Maritime Dangerous Goods (IMDG) Code for Class 7 substances

2:1 The IMDG Code defines Class 7 radioactive materials as those with a specific activity greater than 70 Bq/Kg and states that such material must be declared as radioactive material. The 1994 version of the code provides a list of such materials. This list is not exclusive but currently consists of the following:

- radioactive materials in instruments or articles;
- articles manufactured from natural Uranium, depleted Uranium or natural Thorium;
- ores containing natural Uranium, Thorium or concentrates thereof;
- tritiated water, uranium hexafluoride;
- surface contaminated objects (beta, gamma, low alpha);
- uranium and thorium metals liable to spontaneous ignition;
- fissile materials: including Uranium hexafluoride containing more than 1% U235, and U233, U235, Pu238, Pu239, Pu241 or any combination of the foregoing likely to undergo criticality.

2:2 IMDG Class 7 materials must be carried in one of two types of packaging which fulfil the IAEA regulations on transport packaging for radioactive materials:

- TYPE A packaging is designed with a high probability that if any material was released, or shielding efficiency lost, the packaging would prevent the occurrence of so much radiological hazard as to hamper fire fighting or rescue operations. (TYPE A packages must maintain their integrity after being drop, compression and penetration tested and then sprayed with water for at least one hour).
- TYPE B packaging is designed to be strong enough to withstand severe accidents without significant loss of contents or dangerous loss of radiation shielding. (TYPE B packages are drop, penetration, fire and immersion tested).

2:3 IMDG Class 7 materials may be carried on any type of cargo, passenger or other vessel. Vessels carrying IMDG Class 7 materials must have a Shipboard Emergency Plan (SEP) concerned principally with prevention, reduction, control and mitigation of the impacts of on-board incidents.

2:4 The IMDG Code for Class 7 radioactive substances also carries detailed instructions in similar areas to those of the INF Code, although the requirements are less strict.

INF and IMDG Codes - Summary

The Chapter 2 damage stability required for INF Class 1 and Class 2 is no more than that required for standard passenger or cargo vessels and the damage stability required for INF Class 3 does not exceed that required for vessels carrying dangerous chemicals in bulk. No reference is made in the printed version of the Code, or in any associated documents, to any risk analysis or design accident studies which have compared a cargo of “dangerous chemicals in bulk” to a full cargo of Class 3 INF/Pu/HLRW (Irradiated Nuclear Fuel/Plutonium/High Level Radioactive Waste) in order to reach the judgement that vessel damage stability requirements are the same for both cargoes.

Similarly the fire safety and temperature control measures set out in the INF and IMDG Class 7 Codes refer back to the SOLAS Convention and there is no suggestion that they have been designed specifically for use in ships carrying materials covered by either Code. The duplication of systems stipulated by the Codes may be found on a number of modern passenger ships, ferries, tankers and chemical carriers.

Similarly, the structural considerations and cargo securing arrangements are fairly general and might be expected to be applied to a number of vessel types.

Chapters 7 to 11 contain material that is plainly more specific to ships carrying relevant materials.

INF and IMDG Codes — Conclusion

The INF and the IMDG Class 7 Codes set out a number of requirements for vessel design, cargo management and emergency plans.

Much of that material refers back to the 1974 SOLAS Convention and some of its subsequent amendments. The majority of that material applies to the generality of the world merchant fleet. Only a minority of that material is specific to vessels carrying hazardous and noxious cargo.

The IMO can be commended for drawing up the Codes, and it is recognised that every chapter of the Codes is of assistance in maintaining a good standard of vessel design, cargo management and emergency planning. However, there is relatively little in the Codes to justify claims from the owners of INF Class 3 ships (eg the PNTL fleet) that the IMO's 1993 INF Code had "introduced stringent requirements for ensuring the safety of vessels carrying radioactive materials, covering the design specifications of the vessels concerned". [This statement was made in a 1996 submission to the IMO from the owners of the PNTL fleet: see later text.]

Some sections of the Codes do contain material that is specific only to INF and IMDG Class 7 ships. However the Codes stipulate very little which is not currently found on many types of well appointed, properly maintained, efficient merchant vessels which have been inspected, flagged and insured by responsible and reputable companies, agencies and administrations.

3. The World INF (Class 3) Fleet

3:1 The first contract for the maritime transport of nuclear waste from Anzio (Italy) to Barrow (Cumbria) was awarded to the UK company James Fisher and Sons in 1964. The first voyage was carried out in 1965 and used the freighter *Stream Fisher*, which was modified for the purpose. The modifications consisted of the fitting of a lead lining between the hold and the crew quarters and the installation of refrigeration for temperature control. Subsequently the company used the *Pool Fisher* and the *Stream Fisher* to carry spent fuel to Barrow from a number of European ports. However, it appears that both vessels retained a dual purpose capability and frequently carried non-nuclear cargoes. [Ref 1]

3:2 The *Pool Fisher* sank in the English Channel (6 November 1979) while carrying a cargo of potash from Hamburg to Runcorn. Thirteen hands and passengers were lost and two survived. The cause of the accident is given as a failure to secure the cargo hatches correctly, causing the vessel to take in water, flood and sink. [Ref 1].

3:3 The first contract to carry Japanese spent nuclear fuel was awarded to James Fisher and Sons in 1968. The company made use of the *Leven Fisher*, modified for the purpose. (This vessel was later sold to Syrian interests in 1982). Growing trade led to the purchase of an additional vessel the *Jopulp* which was converted and re-named the *Pacific Fisher*. [Ref 1]

3:4 Shipments of used, and subsequently reprocessed, nuclear fuel between Europe (UK and France) and Japan commenced in 1969. The shippers state that these shipments always conformed to IAEA transport regulations (in respect of the packaging). However, there were no international standards applied to the type of ships employed in this trade until 1993. During the late 1970s those engaged in this trade decided to set about the construction of vessels specially designed to carry INF Class 3 materials.

3:5 Although the voyages mentioned above have the highest public profile in Europe, it is evident that maritime transport of irradiated nuclear wastes is carried out by other states and in other sea areas. Data obtained from the Lloyd's Register of Shipping shows that, to date, 14 vessels have been built and registered as dedicated Irradiated Nuclear Fuel Carriers, and flagged to five different sovereign states. [Ref 2]

- *Lepse* (1961), *Serebryanka* (1974) and *Imandra* (1980) were built and flagged in Russia between 1961 and 1980. Their registered owner is Murmansk Shipping. Given the current parlous state of the Russian economy and the apparent decline of the Russian military and civil nuclear power programme and naval and civil fleets there are reasonable grounds for concern about the status and workload of these vessels. (N.B. Two of these vessels were designed and constructed prior to the late 70s design effort mentioned in para 3:1 above. Their compliance with current INF standards may not be satisfactory.)
- *Seiei Maru* (1991) and *Rokuei Maru* (1996) were built and flagged in Japan. Their registered owner is Nuclear Fuel Transport Ltd (NTL).
- *Tien Kuang* No 1 (1991) was built and flagged in Taiwan and the registered owner is Taiwan Power.
- *Sigyn* (1982) was built in France and flagged in Sweden, the registered owner is Swedish Nuclear Fuel and she is managed by Gotland.
- *European Shearwater* (1981) was built and flagged in the UK. The registered owner is British Nuclear Transport Ltd and she is managed by Fisher & Sons.
- *Pacific Fisher* (1970) was built in the German Democratic Republic and flagged in the UK. Lloyds describe this vessel as having been "broken up" in November 1985. Lloyds do not name the registered owner nor the management company. (N.B. This vessel was also designed and constructed prior to the late 70s design effort mentioned in para 3:1 above. Her compliance with past and current INF standards may not be satisfactory.)

The remaining five vessels are flagged in the UK, their registered owner is Pacific Nuclear Transport Ltd (PNTL) and they are managed by Fisher & Sons. PNTL is jointly owned by British Nuclear Fuels Ltd (BNFL), Cogema and the ORC (representing the Japanese Nuclear Utilities). Construction of the PNTL fleet began in the late 1970s following consultations with Lloyds of London, the UK Salvage Association and leading salvage companies and in line with standards developed in Japan.

The PNTL fleet has been designated "Pacific Class", and has been constructed to approximately the same basic design and dimension.

Length approximately 104 metres; beam approximately 16 metres; dead wt tonnage between 3,702 and 3,865 tonnes; power source 2 X 1,900 hp diesel engines; load capacity: spent fuel casks (TN12) max. 17; load capacity: returnable waste casks (TN 28VT) max. 14.

The UK registered Pacific Class PNTL fleet consists of the following vessels :

Pacific Swan	built	1979	UK
Pacific Crane	built	1980	UK
Pacific Teal	built	1982	UK
Pacific Sandpiper	built	1985	UK
Pacific Pintail	built	1987	JAPAN

[Ref 2]

Although all of the above have been approved for the carriage of most INF Class 3 materials, it appears that the Pacific Crane has not been approved for the transport of vitrified wastes. [Ref 3]

Despite the fact that all five of the UK registered PNTL vessels were designed and built well before the introduction of the 1993 INF Code, it is claimed that the PNTL fleet has always operated to INF Code standards and that extra equipment has been added in line with technological developments and operating experience to maintain high standards of operational safety. [Ref 4]

3:6 Indeed it is remarkable to note that the 1993 INF Code stipulates most of the features designed by the PNTL designers in the late 1970s and that there is no evidence that any major modification of the PNTL vessels has occurred since they were completed. Three implications may be drawn:

- the PNTL design was remarkably far sighted;
- the IM0 (with little previous expertise in this specific subject area) may have been strongly reliant upon the advice of nuclear carriers in drawing up the INF Code recommendations regarding vessel design, and thus based their ship design stipulations on the PNTL parameters;
- the IMO standard is not as "stringent" as the PNTL owners have claimed.

3:7 It is relevant to note that the IMO is essentially a consensual organisation which operates by committee. Special subject committees are composed of representatives sent by interested/concerned member governments, these representatives are generally civil servants from relevant ministries or departments like Transport or Shipping. Observer status may be applied for by relevant Industries and non-government organisations (NGOs) and granted (or denied) by the members of any specific committee. [Ref 5]

There is (as is always the case with the consensual committee) a strong possibility that decisions or recommendations arrived at and promulgated by any IMO committee may not be a reflection of the latest scientific or technical understanding but the product of a good deal of horse-trading and political activity.

3:8 In the case of the early IMO committee recommendations on INF ships there are no indicators that the bureaucrats representing those governments already involved in the maritime transport of irradiated nuclear fuels were expert in general nuclear issues or the specifics of maritime nuclear transport. It is highly likely they were given detailed briefings by nuclear industry representatives and that there were few committee members able to bring independent expertise and analysis to bear upon the subjects under discussion.

4. Causes of Casualties at Sea

4:1 There is a consensus that smaller vessels are more likely to suffer major problems as a result of marine accidents than larger vessels. In terms of the size statistics of the world merchant fleets, the PNTL vessels are relatively small.

4:2 There is a consensus that the four major causes of "total loss" shipping casualties at sea (in order of importance) are:

- Foundering (sinking): as a result of severe weather and/or heavy seas. Secondary contributory factors are structural weaknesses and incidents of cargo shifting;
- Wrecking/stranding: usually in coastal areas with a high density of shipping traffic, often the result of mechanical failure, bad weather, navigational or other human error. Human failures are a significant contributory factor;
- Fire/explosion: a major hazard where flammable or explosive materials are carried, and especially so where the vessel receives no assistance from the shore;
- Collision: between two (or more) vessels, especially in coastal and inland waters and busy shipping lanes. Collisions are particularly associated with human error, various forms of mechanical failure and the mis-interpretation of information. [Ref 6 : pps 164&165]

5. Sea Routes used by PNTL Vessels

5:1 Under the heading "Routing, Physical Protection and Safeguards" the PNTL ownership states that the sea routes used by their vessels "are carefully planned in advance of shipments". No supporting information is provided. [Ref 4: p18]

The IAEA supports the PNTL position and states that PNTL ships "have an important range of safety features, in agreement with (and in some cases exceeding) the code adopted by the International Maritime Organisation" and goes on to say these features include "deliberate route selection and planning". As with the PNTL statement no further details are given. [Ref 8: p5]

(N.B. The IAEA is mistaken. No chapter of the INF or IMDG Class 7 Codes stipulate "deliberate route selection and planning".)

5:2 There is nothing unique in these statements, the only surprising feature is the apparent implication that such a planning process is unusual. Almost every sea passage carried out by contemporary merchant vessels is similarly "carefully planned". In particular route plans for all vessels seek to minimise mileage/fuel consumption costs, delays caused by extreme weather or military/political events and the risk of loss or damage to vessel, crew and cargo.

In the absence of any further detail the PNTL statement indicates nothing specific which might set it apart from, or above, any of the route planning carried out by other fleet owners, shippers etc.

5:3 In fact any concern about the possibility of risk of loss of PNTL ships and/or their INF cargoes is exacerbated by the available details about routing. For security reasons, details of the voyages of the PNTL ships are deliberately kept to a minimum. However, it is evident from the sparse available information that three routes have been used to-date and that these routes necessitate traversing a number of areas where weather, sea states, shipping density and other factors combine to give high casualty figures. [Ref 6: pps 160 to 165]

5:4 Route 1: This route begins at the Ports of Cherbourg (France) or Barrow (Cumbria, UK) and passes through the Irish Sea or the English Channel, passes through the eastern side of the north and south Atlantic, rounds the Cape of Good Hope (South Africa), passes to the south of Australia and New Zealand and then east of New Zealand and north to Japan where it concludes at the Port of Mutsu-Ogawara (northern Japan).

A variation routes vessels through the Tasman Sea, between Australia and New Zealand and then northward through the South Pacific past pacific island states like New Caledonia, Vanuatu, Fiji and the Solomon Islands.

(Opposition to the passage of INF Code maritime transports from the powerful nation states of Indonesia and Singapore has ruled out the use of the northern sea route past Australia.)

5:5 Route 2: This route begins at Barrow or Cherbourg, passes through the Irish Sea or English Channel, traverses the Atlantic, rounds Cape Horn (Argentina/Chile) and then traverses the Pacific (central east to north west) to Mutsu-Ogawara.

5:6 Route 3: This route begins at Barrow or Cherbourg, passes through the English Channel/Irish Sea, traverses the North Atlantic, enters the Caribbean (through the Mona Passage), transits the Panama Canal and crosses the Pacific (central east to north west) to Mutsu-Ogawara.

5:7 All routes could be navigated in the reverse direction when INF cargoes need to be transported from Japan to Europe but the preferred route remains via the Panama Canal.

6. Marine High Risk Areas

6:1 The definition of Marine High Risk Areas is based on the analysis of shipping casualty statistics taken from Lloyds of London and plotted according to the Lloyd's in-house system which uses Marsden squares to divide the oceans by longitude and latitude into 10 degree units.

6:2 All routes commence or culminate in the coastal waters of the north east Atlantic. These waters are defined as one of eight global High Risk Areas for shipping. The major cause of total loss in this sea area is given as "foundering" (179 "founderings" between 1975 and 1980). The major causes of serious casualty in this sea area are given as "stranding/wrecking" (148 "wreckings" between 1975 and 1980) or "miscellaneous" which includes weather damage and ships found drifting or abandoned. Collisions, leading to serious casualty or total loss, are also a high frequency event in this sea area (61 between 1975 and 1980).

6:3 All routes culminate or commence in the coastal waters of north west Japan. These waters are also defined as one of eight global High Risk Areas for shipping. The major cause of total loss in this sea area is given as "foundering" (147 between 1975 and 1980). The major causes of serious casualty are given as "stranding/wrecking" (113 "wreckings" between 1975 and 1980) or "collision" (65 collisions between 1975 and 1980).

6:4 One route involves rounding the Cape of Good Hope, which is also defined as one of eight global High Risk Areas for shipping, where a mixture of extreme weather and sea conditions, coupled with a relatively high density of shipping give rise to high accident potential. (Full statistics not available).

6:5 The Caribbean sea area and the approaches to the Panama Canal are defined as a Moderate Risk Area where the major cause of total loss is "foundering" in severe weather or heavy seas, sometimes from shifting cargo. The major cause of serious casualty in this sea area is stranding or wrecking, usually in coastal areas where shipping density is high and often the result of mechanical failure, bad weather or navigational error. Fire/explosion, hull/machinery damage and collision in busy narrow seaways and straits (particularly as a result of human error) are also significant causes of serious casualty in this area. [Ref 6: pps 162 &163]

7. En-Route Weather Conditions

7:1 Route 1 includes the waters of the North East Atlantic, where wind and sea states of Force 7, or above, occur for 20 to 30% of the year. This route also requires a north/south traverse of the eastern Atlantic through waters noted for more than 100 tropical thunderstorm days per year (off the west African coast). And the rounding of the Cape of Good Hope, a sea area where gales in excess of Force 7 occur for between 20% – 40% of the year and close to the northern limit of the Antarctic iceberg drift and the Roaring Forties.

7:2 Route 1 stipulates passage to the south of Australia and New Zealand through an area adjacent to the northern extreme of the Roaring Forties and the northern limit of Antarctic iceberg drift. In this section of the route winter wind and sea states of Force 7, or above, occur for between 20% – 40% of the year and tropical storms and cyclones occur between November and March.

7:3 Route 1 travels to the east, or west, of New Zealand and north to Japan through sea areas where the cyclone season extends from December to March (in New Zealand waters and the Tasman Sea) and the typhoon season from May to December (in south east Asian and Japanese waters). The waters to the east of Japan are also noted for their high frequency of wind and sea states exceeding Beaufort Force 7 and for a relatively high occurrence of sea fogs. [Ref 6:pps 160 and 161]

7:4 Route 2 includes the waters of the North East Atlantic, where wind and sea states of Force 7, or above, occur for 20 – 30% of the year. This route also includes a north east to south west Atlantic crossing through sea areas which may include areas with a high occurrence of tropical thunderstorms and a June to November hurricane season.

7:5 Route 2 rounds Cape Horn at the southernmost extreme of South America. This route passes through waters that are within the northernmost extent of Antarctic iceberg drift and within the Roaring Forties with a very high incidence of extreme wind and sea states.

7:6 Route 2 then traverses the Pacific from the south east to the north west, through waters where winter gales (in the south east) may exceed Force 7 for between 20% and 30% of the year and where the tropical storm/cyclone and fog frequency is similar to that described in para 7:3 above. [Ref 6: pps 160 and 161]

7:7 Route 3 includes the waters of the North East Atlantic, where wind and sea states of Force 7, or above, occur for 20 to 30% of the year. This route also includes a crossing of the central-west Atlantic and the Caribbean hurricane zone (season June to November).

7:8 Route 3 also includes a passage through the Panama Canal zone, where there are over 100 tropical thunderstorm days a year, followed by a passage across the central-east and north-west Pacific where tropical storms occur between June and October.

7:9 Route 3 includes the waters east of Japan which are also noted for their high frequency of wind and sea states exceeding Beaufort Force 7 (20 to 40% of the year) and for a relatively high occurrence of sea fogs from June to August. Japanese territorial waters, including those in the approaches to Mutsu-Ogarawa are also located in the south and east Asian typhoon zone (season May to December). [Ref 6: pps 160 and 161]

7:10 It can be seen from the above that no matter what route is taken, and no matter what time of the year a voyage is undertaken, the likelihood of meeting adverse en-route weather conditions is relatively high.

8. Canals

8:1 Canals, capes and straits are areas where shipping traffic is particularly dense due to route convergence, they are notable for their high frequency of maritime accidents. Many of these areas are situated where ambient weather and sea conditions may be particularly unfavourable. The major factors dictating the choice of routes and decisions over which canals, capes and straits to use are cost (distance/time ratios), military, weather routing and the political aspects of INF transport.

8:2 INF Carriers have used the Panama Canal. The favourable indicator for the use of the Panama Canal is a significant reduction of voyage time and distance between the Atlantic and the Pacific. This waterway is 43.5 nautical miles (nms) long (80.5 kms) and is raised and lowered by 12 locks to a maximum height of 25.9 metres above sea level. The locks are 305 metres long and 33.5 metres wide. The maximum permitted vessel dimensions are 274.3 metres length and 32.3 metres beam. Transit time through the canal is normally eight to 10 hours.

8:3 Over the last 20 years the average number of vessel transits through the Canal has exceeded 11,000 per annum. As a result of this high density of traffic the Canal has become so seriously congested that there have been proposals to establish a second canal route across the Panama isthmus. The current level of congestion has driven a perceptible increase in the volume of traffic passing through the Straits of Magellan (Cape Horn) during recent years.

8:4 The historical record shows that Total Losses and Serious Casualties are relatively high in the Panama Canal waterway, with an average of two such incidents (per 80.5 kms) occurring per year. In addition the approaches to the Canal through the Caribbean are highly congested and the accident statistics are high. [Ref 6: pps 164 and 165]

8:5 The Suez Canal has not yet been used for the maritime transport of INF wastes. However, this canal offers significant time/distance advantages over alternative routes, especially those requiring the rounding of Capes Horn or Good Hope, reducing the distance between North West Europe and Japan by approximately 4,000 miles. There can be no doubt that if conditions were deemed appropriate this would be considered a highly favourable optional route for INF carriers.

8:6 The Suez Canal is twice as long as the Panama (165.8 kms) and is entirely a sea level passage (no locks). Passage through the canal takes about 24 hours. The Suez is an extremely busy waterway with annual transits averaging between 18,000 and 22,000 vessels per annum, except in times of conflict in the Middle East.

8:7 Various regional conflicts have led to military action within the Suez Canal zone, leading to the outright closure of the Canal as a result of the sinking of vessels in the Canal due to artillery fire and bombing. Areas adjacent to the Canal Zone and it's approaches (the Horn of Africa, Persian Gulf States, Israel/Palestine) are also conflict "hot spots" with a high potential for sovereign state military action or terrorist action. Middle-eastern waters have the highest frequency of "war loss" recorded for merchant vessels.

8:8 Use of the Suez Canal would also demand routing through the Mediterranean, defined as a Moderate Risk Area where wrecks, founderings and collisions are frequent (112 wrecks, 101 founderings and 41 collisions between 1975 to 1980). [Ref 6: page 162]

8:9 Use of the Suez Canal would also require routing through the Gulf of Suez, the Red Sea and the Gulf of Aden, where serious casualty and total loss figures are locally high (64 over a two year period). More accidents occur at the northern and southern approaches to the Canal, within the waterway itself and in the Bab el Mandab (the narrow straits between the Red Sea and the Gulf of Aden). [Ref 6: p 165]

9. Capes

9:1 Capes are characterised by an exposed position in regard to weather and sea states. The speed and volume of tidal and residual currents may rise around capes and traffic density increases around them when a number of sea routes converge. The available evidence demonstrates that capes are high risk areas where shipping casualty figures rise. The routes used to date by the INF carriers include the rounding of two major capes: Good Hope and Horn.

9:2 The Cape of Good Hope is defined as one of eight global High Risk Areas where seasonally extreme weather and sea conditions (see sections 6 and 7 above) combine with density of traffic to give a high relative frequency of shipping casualties. Sixteen total losses or serious casualties occurred in the two Marsden Squares (see 6:1 above) covering the Cape of Good Hope area in two years. [Ref 6: pps 164 & 165]

9:3 Maritime traffic converges on the Cape of Good Hope from both the Indian Ocean and the Atlantic. The annual traffic averages about 200 large vessels per day, with the majority of voyages starting from the Persian Gulf, Iran, East Africa, South East Asia and Australia. This route is particularly used by Very Large and Ultra Large Crude (Oil) Carriers at all times (thus avoiding the relatively high Suez Canal tolls), and other vessels during periods of elevated tension/conflict in the Middle East.

9:4 Cape Horn, being even further south and closer to the Roaring Forties and Antarctica, has more extreme weather and sea conditions than the Cape of Good Hope. However the relative scarcity of maritime traffic means a low number of marine accidents and thus the area has not been defined as a High Risk Area.

(N.B. Increasing congestion of the Panama Canal has increased traffic using the Cape Horn routes. Density of traffic in this area has increased and may increase further in response to changing management strategies of the Panama Canal: increased tolls, further delays and failure to build a second route.)

10. Straits and other congested waters

10:1 Available evidence proves straits and other narrow waterways are high risk areas for shipping. The principal causes of shipping casualties in these areas are the density of vessel traffic and the narrowness of the waterways. Important secondary factors contributing to the high casualty risk are extreme weather and sea conditions, the intensification of tidal and residual currents in narrow waters and human error.

10:2 Japanese Straits.

a. As Japan and its far eastern neighbours are highly industrialised and strongly reliant on maritime trade and fishing, the density of shipping in Japanese and adjacent waters is very high. Many of these vessels are under 100 grt and their fate is therefore not recorded by Lloyds, however it estimated that well over 1,000 vessels per year are lost in Japanese waters.
b. For vessels approaching Japanese waters after an east-west Pacific crossing, the most favourable waterway permitting access to the port of Mutsu Ogarwara would be the Strait of Tsugaru-Kaikyo between the islands of Honshu and Hokaido. This waterway is only 10 nautical miles wide at its narrowest point. Lloyds of London records show that there were five total losses or serious casualties in the vicinity of this Strait in the period over a two year period, and that all of these casualties occurred in the Pacific approaches to the waterway. [Ref 6: p 164]

10:3 Korean Straits.

a. For vessels seeking access to Mutsu Ogarwara after a south-north transit of the western Pacific (commencing in Australian or New Zealand waters), the most favourable waterway might well be the Korean Straits lying between southern Japan and Korea. The Korean Straits offer a significant reduction in route distance and protection from the open north Pacific. Although the Korean Straits are over 50 miles wide at their narrowest point, navigation is complicated by the presence of a number of large and small islands lying within the waterway.
b. Lloyds data shows there have been 27 total losses or serious casualties in the Korean Straits over a two year period and that these casualties are particularly concentrated in the East China Sea approaches to the Straits. [Ref 6: p 164]

10:4 Caribbean Straits

a. Any route utilising the Panama Canal will require passage through one of 15 straits that pass through the Island groups of the outer Caribbean. Navigation in the Caribbean is complicated by locally dense concentrations of vessels, many of which are under 100 grt, this density of traffic is particularly acute in the various straits which at their narrowest range from a width of 82 nautical miles to 13 nautical miles. Additionally the whole sea area is characterised by seasonally severe weather and sea conditions.
b. The Mona Passage provides one of the shortest UK - Panama sea routes and the record shows that the INF transport route using the Panama Canal has involved transit through the Mona Passage which lies between Puerto Rico and the Dominican Republic. The Mona Passage is 31 nautical miles wide at its narrowest point and navigation is complicated by the presence of islands in the approaches to the strait. The Passage is listed as the 11th most important strait in the world. [Ref 6: p 150]
c. The Caribbean is defined as a Moderate Risk Area [Ref 6: p 162] where severe weather, high density of shipping and narrow waterways are a contributing factor to the accident statistics. Lloyds statistics, based on Marsden Square plotting, show that shipping accidents in the Caribbean are concentrated where shipping densities are highest and that straits are high casualty areas. Lloyds data shows that there were three total losses or serious casualties, over a two year period, in the Mona Passage and its approaches. Other straits and passages in the sea area also have an elevated frequency of accidents.

10:5 Cape Horn Straits

a. The records show that at least one INF route involves rounding Cape Horn. Although details of the precise route taken have not been made available it is possible that such a route could make use of one of the three Straits which avoid an actual rounding of the Cape itself. Use of these straits both reduces the exposure to the full severity of weather and open sea conditions which might be experienced off the Cape itself and reduces the journey time.

b. The most landward of these passages, the Magellan Straits offers the shortest route and the possibility of greatest shelter. However, it is a difficult water to navigate, with a tortuous channel and many islands and is only two nautical miles wide at its narrowest point. The more seaward passage involves transit through the Estrecho de Le Maire (20 nm wide) and the Beagle Channel (1nm wide at it's narrowest) navigation through these waters is also complicated by the presence of numerous islands and (in the case of the Beagle Channel) winding, narrow channels.
c. As stated in previous paragraphs the Cape Horn Sea area is notorious for its extreme weather and sea conditions. Despite the congestion of the Panama Canal and subsequent increased use of the Horn as an access route between the Atlantic and Pacific, traffic density remains relatively low. However the Lloyds data, based on the Marsden Square analysis, indicates there were two total losses or serious casualties in the waters adjacent to these straits over a two year period. However this data is for the years 1978-79.

10:6 OTHER STRAITS AND NARROW CONGESTED WATERWAYS.

a. It is highly probable that INF carriers using the route through the Tasman Sea or to the east of New Zealand and en-route for Japan must strike north through Micronesia or Western Polynesia. Under certain conditions, passage through these regions may require transit through one of a great number of straits, some of which are narrow and all of which are located in sea areas where seasonal weather and sea conditions can be extreme (see section 7 above).
b. In some of these island groups traffic may be locally dense and Lloyds data (based on the Marsden Square analysis) shows that casualties may be locally high. The Marsden Square including Fijian waters had six total loses or serious casualties in a two year period. [Ref 6: p165]
c. If INF Vessels were to use the Suez Canal, passage through the Bab el Mandeb straits at the southern end of the Red Sea would be necessary. This is one of the most important straits in the world in terms of the concentration of vessels. Attempts to manage the waterway have been in place for some time and a traffic separation scheme is in existence.
d. Despite these management efforts, casualties remain high in the general area with a casualty "hot spot" centred on the Bab el Mandeb. Lloyds data, based on the Marsden Square plotting system, indicates that there were at least 25 total losses or serious casualties in the square covering the straits, in a two year period. [Ref 6: p165]

11. Double Hulls

11:1 The owners of the PNTL fleet have stated that all five Pacific Class ships in the PNTL fleet have "double hulls". [Ref 4: p 10] However, there is evidently considerable confusion about the meaning of the words "double hull" and there is a significant disparity between the descriptions of this feature given by various relevant parties.

11:2 The consensual understanding of the phrase "double hull" is that the vessel in question has double skinned sides and a double skinned bottom which extend the entire length of the vessel. This is precisely what the Marine Accident Investigation Branch of the UK DETR displays in its discussion and diagrams of various types of protected tanker types. [Ref 7: Figure 8]

11:3 The PNTL owners claim that the basic design of the PNTL fleet is "a double hull configuration with impact resistant structures between the hulls". [Ref 3: p.38]

Elsewhere the PNTL owners state that the Pacific Class PNTL fleet has "double hulls to withstand damage". [Ref 4 : p 10] The IAEA support these claims and state that the PNTL fleet "is constructed with a double hull and double bottom structure". [Ref 8: p 5]

11:4 However, assuming that this means the PNTL fleet is really "double hulled" is inaccurate and deeply misleading, because the various texts in support of the initial claims of double hulling make it clear that double hulling only extends "over two fifths of the vessel's width". [Ref 4: Page 10]

In fact the PNTL fleet can only be accurately described as "partially double hulled".

11:5 Because it suffers from a lack of precise details and dimensions regarding the double hulling and collision reinforcement, the quality of the technical information provided by PNTL owners in their submissions to the IMO [Ref 4] is very poor. It is not possible to verify the accuracy of the statements quoted above.

11:6 Diagrams in those documents are barely adequate and contain no scale or dimensions for the various double hulling and collision reinforcement features described above. Similarly the language is far from clear. The statement that "the double hull structure extends for over two-fifths of the width of the vessel" does not specify the length of the double hulling or define which sectors (of the width of the vessel) are double hulled.

11:7 Study of the available "drawing of a PNTL purpose built ship" contained in References 3 & 4 do not provide further clarification of which sections of the hull are doubled.

Accompanying notes state that the cargo hold section of the PNTL fleet is protected by double hulling. The drawings appear to show that the hold extends for approximately 60% of the length of the vessel. If protective double hulling has been installed over all of this area including the sides and the bottom of the vessel, then this exceeds the described "two fifths of the width of the vessel".

11:8 If the statement that the double hulled section provides protection to the cargo hold area is valid, then approximately 40% of a PNTL vessel has only siingle skinned sides. Single hulled sections of the PNTL fleet would appear to include the bow section (containing the forward generating room and emergency generators, the bow thruster and its associated engines, the main salvage towing brackets and the primary collision bulkhead) and the stern section (containing crew accommodation, all communication and navigation equipment, the two main engines, the main generators, primary steering gear etc.).

11:9 Thus while the radioactive materials are positioned inside the reinforced, double hulled two fifths of the vessel's width, the "vital services" (power, navigation, communications etc.) are not so protected and are as vulnerable to collision and grounding impact (and subsequent disablement) as any other vessel. The PNTL ownership has provided no evidence to support any hypothesis that grounding, wrecking or collision impacts occur only in the cargo hold/midships area of merchant vessels. Nor has my search of various reports of shipping accidents suggested that a clear majority of collision impacts occur in the cargo hold/midship area.

11:10 It may therefore be concluded that the absence of double hulling to the vital service areas of the PNTL fleet makes it as susceptible to potentially catastrophic grounding, wrecking or collision impacts and subsequent disablement as most other vessels.

11:11 The design purpose of double hulled vessels.

a. There has been a distinct tendency for hazardous cargo carriers to allow, or indeed encourage, the public to perceive double hulls as the ultimate safety feature, which will prevent or minimise the loss of hazardous materials. This has been especially the case since the *Exxon Valdez* oil spill in 1989, when the US Government took unilateral action to introduce double hulling for oil tankers by way of the US OPA90 regulations. However, in a more academic theatre regulators, ship owners and hazardous cargo carriers present a somewhat different picture of the design purpose of double hulled vessels.
b. Following the *Sea Empress* spill the subject of double hulling received considerable attention at industrial and academic fora in the UK. At a seminar in 1996 , a representative of the BP Tanker Fleet stated that as a result of the US OPA90 regulations "the issue of the protection of the cargo space was taken even further by the advent of double-hull or double-skin designs". There was no attempt to claim that floatability or accident survival was imparted by double hulling. [Ref 9]
c. In 1997 the UK Marine Accident Investigation Branch of the UK Coastguard Agency and the DETR published it's Report into the *Sea Empress* wreck. One chapter of this document considered aspects of safety and salvage and discussed double hulled vessels. Although focused on double hulling for oil tankers it provides a useful summary of the attempts to find a vessel design offering the most effective protection against pollution in the event of grounding or collision incidents. [Ref 7]
   The MAIB Report stated that several authoritative studies had been carried out into the problem and while there is:
   "almost unanimous agreement that no one design produces the best results in all the possible grounding or collision scenarios which can be envisaged. There is also a general agreement on the following broad conclusions, namely that :
   - double hull vessels in low energy (typically low velocity) accidents should not pollute;
   - vessels which carry cargo in contact with a single skin (with sea on the other side) will cause some pollution in any accident where a cargo tank is penetrated.

   However, certain design alternatives will minimise the amount of pollution in some specified scenarios:
   - high energy accidents nearly always result in pollution. The relative advantages of various design alternatives in reducing pollution from particular scenarios are highly dependent on the assumptions made in the scenarios."

11:12 There are a number of important points here.

a. The discussion is based upon "scenarios", i.e. modelling of hypothetical incidents and no reference is made to any empirical trials.
b. The emphasis is firmly on the avoidance of pollution caused by breach of the inner hull and the subsequent release of a hazardous liquid cargo and not on the avoidance or reduction of sinking or loss of the vessel.
c. Only in low energy, low velocity accidents can a double hull be expected to not pollute: i.e. not suffer penetrating or breaching damage to the inner hull.
d. High energy accidents nearly always result in pollution (i.e. cause penetrating or breaching damage of the inner hull).

11:13 The Design Purpose of the PNTL double hull.

a. There is a consensus among both those who carry hazardous cargoes at sea and those responsible for the regulation of that trade, that both complete and partial double hulling is designed as a measure to protect the cargo space. It is also a measure to prevent or minimise the release or loss of hazardous cargoes in the event of low energy collision or grounding incidents.
b. However, in the case of the PNTL fleet, there are significant differences in the various reasons given by relevant parties for the use of partial double hulled sections, and it remains unclear whether their principal design priority and justification lay with protecting the cargo or maintaining the vessel's flotation.

11:14 In 1996 the PNTL owners stated that the vessels have "double hulls to withstand damage and remain afloat" and add that this effectively creates "a ship within a ship" (which appears to support the claim for floatability). [Ref 4: p 10] The IAEA state that the ship is "constructed with a double hull and double bottom structure to protect the transport packaging in the event of collision or grounding" but do not mention the issue of floatability or accident survival. [Ref 8: p 5] In 1999 the PNTL owners additionally stated that the double hull configuration contributes to "high reliability and accident survivability". [Ref 3: p.38]

11:15 While PNTL owners should be commended for their early use of partial double hulling as a cargo protection feature they should be censured for making the unjustified claim that the feature creates "a ship within a ship" or permits the vessel to "remain afloat".
No other user of double hulling has made this claim

and there is no feature of the PNTL system that makes it superior to other double hull designs in this respect. In fact, because the PNTL fleet is only partially double hulled it is not among the top rank of double hulled vessels.

11:16 In December 1985, by resolution MEPC.19 (22), the International Maritime Organisations' Marine Environmental Protection Committee adopted the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code). The IBC Code applies to ships built after 1 July 1986, and (in order to minimise the risks to ships involved in the carriage of dangerous chemicals) it prescribes the design and construction standards of ships and the equipment they should carry.

Chemical tankers and other vessels under this code must be built to conform to internationally agreed design and construction standards which vary according to the type of vessel and cargo.

11:17 Under the Code there are three classes of chemical. Type 1 is "very hazardous," Type 2 is "appreciably hazardous" and Type 3 is "hazardous". A typical example of the Type 2 chemical tanker was the *Ievoli Sun* which sank in the English Channel on 31 October 2000. Apart from a small section at the bow, this ship was double hulled throughout, representing over 95% of the vessel's length.

11:18 Built in 1989, the *Ievoli Sun* was similar in size to the PNTL vessels (115 metres long). Despite the stringent IBC design (which includes features designed to help the vessel survive the normal effects of flooding and to keep unsymmetrical flooding to a minimum consistent with safety of the vessel) the vessel took on water during a heavy storm, the forward cargo compartments flooded, the vessel became bow-heavy and lost manoeuvrability, was taken under tow by a rescue tug but eventually sank. [Ref 20]

11:19 It should be noted that only one of the PNTL vessels (*Pacific Pintail*) was built after the adoption of the IBC Code.

The documentary submission by the PNTL owners to the IMO [Ref 4} that claim enhanced floatability of the PNTL fleet, "ship within a ship" or accident survivability contain no description of any relevant empirical experience, reference accident or a description of the analytical techniques which have been used to deduce the claimed outcomes.

In the absence of evidence to the contrary it must be concluded that such claims are assumptions, that they lack scientific and technical rigour and have no credibility. Furthermore, it is evident that in terms of the design of their double hulling features, the PNTL vessels are inferior to many others.

11:20 IDENTIFIED WEAKNESSES OF DOUBLE HULLED VESSELS.

During the 1990s a number of studies reviewed the status of the then current designs of double hulled vessels. In what appears to be a generally held position, a representative of BP Shipping expressed concern about a range of real and potential problems affecting the long term integrity of double hulled vessels. These problems included :

- leakage of hydrocarbon products into the double hull "void space", with the subsequent risk of gas build up (with a subsequent potential risk of fire/explosion);
- moisture build up between the hulls;
- the difficulty in venting the hull space of gas and moisture;
- difficulty in inspecting the internal spaces of double hulls;
- the potential for corrosion and repair problems. [Ref 9]

11:21 In 1996 the BP fleet representative stated that there "are still problems with double-hull ships" and described a proposed major fleet rebuild with a second generation of re-designed double hulls. BP's proposed new "enhanced double hull design" had a number of innovations including :

a. an additional stringer (structural member) to provide greater strength in those areas of the hull where fatigue loads are higher;
b. strengthening of key areas to give a greater margin if corrosion does occur within the hull space;
c. use of grade D steel which is tougher and more crack resistant than the normal A grade steel;
d. gas detection points fitted throughout the hull space (this is relevant to INF carriers because they carry engine and generator fuel and lubricants which could leak into the bilge/double hull spaces and gasify);
e. provision to vent (de-gasify) the double hull space;
f. provision to fill the hull space with an explosion resistance inert gas. [Ref 9]

There is no evidence that such issues have been of concern to PNTL fleet owners and operators.

11:22 In the context of these 1996 "re-thinks" on the subject of double hulls, it is possible that the late 1970s PNTL partial double hulling design did not take account of these design problems (which are not unique to hydrocarbon carriers). It may be that the PNTL fleet suffers from some of these design faults.

11:23 Regrettably the design details provided to the IMO by PNTL owners are of such a poor standard that they do not answer any relevant questions. Public access to the full design plans of the PNTL fleet would clarify the situation in regard to assessing:

a. the ability to inspect the interior of the PNTL double hull void spaces;
b. the potential for gasification of the void space to occur as a result of ingress of engine and generator fuel and lubrication spills;
c. the ability to de-gasify the void space;
d. the grade and quality of the steel used in the vessel construction;
e. the degree of corrosion on the interior faces of the void space.

11:24 In this context it is relevant to note that all five ships in the PNTL fleet are now "mature" (respectively 22, 21, 19, 16, and 14 years old). Publication of the full survey history of each PNTL vessel would provide answers to some of these concerns and enable an assessment of their current safety and efficiency.

11:25 In addition to the above, it is self evident that double hull and collision resistant features fitted between the double hulls also pose a number of potential complications in the event of any vessel or cargo salvage action following the loss, by wrecking or sinking, of the PNTL ships.

12. Possibility of flooding of a PNTL vessel

12:1 According to the fleet owners'description, PNTL ships are not double hulled throughout their entire length and beam. It is therefore possible that an incident of less kinetic energy than the "design collision" would have sufficient velocity to penetrate the hull in the single skin sections of the vessel. One of the effects of such an incident would be to cause some degree of flooding of the single hulled section.

12:2 PNTL owners appear to accept the basic premise that an incident involving some degree of flooding could occur. In the course of arguing that their vessels could experience a flooding event without sinking, they suggest that "holds or machinery spaces could be completely flooded". [Ref 4: p 10]

12:3 PNTL owners have also stated that because their vessels are "subdivided into numerous watertight compartments" and the "sub-division of the hull is preserved by the use of watertight doors" the vessels could survive the flooding of a "number" of such holds and machinery spaces. [Ref 4: pps 10&11] More precise details of the relevant design features and the precise number of holds or machinery spaces, that could be so flooded, are not given and therefore it is regrettably not possible to attempt any analysis of such a scenario.

However, it is important to note that PNTL owners do not claim the vessel could survive flooding of "all" or "most" of such compartments.

12:4 One effect of the penetration of the single hull section of a PNTL ship (or of the outer hull of the double hulled section) could include flooding of particularly important sections of the vessel including areas containing the vital primary and secondary (backup) systems like the engine room, generator room etc. (see section 11:9 above). There is plainly a potential for the failure of both primary and support systems in such an event.

A rudimentary reading of Lloyds List casualty reports demonstrates that disablement of primary and secondary (backup) systems is a major factor in a range of maritime accident scenarios including collisions, groundings, wreckings and founderings. It is most surprising that PNTL owners have failed to discuss this serious threat to the integrity of their vessels.

12:5 Another effect of such a flooding incident would be to increase the weight and draught of the PNTL vessel, secondary effects could include a reduction in the manoeuvrability of the vessel and a reduction in its "sea-kindliness" and the ability to "ride" heavy seas. In such an event a number of potentially serious outcomes could be expected, not least foundering and sinking. This is exactly what happened to the superior design, double-hulled chemical tanker *Ievoli Sun*.

A brief study of Lloyds casualty reports reveals this is a factor in many vessel losses. It is surprising PNTL owners have failed to discuss this possible serious outcome of the partial flooding that they concede might occur under certain scenarios involving a PNTL vessel.

The tone of the statement made by PNTL owners and the IAEA is reminiscent of the positive pre-launch propaganda about the Titanic which, with its 15 transverse watertight bulkheads, was also expected to remain afloat with a number of main compartments flooded.

12:6 No details of the reference incident, simulations, trials, tests or hypothetical calculations, upon which the claim for PNTL flooding survival is based, are given. There is no discussion of the performance of the vessel, thus flooded, in different types of weather and sea states.

This lack of precise detail prevents any serious analysis of the subject matter and means the statement is scientifically and technically unjustified and must therefore be regarded as an unsupported, hypothetical assumption.

12:7 In the context of the sinking of the Type 1 chemical tanker *Ievoli Sun*, built to the superior design standards of the 1986 IBC Code, the claims for the PNTL fleet's unproved ability to survive flooding incidents have little credibility.

13. The Design Collision Vessel

13:1 PNTL owners make much of the enhanced safety imparted to the PNTL fleet by the addition of special reinforcement. They state that those sections of the vessels which are double hulled are afforded extra strength by being reinforced, between the side hull "wing tanks" with 20mm (0.8 inch) thick, high-strength horizontal steel plates for added protection to the length of the cargo hold area. [Ref 4: p 10] Since neither the poor quality drawings or the text indicate this reinforcement is added to the double bottom section of the vessels, it must be assumed that this feature is part of the design which is intended to survive collision impact but not grounding impact.

13:2 In 1996, Lyman postulated the PNTL fleet had been designed to withstand a collision with a vessel of 24,000 ton displacement travelling at 15 knots. In such a scenario it was anticipated that the cargo area would not be penetrated because of its double hulling and collision reinforcement features. [Ref 10]

(N.B. Displacement tonnage is a definition normally applied to warships.)

Although taking issue with related matters the IAEA response to Lyman's paper did not debate this specific point. It may thus be assumed that the design collision claimed by Lyman is correct. [Ref 8: p 5]

13:3 In the above referenced PNTL owners and IAEA documents the design collision appears only to refer to the double hulled section of the PNTL vessels. No discussion is undertaken of the survivability of the single hulled bow and stern sections of the vessels. These are the sections containing the vital navigation, communication and service equipment (generators etc.).

13:4 This is not reassuring. When the design for the Pacific Class PNTL fleet was drawn up in the 1970s, a revolution in merchant shipping construction (begun in the 1960s) was underway. The major feature of this revolution was a significant increase in the size and speed of merchant vessels. As a result of this revolution there are now many vessels (both merchant and military) which are far larger and faster than that proposed for the PNTL design collision. By contemporary standards the PNTL vessels are small ships which are actually smaller than a number of vessels engaged in the fishing trade.

13:5 Despite the difficulty of comparing the design collision vessel's 24,000 ton displacement (a standard normally used to describe warships) with the dwt (dead-weight tonnage) or grt (gross registered tonnage) usually used for merchant vessels, it is plain that many modern merchant ships are also larger than the design collision vessel.

The *Times Atlas and Encyclopaedia of the Sea* describes the 14 most important types of merchant vessel design in the late 1980s and early 1990s. All are larger than both the PNTL vessels and the design collision vessel. [Ref 6: pps 138/139]

13:6 Of particular concern are the Very Large Crude Oil Carriers(VLCCs), Very Large Ore Carriers (VLOCs) and Gas Carriers (liquefied natural and petroleum gas) exceeding 100,000 tonnes dwt, which now represent a significant proportion of the world merchant fleet. In the case of some VLCCs, dwt is as high as 550,000 tonnes. In dwt terms, VLCCs are between eight and 45 times larger than the design collision vessel and between 26 and 145 times larger than the PNTL vessels. [Ref 6 : pps 138/139]

13:7 Of the 14 main types of modern merchant ships described, all (except Tramp Ships) are faster than the design collision vessel. VLCCs and VLOCs have design cruising speeds of approximately 16 knots. Many types of merchant vessels have speeds that are significantly greater than that of the design collision vessel's 15 knots:

- Gas Carriers and Car Carriers = 20 knots;
- Barge Carriers = 21 knots;
- Container Ships = 23 knots;
- Ro/Ro Container Ships = 24 knots.

Many contemporary surface war ships have speeds in excess of 30 knots.

(N.B. Tankers and bulk carriers make up roughly 60% to 65% of the world merchant fleet.) [Ref 6 : pps 138/139]

13:8 In the context of the facts set out in the preceding paragraphs, it must be concluded that the design collision vessel proposed in the collision resistance planning for the PNTL fleet is now thoroughly outmoded and redundant.

Given that the trend in merchant shipping through the 1970s PNTL design phase suggested this, it may be argued that the PNTL design team demonstrated a lack of foresight.

13:9 To further contextualise the PNTL design collision vessel, both Lyman's 1996 paper and the IAEA's response to it refer to a 1988 study by the OECD, containing a section on collision resistant vessels. Collision resistant design was examined and it was concluded that it would be possible to design a vessel with holds that could not be penetrated by a ship of any displacement or mass, travelling at speeds up to 24 knots. [Ref 11]

Plainly such a design would have been more appropriate to the conditions found along the world's maritime trade routes in the decades following the PNTL design effort.

13:10 Therefore the claims of the PNTL owners that the late 1970s, PNTL partial double hull design provides:

- the ability to "withstand damage and remain afloat";
- "high reliability and accident survivability"; and
- "ship within a ship" features;

lack contemporary scientific and technical rigour and credibility.

13:11 It is also true that, in their submission to the IMO, PNTL's description of the PNTL "design collision vessel" fails to discuss the nature of any cargo that such a vessel may carry. This review shows that, as of the 1980s, tankers and bulk carriers comprised roughly 60% to 65% of the world merchant fleet. These are plainly vessels carrying potentially high-risk cargoes with the ability to impart significant fire/explosion impacts on the outcome of any design collision.

The failure to discuss this aspect of any design collision vessel or design collision incident is a further major weakness in the consideration of such matters.

13:12 In the context of the information set out above it is evident the "design collision" vessel described by Lyman (and not refuted by PNTL owners or the IAEA) no longer represents a credible reference incident because the number of vessels greatly exceeding the assumed relevant parameters (speed, tonnage, displacement) is now far greater than it was during the design process.

13:13 It may prove a useful exercise to test (by mathematical calculation and modelling) the design vessel postulated in the OECD report against the PNTL design to assess their relative integrity in a variety of scenarios including foundering, fire/explosion, wrecking/stranding and collision.

Since PNTL owners place so much emphasis on their collision resistant features as a protective device for the cargo and an aid to enhanced accident survival and floatability for their vessels, it may also be proposed that both designs be tested in a re-worked "design collision" scenario employing vessel parameters more representative of the merchant fleet of the 21st Century.

Following the completion of such work it would then be appropriate to:

a. rigorously review the status and relevance of the PNTL fleet; and
b. investigate the desirability of designing a new generation of INF Class 3 vessels.

14. World Merchant Fleet Casualty Statistics

14:1 Statistical work on the world merchant fleet is complicated by a number of factors limiting the integrity of the baseline data. Only vessels over 100grt are registered and reported, and additionally the totals for all type and size bands of vessels are often incomplete. The number of vessels in commission varies from year to year, but there is an overall trend for growth despite occasional "slow downs" during shipping recessions.

Thus in 1977 there were approximately 67,945 ships over 100 grt and in 1987 there were 75,240. [Ref 6 : p 141] By 1999 the world fleet had grown to approximately 87,000. [Ref 12]

14:2 Lloyds of London total world merchant fleet casualty data (all types of vessels) reveals 2,915 Total or Constructive Losses of registered merchant vessels (over 100 grt) over a 10 year period (01/01/1990 - 31/12/1999), an average of 291.5 per year. [Ref 13]

14:3 Analysis of the data reveals causes of the casualties were as follows:

- Foundering 40%
- Wrecking/Stranding 22.5%
- Fire/Explosion 17%
- Collision. 11%
- Hull/Machinery damage 4%
- Contact 2.4%
- War/Hostilities 2.3%
- Missing/Unexplained 0.8%

14:4 In the context of the very high profile given (by BNFL, IAEA and others) to the claimed collision resistance of the PNTL vessels, it is highly relevant to note that, taken as a percentage cause of total world fleet losses, collision is a relatively insignificant factor.

In fact collision comes fourth (of eight causes) in the rating, with 79.5% of losses being caused by three more significant factors. (Nearly four times more vessels are lost by foundering, twice as many lost as a result of wreck/stranding and 50% more vessels lost to fire/explosion.)

14:5 Of the 75,240 vessels registered in the world merchant fleet in 1987, 219 ships (over 100 grt) were lost [Ref 6 : p164]. Thus in that year the number of ships lost represented 0.30% of the total fleet.

14:6 The number of vessels in the world merchant fleet grew from 75,240 in 1987 to 87,000 in 1999 (an average growth rate of 980 vessels per year) which supports an estimation that the average number of vessels in the fleet through the period 1990 to 1999 was 83,000. Through the 1990s the average number of ships lost was 291.5 per year. [Ref 13].

14:7 Based on the above, it may be calculated that the loss rate over the decade (1990 - 1999) was approximately 0.35% of the total fleet per year. Over the past 23 years the average loss rate to the world merchant fleet (all types of vessels) has remained remarkably constant within the 0.30% to 0.35%.

15. Double Hulled Vessel casualty statistics

15:1 The IMO has drawn up a report which catalogues the world tanker fleet, categorises vessels as oil tankers,ore/bulk/oil carriers, ore/oil carriers and chemical tankers and classifies them into a number of sub-types including double bottomed and/or double sided vessels.

This document makes it quite clear that there are certain difficulties with regard to such statistical work on the double hull fleet. In particular, vessel categorisation is not done in a uniform way in different data bases and there is a lack of suitable data on vessels built before 1983. [Ref 14]

15:2 The IMO data reveals that by the year 2000 approximately 1,878 vessels with double bottom/double side hulls had been delivered into the world merchant marine fleet. It has not been possible to obtain statistics detailing the losses of double hulled vessels up to the year 1990. [Ref 14]

15:3 However, further analysis of the Lloyds data [Ref 13] reveals that during the 10 year period (1990 - 1999) 21 double bottom/hull vessels were listed as Total or Constructive losses. These vessels were all engaged in the transport of hazardous materials (crude oil, oil products, liquefied gas and chemicals).

The causes of the casualties are given as follows:

- Fire/explosion 48%
- Foundering 38%
- Wrecking/stranding. 10%
- Hull & Machinery damage 4%

Thus 96% of casualties are due to three factors. Apart from the absence of collision from the list, it is broadly in accord with the statistics for world fleet casualties where 79.5% of losses were recorded as being caused by the same three factors (in a modified order of significance).

15:4 Note that fire/explosion is a significant cause of loss to the total world fleet but that it is not confined to hazardous cargo carriers. In fact the Lloyds data reveals only approximately 12% of fire/explosion Total or Constructive Losses are tankers or hazardous material carriers. Even if the PNTL fleet's armaments were claimed to be fire/explosion proofed in some way, this would not eliminate the fact that 88% of fire/explosion losses occur to vessels carrying non-explosive cargoes. It may be concluded that the PNTL fleet is as susceptible to fire/explosion hazard as any other vessel.

15:5 It is relevant to note that none of the double bottom/hull casualties recorded by Lloyds during the 10 year period were caused by collision. In the context of the demonstrated relative insignificance of collision as a cause of Total or Constructive Loss to the world merchant fleet this is not surprising.

However it is somewhat surprising that, in this context, the owners of the PNTL fleet and the IAEA have exercised so much effort in both attempting to collision proof the PNTL fleet and in publicising their unjustified claims about the success of that design effort. [Ref 12]

15:6 In a number of documents (referenced above) the PNTL ownership has claimed that double hulling imparts the ability to “withstand damage and remain afloat” and provides “high reliability and accident survivability”. However, the available statistics do not support such claims.

15:7 From the figures given above it may be calculated that the average loss of double hulled vessels over the 10 year period is 2.1 vessels per year or 0.11% of the double hulled fleet.

15:8 This figure is approximately 1/3rd of the loss rate of single hulled vessels. A superficial interpretation of the figure might suggest that vessels with double hull features are three times safer than single hulls. Such an interpretation should be treated with considerable caution.

A specific problem is that the number of double sided/hulled vessels is such a small fraction of the total world merchant fleet (roughly 2%). Thus their distribution over the world oceans is relatively very thin and their percentage risk of involvement in maritime accidents is very much lower than that for single hulled vessels.

The approximate percentage loss outcome for double hulled vessels, quoted above, should not be taken as an accurate reflection of the safety and accident resistance of double hulled vessels. More intense mathematical analysis of this subject area is strongly recommended.

15:9 Various recent United States, IMO and other regulations driving the increased construction and use of double hulled vessels must be expected to have a significant effect on the percentage ratio of double hulls relative to single hulls. Under these regulations an increasing percentage of single hull hazardous materials carriers will be phased out and replaced by double hulls. In response to this the percentage of double hull vessels in the world fleet will rise steeply. Casualty figures to vessels of this type must be expected to rise commensurately.

16. Collision Avoidance Plans.

16:1 Despite their strong emphasis on the collision resistant features of the PNTL vessels, both the fleet owners and the IAEA insist that collision is a highly unlikely occurrence.

16:2 The PNTL owners report that the vessels have duplicated navigation systems and satellite navigation and tracking systems. [Ref 4: p 10]

16:3 The IAEA states that “the probability of a collision is extremely low and is lower than for conventional ships”. This is the case because

> “The ships under discussion, carrying nuclear materials, have an important range of safety features, in agreement with (and in some cases exceeding) the code adopted by the International Maritime Organisation (IMO):
>
> - installation of automatic radar plotting and collision avoidance systems;
> - enhanced operational procedures and additional manning of the vessel;
> - deliberate route selection and planning”. [Ref 8]

17. Anti-Collision (AC) Radar Systems [Ref 15]

17:1 A large number of vessels carry AC Radar systems, which have now been in widespread use for at least a decade.

AC Radar systems track and compute the course and speed of selected targets and display this information to the Navigating Officer. The useful information for AC purposes is CPA (Closest Point of Approach) and TCPA (Time to Closest Point of Approach). The radar display can be fed with the ship’s own course and speed and can then perform a “Trial Manoeuvre” which will show what would happen if the Navigating Officer were to alter course.

17:2 A typical AC Radar system has the ability to acquire and track more than 20 targets at once. In practice, however, more than 20 targets on screen makes the radar screen “busy”, presents an overload of data to the Officer on watch and mitigates against effective data processing.

However setting preset alarms to sound if any CPA were to be less than a prescribed distance (eg two nautical miles) would reduce this problem. This only applies to acquired targets.

17:3 AC Radar systems usually have two different operating modes:

- Automatic acquisition, most commonly used in open sea conditions where “guard rings” are set at prescribed distances. If any target crosses the “guard rings”, when approaching, then an alarm is sounded and the target is automatically acquired and tracked. Automatic acquisition is not used in congested waters because the AC Radar system would fill up with information and present a confusing jumble of data;
- Manual acquisition requires the Officer on watch to manually place a cursor over an identified target. The system then works out the speed and direction of that target to determine whether it represents a collision risk. This operating mode is commonly used in congested waters, where there are many targets, most of which are harmless.

17:4 The effectiveness of AC Radar systems is limited by a number of technical difficulties. Marine radars are particularly poor at spotting ice, especially low level bergs and “growlers”. Marine radars will not detect anything below the surface such as reefs, wrecks or submarines.

17:5 In common with all radar, AC systems suffer from “Sea Clutter” caused by radar echoes from wave crests. All radar systems have means to reduce these effects but it is still possible to lose genuine targets in this type of interference. Low targets like barges can easily be lost in such clutter.

17:6 “Rain Clutter” is caused by radar echoes from rain showers. AC Radar systems have confused a genuine target with a rain shower to such an extent that when the shower passed over the target, the AC system continued to track the rain shower rather than the target ship that it had been previously tracking, thus leaving the ship unprotected. In such a situation the AC Radar system would not alert the Officer on watch that anything had changed.

17:7 Marine radar systems fall into two different frequency bands: 3cms and 10 cms. Ten centimetre radars are generally regarded as better at dealing with clutter and fog, and 3 cms radars are regarded as providing superior definition. The vast majority of vessels have 3cms radars with 10 cms as a secondary system. Very few, if any, have 10cms installations only.

Most installations allow the AC Radar display to switch from the 3cms Transceiver to the 10cms Transceiver and modern vessels may have two AC Radar displays on the bridge.

17:8 While radar systems generally function well in fog, very dense fog has been known to reduce the amplitude of the radar signal to an unusually great extent so that only very large and close targets can be seen. In such situations 10 cms radar systems are declared "faulty". As soon as the vessel emerges from the fog the signal returns to normal strength and "target" vessels become visible on the screen again. Such an occurrence is unusual but it has been known to occur in busy shipping lanes in temperate latitudes.

17:9 Radar systems are the subject of annual inspections and performance checks. Failure to meet these checks can result in the ship being prevented from sailing depending on which authority is responsible for providing certification.

However, AC Radar systems are complex electronic systems and therefore subject to reliability issues. While specific mean-time-between-failures statistics are available from manufacturers, there is a consensus in the industry that the reliability of AC Radar systems is generally about as good as a domestic light-bulb, (but harder to put right!)

There is, as yet, no system of inspection which can fully forecast the on-voyage reliability, or susceptibility to breakdown, of any AC Radar system.

17:10 Anti Collision Radar Systems in summary :

- AC Radar systems are only a navigational aid. They cannot prevent a collision or grounding incident. They can only advise the Officer on the Bridge;
- An AC Radar system can not take into account human error, take remedial action or allow for the unpredictable behaviour of other vessels;
- Targets can be lost in Rain or Sea clutter making the AC Radar system ineffective;
- Dense fog can reduce the performance;
- The reliability of such complex electronic equipment means that at some stage equipment failure is inevitable.

17:11 Finally it should be noted there is a well recognised category of marine shipping accident known as "Radar Assisted Collisions" which continue to occur despite frequent revision of the relevant codes of conduct. [Ref 6: pps 166 &167]

18. Other "advanced safety features" of the PNTL ships

18:1 In addition to the double hulling and collision resistant features and the AC radar systems discussed above, PNTL owners also list twin props and engines and bow thrusters as part of the advanced safety features of their ships.

18:2 Twin props and engines are undoubtedly a useful feature for any seagoing vessel and will greatly assist the reduction of vessel loss arising from mechanical breakdown.

However, reference back to Sections 14 and 15 shows the total loss rate (as a result of a combination of machinery and hull damage), of vessels is a low, but remarkably consistent, 4% of vessels from both the single hulled and the double hulled fleet.

18:3 The PNTL owners may be commended for fitting double engines and props to their vessels (on the basis that every small contribution helps). However these features were never likely to exercise a significant limiting factor over the major causes of loss to both single and double hulled vessels, eg fire and explosion, foundering and wrecking and stranding.

18:4 In the case of the casualty type defined as "fire/explosion" the records show that many fires originate in the engine rooms of the stricken vessels, quickly become major shipboard incidents leading to loss of control over the engine(s) or engine failure and require evacuation of the engine room. A frequent outcome of such fires is a total loss of power.

Typical of such a scenario was the incident involving the 103m long chemical tanker *Multitank Ascania* which experienced an engine room fire in mid March (1999). This fire quickly became uncontrollable, necessitating evacuation and sealing of the engine room prior to a fire fighting response. In the event the fire burned for approximately five days, while the engines and the engine room were unapproachable and the vessel drifted out of control off northern Scotland, with a highly toxic and explosive cargo aboard. [Ref 16]

Since the PNTL vessels are not provided with separate, protected engine rooms for each main engine, there remains a high risk that a severe fire involving one engine would disable both engines and require evacuation of the engine room.

18:5 Similarly the fitting of bow thrusters does indeed provide greater manoeuvrability at low speeds and this is especially useful while manoeuvring in port and approaching the dockside. However the generally low speeds and low kinetic energy involved in any potential accidental contact/collision incident means that the risk of serious damage to a PNTL vessel in such circumstances was never particularly significant.

18:6 As is the case with the double engines/props feature the fitting of bow thrusters to the PNTL vessels was never likely to exercise a significant limiting factor over the three major causes of loss to single and double hulled vessels.

19. Additional Fire Detection and Fire Fighting Systems

19:1 PNTL Vessels are fitted with "extensive fire detection and fire fighting systems" which cover every space on the ship and much of the equipment is duplicated. At the time when the PNTL vessels were built these features were quite advanced. However several classes of vessels (including gas, oil, products and chemical tankers and passenger vessels) are now fitted with “extensive fire detection and fire fighting systems” similar to those on the PNTL fleet.

19:2 It is relevant to note that, as with other hazardous materials carriers, the PNTL fleet’s fire detection and fire fighting systems are based on the need to fight fire originating within the vessel’s cargo holds and machinery spaces.

Thus response to fires originating from another vessel (ie during a collision incident) is not a design priority of the PNTL vessel. Given that oil, oil product, gas and chemical tankers now represent a significant percentage of the world merchant fleet, the fact that the PNTL fleet carries such systems is no guarantee of survival of fire incidents involving external fire sources.

19:3 In response to the design priority fire originating within the vessel, the PNTL fleet has been fitted with a system which has the “ability to flood the holds and machinery spaces with fire suppressant gases”. However, although such systems may well “improve the odds of survival” they cannot guarantee it.

19:4 In the *Multitank Ascania* case mentioned above once the engine room fire got out of control the engine room was sealed and the ships advanced “carbon dioxide smothering system” was released into the engine room. However this did not extinguish the fire which burned for approximately five more days before it was extinguished and the engine room could be reopened and accessed. Only then, following decisive action by the on-scene salvage master, was it possible to take the vessel into a well sheltered site where its dangerous cargo could be safely transferred to another vessel. [Ref 16]

20. The PNTL transport effort in the context of the world fleet’s transport effort

20:1 Throughout the 1990s the nuclear transport industry and its clients have made highly positive statements about the proven safety of the maritime transport of nuclear materials. The PNTL fleet’s owners state that as of January 1999, the PNTL ships “with more than 4.5 million miles covered without a single incident resulting in the release of radioactivity, have a safety record second to none. With over 20 years experience, PNTL has transported more than 4,000 casks in over 160 shipments”. [Ref 3 : p 9]

20:2 Such statements are not particularly reassuring when analysed against global maritime trade and accident statistics. The main problem is that both the actual transport volume of VHLW (in terms of cargo-miles) and the number of voyages present a statistical sample which is so small as to be meaningless.

20:3 The widely differing capacity of the various flask designs and the lack of detailed information about the number of each flask type carried on each PNTL voyage rule out consideration of a tonne-mile figure for INF transport. However, from the scant information which is available it may be calculated that the 30 year (1969 to 1999) total transport of INF is approximately 4,000 flasks (varying designs) or an annual transport average of 133 flasks. Similarly the 30 year total mileage covered is approximately 4.5 million, giving an annual average of 150,000 miles. [Ref 3]

Thus the average annual seaborne movement of INF casks may be expressed as approximately 20 million “flask miles” while the 30 year total seaborne movement of casks is approximately 18 billion “flask miles”.

20:4 By comparison, the transport statistics for the world oil tanker fleet demonstrate that the PNTL transport effort has been positively minute and statistically insignificant.

Data drawn up by The International Tanker Owners Pollution Federation shows the 1998 total seaborne oil trade was calculated at approximately 10,000 billion tonne-miles, and that the release of intermediate and large oil spills occurred on approximately 27 occasions in that year. Thus it may be calculated that in 1998 one intermediate to large oil spill occurred for every 370 billion tonne-miles of oil carried at sea. [Ref 17]

Outside the oil tanker transport industry few would claim that the international tanker owners had an exemplary safety record in terms of vessels lost, cargoes lost or environmental impacts caused.

20:5 Set in this statistical context the PNTL ownership’s claim that they “have a safety record second to none”, is insupportable because it is based on too small a statistical sample to provide any meaningful evidence. Even the PNTL fleet’s total 30 year flask mileage (18 billion flask-miles) is minute when compared to the one year transport effort to accident ratio of the oil tanker fleet (one intermediate or large spill per 370 billion tonne-miles of oil).

Put simply, the PNTL fleet just hasn’t completed enough flask-miles to start accruing significant accident statistics.

21. Documented Accidents involving INF Class 3 carriers

21:1 I have contacted a number of sources to access the world wide statistics of accidents involving vessels carrying nuclear cargoes. Regrettably it has not proved possible to find a historically or geographically complete list of such incidents. However, the MAIB have provided a list of incidents involving INF carriers (from the world fleet: not PNTL alone) for the period since the computerised recording of such incidents began in 1991.

In the period 1991 to 1998 (inclusive) there were 15 incidents involving maritime INF carriers. Nine of these occurred in United Kingdom (UK) waters and six outside UK waters. [Ref 18]

21:2 These incidents are listed in accordance with the Merchant shipping notice (M Notice) which defines incidents in terms of seriousness, as follows :

- Hazardous incident - near miss events including near collisions;
- Dangerous occurrence - machinery damage, failure/ fires etc;
- Accident – more serious with threat of damage to, or loss of, vessel.

In the case of the INF fleet the MAIB do not release details such as name of vessel, type of cargo, volume of cargo, source or destination of cargo to the public.

21:3 Of the nine UK incidents, three were potentially serious. One was a hazardous incident in 1997 when an INF carrier had a near miss collision incident, in clear visibility, passing within four cables length (4 x 608 ft) of a Ro/Ro ferry while both vessels were manoeuvring at sea.

21:4 Two incidents were contact collisions. The first occurred in 1994 and was defined as an accident. It occurred as a result of the ship's engine failure while under way in a UK port. Control over vessel was lost and she suffered collision with a bridge.

(N.B. Dual engines, dual propellers and bow thrusters did not prevent the occurrence of this incident.) Vessel arrested by Admiralty Marshall in respect of alleged damage.

The second occurred in 1998 as the result of an accident when a barge broke her moorings in bad weather and collided with an INF vessel in port. Both vessels damaged.

21:5 The remaining incidents consisted of the following:

- UK ports or coastal waters - February 1996 Dangerous Occurrence (corroded pipe burst and released hot oil), January 1998 Dangerous Occurrence (mechanical failure of hoist wire on stores crane), April 1998 Dangerous Occurrence (mechanical failure : human error);
- High Seas - February 1991 Accident (machinery), January 1995 Dangerous Occurrence (minor fire), November 1995 Dangerous Occurrence (fuel oil pipe detached and fuel oil sprayed over engine), August 1998 Dangerous Occurrence (lube oil pipe sheared);
- Foreign port or waters - September 1996 Hazardous Incident (mooring line accident to seaman), June 1997 Dangerous Occurrence (minor fire in hold during testing procedure);
- Site and accident details not given - January 1991 Hazardous Incident, December 1991 Dangerous Occurrence, December 1991 Accidents to personnel.

21:6 More recent information for the period 01/01/99 to22/12/2000 has also been obtained from the MAIB. [Ref 19]

This shows that the following incidents have also occurred :

- UK ports and coastal waters - June 1999 Dangerous Occurrences (two engine room fires), September 1999 Accident (engine room fire: minor), August 2000 Hazardous Incident (electrical failure: component over-heating);
- High Seas - February 1999 Dangerous Occurrence (mechanical failure: high pressure air hose).

21:7 A total of 19 incidents occurring to INF vessels has been recorded by the MAIB in the period 1991 to 2000. All of these were relatively minor in terms of their eventual outcome, but plainly demonstrate that the INF vessels and their crew are susceptible to a range of incident types.

Of the 19 incidents reported, over 25% (four) were given the most serious status - accident. There were at least five actual fires and at least three incidents with fire potential (oil leaks etc.). There were two actual collisions and one near miss

22. Incidents involving INF Class 1& 2 & IMDG Code Class 7 materials

22:1 IMDG Class 7 and INF Class 1 & 2 materials may be carried on standard passenger or freight carriers and thus there is no rapid process for identifying any vessel casualty which may have been carrying such cargo at the time of the incident. However as a result of media cover or previous work the following incidents have been recorded.

22:2 *SS ARDLOUGH* 1986/87. General cargo vessel: lost a deck consignment of radioactive Californium 252 (alpha/gamma emitter) overboard in storm conditions while on passage from Liverpool to the Irish Republic. Consignment lost approximately south of the Isle of Man between Holyhead and Dublin and never recovered.

22:3 My subsequent cross examination of Dept of Transport representatives at the Hinkley CPWR Public Inquiry demonstrated that the UK Dept of Transport admitted lead authority in relevant matters and confirmed that they:

- were uncertain whether the consignment would float or sink;
- were uncertain how long consignment might stay afloat or stay sunk;
- were uncertain of the integrity of Type A or Type B packages in marine environments during storm conditions;
- had no method for tracking or locating (non INF Class 3) nuclear consignments lost at sea;
- had no method for predicting the eventual destination/fate of nuclear consignments lost at sea.

22:4 The *MV MONT LOUIS* in the mid 1980s was a general cargo vessel that ran aground and sank in shallow water in the Franco/Belgian sector of the North Sea. Its cargo included 60 casks of Uranium Hexafluoride (U HEX). Weather remained calm, salvage response and equipment centres were nearby. Casks spilled from the vessel and spread over adjacent seabed: salvage work to recover U HEX was relatively prolonged but eventually all casks were recovered. Some casks were reported damaged, but "no significant release of radioactivity" reported.

22:5 The *MV CITY OF MANCHESTER* in May 1999 was a small container vessel that caught fire and drifted. Built 1979, length 104 ft : gross tonnage 4,000 :owners Andrew Weir Shipping (regular carriers of IMDG code 7 materials), Isle of Man flagged. Cargo 10 tonnes of Uranium Dioxide (UO2) powder in two consignments : one on deck and one below.

Cargo had been refined at BNF Springfield nuclear fuel manufacturing plant and was en-route to Salamanca (Spain). UO2 powder is fissile (enriched with U235) and is made into fuel pellets for AGR and PWR reactors (it is both radio-toxic and chemically toxic).

22:6 An engine room fire occurred aboard the vessel on the night of the 9th May 1999, 30 miles south, south-west of the Pembrokeshire coast, the fire was extinguished but the vessel lost power and began to drift in light to moderate winds. Assistance was requested and a tug was despatched from the nearest “safe haven”, the “nuclear free” Port of Milford Haven, Pembrokeshire .

The vessel remained in port for some days while engine repairs were completed and then continued on her journey.

22:7 The incident was characterised by the extreme difficulty experienced in attempting to obtain a coherent picture of the unfolding event and the nature of the cargo.

BBC Wales TV on the 9th May reported that the vessel had “broken down” and was carrying low-grade radioactive wastes and/or contaminated materials for BNFL.

On the 10th of May the Milford Haven Coastguard reported the vessel was carrying a package of low-grade radioactive material, but reported the incident (fire) scenario accurately.

National Coastguard: Southampton 10th May reported the vessel carried two packages of “not very active material” but also reported the incident scenario accurately.

Andrew Weir shipping 11th May would not discuss the incident and stated the vessel had been carrying two packages of regularly used material comparable to those radioactive materials used in hospitals.

BNFL press office gave the final official version of the story as used above on May 12th.

Summary of review findings

1. The INF & IMDG (Class 7) Codes

a. The INF and the IMDG Class 7 Codes set out a number of requirements for vessel design, cargo management and emergency plans. Much of that material refers back to the 1974 SOLAS Convention and some of its subsequent amendments. The majority of that material now applies to the generality of the world merchant fleet. Only a minority of that material is specific to vessels carrying hazardous and noxious cargo.

b. The IMO can be commended for drawing up the Codes, and it is recognised that the Codes are of assistance in maintaining a good general standard of vessel design, cargo management and emergency planning. However there is relatively little in the Codes to justify claims from the owners of INF Class 3 ships (eg the PNTL fleet) that the IMO's 1993 INF Code had "introduced stringent requirements for ensuring the safety of vessels carrying radioactive materials, covering the design specifications of the vessels concerned".

c. The simple truth is that while some sections of the Codes contain material which is specific only to INF and IMDG Class 7 ships, it is also true that the Codes stipulate very little which is not currently found on many contemporary types of well appointed, properly maintained, efficient merchant vessels which have been inspected, flagged and insured by responsible and reputable companies, agencies and administrations.

2. The World INF (Class 3) Fleet

a. The 1993 INF Code stipulates most of the features designed by the PNTL designers in the late 1970s and there is no evidence that any major modification of the PNTL vessels has occurred since they were completed.

b. Three implications may be drawn:
   - the PNTL design was remarkably far sighted;
   - the IM0 (with little previous expertise in this specific subject area) may have been strongly reliant upon the advice of nuclear carriers in drawing up the INF Code recommendations regarding vessel design, and thus based their ship design stipulations on the PNTL parameters;
   - the IMO standard is not as "stringent" as the PNTL owners have claimed.

c. Many of the vessels in the world INF fleet are now aging. Particular concern may be attached to two Russian vessels, *the Lepse* (built 1961) and the *Serebryanka* (built 1974). In this context it is relevant to note that all of the five strong PNTL fleet are now also aging (respectively 22, 21, 19, 16, and 14 years old).

3. Sea routes used by the PNTL fleet

a. There is no evidence to justify the PNTL ownership's claims, supported by the IAEA, that extra safety is imparted to the PNTL ships by careful route planning. On the contrary, the vast majority of all merchant vessel movements are regularly subject to such planning in order to avoid excessive cost, delays or risk to vessel, crew and cargo.

b. Although the PNTL ownership has not provided precise route details, an in-depth analysis of the broad scale routes used to date by the PNTL fleet demonstrates that they involve passage through a number of “Marine High Risk Areas” (Lloyds of London definition) where weather conditions, sea states, vessel numbers and route congestion give rise to high shipping casualty numbers.

4. Double hulls

a. In submissions to the International Maritime Organisation, the PNTL ownership has failed to provide precise details of the double hulling features incorporated into the vessel design and construction. However, despite PNTL claims that the vessels have “double hulls”, it is evident that they should properly be described as “only partially double hulled”, because the double hulling feature only extends around the cargo hold, leaving the fore and aft sections of the vessels with only a single skin.
In this respect the PNTL fleet is not among the top rank of double hulled vessels in the world fleet of hazardous materials carriers which are fully double hulled. It is, in fact, inferior to many.
b. The PNTL ownership has made a number of claims that, because the double hulled design of their vessels provides the ability to “withstand damage and remain afloat”, they are therefore effectively “a ship within a ship” and have “high reliability and accident survivability”.
c. However, evidence from government agencies and other major shippers of hazardous materials makes it quite plain that the double hull design is intended specifically, and only, to protect the cargo and that this task can only be guaranteed in the event of low impact collision or grounding events.
d. Thus the PNTL statements are mistaken and misleading in two respects.
Firstly, the double hull design is only intended to protect the cargo space, not prevent the sinking of the vessel. Secondly, the double hull design will not protect the cargo space in anything other than a low energy impact event.

5. Identified weaknesses of double hull features

a. Since the design programme for the PNTL fleet (1970s) industrial bodies and government agencies have concluded that there have been a number of weaknesses inherent to the first generation of double hull vessels.
These include the potential for gas and moisture build up between the hulls, difficulty in venting that gas and moisture, difficulty inspecting the double hull void space, an enhanced potential for corrosion in the hull space, potential difficulties with repair in the double hull void space and the fact that double hull features are thought to only offer protection in low impact scenarios.
b. In response to these problems at least one major hazardous materials carrier (BP Tanker Fleet) has set about a re-design exercise and commenced the construction of a series of “enhanced” double hulled tankers in the mid 1990s.
Enhanced double hull tankers include innovations such as: extra structural members to provide greater strength in areas of the hulls where fatigue loads are highest, strengthening of key areas to give a greater margin of resistance against corrosion of the hull void space, use of “Grade D” steel instead of the more usually used “Grade A” steel, gas detection points fitted in the hull void space, venting provisions fitted in the hull space and provision to fill the hull space with explosion/fire resistant inert gases.
c. In addition to the above, it is also self evident that double hulling and associated collision resistant features would potentially complicate any attempts to salvage the vessel or their cargo.

6. The possibility of flooding of the PNTL fleet

a. In its submissions to the IMO, PNTL claims that even if holed during a collision “holds and machinery spaces could be completely flooded” while the ships could survive without sinking.
In its submission to the IMO this PNTL claim is not supported by any technical data or precise details. This means that the claim is scientifically and technically unjustified and should be regarded as an unsupported, hypothetical assumption.
b. The PNTL claim fails to discuss the impact of secondary effects of flooding such as: the potential decommissioning of vital primary systems and backup systems (engines, generators, navigating equipment etc.) and the subsequent loss of maneuverability, sea-kindliness and the ability to ride heavy seas.
All of these are major contributing factors to many vessel losses, especially as a result of foundering and sinking.
c. No detail of any reference accident, simulation exercises, trials, tests or any hypothetical calculations are given in the PNTL submissions to the IMO. Nor are there any discussions of the performance of the PNTL vessels thus flooded, in different types of weather and sea states. This means that the PNTL claim is scientifically and technically unjustified and should be regarded as an unsupported, hypothetical assumption.

7. The Design Collision Vessel

a. PNTL and the IAEA have not refuted suggestions that a specific “design collision vessel” has been applied to discussions of PNTL vessel safety. The parameters of that “design collision vessel” are now shown to have been significantly inappropriate throughout the entire lifespan of the PNTL fleet. Specifically, the “design collision vessel” is shown to have been smaller and slower than most merchant vessels in the world fleet during the construction phase of the oldest PNTL. That position has continued to develop since then.
b. The details and description of the PNTL “design collision vessel” also fail to discuss the nature of any cargo that vessel may carry. This review shows that, as of the 1980s, tankers and bulk carriers comprised roughly 60% to 65% of the world merchant fleet and that such vessels plainly pose a potential high risk

collision scenario with associated fire/explosion risks. These parameters are not discussed with reference to any "design collision vessel".

c. In the context of the information set out above it is evident that the "design collision vessel" no longer represents a credible reference incident because the number of vessels greatly exceeding the assumed relevant parameters (speed, tonnage, displacement) is now far greater than it was during the design process and that the design process makes no reference to the extra risks posed by hazardous cargoes carried by other vessels which might be involved in collision scenarios.

8. Casualty statistics

a. PNTL have given collision avoidance a very high profile in their publicity and their submissions to the IMO.
However 10 year casualty data from Lloyds of London reveals 79.5% of total losses to the total world fleet (singe & double hulls) were caused by foundering, wrecking/stranding and fire/explosion: in that order of importance. Collisions accounted for only 11% of total losses.

b. 10 year data obtained from Lloyds of London reveals 96% of the total loss casualties to the world double hull feature fleet are due (in descending order of importance) to fire/explosion, foundering and wrecking/stranding and that collision did not account for any total losses.
Thus it is evident that PNTL's emphasis on collision prevention was never the priority area for enhanced safety features at the design and construction stage.

c. Under recent regulations an increasing percentage of single hull hazardous materials carriers will be phased out and replaced by double hulls. Casualty figures to vessels of this type must be expected to rise commensurately.

9. Collision Avoidance Radar

a. PNTL and the IAEA argue that the use of Collision Avoidance Radar systems renders the likelihood of collision extremely low.

b. However such systems are only navigational aids, which can only advise the crew, on their own they cannot prevent collision or grounding. They cannot account for human error, take remedial action or allow for the unpredictable behaviour of other vessels.

c. Such systems may not pick up low reefs, low icebergs or low vessels such as barges. Targets can be lost in certain rain or sea conditions, dense fog reduces the performance of such systems. The reliability of such complex equipment means that at some stage equipment failure is inevitable.

d. Despite the use of such systems and regular revision of relevant codes of conduct and ever improved standards of radar training, there is a continuing phenomenon known as the "radar assisted collision" which arises as a result of human error.

10. Other advanced safety features of the PNTL fleet

a. PNTL have fitted duplicate engines and props to their vessels. While acknowledging that this is a useful safety feature, this review notes that total losses due to mechanical breakdown represent only 4% of both the single and double hull fleet losses, and that the feature was never likely to exercise a significant limiting factor over the major causes of vessel loss (fire/explosion, foundering, wrecking/stranding).

b. Similarly the fitting of bow thrusters is acknowledged as a useful step.
However, this technology is of little or no use in open sea and high-speed scenarios. It is intended for use while maneuvering in port in low energy/low impact scenarios with very little risk of total loss of the vessel. Bow thrusters are most unlikely to exercise a significant limiting factor over the major causes of vessel loss.

c. Similarly it is acknowledged that the fire fighting and fire detection systems fitted to the PNTL fleet are of considerable value in combating the risk of fires originating from within the vessel. However, there are recent examples where an onboard fire originating in the engine room, has disabled the vessel and very nearly caused total loss, despite the fitting of modern fire-fighting equipment such as that fitted to the PNTL fleet.

d. It is also noted that the design priority for the fire response systems in the PNTL ships was a response to on-board incidents with specific reference to fires which might affect the cargo. This review points out that roughly 60% to 65% of the world merchant fleet consists of tankers and bulk carriers and that, in collision scenarios, these vessels pose a vastly increased potential "outboard" originating fire risk which has not been specifically addressed in the design of the fire response systems.

11. The PNTL transport effort in the context of the world fleet

a. PNTL owners claim an exemplary safety record in regard to their maritime transport of INF materials. This review demonstrates that the PNTL transport effort is insignificant relative to that of other hazardous materials carriers.
The annual average movement of INF cargo by sea may be expressed as 20 million flask/miles.
By comparison it can be calculated that in 1998 there was one intermediate or large oil spill for every 370 billion tonne/miles of oil carried by sea.
Few commentators, even those within the industry, attempt to claim that this represents an exemplary standard.

b. Set in this context, PNTL's claims that they "have a safety record second to none" is meaningless because it is based on a statistical sample too small to provide any useful evidence. Put simply the PNTL fleet just hasn't completed sufficient cargo/miles to start accruing significant accident statistics.

12. Accidents involving INF Class 3 carriers

a. Although there have been no major losses to the INF fleet, the available evidence shows that incidents of varying severity are a regular occurrence aboard INF ships.
Although it has not proved possible to access

complete data on such events it can be shown that, for the period 1991 to mid 2000, there were 19 incidents including at least five actual fires, at least three potential fires (oil leaks etc), two collisions and one near miss collision. Over 25% of the incidents were given the most serious status "accident".

b. Despite the fact that reporting of incidents with specific reference to such cargoes is not mandatory, this review has also identified a number of serious incidents involving IMDG (Class 7) radioactive materials. These include the sinking of a vessel carrying drums of such material, the loss of a deck cargo of such material overboard in a storm and a disabling fire aboard a vessel carrying fissile nuclear fuel.

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A review of contingency planning for at sea emerencies involving irradiated nuclear fuel (INF) cargo

1. The IMO's Shipboard Emergency Plans (SEPs)

1:1 During the work on this report, a feature of discussions with Government Agencies throughout the world has been the repeated mantra that the various flasks used in the maritime transport of INF Code materials have been designed to such a high standard that any loss of radioactivity, as a result of any conceivable maritime accident, is not credible.

1:2 This confidence can be traced back to the IAEA who have been regulating the design of such transport packages for many years, have carried out a series of tests to demonstrate the accident survivability of transport flasks in a series of specific accident scenarios (few of which have a purely maritime nature) and regularly promulgate highly positive statements about the safety and viability of their approved design packages including the range of INF, High Level Waste (HLW) and Vitrified Waste casks.

In this context it is worth noting that the IAEA is an organisation with relatively little involvement and experience in maritime transport matters.

By way of their publications the PNTL owners have also contributed to the proposition that a loss of INF Code materials as a result of any conceivable maritime accident, is not credible.

1:3 However, the IMO (with a vast experience of maritime transport matters) has demonstrated its evident acceptance that accidents leading to a loss, or potential loss, of radioactivity are indeed a credible occurrence by incorporating into the INF Code a series of recommendations which provide guidance and/or advice on procedures which might be followed in such an eventuality.

1:4 Chapter 10 of the 1999 version of the IMO's INF Code stipulates that "every ship carrying INF cargo shall carry on board a shipboard emergency plan", that such a plan should be approved by the Administration (of the vessel's flag state) and that as a minimum the plan should consist of the following :

- the procedure to be followed by the master or other persons having charge of the ship to report an incident involving INF cargo;
- the list of authorities or persons to be contacted in the event of an incident involving INF cargo;
- a detailed description of the action to be taken immediately by persons on board to prevent, reduce or control the release, and mitigate the consequences of the loss, of INF cargo following the incident (my emphasis);
- the procedures and points of contacts on the ship for co-ordinating shipboard action with national and local authorities".

The 1999 version of the INF Code provides no further detail of Shipboard Emergency Plans. [Ref 1]

1:5 However the Shipboard Emergency Plans section of the 1993 version of the IMO's INF Code [Ref 2] is supported by an 18 page appendix "Guidelines for Developing Shipboard Emergency Plans for Ships Carrying Materials Subject to the INF CODE" prepared by the IMO's Marine Environment Protection Committee of the IMO and adopted in November 1997. [Ref 3]

1:6 This document covers all categories of INF Code materials and the vessels used to carry those materials including the following:

- Class 1 INF Ships: certified to carry INF cargo with an aggregate activity of less than 4,000 TBq. (Class 1 INF material may be transported on merchant vessels such as cargo ships/ freighters, Ro/Ro and passenger ferries.)
- Class 2 INF Ships: certified to carry irradiated nuclear fuel or high level radioactive wastes with an aggregate activity less than 2 X 10^6 TBq or ships carrying plutonium with an aggregate activity of less than 2 X 10^5 TBq. (Class 2 INF material may be transported on merchant vessels such as cargo ships/freighters, Ro/Ro and passenger ferries.)
- Class 3 INF Ships: certified to carry INF, or high level radioactive wastes or plutonium with no restriction of the maximum aggregate activity. (INF Cargo required to be carried on Class 3 INF ships shall not be allowed on passenger ships and is generally carried on purpose built vessels like those of the PNTL fleet.)

1:7 The foreword to the Guidelines states the main objectives are:

- "to assist ship owners in preparing comprehensive shipboard emergency plans for ships carrying INF Code materials: and
- to assist in responding to shipboard emergencies involving INF Code materials and in providing information in accordance with international law to authorities involved in assisting or handling incidents at sea involving INF Code materials".

1:8 Section 1 of the Guidelines defines the relevant terms :

- An "incident" is defined as any occurrence, or series of occurrences (including the loss of container integrity) having the same origin which results or may result in a release or probable release of INF Code materials;
- "Release" is defined as either the escape of INF Code material from its containment system or the loss of an INF Code package;
- "Shipboard Emergency Plan" (SEP) is defined as a document that is tailored to a particular ship carrying INF Code materials and contains the procedures to be followed in order to ensure shipboard preparedness for responding to emergencies.

1:9 Section 1 of the Guidelines also warns SEP writers that the SEPs should be prepared on a ship by ship basis and that they should make provision for the many variables (including the type and size of the ship, category of the INF materials and their physical properties, nature of the intended route and any relevant shore-based management structures, the nature of the packaging and the potential consequences of related transport incidents).

1:10 Planners are warned that "for a SEP to be effective, it should be carefully tailored to the particular ship for which it is intended". This point is re-emphasised when the planners are warned that while “a shipowner or operator with multiple ships may prepare one plan” for the whole fleet, there should be “a separate ship-specific annex for each ship covered by the Plan”.

1:11 Section 1 of the Guidelines states that the Plan “should provide for small or routine emergencies. However, it should also include guidance to assist the master in meeting the demands of a large scale incident, should the ship become involved in one.”

It also repeats that the Plan is intended to “assist personnel in avoiding the further escalation of an incident and in dealing with an actual or potential release of INF Code materials. Its primary purpose is to set in motion the necessary actions to avoid or minimise a release and to mitigate its effects”.

2. Responsibilities for Action on SEPs

2:1 Sections 1:14 to 1:21 of the INF Code’s Guidelines for SEPs define the various responsibilities for preparing and dealing with a marine transport incident involving INF Code materials. Specifically these sections define the diverse duties of the consignor or shipper (BFL/Cogema etc.) and the carriers (PNTL).

2:2 The consignor or shipper is responsible for ensuring that before an INF cargo sails, the carrier is “made fully aware of the procedures to be followed, both on board the ship and by shore-based organisations, in the event of an incident involving such materials.”

2:3 The consignor or shipper also has the responsibility to know and comply with all the “applicable international, national, state or local regulations or guidelines pertaining to the shipment of INF Code materials” and to understand “how to deal with all the potential difficulties anticipated when shipping by sea”.

In addition the consignor should make available to the carrier the appropriate technical information, emergency instructions and notification information.

2:4 Generally the consignor “should be prepared to assist in an emergency response to an incident involving any INF Code materials by providing timely and detailed information about shipments and to send immediately emergency response/support assets to an incident site, if required. The planning for such assistance should be complementary to the Plan.”

2:5 The carrier also has responsibility both for “safety during transport and in the event of an incident. In general, both the carrier and the consignor should be prepared to respond immediately to an incident involving INF Code materials.”

The carrier also has the responsibility of “facilitating a prompt response by the consignor/ shipper and crew in the event of an incident”.

2:6 The carrier is also responsible for knowing and complying with all applicable regulations pertaining to the carriage of INF Code materials, including the different response procedures in all areas along the route; ensuring that any incident is properly and quickly assessed by people who are knowledgeable in responding to INF incidents, ensuring that proper emergency instructions are carried on each ship, ensuring that all required notifications are accomplished in an expeditious manner and ensuring that the nearest coastal State, the consignor, and other appropriate authorities are immediately informed.

2:7 A major outcome of the division of duties and responsibility laid out in the IMO’s INF Code is expressed in paras 2:4 and 2:5 above. From these paras it is evident that the IMO expect the consignor (BNFL/Cogema/others in the case of the PNTL fleet) and the carrier (PNTL) to take a major part in any response action in the event of an incident.

However, it should be noted that the Guidelines state that the consignor “should be prepared to assist” and to send “response/support assets....if required”. The use of such language demonstrates that IMO neither expect, nor recommend, that either the consignor or the carrier take lead responsibility in response action.

2:8 The Guidelines also state that, without interfering with the ship owners liability, and under entitlement enshrined in both the 1969 Convention on Intervention on the High Seas in Cases of Oil Pollution and the 1973 Protocol relating to Intervention on the High Seas in Cases of Pollution by substances other than Oil, “some coastal States consider that it is their responsibility to define techniques and means to be taken against a marine pollution incident and approve such operations which might cause further pollution.”

In this context it is therefore surprising to note that a number of statements from some major coastal States imply that first and prime responsibility for response in the event of an incident has been devolved to the consignor and/or the shipper.

3. Devolution of responsibility from coastal States to the consignor or carrier

3:1 Thus the UK’s recently re-written, 140 page, “National Contingency Plan for Marine Pollution from Shipping and Offshore Installations” covers the “UK pollution control zone” which extends out 200 miles from the baseline (or to the nearest median line). The Plan deals mainly with the response to oil spills but does contain a four page section headed “Other Hazardous Substances”.

3:2 In that section three sentences are devoted to the subject of maritime accidents involving radioactive cargo materials. It is stated that, in the case of an incident involving a ship “operated by British Nuclear Fuels Limited or by its subsidiary, Pacific Nuclear Transport Limited”, a set of “special arrangements agreed between the MCA and those companies apply”. [Ref 4]

3:3 Further communication with the MCA has revealed that the MCA is the junior partner in this agreement. The “Special Arrangements” are not the property of the MCA, the MCA has no rights or authority over them and the MCA has no right to release any details of them. Furthermore, the Special Arrangements are “commercial-in-confidence and also under the ownership and authorship of another Authority”, and they “are the property of, and under the editorship of, British Nuclear Fuels Limited”. [Ref 5]

3:4 From the above it may be deduced that BNFL have written the relevant response plans, have retained the responsibility for editing them, retain all rights of ownership, publication and operation of them and that the MCA (although the UK Agency with lead responsibility for national maritime pollution response) is superseded by BNFL and PNTL in respect of response to at-sea radioactive pollution from BNFL or PNTL ships.

These are matters which appear to be “outwith” the control of the UK Government.

3:5 A similar situation appears to be in place in Australia. On 10 September 1999, the Australian Minister for Foreign Affairs answered a series of questions arising from a medical evacuation following an incident aboard a PNTL ship.

Among the questions was a request for details about the kind of accident that would trigger the involvement of a BNFL emergency team and a request for details of the criteria which might govern BNFL involvement. The Australian Minister could not, or would not, answer this question and stated that it should be “referred to BNFL”. [Ref 6]

3:6 Although no reason was given for this answer, it may be deduced that, as is the case in the UK, the final operational decision making responsibility lies in the hands of the PNTL owners and that these are matters which are also “outwith” the control of the Australian government.

3:7 Given that both UK and Australia are developed nations with a domestic nuclear industry and a body of technical experience, equipment and personnel it is surprising they should wish to devolve the right to take on the “responsibility to define techniques and means to be taken against a marine pollution incident and approve such operations which might cause further pollution,” bestowed upon them by various international agreements.

To date neither government has advanced an explanation to justify this position.

3:8 Such an action appears especially incomprehensible in the case of the Australian government which has no other discernible influence over the INF consignors (BNFL etc.) or the carriers (PNTL). By contrast, the UK government (as principal owner/shareholder of BNFL) has a significant potential degree of influence over the action of both consignors and shippers.

4. Essential Provisions of SEPs

4:1 The Guidelines stipulate that SEPs should contain the following:

a. the procedure to be followed in reporting an incident and a list of those to whom such a report should be made;
b. a detailed description of the action to be taken to prevent, reduce or control the release and mitigate the consequences of the loss of INF Code material;
c. the procedures for co-ordinating shipboard action with national and local authorities;
d. the provision of specific information regarding the ship;
e. guidance on reporting to the nearest coastal States (such a report is required whenever there is an actual, or probable, release, and in the event of any damage, failure or breakdown of a ship carrying INF Code materials which effects the safety of the ship: these to include, collision, grounding, fire, explosion, structural failure, flooding, cargo shifting, impairment of navigational safety, failure or breakdown of steering gear, propulsion systems, electrical generating system and navigational aids).
f. initial reporting should include answers to the following questions: are there any injuries on board, is there/was there a fire near the INF Code materials, what kind of radiological/chemical hazards exist, what are the meteorological conditions and wind direction.

4:2 The SEPs should facilitate rapid and efficient reporting. To that end it should contain a detailed list of persons, agencies and organisations to be contacted and take into account the need for 24 hour contact and to provide alternatives to the primary designated contact.

4:3 The Plan should include a list of agencies/officials of the administration of the nearest Coastal State, who have the responsibility for receiving and processing reports of incidents involving INF Cargoes. For ships in port, a similar list of relevant port officials should be available.

In addition there should also be a list of all parties with an interest in the ship and the cargo.

4:4 The SEP should also identify points of contact for specialised radiological monitoring and assessment teams on a 24 hour basis so that they can be “notified expeditiously” when their assistance is required.

5. Shipboard Emergency Procedures

5:1 Commenting that the ship personnel will almost always be in the best position to take quick, primary action to prevent, reduce or control the release of INF Code materials from the ship, the Guidelines stipulate a series of shipboard procedures, which “as a minimum” should provide the ship’s personnel with the ability to counter actual or potential emergencies involving INF Code materials.

The Guidelines are at pains to point out that such procedures will vary widely from ship to ship and that even features like different routes may result in shifting emphasis being placed on various aspects of planned emergency procedures.

5:2 The Guidelines stipulate that various checklists, flow charts and other means which will ensure the master considers all appropriate casualty factors and parameters are incorporated into the SEP.

These should include consideration of the following scenarios : grounding/ stranding, fire/explosion; collision; hull failure; serious structural failure; flooding; heavy weather damage and icing; excessive list; equipment failure (eg main propulsion or steering gear); containment system failure (eg release of INF Code material, contamination, or loss of cargo); security threats; submergence; foundering and wrecking.

While there is no doubt that a range of general principles are applicable to such scenarios, the Guidelines do not point out the fact that any one of the scenario types includes an open ended range and number of events and that no one event covered by a defined "scenario type" is the same as any other.

5:3 The Guidelines state that "procedures for dealing with the following incidents should be developed and practised:

a. abnormal radiation levels detected by remote monitoring instruments;
b. discovery of abnormal contamination on clothing, shoes or in spaces outside of the cargo hold;
c. flask coolant loss or leak;
d. movement or a shifting of a flask from its transport position;
e. unexpected temperature rise at the flask surface;
f. dropping a flask during loading or unloading."

5:4 The Guidelines state that prior to considering any remedial actions the master will need to obtain detailed information on the damage sustained by the ship and the INF Code material containers. The Guidelines stipulate that "a visual inspection should be carried out when it is safe to do so" and that adequate personnel should be on board to assess three basic issues by means of standard equipment and radiological assessment procedures. (These basic issues are: confirming the quantity and type of INF Code materials involved, ascertaining whether the INF containers or packages have been breached and assessing the existing radiological hazards.)

5:5 While "standard equipment and radiological assessment procedures" will provide useful information on the actual loss of INF Code materials, they cannot provide information relevant to assessing the future potential for such loss.

It would thus appear that the IMO accept there is sole reliance on visual observation of the post-incident condition of both the vessel and the INF containers in order to assess their physical condition and the potential for breaching of container integrity and the loss of INF Code materials.

The Guidelines fail to note that visual inspection might not be possible in certain incident scenarios and fail to provide guidance on the action to be taken if a visual inspection cannot be carried out.

5:6 The Guidelines also stipulate the master's priority is to ensure the safety of personnel and the ship and to take action to prevent escalation of the incident. Thus in casualty situations involving a release of INF Code materials the Guidelines describe measures aimed at preventing contamination of personnel:

- altering course so that the ship is upwind of the released or lost cargo;
- shutting down non-essential air intakes;
- using protective clothing etc.

The Guidelines offer no supporting advice or comment relevant to the case of "altering course" which requires the use of functioning engines (one of the casualty scenarios listed in 5:2 above is loss of propulsion) and is a manoeuvre which may not be possible in moderate to severe sea and weather conditions.

5:7 It is also stated that "when it is possible to manoeuvre, the master, in conjunction with the appropriate shore authorities, may consider moving the ship to a more suitable location to facilitate emergency repair work, cargo transfer operations, or to reduce the threat posed to any particular sensitive ocean or shoreline areas."

It is noted that "Such manoeuvring should be co-ordinated with the coastal State." (This is a further indicator of the need for joint and co-ordinated exercises between the INF Ship and the shore based authorities).

5:8 As paragraph 5:5 (above) shows, the IMO Guidelines have concentrated on the safety of crew and vessel. This is appropriate in the context of emergency activities and emergency advice that the IMO might usually be expected to comment on and is also in accord with a wide range of International agreements which are based on the obvious historical risks and impacts to vessels and personnel.

5:9 However, in the case of a range of more recent hazardous cargoes, especially certain chemical and INF cargoes, it is evident that there is also a potential risk of major public health impacts to personnel on adjacent vessels and populations in adjacent coastal States. There is also a powerful potential risk of major environmental and commercial impacts to the immediate and adjacent sea areas and the terrestrial and intertidal environments of adjacent coastal States.

5:10 The IMO Guidelines have failed to offer any advice on measures aimed at preventing contamination of personnel and populations and marine, intertidal and terrestrial environments by INF materials which have breached their containment and escaped into the environment.

5:11 This is a subject area of deep complexity which requires prompt attention by the IMO and others. This review advises that the IMO should give consideration to the weighting of impact risks to the INF vessel and personnel compared to those of personnel or public on adjacent vessels. Similar consideration should be given the weighting of impact risks to the INF vessel and personnel compared to those of aquatic or terrestrial environments.

5:12 This review recommends that the IMO should advise that, in circumstances involving loss or release (or potential loss or release) of INF material, an INF carrier should alter course in order to achieve the following:

a. personnel on adjacent ships, populations in adjacent coastal States and marine, intertidal and terrestrial environments in immediate or adjacent coastal States are placed "upwind of the released or lost cargo";
b. sufficient distance is put between those personnel, populations and environments and the "released or

lost cargo" as to permit dilution and dispersion of released or lost materials to such a level that no public or environmental health impact will arise.

6. Cargo Transfer

6:1 The Guidelines also state that SEPs should provide guidance on the procedures to be followed for ship-to-ship transfer of INF Code materials and for the safe removal from the ship of INF Code materials or packages that may have been damaged during loading or unloading.

The Guidelines assume that there will be pre-existing company plans for such procedures (ship-to-ship transfers) and stipulate that these should be kept with the main SEP.

6:2 It is stipulated that SEPs should address the need for co-ordinating this activity with the coastal State, because such operations may be subject to its jurisdiction. This implies the need for joint and co-ordinated exercises with the coastal State authorities.

6:3 Despite the potential complexity of the ship-to-ship transfer and the wide variety of scenarios in which the process might be necessary, the IMO's discussion of ship-to-ship cargo transfer is brief and imprecise.

6:4 When offering guidance on planning for an emergency which may affect the safe operation of the ship and/or cause potential or actual loss of containment of INF Code materials, the Guidelines list 14 examples (some of them multi-factoral) of incident types which should be considered.

Since ship-to-ship transfer is unlikely to be considered unless the transport vessel was damaged and unable to proceed, or was deemed unsafe for some other reason (i.e. keeping the INF Code material onboard might lead to breach of containment, escape/loss of INF Code material) it would appear logical to use the same incident type list. That is: grounding/stranding, fire/explosion, collision, hull failure, serious structural failure, flooding, heavy weather damage and icing, excessive list, equipment failure (eg main propulsion or steering gear), containment system failure (eg release of INF Code material, contamination, or loss of cargo), security threats, submergence, foundering and wrecking.

No such list of incident types informs the IMO's consideration of ship-to-ship transfer and it remains unclear whether the IMO are referring to at-sea operations or dock/port ship-to ship operations.

6:5 A study of submissions made by the PNTL ownership to both the IMO and other end users, reveals that there is considerable experience of in-port shore-to-ship and ship-to-shore transfer of INF Code materials with the vessels securely attached to the dock side and using both shore based and floating cranes. [Refs. 7 & 8]

6:6 Given the hazardous nature of the INF Code materials, and taking into account the relative vertical and horizontal movement of both vessels (while under way or moored/anchored), it is to be expected that the ship-to-ship transfer of such cargoes in a port, dock, harbour or sheltered coastal environment will be a matter of additional technical complexity relative to ship-to-shore operations.

In order to carry through such operations with any degree of success it is to be expected that the process would be the subject of regular exercises in ports, harbours and sheltered waters.

However, during the course of this study I have found no reference to any such exercises in the PNTL literature nor have I found any examples of ship-to-ship transfers which have taken place in such waters.

6:7 In the open sea environment the ship-to ship transfer of large and heavy items (while stationary or underway) is widely understood to be a matter of considerable complexity. This complexity can be greatly increased by a range of unpredictable and unstable ambient weather and sea conditions which, at their more severe, may make the relative vertical and horizontal movements of the vessels so extreme as to preclude any attempts at ship-to-ship transfer.

Although naval and maritime rescue personnel regularly undergo at-sea transfer and re-fuelling exercises involving vessels under way in open sea environments, I have found no reference to such exercises in any PNTL literature, nor have I found reference to any occasions when such transfer has been completed or attempted in such environments and conditions.

6:8 It should be noted that neither the PNTL owner's 1996 submissions to the IMO [Ref 7] or the PNTL owner's public information file of 1999 [Ref 8], which respectively pre-date and post-date the IMO's Guidelines (adopted 1997), contain any reference to ship-to-ship transfer of INF Code materials. It is particularly noticeable that such material is not included in either document's discussion of "Emergency Planning" or "Emergency Response Arrangements".

6:9 Ship-to-ship transfer of INF Code cargo may be necessary or advantageous if a PNTL vessel was wrecked, stranded or sunk. Plainly these are the events were the complexity of such operations is greatly increased by unpredictable and unstable ambient conditions including , sea and weather state, depth at which vessel/cargo are lying, ambient tides and currents.

There is no reference, in the PNTL documentation quoted above, to any training, exercises, drills or other consideration or study of the environmental parameters and problems associated with ship-to-ship transfer of INF Code materials in these situations.

6:10 Given the obvious complexity of ship-to-ship transfer operations in the wide range of conditions in which it might be deemed necessary, it is regrettable to note that the IMO Guidelines for SEPs have also failed to address the subject of environmental parameters and their likely effect on ship-to-ship transfer operations.

7. Training

7:1 The IMO Guidelines also provide guidance on training procedures. However it is noticeable that the IMO is less prescriptive on this matter than it is on others. Whereas the IMO Guidelines uses phrases such as "the Plan should" in respect of other guidance, in the case of training the IMO Guidelines say "the Plan may".

It is stated that training will ensure that the SEP functions as expected and that the specified contacts and communications are accurate. It is stated that such training may be held in conjunction with other shipboard training programmes.

7:2 Both consignors and carriers involved in the transport of INF Code materials should provide training on their emergency instructions and the hazards of the materials involved. Training should be role specific and provisions should be made for "refresher" training and for the review of incident experience and practical problems.

7:3 Ship's crew should all receive training sufficient to provide them with basic information on relevant subjects including the fundamentals of: first aid, radiological hazards, protective measures, transport regulations and radiation protection and control.

7:4 The IMO Guidelines recommend that "a more extensive training programme is necessary to maintain the skills of the master and ship's officers".

The minimum training for these personnel should include incident assessment techniques using radiological monitoring instruments, the implementation of protective measures, use of protective clothing and equipment, and further detailed instructions on the transport regulations and packaging of radioactive materials.

7:5 Although having an extensive and internationally recognised education scheme offering training for mariners and others in many aspects of at-sea and coastal response to oil spills and chemical spills, the IMO has no training scheme offering any education for responding to emergencies involving the maritime transport of any class of radioactive materials.

8. Exercises

8:1 The IMO Guidelines also provide guidance on exercise and drill procedures. However it is noticeable that the IMO is also less prescriptive on this matter than it is on others. Whereas the IMO Guidelines uses phrases such as "the Plan should" in respect of other guidance, in the case of exercise and drill procedures the IMO Guidelines say "the Plan may".

8:2 The Guidelines say that the SEPs may address the exercise and drill programmes to be carried out by the owner or operator of the vessel in order to maintain the appropriate level of preparedness. Exercise scenarios could be developed and used to test the response capabilities and skill of the officers and crew.

8:3 It is suggested that "exercises could be based upon realistic accident exercise scenarios designed to test all major aspects of the plans" including the effectiveness of communication links and the mobilisation of emergency resources and specialised teams. The IMO have not specified whether the guidance is referring to on-vessel or off-vessel "emergency resources and specialised teams".

8:4 It should be noted that statements from some coastal States have implied that first and prime responsibility for response in the event of an incident has been devolved to the consignor and/or the shipper, and that the response will be managed according to plans, strategies and technology described in the confidential BNFL/PNTL "Special Arrangements".

In this context it is surprising that the IMO offers no specific or detailed advice or guidance for off-vessel exercises. Nor does the IMO offer any advice or guidance on the subject of expediting the despatch, transport and transfer of off-vessel emergency resources and specialised teams to the INF carrier either in port or at sea.

8:5 The IMO Guidelines also suggest that exercises should aim to test the co-operation between agencies and services involved. In order to fulfil this particular brief it would appear necessary to undertake joint exercises with shore based agencies and authorities in relevant coastal States. However, the IMO offers no advice or guidelines on how such exercises should be conducted.

8:6 In respect of both exercises and actual incidents, this is a subject area of some complexity, particularly in matters of international and maritime law.

As stated above (Chap 3) coastal States are entitled, under international agreements, to define techniques and means to be taken against a marine pollution incident and to approve such operations which might cause further pollution. There is also the matter of maritime territorial rights and the right of a non-national to intervene in incidents taking place within the coastal States jurisdiction.

8:7 The IMO, with its broad base of delegates from maritime and coastal States and its consensual method of working, would appear to be well placed to offer guidance in such matters and to work towards achieving some form of international consensus to facilitate and expedite the response to incidents involving INF carriers.

However, the IMO Guidelines on SEPs make no mention of such a consensus and offer no advice or guidance on how to achieve consensual working practices in the event of exercises or actual incidents.

8:8 The IMO Guidelines also state that "another objective of the exercises is to strengthen the confidence of the personnel that they can adequately handle an incident."

Up to a point this may be a beneficial outcome of exercises, however there is a danger of generating an excess of unjustified confidence, particularly in the upper echelons of INF shipping management.

8:9 The Guidelines also suggest that drills designed to develop, test and maintain special skills may be carried out either as subsets of exercises or independent of them.

The Guidelines also suggest that provision "may" be made for the critique of drills and exercises by qualified observers. The IMO does not define the relevant qualifications or indicate whether there is a pool of suitably qualified (INF experienced) independent observers not attached to the nuclear industry.

9. Salvage

9:1 The IMO Guidelines on SEPs also state that SEPs should contain information on the crew's responsibilities, in an incident where the ship is partially or fully disabled, and what constitutes dangerous conditions. There should be a decision making process in place to assist the master in determining when salvage assistance should be obtained. The decision making process should include, at the least, the following details:

- nearest land or hazard to navigation;
- ship's set or drift;
- location and time of impact (with land or hazard) based on the ship's set and drift;
- estimated time of incident repair;
- determination of nearest capable assistance and the response time (in the case of tug assistance, the time it will take for the tug to arrive on scene and secure the tow).

9:2 Noting that in any such incident there will be a "window of opportunity" for response time, the Guidelines advise "it would not be prudent to hesitate in calling for assistance when the time needed to carry out repairs goes beyond the window of opportunity".

9:3 Salvage is a large and complex subject area involving much more than calling for assistance from a tug and waiting for it to arrive on scene and secure the tow.

The IMO Guidelines on salvage matters are both brief and imprecise and fail to address a wide range of subject areas including the wide range of factors which complicate tug towage procedures (eg weather and sea states or the nature of the damage to the INF carrier), what to do if the "window of opportunity" is exceeded, the provision of off-vessel fire fighting facilities and a range of actions which might be taken in order to facilitate any post-incident salvage attempts (eg running the vessel aground in shallow waters were salvage/recovery operations would be easier).

10. The Nature of the IMO decision-making process

10:1 It should be noted that the IMO is a consensual organisation which cannot impose its advice, guidance or recommendations on states or organisations who have not agreed to them.

10:2 Consequently the final draft of the IMO Guidelines on SEPs is the product of a consensual process operating by committee and that special subject committees are in general composed of representatives sent by interested/concerned member governments. These representatives are generally civil servants from relevant ministries or departments such as Transport or Shipping. Observer status is generally granted to relevant industrial bodies.

10:3 There is (as is always the case with consensual decisions) a strong possibility that decisions or recommendations arrived at and promulgated by IMO committees may not be a reflection of the latest technical understanding or emergency experience, but the product of a process involving both bargaining and political lobbying.

11. Published PNTL/BNFL Emergency Response Arrangements

11:1 As identified above (Chapter 3) there are a set of "Special Arrangements" for response to emergencies involving vessels carrying INF Code materials. These arrangements are written and edited by BNFL, commercially confidential and not available to any members of the public or the majority of their elected representatives.

It appears that these "Special Arrangements" constitute a full range of at sea emergency response actions to be taken aboard an INF maritime transport in the event of any emergency. As such it appears that they represent the only response in many sea areas. Certainly this appears to be the case in both UK territorial waters [Ref 4] and Australian territorial waters. [Ref 6]

11:2 However, three other documents which make reference to BNFL and PNTL emergency arrangements for vessel incidents have been reviewed.

Some details of the emergency response arrangements for the PNTL vessels are provided in an Information File published by the PNTL owners in 1999. [Ref 8]

Very similar details are given in a published document submitted by the PNTL owners to the IMO in 1996. [Ref 7] It is evident that this 1996 publication is the source of the material in the 1999 publication.

It is evident that the source of the material in the 1996 submission to the IMO is a verbal presentation made by BNFL's head of Transport Operations to the Special Consultative Meeting on INF Transport at the IMO in 1996 which contains very similar material. [Ref 9]

11:3 Study of these three documents shows there have been no significant changes in the emergency response arrangements between March 1996 and January 1999.

12. BNFL/PNTL reasons for drawing up ERAs

12:1 The transcript of the verbal presentation made by BNFL's head of Transport Operations to the IMO states that:

> "Whilst BNFL know that with respect to these shipments there would be no reason for concern and no consequences which could significantly affect persons or the environment, it is necessary to provide a rapid and effective response in order to provide reassurance,"because it is
> "recognised by BNFL that in the event of an incident involving an INF shipment there would be genuine concern by members of the public, particularly in countries not familiar with our operations."

12:2 The BNFL presentation gave no references or details about the empirical science which formed the basis of the claimed knowledge that "there would be no reason for concern and no consequences" from an emergency. Thus it would appear that, in respect of vessel + INF cargo emergencies, this is a claim with no basis in empirical science.

Since the PNTL fleet's total cargo/miles transport statistic is so minute that it is statistically insignificant and since the PNTL fleet has no experience, to date, of major accidents this is a statement that, in respect of vessel + INF cargo emergencies, has no basis in practical experience.

Furthermore it ignores the consensual maritime and engineering experience that although it is possible to plan for, and reduce the threat of, the known problems, there are always a range of technical, management and human error problems as yet un-identified and unforeseen.

12:3 It is evident that, when addressed directly to the IMO, the BNFL/PNTL response plans and arrangements are based on the twin beliefs that :

a. there is no reason for concern about the INF shipments, but :
b. it is necessary to provide reassurance to the public.

Since a shipment is usually defined as "a consignment of goods or cargo, or an act or instance of shipping goods or cargo" it is unclear whether BNFL were referring to the INF cargo, the INF ships or both in this context.

12:4 It may also be argued that BNFL have misunderstood the nature of the genuine public concerns centred around INF shipments when they indicate their belief that the concern would be particularly significant in countries not familiar with their operations.

The record of public comment and activism related to BNFL activities suggests it is likely public concern about maritime transport of INF Code materials is at least as great in countries with a long experience of BNFL (the UK and Ireland for example) as it is in countries where BNFL operations are unfamiliar.

12:5 The 1996 publication of the PNTL owners submission to the IMO says that:

"PNTL has extensive emergency response arrangements and salvage plans because it recognises that there are hazards in marine activities which could endanger the ships and its crew".

Thus, for public consumption, BNFL and the other owners of PNTL have :

a. modified their interpretation of the need for emergency response arrangements;
b. deleted any reference to the necessity "to provide reassurance" to the public;
c. recognised that there are hazards in marine activities which could endanger the ship and crew but
d. made no mention of INF Code materials and evaded discussion of any potential impact on, or fate of, the INF Code materials and their containers.

13. BNFL/PNTL Emergency Response Communications

13:1 There is a Report Centre, at Barrow in the UK, with suitably qualified staff to provide expert advice to the ships' masters on a 24 hour a day basis.

All vessels are fitted with an automatic voyage monitoring system which transmits details of the vessel's position, speed and heading to the Report Centre every two hours. These transmissions are performed automatically and without any intervention from the crew. If a message was not received by the Report Centre at the allotted time the Emergency Response System would be activated.

13:2 It is stated that in order to ensure good communications all BNFL and PNTL vessels are fitted with satellite communications, telex over radio, wireless telegraphy and radio telephone systems which provide sufficient secondary communication systems. This is good sense because each of these systems may be subject to breakdown or damage during an emergency situation.

13:3 However, in respect of the communications systems the BNFL/PNTL information is brief and imprecise. None of the BNFL/PNTL presentations and/or submissions to the IMO provide any further details of the transmission system, nor have they offered an analysis or discussion of any potential problems with that system.

13:4 It is probable that such a system is some form of SCADA (Self Contained Automatic Data Acquisition) system, which is relayed, by satellite transmission, to the Report Centre at Barrow.

It is probable that the transmission system would be based on, or similar to, the widely used INMARSAT C communication system which uses geo-stationary satellites positioned over the equator to receive and transmit the data.

13:5 This is a system with a generally good record of performance but, in certain specific sea areas, there may be operational problems arising from the fact that the geo-stationary satellites are positioned over the equator. In particular, this means that if a vessel is steaming in far northerly or far southerly latitudes, the satellites are fairly low down on the horizon.

In such a situation the proximity of high land (lying between the vessel and the satellite) has been known to prevent transmission. Such an effect is observed in certain Norwegian fjords.

13:6 Although full voyage details for INF Class 3 shipments are not released, it is understood that some of the PNTL transports have been routed round Cape Horn. It may have been, or may in the future be, that such voyages were routed through the shorter and more sheltered waters of the Straits of Magellan and/or the Beagle Channel where casualty risks are elevated, high mountains lie between the waterway and equatorial geo-stationary satellites and there is a potential to lose contact with the geo-satellites' transmitters. There may be other points on the various routes used by PNTL where similar conditions occur.

In such a situation recourse could be had to voice communications, but these are also largely satellite transmitted, and in such situations would be similarly affected. Short wave radio communication would then be necessary. Thus there is a potential for even multisystem and duplicated communication arrays to be reduced to a reliance on a single system, which in its turn is potentially susceptible to maintenance problems and operational malfunction.

13:7 The available details of the design of the PNTL vessels [Refs. 7 & 8] appear to show that all the communications systems terminals are located in the aft section of the vessels. If this is the case, the vessels are particularly susceptible to a complete communications blackout caused by a severe collision or fire in this sector of the vessel, which is not protected by any double hulling or collision reinforcement features.

13:8 The BNFL/PNTL submissions and publications fail to address these concerns and there is no evidence that the IMO has asked for clarification of these matters.

13:9 If an emergency incident were to occur the vessel concerned is expected to transmit a request for assistance to the Barrow Report Centre and to the authorities in the nearest coastal State. Upon receipt of such a message the Report Centre would be upgraded to an Emergency Control Centre.

None of the BNFL or PNTL presentations or submissions to the IMO provide details of what such an "upgrade" would entail or require and how long such an upgrade would take.

14. BNFL/PNTL Emergency Response Teams

14:1 The three documents reviewed [Refs. 7, 8 and 9] state that an emergency response team is "on standby at all times" on a "24 hour emergency standby system".

The 1996 PNTL published submission to the IMO claims such a team would be despatched "in the event of a serious fire or collision", other scenarios are not mentioned. The transcript of the 1996 BNFL verbal presentation to the IMO does not define which emergency scenarios would require the despatch of the emergency team.

14:2 Precise definitions for "standby" and "24 hour emergency standby" are not given. It remains unclear whether it is being claimed that the emergency teams will be ready for departure to the emergency scene within 24 hours of initial notification, or whether it is being claimed that they will arrive at the emergency scene within 24 hours of initial notification.

14:2 The latter option seems highly unlikely and optimistic in the context of some sectors of the suggested routes for INF vessels and no evidence is offered to support any suggestion that such a proposal could be achieved.

Even if it was possible to reach an INF emergency scene within 24 hours the available historical evidence shows that the crucial and optimum emergency incident management and control "window of opportunity" for many casualties occurs within the first 24 hours and that for many emergencies the "window" is even shorter.

(eg On Sunday 12 December 2000, between 4.30 am and 5 am, the tanker MV ERIKA made a series of Mayday calls which reported loud noises from the hull and superstructure and cracks appearing in the hull and requested immediate assistance. By 5.30 am the vessel had broken in half.)

14:3 If, as appears far more likely, the BNFL/PNTL statement actually means the emergency team could be ready for departure within 24 hours of initial notification, it must be accepted that in some sectors of the INF vessels' route the emergency teams will be unlikely to arrive within 48 hours of the start of the emergency.

If this is the case it is evident that the possibility of the emergency escalating to very significant or total casualty status (with attendant escalating radiological emergency) increases.

14:4 The PNTL owners' 1996 written submission to the IMO (issued as a public document) states that the emergency team is a "fully trained and equipped team of marine and nuclear experts" [Ref 7 : p 20] However this document gives no further detail of the composition, numbers and expertise of the team.

14:5 The transcript of BNFL's 1996 verbal submission to the IMO is more forthcoming and explains the emergency team which would travel to the scene would consist of eight persons. It is interesting to learn that the "expertise" of the team is given as follows (and in the order listed by BNFL):

- "Two Head Office staff " (with undefined expertise, but possibly some previous relevant experience. Their otherwise undefined status suggests that they are managers who may well be principally representing BNFL interests);
- "One Public Relations Officer" (with undefined expertise in marine and/or nuclear matters);
- "Two Health Physics Officers;
- "Two Package Engineers;
- "One Marine Superintendent."

14:6 The team described in the verbal presentation to the IMO thus falls somewhat short of the published claim of a "fully trained ... team of marine and nuclear experts".

The emergency team should more accurately be described as "a team containing one fully trained marine expert, four fully trained nuclear experts and three others with no defined marine or nuclear training or role"

14:7 The transcript of BNFL's verbal submission to the IMO explains that emergency equipment for dealing with a radiological incident involving a "package" (presumably "packages" include flask and casks) is stored in two separate locations aboard each vessel. This review assumes this means that there are duplicate sets of the equipment. The transcript explains that the equipment consists of radiation monitoring and engineering equipment.

14:8 The transcript explains that a full set of the same equipment is carried by the emergency team to the emergency scene but gives no further details of the equipment. In order to assess the ease of deployment of this equipment onto the vessel, by the emergency team, information about its size, weight, protective packaging and sensitivity to breakage (in the case of radiation monitoring equipment) is required.

No such details are provided by BNFL or the PNTL owners. No such details appear to have been requested or supplied by the IMO or any of its member States.

14:9 In order to assess the ease or difficulty of deployment onto the vessel, details are required of the intended method of transport and transfer of both the specialised equipment and the emergency team onto a vessel potentially in an extreme emergency scenario, extreme sea and weather conditions and many miles from land.

No such details are provided by BNFL or PNTL. No such details appear to have been requested or supplied by the IMO or any of its member states.

15. BNFL/PNTL Emergency Exercises

15:1 The transcript of BNFL's 1996 verbal presentation to the IMO [Ref 9] says that the emergency equipment and techniques have been "developed from regular realistic emergency exercises" and states that BNFL believe that regular exercises are an important part of emergency response planning.

15:2 The transcript states that every year at least two full scale sea transport emergency exercises are held in order to test the communication system, the expertise of the team members and the ships' crews and the performance of the emergency equipment.

The exercises simulate a radiological incident and are carried out in a fully realistic manner. Desk top exercises and communication system tests are also carried out periodically each year.

15:3 The PNTL owners' 1996 published submission to the IMO [Ref 7] gives slightly more detail of the emergency exercises and states that BNFL holds one land based and two ship based emergency exercises every year, while the Japanese emergency response contractor also holds exercises per year (but fails to define whether these are ship or land based).

15:4 The Information File published by the PNTL owners in 1999 [Ref 8] provides additional details and confirms that there are indeed two UK based ship exercises each year and explains that only one of these is an at-sea exercise and that the other is an in-port exercise.

15:5 The 1999 Information File refers to two Japanese ship exercises but does not explain whether these are port or sea based. In light of the nature of the UK exercises it seems likely that the Japanese exercises also consist of one in-port and one at-sea exercise.

The Information File also explains that in addition to the ship-based exercises there are four annual fire exercises and one annual desk top communications exercise (UK and Japan).

15:6 The 1999 Information File states that all transport emergency exercises involve the call out of suitably trained and qualified personnel, their transport to the incident scene, and the necessary remedial actions to resolve a simulated radiological cask incident.

15:7 However, the information given by BNFL and PNTL is both brief and imprecise.

This review notes that it is specifically stated that the exercises simulate a radiological incident, but that in regard to the two at-sea exercises no details have been given about the weather and sea states under which those exercises have been carried out.

15:8 In order to adequately test and improve the expertise of the emergency teams it would be advantageous to carry out exercises in the most severe weather and sea states, provided that personnel or vessels are not put at unnecessary risk.

If the weather and sea states are never severe when the exercises are carried out, there is a strong likelihood that a false exercise outcome will result, technical difficulties likely to be met in real time emergencies will not be evaluated and personnel will be insufficiently experienced and tested.

In the absence of any evidence to the contrary it may be assumed that neither the IMO nor any of the coastal States, nor any of the States where INF carriers are flagged or registered have demanded that the details of weather and sea states during the exercises are supplied.

15:9 One interpretation of the available information is that the at-sea exercises are conducted from, or adjacent to, a Japanese and UK shore base.

In order to fully evaluate the true technical difficulties attendant upon emergency response it would be advantageous to carry out exercises at a considerable distance from the shore and from favourable shore-side infrastructure.

15:10 In the case of emergency responses overseas (non-UK) transport infrastructure will be expected to feature significantly. Delivery of emergency teams and their specialised equipment, to the emergency site, will inevitably become more complicated and delayed the more distant the emergency site is from major ports or airports.

Similarly, the more basic the airport or harbour/port facilities (cargo handling, personnel and cargo processing) the slower the throughput of team personnel and emergency equipment will be.

15:11 If the exercises are not carried out at sites distant from major transport centres and well developed transport facilities there is a strong likelihood that a false exercise outcome will result, technical difficulties likely to be met in real time emergencies will not be evaluated and personnel will be insufficiently experienced and tested.

15:12 In the context of the preceding paragraphs it is important to note that the transcript of the BNFL presentations claims that the "the exercises simulate a radiological incident" and makes no mention of a maritime casualty incident.

15:13 This review notes that any attempt to respond to an at-sea, ship-based radiological emergency would take place in the context of the marine environment and, almost inevitably, in the context of a major marine casualty scenario.

Such a response will have to overcome a wide range of potential variables including weather and sea conditions, distance from shore and shore based infrastructure and support facilities and one (or more) of the 14 casualty types listed in the IMO Guidelines for SEPs and discussed in Chapter 6 (above).

15:14 There is no indication that any such parameters have been factored into the emergency exercises. In the absence of evidence to the contrary it may be assumed that neither the IMO nor any of the coastal States, nor any of the States where INF carriers are flagged or registered have demanded that such details of the exercises be supplied, or urged that such parameters should be included in emergency scenarios.

15:15 This review concludes that, if this is the case, it represents a serious failure in the planning of emergency response operations and exercises since it is highly likely that a radiological emergency will be caused by one, or a combination, of those parameters

15:16 This review concludes that the available data does not demonstrate that the emergency exercises described in the BNFL and PNTL documents (Refs. 7, 8 & 9) have achieved the necessary stringency. They will neither build up nor test the expertise of emergency team members, or the deployment of emergency equipment, in the full range of potential at-sea casualty scenarios.

16. BNFL/PNTL Salvage

16:1 The 1996 BNFL and PNTL submissions to the IMO say that the full world-wide Emergency Response Arrangements include: rapid response world-wide salvage cover, equipment and techniques developed from specialised demonstrations including sea-bed recovery of a spent fuel package and a salvage location and a telemetry system which assists in vessel location and provides information to the salvage team regarding the condition of the ship and cargo. [Refs. 7 & 9]

16:2 Worldwide salvage cover is provided by way of a contractual agreement between BNFL and Smit International Salvage. Under this agreement Smit provides advice in procedures and equipment which facilitate salvage assistance and continuously reviews the latest applicable technology. A joint committee of the two companies meets twice a year to discuss relevant matters.

16:3 A number of arrangements have been made following this liaison between BNFL and Smit Salvage. These are laid out below:

- The Barrow Report Centre has 24 hour contact arrangements with Smit Salvage;
- Smit towing brackets and chain have been fitted to the fore and aft ends of all PBTL/BNFL vessels;
- At-sea and in-port exercises are conducted to practice making tow connections to the vessels;
- Hand operated emergency lifting gear is fitted to the vessels to enable heavy salvage equipment to be lifted aboard if the vessels have lost all power;
- Brackets which can be welded to the vessel's hull to assist righting have been pre-designed for each ship;
- Salvage inspection tours are made periodically by a BNFL/SMIT team to renew contacts and investigate the availability of equipment along the routes taken by the BNFL/PNTL vessels;
- BNFL has also arranged to receive monthly updates on the availability and disposition of all types of salvage equipment worldwide. [Ref 9]

These are all useful arrangements which may prevent an emergency from worsening. However the majority of these arrangements are not relevant to the recovery/salvage of INF Code material in the event of a loss of the INF vessel.

16:4 In addition, the PNTL owners' Public Information File [Ref 8] says that all the PNTL vessels are fitted with an underwater detection system which enables the vessel to be located in water depths over 6,000 metres at a range of 20 km. (Note: the BNFL vessels are not mentioned in this context.)

This system can relay information to the surface and provide details on the following: depth and angle of vessel on the bottom; whether the vessel is intact or distorted; whether the hatch covers are in place; what the radiation level is in each of the cargo holds and the temperature inside the vessel. The equipment is powered by high-grade lithium batteries with an expected life span of over seven years.

17. Factors affecting the claimed rapidity/immediacy of the BNFL/PNTL Salvage Cover

17:1 In the matter of the "rapid response" worldwide salvage cover, which BNFL and the PNTL owners have claimed is provided by way of their contractual agreements with Smit International Salvage, none of the reviewed documents [Ref 7, 8 and 9] have offered a definition of the claimed "rapid response".

The PNTL owners' 1996 submission to the IMO [Ref 7] states that "immediate arrangements can be put in hand to salvage the ship or cargo where required in the event of a vessel sinking." No definition or supporting detail for any of these claims is offered in any of the documents.

17:2 The truth is, that while Smit International is certainly among the leaders in global salvage (particularly in respect of size, geographical coverage and successful experience) the "rapidity" or "immediacy" of any emergency response the company could mount would depend upon a number of factors including the nature of the required response, the nature of the contractual agreement relative to the current work priorities of the Smit organisation, the location of the emergency relative to the distribution of Smit equipment and the ambient weather and sea states.

THE NATURE OF THE REQUIRED RESPONSE

17:3 As regards the nature of any required response: maritime salvage companies have an excellent record of putting to sea and making valiant efforts to save life in very difficult conditions, where there is a possibility of achieving something useful. Thus if a PNTL vessel were to be in need of assistance it is highly likely that Smit would undertake an attempt to assist as soon as possible and in all but the most severe sea conditions.

If on the other hand a PNTL vessel had sunk and it was deemed necessary to make an attempt to recover the INF Code cargo it is highly unlikely that such an operation would be undertaken with any rapidity or immediacy because it would not be possible in anything other than relatively calm conditions.

17:4 Thus, even with a relatively straightforward operation such as the recovery of heavy fuel oil from the relatively shallow wreck of the tanker Erika (less than 200 metres) using the well tried "Hot-tap technology", it was deemed necessary to wait for seven months before commencing the recovery of the Erika's cargo in order to maximise the chances of an extended and suitable weather "window of opportunity". The final chronology was as follows: vessel sunk 12 December 1999, cargo recovery commenced 3 July 2000, cargo recovery completed September 2000.

It is to be expected that the salvage of INF Code materials (secured to permanent devices within the cargo holds, which are themselves situated inside the double hulled section of a PNTL vessel and inside the collision reinforcement plating) would be at least as complicated as the Erika salvage, require a similar "window" of suitable weather and sea conditions and thus not fulfil any definition of rapidity or immediacy.

THE NATURE OF CONTRACTUAL AGREEMENTS

17:5 Unless the BNFL/PNTL contractual agreement with Smit International is based on a pre-agreed "drop every other job" clause it is likely that Smit's other contractual arrangements will demand that any response to a BNFL/PNTL emergency will have to take its place in a priority queue and thus the claimed rapidity and immediacy will not be fulfilled.

The failure of BNFL and the PNTL ownership to provide the relevant detail in any of the two 1996 submissions to the IMO or the 1999 Public Information File (Refs. 7, 8 & 9) means that no justification exists for the claim of rapidity and immediacy.

LOCATION OF THE EMERGENCY RELATIVE TO THE DISTRIBUTION OF SMIT EQUIPMENT

17:6 A study of Smit International's publicity material [Ref 10] shows that the company does indeed have worldwide representation grouped into four geographic zones (Africa, Americas, Europe and Far East) with 21 regional offices/depots. As might be expected the regional offices/depots are centred on the major shipping lanes, maritime "choke points" and port areas.

Smit International has four salvage logistics centres in Cape Town, Houston, Rotterdam and Singapore. A comprehensive range of specialist salvage equipment is held at instant readiness at these centres. Smit states that "the equipment is air-mobile and held ready for immediate despatch anywhere in the world."

17:7 Smit International has a large fleet of rescue and salvage vessels and at any one time simple economics dictate that the company will be seeking to have the majority of those vessels engaged in gainful employment or travelling between tasks. Thus a number of those vessels will be distributed across the world's maritime trade routes.

However as with the offices and depots it is to be expected that such vessels will be concentrated on the busy sea areas.

17:8 Thus some sea areas have a far lower "cover" than other areas. A number of sections of the routes used to date by the PNTL fleet are very poorly covered by the distribution of offices, depots and salvage logistics centres. These sectors include the mid ocean areas, the South Atlantic, the South Indian Ocean, Australian waters and the South Pacific.

If a PNTL vessel were to require salvage/assistance within the southern areas of the Australian 200 mile EEZ, or adjacent waters, the nearest salvage equipment logistics centre is at Cape Town and the nearest regional offices/depots are in Malaysia and Indonesia to the north and Cape Town to the west.

While it might be appropriate to air transport relevant salvage equipment into Australia, it will still have to be transferred to a suitable vessel in an Australian port and then taken, by sea, to the emergency site.

None of the BNFL, PNTL or Smit documentation offers any data which might clarify the time scales of availability of the range of salvage equipment needed to respond to an emergency involving a PNTL vessel carrying INF Code materials in a variety of different sea areas along the routes used by the PNTL vessels.

Unless permanently escorted by a full time rescue/salvage vessel, it is evident that during any voyage between Europe and Japan a PNTL vessel will inevitably be isolated from sources of assistance and sources of salvage for considerable periods of time.

17:9 The history of events surrounding maritime emergencies is not encouraging in respect of the availability and deployment of emergency response/salvage equipment.

For example, when fire broke out aboard the container ship Ever Decent (after she collided with the cruise liner Norwegian Dream in calm, clear conditions on 24 August 1999 in the English Channel) the fire burnt for several days although three fire fighting tugs did eventually reach the scene. Commentators believe the situation would have been much improved and the fire less severe if the UK's dedicated, powerful Straits of Dover fire fighting and emergency towing vessel had been available. This vessel was undergoing a refit in Norway at the time of the incident. [Ref 11]

This incident demonstrates that even in a very busy sea lane provided with some of the best emergency cover in the world, occasions occur when it is not possible to respond rapidly to an emergency with the most appropriate response vessel.

18. Salvage equipment and techniques developed from "specialised demonstrations"

18:1 The transcript of the 1996 BNFL verbal submission to the IMO [Ref 9] states that the emergency response system includes the use of equipment and techniques developed from "specialised demonstrations including sea-bed recovery of a spent fuel package".

The PNTL owners' 1996 submission to the IMO [Ref 7] reiterates the point and says that "exercises are also undertaken with PNTL's salvage contractors to demonstrate the recovery of flasks from the sea bed". It makes no reference to any other form of demonstration or exercise in the context of salvage.

No further details are given about these "specialised demonstrations" or "exercises".

18:2 In the context of the language used ("recovery of flasks from the sea-bed" etc.) and the absence of any evidence to the contrary, it may be assumed that the exercises and special demonstrations have not involved recovering the flasks or packages from within a sunken INF vessel or a replica of a sunken vessel on the seabed.

18:3 If this is the case the exercises and demonstrations have been virtually pointless, since (unless the INF vessel was subjected to either a massive at-sea explosion or a failed at-sea ship-to-ship transfer) it is only in the most favourable conditions (i.e. in-port or dock-side) that a flask or package is likely to end up on the seabed without being attached to the interior of the vessel. Such a scenario would occur as a result of a flask or package being dropped during ship-to-shore or shore-to-ship transfer operations.

18:4 No details have been given of a wide range of additional exercise/demonstration parameters including:

a. the nature of the seabed (topography, sediments, depth, visibility) from which the flask/package was recovered;
b. the nature of ambient bottom water conditions (visibility, currents, wave effects) at the recovery site;
c. the nature of the surface water conditions during the exercise (sea states, weather conditions, surface traffic density);
d. distance from any necessary back-up facilities;
e. type and description of the flasks/packages recovered;
f. other details of the salvage working platform (vessel, dockside);
g. time scale of the operation;
h. whether or not the exercise involved the simulated release of radioactivity to test the ability of salvors to operate without contamination of personnel/equipment.

18:5 All these parameters can exert major complicating and/or limiting stresses on any salvage attempts. The absence of such details renders serious discussion and assessment of these "exercises" and "specialised demonstrations" impossible.

Given the potential importance of the recovery/salvage of INF Code materials it is remarkable that such a superficial, brief and imprecise description of the demonstrations (in two versions: Refs. 7 & 9) has been accepted by the IMO without any evidence that the organisation has requested further details of the exercises or specialised demonstrations.

It is similarly remarkable that none of the coastal States along the various sea routes taken by PNTL vessels have requested further details of these exercises or specialised demonstrations.

19. The BNFL/PNTL Underwater Detection System

19:1 The PNTL owners' 1996 written submission to the IMO describes the sonar location system "capable of operation in waters over 6,000 metres deep". The transcript of the 1996 BNFL verbal submission to the IMO makes the same claim. Unfortunately the phrase used is infinitely open ended and no attempt is made to define the maximum working depth of the system.

This is an unfortunate oversight because there are relevant areas of the ocean which are over 6,000 metres deep and the maximum ocean depth charted to date is 11,035 metres.

19:2 In the North Atlantic there are three areas of seabed below the 6,000 metre depth. Two lie between West Africa and the Caribbean. It is conceivable that the PNTL vessel routes could involve sailing over these areas. The third such area is the Puerto Rico Trench and this must be crossed in any route via the Mona Passage, a route that the PNTL vessels have taken in the past.

There are areas of similar depth in the South Atlantic which might be crossed during the course of any passage round Cape Horn.

19:3 The Pacific Ocean has a number of deep ocean trenches which exceed 6,000 metres depth. The Kermadec Trench, the Tonga Trench, The Solomon and New Hebrides Trench System, The Mariana Trench and the various Japanese Trenches all lie across one or more of the three routes from Japan to Europe. In addition the north west and central Pacific contains a number of Basin areas which also exceed the 6,000 metre depth.

19:4 A number of these deep ocean areas lie close to en-route coastal States, however because of the brief and imprecise information provided by BNFL and PNTL owners it remains unclear whether the sonar location system would operate in such depths.

20. Deep Ocean Salvage

20:1 At a conference in 1996 the director of Deep Water Recovery and Exploration Ltd, a leading independent salvage company responsible for significant deep water salvage technical development and holders of the record maximum depth for the salvage of commercial cargo (1,250 metres), described some of the technical difficulties involved in the work on that particular salvage.

20:2 These included the angle of list of the wreck, extensive debris which restricted access to the vessel's holds, the nature of the seabed materials and topography which made anchoring and mooring the salvage vessel difficult and hazardous. The greatest technical problems arose from the nature of sea surface conditions which meant that the current design of standard monohull salvage vessel is unable to work in sea state conditions exceeding Beaufort Force 5. [Ref 12]

20:3 Recent discussions with Deep Water Recovery Ltd reveal the company is engaged in salvage work on a vessel at 3,000 metres depth and have completed the development of a system theoretically capable of working to full ocean depth: i.e. 11,000 metres.

It is reported that surface conditions remain the major problem but that, other than this, there are no major technical obstructions to full ocean depth salvage and recovery of cargo. However, the company said such an operation would require close co-operation with other marine industries (hydrocarbons and surveying) and possibly government agencies, with deep water expertise and technologies and that any successful salvage at such depths would be a very high cost operation. [Ref 13]

20:4 This review has found no evidence in the companies' submissions to the IMO, that BNFL's discussions, meetings and contractual agreements with Smit International have examined any potential agreement with other deep sea operators in respect of the salvage of INF Code materials.

If such discussions have not taken place this review recommends they be prioritised in order to identify relevant players and to put in place the baseline for any financial and legal agreement which may be required in the event of full ocean depth, INF Code material capable, salvage work.

20:5 This review has found no evidence in the BNFL and the PNTL owners' submissions to the IMO that they have offered any analysis of the full financial implications of salvage and recovery of INF Code materials from within a sunken INF carrier located in continental shelf waters, continental slope/rise waters or deep ocean waters.

20:6 This review has also found no evidence in the BNFL/PNTL submissions to the IMO that they have made an open ended commitment to recover lost INF Code material from any marine environment regardless of the cost.

It might be expected that, in light of the long standing international rejection of sea bed dumping or "emplacement" of nuclear wastes (otherwise INF Code materials) that pressure for such a commitment would be readily forthcoming.

20:7 Accordingly this review recommends BNFL and PNTL be pressed for such a financial analysis and for an open ended commitment to recover INF Code materials from wherever they are lost in the marine environment.

21. Australian Emergency Response Plans

21:1 As a coastal State, Australia has the right under international agreements to exercise its "responsibility to define techniques and means to be taken against a marine pollution incident and approve such operations which might cause further pollution".

In nearly every respect Australia has accepted this responsibility. Australia is a long standing member of the IMO and is a party to the five IMO Conventions addressing ship based pollution which it implements by way of a package of national legislation, some of which is set out below.

21:2 Jurisdiction over Australian waters was agreed following discussion between the Commonwealth and the States/Northern Territory (NT), which culminated in an agreement known as the Offshore Constitutional Settlement (OCS). The OCS gave jurisdiction over the Territorial Seas to the States/NT while jurisdiction over the High Seas was given to the Commonwealth.

21:3 However, it was recognised that it was necessary to find a mechanism which enabled Australia to become a party to important international maritime conventions without the need for separate legislation in every jurisdiction. Under the OCS it was agreed that Commonwealth law would apply to all jurisdictions with regard to recognising the Conventions, but that Commonwealth law would "step back" if/when a State/NT enacted the provisions on its own behalf. Thus the States/NT are given time to enact parallel legislation, or to choose not to.

21:4 Under the UN Law of the Sea Convention (UNCLOS) which Australia has acceded to, the Commonwealth's jurisdiction extends to both the 12 mile wide Territorial Sea and the 200 mile wide Exclusive Economic Zone (EEZ). However, the States/NT refused to accept the extension of their jurisdiction beyond the pre-UNCLOS Territorial Sea limit of three nautical miles.

21:5 Australian national legislation has implemented the provisions of the following international conventions:

a. 1969 International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties;
b. the 1973 Protocol to that Convention (relating to Intervention on the High Seas in Cases of Pollution by substances other than Oil);
c. 1969 International Convention on Civil Liability for Oil Pollution Damage;
d. 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage;
e. 1973/78 International Convention for Prevention of Pollution from Ships (MARPOL);
f. 1990 International Convention on Oil Pollution Preparedness, Response and Co-operation 1990.

21:6 The 1990 Australian Maritime Safety Authority Act sets out the duties and responsibilities of the Australian Maritime Safety Authority (AMSA), among which was the "combating of pollution in the marine environment." It also stipulates that AMSA must perform its functions in "a manner consistent with the obligations of Australia, under any agreement between Australia and another country".

21:7 In order to ensure that Australia has the ability to respond to ship sourced pollution incidents the National Plan to Combat Pollution of the Sea by Oil was first implemented in October 1973.

21:8 Unless very carefully defined, the division of responsibility for action may be complicated by the subject of jurisdiction. It may also be similarly complicated by the fact that, in addition to the national legislation described above, each of the

States/NT have legislation which covers their own requirements and responsibilities in relation to pollution in their own areas of jurisdiction.

22. The National Plan

22:1 In fulfilment of the duties accepted by Australia as a party to the 1990 International Convention on Oil Pollution Preparedness, Response and Co-operation, Australia has reviewed the original oil spill plan and established the National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances (the National Plan).

The National Plan combines the resources of the Commonwealth of Australia, the States/NT Governments and the relevant industries and shipping interests in order to provide a combined response effort to the threats to coastal environments and populations by spills from ships and other offshore installations.

22:2 The preamble to the National Plan states that "measures to prevent pollution, combined with pre-planned clean up strategies, are essential for the protection of the marine environment".

The stated aim of the National Plan is "to protect the natural and built environments of Australia's marine and foreshore zones from the adverse effect of oil and other noxious and hazardous substances. It also aims to minimise those effects where protection is not possible".

The National Plan states that it "provides a national framework for responding promptly and efficiently to marine pollution incidents by designating competent national and local authorities".

22:3 The National Plan states that "a fundamental pre-requisite" for the successful management of at-sea spill incidents in Australia, is a clear definition of the responsibilities of the Commonwealth, the States/NT and the relevant industries.

In fulfilment of this pre-requisite, the National Plan describes the geographical coverage of the response, the divisions of responsibility, the response structures and working hierarchies, details the policies, plans, operations and procedures, and describes the contingency plan support. These matters are described clearly and in considerable depth and detail.

22:4 The National Plan is complemented by appropriate State/NT contingency plans and there is also a dedicated plan for the Great Barrier Reef Marine Park (REEFPLAN).

In 1998, the Federal and State/NT Transport Ministers adopted the "Commonwealth/State/Territory Administrative Arrangements Applicable to Action to Prevent and Clean Up Spills of Hazardous or Noxious Substances from Ships".

22:5 These Arrangements were based on the premise that the existing National Plan to Combat Pollution of the Sea by Oil provided the best basic framework for response arrangements to all spills of hazardous and noxious substances.

It was therefore agreed that the most effective response system involved the integration of the existing marine oil spill plan and the land based chemical and hazardous materials response capabilities of agencies such as the Fire Service, government bodies and industrial bodies.

22:6 Despite the nature of the language used in the National Plan and the various agreements described above, no definition of "other noxious and hazardous substances" has been found.

22:7 Since its adoption in 1973, the National Plan has been principally concerned with the threat of oil spills. However, since 1998, there have been two segments to the National Plan, a National Maritime Oil Spill Contingency Plan [Ref 14] and a National Maritime Chemical Spill Contingency Plan [Ref 15].

There is no dedicated National Maritime Contingency Plan for responding to a spill of radioactive materials.

22:8 The National Maritime Chemical Spill Contingency Plan provides details of chemical relevant international codes and guidelines which refer to various IMO Codes including the International Maritime Dangerous Goods Code (IMDG Code) and its various supplements including the International Nuclear Fuels Code. Other than this there is no further discussion of nuclear or radioactive materials.

A review of both the oil spill plan and the chemical spill plan reveals that there is no sub-component (of either plan) which deals with the issue of radioactive materials.

22:9 Thus, despite the National Plan's mission statements that:

a. "Measures to prevent pollution, combined with pre-planned clean up strategies, are essential for the protection of the marine environment;
b. the aim of the National Plan is "to protect the natural and built environments of Australia's marine and foreshore zones from the adverse effect of oil and other noxious and hazardous substances", and to minimise those effects where protection is not possible;
c. "provides a national framework for responding promptly and efficiently to marine pollution incidents by designating competent national and local authorities".

None of this has been applied, in the National Plan, with respect to the potential for ship based pollution by radioactive materials.

22:10 The lack of a formal INF Code materials maritime transport response plan is remarkable given that Australia :

a. regularly imports and exports by sea a range of radioactive materials including both radioactive materials that fall under the IMDG Code Class 7 definition, and reactor waste (within the definition of INF Class 2) from the Lucas Heights facility and
b. is on one of the regularly used routes for the INF Code Class 3 (unlimited radioactivity) shipments between Japan and Europe.

23. The Australian Maritime Safety Agency (AMSA)

23:1 Under the 1990 Australian Maritime Safety Authority Act much of the initial responsibility for marine issues falls on the Australian Maritime Safety Agency which is the competent authority for dealing with Search and Rescue matters and ship based marine pollution issues.

23:2 AMSA has a duty to set the standards for contingency planning and to review selected regional and local contingency plans on a quality assurance basis. AMSA also has a co-ordinating role and the duty to provide technical advice, logistic and maintenance support, training, materials and equipment.

23:3 All of the AMSA duties and roles in regard to the oil and chemical spill components of the National Plan are very clearly explained. Similarly all of the roles and duties of other Commonwealth and State/NT government agencies and industrial bodies are very clearly explained.

23:4 However, it is evident that, in the absence of a National Plan component for radioactive pollution from shipping, AMSA has no direct responsibility for INF cargoes. Various AMSA sources have confirmed this fact.

23:5 "AMSA is the competent authority for dealing with Search and Rescue matters, as well as spills of oil and chemicals other than INF cargoes." [Ref 16]

Despite having no competence or authority to deal with INF Cargo emergencies, as the competent authority dealing with Search and Rescue matters it seems probable that AMSA would be among those agencies which the IMO Guidelines for SEPs have advised should be contacted in the event of an emergency.

As such, AMSA is likely to be among the first Australian authorities to receive notification of such an incident and their task would be to pass that notification on to other agencies. However it remains unclear precisely which Australian agencies are so listed and where AMSA's place on such a list would be.

23:6 AMSA has stated that "in the event of an incident involving radioactive and nuclear material comprising an INF cargo, the Australian Nuclear Science and Technology Organisation (ANSTO) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), in liaison with the shipper, would be responsible for co-ordinating the response to deal with the particular circumstances at the time." [Ref 16]

23:7 AMSA has also stated that Australia has arrangements and processes in place to manage an incident involving an INF vessel. "Australia's Commonwealth Government Disaster Response Plan (COMDISPLAN) would be activated to bring together expertise and contingency plans of a number of specialised Commonwealth and State agencies to address the specific issues of the incident concerned". [Ref 17]

24. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

24:1 ARPANSA was established in 1999 and is the Federal Government agency with responsibility for regulating the Commonwealth's use of radioactive materials, protecting public health and the environment from ionising and non-ionising radiation. ARPANSA was formed by amalgamation of the Australian Radiation Laboratories and the Nuclear Safety Bureau. ARPANSA has also assumed the responsibilities of the National Health and Medical Research Council (NH&MRC) regarding radiation and health matters. ARPANSA is responsible for providing advice to State Emergency Services (SES) and ANSTO in the event of off site contamination from Lucas Heights.

24:2 ARPANSA has specific responsibility for:

a. promoting radiation protection and nuclear safety policy and practices throughout Australia;
b. advising the Commonwealth Government and the community on radiation protection and nuclear safety;
c. undertaking research and providing services in radiation protection, nuclear safety and medical exposure to radiation and;
d. regulating all Commonwealth departments, Agencies, and Bodies involved in irradiation or nuclear activities.

24:3 ARPANSA has a scientific unit in Melbourne and a regulatory unit in Sydney. Radiation Emergency Planning is co-ordinated by the Health Physics Section of the Environmental and Radiation Health Branch of the Melbourne unit.

24:4 "In the remote event of a large scale radiological incident ARPANSA's role would be to assist in the intermediate to longer phase post accident recovery." [Ref 18]

24:5 In order to carry out this role ARPANSA maintains:

- a team of senior health physicists able to provide expert radiation protection advice;
- a number of Radiation Emergency response Teams;
- specialised radiation monitoring resources and emergency response kits;
- a nation wide network of radiation fallout monitoring stations and
- a 24 hour contact number for the radiation emergency preparedness Duty Co-ordinator. [Ref 18]

24:6 Having taken over the responsibilities of the National Health and Medical Research Council (NH&MRC) in regard to radiation and health matters, ARPANSA has assumed the NH&MRC responsibilities for radiation monitoring arrangements in the event of visits from nuclear powered warships. ARPANSA also has a formal role in the event of satellite/space debris landings involving radioactive material.

ARPANSA, in conjunction with a Melbourne hospital, is World Health Organisation (WHO) Collaborating Centre for Radiation Protection and Radiation Emergency Medical Centre. The centre would play a role in advising and helping with accidents involving nuclear materials in Australia, and in offering assistance to neighbouring countries in such an event. It is not clear however if this centre has any capacity to provide assistance in the event of an accident at sea involving nuclear materials. No documentary evidence has been found to indicate that ARPANSA has a formal role in the event of an at-sea INF Code materials emergency.

24:7 In informal discussions with various ARPANSA, staff have indicated the following:

a. ARPANSA's principal role is the provision of advice on plans for emergencies occurring at Australia's nuclear sites rather than in the case of transport accidents. (Off site emergency response comes under the remit of the relevant State emergency services);
b. ARPANSA's duties include the provision of advice on land transport and satellite issues, but not maritime emergency issues;
c. if an INF Code material maritime transport was inside territorial waters (i.e. within the three mile limit: see Chapter 21 above) it would be the relevant State Emergency Service that would be the first point of call, they would then call Emergency Management Australia, who would call the Dept of Defence, ANSTO and others (but not in the first instant ARPANSA);
d. ARPANSA does not have a formal role in responding to maritime INF emergencies, but in light of its expertise and resources may be called upon in the event of a significant incident.

However, to date this material has not been officially confirmed by ARPANSA.

This Review recommends that such issues should be clarified by way of direct information requests to ARPANSA.

25. Australian Nuclear Science and Technology Organisation (ANSTO)

25:1 ANSTO is an agency of the Dept of Industry, Science and Tourism and is based at the Lucas Heights facility. ANSTO has nuclear analytical laboratories with a wide range of monitoring and analysis capabilities. ANSTO has a range of responsibilities in regard to radiological accidents and is staffed by over nine health physicists and 12 health physics technicians. [Ref 19]

25:2 The ANSTO Emergency Plan contains procedures for responding to an off-site accident at the Lucas Heights facility (on site response is covered in the Lucas Heights Emergency Plan).

25:3 In the case of accidents involving radio-pharmaceuticals the primary response responsibility lies with the appropriate Health Authorities, but special agreements exist for ANSTO staff from Lucas Heights to provide assistance if and when required.

25:4 While it is reported that ANSTO may contribute to the Shipboard Emergency Plans for the vessels carrying reactor waste products sourced from Lucas Heights to Europe, no documentary evidence has been found to indicate that ANSTO has a formal role in responding to maritime transport incidents involving INF Code materials not sourced from Australian facilities.

However, it is confirmed that in the event of a maritime transport of INF Code materials entering a designated Australian port for conventional emergency repairs to the vessel plans similar for those intended for visiting Nuclear Powered Warships "could be invoked" through Emergency Management Australia and ANSTO as appropriate. [Ref 16]

25:5 Division of responsibilities between ARPANSA and ANSTO is not clear. When ARPANSA was established in 1999, as the Federal Government agency with responsibility for protecting public health and the environment from ionising and non-ionising radiation, it not only took over the role of the NHRMC re radiation and health matters but also some of ANSTO's role in emergency response procedures.

It is reported (but not confirmed) that the division of responsibilities between the two bodies has still not been clarified or formalised. This Review recommends that such issues should be clarified by way of direct information requests to ANSTO.

26. The Commonwealth Disaster Plan (COMDISPLAN) [Ref 20]

26:1 The COMDISPLAN is issued by Emergency Management Australia (EMA), an agency of the Dept of Defence. The EMA is the agency responsible for planning and co-ordinating Commonwealth physical assistance arising from any type of disaster or emergency. The EMA does not appear to have a seagoing capability and in general appears to defer to, or rely on, AMSA in this regard.

The current version of the COMDISPLAN was issued in December 1997 and is currently undergoing a major review. A revised edition is expected to be issued in June 2001.

26:2 The preamble to the COMDISPLAN explains that when the total resources (government, community and commercial) of the State or Territory are insufficient to mount a suitable response, the State or Territory is empowered to seek assistance from the Commonwealth government, which accepts that responsibility and has prepared plans for such an eventuality.

26:3 State and Territory authorities have the constitutional responsibility to plan and co-ordinate the response to disaster and civil emergency within their territorial jurisdiction. As has been shown elsewhere this will apply to the three mile wide "territorial waters".

26:4 While it is clear that the COMDISPLAN applies to all the jurisdiction of the Commonwealth member States and Territories, its application to the remaining nine miles of the "territorial waters" and the 200 miles of the EEZ has not been made clear in the 1997 edition of the plan. Hopefully these issues will be addressed through the current revision process and the 2001 edition of COMDISPLAN will define the applicability of the COMDISPLAN to Australia's maritime jurisdiction including the adjacent High

Seas.

26:5 AMSA has stated that, in the event of an emergency involving the maritime transport of INF Code materials, “Australia’s Commonwealth Government Disaster Response Plan (COMDISPLAN) would be activated to bring together expertise and contingency plans of a number of specialised Commonwealth and State agencies to address the specific issues of the incident concerned”. [Ref 17]

AMSA has also claimed that in the event of a maritime transport of INF Code materials entering an Australian port for emergency repairs, plans “could be invoked” through Emergency Management Australia. [Ref 16]

26:6 Despite AMSA’s statement, an analysis of the COMDISPLAN shows there is little which has direct relevance to accidents involving INF Code materials. The most closely relevant material is found in a series of “Attachments” to the COMDISPLAN which provide planning information for specific disaster scenarios which might require special arrangements. Attachment 7 provides “Additional Planning Information - Radiological Accidents/Incidents”.

26:7 Attachment 7 states that “A number of standing arrangements are in place to cope with situations which have a potential for, or result in, a release of radioactive material.” The listed standing arrangements are those for:
a. Safety Procedures for Nuclear Powered Warships;
b. Accidents involving Radiopharmaceuticals;
c. ANSTO Lucas Heights Research Labs;
d. Radioactive Space Re-Entry Debris.

26:8 Only example a) appears likely to have any relevance to maritime transport accidents involving INF Code material. However this is strictly limited because the arrangements concern only vessels visiting a few specific Australian ports, while they are in port, and contain no arrangements for dealing with a vessel at sea.

The COMDISPLAN does give information concerning the seven person team called the Chemical Radiological Response Team (CRRT). This team is part of the Defence Forces. It has a capability of dealing with chemical and radiological incidents and retains limited capacity to deal with biological warfare. The team is capable of leak, seal and package operations for chemical and radiological agents and isotopes. Exactly what materials CRRT could effectively deal with is not clear.

CRRT can utilise equipment for measuring radiation and has ‘radiation suits’ with separate air supplies. How the team would cope with highly radioactive material without appropriate shielding is not explained.

CRRT monitoring and personnel protection equipment is transportable by air or road transport. However, it is not clear if it could be easily moved and operated at sea.

26:9 Attachment 7 also briefly addresses “Other Circumstances” which might have the potential for, or result in, a release of radioactive material and says that if Commonwealth assistance is required to deal with the release of radioactive material in circumstances not covered by the above standing arrangements, the provisions of COMDISPLAN apply.

26:10 Thus the contents of the COMDISPLAN confirm the earlier observation that there is no plan for responding to ship based radioactive pollution either from IMDG Class 7 materials or INF Code materials Classes 1, 2 and 3.

26:11 The COMDISPLAN describes the arrangements which are in place to centrally co-ordinate the deployment of Commonwealth resources and lists (in Annexes A & B) those resources and the agencies that may be called upon to provide them. These lists include the following INF relevant resources:

- “ Nuclear radiation monitoring teams for low level leaks.” Four teams in total. Available from ANSTO and ARL (Australian Radiation Laboratories).

and the following INF relevant advisory, analysis and liaison services:

- “Australian Radiation Laboratories (ARL): Capability to conduct radio analysis of environmental and other samples... whole body monitoring...fallout monitoring stations...computer models...”.

(As stated elsewhere the ARL no longer exists and has been subsumed into ARPANSA. It is presumably the latter who would now perform the ARL functions.)

“ANSTO : Nuclear analytical laboratories with a wide range of monitoring and analysis capabilities including whole body monitoring and chemical radiation analysis”. [Ref 20 : pps 11 to 18].

27. Comparison between the COMDISPLAN and the Oil and Chemical Plans.

27:1 All three plans explain their scope, identify the relevant priority emergency tasks and identify the relevant players (agencies, departments, industrial bodies etc.). They also identify appropriate management priorities and procedures, communications procedures and review and training systems.

Allowing for the nature and specificity of the plans, these tasks have been completed to a high standard. However, these tasks are primarily concerned with matters of management infrastructure, bureaucracy and organisation.

27:2 It is self-evident that the Oil and Chemical spill components of the National (Marine Pollution) Plan are subject specific and thus the focus of the work can be both close and precise. As a result, very precise identification of relevant major players and necessary response strategies has been possible.

Additionally the identification and stockpiling of all conceivably necessary emergency response equipment and facilities has been possible, with regard to national/internal resources and additional resources located in neighbouring states.

27:3 A study of the available plans demonstrates that, in the case of a response to oil or chemical spills at sea, a well structured, well trained and appropriately equipped response can be mounted.

This review finds that the oil and chemical plans are of as high a standard as those of any developed nation and that the response to such pollution has appropriate management procedures in place for dealing with the at-sea response and also intertidal and shoreline clean-up and the safe disposal of recovered contaminated materials.

27:4 The National Plan (for response to oil and chemical pollution) makes the following statement :

"Measures to prevent pollution, combined with pre-planned clean up strategies, are essential for the protection of the marine environment."

The National Plan also states that "a fundamental pre-requisite" for the successful management of at-sea spill incidents in Australia, is a clear definition of the responsibilities of the Commonwealth, the States/NT and the relevant industries.

27:5 By contrast the 1997 COMDISPLAN is not subject specific and its focus is inevitably more broad. For some specific potential emergency scenarios precise identification of players, equipment and facilities is not possible. Emergencies affecting maritime transports of INF Code materials are one of those potential emergency scenarios.

27:6 Because it does not have a specific marine pollution focus, COMDISPLAN contains none of the planned "Measures to prevent pollution, combined with pre-planned clean up strategies" which, as the marine pollution National Plans advise, "are essential for the protection of the marine environment."

27:7 While COMDISPLAN contains components of relevance to certain radioactive materials emergencies, there is nothing in the plan (or its attachments and appendices) dealing specifically with emergencies affecting maritime transports of any class of radioactive materials.

Thus there has been no identification of players, resources, equipment and facilities relevant to emergencies involving INF maritime transports.

27:8 In light of the matters discussed in Chapters 26 and 27 this review concludes that the COMDISPLAN is incapable of mounting a rapid and effective response to an at-sea emergency involving INF Code materials.

28. Other planning matters which may be relevant

28:1 There are a number of other plans which may be thought to have some relevance to an emergency involving the maritime transport of INF Code materials.

28:2 It should be noted that the COMDISPLAN and various State/NT contingency plans have been usefully activated on a number of occasions in order to deal with a range of disaster/emergency scenarios including cyclones and the re-entry of space debris.

In addition AMSA and various State/NT contingency plans have been usefully activated to respond to maritime incidents including a number of ship based marine pollution incidents.

28:3 This review concludes that the COMDISPLAN and the AMSA and state/NT plans have a proven track record with regard to the construction of effective management infrastructures which have been tested in genuine emergency situations. It may thus be concluded that, although there is no standing arrangement/plan for INF marine transport emergencies, there is a possibility that such a plan or arrangement could eventually be constructed in response to such an incident.

28:4 However, there is no doubt that such a process would be time consuming and, if rushed, would inevitably contain a greater number of flaws and weaknesses than one conducted thoroughly, slowly and with great care.

Such a process could not possibly respond as effectively as a well constructed, pre-arranged response plan for at sea emergencies involving INF Code materials.

28:5 As Attachment 7 to the COMDISPLAN has indicated, there are standing arrangements/plans for Safety Procedures for Visiting Nuclear Powered Warships.

However those arrangements/plans are of only minimal relevance because they deal exclusively with visits of such ships to ports, berths and anchorages that have been specifically designated after being assessed against strict radiological criteria and approved by a special panel. They have no applicability to vessels at-sea in the territorial waters or EEZ.

28:6 Furthermore, the strict Conditions of Entry for nuclear powered warships to Australian Ports appear to rule out the use of even the specifically designated ports, berths and anchorages by INF transports even in the case of their requiring "safe haven" for either conventional repairs or repairs or response action involving the INF packages/flasks.

Some of the relevant Conditions of Entry are summarised below:

a. visits will not be for the purpose of nuclear fuel handling or repairs to reactor plant (necessitating breach of containment);
b. visits will be subject to satisfactory arrangements concerning liability and indemnity;
c. there must be a capability to move the vessel, either under its own power or under tow, to a safe anchorage or a safe distance to sea if an incident should occur.

28:7 From the above it would appear that in any emergency involving a maritime transport of INF, the opportunity to make use of an Australian port, harbour or anchorage for "safe haven" would be severely restricted and would probably be refused if there was any breach of containment, unsatisfactory insurance arrangements or the vessel were unable to be moved to a safe position.

28:8 There is a further area of confusion here, because despite the apparent restrictiveness of the clauses, an AMSA source has advised that, in such an event the carriage of INF cargo "would not necessarily preclude a ship from entering a designated Australian port for conventional emergency repairs". (my italics)

In such a situation plans (to deal with cargo related issues) which are similar to those used for visiting nuclear powered warships could be invoked through EMA, the local port authorities and ANSTO as might be considered appropriate. [Ref 16]

29. Spill response equipment and training

29:1 All industrially developed coastal nations and most less developed coastal nations have identified and stockpiled a range of equipment to be used for response to oil spills. Less common, but growing in frequency and distribution is the stockpiling of a range of equipment that can be used for chemical spill response.

Such stockpiles consist of equipment that can be used in the open sea, enclosed coastal waters and on the coastline

29:2 A vital component of such equipment is the personal protective equipment to be used by personnel employed in response, clean up and disposal work. This typically consists of :

- protective (barrier) clothing, footwear and gloves;
- breathing apparatus (including compressed air and back-up refill equipment);
- first aid and medical emergency equipment.

Provision of protection to response personnel and the public should also include identification of the nearest facilities capable of providing the appropriate medical treatment to response personnel or the public who have been exposed to the spilled substance.

It is always necessary to reliably estimate the number of personnel required for the largest conceivable response action in order to make appropriate provision of personal protective equipment.

29:3 Also of major importance is the sampling and monitoring capability (in terms of both the equipment and the laboratory space) required in order to gather the appropriate data and check:

- the health of response workers and the general public;
- the impact on (and distribution through) the aqueous, terrestrial and atmospheric environments;
- and the contamination of any foodstuffs or drinking water.

Again it is always necessary to reliably estimate the required equipment and the numbers of necessary operator personnel required for the maximum credible accident.

29:4 The third vital component of such an equipment stockpile is the actual response equipment required for dealing with the specific material which has been spilled. This includes:

- the necessary land, air and sea transport equipment;
- physical containment equipment such as booms, drums, tanks, sorbents and the relevant handling machinery for such equipment;
- the various chemical response agents such as dispersants, chemical sorbents, retardents, neutralisers, dilutants, foams, inert gas generators;
- facilities for maintenance, repair, decontamination and re-calibration of response monitoring and analytical equipment.

29:5 Any shoreline clean-up and decontamination process following at-sea spills generates enormous quantities of contaminated wastes. Thus the ERIKA oil spill (France: Dec. 1999) actually spilled about 18,000 tonnes of oil, not all of which came ashore. However by June 2000 the clean up operation (not yet completed) had generated approximately 180,000 tonnes of oily waste and an estimated 9,000 HGV movements.

Thus any shoreline clean up and decontamination response requires:

- a good transport plan;
- a fully authorised waste storage and disposal plan;
- sufficient licensed, appropriately protected, sealed and isolated disposal sites to service the maximum credible clean-up and decontamination response.

29:6 None of this is in place in Australia (or indeed in any other nation) in regard to a response to an emergency affecting either an IMDG Class 7 or an INF Code maritime transport.

29:7 Oil, chemical and hazardous spill response is the subject of specific and intensive training in respect of both at-sea and shoreline operations.

Thus for all of the above categories of spills there are national training schemes for all levels and grades of mariners, response personnel and government and local authority personnel. Since many of these are internationally recognised, nations lacking the relevant training facilities can send personnel overseas for such training. In addition the IMO also has similar training courses and facilities and an international training accreditation scheme.

29:8 This review has found no evidence of the existence of any such training schemes in regard to at-sea, ship based spills of IMDG Class 7 radioactive materials or INF Code materials. The only such training that exists is that carried out by the national radiological protection authorities and nuclear site managers. In Australia this is ARPANSA and ANSTO.

29:9 This review notes that the COMDISPLAN says that those Australian organisations will be expected to have a field capability of. four teams (number of team members not given) with the ability to monitor only "low level leaks" of radiation (see Chapter 26 above).

This review concludes that such a capability will not be adequate to the task of responding (in terms of any necessary clean up and decontamination) to an emergency involving INF Code materials maritime transport.

29:10 This review recommends that in order to respond appropriately to a maritime emergency involving INF Code materials suitable training schemes should be initiated. Such schemes should provide training in basic radiological response and handling skills for front line response workers and more detailed training to identified management, control and executive staff.

Summary of review findings

1. International Maritime Organisation (IMO) Shipboard Emergency Plans

1:1 The IMO recognises that an incident involving the actual or potential at-sea loss of Irradiated Nuclear Fuel (INF) Code materials is a credible occurrence. As a result of that recognition the IMO has produced "Guidelines for Developing Shipboard Emergency Plans for Ships Carrying Materials Subject to the INF Code".

1:2 The Guidelines identify 15 types of casualty scenario giving rise to an actual or potential breach of INF package containment and loss of INF Code materials.

1:3 The IMO Guidelines lay out the division of duties and responsibilities and express the IMO's expectation that the Consignor and the Carrier of INF Code materials should take a major part in any response action in the event of an incident.

1:4 This review notes that under international agreements coastal States have the legal right to take responsibility for defining the means and techniques for responding to marine pollution incidents and to approve any operations that might cause further pollution.

1:5 This review notes some developed coastal States (including the UK and Australia) with a domestic nuclear industry and appropriate technical experience, equipment and personnel appear to have devolved their responsibilities to BNFL and PNTL.

1:6 The Guidelines appear to accept that in certain situations visual inspection may be the only means to assess the condition of the vessel and the INF containers. The Guidelines provide no advice relevant to situations where such visual inspection may not be possible or safe.

1:7 The Guidelines provide advice and guidance on ensuring the safety of the vessel and her crew are prioritised and that escalation of the incident is minimised. However, the Guidelines fail to provide advice and guidance on ensuring the safety of personnel on adjacent vessels, populations in adjacent coastal States and the safety of marine, intertidal and coastal zone terrestrial environments.

1:8 The Guidelines recommend Shipboard Emergency Plans (SEPs) should provide guidance on ship-to-ship transfer operations but their discussion of the subject is brief and imprecise. They offer no details of scenarios in which such transfer may be necessary, no guidance on sea or weather states where such transfer may not be advisable, no details of any exercises, training or drill which may be carried out to improve or check the relevant techniques.

1:9 The Guidelines offer advice and guidance on training, exercise and drill programmes covering techniques required in the event of an emergency. However, the Guidelines offer no guidance or advice on training etc. for the deployment and use of off-vessel emergency resources and specialised teams.

The Guidelines offer no advice or guidance on joint exercises with shore based agencies and authorities in coastal States.

1:10 The Guidelines also suggest exercises and drills may be observed by independent observers, but fail to define the relevant qualifications for such observers or to identify where a pool of suitably qualified and truly independent observers might be found.

1:11 Finally the Guidelines' advice on salvage matters is both brief and imprecise and is confined to very simplistic comments concerning towage tugs and windows of opportunity. The guidance on salvage offers no advice on a number of very important salvage related issues.

2. British Nuclear Fuels Ltd (BNFL)/Pacific Nuclear Transport Ltd (PNTL) Emergency Response Arrangements

2:1 This review concludes the BNFL and PNTL emergency plans and arrangements encapsulate the only response to an emergency involving the maritime transport of INF Code materials, because both the UK and Australia appear to have handed over total responsibility for such response actions in their maritime jurisdiction to BNFL and PNTL.

2:2 BNFL has a set of "Special Arrangements" for responding to at sea emergencies involving INF Code materials. These arrangements appear to be designed for use by BNFL/PNTL alone. A small number of senior executives of national maritime agencies, senior civil servants and senior government ministers are permitted access to these Special Arrangements, which are "commercial in confidence", the sole property of BNFL and not available to members of the public or their elected representatives.

2:3 Because access to the "Special Arrangements" has not been possible, this review has studied safety plans and arrangements outlined in two documents submitted to the IMO by BNFL and PNTL and one document issued as a public information file by PNTL.

2:4 A BNFL submission to the IMO states the production of the publicly accessible safety plans is based solely on the need to "provide reassurance" to the public, because there "would be no reason for concern and no consequences which could significantly affect persons or the environment". This review notes that no reference or details of the empirical science which might support such a claim have been given, and that BNFL and PNTL's maritime transport experience and statistical base are so small that their operating experience is relatively negligible and does not provide an adequate basis for making such claims.

2:5 There is a potential for a failure of some of the PNTL vessels' communications equipment in certain very specific geographical locations. While rare and unusual, such a failure could be problematical. The issue has not been addressed by BNFL/PNTL.

2:6 From the available details of the design of the PNTL vessels it appears that their communications systems are located in the aft/bridge section of the vessel. This makes them susceptible to a complete communication failure in the event of a number of severe casualty situations, especially those involving collision or fire.

2:7 The reviewed documents state that a BNFL emergency team is on standby "at all times" and on a "24 hour emergency standby system". However these phrases are not defined and it is unclear whether it is being claimed that the teams can be ready to leave within 24 hours of initial notification or that they can arrive on the emergency scene within 24 hours.

2:8 This review notes that maritime emergencies can escalate rapidly and that the optimum "window of opportunity" for incident management and control occurs within the first 24 hours.

This review concludes that if the BNFL emergency teams cannot arrive on the scene within the first 24 hours the possibility of the emergency escalating to very significant or total casualty status (with attendant escalating radiological emergency) increases.

2:9 PNTL's submission to the IMO claims the emergency team is a "fully trained and equipped team of marine and nuclear experts". However, other documents explain that such a team actually consists of one marine expert, four nuclear experts, two head office staff and one public relations officer.

2:10 BNFL's submission to the IMO refers to the radiation monitoring and equipment accompanying the emergency teams. No details of the size, bulk and sensitivity to breakage of that equipment are given.

No details are given about the proposed methods of transporting the team and the equipment from major transport centres (ports and airfields) to the emergency, nor about the proposed method of transferring the emergency teams and equipment to the vessel.

2:11 This review concludes the assessment of the ease or difficulty of deployment depends upon full details of the intended methods of transport and deployment. Especially in the context of the parameters likely to be found in an extreme at-sea emergency scenario, extreme sea and weather conditions and many miles from land. No such details are provided by BNFL and PNTL and no such details appear to have been requested by the IMO or the coastal States.

2:12 BNFL and PNTL refer to emergency equipment and techniques which have been "developed from regular realistic emergency exercises". However they have failed to describe the weather and sea states or the distance from shore during those exercises. The absence of such information means it is impossible to assess the adequacy of the exercises and their influence on the expertise of the emergency teams, techniques and equipment. There is no evidence that the IMO or the coastal States have requested that information.

2:13 There is no indication that a wide range of significant parameters like weather and sea states, distance from shore and shore based facilities, the state of the vessel and the nature of the emergency have been factored into ship based exercises.

This review concludes that if this is the case it represents a serious failure in the planning of emergency exercises and response operations because a radiological emergency will probably have been caused by one or a combination of these parameters.

2:14 This review concludes that the available data presented in the reviewed documents does not demonstrate that the emergency exercises carried out by BNFL and PNTL have achieved the necessary stringency and will neither build up nor test the expertise of emergency team members and the deployment of emergency equipment in the full range of potential at-sea INF casualty scenarios.

2:15 BNFL and PNTL submissions to the IMO have claimed that there is a full "rapid response world-wide salvage cover" and that "immediate arrangements can be put in hand to salvage the ship or cargo".

This review concludes such claims lack precision and definition. In terms of the start of actual salvage activity the response is not likely to be rapid or immediate. The timing of the start would depend on a number of factors including the nature of the required salvage effort, the nature of the contractual agreements relative to the current work priorities of the salvage company, the location of the emergency relative to the distribution of salvage equipment and the ambient weather and sea states.

2:16 This review concludes that, unless permanently escorted by a salvage/rescue vessel, it is evident that during any voyage between Europe and Japan an INF maritime transport will inevitably be isolated from sources of assistance and salvage for considerable periods of time.

2:17 BNFL's submission to the IMO states that emergency response systems equipment and technologies have been developed from "specialised demonstrations including sea-bed recovery of a spent fuel package".

2:18 This review concludes that, in the absence of evidence to the contrary, it may be assumed specialised demonstrations have not involved recovery of flasks and packages from inside a sunken INF carrier on the seabed, nor in a variety of parameters which can exert major complicating and limiting factors on any salvage attempts.

2:19 This review concludes that if this is the case the demonstrations have been virtually pointless, fail to test the salvage procedures with the necessary rigour and will not adequately prepare personnel, techniques or equipment for a relevant salvage response.

2:20 This review concludes that, given the potential importance of the recovery/salvage of INF Code materials, it is remarkable that the IMO and the coastal States accepted such a superficial and imprecise description of the demonstration. There is no evidence that further details were demanded.

2:21 BNFL and PNTL have installed sonar location devices on the INF vessels. This device can work at depths in excess of 6,000 metres. Noting that there are a number of sea areas on the PNTL routes where depths exceed this limit and that the maximum depths in such areas may be 11,000 metres, this review concludes that it is unclear whether the sonar device will operate in such depths.

2:22 This review reports that deep ocean salvage of INF material, while theoretically possible, has never been completed and that the current maximum working depth is approximately 3,000 metres, while the current record for the maximum depth from which a commercial cargo has been salvaged is 1,259 metres.

2:23 This review notes that a leading expert in the field believes that full ocean depth (11,000 metres) salvage is theoretically possible, but that it would be time consuming, beset by various technical difficulties and very expensive. Expert opinion believes that such an operation would currently require the co-operation of a wide range of bodies and agencies including deep water hydrocarbon and surveying industries and possibly government agencies.

2:24 This review notes that BNFL and PNTL have not made an open ended commitment to recover lost INF Code material, from any marine environment regardless of the cost in terms of resources and finance.

3. Australian Emergency Response Arrangements

3:1 This review notes that Australia has rights under international agreements to exercise its "responsibility to define techniques and means to be taken against a marine pollution incident and approve such operations which might cause further pollution".

3:2 This review notes that while it has fully accepted and acted upon these rights and responsibilities in respect of marine pollution incidents involving oil and chemicals, Australia has not done so in respect of radioactive materials classified by the IMO as IMDG Class 7 materials or as INF Class 1, 2 and 3 materials.

3:3 However, this review has found there are no specific plans for response to at sea incidents involving radioactive cargoes. In addition there are no sub-sectors of any other plans that address the subject of radioactive cargoes. A number of sources have indicated that a response to such an incident could be launched under the Commonwealth Disaster Plan (COMDISPLAN).

3:4 Accordingly the COMDISPLAN has been reviewed. This review concludes that although the COMDISPLAN has a proven record of response to a range of emergencies it is incapable of mounting an effective and rapid response to an emergency involving the maritime transport of IMDG Class 7 and INF Code materials because :

- it is unclear what jurisdiction and responsibility the COMDISPLAN has over the waters of the territorial sea, the EEZ and the adjacent High Seas;

- in contrast to Australia's detailed and subject specific maritime oil and chemical spill plans, COMDISPLAN contains no detailed, subject specific arrangements or plans for at sea spills of radioactive materials;
- COMDISPLAN does not identify either players or resources relevant to a response to spills of radioactive materials at sea.

3:5 This review finds that a further indicator of the COMDISPLAN's inability to respond to an emergency, is that, in contrast to the stockpiles of equipment and facilities used in the Australian response to oil and chemical spills, there is no stockpile of equipment suitable for responding to an at-sea spill of radioactive materials.

Specifically this applies to the personal protection equipment for response workers and the public and any necessary medical facilities; the monitoring and analytical equipment required for dealing with radioactive materials and radioactively contaminated materials; the facilities and equipment required for handling, transporting, storing and disposing of radioactively contaminated materials arising as a result of clean up and decontamination procedures.

3:6 This review notes there are a wide range and number of industry and government based national and international training schemes providing training on all aspects of response to oil and chemical spills (both at sea and on the shoreline), and that in both Australia and the UK there are hundreds, possibly thousands, of people who have undergone such training.

3:7 This review notes that there is no evidence that similar training schemes exist in respect of a response to radioactive spills. This review notes that the training effort and equipment supply in Australia is so small that in the event of any radiological incident it would only be possible to field four teams (number of team members not given) and that those teams would only have the equipment capability to monitor "low level" radioactivity.

3:8 The Australian National Contingency Plans for oil and chemical spills says that "measures to prevent pollution, combined with pre-planned clean-up strategies are essential for the protection of the marine environment".

This review finds Australia has comprehensively failed to operate such a policy in respect of spills of radioactive materials into the marine environment.

4. Other related matters.

4.1 Within the COMDISPLAN structure there are many areas of potential confusion over who leads and how various responsibilities are allocated in regard to potential emergencies involving the maritime issues because:

- There is an unclear division of responsibility/jurisdiction between State and Commonwealth Agencies;
- The relative roles of ARPANSA and ANSTO are still unclear in some circumstances;
- Eight different agencies could be involved in any emergency response (ARPANSA, ANSTO, Dept of Science & Industry, Dept of Defence, AMSA, EMA, Dept of Foreign Affairs, State Emergency Services).

4.2 It is not surprising that BNFL, PNTL and other nuclear industry bodies and agencies deny there is any serious risk of a breach of containment of INF flasks and packages.

More surprising is the fact that a number of government agencies in developed industrial nations have uncritically accepted this denial.

4.3 This review warns the repeated downplaying of the likelihood of an INF Cargo means there is a risk that resources, energy and funding directed towards response planning can be reduced because it is perceived as a minimal threat. Similarly there is no need to push ahead with the development of relevant response equipment.

4.4 This review notes that the majority of the discussion of the potential effects of a loss of INF material focuses on the potential human health impacts of an incident.

4.5 This review points out that it is equally important to discuss the environmental and economic impacts. In the event of the loss of a flask/package, even if it is not breached and no INF material leaches/escapes, the economic effect on fisheries and marine and coastal recreation and tourism is likely to be enormous.

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