PART III ANALYSIS OF INCIDENT (SALVAGE OPERATION)

10. INTRODUCTION

10.1 For the purposes of this Report the salvage operation is considered to have commenced from the time just after SEA EMPRESS initially grounded until the time the casualty was successfully refloated and taken to Herbrandston Jetty. The total time for this operation was six days but it can be divided into seven well defined periods. Each period ended with a significant event which, in general, necessitated a change in direction for the salvage operation. The times stated below should not be taken as the precise time an event took place, they are just convenient times for the start and finish of the periods.

Period 1

10.2 This period covered the time from when SEA EMPRESS reported that she required assistance until the arrival of the first salvage team from the co-salvors, Smit Tak.

The period began at 2007 hrs on Thursday 15 February and finished at 1300 hrs on Friday 16 February.

Period 2

10.3 This period covered the assessment of the casualty's condition by the salvors and the formulation of their salvage plan. It was during this period that the casualty was turned towards the impending gale force winds. The period finished when the casualty was swept aground onto Saint Ann's Head Shoal.

The period began at 1300 hrs on Friday 16 February and finished at 1830 hrs on Saturday 17 February.

Period 3

10.4 In the early part of this period the salvors needed to rapidly reassess their plans. With SEA EMPRESS's anchors no longer available the problem of holding the casualty had increased. Attempts to pin the casualty on Saint Ann's Head Shoal were unsuccessful and the period finished when SEA EMPRESS was swept across the Channel to ground on Middle Channel Rocks.

The period began at 1830 hrs on Saturday 17 February and finished at 0900 hrs on Sunday 18 February.

Period 4

10.5 The atrocious weather precluded full scale salvage activity. This period was essentially used as a holding period when the salvors rested and tugs made repairs while they awaited the arrival of extra personnel and tug power. It was during this period that the casualty drifted in the eastern portion of the 'pool' and the tug DE YUE (200 tbp) was unsuccessful in holding SEA EMPRESS. The period finished with the casualty being aground once again off Middle Channel Rocks Light.

The period began at 0900 hrs on Sunday 18 February and finished at 0900 hrs on Monday 19 February.

Period 5

10.6 SEA EMPRESS grounded to the north of Middle Channel Rocks Light at the start of this period. Plans had been made, during the previous evening, to board the casualty and, with the assistance of some of her crew restore power and inert gas supplies. On refloating, tugs were unable to hold SEA EMPRESS and this period finished with her once again aground off Saint Ann's Head.

The period began at 0900 hrs on Monday 19 February and finished at 2245 hrs on the same day.

Period 6

10.7 SEA EMPRESS was again unmanned at the beginning of this period. Plans were made to reboard the casualty the following morning, Tuesday, and make preparations for refloating, this time with the aid of the casualty's main engine. This period finished with the refloating operation having failed and SEA EMPRESS still remaining aground off Saint Ann's Head.

The period began at 2245 hrs on Monday 19 February and finished at 2000 hrs on Tuesday 20 February.

Period 7

10.8 The casualty was successfully refloated and the period finished with SEA EMPRESS alongside the Herbrandston Jetty.

The period began at 2000 hrs on Tuesday 20 February and finished at 2400 hrs on Wednesday 21 February.

10.9 During each of the above periods a number of activities were taking place, both on board SEA EMPRESS and ashore. All of these activities contributed in one way or another to the salvage operation. **Each period has been analysed thoroughly and the details are given in Annex D.** However, the major factors associated with the execution and strategy of the salvage are analysed in the following sections of this Report.

11. TUGS USED DURING THE SALVAGE OPERATION

Tugs which were Prompt/Available

11.1 In the early stages of the incident the salvors and/or their brokers were aware of a number of tugs which were prompt/available but account also had to be taken of their location. In addition to the Milford Haven harbour tugs there were a number of other harbour tugs, with similar tonnes bollard pull (tbp), in ports such as Avonmouth, Cobh, Liverpool and Swansea (**see Annex C for explanation of tonnes bollard pull**). A number of powerful anchor handling/tug/supply vessels (AHTS) with bollard pulls ranging from 125 tonnes to 178 tonnes were in Aberdeen. The distance from Aberdeen to Milford Haven, north about, is 657 miles so at 15 knots, steaming time is 1 day 20 hours and this would probably be increased due to adverse weather conditions. There were also two AHTSs in Great Yarmouth. In this case the distance to Milford Haven is 491 miles so at 15 knots, steaming time is 1 day 9 hours, however this would probably increase due to adverse weather in the Channel. In addition there were a number of other tugs and AHTSs in the Thames area and the English Channel, including an ocean towing salvage tug in Falmouth. Distance from Falmouth to Milford Haven is 148 miles so at 15 knots, steaming time is 10 hours. There were also the two Coastguard emergency tugs, both AHTSs, one stationed in the Dover Straits and one at Stornoway. (**General details of various types of tug and the hiring of tugs is given in Annex C.**)

11.2 All the above were prompt/available and are not to be confused with many other tugs based in the UK and near Continent which were brought to the notice of the salvors and/or brokers but which were already committed to other duties. However a number of tug operators who were aware of the incident and had their tugs committed to other duties negotiated release from those contracts in anticipation of taking part in the salvage.

Tugs Offered and Used during the Salvage Operation

11.3 Acomarit, the managers of SEA EMPRESS, accepted an offer of assistance from a salvage consortium within three hours of the initial grounding. By that time the four harbour tugs from Milford Haven, DALEGARTH (45 tbp), STACKGARTH (43 tbp), THORNGARTH (45 tbp) and TITO NERI (50 tbp) were attending the casualty. As Cory Towage was part of the salvage consortium this meant that the four harbour tugs at Milford Haven were immediately available and on scene. Two Klyne tugs, ANGLIAN DUKE (AHTS 100 tbp) and ANGLIAN EARL (AHTS 84 tbp) were committed to the operation, the former was in Falmouth and the latter in the English Channel. Also there were a number of other Cory harbour tugs in Liverpool, Cobh and Avonmouth but at that

stage none were committed to the operation. With this in mind, although the salvors were aware of the other tugs and their locations which were prompt/available they did not consider it necessary to charter any of them.

11.4 ANGLIAN DUKE (100 tbp) arrived in Milford Haven at about 0800 hrs on Friday 16 February and was therefore able to assist in holding the casualty in the 'pool'. At about 2035 hrs the tug VANGUARD (23 tbp) was engaged by MHPA for general duties, but this agreement was later taken over by Cory. Cory's tug from Cobh, ESKGARTH (50 tbp), and ANGLIAN EARL (84 tbp) then arrived at 0650 hrs and 0848 hrs respectively on Saturday 17 February to support the operation. With the arrival of these two additional tugs it is considered that the total amount of tug power available to the salvors was adequate for the operations which were envisaged, namely turning the casualty, holding her in the 'pool' in line with the main tidal stream, with the assistance of her anchors and engine, and lightening her. However, once the turning operation ran into unforeseen difficulties, including the loss of the casualty's anchors, the amount of tug power available was inadequate.

11.5 At about 1810 hrs on Saturday, shipbrokers were informed by Klyne Tugs of the situation regarding the casualty. In the next hour and fifteen minutes the shipbrokers had established that the Chinese registered ocean going salvage tug DE YUE (200 tbp) was still prompt/available in Falmouth, although her agents in Rotterdam had to check with the tug's owners in China. They identified also the following vessels as being available. In Falmouth the coastal tug TOWING WITCH (42 tbp) was only available for a limited period. DEA CAPTAIN (AHTS 43 tbp) was prompt at Lyme Bay and whilst not being fixed was mobilising and proceeding towards Penzance in order to be closer to the casualty. CANMAR IKALUK (AHTS 165 tbp) was currently engaged in a rig shift off Great Yarmouth and may have been available later. MAERSK PUNCHER (AHTS 178 tbp) and MAERSK MASTER (AHTS 170 tbp) were prompt and available in Aberdeen.

11.6 In light of the fact that the casualty's anchors had been slipped during the operation to turn her the Salvage Master required additional tug power. He called his Head Office in Rotterdam at about 1830 hrs on Saturday requesting an AHTS with a multi-role capability and at least 100 tbp. He was informed about DE YUE (200 tbp) and that the Smit owned VIKINGBANK (AHTS 62 tbp), on passage in the southern North Sea, was available.

11.7 At about 1925 hrs DE YUE (200 tbp) had been selected by the salvors. She was fixed and would be in Milford Haven on Sunday morning. There were discussions between shipbrokers and the salvors about other tugs but these were considered to be either too small or too far away. Cory Towage had also arranged for two of their harbour tugs from Liverpool, ELDERGARTH (42 tbp) and YEWGARTH (50 tbp), to be

sent to Milford Haven to take over port duties to allow the Milford Haven Cory tugs to be committed to the salvage operation. These were due to arrive at Milford Haven in the early hours of Sunday morning.

11.8 However DE YUE (200 tbp) arrived after the casualty had drifted free and regrounded on the southern side of the 'pool' and with this change in circumstances this tug did not provide the answer to holding the casualty in the desired position. DE YUE (200 tbp) has the typical characteristics of an ocean going salvage tug, including a deep draught and heavy cumbersome towing gear, and therefore was not really suitable for holding the casualty in the relatively confined waters of the 'pool'. Although the disadvantage of the towing gear was overcome to some extent by the salvors providing her with a specialised high strength, easy to handle, synthetic towing line, the problems of deep draught and restricted manoeuvrability could not be overcome. From the time she arrived at Milford Haven, a salvors' representative (a tug master from Klyne Tugs who was to act as liaison officer) was on board to advise the Master what was required of his vessel. The Master questioned some of the actions which were required and offered alternative suggestions based on his knowledge of the capabilities of his vessel. These suggestions were not accepted though it is impossible to say with certainty whether there would have been a better outcome if he had been allowed to do things as he thought best. Because of DE YUE's (200 tbp) apparent lack of manoeuvrability in such a situation, it was accepted that she was not suitable and took no further part in the salvage operation.

11.9 It is worth clarifying also the much publicised role of the interpreter from a local Chinese restaurant. The Master of DE YUE demonstrated no knowledge of the English language but some of his senior officers spoke reasonable English therefore there was no real problem of communication between the salvors' liaison officer and the crew. However, the questioning by the Master of some of the actions required of him and the resultant discussions with the liaison officer, when relayed to those ashore, was interpreted by them as a language problem, whereupon the services of a Cantonese speaking person to act as interpreter were obtained. Although this person did pass messages to DE YUE in Cantonese which were understood by the Master the real problem was not a difference in language but a difference of views on the operation of his vessel.

11.10 On Monday 19 February following the unsuccessful attempt to hold the casualty with DE YUE (200 tbp) (supported by some of the other tugs) the salvors took measures to find a more suitable replacement, namely the nearest large AHTS vessel which was immediately available. Enquiries were made concerning MAERSK PUNCHER (178 tbp) and MAERSK MASTER (170 tbp) but these were no longer available as Aberdeen had been closed at 1430 hrs on Sunday due to the weather. (Aberdeen reopened at 2323 hrs on Monday.) The nearest tug which would fulfil the salvors' requirements was ARILD VIKING (AHTS 145 tbp)

which was at Great Yarmouth. She was fixed immediately, sailed for Milford Haven and expected to arrive at midnight Tuesday or early on Wednesday.

11.11 By Tuesday morning two other tugs had arrived on the scene, VIKINGBANK (62 tbp) and Cory's harbour tug PORTGARTH (50 tbp) from Avonmouth. The former tug joined the other available tugs in the unsuccessful attempt to refloat the casualty on Tuesday afternoon. This failed because there was still insufficient tug power attached to the casualty to turn her against the current. The tug power was insufficient because as the casualty began to turn, one end would have come up against the seabed and prevented her from turning further. It has been calculated that a total bollard pull which would have been required to be made fast to one end of the vessel would have been about 900 tonnes.

11.12 ARILD VIKING (145 tbp) arrived late Tuesday evening in time to take part in the successful refloating of the casualty. Although her arrival did increase the total tug power available quite considerably, the refloating operation was successful mainly because the casualty was at such a low draught that she was clear of the shoal ground.

Conclusion

11.13 There was sufficient tug bollard pull to carry out the holding operations but only in reasonable weather and tidal conditions. However, the smaller tugs were not suitable when these conditions deteriorated because neither they nor the towing equipment on board was designed for such sea and weather conditions. This situation could have been foreseen by the salvors and they should have made contingency plans to bring to the site more suitable larger tugs, such as AHTSs which have heavy towing equipment. Too great an emphasis was placed by the salvors on the summation of the total nominal bollard pull rather than the types of tugs which apply that bollard pull. Although DE YUE (200 tbp) had a high bollard pull and heavy towing equipment her handling characteristics did not make her truly suitable for the task given to her.

Availability of Coastguard Tugs

11.14 In parallel with the salvors search for suitable vessels on Monday 19 February, the MPCU's Overall Commander (**see Annex B for details of MPCU command structure**) based at the Marine Emergency Operation Room (MEOR) in Southampton enquired as to the availability of the two Coastguard tugs, FAR TURBOT (AHTS 100 tbp) and SMIT LLOYD SAFE (AHTS 126 tbp) stationed at Dover and Stornoway respectively. It was reported that it would take the former 26 hours and the latter 36 hours to reach Milford Haven. However because of a scheduled crew change

at 1600 hrs that afternoon and also because she would have to refuel en route, it would have taken longer than 36 hours for SMIT LLOYD SAFE (126 tbp) to reach Milford Haven. FAR TURBOT (100 tbp) was unable to leave due to bad weather in the Channel and her services might have been required in her designated area. However as ARILD VIKING (145 tbp) had been fixed it was felt that the Coastguard tugs were not required.

11.15 Nevertheless, the question has to be asked whether consideration should have been given at an earlier stage to calling in the Coastguard tugs. HM Coastguard have submitted to the Inquiry that factors which would have to be taken into account include distance, weather, urgency and the availability of other tugs.

11.16 However strong these considerations, when there is an emergency anywhere around the UK coastline which has the potential for loss of life and/or extensive pollution, and there is no emergency in their own sector, it is considered that these tugs should be automatically mobilised towards the scene. Their place could be substituted by units from the market if this was deemed necessary. It is considered that if the two Coastguard tugs had been mobilised as a matter of routine their use, in addition to the other tugs, would have made a major contribution to the holding and salvage operation.

Donaldson and Belton Reports

11.17 Both at the time of the incident and afterwards there were a number of claims from some quarters that if a salvage tug had been positioned in the South Western Approaches in accordance with Lord Donaldson's Report the incident would not have escalated. Lord Donaldson's Report only identified two key areas, the Dover Straits and northwestern Scotland and this was acted upon by the Government. However, the Report went on to identify the South Western Approaches as the area to be considered next. A further study into the costs and benefits of emergency towing vessels was commissioned from a study team headed by Captain Belton RN. The report concluded that Dover, Hebrides and South Western Approaches should be considered as Primary Areas in terms of risk. A third emergency towing vessel has been stationed in the South Western Approaches as part of the winter 1996/97 trial, since the SEA EMPRESS incident.

11.18 Both reports appertain to rescue/salvage capability in the open sea, rather than in the grounding of a vessel in a harbour area. It is clear that a salvage tug based in the South Western Approaches could not have prevented SEA EMPRESS going aground in the first instance. However, if a powerful and manoeuvrable tug such as an AHTS had been based there and summoned to assist in the very early stages of the salvage operation it would have improved the chances of safely holding the casualty in the 'pool'.

12. CONTINGENCY AND EMERGENCY PLANS

General

12.1 During the salvage operation reference was made to the National Contingency Plan and MHPA plans for dealing with such emergencies. The Inquiry has therefore considered this important aspect to determine whether these existing plans are adequate, whether they were implemented and if so how successfully.

12.2 The National Contingency Plan is the repository of MPCU's philosophy and strategy and sets out the arrangements for dealing with pollution from ships into the marine environment with the objective of ensuring a fully integrated and co-ordinated response. The MPCU advises local and port authorities on the formation of their own plans so that they are consistent with the National Contingency Plan and that the response approach and policies accord with those of the Government. However the plan is not a legal document.

12.3 The plan was being revised at the time of the incident to take account of, among other things, the establishment of The Coastguard Agency and Lord Donaldson's recommendations. The document discussed in this report is that current at the time of the accident.

12.4 Most Harbour Authorities currently do not have a statutory responsibility to prepare oil pollution emergency plans. Although the Government has ratified the International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 which requires sea ports to have such plans, primary legislation is required to make the requirement mandatory. However Milford Haven, in common with most large UK port authorities, has a "Pollution Plan". It also has an "Emergency Plan" which fulfils the requirements of the Dangerous Substances in Harbour Areas Regulations 1987.

Milford Haven's Emergency Plan

12.5 This plan takes the form of a section dealing with emergencies in general, followed by six separate sections giving the action to be taken in particular categories of emergencies. There are a number of appendices indicating contact numbers, possible control posts, the initial action to be taken at the Signal Station and the resources available.

12.6 The plan does not deal specifically with an incident like that of SEA EMPRESS but one chapter does deal with an incident "*which is a collision or emergency other than a fire or explosion involving vessels within the Haven*". The plan makes it quite clear that in such an incident

the Harbour Master would be in charge for the Authority, that he would liaise with the Master of the vessel on actions to be taken, would nominate a suitable beaching area if necessary, would nominate someone to co-ordinate tugs and other services and he would on discussion with the Master determine individual responsibilities depending on the circumstances. The plan indicates that the Harbour Master would normally be stationed in the 'Forward Control Point'.

Milford Haven's Pollution Plan

12.7 This plan concentrates on dealing with the oil once spilled, reporting procedures and the roles of MHPA, the jetty owner and ship's Master. Nevertheless one clause states: "*It should be appreciated that the Government's power to intervene in respect of salvage operations would apply within the port area if the port authorities were dissatisfied with the conduct of such operations from an environmental risk point of view.*" This seems to imply that MPCU would intervene at the request of MHPA.

This plan was submitted to MPCU for approval in 1991 at their request and they were involved with subsequent revisions.

Milford Haven's Plans and the Marine Pollution Control Unit

12.8 Neither of the plans referred to above make express reference to the National Contingency Plan. No allowance is made for the role that MPCU personnel and their advisers play in connection with a major casualty and its salvage within the Haven (as opposed to their role in connection with at-sea and on-shore pollution) and how that role and the Command and Control Structure, as laid out within the National Contingency Plan, fits in with the Milford Haven Emergency and Pollution Plans. In these respects the plans fall short of adequately covering important aspects of an incident of the magnitude of SEA EMPRESS.

12.9 Nevertheless the Harbour Master has stated that unless and until MPCU intervened officially he felt he was in charge of the salvage operation from MHPA's point of view and MPCU's role was to assist him. The initial stages of the emergency were handled well under the Milford Haven plans and the correct people were mobilised in good time. However, it is clear that the plans were not designed to cope with an accident of the scale of SEA EMPRESS which continued over a number of days, involved international salvors and government authorities and was of national and even international significance.

The National Contingency Plan

12.10 The content of the National Contingency Plan is necessarily broad based to cover a wide range of possible incidents. Much of it deals specifically with pollution on the sea surface or on the shoreline and methods of combatting and controlling that pollution. The general sections of the plan include some references which, although obviously aimed principally at MPCU's responsibilities in the clean-up and control of the pollution, could be, and perhaps are meant to be, construed to include their involvement with the casualty and its salvage. The potential for confusion is increased, in a case like that of SEA EMPRESS, by no clear definitions of the terms "at-sea" and "offshore" and particularly whether these terms encompass harbour waters. For instance it states that in a major incident MPCU "*will direct offshore operations*". Should this be interpreted to include the casualty and if so does it include a casualty within harbour waters? There might be circumstances where MPCU will direct operations offshore to deal with the pollution but not necessarily with the casualty. In addition, the mechanism whereby an incident changes into a "major" incident and where MPCU will assume greater control is not described.

12.11 Three sections of the plan, those entitled "Intervention", "Response to At-Sea Pollution" and part of the section entitled "Counter Pollution Operations At-Sea", do deal more specifically with a casualty and its salvage. Intervention is discussed elsewhere in this Report as are aspects of the section entitled Response to At-Sea Pollution. The section on Counter Pollution Operations At-Sea is divided into two parts, one dealing with the casualty and the other dealing with the spilt oil. As the remit of the Inquiry does not extend to the handling of the pollution, the following comments relate to the section of the plan which addresses the matter of dealing with the casualty.

Role of the Marine Pollution Control Unit

12.12 The section dealing with the casualty outlines MPCU's role in the vessel and salvage aspects of an incident. It explains that the role of MPCU, where salvors are actively engaged in dealing with the casualty, might be limited and involve no more than monitoring the activities of the other parties to satisfy itself that the wider public and environmental interests are being safeguarded. It also allows for MPCU to assume "a central role", including possible use of the powers of intervention. The role and responsibilities of the Harbour Authority are not considered. It could be construed that this assumes the casualty to be outside harbour limits where MPCU would undoubtedly be the principal authority with responsibility for the casualty.

12.13 There is no doubt that MPCU, in the case of SEA EMPRESS, as well as monitoring the situation assumed a "central role" although they did not actually use their powers of intervention. From the Inquiry it is apparent that there was some confusion as to who was in charge ashore. The Harbour Master clearly felt that he had the responsibility unless and until MPCU intervened on behalf of the Secretary of State. This view seems to be largely echoed by MPCU, although confused by references to MPCU assuming overall command, but not "executive overall command". This issue is further confused as MPCU cannot use its intervention powers directly to the harbour authority under the Merchant Shipping Act 1995 even though the Secretary of State, and those with his delegated responsibility, clearly have the greater legal responsibility.

12.14 In the case of SEA EMPRESS, MPCU did not intervene although the National Contingency Plan was undoubtedly used as the basis for MPCU's actions. This points to the conclusion that, in terms of the salvage at least, the Harbour Master retained the responsibility and was the person in charge. MPCU's role until such time as they assumed a greater responsibility should therefore have been to monitor the activities of the other parties, including MHPA. They clearly went beyond that and assumed a central role as envisaged by the National Contingency Plan by personally approving plans, stationing their advisers on board the casualty, providing help and advice, and chairing meetings ashore.

12.15 There is no doubt that MPCU acted in good faith and at a level appropriate to the magnitude of the emergency. The confusion arises because the National Contingency Plan deals inadequately with this aspect of the command and control of the incident. The plan should make it very clear under what circumstances MPCU assumes overall command, exactly what that entails and where it fits in with the salvors and other authorities which have legitimate responsibilities.

Specialist advice available to the Marine Pollution Control Unit

12.16 The National Contingency Plan outlines the sources of specialist advice available to MPCU to assist in a incident involving a casualty. The first of these organisations is the Surveyor General's Organisation, now the Marine Safety Agency (MSA). MSA were informed of the SEA EMPRESS incident soon after the initial grounding. The local MSA surveyor advised on matters related to lightening and other small vessels, but did not take any formal role regarding the casualty until after berthing at Herbrandston Jetty.

12.17 The second potential source is named as the Committee on Salvage - Panel of Salvage Experts. In recent years there has been a move away from the concept of a panel of salvage experts to greater reliance on the Ministry of Defence (MoD) Salvage Officers for assistance and advice although MPCU maintains a list of contacts in the industry from whom advice can be sought if deemed necessary. With the demise of the UK salvage industry the number of potential experts who would be available

to MPCU has diminished considerably and the probability of any of them being available to advise MPCU has reduced. In the case of SEA EMPRESS no direct approach was made for advice from a commercial salvage expert and of course a large number of the principal experts were already commercially involved in the SEA EMPRESS incident.

12.18 The third source is named as MoD Salvage Officers. Their role, as envisaged in the plan, is to board the damaged vessel, advise MPCU and the Panel of Salvage Experts on the salvage operations and to monitor the conduct of those operations. They are not expected to assume any direct responsibility for those operations. A draft Memorandum of Understanding (MOU) between the Directorate of Marine Services (Naval), MoD, and MPCU was drawn up in August 1995 which sets out the Terms of Reference for MoD Salvage and Mooring Officers seconded to MPCU. The MOU is more explicit on the role and authority of MoD Salvage and Mooring Officers seconded to MPCU than the National Contingency Plan is. (**A copy of the draft MOU is at Annex F.**) The MoD Salvage and Mooring Officers involved in the SEA EMPRESS incident were employed under the terms of the MOU and represented MPCU on board SEA EMPRESS soon after the initial grounding. Further support was given to MPCU by the secondment of the Chief Salvage and Mooring Officer who acted as senior adviser ashore, sometimes deputising for the MPCU Local Commander in accordance with the MOU (**see Annex B for details of MPCU command structure**). However, it is surprising that the Chief Salvage and Mooring Officer was not aware of the National Contingency Plan.

12.19 The role of MoD Salvage and Mooring Officers, acting as MPCU advisers on board the casualty, was purely to observe and specifically not to influence the salvage decisions. Also, they were to provide specialist advice to MPCU ashore and to undertake operations using MPCU resources under the control of the MPCU Local Commander. This is a very difficult role for men who are used to leading their own salvage operations. In fact they took more of an active role and assisted in tank soundings and position fixing and in many other ways without getting too involved with the actual salvage operation. They also took a very active role when the casualty was swept aground on Saturday evening in organising the safe evacuation of firstly non-essential personnel and then, eventually, all the crew and salvors. In these respects their presence on board was helpful to the salvors however, in other ways, they were seen by the salvors to be Government officials without responsibility.

12.20 It should be noted that MPCU did offer the salvors a great deal of assistance in terms of salvage and mooring equipment and personnel, helicopter assistance, and in many other ways. However it is a pity that, in terms of salvage planning, MPCU and their advisers who have, or should have, the powers to positively assist the salvors took the negative role on board of monitor, do not influence and veto if necessary. This did not assist the salvor and put the MPCU advisers on board the casualty in an awkward position and might even have been counterproductive.

12.21 The National Contingency Plan seems to recognise, in the reference to MoD Salvage Officers advising both the Overall Commander and the Panel of Salvage experts, that the Panel has something to offer notwithstanding the involvement of MoD Salvage Officers. It is believed that, while it may be impractical to recall the Panel of Salvage Experts in the form that formerly existed, new arrangements should be sought whereby independent commercial salvage advice can be gained by the authorities during an incident.

Shelter for Damaged Vessels

12.22 In a section entitled "Shelter for damaged vessels" the National Contingency Plan explains the philosophy of taking a damaged tanker into a sheltered area and even alongside a terminal where cargo transfer operations can be safely carried out. MPCU has undertaken a survey of the UK shoreline to provide information on possible safe havens. The document containing this information provides details of anchorages and ports including the maximum draught and length for a particular location, the quality of the navigational access, the local facilities, environmental factors and in the case of anchorages the quality of the shelter and the holding ground. Part of the foreword to this document should be noted in relation to the SEA EMPRESS incident because it states:

"It has long been established that whenever possible the best way of avoiding continuing and extensive pollution from a marine casualty is to remove the cargo oil from the damaged ship into a sound vessel. The longer oil remains on board a casualty, particularly in an exposed situation where subsequent hull damage is likely, the greater is the chance of substantial spillage. If a casualty can be removed to a sheltered place the risk of spillage is lessened; an emergency cargo transfer operation can more safely be mounted; and counter pollution resources can be more effectively deployed."

In a subsequent section of the foreword it is recognised that any safe haven will likely be close to the initial scene of the incident to keep movement of the casualty to a minimum.

12.23 In considering the safe havens which are identified for the area "South Wales and the Bristol Channel" it is apparent that no identified location could take SEA EMPRESS with a draught of 23.5 metres. The location with the largest maximum draught restriction is identified as Milford Haven with a quoted maximum draught of 20.4 metres at high water. Milford Haven is specifically identified in the document as "a port" as opposed to "an anchorage".

12.24 Of particular interest is that the National Contingency Plan highlights the fact that there might be opposition to a decision to bring a vessel into, or leave her in, a safe haven from the parties concerned. In such cases the Government can play a very significant role in assisting a competent salvor to minimise pollution damage by persuading a Harbour Master to allow a damaged tanker to enter his port despite the short term risk of

some pollution and possibly commercial damage, but in so doing minimising the risks of a greater casualty. This principle is enshrined in Article 11 of the 1989 Salvage Convention. However if persuasion does not work the Secretary of State's powers of intervention may be used to direct those in control of the vessel to take, or not to take, the vessel to the specific sheltered area.

Emergency Cargo Transfer Operations

12.25 This section of the National Contingency Plan describes the sort of equipment held and kept in readiness by MPCU for use in emergency cargo transfer operations. This equipment was made available to the salvors at an early stage and much of it, along with personnel to assist in operating the equipment, was utilised by the salvors to good effect.

Command and Control

12.26 In another section of the National Contingency Plan entitled "Command and Control" the roles of the principal MPCU representatives are outlined. This section defines Overall Command as "*full responsibility for the direction of counter pollution operations during a marine emergency*". Counter Pollution Operations are defined as "*any action taken to prevent, reduce, monitor or combat pollution or the threat of pollution arising from a spillage of oil or other harmful substance from a ship*". The command structure seems to assume that MPCU will be in total control of the situation in that there is no allowance for a unified command for an incident like that of SEA EMPRESS where other authorities have legitimate responsibilities. It can be assumed from this that if the plan was "activated" the command structure in that plan would operate.

12.27 MPCU operated the command structure as set out in the plan during the SEA EMPRESS incident in respect of the at-sea counter pollution operation. However, command and control of a salvage incident like that of SEA EMPRESS is not covered specifically and as there is no mention of the role and structure of the Marine Team in either the National Contingency Plan or the Milford Haven Emergency Plan the basis for confusion existed. The objective stated in the National Contingency Plan that the involvement of MPCU will "ensure a fully integrated and co-ordinated response", was not achieved in relation to the casualty and its salvage.

12.28 In conclusion the plan, although broad based, does not deal clearly with the MPCU's potential involvement in a salvage incident where a tanker is damaged and is spilling oil within the jurisdiction of a port authority. The main thrust of the plan is towards pollution which has already taken place and the methods of control and clean-up. Key subjects such as "Command and Control" in the plan seem to be defined in relation to spilt pollution and clean-up operations with the casualty and salvage appearing to be of secondary importance. Quite clearly the plan needs to be reviewed and updated to take account of the inadequacies which the SEA EMPRESS incident has brought to light.

13. ONSHORE MANAGEMENT OF SALVAGE OPERATION

Onshore Management Structure

13.1 It was recognised in the very early stages of the incident that a significant management system needed to be set up ashore to deal with marine aspects of the emergency. On advice from MPCU, a Marine Group was set up to deal with matters concerning the salvage and the at-sea pollution. Other non-marine aspects of the emergency including the considerable problem of shoreline clean up and the media response were handled separately.

13.2 Initially the MPCU Local Commander was appointed to lead the Marine Group. As procedures evolved the casualty and its salvage was handled separately to at-sea pollution by a Marine Team principally consisting of, but not limited to, the Harbour Master, MPCU, Acomarit and the owners of the cargo. Meetings of the Marine Team were chaired by the Harbour Master.

13.3 The Marine Group was located in a single room, the Emergency Planning Room of the Coastguard Station, which became the Marine Response Centre (MRC) for the incident. As the incident progressed a large number of persons, each of them with a legitimate interest in the casualty and its salvage, arrived at the Coastguard Station and, through lack of an alternative base, were accommodated in the MRC. Each of these persons had a pressing interest in the considerations of the Marine Team and thus aspects of the casualty and its salvage were discussed widely although the principal team members retained the decision making role.

13.4 In the early stages the salvors were not represented within the Marine Team but the Harbour Master and the MPCU were represented on board the casualty by the pilots and the MPCU advisers respectively. Acomarit also had their superintendents on board the casualty. These groups fed back information to individual members of the Marine Team. In the afternoon of Friday 16 February a need for the salvors to present their plans to the Marine Team was perceived and the Assistant Salvage Master came ashore to perform that role as well as to co-ordinate the procurement of equipment. This provided another, separate, line of communication between the casualty and the Marine Team. Later in the incident the newly arrived additional Salvage Master from Smit Tak (who for sake of clarity was termed the Senior Salvage Master) performed the liaison role. There were also a number of other interested parties on board the casualty who were relaying information back into the MRC.

13.5 It would appear that prior to the grounding on Saturday night the Marine Team meetings were informal discussions with no minutes being taken. The MPCU Local Commander had a desk and telephone adjacent to that of the Harbour Master in the MRC and decisions seem to have been taken between these two persons, and others present in the room, as the need arose. After the events of Saturday night the meetings became more formal and were held in the Harbour Master's Office although the MRC continued as the central office for the Marine Group. These more formal meetings were minuted by a representative of Texaco, the cargo owners. They were attended by a number of the other interested parties in addition to the principal team members and representatives of the team that had, by this time, been set up ashore by the salvors.

13.6 The MPCU Overall Commander was based at the MEOR in Southampton for most of the incident and moved his command to Milford Haven on Wednesday 21 February.

Marine Team

13.7 The role of the Marine Team as a group, although not specifically identified, could be broadly stated to have been to assist the salvors by co-ordinating the efforts of all those with a legitimate interest in the casualty and its salvage in order to monitor the salvage operation and approve the salvage plans; to assist the salvors as much as possible with equipment and specialist and local knowledge and; as far as possible, to ensure that the operations were being carried out safely and efficiently.

13.8 In addition to the group role, individual organisations within the Marine Team had their own priorities including the avoidance of further pollution and protecting the best interests of the general public, port users, owners and insurers.

13.9 In order to fulfil their group role the Marine Team needed good quality timely information. They needed to control the information flow and to act as a focus for communications to and from the salvors. As the numbers of persons using the MRC increased and the number of persons on board the casualty increased the ability to keep control over the flow of information decreased. The situation was further complicated as MPCU began to think that some of the advice being received from their advisers portrayed a lack of expertise in the salvage of this type of vessel, and the exchange of information between the Harbour Master and the pilots was not good.

13.10 In the period up to Sunday 18 February the Marine Team's monitoring of the salvage operation was apparently an ad hoc process. The salvors were not required to produce written plans. However, there were reasonable communications between the Salvage Master and MPCU representatives and others on board. News of the salvage plans,

and changes to the plans, was communicated, by the various channels available, to those ashore as the situation developed and became known to the representatives on board. On receipt of information in the MRC, members of the Marine Team who were present would discuss any developments and consult outside with others, including the MPCU Overall Commander in Southampton and the MHPA's General Manager. By this means decisions would be reached and if necessary, through the various channels, communicated back to those on board.

13.11 Information was reaching the key members of the team, decisions were being taken and approvals were being given, but the ad hoc nature of the processes and the number of lines of communication and persons involved gave rise to the possibility of key facts being overlooked, or misinterpreted, by the principal members of the Team. It is apparent from the evidence that some important information was missed, not collected or misinterpreted.

13.12 Examples of the above include:

i) The salvors had calculated on Friday evening that the casualty's draught could have been reduced to a minimum of, perhaps, 19.17 metres by pressurising the ballast tanks to 0.5 bar. This fact was not made known to the Harbour Master and Acomarit.

ii) The salvors on board the casualty received the message that they must reduce the draught to 18.3 metres or less before being allowed to take the casualty further into the Haven. This appears to have been interpreted as a blanket restriction without question.

iii) As the incident progressed the strength and direction of the tidal streams in the area of the 'pool' became a very important issue. The casualty had been caught by unexpected tidal streams on Saturday, Sunday and Monday. There was no recorded data on the tidal streams in the 'pool' and yet the collective view of experienced pilots or others with practical experience was not sought.

iv) The pilots who experienced problems in holding the casualty in the 'pool' on Friday night were not debriefed on coming ashore.

v) There was confusion when the MPCU adviser requested permission for the casualty to be taken to sea as it drifted in the channel on Monday. The Harbour Master thought that there was a pilot on board and he thought the casualty was heading to seaward; the Overall Commander thought that the request had come from the Salvage Master and he was unaware that the intention had been to take the casualty to sea stern first. Although permission was granted, under certain conditions (which were not met), the reply was received on the casualty as negative.

13.13 Under such circumstances those ashore were not able to maintain an accurate picture of the problems being experienced on the casualty and the options for salvage which were available to the salvors. In consequence their ability to take the correct decisions would have been seriously affected by this.

13.14 After the events of Saturday, the Marine Team meetings became more formal, minuted events and occasionally a pilot was invited to attend one of the meetings. Also, the salvors were requested to provide their plans for approval on a more formal basis. This request coincided with the arrival of the Senior Salvage Master from Smit Tak. From this time the salvors' broad plans were formed ashore by the Senior Salvage Master.

13.15 At about this time the salvors moved out from the MRC to less crowded offices in the town and the Senior Salvage Master communicated with the Marine Team principally through the Harbour Master. The salvage plans were generally presented to meetings of the Marine Team where they were discussed, but the meetings were of limited value to the salvors. Salvage plans were changing rapidly, twice in the middle of meetings and the plan approval process could not keep pace with events.

13.16 The salvors ideally needed to channel their communications through one body which had the authority to approve and facilitate their plans for the casualty as well as the necessary contacts to help them with local and specialist advice and possibly logistic support. After the salvors moved out from the MRC they clearly looked to work principally with the Harbour Master as the casualty was within the Port Authority area, and the Harbour Master had the principal day-to-day authority for the onshore management of the salvage operation until and unless MPCU intervened. This strategy was only partly successful due to MPCU becoming more active as the incident progressed. For example the MPCU Overall Commander who was still based at the MEOR in Southampton, required to personally approve the salvors' plans. The MPCU representatives were also critical of the salvors' performance and on Tuesday evening required the salvors to consider radical alternative plans. With MPCU active on the casualty and ashore, the Harbour Master could clearly not take decisions without consultation. It was during this period, especially, that the question of "Who's in Charge" became an important issue.

Effectiveness of the Marine Team and Ideas for Improvement

13.17 Although all parties in the onshore management of the incident worked closely together, and there was co-operation and a degree of integration and co-ordination, the effectiveness of the onshore management of the salvage operation was not fully satisfactory for a number of reasons. These are discussed below, together with some ideas for improving matters for any future incidents where there is a major salvage operation in which the Government becomes involved.

13.18 The MPCU Overall Commander, who performed a major decision taking role in the management of the incident, was based in Southampton for most of the incident. It is considered that the person with the Secretary of State's delegated responsibility would have been better placed in Milford Haven in direct contact with the casualty and the other key members of the Marine Team.

13.19 The role of the Marine Team as a group was not clearly identified. It became too large a group to fulfil efficiently its role in a fast moving salvage incident, it did not have a clear authoritative leader, it functioned with team members each having individual objectives and the decision making arrangements within component bodies in the team were too unwieldy. The fact that the Marine Team was not a cohesive unit placed demands on the salvors' resources. It is considered that a team of three or four working closely together and with a single reliable line of communication with the ship would have been better able to cope with the demands of the situation.

13.20 It is believed that individual members of such a team should have the personal authority to approve the salvors' plans on behalf of the organisations they represent. Such a team would provide a unified command team approach to the monitoring of the incident, however, it is advisable for one person to be designated to lead the team. It is likely that the person with the greatest legal authority for the incident should be selected for this role, for example the MPCU Overall Commander.

13.21 In any salvage incident like that of SEA EMPRESS which is clearly of national significance, MPCU will be fully involved and seeking to influence the salvage operations. This, along with their greater legal authority, should be recognised and MPCU should accept full responsibility for their role. This might be achieved by intervening, positively and in general terms, at an early stage and then leading the onshore management team. The salvors' broad plans should be submitted to the Marine Team for approval of the team thus eliciting a single considered response

13.22 A small authoritative Marine Team, such as that outlined above should be available 24 hours a day to assist the salvors, debrief pilots and others coming off the casualty and monitor the situation. They should be dedicated to the purpose and they should have the facility to seek local and specialist advice. They should be represented on board the casualty by a properly briefed and experienced person whenever the casualty is manned and official communications between the casualty and the Marine Team should be channelled through this one person.

13.23 The Marine Team and its clear role to assist the salvor should be made known to the salvors at the earliest opportunity.

14. INTERVENTION

General

14.1 A number of problems were encountered during the six day salvage operation. As these problems unfolded there were demands that the Secretary of State for Transport powers of intervention should be invoked either by the Secretary of State himself or by those to whom they are delegated. This section of the Report discusses those powers, together with other powers of direction, to determine whether or not they should have been invoked and whether they are adequate in the circumstances of an incident of the magnitude of SEA EMPRESS.

Powers of Intervention

14.2 The powers derive from the Intervention Convention 1969 and Article 221 of the United Nations Convention on the Law of the Sea (UNCLOS). They are currently set out in section 137 of the Merchant Shipping Act 1995 and the Merchant Shipping (Prevention of Pollution) (Intervention) Order 1980 and permit the Secretary of State for Transport to intervene after an accident has occurred to a vessel which will cause pollution or has the potential to cause pollution to UK waters and/or the UK coastline.

14.3 Three conditions have to be met before the powers are exercisable. These are:

- an accident has occurred to or in a vessel (this includes, but is not limited to, the loss, stranding, abandonment of, or damage to a vessel); and

- in the opinion of the Secretary of State, or the person acting on his behalf, oil or other harmful substance from the vessel will or may cause pollution on a large scale in the United Kingdom or in the territorial waters thereof; and

- in the opinion of the Secretary of State, or the person acting on his behalf, the use of the powers is urgently needed.

When the above three conditions have been met directions may be given in respect of the vessel or its cargo. These directions can only be given to the following people:

- the owners or any person in possession of the vessel; or

- the master; or

- any salvor in possession of the vessel.

14.4 A direction can require the person to whom it is given to take or refrain from taking any action of any kind whatsoever, including requiring the vessel to be moved, or not to be moved to a specified place; the vessel to be removed from a specified place or locality; the oil or other cargo to be or not to be unloaded or discharged; and specified salvage measures to be or not to be taken. However, in a case where the powers to give directions are considered to be inadequate or are proved to be inadequate, the Secretary of State, or the person acting on his behalf, can take any action of any kind whatsoever including, but not limited to, sinking or destroying the vessel.

14.5 The Secretary of State for Transport's powers of intervention are exercisable by the Chief Executive of The Coastguard Agency, the Director of MPCU or the Chief Coastguard. These persons can also further delegate the powers to a Coastguard Regional Controller or Deputy Regional Controller by name for a specific incident.

14.6 In circumstances where the intervention powers are enforced there is provision for compensation to be paid by the Secretary of State for Transport. This would happen only when:

- the action directed or taken was not reasonable to prevent or reduce pollution or the risk of pollution; or

- the action taken or directed was such that the good that it did or was likely to do, was disproportionately less than the expense incurred or the damage suffered as a result of the action.

Wherever possible, the person exercising the powers should seek Ministerial consent before intervening. Where this is not possible the designated persons have the authority to act without consent, however they are advised, where practicable, to seek legal and professional advice. It is obvious that the Secretary of State for Transport would also need to seek similar advice before giving an intervention order.

Harbour Master's Powers

14.7 In addition to the Secretary of State for Transport's powers of intervention, a Harbour Master also has powers to direct those in control of a vessel. Under the Dangerous Vessels Act 1985 he may give directions to those in charge of a vessel, where:

- there is grave or imminent danger to the safety of any person or property; or

- there is grave or imminent risk that the vessel may, by sinking or foundering in the harbour, prevent or seriously prejudice the use of the harbour by other vessels.

The direction may prohibit the vessel's entry into, or require its removal from, the harbour.

A Harbour Master has further powers under The Dangerous Substances in Harbour Areas Regulations 1987, namely to:

- regulate or prohibit the entry into;

- require the removal from;

- regulate the handling, movement or position within;

the harbour or harbour area of a vessel which is carrying a dangerous substance and where there is a risk to the safety of any person because of the condition of the substance or of the vessel.

14.8 MHPA also has extensive powers under the Milford Haven Conservancy Act 1983 to give directions and even, in extreme cases, take control of a vessel in the harbour which is sunk, stranded or abandoned and is discharging oil or, in the opinion of MHPA, is likely to discharge oil into the Haven or into adjacent waters. However, no directions will be given if, in the opinion of MHPA, every practicable measure is being taken with all reasonable diligence for the purposes of preventing or reducing oil pollution, or the risk of oil pollution.

14.9 It might appear that there could be conflicts between the powers of the Secretary of State for Transport and those of the Harbour Master. However the Secretary of State can overrule a direction given by a Harbour Master and in the Dangerous Vessels Act it is stated that directions given by a Harbour Master shall not affect the exercise by the Secretary of State of his powers of intervention and direction. Also, with respect to the Milford Haven Conservancy Act it is apparent that, although the Harbour Master has specific responsibilities to protect the safety and commercial interests of the port, where there is danger of large scale pollution, the Secretary of State and the person with his delegated authority has the overriding authority.

14.10 As reputable salvors had been appointed and were expending effort to bring the incident to a successful conclusion, it is considered that MHPA did not have cause to use their powers during the SEA EMPRESS incident.

Possible use of the Powers of Intervention

14.11 The powers of intervention were conceived for dealing with a situation where those in control of a polluting or potentially polluting vessel were blatantly not complying with the wishes of the Secretary of State for Transport by failing to employ competent salvors for instance or by refusing to take a tow or refusing to proceed to a designated safe

haven, or were unable to proceed with the salvage operations due to unforeseen developments. It was not envisaged that they would be used to intervene in a situation where competent salvors were clearly doing all they could to bring a salvage incident to a successful conclusion.

14.12 A reputable firm of international salvors was appointed in the early stages of the SEA EMPRESS incident and the Secretary of State for Transport monitored the salvage through the MEOR, the MPCU advisers on board the vessel and MPCU representatives ashore. For the powers of intervention to be used, the Secretary of State through the Overall Commander would have to make a judgement that an alternative course of action to that proposed, or being followed, by the salvors should be pursued. Broadly speaking there are two reasons why the Overall Commander might hold a different opinion to that of the professional salvors. They are that the advice given to the Overall Commander disputes the professional salvors' judgement or it is believed they have been influenced by commercial considerations in forming their judgement to the detriment of the wider public interest.

14.13 It is considered highly unlikely that a situation could have arisen in the SEA EMPRESS incident where the first of these reasons would have applied with the level of confidence necessary for intervention to be considered. Those advising the Overall Commander did not have the expertise or experience of commercial salvage on the scale of SEA EMPRESS which would enable their opinion to counter the considered professional opinion of a reputable international salvage organisation such as Smit Tak. It is possible that the salvors' plan had not been thoroughly thought through, but the proper course of action in such a circumstance would have been to advise the salvors of this fact in order to avoid the need to intervene. Intervention might have been provoked by the second set of circumstances outlined above, but this is considered improbable for the following reasons.

14.14 Possible commercial factors that would influence the salvors' plans might arise from the salvors' own considerations, or from restrictions placed on them by another party such as the Harbour Master. However the 1989 Salvage Convention (incorporated into Lloyd's Form of Salvage Agreement) effectively guarantees to the salvor who is assisting a vessel which by herself or her cargo threatens damage to the environment, a refund of all expenses incurred, plus, if the service actually prevents or minimises damage to the environment, a "bonus" of up to 100% of the expenses (**see Annex A**). This is designed to give the salvor more freedom of action in the case of a casualty which threatens to cause environmental damage but where the potential salved value is small, and should, therefore, reduce the likelihood of commercial considerations influencing the salvors' decisions.

14.15 Another factor that should be taken into account is the effect on the salvors' conduct of the salvage operation of invoking the intervention powers. Although the Secretary of State for Transport can give directions to any salvor that specified salvage measures are to be, or are not to be, taken it is questionable whether the exercise of such powers would ever be appropriate where a salvage contract has been concluded between the owners of the casualty and a reputable salvor such as Smit Tak. The conduct of a salvage operation demands a high degree of original thought in conditions of danger and stress, and action by outsiders, even governments, could be perceived as interference.

14.16 It is concluded that, whatever the strict rules of law, if the Secretary of State for Transport had seriously interfered with the conduct of the SEA EMPRESS salvage operations, there was a realistic possibility of the salvage team walking off the job. This is not to say that a salvor such as Smit Tak would have flagrantly disregarded their obligations under the salvage contract, but the motivation and management of the personnel involved would inevitably have deteriorated, and the salvage operation would have been prolonged even further with the risk of increased damage to the vessel and increased loss of cargo and pollution.

14.17 In the SEA EMPRESS situation, intervention was the ultimate sanction to be held in the background as the symbol of the Government's legal authority but its use would have been restricted to extraordinary circumstances and even then with extreme care. The very existence of the powers should, in all but the most extreme circumstances, be sufficient to influence the salvors and avoid a confrontational situation.

Actual use of the powers

14.18 The Secretary of State for Transport did not intervene in the SEA EMPRESS incident but on one occasion actions taken did give rise to confusion as to whether he had or was about to. It was after the unsuccessful float-off attempt on Tuesday evening when one of the senior MPCU representatives ashore called a meeting with senior representatives of the owners, salvors and MHPA. At the meeting the salvors were told to consider all possible solutions to the problem irrespective of costs. It is arguable whether this actually constituted intervention. The salvors were told to consider radical solutions but not to actually carry them out.

14.19 Although the Secretary of State for Transport did not intervene the powers of intervention were the basis for his authority in the salvage incident. The Secretary of State for Transport representatives held a broadly termed intervention notice ready to use if it became necessary but their policy was to monitor the situation, approve all plans and try to influence the salvage by persuasion and only to intervene as a last resort.

14.20 MPCU did not have the expertise, experience or resources to take control of the salvage from the salvors. The Secretary of State for Transport needed the salvors and MPCU needed to work with them to form and expedite the plan. Reputable salvors had been engaged and they were clearly expending effort under difficult circumstances. As long as they continued with their efforts use of the powers of intervention would have been inappropriate except, perhaps, to assist the salvors to overrule any decisions imposed on them by others.

14.21 Unless and until MPCU intervened for the Secretary of State for Transport, the Harbour Master remained in charge ashore and the salvor in charge on board. It follows that unless and until the Secretary of State intervened the responsibility for the salvage lay firmly with the salvors and to a lesser extent MHPA. In order to ensure that commercial considerations do not outweigh those of the greater public interest it is suggested that consideration be given to changing the guidelines on the use of the intervention powers to allow an intervention in general terms at the beginning of a salvage incident like that of SEA EMPRESS. Such an intervention notice should be worded so as to firmly place those representing the Secretary of State for Transport alongside and working with the salvors and, where necessary, accepting responsibility for their role and influence. It is considered that, if properly managed, this would provide a firm foundation for the planning and execution of a potentially catastrophic salvage incident like that of SEA EMPRESS. On Tuesday evening the salvors were told by the senior MPCU advisor to plan as if costs were not a consideration. There is an argument that this should have been the case throughout the incident. It is not possible to identify with certainty whether the outcome would have been altered had it been so, however, it is possible to speculate that more tugs might have been mobilised at an early stage and greater consideration might have been given to the other early options.

Possible Changes to the Intervention Powers

14.22 It is accepted that the 'stick' of intervention needs to be available for wielding against irresponsible owners and masters and incompetent salvors. However it should be recognised that, in other circumstances, the powers can be used positively. In this respect if they had a wider application they could be a powerful tool to assist competent salvors in the expedition of complicated and controversial salvage incidents.

When considering changes to the intervention laws, particular consideration should be given to including the power to issue a direction straight to a Harbour Authority, harbour master or pilot, or the power to intervene in the chartering of lightening tonnage, tugs and helicopters. In the former case such intervention powers could be used to ensure that a casualty threatening pollution damage is allowed to

enter a port of refuge. This would, incidently, be a recognition of the Government's treaty obligations under Article 11 of the Salvage Convention. It is recognised that this would involve legislation and, in application, possibly involve Government in compensation but it is felt that wider powers coupled with a positive approach could substantially assist in bringing a future incident to a successful conclusion.

15. SALVAGE OPTIONS

15.1 During the whole of the salvage operation the casualty was within the confines of the 'pool'. The Inquiry has examined whether there were other options open to the salvors, and if so, whether they were feasible options and also whether they were known to the salvors.

Option to take the Casualty to Sea.

15.2 At several points during the salvage operation the prospect of taking the casualty to sea was raised and discussed and, with one exception, always rejected. Many observers, not directly involved with the operation, have in their submissions to the Inquiry suggested that the pollution could have been largely avoided if the casualty had been taken to sea at the earliest opportunity. The arguments for and against taking the casualty to sea are discussed here.

15.3 Initially the casualty was being held in the 'pool'. This was a difficult task in such an exposed location where movement of the casualty was limited by the surrounding rock shoals. Due to the worsening weather and growing tidal strength the salvors' task was becoming increasingly difficult. Some parties were of the opinion that it was imperative to remove the casualty from the 'pool' at the earliest opportunity. Taking the casualty to sea would remove her from these dangers and allow her freedom to manoeuvre.

15.4 Taking the casualty to sea was first seriously proposed in the 12 hours after the initial grounding. At this time the casualty was listed by about 10° to starboard and trimmed by her head so that the forward starboard deck edge was immersed. She was no longer leaking significant quantities of oil but, because of the fear of renewed oil losses and increasing her draught even further, she could not be brought upright. The extent of the structural damage to the casualty was not known. It is probable that the damaged cargo tanks were no longer protected by inert gas, and inert gas could not be fed to them via the casualty's inert gas main because of the significant starboard list. The damaged Starboard Ballast tanks contained a hazardous atmosphere due to contamination by oil and these tanks were not protected by the casualty's inert gas system. The pump room was flooded with a mixture of sea water and oil, although it was anticipated that it could be pumped out by submersible salvage pumps. Clearly the casualty was not in a seaworthy condition. Consequently, it would have been imprudent to instruct the Master to take her to sea into an impending gale. The lives of all on board would have been put at risk by such an action, especially when one considers that the rescue services would have had to travel greater distances to perform their task thus prolonging the time required to evacuate the personnel.

15.5 The width of the navigable channel between the 'pool' and the open sea which would have been available to SEA EMPRESS - at a draught of 23.5 metres - was only about 220 metres, in effect about half the width at her original entry draught and some 50 metres less than her overall length. With her starboard list and head trim the casualty's manoeuvring characteristics would have been unpredictable and she would have been difficult to handle. Even neglecting the effects of wind and tide, and allowing for tug assistance, the transit of such a narrow entrance by a vessel in this condition would have allowed little room for error or equipment failure. The probability of the casualty touching the hard rocky sides of the entrance must be considered as having been high. If her engine room had consequently been holed she would most certainly have foundered, possibly blocking the entrance to the West Channel and possibly with the loss of all her remaining 127,500 tonnes of cargo and 2,300 tonnes of heavy fuel oil (see Section 19). Further, the subsequent wreck removal operation would have taken some considerable time during which the West Channel to the port would have been closed.

15.6 If it had been decided to take SEA EMPRESS to sea she would have had to negotiate the channel at a much lower speed than the normal 10 knot entry speed and she would thus have been exposed to the effect of the tidal streams for a longer period. In hindsight, and considering in particular the misjudgment of the tidal current which occurred on the evening of Saturday 17 February, it cannot be confidently concluded that the casualty would have successfully negotiated the narrow entrance of the Haven to the open sea.

15.7 Notwithstanding the difficulties of negotiating the entrance, of equal importance in considering the decision to take the casualty out to sea would have been an assessment of the consequences of this action if it had been successful. One such consequence would have been further oil losses as the casualty rose and fell in the seaway. This oil would have been pumped out of the vents to the damaged cargo tanks by the wave action, as occurred when the casualty was floating free on Sunday 18 February.

15.8 Another consideration was that, assuming that the salvors remained with the casualty, there would have been the considerable problem of successfully removing the 127,500 tonnes of oil remaining on board (**see Annex D**). The salvage work on the casualty's inclined and exposed deck would have been an extremely hazardous operation with large areas of the deck awash in any significant seaway. In addition, having removed the casualty further from the port, the logistical problems of transporting salvage equipment and personnel would have increased. The berthing of lightening tankers alongside the casualty at sea would also depend heavily on the sea state in order to prevent damage to both vessels. Thus the salvage operation would have become extended and acutely dependent upon the prevailing weather conditions.

15.9 Additionally, once out of territorial waters, it would have been likely that the casualty would not have been allowed back in to seek the sheltered waters necessary to complete the salvage operations. In the case of ANDROS PATRIA in 1978, this stricken tanker was not allowed to enter any of the closest states' territorial waters and was towed to the southern part of the North Atlantic where the calmer conditions were more suitable to carry out the salvage operations. SEA EMPRESS's damaged condition could have deteriorated further in the prolonged time necessary to shift her to other waters, increasing the danger to the vessel.

15.10 A major consideration of, particularly, the salvors was the potential problem of returning the lightened casualty to Milford Haven or to any other port for the removal of the bulk of her cargo. There is no evidence to suggest that UK ports would be unwilling to accept the badly damaged casualty at a later stage of the salvage, but if they were the Secretary of State could, under the intervention powers, direct the casualty to a specific sheltered area. Nevertheless, the Salvage Master had, from previous experience, a quite understandable concern regarding this problem. One can only speculate as to the likely response of the authorities, public opinion, environmental groups and the media to a request from SEA EMPRESS to return to Milford Haven to complete the discharge of her cargo.

15.11 The salvors expressed the valid concern that damaged steelwork was hanging down from the bottom of the casualty as a result of the grounding, so effectively increasing her draught. When the casualty was safely alongside the Herbrandston Jetty, she was surveyed by the salvors' divers. The divers found that areas of steel structure were indeed hanging from the underside of the casualty over a length of some 30 metres in way of No 4 Starboard Ballast tank. In some places the steel extended 7 to 8 metres below the keel. Whether this was present at the outset of the salvage operation or whether this was the result of later groundings cannot be known. However, it has to be recognised that any structure which is hanging below the casualty is present because it has been torn out of the bottom or side of the casualty and is thus likely to be heavily distorted and relatively loosely attached to the main body of the hull. If it caught on the seabed the momentum of the casualty, even at only 2 knots, would be more than sufficient (probably by one or two orders of magnitude) to destroy the unwanted link. Thus the Inquiry does not consider that steel structure hanging from the underside of the casualty would unduly impede her progress or lead to further significant damage. The subsequent unrestrained movements of the casualty over the ensuing four days supports this contention. Nevertheless, taking account of all the other considerations the Inquiry concludes that the decision not to take the casualty to sea was correct.

Option to take the Casualty directly to Herbrandston Jetty.

15.12 In the very early stages of the salvage operation during period 1 (**Annex D**) a number of alternatives to holding SEA EMPRESS in the 'pool' were considered. One of these was to take the casualty directly to Herbrandston Jetty. The controlling factor in considering this possibility was the draught of SEA EMPRESS. She was listing to starboard with a maximum draught of 23.5 metres forward, therefore even with the six metres of tide predicted for 0342 hrs on Friday, her draught was too great to allow the casualty to be moved out of the 'pool'.

15.13 The possibility of reducing the draught of the casualty by the addition of sea water ballast so that she could be brought directly to the Herbrandston Jetty has been examined by the Inquiry. The conclusion was reached that by cross-flooding No 2 Port Ballast tank from the breached No 2 Starboard Ballast tank, and cross-flooding No 4 Port Ballast tank from the breached No 4 Starboard Ballast tank and then pressing up the Port tank to maximum capacity, and filling the Aft Peak with either of the two engine room bilge pumps, a draught of about 20.5 metres could have been achieved.

15.14 To carry out such an operation would take some time. If it had been commenced on Friday it is assumed that a draught of about 20.5 metres could have been achieved by the Saturday afternoon high water. The minimum charted depth in the main channel from the 'pool' to Herbrandston Jetty is 16.3 metres and the height of tide on Saturday afternoon was predicted to be 6.8 metres. Taking into account that a reasonable time for the casualty to travel to the Jetty would be about one and a half hours a tidal height of greater than 6.5 metres would have been held during the transit. Therefore the maximum draught on which the casualty could travel up the channel to the Jetty would have been, 16.3 metres (minimum charted depth) + 6.5 metres (height of tide) = 22.8 metres. With a safety margin of 10% this draught would be reduced to 20.73 metres. Therefore bringing the casualty in at a draught of about 20.5 metres would have been a practical alternative but one not without risk.

15.15 The Inquiry is concerned that the merits of this practical alternative were not discussed by the Marine Team and indeed that the Marine Team in general were not aware that the option existed.

15.16 The Inquiry does not wish to suggest that this alternative course of action should have been followed, this would be unfair since such a suggestion can only be made with the full benefit of hindsight. Operational decisions are made on the basis of the information which is available at that time. However, this significant item of information did not come to light and it is important to understand why this was.

15.17 It is clear that from the earliest stages MPCU's preferred option was to hold the casualty in the 'pool' for a lightening operation. All the immediate preparations were with this end in mind. This option had one overwhelming attraction that if it was successful there would have been no further oil lost from the casualty. Up to this point the casualty had lost less than 2,500 tonnes and significant oil losses had ceased. The option to bring the casualty directly into Herbrandston Jetty was dismissed without detailed analysis because it was not thought to be possible but, most influentially, it would have involved reducing the list of the casualty with the likelihood of a renewed loss of oil. It was unthinkable that any action could be sanctioned which would have directly resulted in additional pollution.

15.18 The Harbour Master relied upon MPCU to advise him of the best course of action. Their recommendation to lighten the casualty was received favourably because this strategy had proved entirely successful in dealing with BORGA only three and a half months previously.

15.19 Initially however, both the pilots and the MPCU salvage advisers made strong representations to the Harbour Master that the casualty could not be held in the 'pool' through the impending gale without additional tugs. With the arrival on Saturday morning of the tugs ANGLIAN EARL (84 tbp) and ESKGARTH (50 tbp), and the decision to turn the casualty, their concerns appeared to have been removed, and thus the single important objection to the proposed salvage strategy had been resolved.

15.20 The salvors had examined the possibility of reducing the casualty's draught, and had calculated that a minimum draught of about 19.17 metres could have been achieved by pressurising the damaged ballast tanks. This fact was never made known to the Marine Team, and there appear to be two reasons for this. One is that the salvors did not consider that a proposal which would involve the likelihood of a further limited oil loss would have been approved. The other is that the Harbour Master indicated that he would permit a maximum draught of only 18.3 metres.

15.21 When the draught limit of 18.3 metres was stated, the Harbour Master had no idea that it was possible for the casualty's draught to be reduced without a lightening operation to the point where, on the Saturday afternoon high tide, she could negotiate the channel to Herbrandston Jetty with a 10% clearance under her keel. If this information had been tabled it might have influenced his thinking.

15.22 An analysis of this incident has shown that the salvage goal of minimum total pollution is not necessarily achieved by the pursuit of an option which offers the possibility of zero additional pollution. In certain circumstances it may be prudent to tolerate a limited, and hopefully containable, oil loss in order to bring a salvage operation to the earliest

conclusion (thus securing the bulk of an oil cargo) rather than to attempt to avoid any further oil loss at all by engaging in a strategy which prolongs the salvage operation. It is therefore essential that in the early stages of an incident the search for a solution has to be as broad as practicable.

15.23 The additional oil loss which may have accompanied the reduction in maximum draught from 23.5 metres to 20.5 metres or 19.17 metres would have been dependent upon the extent of the casualty's side damage, which was of course not known at the time. However, there were two indicators to suggest that side damage was not extensive: firstly, the initial oil loss was relatively small (an estimate of the quantity could have been obtained from MPCU and from this a conservative estimate of the extent of side damage could have been made), and secondly, oil was forced out of the top of the pressure/vacuum valves which suggests that an overpressurisation from the sea equivalent to at least 6 metres head of oil existed, or to put it another way a sea water head of about 22.8 metres was present at the top of the side damage. Given that the maximum observed draught of the casualty was about 23.5 metres in places it is clear that the side damage was not severe and less than 2 metres high. Calculations indicate that the additional oil losses could have been of the following order, depending upon the extent of side damage which is assumed:

		Height of Side Damage		
	0m	2m	3m	4m
Final draught		Oil Loss (tonnes)		
20.5 m	0	1,500	1,700	1,900
19.17 m	0	2,700	3,300	3,700

15.24 Another consideration needs to be taken into account in such a hypothesis. It is known that grounding accidents can leave significant lengths of damaged structure hanging beneath the underside of the casualty. The extent to which this was present on SEA EMPRESS, if at all, was not known in the early stages. However, this factor does not appear to have been significant in the salvors' discussions with the Marine Team on the proposed draught limit of 18.3 metres. This target draught was accepted without reservation. The Inquiry does not believe that this situation would have been changed if instead, an entry draught limit of 20.7 metres had been proposed - because even at that increased draught there would still have been over 2 metres of water under the deepest point of the hull at the shallowest point in the channel. The practical effect of steel hanging down upon the movement of the casualty has been discussed in Section 15.11.

16. OTHER IMPORTANT CONSIDERATIONS

Safety of Life

16.1 The entire operation was completed with no loss of life or serious injury to any person involved. Considering some of the appalling conditions experienced over the six days and nights of the salvage operation, this welcome conclusion was a fair reflection of the professionalism and good fortune of all directly involved. However, some concern must be expressed about the potential dangers generated by the numbers of persons who were allowed to remain on board the casualty, particularly at the time of its initial evacuation during the night of Saturday/Sunday.

16.2 In the hours after the vessel's initial grounding, and subsequent re-anchoring, a number of people boarded who had an interest in the anticipated salvage operation but no direct role to play in its execution. These persons boarded a casualty which was known to be seriously damaged, listing and unable to move to a position of greater safety. No thought appeared to have been given to whether sufficient life saving equipment was on board for these additional persons in the event of her condition deteriorating further. A vessel, even when in sound structural condition, before proceeding to sea is required to have sufficient life saving equipment for all those on board. It is not clear why this principle was overlooked in this incident when the vessel was in a far from sound condition. Indeed, this point was clearly demonstrated during the evacuation of Saturday/Sunday night when many of those evacuated were ill equipped for a rescue operation in such appalling conditions. Although it is accepted that this problem was probably compounded by the casualty's proximity to land and the ease of access so afforded, it is considered essential for the safety of all involved that the owners and/or salvors of casualties take on the role of controlling and, if necessary severely limiting, the number of persons boarding a casualty who are not essential to the immediate task in hand.

Role of Other Parties

16.3 It is notable that many individuals made contributions to the overall shipboard operation to salvage SEA EMPRESS, a significant number of whom were not members of the co-salvors' consortium and had no direct responsibility for the execution of the salvage operation. These included surveyors, pilots, MPCU advisers, etc. Whilst the primary role of these individuals could be considered as one of observing, reporting and possibly advising, almost by definition some of these persons had significant marine experience which was of value during an operation of this nature. Almost inevitably these persons took on a hands-on role in the operations, often without being requested to so do, because they saw a need for a task to be performed.

16.4 If it is accepted that all of the above mentioned individuals had a legitimate reason to be on board the casualty in order to perform their primary role, the practical contribution they made must be seen to have been of value to the operation. However, the number of such persons was significant in relation to the number of staff working directly for the co-salvors' consortium, sufficient indeed to raise questions on two matters of concern, one of which has already been addressed in the above conclusions on safety of life.

16.5 The salvors were well used to managing their own groups of staff and had effective communications within these groups. However, communications to others on board were, due to the numbers involved, somewhat less effective. This is no serious reflection on the workings of the salvors, and was probably due to them being unfamiliar with such a large number of supernumeraries being on board a casualty and involved with operations. But it did result in many persons on board feeling that they were unsure of who was in charge. Recognising that each of these supernumeraries had a counterpart ashore to whom he reported, either in the form of an individual or an organisation, any deficiency in communications on board the casualty was amplified, possibly many times over. Again this compounded any sense of confusion and feeling of being ill-informed of developments on the part of shore personnel and organisations.

16.6 For the above mentioned reasons of safety and clarity of communications, some monitoring and control of the number of persons on board a casualty is seen to be important. It is accepted that each casualty will generate its own demands for numbers of personnel, that certain individuals may have a statutory right to be on board and that no figure can be stipulated as the optimum or ceiling. However, prudence would suggest that each owner and salvor involved with a casualty should take into consideration the problems highlighted here when exercising this control.

Media Relations

16.7 The logistical advantages to the salvage operation of having this incident occur close to land and within a harbour area has already been mentioned. A corollary of this situation was that all parts of the incident were easily observable by all, particularly the media. It is understandable that in an incident of this nature where dramatic events may sometimes occur the desire for knowledge by the public should be satisfied. However, media interest can so easily develop into media pressure, even unintentionally, and it is a strong minded person indeed who, when the subject of such pressure, can claim that their decisions and actions are totally unaffected by its presence.

16.8 It should be made very clear that no person or organisation involved in this salvage has formally made the claim that media pressure caused them to make decisions which they would not otherwise have made. Any evidence which indicates that the media may have influenced the decision making processes is thus purely anecdotal. Notwithstanding the reluctance of any party to admit media pressure was significant, it is considered important that organisations involved in an operation of this nature should have staff available to supply the legitimate demands of the media without removing technical personnel from their primary tasks. Clear evidence is available which shows that key personnel from MPCU were withdrawn from vital technical roles, during the salvage operations, to handle the media. Sections 17.8 to 17.17 of the National Contingency Plan sets out the use of the Department of Transport's Press Office for this purpose and the plan includes a requirement that senior technical staff shall give press conferences, as required. This is sensible and correct, however a specially appointed technical member of staff from MPCU should be designated solely to this task leaving the other members of the team to concentrate on their specific roles.

17. LIGHTENING TONNAGE

17.1 At an early stage of the salvage operation one of the options considered was a ship-to-ship lightening operation to be undertaken. Indeed, for much of the incident this option was the primary objective of the salvors.

17.2 One of the factors which influences the consideration of any vessel for lightening duties during a salvage operation is geographical location. The greater the time required by the vessel to reach the scene of the salvage operations the less attractive that vessel becomes. Should a suitable vessel, or vessels, be operating in the area of the casualty then they could be of great value to a salvor. However, the fact that a vessel is operating implies that it is operating commercially and therefore subject to commercial restraints which may generate further difficulties.

17.3 Also to lighten significantly a vessel of the size of SEA EMPRESS requires the services of another tanker having a capacity related to the amount of cargo which needs to be transferred. To remove for example 30,000 tonnes using only a tanker of 3,000 tonnes would be a time consuming series of shuttle type operations. A preferable method would be to employ a tanker, or tankers, which could complete the total operation in one or two trips. It would be unreasonable to expect any salvor to have ready for immediate use a tanker of this size therefore it is necessary for the salvor to approach an owner of a vessel in service.

17.4 Should the manager of a suitably sized tanker be willing for his vessel to be employed in an operation of this type, on a normal commercial or charter basis, he may well be constrained by existing commercial commitments. To ignore such obligations would normally expose the vessel's manager to substantial financial penalties for breach of contract or charter, together with possible loss of reputation. In order to renegotiate their commitments a vessel's manager would require a significant time, even if such rearrangements were possible. A ship-to-ship transfer operation, being significantly different from the usual operation of a vessel, may well also require renegotiation of the vessel's insurance arrangements. All these negotiations would require time which may not readily be available during periods which are outside normal office hours.

17.5 There are two mechanisms which are presently available for incidents in UK waters which have the objective of overcoming the problems mentioned above. These are the International Salvage Union Award Sharing Sub Contract under LOF95 or a form of intervention by the Government.

17.6 One of the primary objectives of the LOF is to enable operations related to salvage to be commenced without any of the delay which may be caused by the negotiation of a commercial contract. Any negotiations which may be required will take place after the conclusion of the

salvage operation and any financial settlement be made by arbitration. Should the manager of a tanker, who may be considering offering his vessel for a lightening operation as part of a salvage, be able to take part as a co-salvor or on a salvage sub-contract, then the LOF offers a mechanism whereby he may be able to claim financial compensation for commercial losses suffered as a direct result. Should the vessel's manager fail to take part under these conditions he would necessarily need to perform the required negotiations before the commencement of the transhipping operation, a time consuming process which could delay the commencement of any transhipping operation.

17.7 Two tankers were identified for lightening purposes in the SEA EMPRESS salvage. STAR BERGEN, 31,502 dwt, which is managed by Texaco, the owners of the SEA EMPRESS cargo, was chartered successfully by the salvors during Friday 16 February on a commercial charter. However the vessel was alongside in Milford Haven loading a cargo. This cargo had to be discharged ashore and she was not available until 0600 hrs on Saturday. The other vessel was WHITCREST, 3,429 dwt, also under operational control of Texaco. This particular vessel, whilst smaller than STAR BERGEN, had the advantage of having self-priming cargo pumps which would enable cargo to be transferred from SEA EMPRESS without the use of the casualty's pumps. Vessels with this type of pump are not common.

17.8 Another tanker, TILLERMAN 12,800 dwt, was identified. The managers of TILLERMAN embarked on the process of negotiating a commercial contract, with agents acting on behalf of the salvors, during Sunday 18 February. These negotiations continued until SEA EMPRESS berthed on the evening of Wednesday 21 February, without reaching a conclusion.

17.9 The delay in the above negotiating process was recognised by the officials of MPCU. The managers of TILLERMAN were contacted by telephone, late on Tuesday 20 February, by an official from MPCU indicating that the Government would underwrite any costs which may be generated by taking the vessel away from her planned commercial programme. Shortly afterwards, at 0145 hrs on 21 February, TILLERMAN was called to a berth to load its planned cargo. At this stage the managers of TILLERMAN withdrew the vessel from commercial operations in order to stand by to assist with a possible lightening operation.

17.10 The powers of intervention under Section 137 of the Merchant Shipping Act 1995, which may be exercised on behalf of the Secretary of State by MPCU, would appear not to cover any vessel other than the vessel which is the casualty or is likely to cause pollution. MPCU were thus, in this instance, not exercising these powers of intervention but were enabling the managers of TILLERMAN to assist in any lightening operation without suffering significant financial penalty. The managers of TILLERMAN must therefore be seen as offering the services of their vessel under normal commercial conditions.

17.11 It is not clear whether the action taken by the MPCU, in underwriting possible losses, will have set a precedent which will be of assistance during any future salvage operations of this type in UK waters. However, such action does not avoid the need to have the full co-operation of the manager of the lightening vessel without which no suitable lightening tanker could ever be made available. The pre-agreement of tanker managers may be of value in saving valuable time in future incidents, possibly in the form of 'stand-by contracts' with MPCU. There would also appear to be some merit in extending the powers of the Secretary of State to allow him to intervene in the chartering process of vessels under circumstances where an owner is constrained from offering the use of his vessel.

17.12 Due to the above mentioned difficulties in obtaining conventional tankers for lightening purposes, there may well be value in giving consideration to other methods which may be available to receive oil in order to lighten a casualty. One system is a flexible oil tight envelope which floats alongside the casualty. At their present state of known development such methods are restricted to receiving oil in maximum parcels of 1,000m^3. However there may well be other systems available or in the process of being developed. Recognising that the stated intended use of the stored MPCU salvage equipment is that of ship-to-ship transfer, a receiving vessel other than a commercial tanker, may well enhance the value and flexibility of the existing equipment.

17.13 It is accepted that a system of this type, even in an enhanced yet to be developed state, may never be suitable for removing all cargo from a large damaged tanker. However, in an incident where cargo or bunker tanks of a vessel are breached, removing even some oil from these tanks alone would have the benefit of reducing the total quantity which could be released to the environment. A secondary benefit would be to increase the size of the water plug in these tanks, further reducing the chances of pollution if the vessel was aground or later ran aground. Accepting that the primary role of MPCU is that of preventing pollution, consideration of the merits and uses of these systems should be undertaken by that organisation with a view to future deployment. It is considered that such a system may have the potential to enhance the pollution prevention capability of MPCU.

18. AVAILABILITY OF VESSEL'S MACHINERY

Steering gear

18.1 During various stages of the salvage operation the steering gear was used and found to be satisfactory. After completion of the salvage operation, while the vessel was berthed alongside Herbrandston Jetty, steering gear tests were performed which were also satisfactory. When the vessel was in dry dock an inspection of the rudder revealed no damage, therefore it is concluded that the steering gear was operational and undamaged throughout the incident.

Fuel Supply Systems

18.2 The main engine, boilers and main generators of SEA EMPRESS are all designed to operate primarily on heavy fuel oil. The normal operational practice on the vessel was to employ heavy fuel oil for all of these items during all seagoing, manoeuvring and cargo operations. This 'single fuel concept' is an arrangement which is now common on many modern vessels. Only when a period of idleness can be anticipated, such as a refit or dry docking, is diesel oil substituted for heavy fuel oil. Diesel oil does not require pre-heating for use therefore facilitates the reactivation of the vessel's machinery from the cold state. It is also the practice to maintain diesel oil within the fuel system of one of the main generators which is idle and this becomes the stand-by generator. When required, diesel oil is supplied to the main engine and generators from the diesel oil service tank having a capacity of 7.8m^3. This compares to the heavy fuel service tank capacity of 39m^3.

18.3 On those rare occasions when heavy fuel needs to be replaced by diesel fuel in any engine this is undertaken with the engine in operation. As fuel is consumed by the engine, diesel fuel is introduced into the fuel system, so gradually replacing the heavy fuel. To perform this change over without an engine running, and with the fuel system cold, cannot be seen as a routine operation. It would be a rather difficult operation due to the problems of attempting to pump cold and very viscous heavy fuel oil. The time required to perform an operation of this type would be difficult to predict and it is unlikely that it would ever have been performed during the previous life of the vessel.

18.4 During the vessel's approach to Milford Haven, heavy fuel oil was in use by all of the vessel's main items of machinery mentioned above. This remained the situation until the crew were evacuated from the vessel, with the salvors and others, in the early hours of Sunday 18 February.

Compressed Air Supply

18.5 For several extended periods throughout the salvage operation the main engine of the vessel was in manoeuvring mode and was operated as such to the pilots' and salvors' requirements. The earliest occurrence of a potential problem with any of the main machinery systems concerned the supply of compressed air employed for main engine starting purposes.

18.6 Early efforts to ventilate the pump room required the use of two portable ventilation fans which were powered by compressed air. The compressed air was from the vessel's own supply. Continual running of these two fans, coupled with the starting air requirements of the main engine during the manoeuvring operations of Friday placed a demand on the vessel's air compressors which caused concern. To a limited extent, and for a very brief period, this concern was compounded by a minor difficulty with one of the vessel's air compressors which required it to be shut down for a short period. One air driven ventilation fan was shut down in order to reduce the demand for compressed air. Once this was done there were no further concerns on the matter of compressed air supply and demand until much later in the salvage operation on Wednesday 21 February.

Main Engine

18.7 No work was performed on the main engine between the evacuation in the morning of Sunday 18 February and reboarding on Monday morning. Only the vessel's emergency generator was in operation during this period, all other machinery was idle and allowed to cool.

18.8 On reboarding the vessel on Monday, the declared priority was to restore main electrical power and no particular emphasis was placed on rapidly restoring the main engine to operating mode. The absence of steam for fuel oil heating purposes had allowed the heavy fuel oil contained within the fuel system of the main engine to cool. Efforts to replace this heavy fuel with diesel were commenced once main generators and boilers were restored to service. This operation was underway when a request was made for information on the status of the main engine at 1713 hrs. In the circumstances it was not available for use.

18.9 The operation to substitute diesel oil for heavy oil in the main engine's fuel system commenced on Monday was only partly completed by the time the vessel was again evacuated at about 2240 hrs on that day. However, shortly after the vessel's engineers reboarded on the Tuesday morning they commenced warming through the main engine cooling system and recommenced the process of substituting diesel oil for heavy oil in the main engine's fuel system. These operations had been completed, and the main engine tested on diesel fuel, by the early

afternoon. During the attempts to refloat the vessel between 1700 hrs and 1945 hrs later that day the main engine was operated with diesel oil on many occasions, and at various speeds between Full Ahead and Full Astern, with no difficulty being experienced until shortly before these efforts were abandoned at 1945 hrs. While the main engine was running it slowed intermittently when a spurious overspeed signal was received by the engine's control system. However, the main engine continued to start and run until the end of this refloating attempt, albeit in a fashion not consistent with control lever settings. When all persons again evacuated the vessel that evening the main engine's fuel system contained diesel oil.

18.10 Salvors and members of the vessel's crew boarded the vessel again during the morning of Wednesday 21 February. Preparations were made to restore services and to identify the cause of the main engine overspeed trip. The problem was identified as being due to a failed contact possibly aggravated by the vibration levels generated during the refloating efforts of the previous day. The problem could only be overcome successfully by controlling the engine from the emergency engine control station. Operating in this emergency mode the main engine was started at 1814 hrs.

Main Generators

18.11 Immediately prior to the evacuation early on Sunday morning all machinery, including the boilers, was shut down with the exception of one generator. This was running on heavy fuel oil and it was anticipated that it would stop at some unknown time after the evacuation, due to the heavy fuel oil cooling in the generator's fuel system. However it was known that once this had occurred the emergency generator, which operates on diesel oil, would automatically cut in. This is a feature of the system and slightly less than two hours later this happened. Many observers of these events interpreted this development as an indication that the vessel's engine room had been breached and flooded. This was not the case.

18.12 The vessel was next boarded by a small group of salvors on the Sunday. Although some of the vessel's engineers made an attempt to board the vessel, this was aborted due to concern for their safety. This group of salvors made unsuccessful attempts to restore the main power supply by starting a main generator but these efforts failed in spite of technical information being passed to them via VHF from the vessel's Chief Engineer and her Technical Manager. The emergency generator continued to run. This episode, however insignificant it may have been to the overall operation, does highlight the potential difficulties which may be encountered by salvors and even the most experienced engineers in activating a vessel's machinery, when it is equipped with sophisticated control and monitoring systems, without direct assistance from persons familiar with the equipment.

18.13 When the vessel's engineers reboarded the vessel on the Monday morning they were able to start No 2 main diesel alternator, it being selected because its fuel system contained diesel oil, and the emergency generator shut down. Although this generator was left running on diesel oil when the vessel was evacuated late on Monday night, it shut down due to the contents of the diesel oil service tank being exhausted. Again the emergency generator started automatically and when the vessel was reboarded on Tuesday morning the diesel oil service tank was quickly replenished by crew members allowing the main generators to be re-started. Main electrical power continued to be available from that time until completion of the salvage operation.

Inert Gas System

18.14 For efficient and effective operation of the inert gas plant the boilers have to be on load. On this vessel a dump line is available which connects the steam outlet line from the main boilers to the main condenser. This line allows the steam produced by the boilers to be passed to the main condenser, so placing a load on the boilers and allowing inert gas to be produced in acceptable quantities.

18.15 Two problems were experienced with the inert gas system. Firstly, there was a high water level in the scrubber tower which caused the system to shut down. At the time the vessel had a significant list. However, when the magnitude of this list was reduced the scrubber tower commenced functioning correctly. Although a blocked vent pipe of the water overflow line from the scrubber tower had been found, and rectified, it is not clear whether the vessel's list or this blocked pipe was the true cause of the difficulty.

18.16 The second problem occurred when the water seal of the inert gas main pressure/vacuum breaker was lost at some stage before the Wednesday morning. As the vessel's fire main, which would have been used to refill it, was being employed to transport compressed air forward to the damaged ballast tanks it was necessary to refill the water seal using buckets.

Ballast System

18.17 Soon after the initial grounding the list was reduced by running sea water into the two port side ballast tanks, Nos 2 and 4, under gravity via the ballast main from the damaged starboard side tanks which had flooded. The success of this operation indicated that the remotely operated ballast valves, on the ballast main within the centre tanks, were functioning and that the ballast main was largely intact. Later, doubts as to the integrity of the ballast main were expressed during the operations of Saturday 17 February when efforts were being made to fill No 2 Port Ballast and the Fore Peak tanks. A test of the ballast main was performed which indicated that it was intact.

18.18 Due to flooding in the pump room the locally operated valves for the ballast system were immersed thus making it essential to pump out the pump room before the ballast system could be deployed in its standard mode of operation. Evidence from initial efforts to pump out the pump room using MPCU portable pumps, would suggest that the bottom damage from the initial grounding was limited. However, a later inspection of the ballast main when the vessel was in dry dock, showed that it had suffered serious damage within the pump room. The damage, in the form of fractures adjacent to two valves, was consistent with the area of bottom damage at the port side of the pump room. Such damage would have presented some problems with any ballasting operations being carried out via the pump room side of the system, particularly due to leakage into the pump room. However, partial ballasting of any intact tank from any damaged tank would have been possible at almost any stage of the incident, without requiring access to the pump room.

18.19 Other damage to the ballast main, which passes fore and aft through the lower part of the centre cargo tanks, was also found while the vessel was in dry dock and was consistent with the bottom of the vessel being set up in way of the cargo tanks. However this setting up of the line was accommodated by the bellows piece and did not lead to fracture of the system.

18.20 The Aft Peak tank was employed for ballasting purposes during the salvage operation. This tank is not served by the ballast main or the main ballast pumps. It is filled or emptied using pumps within the engine room and the system was available throughout the incident.

Integrity of Machinery Spaces

18.21 A rupture of the Port Double Bottom Diesel Oil Tank occurred on the morning of Wednesday 21 February, the very last day of the salvage operation. When the vessel was in dry dock the rupture was found to be a small puncture rather than a massive structural failure. The size of the puncture was minimal, consistent with being pierced by a sharp object, and resulted in water entering the tank. No significant pollution is likely to have been caused as this damage was in the lowest part of the tank.

18.22 On three occasions the starboard ballast pump gland allowed a water/oil mixture to pass from the pump room into the engine room. Although on one occasion a gas test was performed to establish whether explosive vapours were entering the engine room, and this proved negative, this leakage was slight and caused no great concern.

Deck Machinery

18.23 The deck machinery is hydraulically operated and whenever a main generator was running it was possible to supply hydraulic power to any item of the vessel's deck machinery. Although minor problems did occur, largely due to lack of familiarity with the hydraulic systems on the part of salvors' staff, no failure of any of these systems was reported.

18.24 During the manoeuvring operations of Saturday afternoon a minor failure, in the form of a sheared pin in the handwheel of the extended spindle to the brake of the starboard windlass, caused some difficulty. This was promptly repaired and it caused no further problem.

Conclusions

18.25 No major or catastrophic failure of any of the vessel's machinery or equipment occurred which can reasonably be considered to have influenced the outcome of this incident. However, several incidents illustrate the problems which may be encountered by salvors when they board a casualty, the layout and machinery of which is unfamiliar to them. The ever increasing sophistication of marine machinery, and in particular that of control and monitoring systems, highlights the importance of a casualty's crew being able to continue to offer their assistance throughout a salvage operation.

19. LOSS OF OIL FROM VESSEL

General

19.1 Prior to the accident SEA EMPRESS was carrying a cargo of some 130,000 tonnes of crude oil (this figure is based on the vessel's calculations). She also had in her engine room tanks some 2,300 tonnes of heavy fuel oil, 86 tonnes of diesel oil and 60 tonnes of lubricating oil. The heavy fuel oil was contained in wing tanks well above the bottom of the ship while most of the diesel oil was stored inside the engine room double bottom tanks.

19.2 In total 71,800 tonnes of crude oil was lost from the vessel during the initial grounding and the subsequent salvage operation. The Inquiry has endeavoured to determine how those losses occurred. The purpose of this aspect of the Inquiry is not only to provide data on how the oil was lost from the casualty but also whether at any point in the salvage operation a part of the cargo was deliberately discharged into the sea to save the vessel.

19.3 As the operation to salve the vessel ran into difficulties and more cargo tanks were ruptured more oil was lost from the vessel. Oil is lost to the sea from a damaged cargo tank in a number of ways:

- when the vessel has forward motion or is stationary in a fast flowing current the oil in contact with the passing water at any opening will tend to be drawn out;

- as the vessel rises and falls in a swell further oil will be lost through the hull damage or even forced out of unsecured deck openings due to the movement of the vessel in a seaway;

- because the oil level within a damaged tank will find its own level in hydrostatic balance with the external sea surface.

19.4 In practice, only those losses due to hydrostatic effects can be estimated with any degree of accuracy. However, since these hydrostatic (or tidal effects) are dominant it is believed that the mechanism for the oil lost over the various periods of the salvage operation can be deduced with reasonable confidence.

19.5 Hydrostatic losses occur in two ways. Firstly, when the vessel is afloat and the oil in ruptured tanks generates a greater pressure, due to the level of oil in the tanks, than does the seawater at the position of the damage there will be an outflow of oil. This outflow will continue until the falling oil level decreases to a point where oil pressure and seawater pressure are equal. Secondly, with the vessel aground on a falling tide, as the sea level drops the external pressure from the sea which is keeping the oil inside the vessel reduces. Once the sea level reduces below a critical height oil will flow out from the ruptured tanks.

19.6 There are several difficulties in analysing the oil losses over any specific period of the SEA EMPRESS salvage. These difficulties are associated with the accuracy and sparsity of data available. Also, not having a record of the precise time of many events is a particular problem. At the entrance to Milford Haven, the tides rose and fell at a maximum rate of about one metre every 35 minutes. A difference of only one metre on vessel draught, or an error of 35 minutes on event times, could lead to an inaccurate estimate of oil loss by up to 7,000 tonnes, which is significant. Another difficulty is the determination of the vessel's precise location and heading at any time. The problem is further compounded because of the impossibility of knowing precisely which part of the vessel grounded first on each occasion, and hence the corresponding water depths when the vessel first grounded.

19.7 In order to minimise the inevitable errors in the data, particular care has been taken to obtain consistency between the various records and wherever possible to handle key parameters on a relative rather than an absolute basis. The approach generally adopted was to deduce a consistent series of events which fits the available data and which, if possible, would have resulted in an oil loss at least equal in quantity to that which can be deduced from records. It needs to be borne in mind that the measurement of oil in circumstances such as those surrounding the salvage is not precise and for the purposes of this aspect of the Inquiry quantities quoted have been calculated and estimated to the nearest thousand tonnes.

Measured Oil Losses

19.8 Measurements were taken by the salvors on four occasions which allowed them to determine the quantity of oil remaining on board. The first measurements were taken in the afternoon of Monday 19 February which showed that 111,000 tonnes of cargo remained on board, therefore 19,000 tonnes had been lost. The second measurements were taken in the morning of Tuesday 20 February and these showed that 95,000 tonnes remained on board. This meant that a further 16,000 tonnes had been lost, taking the total lost to 35,000 tonnes. The third set of measurements were taken in the morning of Wednesday 21 February. These showed that 63,000 tonnes now remained on board therefore a further 32,000 tonnes had been lost bringing the total to 67,000 tonnes. The fourth and final measurements were taken in the morning of Thursday 22 February when the vessel was alongside at Herbrandston Jetty. These showed that 56,000 tonnes remained on board which meant that a further 7,000 tonnes been lost bringing the total lost to 74,000 tonnes.

Once the remaining cargo had been discharged, which it was possible to measure accurately, it was calculated that 58,200 tonnes had been off-loaded therefore a total of 71,800 tonnes had been lost. The difference between the actual quantity lost and the estimated quantity, some 2,200 tonnes, reflects the problems with measuring techniques during a prolonged and difficult salvage operation.

Causes of Oil Losses

19.9 It is not clear what oil was lost as a direct consequence of the initial grounding. The vessel reported a loss of some 6,000 tonnes, but it is believed that this figure was based on erroneous data. Calculations based on the condition of the vessel after flooding indicated that the oil loss at this time would have been likely to be about 2,500 tonnes. It is clear however, that the vessel lost no further oil during Friday 16 February or during Saturday 17 February until she grounded again that evening.

19.10 With the first measurement of oil on Monday 19 February it was determined that some 19,000 tonnes of oil had been lost. This total oil loss was an aggregate of the oil lost in the initial grounding and the oil lost due to the groundings on Saturday 17 February and Sunday 18 February. It is not possible to quantify the oil losses in these individual events but as the vessel was effectively out of control and unmanned for long periods the losses were clearly not influenced, either adversely or beneficially, by the salvage team.

19.11 For the remainder of the salvage operation the periods between each set of measurements referred to above were examined to identify the causes for the estimated quantities of oil lost. Examination included consideration of the various salvage activities which had been undertaken, estimates of when further breaches of the hull occurred, the locations of the various groundings, the rise and fall of the tide, the draught of the vessel and witness evidence. Allowing for the problems referred to in paragraphs 19.6 and 19.7 above it has been possible to determine with a reasonable degree of confidence how the losses occurred.

19.12 Of the losses which occurred between the time of the first measurements on Monday 19 February and those on Tuesday 20 February, that is 16,000 tonnes, it is concluded that the loss was wholly due to stranding of the vessel. It was not exacerbated by the actions on board of the salvors who manned the vessel infrequently over this period.

19.13 During the next period, between the measurements taken on Tuesday 20 February and Wednesday 21 February, the loss was 32,000 tonnes. Some 16,000 tonnes of this loss occurred naturally over the low water period in the early afternoon of Tuesday. This was not exacerbated by the salvors preparations to refloat the casualty. However, no wholly satisfactory theory has been identified for the precise circumstances surrounding the remaining 16,000 tonnes of the total which was lost during this period. It is known that a draught reduction of about 3 metres was achieved at the time of the failed refloating operation. It is also known that the casualty drifted to the west into shallower water during the refloating attempt. Calculations have shown that if the vessel stranded at this reduced draught then an oil loss of the order of 16,000

tonnes would result. It therefore seems reasonable to conclude that a further 16,000 tonnes of oil was lost over the low water period early on Wednesday morning because of the significant reduction in the low water draught of the casualty which resulted from the failed refloating attempt.

19.14 The final period analysed, between the measurements taken on Wednesday 21 February and Thursday 22 February, included the pressurisation of various tanks and the other activities by the salvors which resulted in the successful re-floating operation. The 7,000 tonnes of oil lost to the sea in this period was very probably a direct consequence of the actions required of the salvors to ensure that the re-floating operation was successful. It was not a premeditated act, rather a risk to be taken to avert a much greater potential oil loss. The alternative involved a much greater risk of further oil pollution.

19.15 The Inquiry could not find any evidence to show that at any stage during the salvage operation did the salvors deliberately discharge oil into the sea.

20. DAMAGE TO VESSEL AND DISCUSSION ON DOUBLE HULL VESSELS

Introduction

20.1 From the time the initial grounding took place to the completion of the salvage operation one question which was raised in many quarters was whether the consequences would have been different if the vessel had been of double hull construction. The vessel was thoroughly examined by the Inspectors after she had been taken to the shipyard in Belfast and a comprehensive record taken of the damage which had been sustained. This section of the Report examines the full extent of that damage and discusses whether the pollution would have been substantially reduced, or avoided entirely, if the vessel had been constructed to the standard of a double hull tanker or equivalent. It also examines the regulatory framework for the avoidance of oil pollution under which tankers operate.

Overview of Damage Sustained by the Vessel

20.2 A broad overview of the hull bottom damage is shown in Figure 6. It can be seen that the most severe damage ran in a continuous band from around the Fore Peak and down the length of the starboard wing tanks. In marked contrast the port wing tanks showed only isolated areas of damage, whilst the majority of the area in way of the centre tanks was largely undamaged or only lightly so. The entire damaged area exhibited pounding damage with the plating dished in between adjacent stiffeners with fractures running along the lines of bulkheads and frames (see Photographs 3 - 6). A more detailed account of the damage to various areas of the hull bottom follows.

Starboard Bottom

20.3 The most striking aspect of the damage was the extreme degree of deformation to the starboard bottom right along the line of the starboard wing tanks. In this area the turn of bilge had disappeared over virtually the whole of the cargo tank length, and the bottom shell appeared to meet the side shell along a knuckle line some 3 to 4 metres above the keel. Over large areas the longitudinal bulkhead plating had protruded through and then been forced flat against the bottom shell.

20.4 In some areas it was possible to observe earlier fore/aft aligned damage which had been overlain by the plating which had been thrust athwartships. The original raking grounding damage which occurred on Thursday 15 February at the outset of the accident was to a large extent obscured by the overwhelming pounding damage incurred over the ensuing six days to Wednesday 21 February and cannot be entirely separated out. However, the initial bottom raking damage ended at a

point about 82% of the length of the vessel aft of the forward perpendicular. This is greater than the 60% figure allowed for in the current MARPOL regulations for a vessel of the size of SEA EMPRESS.

20.5 The damage which caused the initial flooding to No 1 Centre tank, is thought to have been along the line of the longitudinal bulkhead as this was the only damage which was found on the starboard side which would have opened No 1 Centre tank to the sea. The source of the initial flooding to the pump room was found at bulkhead 41. Associated with this damage were fore/aft scores in the hull plating along a line about 6 metres off the centre-line. These two damages suggest that the initial raking damage extended inboard from the starboard side to about 6 metres off the vessel's centre-line. This is illustrated in Figure 7.

20.6 A section of plating some 2 metres square was missing from underneath No 2 Starboard tank while underneath No 3 Starboard tank there were several areas of plating completely detached from their stiffeners and sagging down. There was also an area some 5 metres long by 2 metres wide which had been folded back along the bottom shell leaving a clear opening in the bottom. The bottom of No 4 Starboard tank had suffered catastrophic damage, the bottom shell structure having been destroyed over almost the entire area of the tank.

Port Bottom

20.7 The turn of bilge over the majority of the parallel mid-body was largely undamaged, apart from the damage to the bilge keel itself. The damage on the port side was concentrated at the ends of the vessel, and usually appeared as discrete indentations. The most notable damage was in way of the pump room.

20.8 The damage to the port side forward of bulkhead 77 was similar to the general pounding damage shown on the starboard side.

Midships Damage

20.9 A massive indentation in the bottom shell structure was present over an area of 10 metres either side of the vessel's fore and aft centre-line. This extended 7 to 10 metres forward from bulkhead 62. The crown of the indentation was some 1.1 metres above the keel while at the crown the bottom plating had fractured along a length of about 17 metres and the faces of the fractured plating were pulled apart by about 150mm and displaced vertically by a further 300mm. The bottom plating in this area is between 18 and 22mm thick. It is thought that this damage occurred as the tide fell on the evening of Monday 19 February when, it is surmised, the vessel must have pivoted about a point somewhere near amidships to achieve the dramatic reduction in her low water draught which the large oil loss at that time indicated.

Pump Room and Slop Tank Damage

20.10 The area of the initial damage to the pump room bottom plating which caused flooding to the pump room was identified just aft and in way of the forward bulkhead 41 on the starboard side. The bottom plating had been pressed upwards with the bulkhead over a length of about 9 metres. In so doing it had split along the base of the bulkhead allowing the ingress of seawater. It is not known to what extent this damage was caused by the initial grounding. However, the damage as inspected is consistent with the limited rate of flooding observed by the salvors and others during Friday and Saturday. The bottom plating on the forward side of bulkhead 41 in way of the slop tank was also pressed upwards, to a greater extent than on the aft side. This split was about 6 metres long, and made the two spaces open to each other and the sea. It is reasonable to suppose that oil escaping from the slop tank was drawn into the pump room via this area of common damage.

20.11 The most notable damage was in way of the pump room on the port side. This damage, which probably occurred on Monday or Tuesday, prevented the pump room from being pumped dry. The damage was less than one frame space away from penetrating the engine room.

20.12 The initial minor damage to the pump room resulted in the atmosphere becoming unsafe when the pump room flooded with seawater and cargo. This meant that lightening operations using the casualty's own cargo pumps could not take place until the pump room had been pumped out and ventilated. This was not achieved until the afternoon of Saturday 17 February. It is arguable that but for this enforced delay to the start of the lightening operation SEA EMPRESS might have been salved on the Saturday without a further loss of cargo. Certainly the lightening tanker was available from 0600 hrs on the Saturday morning.

Damage to Heavy Fuel Oil Tanks

20.13 The first indications of heavy fuel oil pollution came from the remote sensing aircraft whilst the casualty was still in the 'pool'. Prior to refloating it was thought that all the oil had been transferred out of the damaged tank and that the leak had been stemmed. The casualty was not leaking fuel oil on her transit to Herbrandston Jetty. Recognising the potential for pollution from a damaged bunker tank and the amount of bunkers remaining on board, an off-loading vessel was tasked to berth alongside the casualty and remove the majority of her bunkers, thus removing the risk of further pollution. However, during the transfer operation on the morning of 22 February, the casualty's crew began transferring bunkers internally and fuel oil was lost overboard from a tank or piping previously thought to have been undamaged. It was found that both Nos 2 and 4 Fuel Oil tanks on the starboard side were damaged. The damage to No 2 Fuel Oil tank was associated with the damage running along the line of the longitudinal bulkhead (on the port

side) aft of frame 43. The damage to No 4 Fuel Oil tank (which is immediately aft of No 2 Fuel Oil tank) was high up on the casualty's side on frame 43. This damage, some 13 metres above the base, was undoubtedly due to contact with the hull made by the tugs during the salvage operation.

Discussion on Double Hull Oil Tankers and Equivalents

20.14 As a consequence of the EXXON VALDEZ accident in 1989, and the unilateral action by the United States Government in favour of double hull oil tankers, there has been a renewed urgency within the marine industry to find a design of vessel which offers the most effective protection against oil pollution in the event of a collision or grounding accident. Several authoritative studies have been carried out into the problem and 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 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 minimize 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.

20.15 There are many design concepts which have been proposed to reduce the risk of pollution in the event of an accident. International attention is increasingly focused on three main types: the Double Hull tanker, the Mid-deck tanker and the Coulombi Egg tanker. A typical cross-section for each of these types is shown in Figure 8, but to date only the double hull tanker type has actually been constructed.

20.16 One of the original objectives in examining the damage to SEA EMPRESS was to provide data for a subsequent computer analysis to determine how the structure of a double hull tanker (or equivalent) would have withstood similar loads. However, the damage to SEA EMPRESS was found to be both extreme and complex and it was concluded that it was not possible to accurately derive the loading regime which might have caused the observed damage. The plan to carry out a computer analysis of alternative tanker structures was therefore abandoned. Nevertheless a number of scenarios have been

selected and utilising the detailed information gained from the inspection of SEA EMPRESS and other areas of the inquiry an assessment, based solely on engineering judgement, has been made to determine how tankers of different structural configuration would have responded to the loadings encountered by SEA EMPRESS.

20.17 To include within this Report the full details of the various scenarios examined is not appropriate, however the findings are given below. The scenarios cover an initial grounding followed by anchoring in the 'pool' (in the same way as SEA EMPRESS) and a further grounding on the shoals off Saint Ann's Head (in the same location as SEA EMPRESS on the Saturday evening). All scenarios envisage tankers of an equivalent size to SEA EMPRESS.

The Double Hull Tanker

20.18 This type of vessel derives its defence against oil spillage, in the event of grounding or collision, by surrounding the entire cargo tank length by a 2 or 3 metre wide void space which separates the cargo tanks from the outer skin of the vessel. In order for an oil spillage to occur the damage has to rupture two skins. In the first scenario with a vessel of this construction, the initial grounding would only rupture the outer skin and there would not be any leakage of cargo. However as the double skin does not encase the pump room that space would be lightly damaged allowing flooding from the sea, however without any oil entering it. The total of this damage would result in an increase in draught which prevents the vessel from proceeding to her berth. It is probable in these circumstances, because the pump room atmosphere is safe, that the flooding is quickly brought under control and the lightening operation (for which a tanker was available from about 0600 hrs on the Saturday morning) is concluded on the Saturday. The casualty is then taken in to the safety of the Herbrandston Jetty during the evening of the Saturday thus avoiding the need to turn the casualty into the weather. The vessel is thus salvaged without any loss of oil. The probability of this outcome would be increased if the pump room were fitted with a double bottom and consequently did not flood initially.

20.19 In the second scenario it is assumed that, for some reason, it is decided to turn the vessel before beginning the lightening operation, that the vessel is turned and anchored in the same location as SEA EMPRESS on the Saturday evening. Then, like SEA EMPRESS, she would certainly be carried onto the shoals off Saint Ann's Head. In these circumstances it is likely that three cargo tanks would be breached with the loss of some 12,000 tonnes of oil. However, in contrast to SEA EMPRESS she could not be salvaged from this location without a prolonged lightening operation, the outcome of which cannot be predicted, but certainly further substantial oil losses would be a real possibility.

The Mid-deck Tanker

20.20 This type of vessel derives its defence against oil spillage, in the event of collision, by protecting the sides along the entire cargo tank length by a 4 to 5 metres wide void space which separates the cargo tanks from the outer side skin of the vessel. The underside of the cargo tank region is unprotected and the cargo is in direct contact with the bottom shell. However, the cargo tanks are split horizontally by an oil-tight deck. The height of the oil-tight horizontal deck is chosen so that in the event of bottom damage the external water pressure should exceed the head of oil in the lower cargo tanks thus forcing the oil to be retained within the vessel. In the first scenario with a vessel of this construction the initial grounding would rupture the void space along the starboard side, at least Nos 1 and 6 Lower Cargo tanks and the pump room. There would be an increase in the draught which prevents the vessel from proceeding to her berth and there would be some oil released. It is possible that the draught of the vessel could be reduced sufficiently, as a result of pressurising the void spaces, to allow the casualty to be taken to the safety of the Herbrandston Jetty. Thus the casualty is salvaged with a minimal loss of oil. Published research data suggests that the total oil loss would have been of the order of 100 to 200 tonnes.

20.21 In the second scenario it is assumed that, for some reason, it is decided to turn the vessel before beginning the pressurising of the void space, that the vessel is turned and anchored in the same location as SEA EMPRESS on the Saturday evening. Then, like SEA EMPRESS, she would certainly be carried onto the shoals off Saint Ann's Head and by the Tuesday would be stranded there. Oil losses up to this time would increase to some 1,000 to 2,000 tonnes. In contrast to SEA EMPRESS, she could not be salvaged from this location without a prolonged lightening operation, the outcome of which cannot be predicted, but certainly further substantial oil losses would be a real possibility.

The Coulombi Egg Tanker design

20.22 At first sight this configuration appears to be a variant of the mid-deck tanker but it differs in three important respects from that type. Firstly the width of the wing tanks is about 50% greater, secondly the wing tanks are divided horizontally into upper and lower tanks with the lower wing tanks dedicated to cargo, and thirdly the upper wing tanks are not only dedicated segregated ballast tanks but also perform the function of "rescue tanks". The Coulombi Egg tanker has an emergency cargo transfer system which allows oil from damaged cargo tanks to be directed into the sound empty upper wing tanks, thus minimising the oil lost to the sea in the event of a collision or grounding. The system utilises the fact that the external pressure from the sea due to the vessel's laden draught will be greater than that due to the head of oil in the damaged cargo tanks, thus the oil in the damaged cargo tanks

will be forced into the "rescue tanks". There is only a single skin underneath the pump room. As with the mid-deck tanker no vessel of this type has yet been built but the concept of the "rescue tanks" has been shown to work in model tests.

20.23 In the scenario with a vessel of this construction comparison with the damage found on SEA EMPRESS suggests that the initial contact would rupture the bottoms of the starboard lower wing cargo tanks, Nos 1 and 4 Centre Lower Cargo tanks and the pump room. The immediate effect is that the damaged lower tanks would be pressed full as water floods in below the oil and forces it up into the ullage spaces and access trunks. There would be no loss of oil due to hydrostatic effects, but a small loss of oil could be expected due to the forward motion of the ship through the water. The draught of the vessel is increased slightly and there is a small angle of list to starboard due to the small quantity of water which has entered the tanks and due to the flooding of the pump room. In these circumstances it would be possible to proceed directly to Herbrandston Jetty and the salvage operation would be largely circumvented. Published research data suggests that the total oil loss would be of the order of 1,000 tonnes.

Regulations for the Reduction of Oil Pollution from Crude Oil Tankers Following Grounding Accidents

20.24 SEA EMPRESS was required to be designed and built to comply with Annex 1 of MARPOL 73/78 which came into force in October 1983. By these regulations she was required to have segregated ballast tanks arranged to minimise oil outflow and the subsequent pollution resulting from a collision or grounding. The protective area can be placed either in the sides or the bottom of the vessel. These were the standards to which SEA EMPRESS was completed in 1993. Her protective area was concentrated in the sides, against the expectation of collision, in Nos 2 and 4 Port and Starboard Ballast tanks. It is of interest to note that BORGA, which grounded off Milford Haven in October 1995, was designed to the same standard, although in her case the designers elected to obtain the required protective area by fitting a double bottom.

20.25 The fitting of protective areas clearly reduces the risk of damage to the protected cargo tanks. However, one drawback to this mode of pollution avoidance is that in the case where the empty protective segregated ballast tank is ruptured, a significant increase in the draught of the vessel can be expected, accompanied possibly by a large angle of list. This was a critical factor in the SEA EMPRESS accident. It illustrates that in some circumstances the protection of cargo tanks by large void spaces can impede the entry of a casualty to a safe refuge and thus adversely affect the salvage operation.

20.26 The US National Transportation Safety Board in its report on the grounding of EXXON VALDEZ concluded: "*....if the EXXON VALDEZ had been fitted with a double bottom, the oil outflow would have been significantly reduced, if not, eliminated.*" Since double bottoms offer no protection against collisions the double hull was identified as offering the best overall protection against both grounding and collision. In August 1990, as a consequence of that accident, the USA brought into force the Oil Pollution Act of 1990 (OPA90). The most significant requirement of the Act is that new tankers entering the waters of the USA have to be of double hull construction. It also requires that existing tankers, at a date dependent upon their age, have to be retrofitted to double hull standard or removed from service. This effectively means that all single hulled tankers will be excluded from US waters after 1 January 2010 and existing double bottom or double side tankers by 2015. (An exemption from the double hull requirement until 2015 is made in favour of vessels delivering to a lightening operation and/or servicing the Louisiana Offshore Oil Port.)

20.27 In 1992, following the introduction by the USA of OPA90, Annex 1 of MARPOL 73/78 was substantially revised. The amendments came into force in July 1993 and the major amendment was that every new oil tanker of over 5,000 dwt to be of double hull or mid-deck construction or to be of a design approved by the IMO as offering an equivalent level of protection against oil pollution. All existing oil tankers of a size covered by these regulations must comply with the amended provisions no later than 30 years after their date of delivery. This effectively means that by the year 2026 (at the latest) all tankers will comply.

20.28 The MARPOL requirements for double hull tankers, or their equivalent, were enacted in their entirety in the UK Merchant Shipping legislation by Statutory Instrument 1993 No 1680 The Merchant Shipping (Prevention of Oil Pollution) (Amendment) Regulations 1993. Thus, like the USA, the UK is also committed to the requirement that all new oil tankers of over 5,000 dwt should be of double hull construction. However the USA requires that existing tankers shall comply by the year 2015 at the latest whereas the UK and IMO require compliance by 2026.

20.29 OPA90 also requires tanker owners/managers to produce an oil spill emergency response plan, which has to be approved by the United States Coast Guard before the tanker can operate in US waters. One requirement of this, which is recorded in the Code of Federal Regulations is: "*Owners and operators of oil tankers and offshore oil barges shall ensure by no later than January 21, 1995, that their vessels have pre-arranged, prompt access to computerised, shore-based damage stability and residual structural strength calculation programs*". The managers of SEA EMPRESS had a contract with Lloyd's Register of Shipping, Ship Emergency Response Service (SERS) for this support. This support was therefore available during the SEA EMPRESS accident.

Conclusions

20.30 The SEA EMPRESS accident has highlighted only too clearly some of the fundamental problems which have to be overcome in the design of oil tankers if the risk of oil pollution following grounding damage is to be minimised. However, it has also produced an abundance of information to assist with the development of measures to significantly reduce the risk of oil pollution in similar accidents.

20.31 An analysis of the grounding damage and an exploration of alternative scenarios leads to the following broad findings:

- the easier it is to salvage a casualty the more the risk of further pollution is reduced;

- in coastal waters (where most groundings can be expected to occur) large increases in draught and list following a grounding accident adversely affect the ease with which a casualty can be salved;

- if, because of a large increase in draught, a lightening operation is required in order to salve the casualty it is imperative that the casualty's own cargo pumping system is operable;

- large increases in draught, following grounding accidents, are associated with the rupture of the protective void spaces around the cargo tanks;

- recovering the buoyancy of damaged ballast tanks through pressurisation is more easily accomplished if the ballast tanks are not contaminated with significant quantities of cargo;

- large increases in draught, following grounding accidents, can be avoided by having the tanks adjacent to the bottom skin full of cargo or ballast;

- little oil is lost from breached cargo tanks where the cargo "head" is less than the external positive pressure due to the vessel's draught;

- conversely, massive oil losses can occur if the external pressure due to the casualty's draught falls below that of the cargo "head", as would occur if the casualty were stranded over a low water period;

- of the three generic types of tanker examined only the double hull type has actually been constructed;

- of the three generic types of tanker examined the Coulombi Egg appeared to give the highest probability of avoiding oil losses in excess of 1000 tonnes in a repeat of the SEA EMPRESS accident;

- of the three generic types examined the double hull tanker was the only one offering the chance of zero oil loss in a repeat of the SEA EMPRESS accident;

- the fitting of a double bottom to a pump room would protect the space against flooding and gassing, in the event of a grounding, and have the potential for making a salvage operation easier.