



Bahamas Maritime Authority

**Report of the investigation into
fire in the generator room of the
Bahamian registered passenger
vessel "Seven Seas Navigator
on 17 January 2005**

The Bahamas Maritime Authority investigates incidents at sea for the sole purpose of discovering any lessons which may be learned with a view to preventing any repetition. It is not the purpose of the investigation to establish liability or to apportion blame, except in so far as emerges as part of the process of investigating that incident.

It should be noted that the Bahamas Merchant Shipping Act, Para 170 (2) requires officers of a ship involved in an accident to answer an Inspector's questions fully and truly. If the contents of a report were subsequently submitted as evidence in court proceedings relating to an accident this could offend the principle that a person cannot be required to give evidence against himself. The Bahamas Maritime Authority makes this report available to any interested parties on the strict understanding that it will not be used as evidence in any court proceedings anywhere in the world.

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- 1.1 The vessel was engaged on a Caribbean cruise with 481 passengers on board and left Grand Turk to return to Port Everglades on the evening of 16 January 2005. While passing south of Great Inagua Island, the crew were alerted to a fire in the Diesel Generator room at 0048 on 17 January 2005.
- 1.2 The engine room rating on duty immediately entered the Diesel Generator room and attempted to extinguish a fire located at the top of No 2 Diesel Generator. He was unable to control the fire due to the volume of dense black smoke and fire-fighting duties taken over by the Engine Room Fire Party. The fire was rapidly extinguished without loss of life or injury to any person.
- 1.3 The electrical cables serving the Diesel Generators were damaged by the fire causing the generators to stop and leaving the vessel without main electrical power. Although the Emergency Generator started immediately and supplied emergency power, the main engines shut down when the main electrical power supply failed. The vessel drifted while under emergency power until 0130 when a main engine was started and electrical power was supplied from a shaft generator. All main engines were started soon after and the passage resumed at 0200 on 17 January with electrical power supplied by one shaft generator and No 3 Diesel Generator.
- 1.4 An investigation began immediately on arrival at Port Everglades. The findings of the investigation were that the fire started at the top of No 2 Diesel Generator or in the deckhead close above. The cause of the fire was determined to be possible the overheating in an electric light fitting, but more probably the escape of exhaust gases through an unseated air start valve in No 2 Cylinder head in No 2 Diesel Generator. Once started, the fire developed rapidly and activated the smoke alarms. The fire damage in the deckhead and electrical cabling is considered to have resulted from accumulation of oil vapour over time.
- 1.5 While the fire was promptly extinguished by the rapid response of the crew, the report recommends measures to provide closer monitoring of the Diesel Generator Room, more frequent inspection of the diesel generators and prevention of absorption of oil vapour in the deckhead.

- 2.1 The hull of the vessel was built by Admiraltyrskyi Sudostroitelny Zavod at St Petersburg in 1988 and sold to T Mariotti shipyard in Genoa, who completed an extensive conversion to a passenger cruising vessel in 1999. The principal particulars of the vessel are:
- Official Number - 732251
 - IMO Number - 9064126
 - Length overall - 170.69 metres
 - Breadth - 24.0 metres
 - Depth - 12.28 metres
 - Gross Tonnage - 28,550 tons
 - Net Tonnage - 9,546 tons
 - Deadweight - 2,581 tonnes
 - Call Sign - C6QS8
- 2.2 The vessel was powered by 4 Wartsila Type 8138 diesel engines developing 21,120 kW and which drove two fixed pitch propellers through gearing. There were three diesel generators developing 2,200 kW and two shaft generators developing 3,000 kW. The normal service speed was 17.5 knots.
- 2.3 The vessel was classed by Registro Italiano Navale as a passenger ship with the notation ★100-A-1.1 and was maintained in class.
- 2.4 The vessel was initially registered under the Italian flag and transferred to Bahamas registry on 5 May 2000. At the time of the incident the vessel was owned by Celtic Pacific Two and operated by Radisson Seven Seas Cruises.
- 2.5 The vessel complied with the requirements of the International Convention for Safety of Life at Sea for passenger ships and was certified to carry 490 passengers on international voyages. A Bahamas Maritime Authority annual inspection was carried out on 9 September 2004 when the vessel was found to be in a satisfactory condition. A port state control inspection as carried out by the United States Coastguard at New York on 14 June 2005. No deficiencies were found on the vessel during this inspection.
- 2.6 The vessel is of standard passenger ship design, having 12 decks, with passenger accommodation on decks 5 to 12 and on the forward part of deck 4. The Diesel Generator compartment is situated on deck level 3 immediately forward of the steering gear compartment and aft of the engine room, between transverse watertight bulkheads. Entry to this compartment is made through centre line watertight doors on each of the transverse bulkheads.

- 3.1 All times in this narrative are given in the standard 24 hour clock format without additional annotation and as local time at ship unless otherwise stated.
- 3.2 The vessel was engaged on a one week Caribbean cruise and sailed from Grand Turk on 16 January 2005 for Port Everglades with 481 passengers on board. The vessel passed south of Great Inagua Island soon after 0030 on 17 January on a course of 263°T as intended and making a speed of 19.2 knots. The weather was fine with an east-south-easterly wind of Force 3 and slight sea.
- 3.3 At 0048 on 17 January smoke detector alarms sounded simultaneously on the navigating bridge and in the engine control room. The initial alarm was identified as Smoke detector No 30 located in the forward section on the port side of the Diesel Generator Room. This is situated on deck 3 within No 4 Main Vertical Fire Zone division. Almost immediately following the smoke alarm the main engines and diesel generators stopped. Electrical power was then supplied by the Emergency Generator which started automatically.
- 3.4 The Second Officer immediately alerted the Master and Chief Engineer, who both came to the bridge. The emergency fire parties were summoned and watertight doors ordered closed. An engine room rating on duty in the Engine Control room then entered the Diesel Generator Room. He attacked the fire at No 2 Generator using a dry powder extinguisher but was forced to withdraw by the dense smoke from the fire.
- 3.5 All emergency fire parties were at their respective stations by 0100. All other crew were summoned to their emergency stations but were not required to take any action. The Engine Room Fire party, wearing firemen's suits and breathing apparatus, then entered the Diesel Generator compartment from the engine room through watertight door at 0104.
- 3.6 The Engine Room Fire party encountered dense black smoke on opening the door to the Diesel Generator compartment and all other crew were then summoned to their emergency stations. The fire was found to be at the top of No 2 Generator and was extinguished by the Engine Room Fire Party by 0110. The fire party then withdrew from the Diesel Generator room. An inspection at 0124 confirmed that the fire had been successfully extinguished and had not re-ignited.
- 3.7 At 0130 No 3 Main Engine was started and electrical power restored by means of the shaft generator. Main propulsion was restored at 0200 using the other three main engines and the passage to Port Everglades resumed at a speed of 12 knots. The emergency fire parties were then dismissed and the United States Coastguard was notified of the situation at 0240 and updated at intervals until arrival.

- 3.8 After the main engines had been restarted and operating satisfactorily, the diesel generators were examined. It was found that Nos 1 and 2 Diesel Generators were inoperable due to fire damage to cabling, but that No 3 Diesel Generator could be successfully started following temporary repairs to cabling. Sufficient electrical power was then restored for normal service requirements.
- 3.9 The remainder of the passage was completed without incident and the vessel arrived at Port Everglades on the evening of 18 January, when passengers were disembarked and arrangements made for survey and repair of damage to the diesel generators.

- 4.1 The investigation of the location and cause of the fire in the Diesel Generator Room is based on the evidence provided by the crew of the vessel, the print out of the bridge fire detection system and an examination of the machinery, cabling and fire damage in the Diesel Generator compartment. Diesel Generator No 2 in the area in which the fire started was examined as it was undergoing repair. Various components in the Diesel Generator Room, including smoke detectors, light fittings, electrical cabling and fuel pumps and pipes and components were removed and tested as appropriate to ascertain if there were any deficiencies that may have contributed to the cause of the fire.
- 4.2 The fire damage in the Diesel Generator Room was found to be as follows:
- (a) No 1 Generator: fire damage to main power cables and control cables on deckhead mounted cable trays.
 - (b) No 2 Generator: fire damage to main power cables, control cables, lighting cables, power sockets, fluorescent light fittings, public address system speaker and visual alarm indicator, cylinder covers and fuel pump covers, and turbocharger air inlet filter.
 - (c) No 3 Generator: Fire damage to control cables.
 - (d) Fire insulation: Approximately 40 square metres of deckhead insulation material fire damaged.
- 4.3 The vessel was equipped with a Voyage Data Recorder and an ABB alarm recording system for engine room alarms, both of which may have provided useful information for the investigation. In order to make this available the data on the Voyage Data recorder must be saved. This requires positive action, which was not taken and so the data for the period of the fire was not available for the investigation. The engine control system incorporated an alarm recording system, which might have provided information on the sequence and type of alarms activated. It is understood that the design of the system is such that a series of alarms caused erasures of the alarm log, so that no data from this source was available for the investigation. The only recorded data available was the print out of alarms recorded on the bridge smoke detector alarm system.
- 4.3 It is clear from the distribution of damage and evidence of the fire party first on scene that the fire originated at or above No 2 Diesel generator, situated in the centre of the space. The print out of the bridge smoke detector alarms indicates smoke alarms in the Diesel Generator compartment and adjoining spaces immediately astern were activated in the sequence indicated in Table 1:

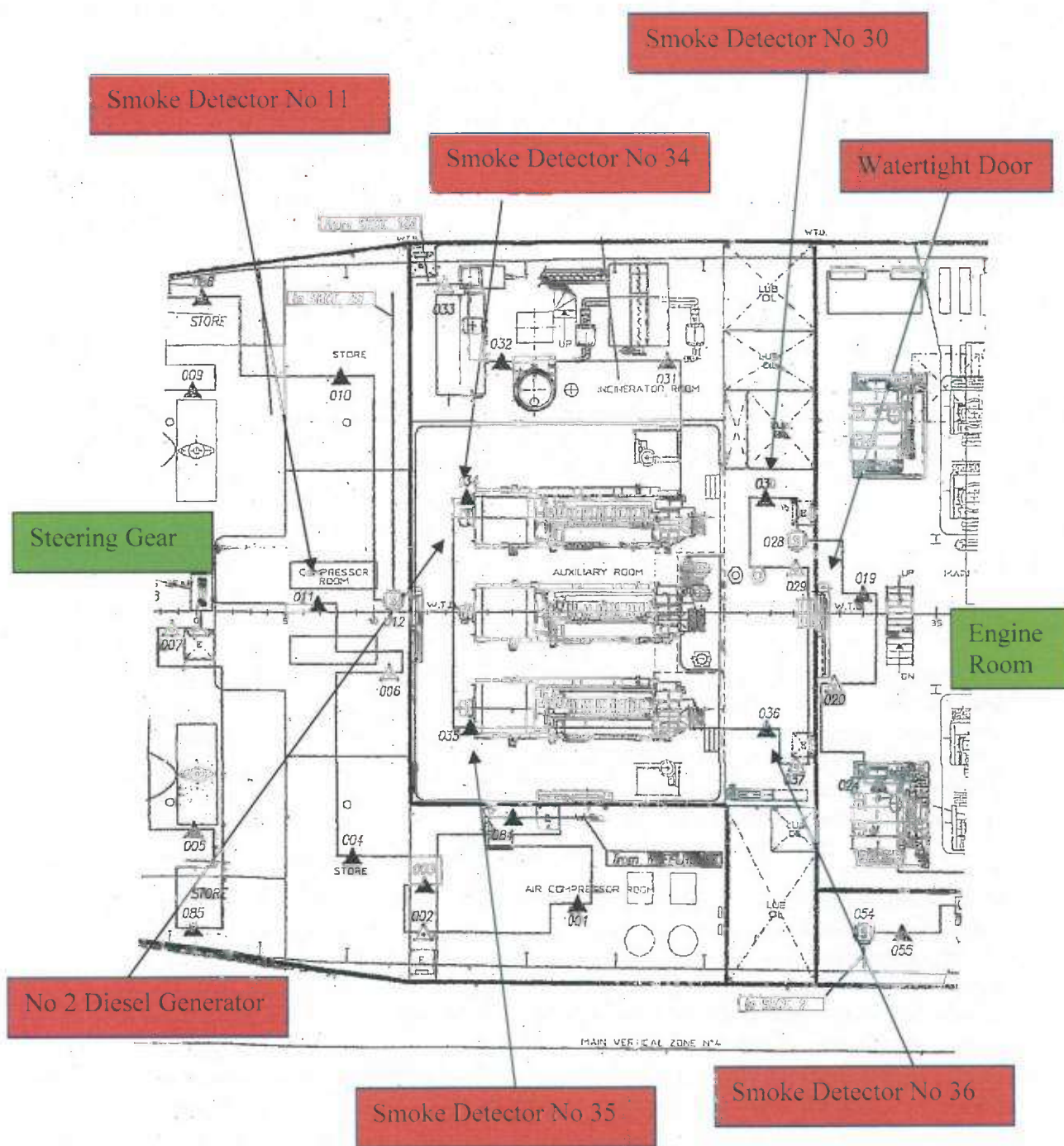


Fig 1 Plan of Diesel Generator Room showing location of fire detectors and watertight door

Table 1 Smoke Detector Activation		
Smoke Detector Number	Time of activation	Location
30	05h 58m 52	Diesel Generator Port Side Forward
34	05h 59m 04s	Diesel Generator Port Side Aft
36	05h 59m 34s	Diesel Generator Starboard Side Forward
35	06h 00m 45s	Diesel Generator Starboard Side Aft
11	06h 00m 50s	Compressor Room Midships
9	06h 01m 22s	Steering Gear Port Side
8	06h 02m 37s	Steering Gear Midships
5	06h 02m 41s	Steering Gear Starboard Side

The location of the smoke detectors is shown in Fig 1.

- 4.4 The arrangement of the mechanical ventilation in the Diesel Generator compartment caused a flow diagonally across the space from starboard forward to port aft, and similarly in the Compressor Room and Steering Gear compartments immediately astern. As smoke would be carried in the ventilation flow, it would be expected that No 34 Smoke Detector would have been activated before No 30. The smoke detectors in the Compressor Room and Steering Gear compartment were activated in accordance with a flow of smoke from starboard forward to port aft.
- 4.5 During the investigation all of these smoke detectors were tested and found to be functioning normally. The sensitivity of detector No 34 was however lower than the others. This is considered to have resulted from a build up of desensitizing oily and carbonaceous deposits emitted from the diesel generator engines during normal operation, with a higher deposit on detector No 34 arising from the natural ventilation flow across the space. The order in which the smoke detectors were activated is therefore consistent with the fire originating in or above No 2 Generator, as indicated by the pattern of damage in the compartment, and further suggests that the fire was well established before smoke detector No 30 was activated.
- 4.6 The fire damage to the control cables on all three generators resulted in the generators stopping and a general power failure. The supply of electrical power was limited to the output from the emergency generator from the instant of the main generator failure until restoration of power from a shaft generator when the main engines were restarted and subsequently when No 3 Diesel generator could be started following temporary repairs to fire-damaged cabling. This also resulted in

the ventilation fan motors stopping, so reducing the air supply to the fire at an early stage, probably before the ventilation fans could have been stopped by manual control. This in turn limited the extent and severity of the fire.

Location of fire

- 4.7 The evidence of the engine room rating who first approached the fire and that of the fire party which followed indicates that the fire originated either at the top of No 2 Diesel Generator motor or on the deckhead above. This is confirmed by the survey of the damage conducted on arrival of the vessel at Port Everglades. Photograph No 2 in Appendix 1 taken during the damage survey show damage to the top of No 2 diesel generator and to the deckhead immediately above, while the lower part of the engine is unaffected by the fire or smoke (Photograph No 12)..

Cause of fire

- 4.8 The engine room rating on duty prior to the outbreak of fire was working in the after section of the engine room. He was called on the public address system by the watch engineer to come to the Engine Control room. On his way there he passed watertight door No 11 in the aft engine room bulkhead at about 0040. This door was open and he saw no indication of any fire in the Diesel Generator compartment at that time. That rating then remained in the engine Control Room and received a call from the bridge advising of the smoke alarm activation on the bridge. While receiving this call, the smoke alarms in the Engine Control Room sounded. He then entered the Diesel Generator room and found the fire at No 2 Diesel Generator. He attempted to control the fire using a dry powder extinguisher, but was forced to retire by the dense black smoke, leaving the fire fighting to the Engine Room Fire Party which arrived on scene almost immediately after. This indicates that the fire started soon after 0040 and must have developed rapidly to produce large volumes of black smoke by the time the smoke alarm was activated at 0048.
- 4.9 As there were no witnesses to the outbreak of fire, the precise origin and cause can only be determined from observation of the resulting damage, and inspection of No 2 Diesel Generator. Some cleaning of this generator and surrounding area took place following the fire and prior to arrival at Port Everglades. It has been possible from the evidence available to identify two possible causes of the fire, namely an escape of hot exhaust gases from No 2 cylinder air start valve on No 2 Diesel Generator, and overheating of the fluorescent light fitting situated immediately above No 2 Diesel Generator, leading to flame and ignition of the deckhead insulation and spread of fire.

Exhaust gas leakage from the No 2 cylinder air start valve

- 4.10 An examination of No 2 Diesel Generator revealed that the rocker cover on No2 cylinder had lifted off its seat, while others on the same engine appeared to be in their original positions, seated on the cylinder block. On removal of the rocker cover, it was found that No 2 Unit Air Start valve had lifted around 10 mm, while those on other units were not displaced.(Photographs No 14). Furthermore, it was discovered that a stud securing No 2 Unit air start valve had broken at some time prior to arrival at Port Everglades.

- 4.11 The displacement of the air start valve while the engine was running is considered to have been insufficient to have permitted the passage of flame, but would have been permitted the escape of hot exhaust gas. This view is supported by a build up of products of incomplete combustion depositing on the inside of the cylinder cover (Photograph No 15). If the build up of vaporised lubricating oil inside the cover ignited, the resulting flame would have impinged on the cylinder cover. This would account for the holes found in the covers of No 1 and 3 cylinders.(Photograph No 4).
- 4.12 A fire at the top of the diesel generator would have readily spread to the deckhead above, which is 1.5 m above the top of the engine. This would account for the damage to the electrical cabling, deckhead insulation, public address loudspeaker and fluorescent light fitting.
- 4.13 A section of the deckhead insulation unaffected by the fire was removed and tested for flammability. The sample was found to ignite readily on application of a cigarette lighter flame and emit black smoke. This is possibly due to absorption of oil vapour to the extent that it became flammable, or alternatively the flame retardant material was not as effective as required for such locations.

Electrical ignition

- 4.14 A fluorescent light fitting was fitted immediately above the catwalk between Nos 1 and 2 generators level with the cylinder covers (Photograph No 13). If the electrical components of this light overheated to the extent that they ignited, flame could have spread to the deckhead insulation close above. This in turn would have resulted in the fire damage to the cable insulation and deckhead rotating light. The fire may then have spread to the top of No 2 Diesel generator through burning debris falling on the cylinder covers of the generator. It is however not possible from the evidence available to establish the probability of this mode of ignition from examination of the light fitting and surrounding fire damage.

Probable cause of fire

- 4.15 While it is clear that the fire was centred at the top of No 2 Diesel Generator, it is not possible on the evidence available to identify the cause of the fire with absolute certainty. There is however clear evidence in support of the exhaust gas leakage as the cause. The air start valve on No 2 cylinder had lifted and the escape of exhaust gas is confirmed by the carbon deposits on the inside of the cylinder cover. The ignition of these deposits by escape of hot exhaust gas would also account for the lifting of the cylinder cover.

Spread of fire

- 4.16 Whatever the cause of the fire, it is clear that it developed rapidly and generated large volumes of dense black smoke, resulting in damage to the power and control cables of all three generators. Damage would have been much more extensive had not the fire been extinguished rapidly. While the fire-fighting was assisted in part by the power failure resulting stopping the ventilation fans, it was also successful as a result of the rapid reaction of fire party.

- 4.17 The extent of damage to the deckhead insulation covering material suggests that it may have absorbed oil vapour to the extent that it could be readily ignited by flame. The possibility of this recurring could be reduced by improvement of the deckhead insulation covering so that it could be more readily cleaned.

Electrical Cabling

- 4.18 The control cables for all three generators were mounted on cable grids close to the deckhead. As a result, all were vulnerable to damage from a common source (Photograph Nos 8 and 11). In this incident, only one generator could be operated after the fire, and this was only possible following temporary repairs to the damaged cables. The risk of losing all generating capacity in similar circumstances could be reduced by running the control cables separately.

Fire protection of Diesel Generator Room

- 4.19 Although rapid fire-fighting action was taken as soon as the first smoke alarm was activated, an earlier indication of such an outbreak could be provided by fitting a closed circuit television camera coupled to a monitor in the engine control room. This might be considered justifiable by the desirability of avoiding a total loss of power as occurred in this case.

- 5.1 The first indication of a fire in the Diesel Generator Compartment was the simultaneous activation of smoke alarms on the Navigating Bridge and Engine Control Room at 0048 on 17 January. The fire started shortly before that time but developed rapidly, resulting in damage to the electrical cabling serving all three diesel generators. Deckhead insulation and fittings and No 2 Generator were also damaged by fire.
- 5.2 As a consequence of the fire damage to the generator control cables, all three generators stopped, resulting in a power failure and main engine shut down. The vessel then drifted with emergency power supplied by the emergency generator which started automatically when the diesel generators stopped.
- 5.3 The Engine Room Fire party was immediately assembled and other crew summoned to emergency stations as a precaution. The fire fighting party wearing breathing apparatus entered the Diesel Generator Compartment at 0105 and located the fire at the top of No 2 Generator. The fire was then completely extinguished by 0110. The rapid extinction of the fire resulted from prompt, efficient and effective response of the crew to the activation of the smoke alarms.
- 5.3 On completion of the fire fighting, the No 3 main engine was restarted at 0130 to provide electrical power from the shaft generator. This generated sufficient electrical power for auxiliary machinery to enable all main engines to be started and propulsion restored. The passage to Port Everglades was then resumed at reduced speed using three engines for propulsion and one for electrical power generation. Temporary repairs were then made to the cables serving No 3 Diesel Generator thus providing sufficient electrical power for normal service requirements.
- 5.4 Although the vessel was disabled for a period of around one hour with only emergency electrical power available, there were no injuries to any persons and the vessel was not in danger of drifting towards the coast.
- 5.7 As the Diesel Generator compartment was not manned at the time of the outbreak of fire, the conclusions as to the origin of the fire are based on inspection of the No 2 diesel generator and the fire damage around the deckhead above after the vessel returned to Port Everglades. It is concluded that the cause of the fire was either the escape of exhaust gases from a damaged air start valve on No 2 cylinder on No 2 Diesel Generator, resulting in ignition of lubricating oil within the cylinder head and spread of fire to the deckhead, or the overheating and of the electrical components of a fluorescent light situated above No 2 Diesel Generator. While it has not been possible to identify the cause of the fire with absolute certainty, the weight of evidence suggests that the escape of exhaust gases from No 2 cylinder of No 2 Diesel Generator is the more likely cause.
- 5.8 Whatever the cause, the fire spread to the deckhead insulation which was found to be flammable when tested. The flammability of the deckhead insulation may have

been due to absorption of oil vapour over time. The irregular surface of the deckhead insulation covering may also have facilitated the accumulated absorption of oil vapour because of the difficulty of cleaning that surface.

- 5.9 Once started, the fire developed rapidly and resulted in a failure of main electrical power and loss of propulsion, notwithstanding the prompt response of the fire party. As the Diesel Generator compartment is not continuously manned, the existence of the fire did not become known to the engineer on watch until the smoke detector alarm first activated. If earlier indication of the fire at No 2 Diesel Generator had been available, there may have been sufficient time to shut it down and so avoid the total power failure that occurred. The fitting of a closed circuit television camera in the Diesel Generator compartment with a monitor in the Engine Control Room would provide visual warning of any outbreak of fire to the engineer on duty.

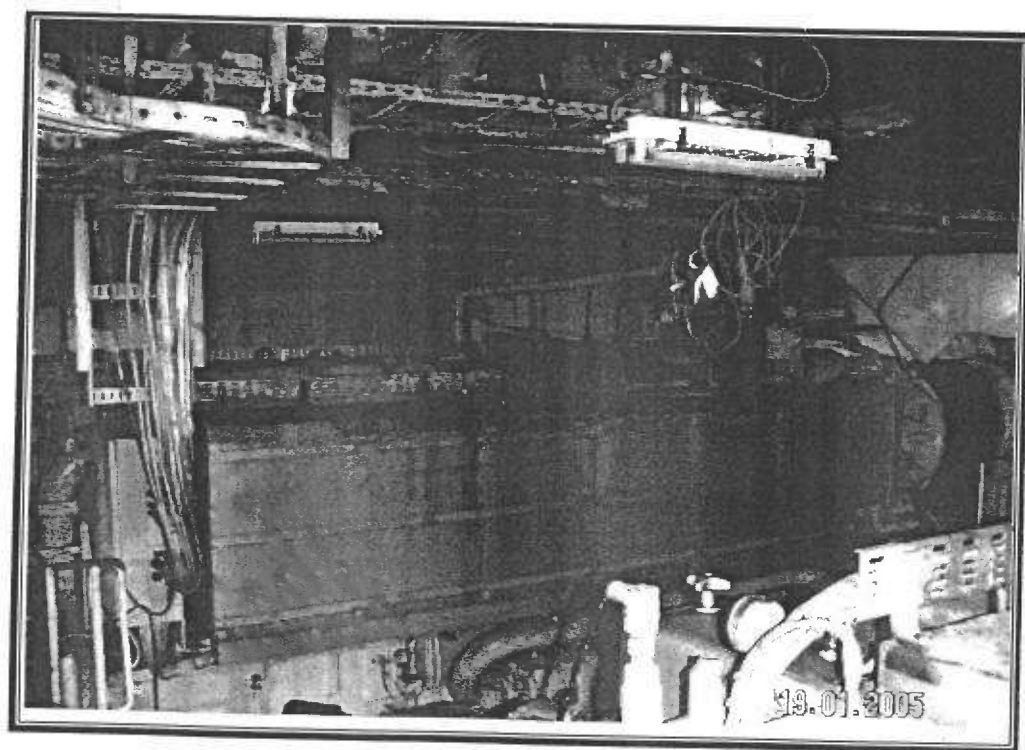
- 6.1 In view of the vulnerability of the total power generation to fire damage, and the resultant disablement of the vessel, it is recommended that the cabling serving each of the three diesel generators be separated and protected with some degree of insulation.
- 6.2 As the fire appeared to spread rapidly, in part due to the flammability of the deckhead insulation covering, it is recommended that the insulation be improved and finished with a smooth surface for ease of cleaning where practicable to avoid the accumulation of oil mist over time.
- 6.3 As the more probable cause of the fire has been identified with cylinder head air start valve on a diesel generator, it is recommended that consideration be given to strengthening the shipboard inspection of the cylinder head components of the generators.
- 6.4 As the Diesel Generator compartment is not continuously manned, and fire, once initiated, can intensify rapidly, it is recommended that the monitoring of this space is improved, and consideration given to installing a closed circuit television monitoring system.
- 6.5 The arrangements on the vessel for preservation of data from the Voyage Data Recorder and Engine Room Alarm system be reviewed and amended to ensure that data is preserved for investigation of any future incidents.

Appendix 1

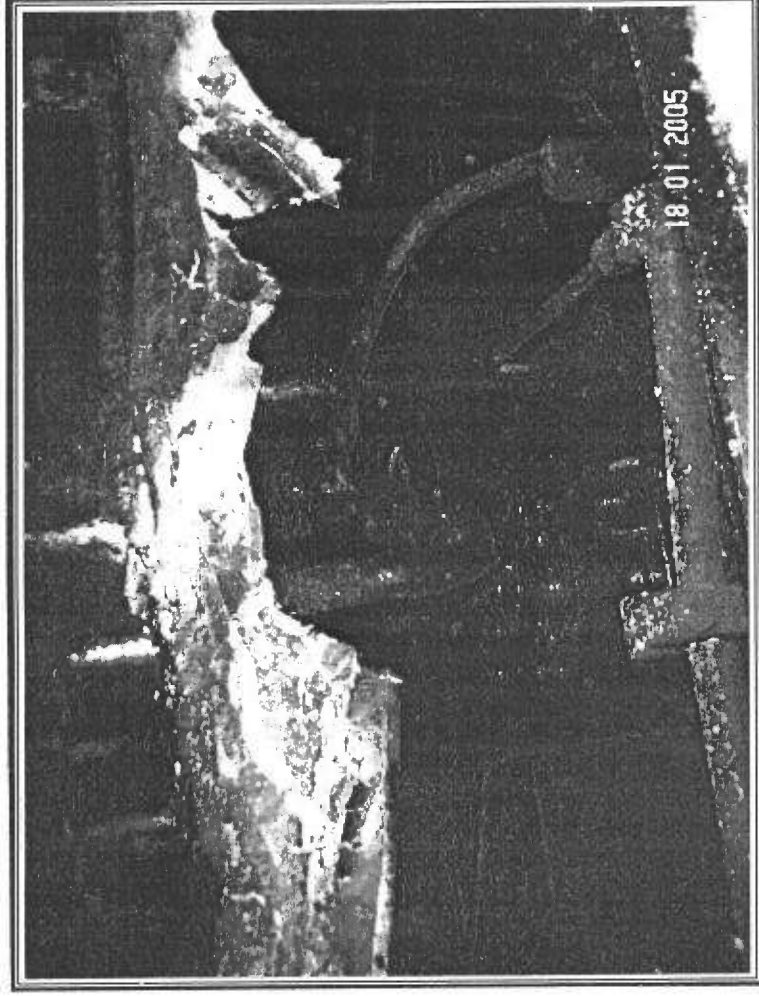
Photographs of the vessel and fire damage



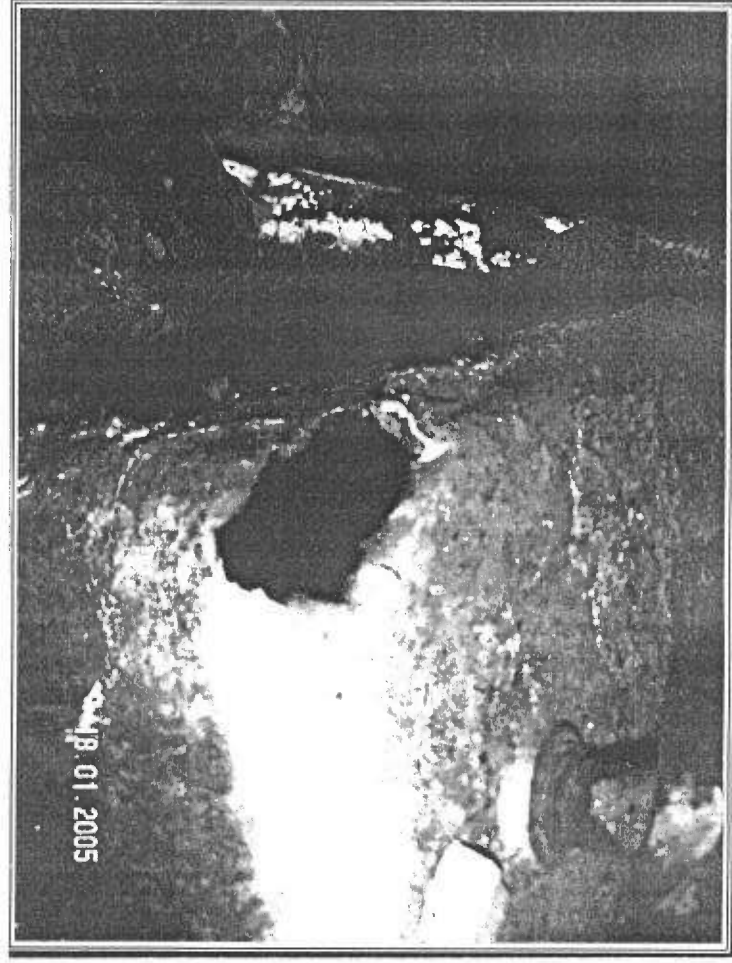
1. Seven Seas Navigator at Port Everglades



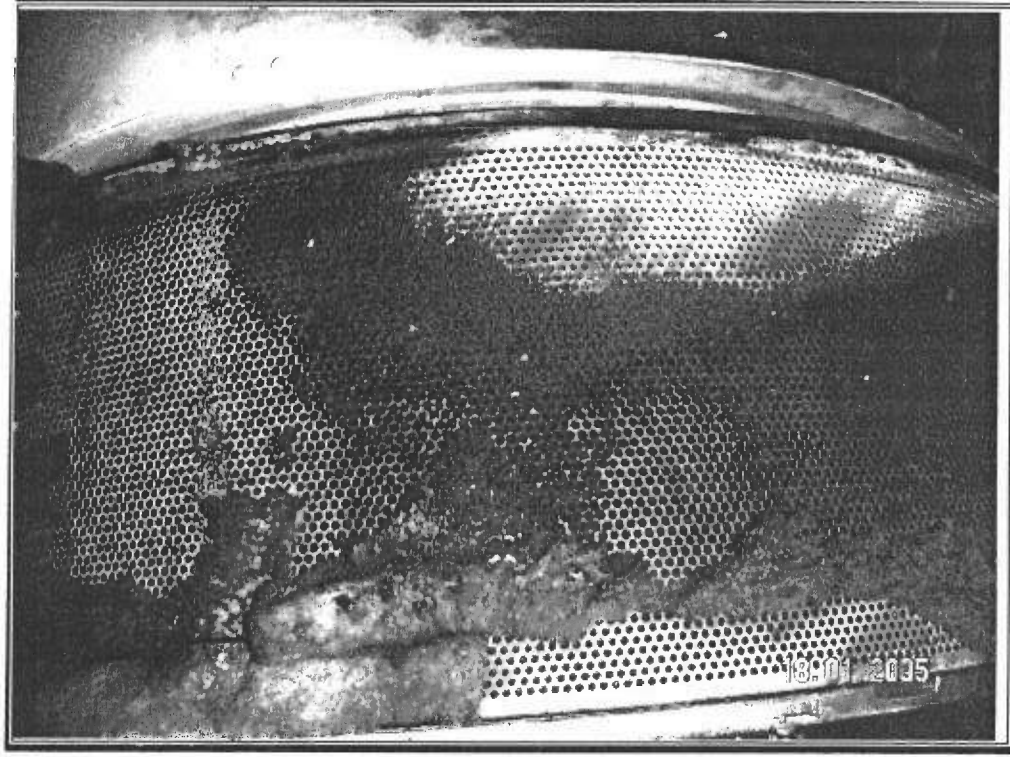
2. Diesel Generator Room showing No 2 Generator in foreground



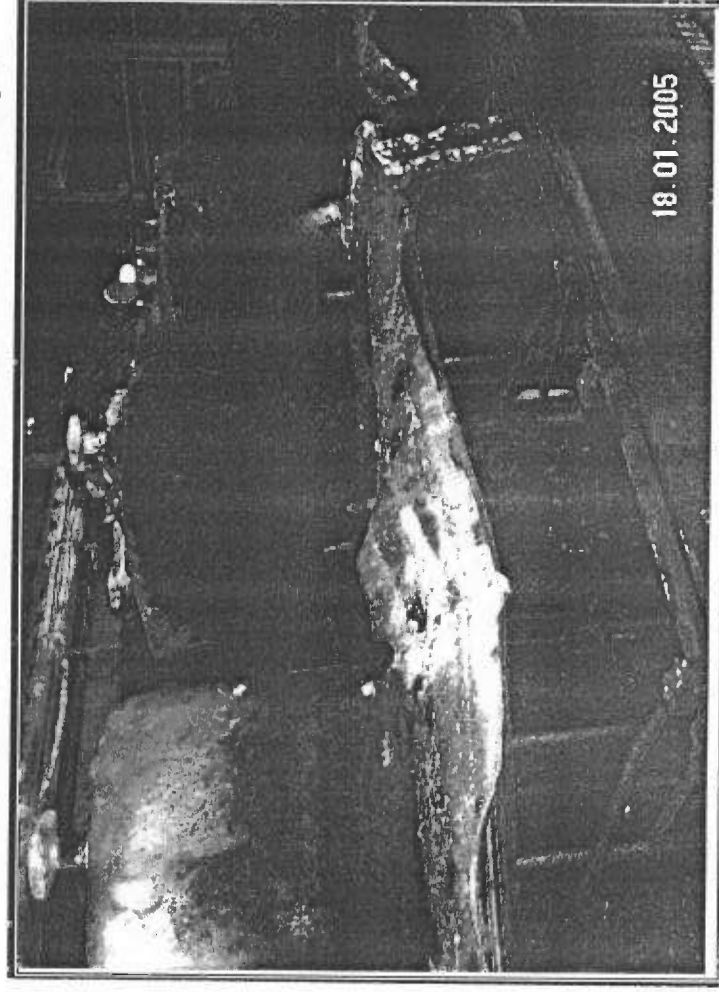
3. No 2 Diesel Generator Fuel Pump No 2



4. No 2 Diesel Generator No 1 Cylinder Cover



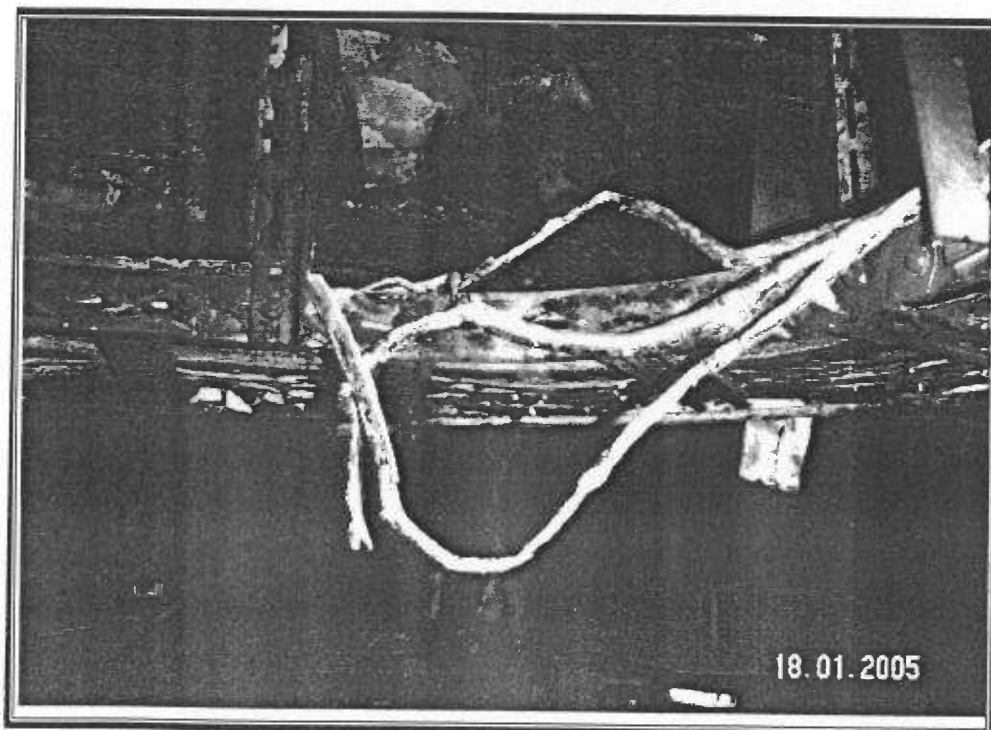
5. No 2 Diesel Generator Turbocharger Inlet Filter Casing



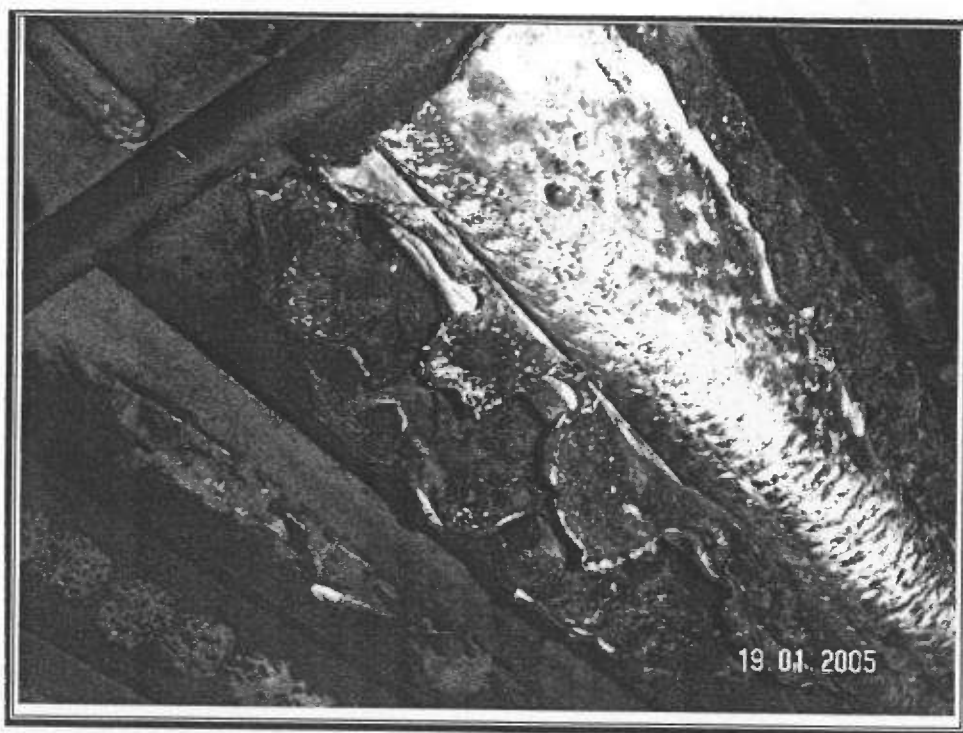
6. No 2 Diesel Generator Aft Fuel Pump Casing



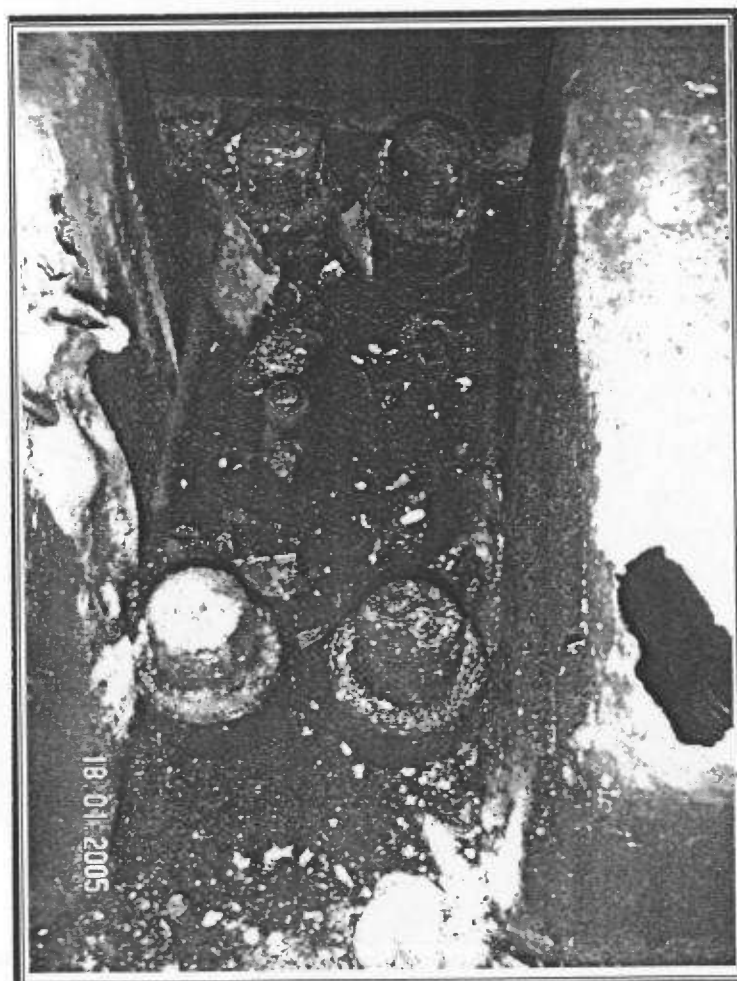
7. Remains of rotating alarm light



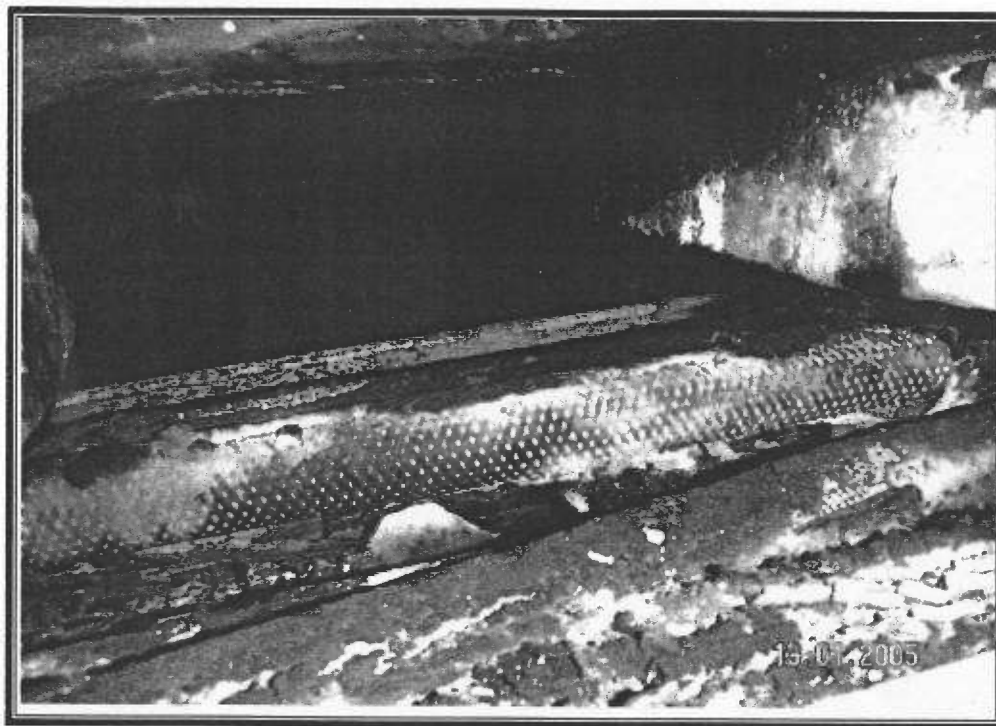
8. No 2 Diesel Generator Control Cables



9. Damaged No 1 Diesel Generator Power cables above No 2 Diesel Generator



10. View between No 1 and 2 Units on No 2 Diesel Generator



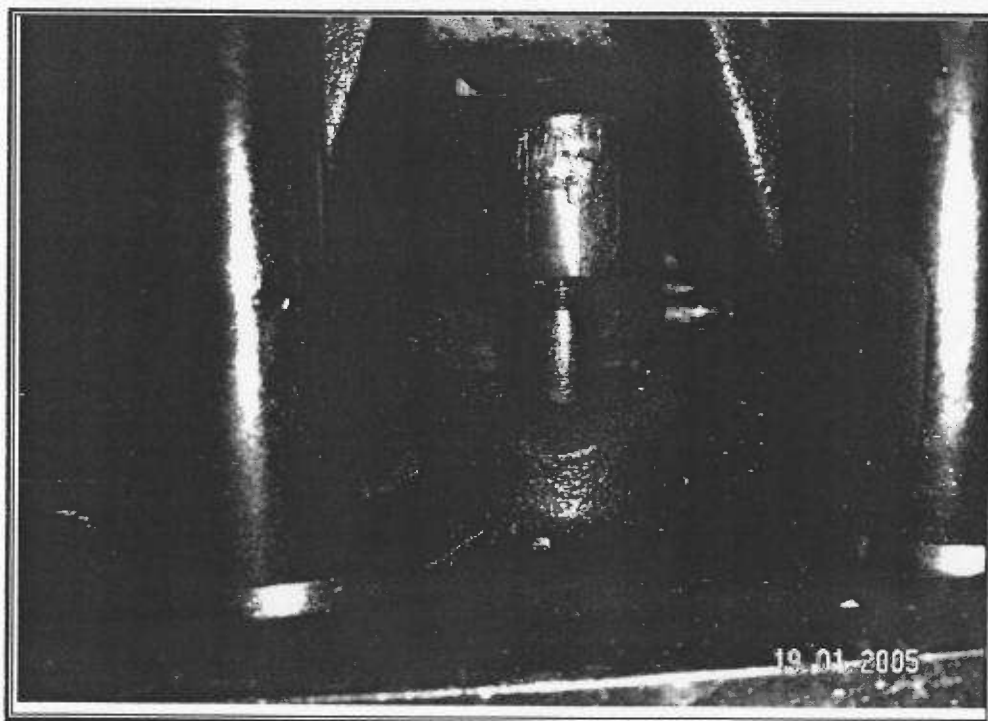
11. Damaged power cables above No 1 Diesel Generator



12. No 2 Diesel Generator Crankcase Doors



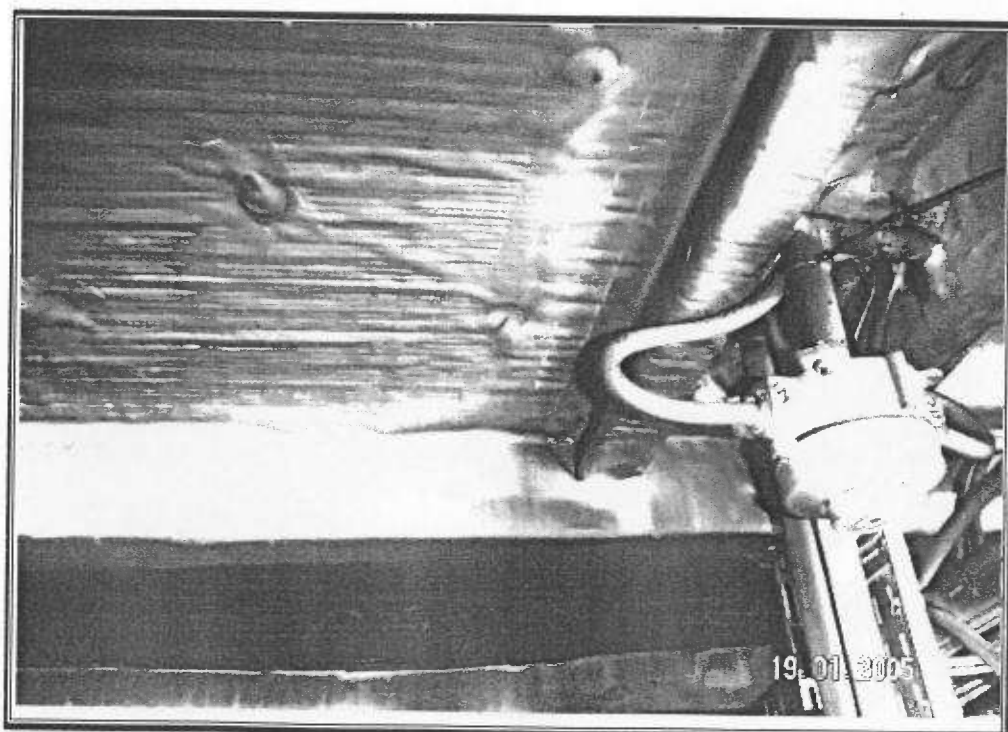
13. Fluorescent light fitting previously above catwalk between Nos 1 & 2 Diesel Generators



14. No 2 Diesel Generator No 2 Unit Air Start Valve, lifted 10 mm



15. Build up of carbon inside No 2 Cylinder Cover of No 2 diesel Generator



16 Undamaged deckhead insulation on starboard side of Diesel Generator Room



17. No 2 Diesel Generator No 2 Air Start Valve



18. Diesel Generator Room Smoke Detectors