



# The Bahamas Maritime Authority

## **“Explorer” and “Voyager”**

**IMO Numbers 9183518 & 9183506**

**Official Numbers 8000789 & 8000790**

**The combined report of the investigations into  
the disablement of the passenger vessels  
Explorer & Voyager, due to the failure of the  
bridge front windows, during severe weather  
conditions, on the 27 January & 14 February 2005**

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*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 Explorer and Voyager are virtually identical sister ships built for the same owner for passenger cruising service. They are of conventional passenger ship design, with bridge relatively close to the bows and two decks above the forecastle deck. The vessels suffered very similar damage to bridge windows within a short period of time, with the same consequences.
- 1.2 While on passage from Vancouver to Hakodate, Explorer encountered severe weather over several days during which superficial damage to deck fittings occurred and difficulties were experienced in securing lifeboats, tenders and gangways. On 27 January 2005, while making a speed of 7 knots, the vessel was struck by two large waves in succession. Water was slow to clear from the foredeck and the second wave struck the bridge front, breaking a wheel house window near the centreline of the vessel. A large quantity of water entered the bridge and caused severe water and physical damage to the control console. The main engines stopped and the vessel drifted beam on to the weather.
- 1.3 After overcoming difficulties in starting the main engines on local engine room control, the vessel regained steerage way and altered course to place the wind and seas astern. The vessel then diverted to Hawaii where essential repairs were made.
- 1.4 Voyager was engaged on a Mediterranean cruise and was on passage Tunis to Barcelona. On 14 February 2005 the weather deteriorated and speed was reduced until the vessel was in effect hove to, making about 3 knots against the wind and seas. Voyager was struck by two waves in succession, breaking over the bow and advancing towards the bridge. A window at the centreline of the vessel was forced inwards and a large quantity of water entered the bridge. The main engines stopped and the vessel drifted beam on to the wind and seas, rolling heavily.
- 1.5 As on Explorer, difficulties were experienced in re-starting the main engines and operating them on local control from the engine room. With two engines running, the vessel was turned away from the weather and sailed to Cagliari, accompanied initially by the LNG carrier Gimi which provided communication and navigational assistance.
- 1.6 The report analyses the circumstances leading to the identical occurrences. While the weather was severe, more so in the case of Explorer, it was not exceptional. The vessels met all classification and relevant international conventions requirements yet were disabled following the impact of waves on the bridge front. Although the route followed by Explorer was not in accordance with that generally recommended for the North Pacific in winter, and was almost certain to take the vessel through more severe weather than on the recommended

routes, this is not sufficient to account for the breakage of the bridge window. Voyager was hove to in a timely manner and yet suffered identical damage, though in slightly less severe weather.

- 1.7 The report finds that the strength of the bridge windows on the vessels exceeded that required by international standards. Noting that the owners have voluntarily strengthened the vessels and constructed breakwaters on the foredeck to impede the passage of waves breaking over the bows, the report recommends that the loading on the bridge front in severe weather be re-evaluated. The report further concludes that the proximity of the bridge to the bows and to the foredeck, and the entrapment of water by the bulwarks enabled the damaging wave to travel along the surface of the entrapped water and engulf the entire bridge front, and suggests that designers take this into account in the design of passenger and other ship types in the future.
- 1.8 The report further recommends that the bridge control systems on the vessels be reviewed to ensure that the engines can be operated on local control in the event that the bridge consoles are damaged. This requirement is in accordance with SOLAS II-I/31.2.6

## 2 PARTICULARS OF VESSELS

- 2.1 The vessels are sister ships built by Blohm and Voss in Hamburg and operated by V Ships Leisure SAM for passenger cruising service. The principal particulars of the vessels are as follows:

	<b>Explorer</b>	<b>Voyager</b>
Official Number	8000789	8000790
IMO Number	9183518	9183506
Length overall	180.4 m	180.4 m
Length BP	157.50 m	157.40 m
Breadth	25.52 m	25.52 m
Depth	12.70 m	12.70 m
Gross Tonnage	24,318	24,391
Net Tonnage	10,020	10,053
Deadweight (maximum)	2,400 tonnes	2,400 tonnes
Call Sign	CTN4	CTN5
Year of build	2001	2000
Maximum speed	29 knots	29 knots

- 2.2 The vessels have 9 decks. Deck 1 coincides with the designed waterline and the forecastle in on Deck 4. The superstructure on decks 4 and 5 have front Crew cabins, these are situated at the forward end of Deck 5, immediately below the navigating bridge. There is a pronounced flare on the bow, and bulwarks extend from the fore end of the forecastle aft to the superstructure front bulkhead. These bulwarks slope upwards to reach deck level 5, and are fitted with freeing ports conforming to class and international convention requirements.
- 2.3 The vessels are powered by four Wartsila NSD Type diesel engines each developing 9,450 kW on maximum power. Two engines are connected to each of the twin propeller shafts through a clutch and reduction gearing. By means of the clutch mechanism, the vessel can be powered by one or more engines. Due to difficulties in steering the ship on a single screw, it is normal to operate with a minimum of one engine driving each propeller. The propellers are of the controllable pitch type. The maximum speed on four engines is 29 knots.
- 2.4 The engines are controlled from the bridge, all controls being situated in the console at the centre of the wheelhouse, immediately aft of the wheelhouse front

bulkhead and windows. Engines may also be controlled manually from the engine control room, provided that control is transferred from the bridge console to local control in the Engine Room.

- 2.5 Electrical power for passenger and crew spaces, auxiliary machinery, steering gear and deck machinery is provided by diesel generators in the Auxiliary Engine Rooms.
- 2.6 The vessels were built to the requirements of Germanischer Lloyd Classification Society in force at the time of building and have been in Class continually since entering service. Although intended for service in the Mediterranean when built, there were no restrictions on the employment of either vessel. The scantlings of the bow structure were however increased to withstand a higher loading on vessels with a bow flare exceeding 40° than that which was previously required by Class rules. Both vessels complied with these higher strength requirements for the bow structure.
- 2.7 The wheelhouse extended for the entire breadth of the vessel, and was constructed of steel. Windows are fitted along the forward bulkhead and on the sides of the wheelhouse. These windows comprise double panes of glass retained in conventional metal frames by closely spaced bolts. The windows slope forwards to reduce glare. The bridge front bulkhead is sloped aft from the foredeck and contains windows to crew cabins and offices. Steel plate bulwarks extend from the stem to the bridge front bulkhead, increasing in height towards the bridge.
- 2.8 Each vessel has four lifeboats and tenders on each side stowed between deck 5 and 6, and a gangway and platform stowed each side on deck 8.
- 2.9 The vessels have been continuously registered in The Bahamas since first entering service.
- 2.10 Explorer complied with all statutory and international convention requirements for passenger ships on international voyages. No deficiencies were recorded during the port state control inspection on 6 August 2004, nor on any of the previous seven port state control inspections. The Bahamas Maritime Authority annual inspection carried out on 8 November 2004 was also satisfactory.
- 2.11 Voyager likewise complied with all statutory and international convention requirements. No deficiencies were recorded in the port state control inspection carried out at Messina on 10 February 2005, nor on any of the previous seven inspections since 31 March 2002.

**Part A - Explorer**

3.1 All times stated in this section are local times at ship in the standard 24 hour clock format, without additional annotation, unless otherwise stated. The equivalent time in UTC format is given in brackets where appropriate.

3.2 Explorer was chartered to Semester at Sea for an educational cruise from Vancouver to Japan and Korea and carried 681 students and 113 teaching staff in addition to a crew of 113.

On 18 January 2005 the Master conducted a detailed briefing of all officers for the intended voyage from Vancouver, British Columbia to Pusan, calling at Hakodate for bunkers en route. The sailing plan provided for the vessel to follow a course of 270°T for a distance of 1,378 miles after leaving the traffic Separation Scheme at the entrance to Juan de Fuca Straits. This course would have taken the vessel to Longitude 160°W along latitude 47°N. The intended course was then 260° for a distance of 2,435 miles to the approaches to Hakodate, gradually moving southwards to latitude 40°N.

3.3 The vessel left Vancouver at 1642 on 18 January 2005 and proceeded along the planned route through the Juan de Fuca Strait without incident. The draught on departure was 7.3 m forward and aft. Nos 2 and 3 main engines were started on leaving Vancouver and remained in continuous operation for several days.

3.4 Strong winds, rough seas and a heavy swell as encountered at the beginning of the sea passage on 19 January. A Force 7 west-south-west wind and high seas from a south-westerly direction were experienced during the middle of the day, resulting in heavy rolling and pitching with some pounding. Engines were running at 50% power, until 2200 on 19 January, when power was thereafter increased as the weather moderated. Weather forecasts were obtained daily and evaluated in relation to the intended track.

3.5 Weather abated briefly early on 20 January, but wind began to freshen during the day and by midnight had reached Force 8 to 9 from a southerly direction. Motion of the vessel caused the tenders to move and additional lashings were applied.

3.6 At 0255 on 21 January, the vessel was struck by a large wave which broke over the forecastle and dislodged two mooring baskets from their deck fixings. The wind force was estimated to be Force 9, with wave height estimated to be 8 to 9 metres. The vessel was rolling and pitching heavily and at times pounding. The weather then moderated slightly, and course was altered from time to time to

reduce the rolling and pitching. The vessel was at that time running on Nos 2 and 3 engines at 86% and 66% of full power respectively and making an average speed of 16.2 knots

3.7 The weather worsened again on 23 January, with the strongest Force 8 winds around the middle of the day from a south-westerly direction. At 1531 a wave broke over the bows and caused the following damage:

- Fan Room on No 3 Deck partially flooded
- Bosun's Store on Deck 3 partially flooded
- Telephone box at winch control washed overboard
- Two public address speakers destroyed
- Two fire hose boxes destroyed
- Four mooring line baskets destroyed
- Six external lights on bridge front bulkhead and forecastle destroyed
- Storage box and 3cm radar destroyed
- Two bridge windscreen wipers severely deformed

The course at that time was 269° T and the engines were running at 70% of full power. The vessel was making an average speed of 17.6 knots. Engine power was reduced to 50% of full power on Master's orders at 2130. Course was varied throughout the 24 January to lessen the motion of the vessel while experiencing Force 7-8 winds and seas of 7 - 8 metres in height from a westerly direction.

3.8 Throughout the 25 January the vessel remained on a westerly course making an average speed of 12.7 knots with no abatement in the wind and sea conditions with the vessel pitching and rolling heavily. Around 2145 the wind increased to Force 9-10. The Master was informed and speed reduced to 50% of full power.

3.9 As the vessel crossed the International Date Line at 1608 on 25 January and ship's time then advanced and the following day became 27 January. At 0025 on 27 January the window on the Chief Engineer's cabin was smashed by a large wave breaking over the foredeck. The Chief Engineer was struck by glass from the shattered window and taken to the ship's hospital for medical treatment. Course was altered to 030° T to permit temporary repairs to the window. This was completed by 0120 and the course of 285° T resumed. Shortly after a mooring rope basket on the foredeck was dislodged. Course was again altered to 030° T and speed reduced while the mooring rope basket was secured and the mooring rope which it had contained stowed in the Bosun's Store. Two large

tender embarkation platforms were found to be moving and secured with additional lashings. At 0245 on 27 January the vessel was brought to a course of 285°T, but experienced very heavy rolling on this heading. Course was then altered to 030T° to lessen the motion of the vessel.

- 3.10 The heavy motion of the vessel continued and an announcement was made to passengers and crew regarding the situation. The chart table on the bridge was destroyed at 0312 due to heavy rolling and an additional lashing on the port side tender parted and was renewed. Course was altered to 080°T at 0335.
- 3.11 While making a speed of 7 knots, the course was altered to 240°T at 0542 on 27 January. At 0630 two very high waves struck the vessel from ahead. While the vessel was moving down into the trough of the first wave, the second wave broke over the bow, moved aft and struck the bridge front bulkhead. The centre bridge window was blown inwards under the force of the wave and a large quantity of water entered the bridge deck. An attempt was made to turn the vessel downwind to place the seas astern. Before this could be accomplished the control console situated in the centre of the bridge immediately aft of the broken window was swamped by a series of waves breaking over the foredeck resulting in sea water entering the wheelhouse through the broken window. This caused the main propulsion and steering systems to shut down. The vessel then settled on a heading of around 209°T, about 80° off the direction of the wind and swell. Some small electrical fires in the bridge console caused by electrical short circuits following the ingress of water were extinguished with portable appliances.
- 3.12 The emergency steering gear was immediately manned but steerage was not possible without main propulsion. The vessel was rolling to angles estimated to be as high as 45° at times in waves of 10 to 12 metres in height. Electrical power was maintained by the emergency generator, which started automatically when the main engines stopped. A distress signal was transmitted and received by the United States Coastguard at Juneau in Alaska. The operators of the vessel were also informed and contacted the United States Coastguard. Passengers were summoned to muster with lifejackets on deck 5 at 0645.
- 3.13 Difficulties were experienced in re-starting the main engines as a result of the damage to the bridge console. No 3 Main Engine was started under local control at 0710. This was made possible by manual adjustment of the fuel racks by crew in the engine room, and facilitated maneuvering of the vessel to minimize rolling. A magnetic compass was removed from a lifeboat and used to steer the vessel. During these manoeuvres a second window on the starboard side of the bridge was broken following impact with a heavy sea. By 0930 the Chief Engineer and his staff ascertained how to disconnect the main engine controls from the bridge console and were able to start No 2 Main Engine and run it using local manual control. No 1 Main Engine was started at 1015. The vessel then proceeded at slow speed under the power of Nos 1 and 2 Main Engines and

turned onto an easterly heading with wind and seas astern. The position at 1100 on 27 January was Lat 40° 41.0'N Long 178° 03.0'E

- 3.14 When control of engines was regained, the vessel proceeded on a course of 130°T towards Midway Island, with the wind and sea astern. Weather conditions remained severe throughout the remainder of 27 January but began to abate later that night. As the vessel re-crossed the International Date Line in an easterly direction, the following date was also recorded as 27 January in the ship's log books. Some further difficulties were experienced with the steering gear motor and the starboard shaft reduction gear, all of which were resolved. Weather continued to abate and it was decided to make for Honolulu rather than Midway. The vessel was met by an escort tug off Honolulu and escorted for the remainder of the passage, and berthed at 1442 on 31 January.
- 3.15 As a result of the heavy rolling and pitching experienced by the vessel, fourteen passengers were given medical treatment aboard the vessel for injuries resulting from the violent motion of the vessel. Three of these passengers received further treatment in Honolulu. Seventeen members of the crew were also injured and treated on the vessel, eleven of whom required further treatment in Honolulu.
- 3.16 A survey by the classification society identified the following damage to the vessel during the passage from Vancouver:
- a) Two longitudinal frames and under-deck longitudinal in the Forepeak Void Space cracked;
  - b) Extensive damage to bridge control systems and instrumentation;
  - c) Side shell plates starboard side, frames 20-24, draughts 7.4 to 7.8 m;
  - d) Sharp indent to port side shell plating at frame 228;
  - e) Forepeak Lamp Room and Deck Store side shell and internals damaged;
  - f) Paint Store and Void Space side shell and internals damaged;
  - g) Forepeak tanktop, longitudinals and web frames damaged;
  - h) Engine Room side shell damaged between decks 1 and 2, frames 117 to 142 Port and 108-147 Starboard;
  - i) Foredeck ventilators damaged;
  - j) Foredeck lifebuoy rack and firehose boxes damaged;
  - k) Bridge window and Chief Engineer's window.

Photographs of the damage are in Appendix IIIA.

## Part B – Voyager

- 3.17 Voyager was engaged on a Mediterranean cruise and vessel sailed from Tunis on the afternoon of 13 February 2005 to return to Barcelona. On reaching open sea a course of 302°T was set with the engines running at full power. During the afternoon the wind began to veer to North-west and strengthen. By 2100 on 13 February the wind had increased to Force 6 to 7 and wave height to 3 to 4 metres. Engine speed was reduced to 65% of full power to maintain a speed of about 12 knots. The ship's stabilisers were in operation. A further reduction to 50% of full engine power was made at 2115 to maintain a speed of 10 knots.
- 3.18 The Master continued to monitor the weather and movement of the vessel and at 0530 on 14 February he ordered the course changed to pass between the islands of Mallorca and Menorca to take advantage of the less severe seas expected between these islands. The vessel continued to pitch in the heavy seas and gale force winds and at 0700 the engine power was further reduced to maintain a speed of about 3 to 4 knots. The position at this time was Lat 39° 22.2'N Long 5° 46.4'E. The vessel was then in effect hove too with wind and seas ahead, and shipping heavy seas over the foredeck.
- 3.19 At 0840 on 14 February, while encountering successive waves of 7 to 9 m height breaking over the foredeck, a window near the centre of the navigating bridge was struck by an oncoming wave, broken, and washed into the wheelhouse. A substantial quantity of water entered the wheelhouse and landed on the control console situated in the centre of the bridge. The window was detached from the bulkhead and one pane of the two panes of glass was shattered.
- 3.20 The ingress of water caused a complete loss of all electrical systems on the bridge and all except the No 3 main engine stopped. No 3 engine continued to run until 0849 and then stopped. The ship's stabilisers retracted automatically when the power was lost. The vessel then lay beam on to wind and sea, rolling heavily.
- 3.21 At 0845 contact was made with the vessel LNG carrier "Gimi" using the emergency hand held VHF radio. This vessel alerted the owners of the vessel and MRCC at Cagliari then proceeded towards Voyager and stood by the vessel. The weather conditions were recorded on Gimi as, wind Force 11 from a north-westerly direction and seas of up to 9 metres in height.
- 3.22 On Voyager, passengers and crew were called to muster stations using the public address system on deck 5 and the General Alarm sounded. An Epirb was activated and at 0934 several attempts made to restart No 3 Main engine to provide propulsion. This was achieved at 1030, but there was insufficient power to enable the Master to bring the vessel head downwind. A second engine was

started at 1110 and attempts made to turn the vessel away from wind and sea. This was accomplished by 1310, when the vessel was running away from wind and sea. Engines were controlled directly from the engine room and steering controlled directly at the steering gear, with orders passed from the bridge by radio.

- 3.23 Navigational information was relayed from Gimi to Voyager by VHF radio. The vessel then proceeded to Cagliari at a speed of 11 knots and accompanied by the LNG carrier “Gimi”. In response to the distress message transmitted by Epirb from the vessel, a helicopter arrived overhead at 1237 and offered assistance. By this time the injured passengers had been treated and external evacuation by air was not required.
- 3.24 The vessel berthed at Cagliari at 1000 on 15 February with the assistance of tugs. Injured passengers were provided with medical treatment and all passengers returned to Barcelona by air. Gimi was released from escort duties at 0540 on 15 February on the arrival of an escort tug from Cagliari.
- 3.25 In addition to the breakage of the bridge window, the following damage resulted from the initial impact of the breaking wave and subsequent violent rolling while the vessel was disabled:

- Three mooring rope baskets on the foredeck severely damaged
- Extensive water damage to bridge control systems and equipment
- Panelling in bridge severely damaged around broken window
- Extensive damage to furniture and fittings within accommodation

Photographs of the damage are in Appendix IIIB.

**Part A - Explorer**

- 4.1 Following the incident, an expert analysis of the meteorological conditions experienced on the passage from Vancouver until the time of the occurrence was made. The results of this analysis correspond reasonably closely with the observations of wind and sea conditions recorded by the watchkeeping officers in the deck log book. The crew of the vessel on duty at various stages in the emergency also provided eye witness accounts of events and in particular the circumstances leading to the damage to the bridge windows and subsequent events. All of this evidence is considered reliable and provides a sound basis for the investigation of the casualty.

Weather damage preceding the loss of power

- 4.2 While the major damage and loss of propulsion occurred when the bridge window was breached on 27 January, there were several incidents involving weather damage prior to that date, namely;

- heavy rolling and pitching on 19 January necessitating a reduction in speed;
- motion of the vessel on 20 January resulted in tenders moving and requiring additional lashings;
- large wave breaking over the foredeck dislodged two mooring rope baskets on 21 January;
- large breaking wave caused damage to fittings and flooding of Fan Room and Bosun's Store on 23 January;
- Chief Engineer's window smashed by a large breaking wave on 27 January, followed soon after by a rope basket on the foredeck becoming dislodged and tender platforms found to be moving, requiring additional lashings to be applied.

Although the disablement of the vessel following the ingress of water through the broken bridge windows on 27 January could not have been reasonably predicted, this did provide a forewarning that the vessel was vulnerable to the prevailing weather on the chosen route across the North Pacific Ocean.

- 4.3 At the time the bridge window was smashed, the vessel was on a course of 240°T and making a speed of 7 knots. The meteorological analysis indicates that

wave heights of 9 metres would have been experienced. Accounts of those crew present on the bridge indicated that the vessel encountered two waves of shorter period than the prevailing wave pattern. After the crest of the first wave had passed the bridge, and while the vessel lay in the trough of the waves, the second wave broke over the bow. A large body of water advanced toward the bridge, impacting on the bridge front bulkhead, resulting in the centre bridge window being dislodged inwards and a large mass of water entering the wheelhouse. It seems probable that the foredeck was flooded to the height of the bulwarks by the first wave, following which the second wave advanced along the surface of the entrapped water. The crest of this second wave was described as being higher than the bridge windows. This suggests that the wave impacted directly onto the bridge window. Due to the forward and upward slope of the bridge windows, the effect of the impact would have been greater than if the windows had been either vertical or inclined aft, in the other direction.

#### Choice of route

- 4.4 While there is no evidence that the vessel had previously experienced any significant weather damage on the scale sustained on this voyage, the size of the vessel and the known weather conditions in the North Pacific in winter might have been expected to be considered in planning the track to be followed. The Ocean Passages of the World recommends that vessels bound from Vancouver to Hakodate follow a near great circle track north of the Aleutian Islands or close south of them. The rationale in following this route is that low pressure systems generally move north-eastwards from Japan towards the Aleutian Islands and the Gulf of Alaska. The worst sea conditions are therefore experienced to the south of the low pressure centres, with westbound vessels experiencing head seas. Conditions are generally less severe to the north of the low pressure centres or far south of their easterly tracks. If this northerly route is not followed, Ocean Passages recommends following a westerly route along latitude 35°N or even further south.
- 4.5 After leaving Vancouver, the intended track was westwards along Latitude 48° 30'N to Longitude 160° and thereafter a course of 260°T to reach Latitude 41° 47'N. This track was proposed by the Master and considered at briefings to the navigation officers, none of whom expressed any reservations as to the route. This route lay roughly midway between the northerly and southerly routes recommended in the Ocean Passages of the World. The more northerly route would have been slightly shorter, while the southerly route would have been longer than the chosen track. Although the vessel may have encountered severe weather on either of the recommended routes, the risk of severe weather on the chosen route was clearly significantly higher.

#### Action to avoid weather damage

- 4.6 While speed was reduced and course altered on several occasions before the bridge window incident, the vessel was nevertheless subject to violent pitching

and rolling at times. The Master was clearly conscious of the potential for weather damage to the vessel, excessive pitching and rolling, and gave instructions in his Night Orders at various times to avoid excessive pounding and to call him at any time if in doubt. There are however some indications that the Master may have been over anxious to maintain progress towards Hakodate. On 24 January, while the vessel was experiencing headwinds of Force 7 to 8 and seas of 7 to 8 metres, the watchkeeping officers were instructed as follows in the Master's Night Orders:

“Hold course between 260-280. We must go in as straight a line as we can. Yes we might roll and pound but go straight we must. Fuel is a very real consideration”

This suggests that the Master may have been over anxious to maintain progress and concerned about fuel consumption. At Noon on 19 January the vessel had 1026 tons fuel oil remaining on board. At an average speed of 15 knots, approximately 635 tons would have been expected to be consumed for the remainder of the passage. This would have left 391 tons fuel remaining on board on arrival. This is a reasonable margin of safety, so there need have been no concern as to the adequacy of fuel on board. If however a higher speed was intended or required, as seems likely, then fuel may well have influenced the Master in maintaining higher speeds than might be considered in relation to the weather.

- 4.7 Weather forecasts were received on the vessel twice daily throughout the passage. This included the synoptic chart of the North Pacific and forecasts of significant wave height predictions for 24, 48 and 96 hour periods. These were reviewed daily by the Master and alterations of course made to avoid the more extreme weather conditions. Problems were experienced from 20 January onwards, when tenders were observed to be moving and required additional lashings as a result of the motion of the vessel. Two mooring line baskets were dislodged on 21 January and again on 23 January a significant amount of damage occurred to fixtures and fittings on the foredeck. Structural damage also occurred in the forward part of the hull, though it cannot be determined at what point in the passage this damage occurred. The major damage however occurred in the early hours of 27 January, starting with the breaking of the window in the Chief Engineer's cabin at 0025, followed by the dislodgement of a mooring basket on the foredeck at 0205. This necessitated manoeuvring of the vessel to allow crew to enter the foredeck to stow the mooring lines. This might have been avoided had the mooring lines been stowed below decks immediately after leaving port, since it was well known that some severe weather was almost certain to be encountered in the North Pacific in January, particularly in view of the route chosen. No additional practicable measures could have been taken to prevent the mooring baskets being dislodged, however seas would have passed through the baskets better, with less impact when empty. During this manoeuvre the vessel experienced rolling to angles of up to 45°, which must have created severe discomfort for all on board.

- 4.8 Notwithstanding the difficulties experienced in the severe weather experienced, and the successive incidences of damage with which the crew had to deal, and in particular the unprecedented difficulties faced by the engineers in restoring propulsion following the disablement of the control console when the bridge was swamped with seawater, the entire crew appear to have handled all of these emergencies in a highly professional manner, and are to be commended for their efforts.

### **Part B Voyager**

- 4.9 The circumstances leading to the disablement of Voyager are well documented by witness statements and log books and provide an accurate account of events leading to the breakage of the bridge window and action taken thereafter to regain control of the vessel and reach the safety of port.
- 4.10 The Master was informed of the damage to Explorer while visiting the offices of the owners prior to joining the vessel for this cruise. As the incident was at that time very recent, and he could not have been provided with a full analysis of events on Explorer, but would have been aware of the nature of the damage to Explorer and the circumstances in which it occurred.
- 4.11 Weather forecasts were obtained for the passage from Tunis to Barcelona, so that he was clearly aware of the possibility of severe weather. He acted prudently in reducing speed on the evening of 13 February on the first occasion in which strong winds and heavy seas were experienced. Further reductions in speed were made at 0700 on 14 February, when the vessel was in effect hove to, making bare steerage way against the weather. In spite of these seamanlike precautions, a bridge window was broken by the force of a large wave breaking over the foredeck and engulfing the bridge front.
- 4.12 The evidence available suggests that the damage to the bridge window occurred while experiencing waves fine on the port bow while making bare headway of 3 to 4 knots. In these conditions, waves were breaking over the foredeck and a substantial quantity of water flooding the deck to the height of the bulwarks. Before the water could drain, a second wave broke over the bow and advanced towards the bridge. The aft inclination of the bridge front bulkhead and forward inclination of the bridge windows would have allowed the wave to strike the bridge windows with maximum impact, resulting in one window being forced inwards.
- 4.13 Although the ship was temporarily disabled by the effect of the seawater entering the bridge onto the control systems, the weather at the time was not exceptionally severe, and no worse than predicted by the weather forecasts or might be expected in the Mediterranean in winter. It is the normal practice of good seamanship to heave-to in the weather conditions experienced, as keeping head on to the wind and seas is generally regarded as the safest course to avoid structural damage. The only alternative would have been to turn the vessel

around and run with the wind and seas astern. This would however have risked very heavy rolling during the turn and was justifiably avoided in this case. It should be noted that the injuries to the passengers and crew occurred while the vessel was disabled and rolling to large angles while lying beam on to the seas.

- 4.14 The intended track from Tunis to Barcelona was directly in a north-westerly direction, with the possibility of passing between Majorca and Minorca to take advantage of the shelter from north-west winds provided by these islands. The weather forecasts available on the vessel indicated that some gale force winds would be encountered in the latter part of the passage, but with the option of passing between Minorca and Majorca available, there was no reason why the intended track should not have been followed.
- 4.15 As the Master of Voyager was aware of the breaking of the bridge window on Explorer, it might be questioned whether he could have done anything to avoid the same occurrence in planning or executing the passage from Tunis to Barcelona. He was aware of the weather forecast and acted in a timely manner to reduce speed as soon as the weather deteriorated. The expected weather was not abnormal for the time of year in the Mediterranean and his choice of course was entirely justifiable, particularly as he had the option of deviating to pass between Majorca and Minorca to avoid the worst of the north-westerly winds and seas. There are therefore no grounds for suggesting that the bridge window breakage might have reasonably been avoided in this case. To do so would require a large measure of hindsight, and there can be no criticism of the Master in this regard.
- 4.16 Following the damage to the bridge window there was no practicable alternative but to turn the vessel once control was re-established and make for a port of refuge at Cagliari, where repairs could be carried out. This was accomplished after the ship's engineers were able to start the main engines and control them locally in the Engine Room. Valuable assistance was provided by the Master and crew of the vessel "Gimi" which responded immediately to the call for assistance and escorted Voyager towards Cagliari. The master and crew of Gimi are to be commended for their actions, as are the Master and crew of Voyager for their action following the disablement of their vessel in bringing the vessel safely to port.

### **Part C Issues common to Explorer and Voyager**

#### Design of vessels and susceptibility to weather damage

- 4.17 The vessels are of modern design but smaller than many ocean going passenger ships currently in service. The bridge is well forward, with the bridge front bulkhead 27.8 metres from the stem. In addition to the proximity to the stem, the bridge is two decks above the foredeck. The bridge front bulkhead inclines upwards and aft, while the bridge front windows incline upwards and forward.

Any waves breaking and moving over the foredeck will therefore be deflected upwards towards the bridge deck and impact directly on the bridge front windows. This will tend to maximise the impact of the breaking waves on the bridge front windows. Steel plate bulwarks extend from the stem to the bridge front bulkhead and increase in height in the aft direction, rising to the level of deck 5, one below deck 6 on which the bridge is situated.

- 4.18 The design of the vessels appears in these two incidents to have enabled heavy seas to break over the foredeck and flood the foredeck to the level of the bulwarks. While freeing ports are fitted in the bulwarks, the water did not drain before the next oncoming wave broke over the deck. The second wave appears to have advanced on top of the water entrapped by the bulwarks, allowing a large mass of water to strike the bridge front bulkhead with catastrophic results. While the design of the vessel is clearly aimed at maximising space available for passenger use and providing a vessel with pleasing lines, it is not unfortunately the most appropriate for encountering severe weather.
- 4.19 While both vessels sustained identical damage to bridge windows in similar weather conditions, the damage to Explorer was much more extensive than on Voyager. In addition to the bridge window damage, Explorer sustained structural damage to the forward hull and much more extensive damage to fittings on the foredeck. This may be attributed to the more prolonged exposure to the weather and possibly to some degree, to maintaining higher speeds than might be deemed prudent in the prevailing weather conditions. The most significant damage however was to the bridge windows on both vessels. This led to the disablement of the vessels until local control of the main engines could be established. This raises a number of issues which will be considered in turn.

#### Hull strength

- 4.20 Both vessels complied fully with the strength requirements of the classification society in force at the time of building. Furthermore, the vessels met the increased loadings on the bow structure required by Germanischer Lloyd since 1998 for vessels with bow flare angles exceeding 40°. Superficial damage to deck fittings are not uncommon in vessels encountering severe weather. Pounding damage sustained by Explorer may also be expected to some degree in the prolonged encounter with severe weather conditions. This may have been less severe if speed reductions on Explorer had occurred earlier, but it is not possible to quantify the degree to which this damage could have been avoided.
- 4.21 Following assessment of the damage sustained by the two vessels, the owners have, with approval of Germanischer Lloyd, modified the steel structure of the vessels. These modifications comprise reinforcement of the side shell structure on Explorer and the bridge front bulkhead on Voyager. Breakwaters have also been fitted on the foredeck of both vessels to impede the passage of seas along the deck towards the bridge.

#### Bridge window strength

- 4.22 The bridge windows are of conventional design, comprising double glass panes secured in metal frames and held in place by closely spaced bolts. The windows are designed to comply with the requirements of ISO 614. Following the casualties, the glass window panes were subject to pressure tests by the manufacturer. These tests indicated that the glass panes had strength significantly greater than that required by ISO 614. Despite the strength being significantly higher than that demanded by international standards, the windows nevertheless, were broken on both vessels, albeit in severe weather conditions. The loading on the windows at time of impact may however have been higher than that envisaged in setting the strength requirements. It is possible that this may have resulted from the entrapment of water within the foredeck bulwarks, allowing the damaging wave to progress with sufficient height to engulf the bridge front. Loading might also have been increased by the wave progressing up the aft and upward inclined bridge front and impacting on the forward and downward facing windows. This suggests that international strength requirements for bridge windows should be re-evaluated, with particular reference to the vulnerability of bridge windows close to the bows and the weather deck.

#### Vulnerability and design of bridge control systems

- 4.23 It is necessary for operational reasons that the bridge control console be placed on or near the centre line and close to the bridge front in order that those operating the controls have a clear view ahead. This does however make the control systems vulnerable in the event that a bridge window is breached and sea water drenches the controls, as occurred on these two vessels. The bridge controls are clearly not designed to withstand sea water ingress on the scale that occurred on Explorer and Voyager, nor is there presently any statutory or international requirement for them to do so. Apart from the loss of propulsion, many other systems were rendered inoperable, requiring the crew to resort to emergency measures such as use of portable VHF sets for communications and lifeboat compasses for steering.
- 4.24 The principal difficulty experienced following the drenching of the control console was the shut down of the main engines. While the systems were designed to transfer control of the main engines to the engine room, this had to be accomplished by operating the settings on the bridge control console. This was not possible, and it took some time for the engineering staff to find out how the engines could be isolated from the bridge control system and re-started and controlled manually from the engine room. As a result both vessels lay beam on to the heavy seas rolling violently to large angles until the engines could be restarted and control of the vessels regained.
- 4.25 It is conceivable that the same difficulties might be experienced if, for example, the bridge control console was damaged by fire. In view of this possibility, and of

a recurrence of bridge window failure, it would seem prudent to review the bridge control systems to ensure that the engineers can take immediate control of the main engines from the engine room in the event of failure by whatever mode of the bridge control systems. This requirement is in accordance with SOLAS II-I/31.2.6 and there may be a need for some modification of the control systems. Protection of the control console from water ingress in the bridge is more problematical. While it may be technically feasible, it would inevitably require a complete re-design and build of the control consoles to make them able to withstand immersion in water.

#### Voyage Data Recorders

4.26 Both vessels were fitted with voyage data recorders as required by Regulation V.20 of the SOLAS Convention. In both cases however the data could not be downloaded following the sea water damage to the recorders after the breakage of the bridge windows, although the data within the recorders had not been destroyed. In order that the data in these recorders is more easily accessible in the event of a similar occurrence, this problem should be addressed.

#### 4.27 SOLAS Amendments

While more specifically targeted at fire damage, rather than water damage, the requirements of Resolution MSC.216(82) (adopted on 8 December 2006) contained within Annex 3, Regulation 21, which shall enter into force on 1 July 2010, would have aided in preventing the disablement of both vessels. These new regulations consider the necessary system requirements for passenger vessels to maintain the capability of making a "safe return to port".

- 5.1 It is somewhat unusual for sister ships to suffer identical damage in similar weather conditions within a short space of time, though in widely differing locations. In forming any conclusions as to the causal factors in each case, the probability of a repetition should be borne in mind, and an attempt made to isolate the causes and formulate realistic recommendations that might avoid any recurrence. Although there was no loss of life and injuries to passengers and crew were not life threatening, both vessels were disabled for a short time and lay beam on to heavy seas while rolling violently to large angles.

#### Route

- 5.2 In planning any passage, it is accepted practice to have due regard to weather conditions likely to be experienced along the route. In the case of Explorer, no regard appears to have been paid to the advice in the Ocean Passages of the World. It should have been foreseen that severe weather would almost certainly be encountered, and that less severe conditions would have been expected in following either of the routes recommended in the Ocean Passages of the World. It is accepted that the Master had no influence over the itinerary of the vessel, but concluded that his choice of route would almost certainly lead to encounters with strong winds and heavy seas from ahead.
- 5.3 In the case of Voyager, there can be no criticism of the planned passage, for no practicable alternative route was available. Furthermore, an amendment to the route was planned in view of the prevailing weather conditions and in order to take advantage of the less severe conditions afforded by passing between the islands of Majorca and Minorca.

#### Severe weather precautions

- 5.3 It is the ordinary practice of seaman to secure all loose gear in preparation for an ocean passage, particularly when the weather forecasts indicate severe weather might be experienced. It is accepted that Explorer encountered severe weather for prolonged periods on the passage from Vancouver up to the point at which the vessel was temporarily disabled by the flooding of the bridge, and that it is not uncommon for weather damage to deck fittings and pounding damage to the forward hull to occur. Although the damage to the mooring baskets on the foredeck may not have been avoided, it would have been a seamanlike precaution to stow the mooring ropes below decks. This would have avoided the exposure of the crew to a degree of danger while they re-stowed the ropes in difficult conditions.
- 5.4 In view of the consequences of the damage to the bridge windows, it must be questioned whether or not this could have been avoided. In the case of Explorer,

there appears to have been some urgency in the mind to the Master to maintain westward progress. Action was taken to reduce and speed and alter course to safeguard the vessel on each occasion on which severe weather was encountered. While it may be concluded that the structural damage to Explorer might have been less severe had this action been taken sooner, the course and speed at the time of the breakage of the bridge window was not excessive, though the speed of 7 knots might have been reduced further.

- 5.5 In the case of Voyager, the vessel was in effect hove to, making between 3 and 4 knots at the time the bridge window failed. Any further reduction in speed would have made it extremely difficult to keep the vessel head to wind and seas.
- 5.6 It is probable that the damage to the bridge windows might have been avoided if the vessels had been turned to run with the wind and seas astern. This would have necessitated a 180° turn in gale force winds and waves of up to 9 metres in height, and resulted in rolling violently to large angles. This is not a manoeuvre that is ever undertaken lightly, and not one the Masters should have considered. In neither case could the Masters of the vessels have foreseen the damage to the bridge windows, though they may consider such a manoeuvre if faced with similar circumstances in the future.

#### Weather conditions

- 5.7 While Explorer encountered severe weather over a longer period than Voyager, the weather was no more severe than might have been expected over the route chosen in January. For Explorer, the weather conditions were Force 10 winds and seas of up to 10 m in height. In the case of Voyager, the winds were Force 8 to 9, with waves of between 7 and 9 metres in height. Explorer was also experiencing a long westerly swell of around 7 metres in height, in addition to the wind generated waves. Although Explorer experienced more severe weather conditions than Voyager, the consequences were no different in respect of the breakage of the bridge windows.

#### Vessel design

- 5.8 Although both vessels were of conventional passenger ship design, the proximity of the bridge to the bow, its relatively low height above the weather deck, the upward sloping bulwarks and slow draining of seawater from the foredeck appear to have created the conditions under which a wave broke over the bows and advanced on top of the water entrapped in the foredeck. This resulted in the wave striking the bridge front and the breakage of one window on each vessel. While the vessels both complied with relevant hull strength requirements, these two incidents suggest that the bridge windows may be more vulnerable to weather damage than desirable and that some additional strengthening measures would be appropriate to avoid any recurrence. Consideration should also be given to the foredeck freeing port arrangements, while these may be compliant with current Load Line requirements, could these arrangements be improved for vessels with a relatively low bridge, situated in a forward position on the ship.

#### Bridge window strength and design

- 5.9 The bridge windows were of conventional design and exceeded the strength requirements of the relevant ISO standards, yet they failed in severe, but not abnormal weather conditions. In these circumstances, it would seem that a review of the loading on the bridge windows be subject to review for vessels of this design.

#### Bridge control systems

- 5.10 The loss of propulsion which followed the flooding of the bridges resulted from damage to the control consoles, which prevented transferring control of the main engines to the engine room. As a result the vessels were disabled during the period required for the control consoles to be isolated and control of the engines to be regained from the engine room.

- 5.11 There is no practicable alternative to placing the control consoles close to the bridge windows, where the operators have a clear view of the foredeck and horizon, it is highly desirable that the systems be modified so control of the main engines can be immediately transferred to the engine room in the event of damage to the bridge control consoles.

#### Voyage Data Recorder

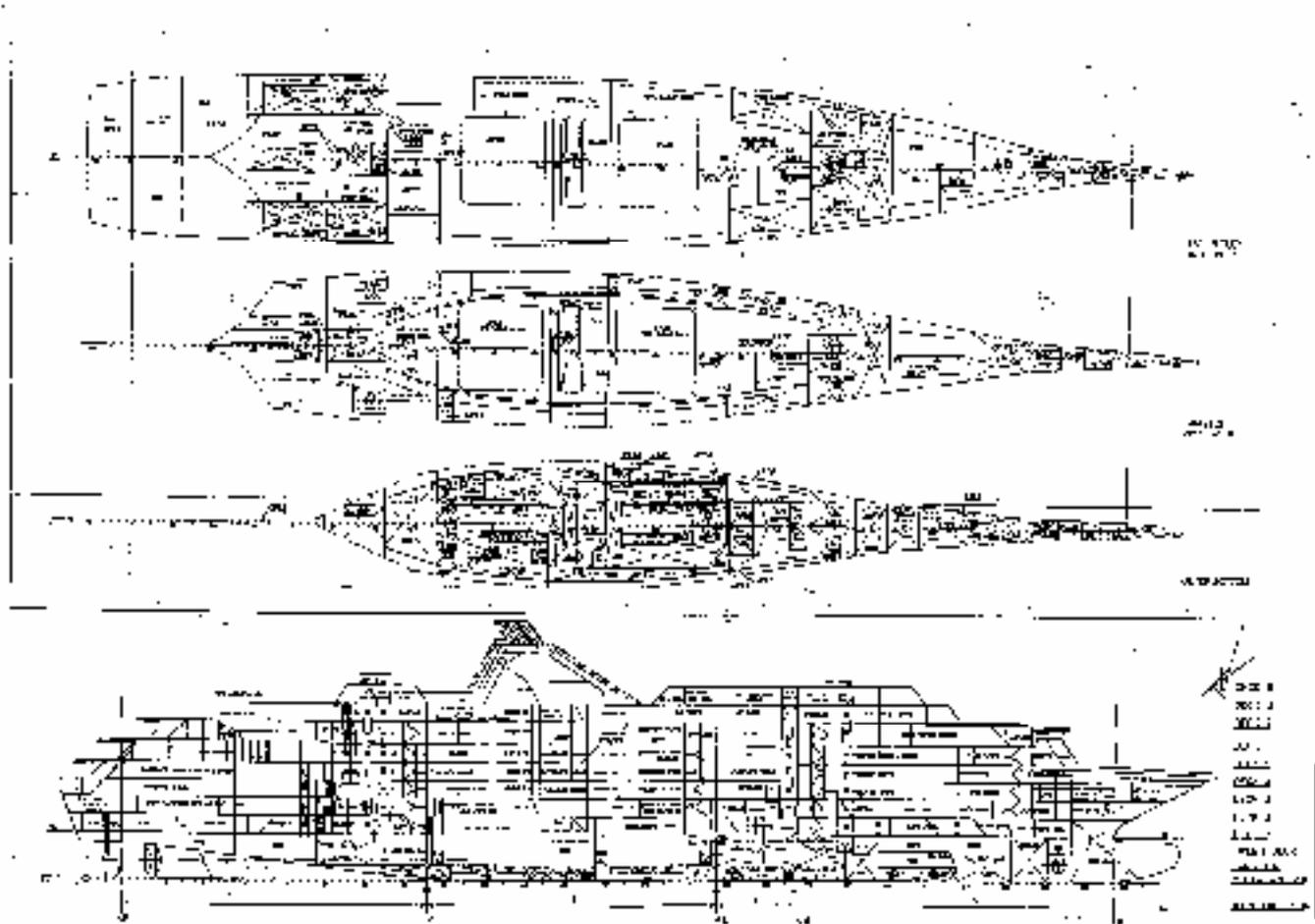
- 5.12 Although the voyage data recorders were destroyed when the bridge control consoles were flooded, the data remained within them but could not be easily extracted. This highlights a weakness in the design of the voyage data recorders, which should be capable of having data extracted in the event of damage to the recorders as occurred on Explorer and Voyager.

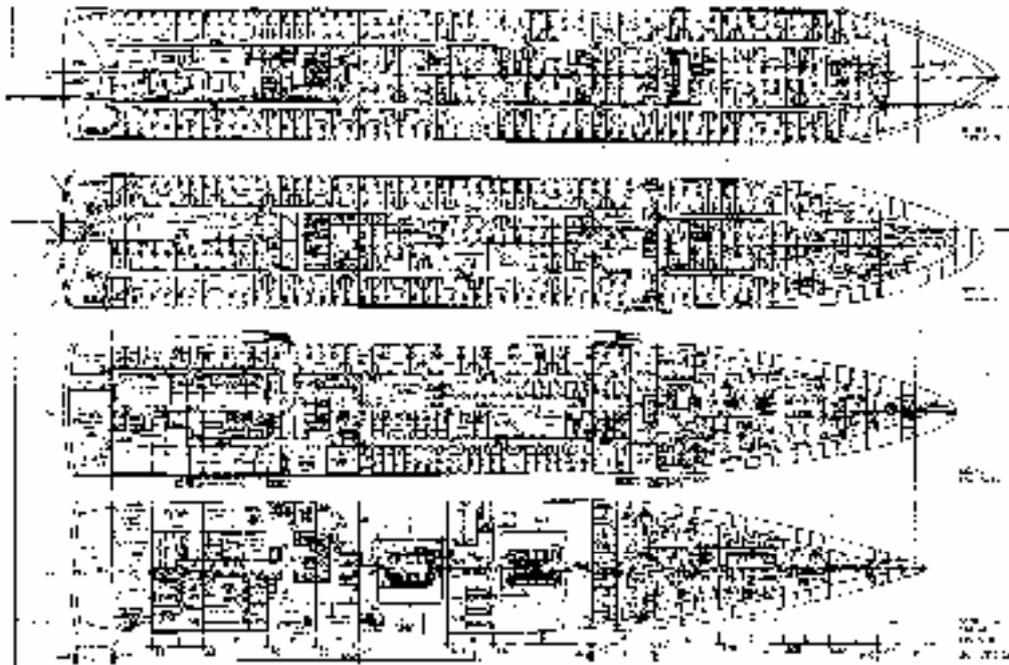
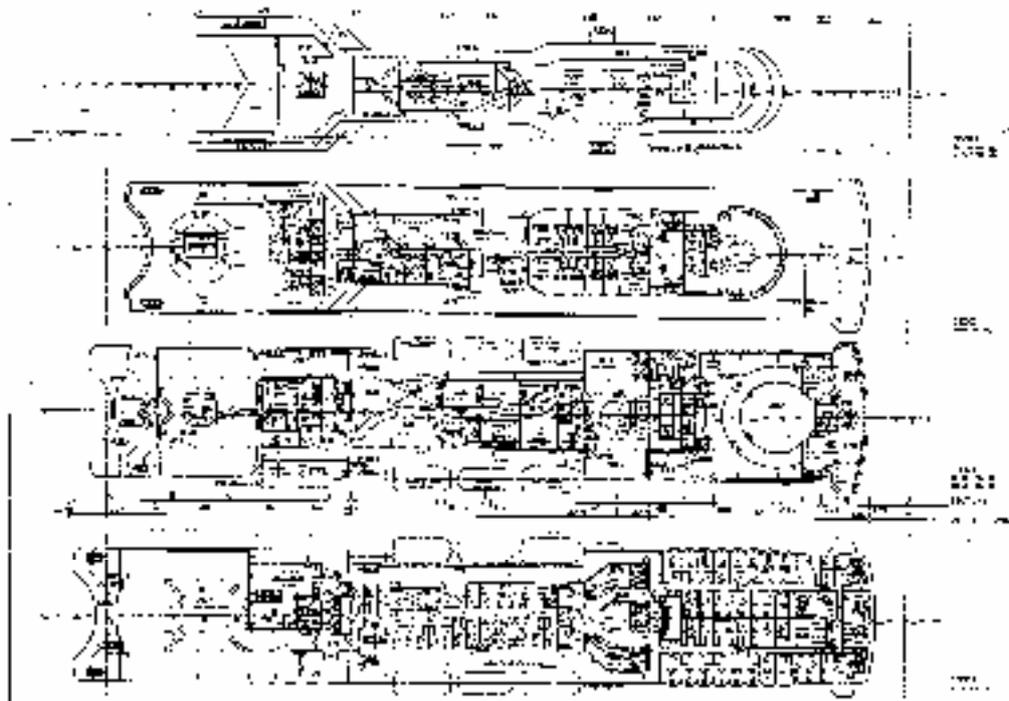


- 6.1 In view of the potential consequences of arising from sea water entering the bridge through broken windows in severe weather, it is recommended that the re-evaluation of loadings on the bridge front bulkhead and windows on these vessels being carried out, and suitable measures adopted where warranted.
- 6.2 In order to ensure that control of the main engines can be transferred rapidly to the engine room, it is recommended that the bridge control system be reviewed to ensure that such transfer of control can be effected in the event of damage to or disablement of the bridge control systems. This requirement is in accordance with SOLAS II-I/41 and there may a need for some modification of the control systems.
- 6.3 The owners have voluntarily strengthened the vessels and fitted breakwaters on the foredeck. While endorsing these measures, it is also recommended that future Masters of the vessels are made aware of the vulnerability of the bridge windows in severe weather due to their proximity to the bows, in order that they can take timely and effective measures to avoid any recurrence of breakage of bridge windows. Operational limitations may need to be considered.
- 6.4 As data from the Voyage Data Recorders could not be accessed following the damage to the recorders, it is recommended that they be modified or replaced to ensure that data stored therein can be more easily accessed in the event of damage to the recorders.
- 6.5 While acknowledging the reasons underlying the design of passenger vessels, it is recommended that the risk to a bridge located forward from waves breaking along the foredeck in severe weather be taken into account in the design of future passenger ships, and other vessels intended for unrestricted service.

# APPENDIX I

## Plans of Explorer (and Voyager)

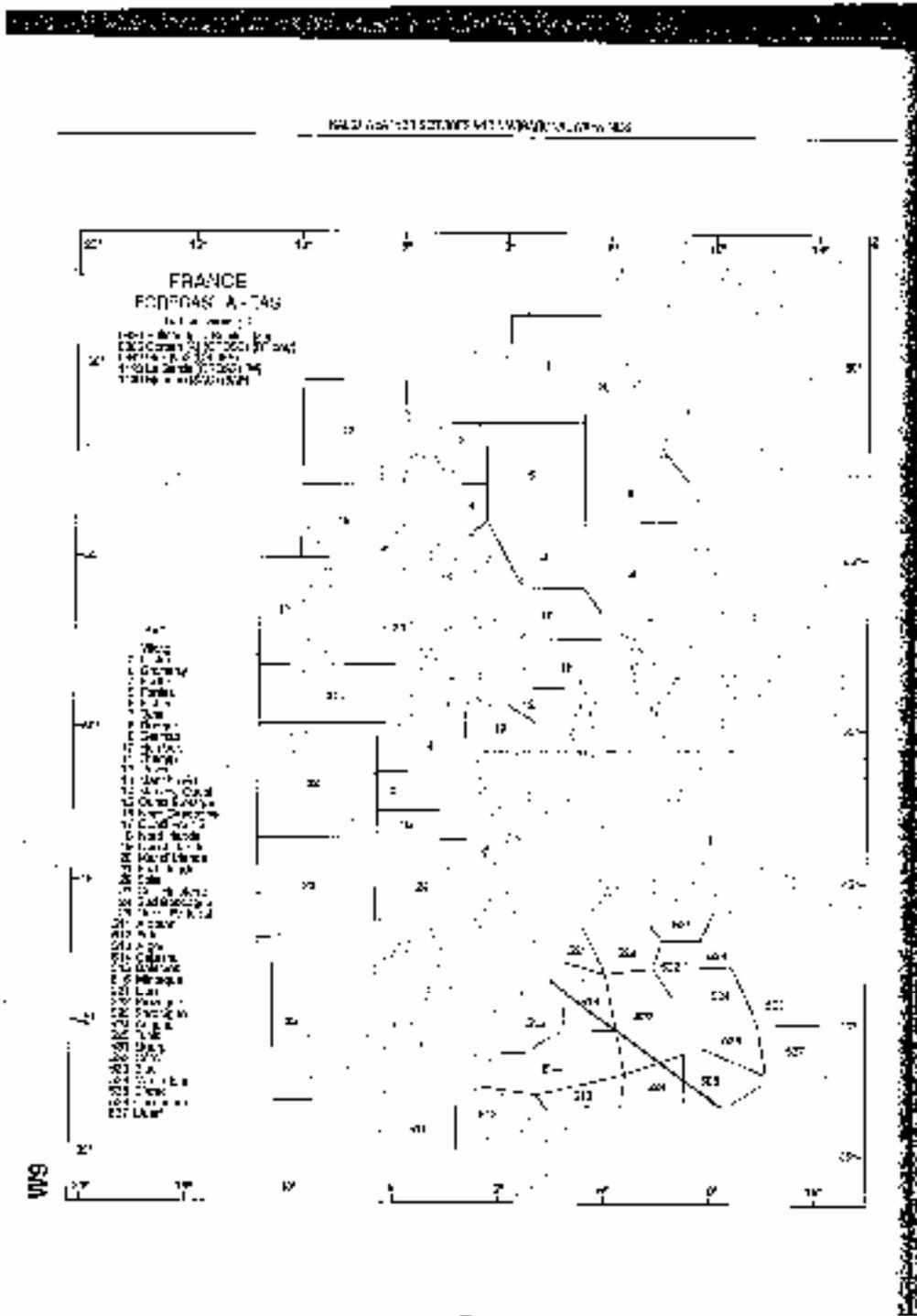




## **APPENDIX II**

### **A. Weather analysis for North Pacific (Explorer)**

B. Weather forecast and charts for the Mediterranean (Voyager)



REPORT: 148

REPORT: 148

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14870:07:01:00

SYDNEY

NATIONAL METEOROLOGICAL SERVICE  
AUSTRALIAN MARINE METEOROLOGICAL CENTRE  
WEATHER AND SEA BULLETIN FOR SHIPPING - OH METAREA 3  
DATE AND TIME OF ISSUE 13-02-2005 / 0000 UTC  
PART 1

GALE WARNING 13-02-2005 / 0000 UTC

VALID FROM 120700 UTC UP TO 132200 UTC

THE COMBINATION OF LOW PRESSURES 1000 OVER NORTHWEST AUSTRALIA WITH

HIGH PRESSURES 1020 OVER GIDRA IS RESULTING:

WINDS AND GIDRA NORTH OF 34.30 S. IN WEST SOUTH WEST 7 LOCALLY 8

SOUTH ADRIATIC, ARII, AND FROM 10000 UTC SOUTHWEST AUSTRALIA AND

INDIAN SEA WITH WINDS SOUTH SOUTH WEST 7 LOCALLY 8

WEST BLACK SEA, FROM 13100 UTC CENTRAL AFRICA,

SOUTHWEST AFRICA, KARIA AND NORTHERN ALGERIA WITH WINDS 7 LOCALLY 8

FROM 13200 UTC EAST INDIAN SEA WITH SOUTH SOUTH WEST 7 LOCALLY 8

PART 2

SYNOPSIS OF HIGH-LEVEL WEATHER CHART 130300 UTC

ON 130300Z IN GALE WARNING

PART 3

FORECAST FOR 24 HOURS FROM 131000 UTC LP TO 141000 UTC

NORTH ADRIATIC

WEST NORTHWEST 5 LOCALLY 6, MODERATE, LOCAL RAIN OR

THUNDERSTORM

CENTRAL ADRIATIC

WIND 6, MODERATE, LOCAL RAIN OR THUNDERSTORM

SOUTH ADRIATIC

SOUTH (INDIAN) 7 LOCALLY 8 INCREASING SOON, MODERATE, LOCAL RAIN,

RAIN OR THUNDERSTORM

INDIA

WEST SOUTHWEST 7 LOCALLY 8, MODERATE, RAIN

INDIA

WEST SOUTHWEST 7 LOCALLY 8, MODERATE, LOCAL RAIN

INDIA

WEST 7, WIND LOCALLY MODERATE

INDIA

NORTH OF 34.30 WEST SOUTH WEST 7 LOCALLY 8 SOUTH OF 34.30 WEST

SOUTH WEST 7, WIND LOCALLY MODERATE

INDIA

SOUTH 7, MODERATE, RAIN OR THUNDERSTORM

INDIA

SOUTH WEST 7, MODERATE, RAIN OR THUNDERSTORM

INDIA

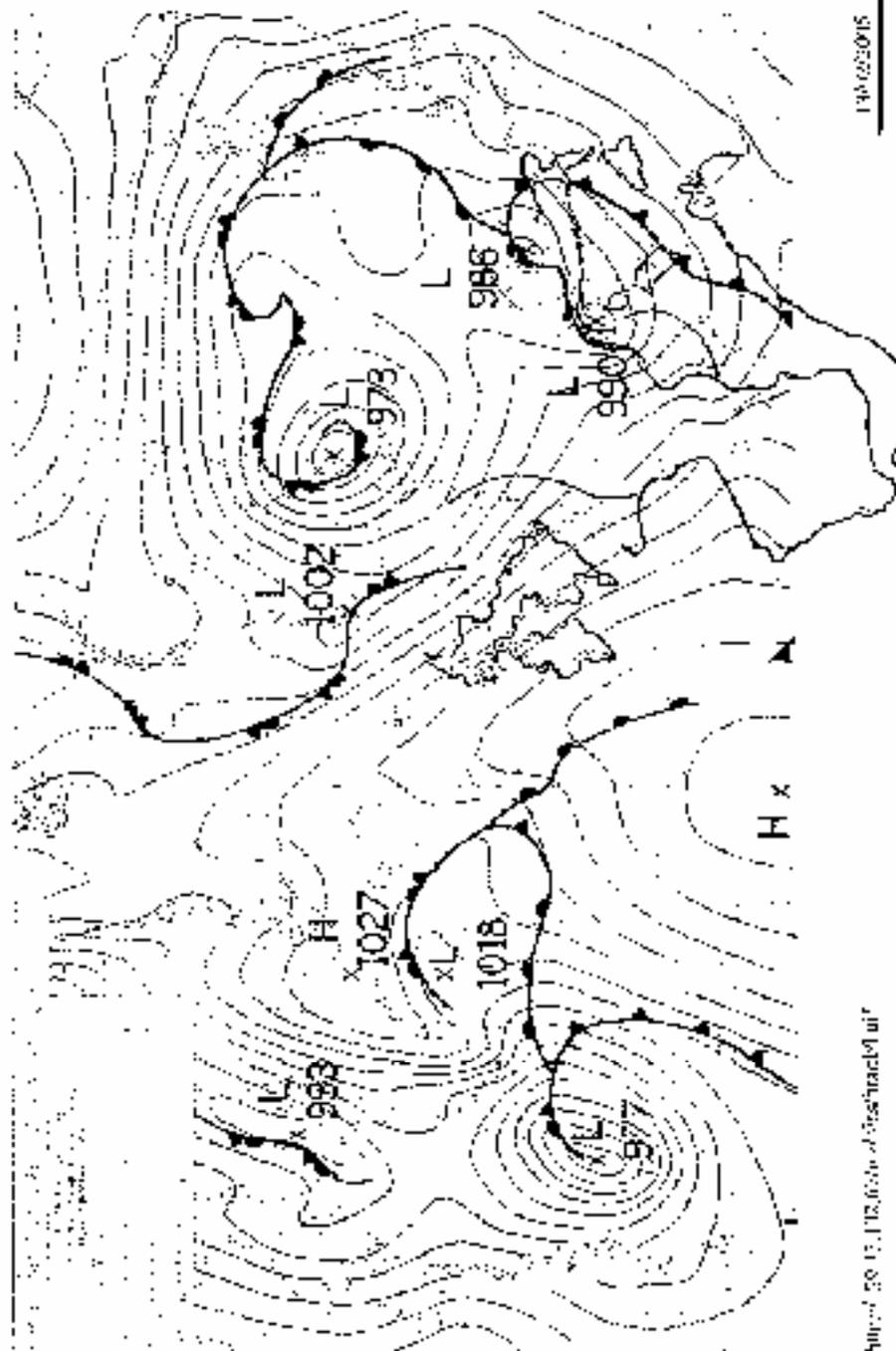
SOUTH WEST 7, MODERATE, RAIN OR THUNDERSTORM

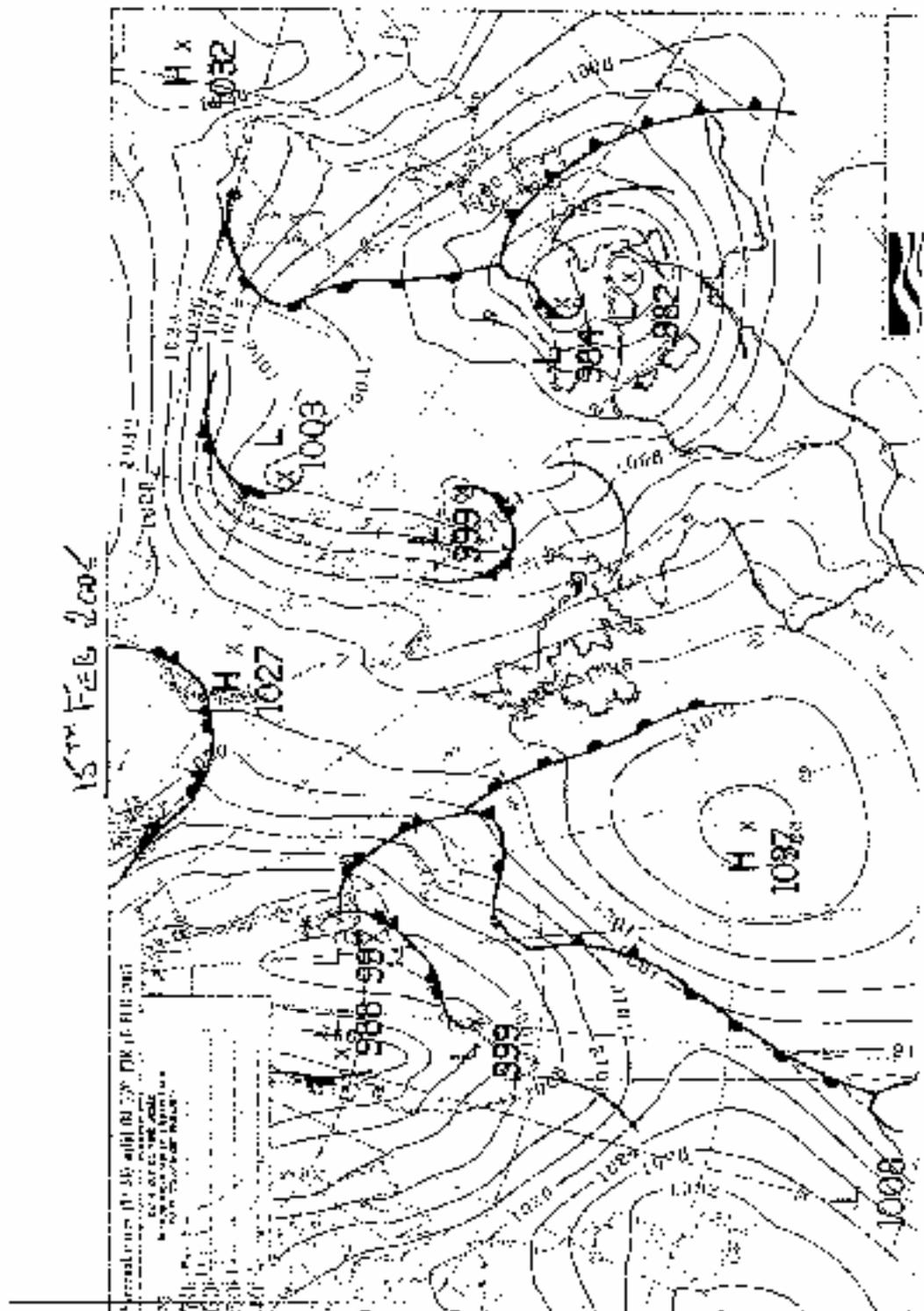
INDIA

SOUTH









## APPENDIX III

### A - Photographs of Explorer

1. General view of Explorer



2. View of foredeck



3. Mooring line basket



4. Bridge



Damage to vessel

5. Damaged mooring line basket



6. Chief Engineer's Window External view



7. Chief Engineer's window – Internal view



8. Damage to shell plating x 3







9. Fore Peak internal damage



10. Fore Peak internal damage



11. Centre Bridge Window



12. Starboard Bridge Window



13. Bridge Control Console



14. Temporary repair to Bridge Window



15. Damage to deckhead paneling on bridge



16. Winch torn from mountings



## APPENDIX III

### B - Photographs of Voyager

1. Foredeck showing damaged mooring baskets



2. Bridge front showing broken window



3. Bridge control console



4. Bridge internal view



5. Broken bridge window



6. Damage to bridge deckhead



End of report.

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**NORMAN LYNAGH**  
**Weather Consultancy**

# m/s “Explorer”

*Hindcast of weather conditions during  
a trans-Pacific Voyage in January  
2005*

**Report No: 0072-F/05/NL**

Prepared on instruction from

**V.Ships**

File No: 4/0322

Date: 31<sup>st</sup> March 2005

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7.	CONCLUSIONS	27

## APPENDICES

A CURRICULUM VITAE FOR NORMAN LYNAGH

## 1. INTRODUCTION

### 1.1 The Author

1.1.1 I am a Chartered Meteorologist and a Fellow of the Royal Meteorological Society. I am a Member of The Academy of Experts, a Diplome of the American Board of Forensic Examiners and a Member of the Royal Institute of Navigation.

1.1.2 I have worked in meteorology continuously since 1961 and since 1985 I have regularly been applying my accumulated experience to the field of Forensic Meteorology.

1.1.3 A full c.v. is included as Appendix A to this report.

### 1.2 Summary of My Conclusions

1.2.1 The route followed by the "Explorer" across the North Pacific Ocean took her through the latitudes where spells of very persistent strong head winds and heavy head seas are likely to be encountered in January.

1.2.2 A lengthy spell of such conditions started on 24<sup>th</sup> Jan and persisted through to 29<sup>th</sup> Jan.

1.2.3 The most significant single event appears to have been the sudden onset of a long, high westerly swell of 7-7½ metres in 13 seconds during the late morning (ship's local time) of 27<sup>th</sup> Jan (the first day with that date).

## 2. STATEMENT OF INSTRUCTIONS

2.1 I am instructed by V.Ships, Monaco to provide an analysis of the weather conditions experienced by the m/s "Explorer" while on passage from Vancouver, Canada to an intended arrival port of Hakodate, Japan in January 2005. Following a weather-related incident the arrival port was changed to Honolulu.

2.2 My report is to include a 6-hourly time-series of

- wind speed and direction
- wave height and period
- swell direction, height and period

2.3 Noon positions (ship's local time) have been provided as follows:

Jan 19 <sup>th</sup>	-	48° 03.0'N	128° 34.5'W
20 <sup>th</sup>	-	47° 06.5'N	138° 20.0'W
21 <sup>st</sup>	-	46° 58.5'N	148° 05.0'W
22 <sup>nd</sup>	-	44° 02.5'N	156° 48.5'W
23 <sup>rd</sup>	-	42° 13.5'N	166° 20.0'W
24 <sup>th</sup>	-	40° 16.0'N	171° 58.5'W
25 <sup>th</sup>	-	40° 16.6'N	178° 44.0'W
26 <sup>th</sup>	-	day skipped	
27 <sup>th</sup>	-	40° 41.0'N	178° 03.0'E
27 <sup>th</sup>	-	38° 28.0'N	176° 26.0'W (day repeated)
28 <sup>th</sup>	-	35° 35.0'N	170° 56.0'W
29 <sup>th</sup>	-	31° 18.0'N	167° 02.0'W
30 <sup>th</sup>	-	25° 57.0'N	162° 04.0'W
31 <sup>st</sup>	-	21° 17.3'N	158° 13.1'W

### **3. DATA USED**

3.1 For this analysis I have used the following meteorological data extracted from our in-house archive:

- a) Broadscale surface analysis weather charts covering the North Pacific Ocean. These originate at the U.S. National Weather Service and are available 6-hourly.
- b) Detailed numerical model surface wind fields. These are available on a 1-degree grid at 12-hourly intervals.
- c) Broadscale and detailed numerical wave model analysis fields. These are available at 12-hourly intervals.
- d) All available weather observations from ships and data-buoys at 6-hourly intervals within a 300-mile radius of the location of the "Explorer".

3.2 As all the meteorological data uses UTC time I have calculated the approximate positions of the vessel at 0000, 0600 1200 and 1800 UTC for each day, based on the daily noon (local) positions given in paragraph 2.3.

#### **4. ROUTE TAKEN BY THE M/S "EXPLORER"**

4.1 In winter, the North Pacific Ocean is greatly affected by mobile low pressure systems, typically running in a NE direction from the vicinity of Japan towards the Aleutian Islands or the Gulf of Alaska. The worst sea conditions are usually found to the south of the low pressure centres and these are generally head seas for westbound vessels. Sea conditions are usually better to the north of the low pressure centres or far to the south of their track.

4.2 For west-bound passages, in general, "Ocean Passages for the World" states in para. 7.350:

"W-bound, it may be preferable to take a route N of the Aleutian Islands, or alternatively one well S of the northern routes, based on the parallel of 35°N, or even further S, compromising between extra distance and the reduced speed due to the effect of adverse winds and currents."

One advantage of taking a northern route is that it is shorter, being close to a great circle.

4.3 Specifically, for passage between Juan de Fuca Strait and Tsugaru Kaikyo, the only routes recommended in "Ocean Passages for the World" are near-great circle routes either north of or close south of the Aleutian Islands. The details are given in para. 7.379 of "Ocean Passages for the World". The distance via the route north of the Aleutian Islands is 3800 miles while that close south of the Aleutian Islands is 3850 miles.

4.3 From Juan de Fuca Strait the "Explorer" sailed on a course between a great circle and a rhumb line to near 40.2°N 172°W then on a rhumb line almost due west to near 40.5°N 178°E before altering course and heading for Honolulu. This course is far to the south of the recommended route and took the vessel into the area where the worst and most persistent head seas were likely to be found. There may have been over-riding operational reasons for

following this course but, from purely meteorological considerations a great circle course via the Azetian Islands or a course much further south, probably south of 35°N, would have been preferable.

## 5. DAY-BY-DAY EVOLUTION OF THE WEATHER SITUATION

5.1 In this Section I describe the evolving weather situation day by day, and its effect on the "Explorer". For ease of reference to the meteorological data all dates and times in this Section are in UTC.

### 5.2 Wednesday 19<sup>th</sup> January 2005

5.2.1 When the "Explorer" sailed from Juan de Fuca Strait a large high pressure area lay over the western United States while a large, complex low pressure area lay over the North Pacific Ocean between 150°W and 170°E. She encountered relatively light winds but with a moderate to high SW swell.

### 5.3 Thursday 20<sup>th</sup> January 2005

5.3.1 A deepening low pressure centre moved NE from mid-ocean heading towards the Gulf of Alaska. Fronts associated with this low approached the "Explorer" during the second half of the day. As these fronts approached, the wind at the vessel strengthened from the SE, reaching gale force by midnight. (See Figs. 5.1 and 5.2).

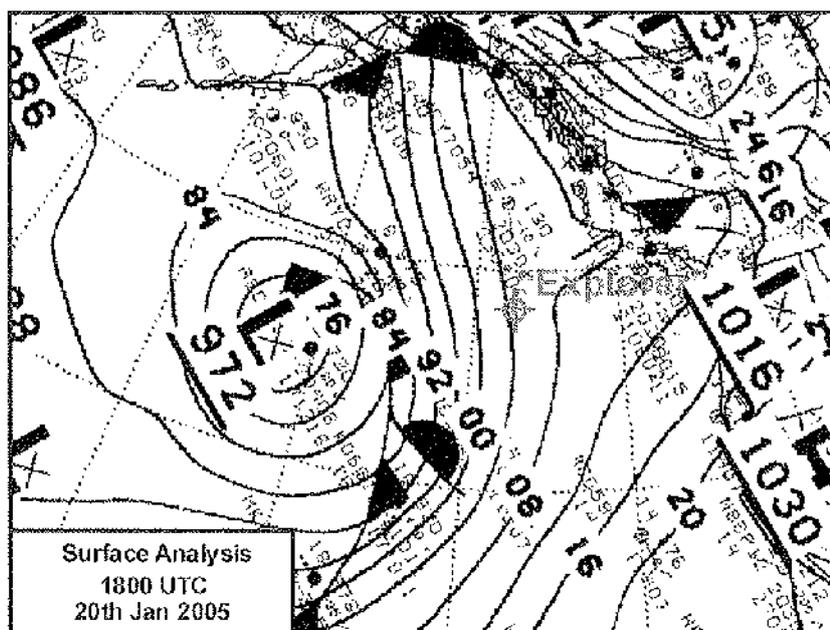


Fig. 5.1. Surface Analysis at 1800 UTC 20<sup>th</sup> January 2005

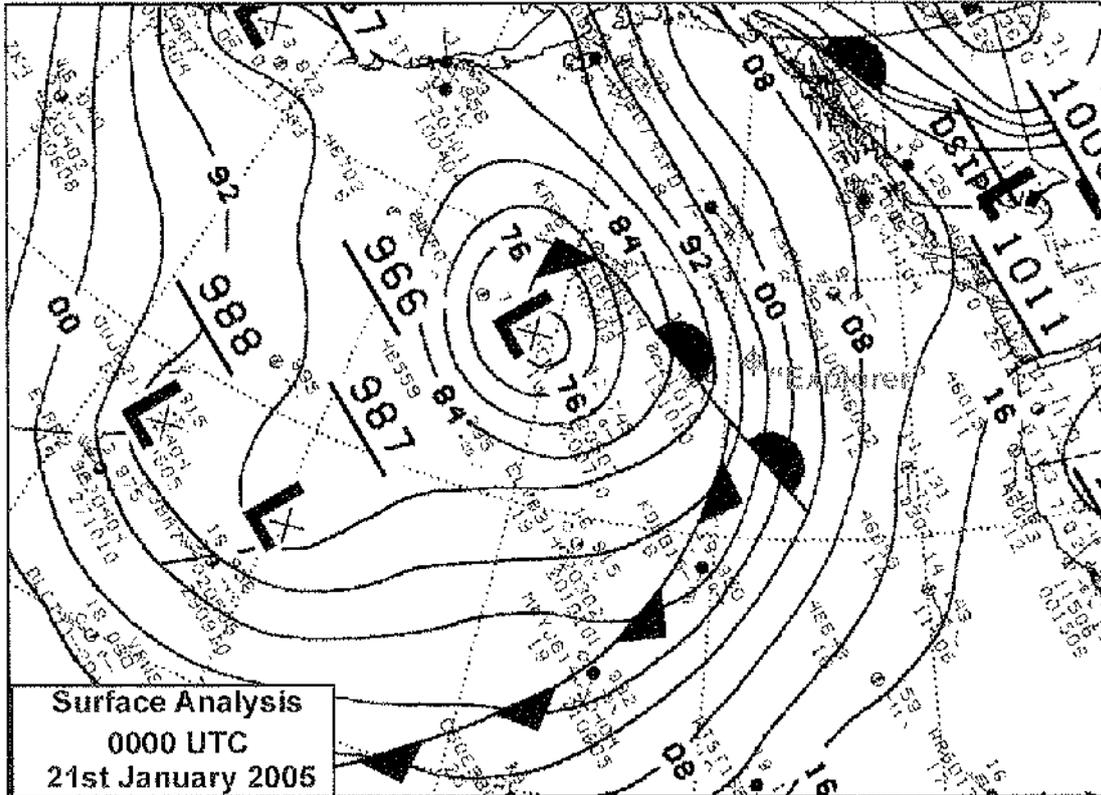


Fig. 5.2 Surface Analysis at 0000 UTC 21<sup>st</sup> January 2005

5.3.2 As the wind strengthened from the SE the swell from the SW gradually decreased. This resulted in a gradual decrease in the total significant wave height at the vessel from around 4½-5 metres early in the day to 3½-4 metres by the evening.

#### 5.4 Friday 21<sup>st</sup> January 2005

5.4.1 The low centre passed about 300 miles NW of the "Explorer" during the middle of the day. The central pressure of the low was analysed as 966 mb at 1200 UTC (see Fig. 5.3). During the morning the wind at the vessel veered to SW and persisted at gale force until early afternoon. It then gradually decreased and by midnight it was down to about Force 5.

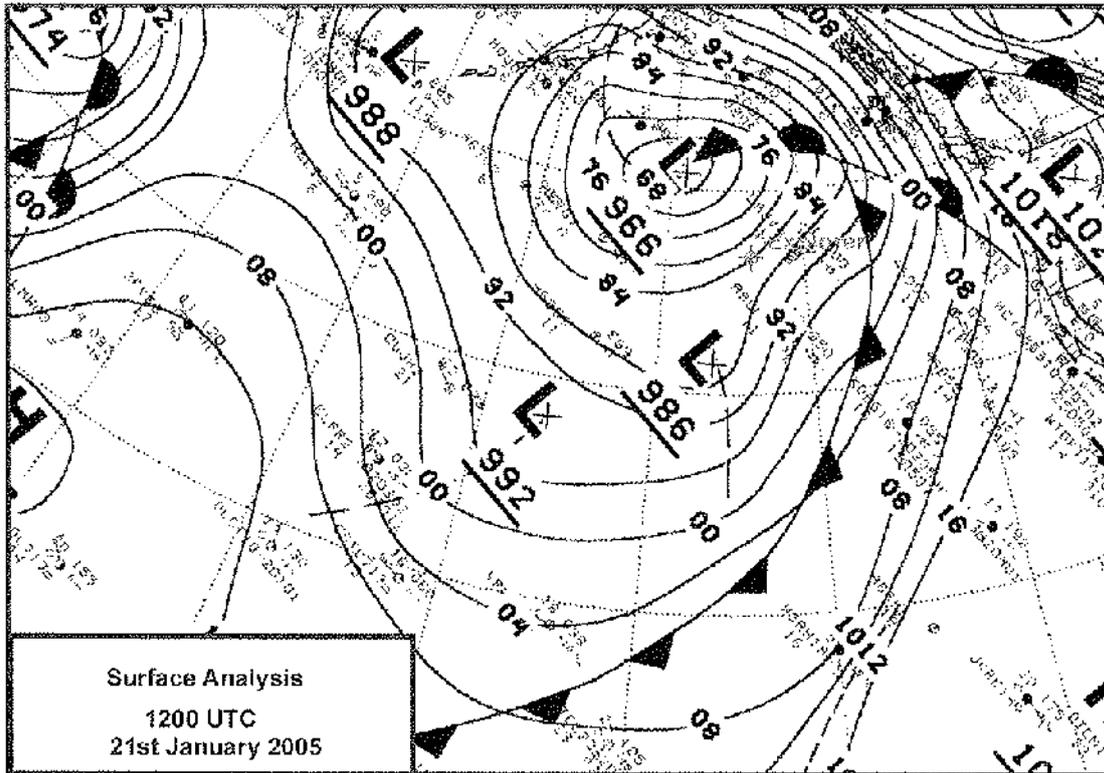
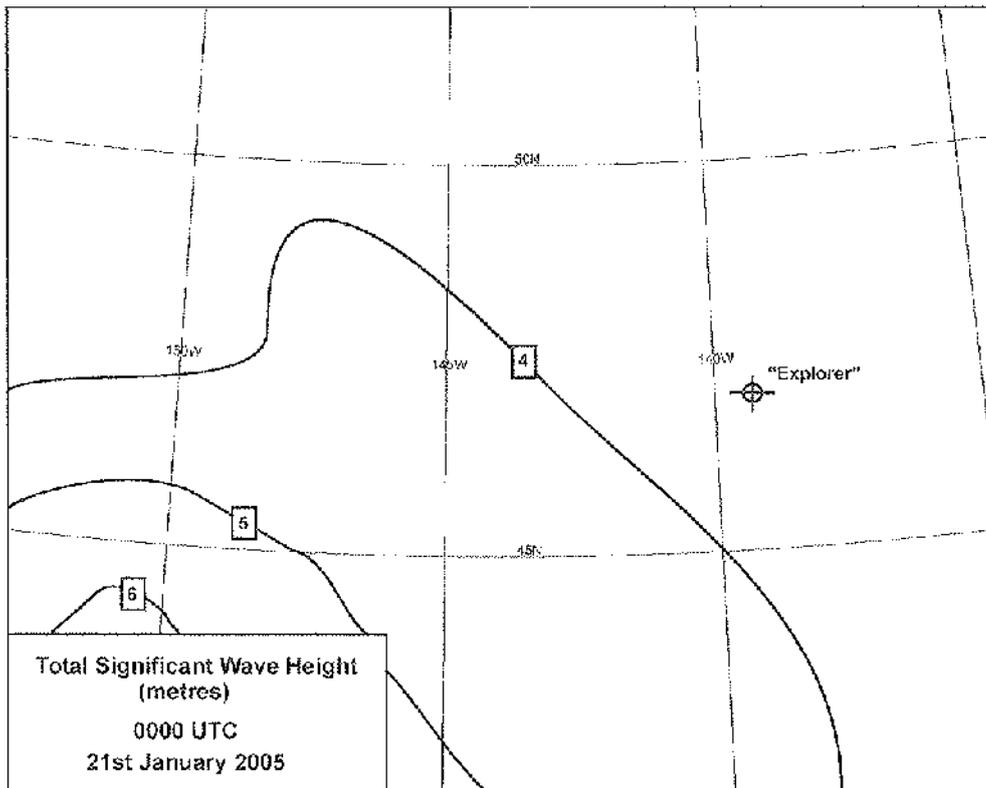
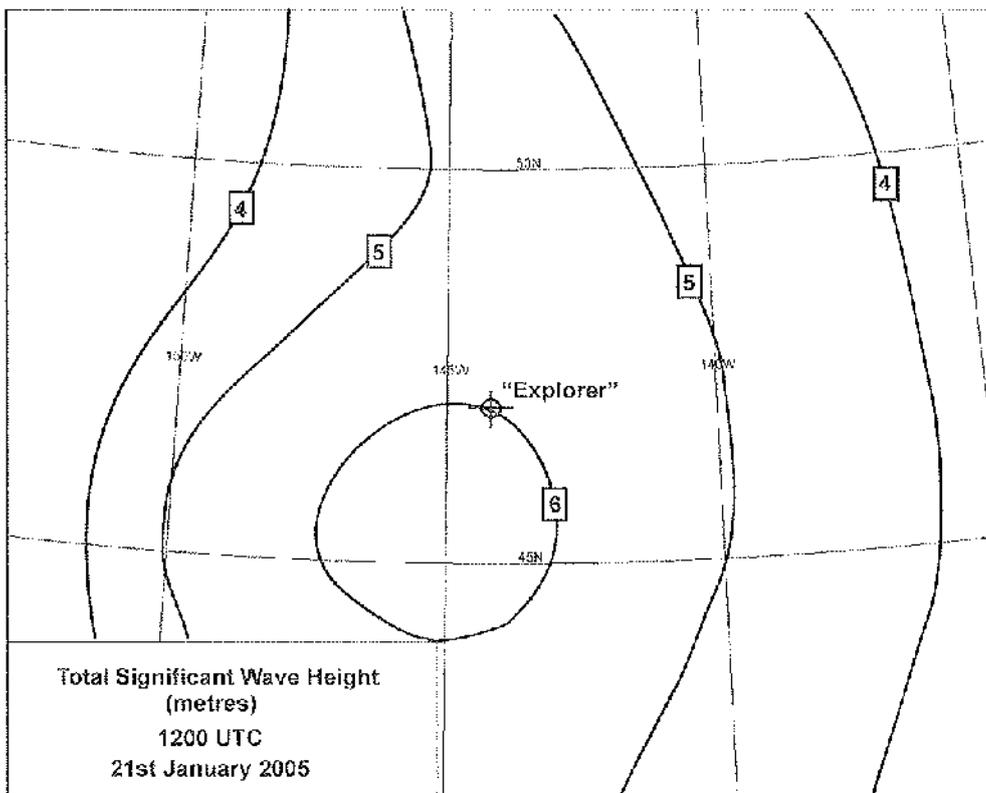


Fig. 5.3. Surface Analysis at 1200 UTC 21<sup>st</sup> January 2005

- 5.4.2 The total significant wave height at the "Explorer" gradually increased from 3½-4 metres in the early morning to 6 m or a little higher in the middle of the day (see Figs. 5.4 and 5.5).
- 5.4.3 As the wind decreased later in the day the total significant wave height decreased slowly but by midnight it was still around 4-4½ metres including a moderate SW swell.



**Fig. 5.4. Total Significant Wave Height at 0000 UTC 21<sup>st</sup> January 2005**



**Fig. 5.5. Total Significant Wave Height at 1200 UTC 21<sup>st</sup> January 2005**

5.5 Saturday 22<sup>nd</sup> January 2005

5.5.1 As the low centre moved away to the NE a ridge of high pressure moved eastwards over the waters where the "Explorer" was located (see Fig. 5.6.). Winds at the vessel gradually decreased and by evening it was down to Force 3 from the SW.

5.5.2 To west of the ridge of high pressure a very large and deep low pressure system was moving slowly eastwards. During the day the "Explorer" began to feel the westerly swell generated by this system. By midnight the swell had increased to 3½-4 metres.

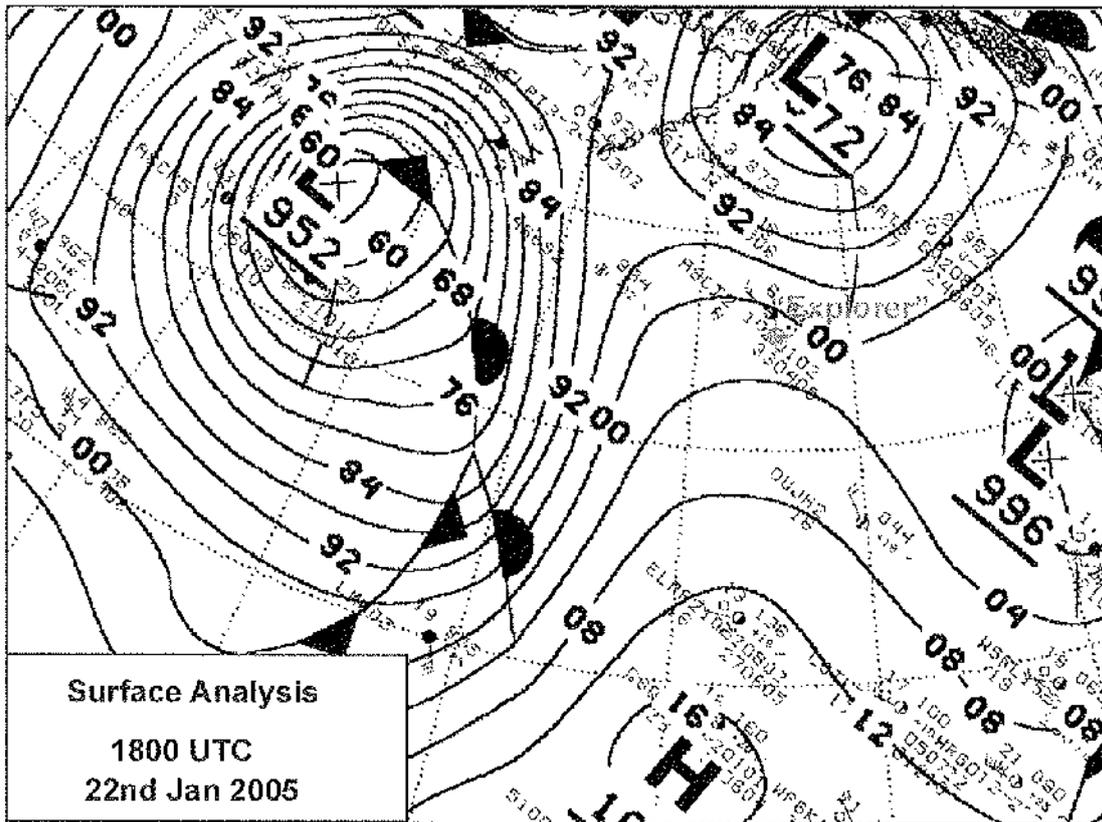


Fig. 5.6. Surface Analysis at 1800 UTC 22<sup>nd</sup> January 2005

5.6 Sunday 23<sup>rd</sup> January 2005

5.6.1 The deep low pressure centre remained slow-moving through the day. The wind at the "Explorer" briefly increased during the morning to Force 7 from the SE ahead of a front running NE around the low centre (see Fig. 5.7). Once the front passed the wind veered to SW and quickly decreased to Force 4-5. There was a persistent W-SW swell of 3-4 metres (see Fig. 5.8).

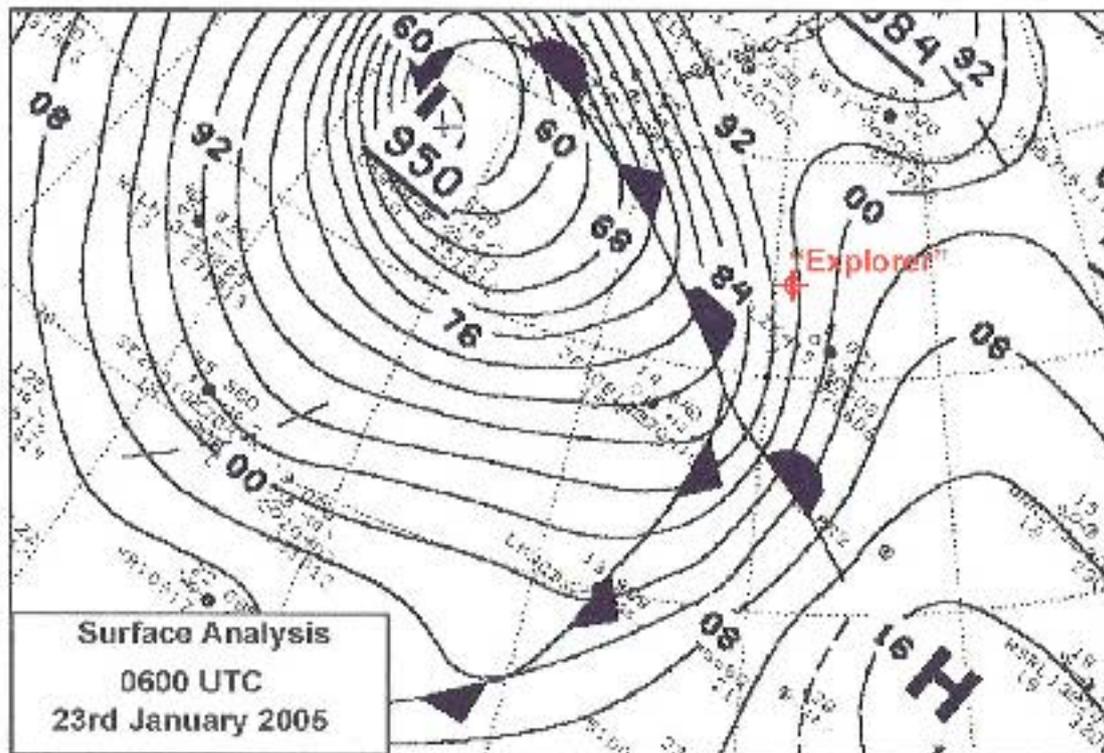


Fig. 5.7. Surface Analysis at 0600 UTC 23<sup>rd</sup> January 2005

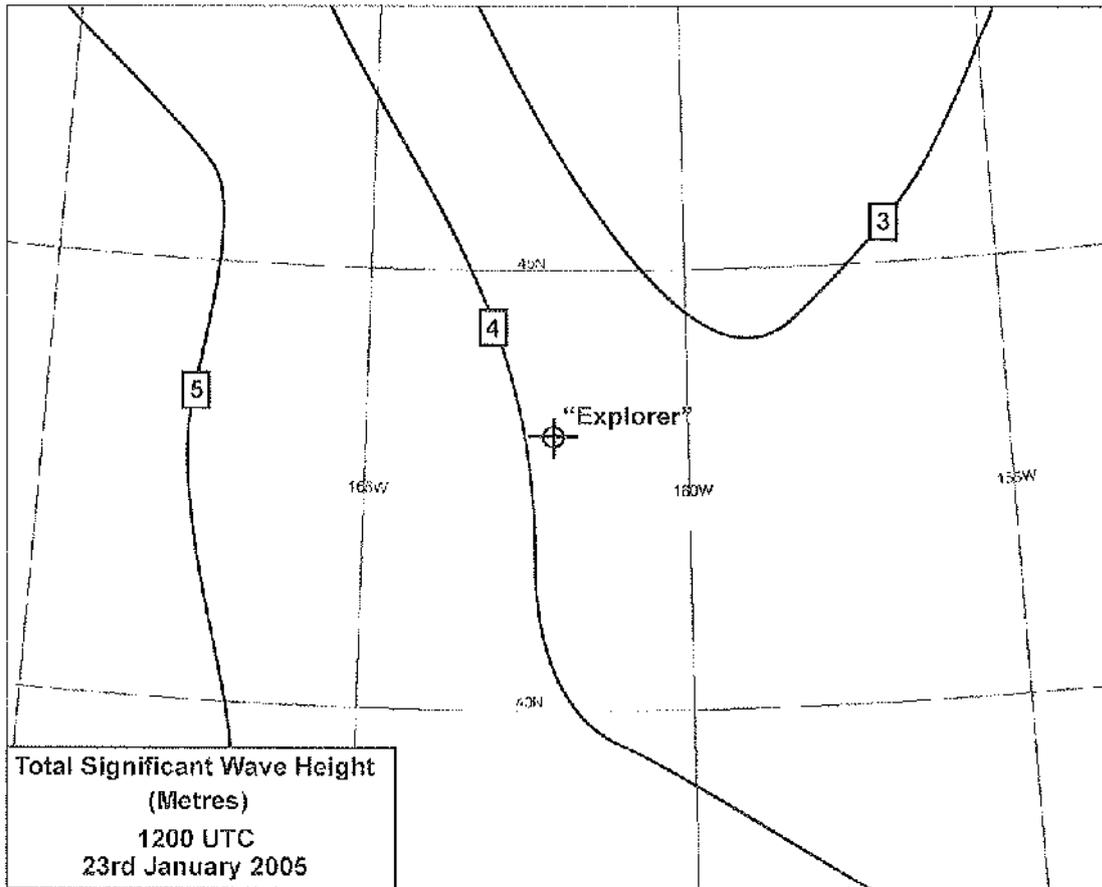


Fig. 5.8. Total Significant Wave Height at 1200 UTC 23<sup>rd</sup> January 2005

### 5.7 Monday 24<sup>th</sup> January 2005

- 5.7.1 The low centre remained almost stationary during the day and filled a little. An extensive area of very strong winds on the SW flank of the low generated progressively higher seas in these areas.
- 5.7.2 As the "Explorer" continued on a WSW course she gradually sailed into the area of stronger winds and higher seas (see Figs. 5.9-5.12). By the evening she was experiencing a total significant wave height of 7-7½ metres. By this time she was about 700 miles SE of the centre of the low.

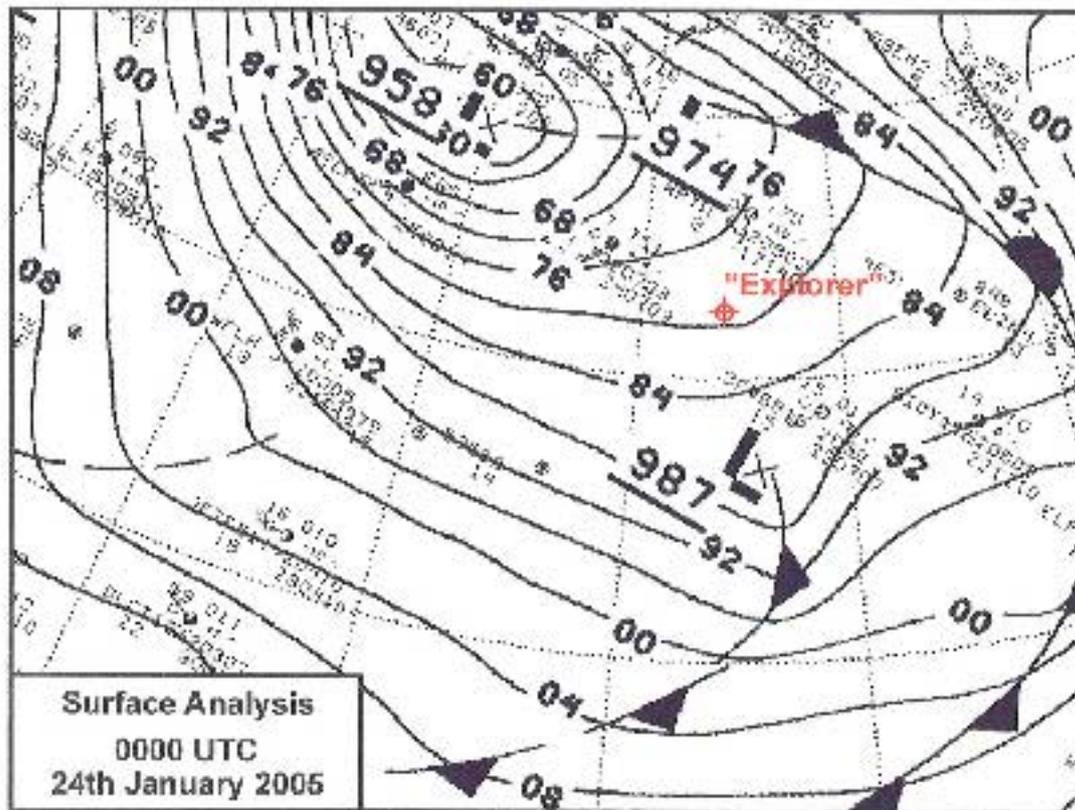


Fig. 5.9. Surface Analysis at 0000 UTC 24<sup>th</sup> January 2005

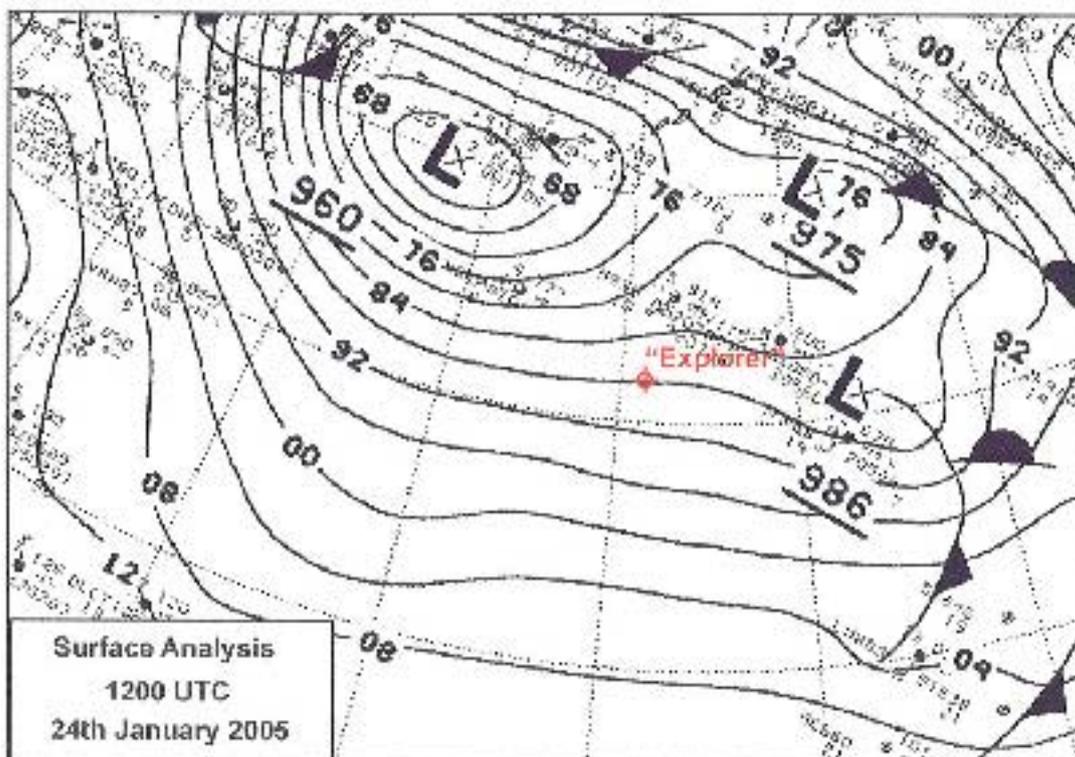
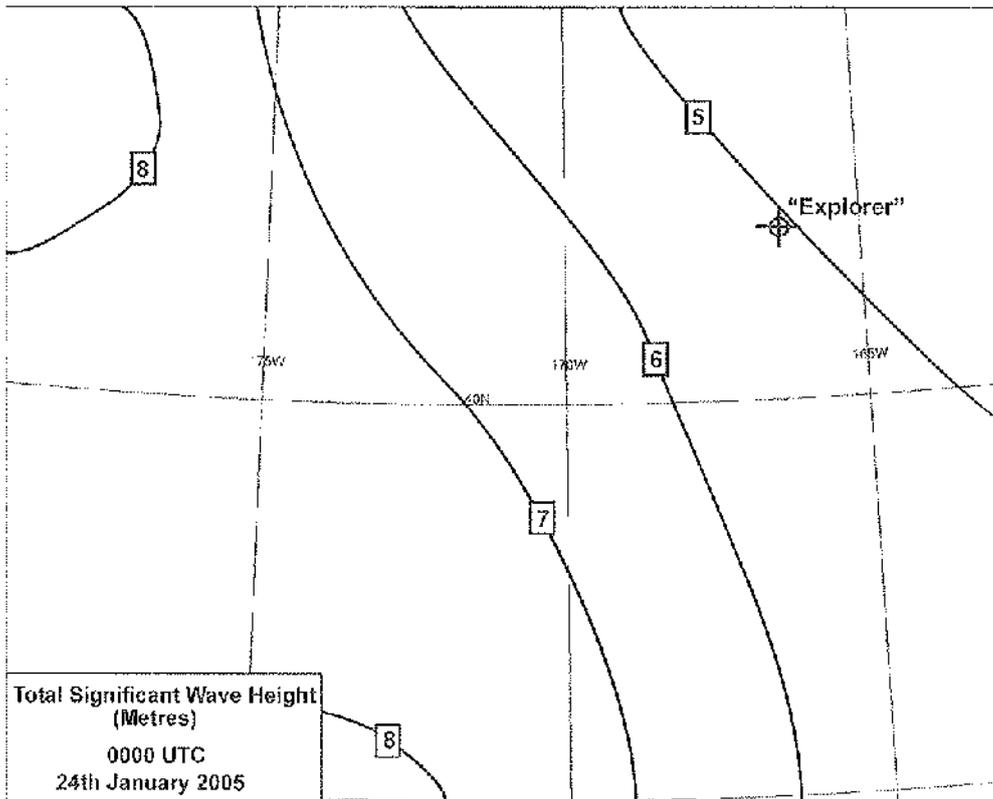
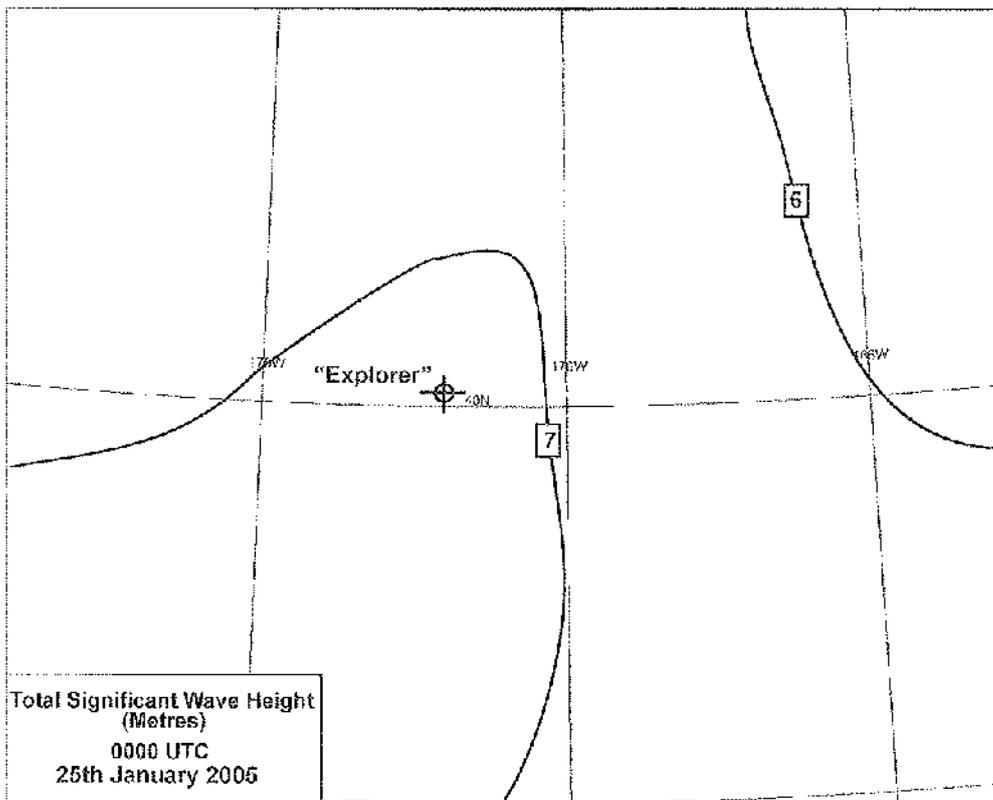


Fig. 5.10. Surface Analysis at 1200 UTC 24<sup>th</sup> January 2005



**Fig 5.11. Total Significant Wave Height at 0000 UTC 24<sup>th</sup> January 2005**

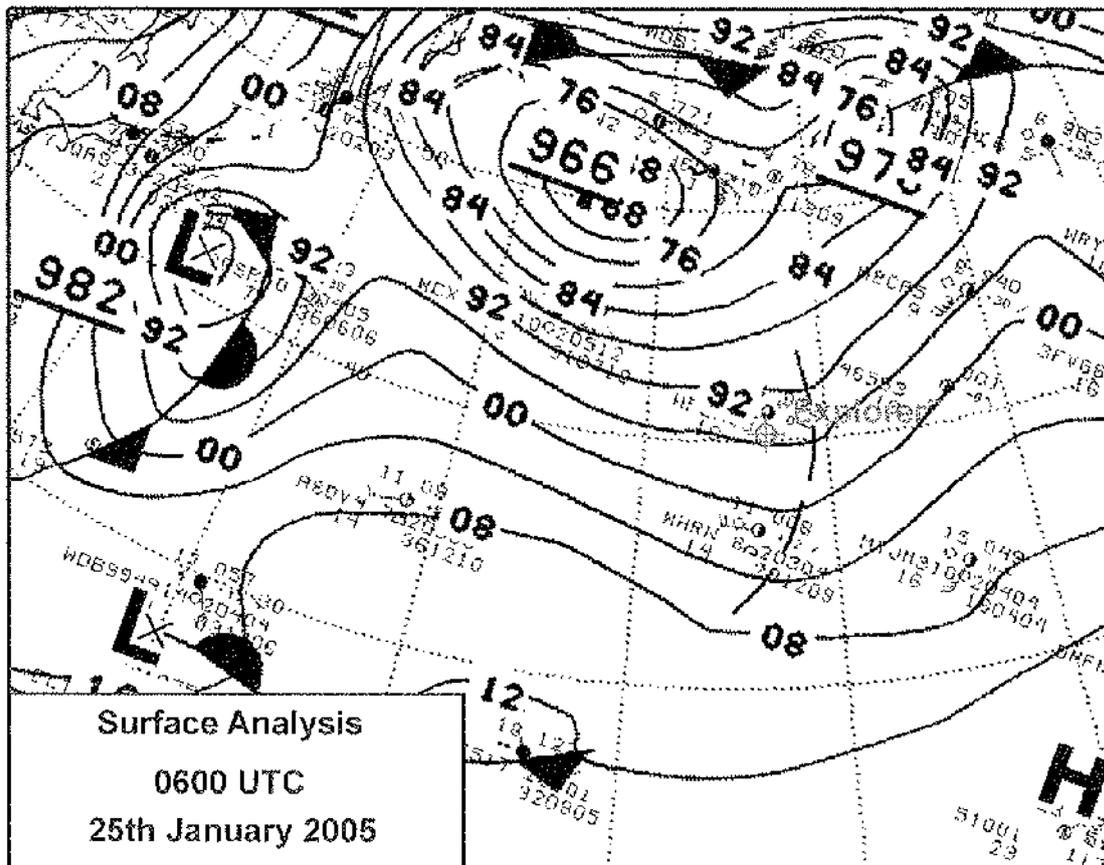


**Fig. 5.12. Total Significant Wave Height at 0000 UTC 25<sup>th</sup> January 2005**

5.8 **Tuesday 25<sup>th</sup> January 2005**

5.8.1 The stationary low pressure centre continued to fill slowly but the area of heavy seas on its southern side persisted.

5.8.2 During the day a new low began to move east into the Pacific Ocean from the vicinity of Japan (see Fig 5.13).



**Fig. 5.13. Surface Analysis at 0600 UTC 25<sup>th</sup> January 2005**

5.8.3 The "Explorer" encountered Force 6-7 winds from the west for most of the day but in the evening the wind dropped to Force 4-5 and became SW'ly ahead of the new low. The total significant wave height persisted in the range 6-8 metres throughout the day (see Fig. 5.14.) with all the wave energy coming from the west.

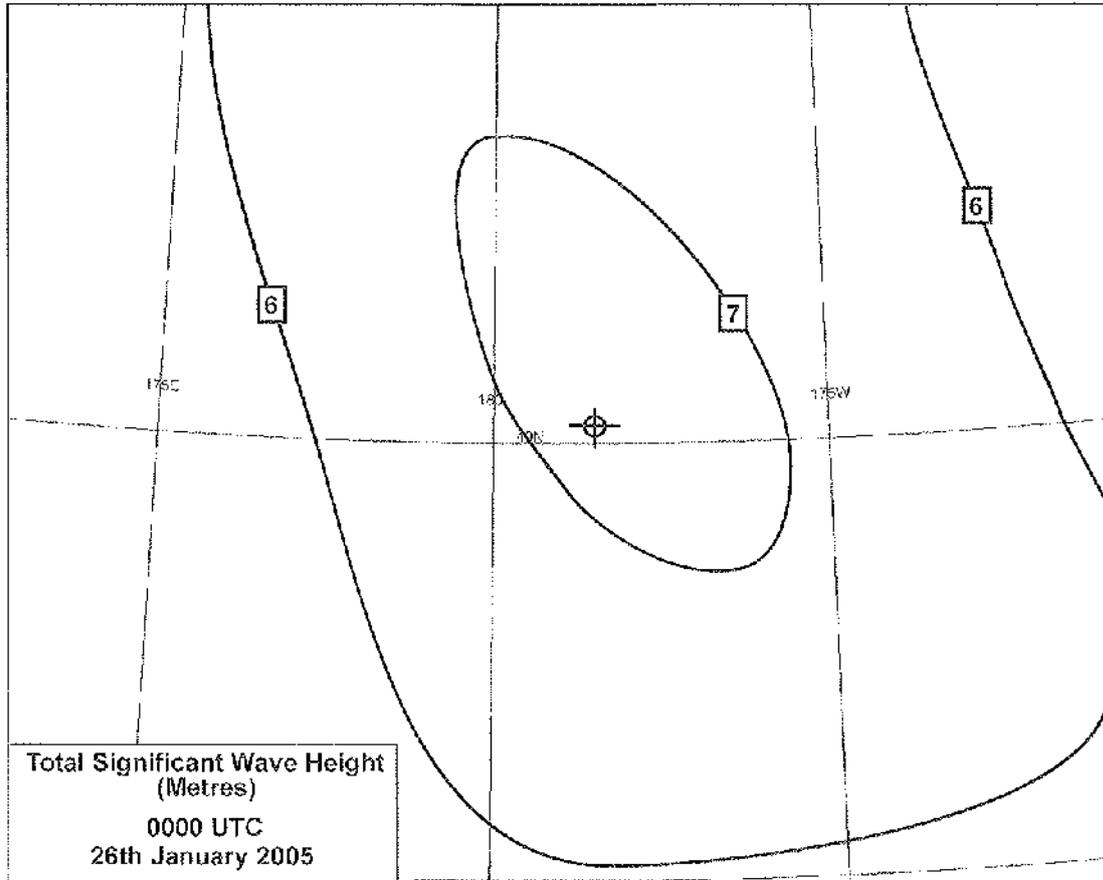


Fig. 5.14. Total Significant Wave Height at 0000 UTC 26<sup>th</sup> January 2005

### 5.9 Wednesday 26<sup>th</sup> January 2005

5.9.1 The new low moved NE and deepened during the day. By midnight it was centred about 250 miles north of the "Explorer" with central pressure about 967 mb (see Figs. 5.15 and 5.16).

5.9.2 A front associated with the low passed NE across the "Explorer" during the late morning. Ahead of the front the wind became southerly and increased to gale force for a short time. As the front passed through the wind veered to SW and decreased temporarily but during the afternoon a severe westerly gale set in and persisted through the evening. The total significant wave height increased to 9-10 metres in the evening (see Figs. 5.17 and 5.18). A notable component of this increase was the arrival of a long W'y swell with a height of 7-7½ metres. This was a very substantial deterioration.

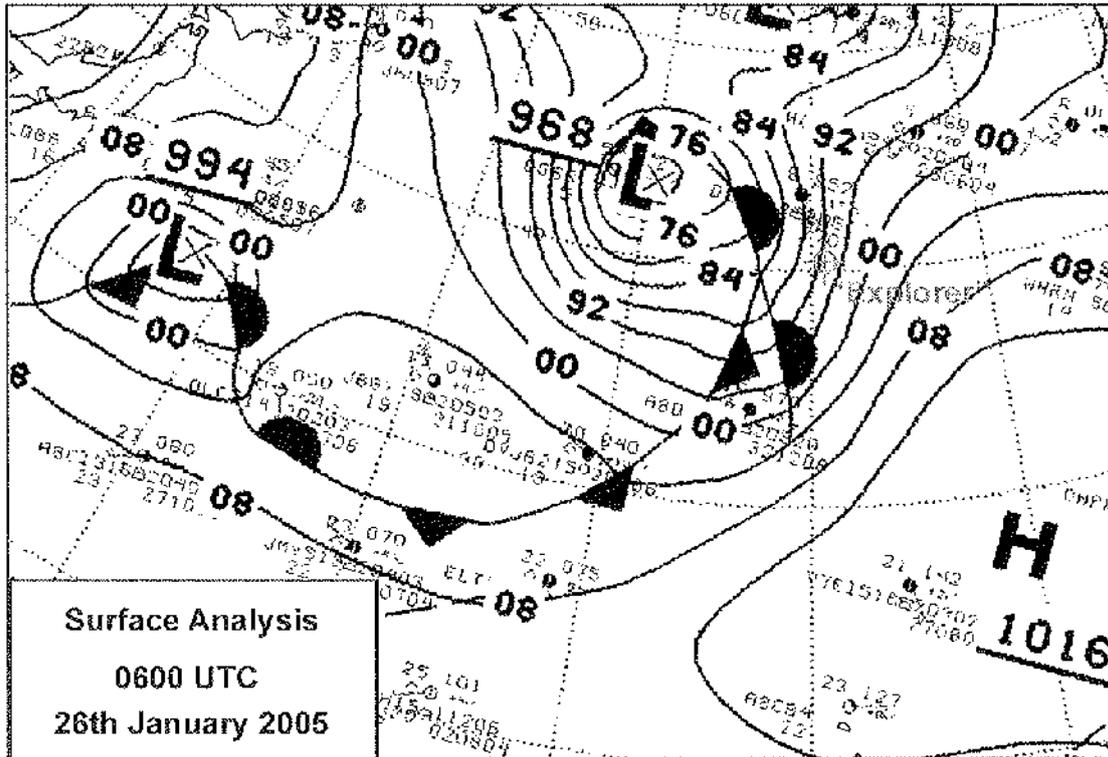


Fig. 5.15. Surface Analysis at 0600 UTC 26<sup>th</sup> January 2005

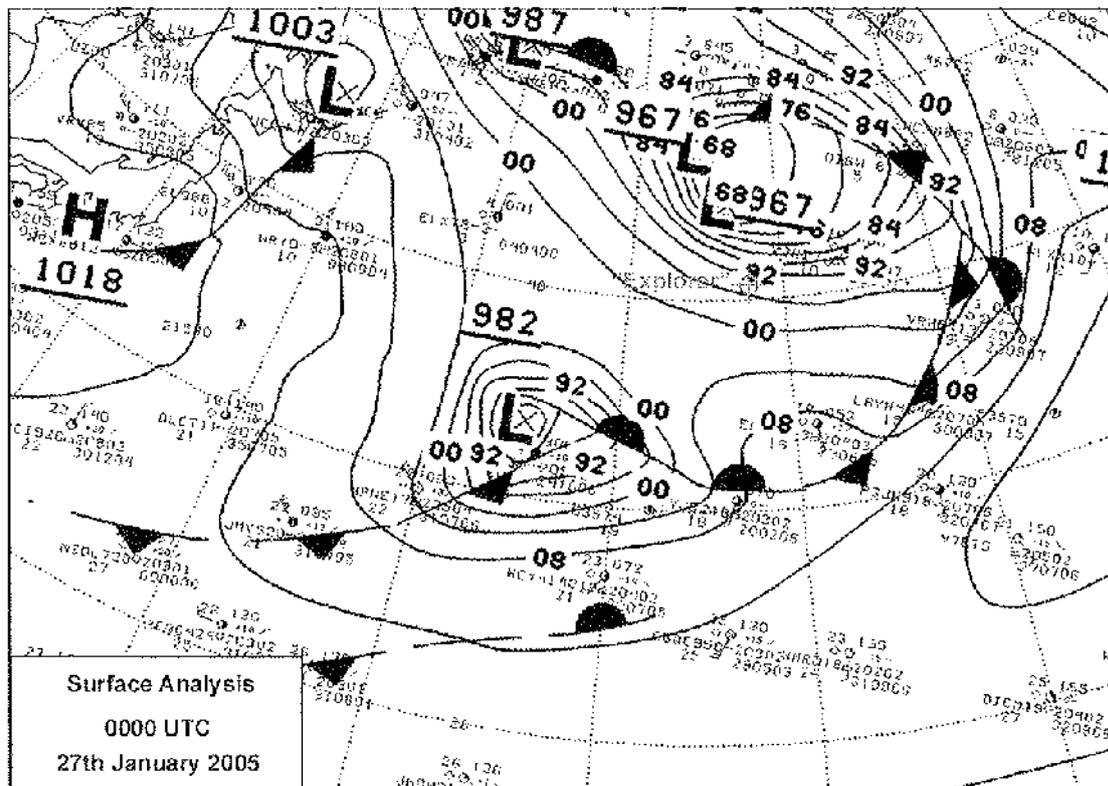


Fig. 5.16 Surface Analysis at 0000 UTC 27<sup>th</sup> January 2005

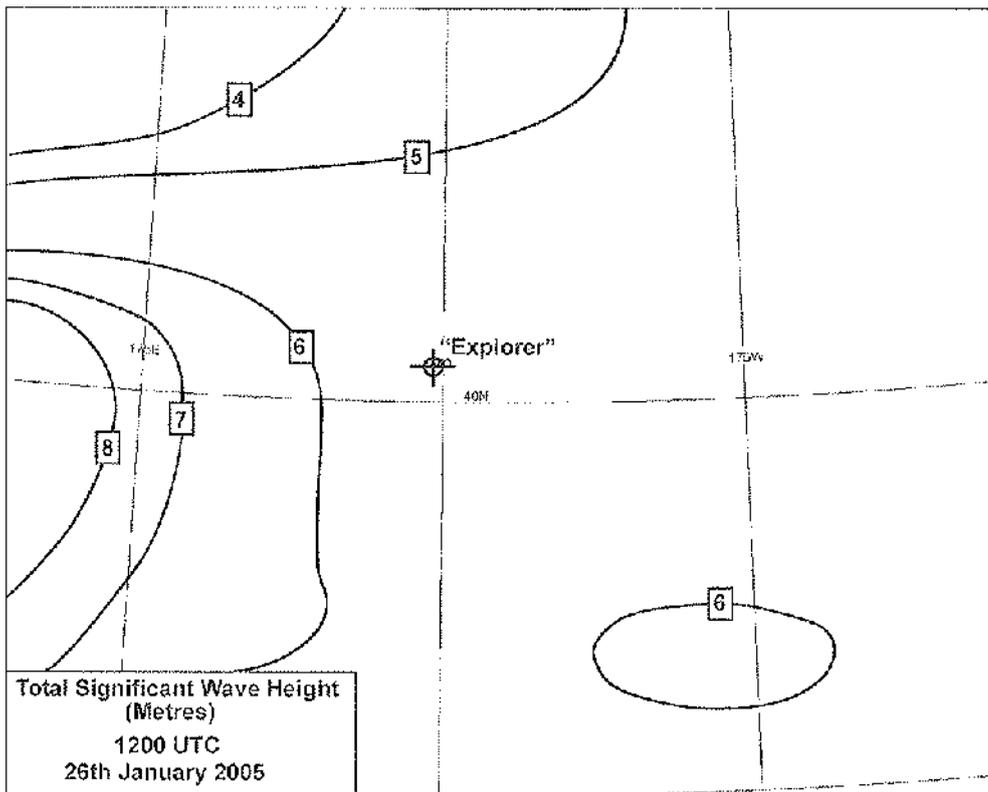


Fig. 5.17. Total Significant Wave Height at 1200 UTC 26<sup>th</sup> January 2005

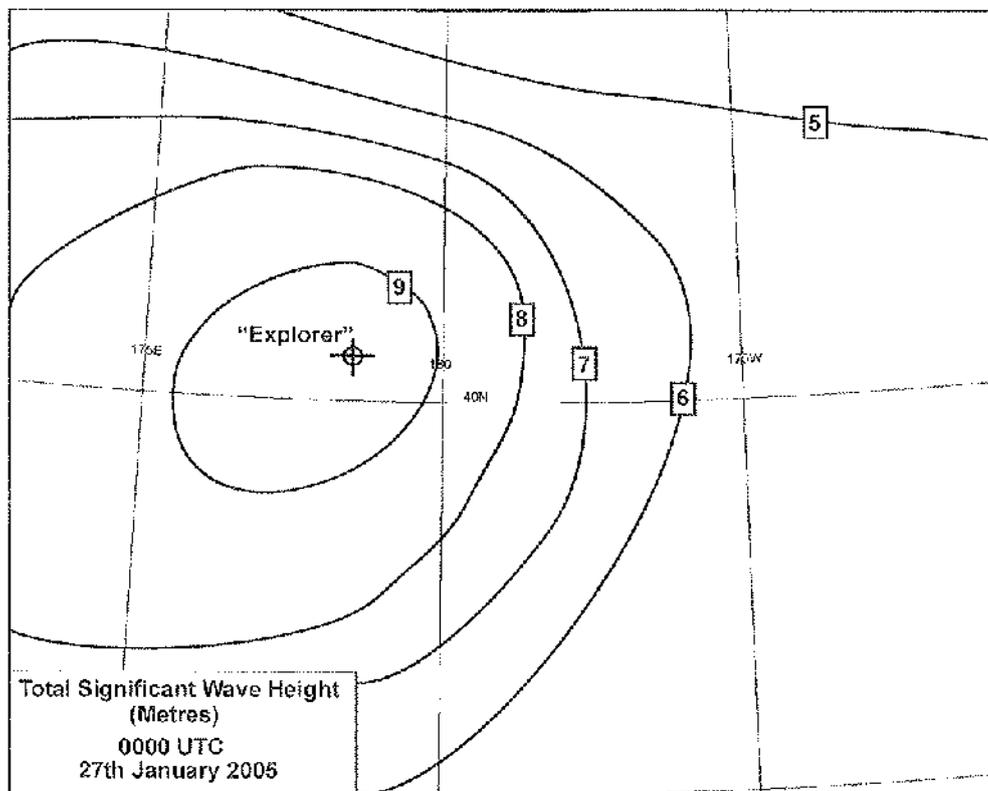


Fig. 5.18. Total Significant Wave Height at 0000 UTC 27<sup>th</sup> January 2005

5.10 **Thursday 27<sup>th</sup> January 2005**

5.10.1 The low centre moved away northwards but the centre of another deepening low moving NE passed almost directly over the "Explorer" during the afternoon (see Figs. 5.19 and 5.20).

5.10.2 The severe westerly gale at the "Explorer" decreased quickly during the very early hours. For a time in the middle of the day winds were relatively light and probably variable in direction. As the low centre passed the wind increased rapidly from NW, probably reaching severe gale or storm force through the evening.

5.10.3 The total significant wave height was around 8-9 metres for much of the day, but decreased a little towards midnight (see Fig 5.21). The long, high W'ly swell persisted for much of the day.

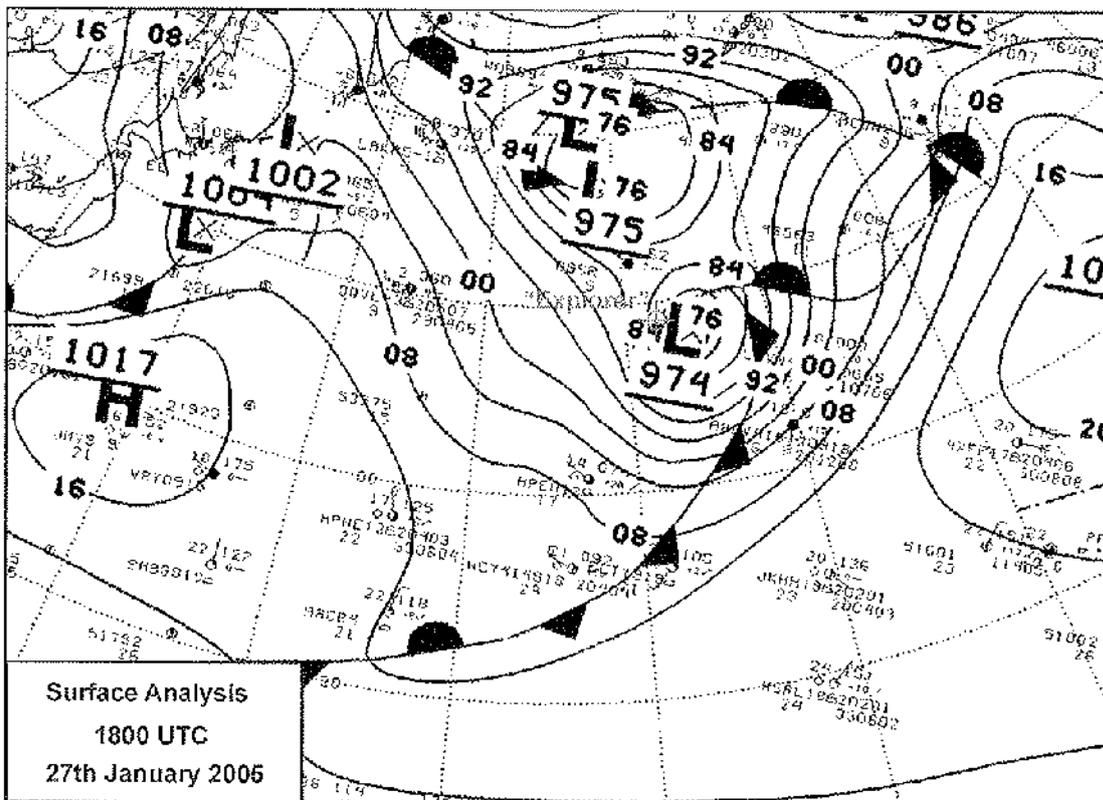


Fig. 5.19. Surface Analysis at 1800 UTC 27<sup>th</sup> January 2005

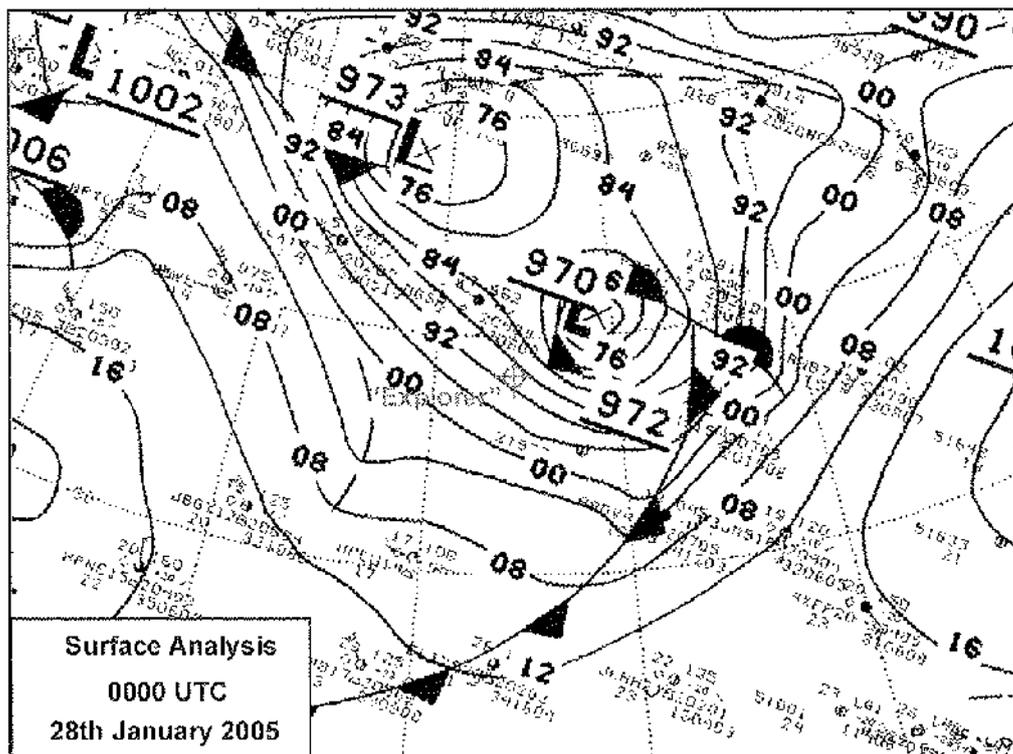


Fig. 5.20. Surface Analysis at 0000 UTC 28<sup>th</sup> January 2005

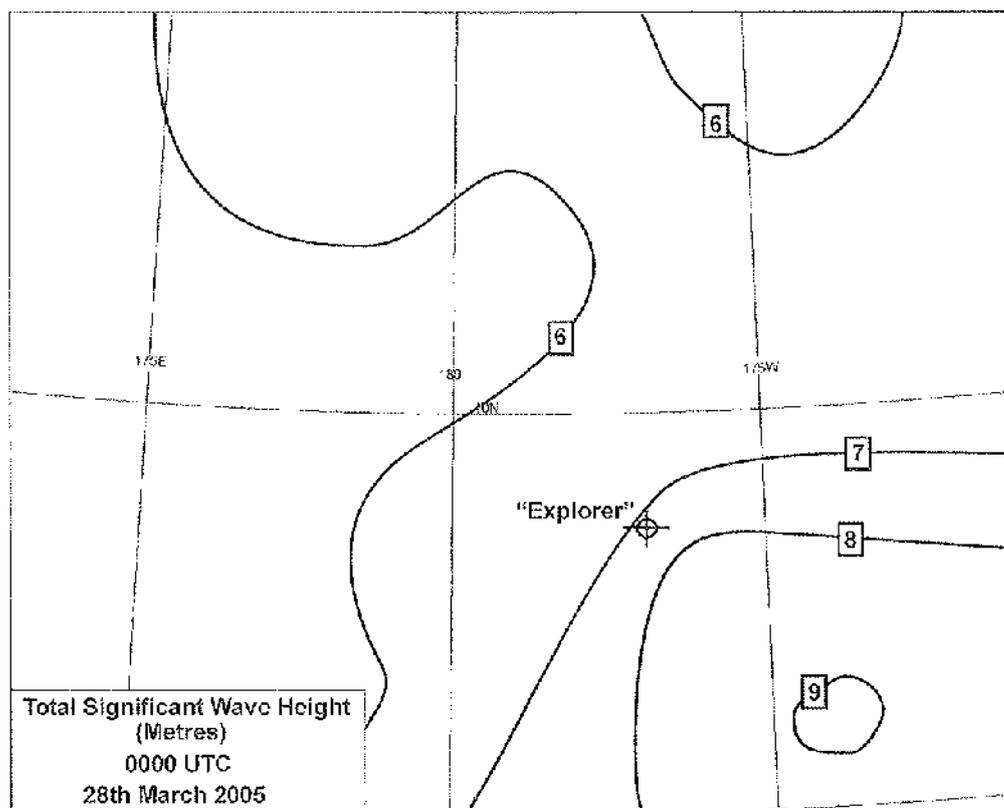


Fig. 5.21. Total Significant Wave Height at 0000 UTC 28<sup>th</sup> March 2005

5.11 **Friday 28<sup>th</sup> January 2005**

5.11.1 The low centre continued to move NE and deepen while, to the west, a high centre moved out into the Pacific Ocean along 30°N. Between these two systems the "Explorer" experienced persistent gale force winds from W-WNW.

5.11.2 The total significant wave height at the vessel persisted at 7-8 metres throughout the day with all of the wave energy coming from W-WNW.

5.12 **Saturday 29<sup>th</sup> January 2005**

5.12.1 The high centre moving eastwards gradually became the dominating influence on the weather experienced by the "Explorer" with a steady decrease in wind throughout the day (see Fig. 5.22). By evening the wind was down to force 3-4 but the total significant wave height was still 6-7 metres (see Fig. 5.23).

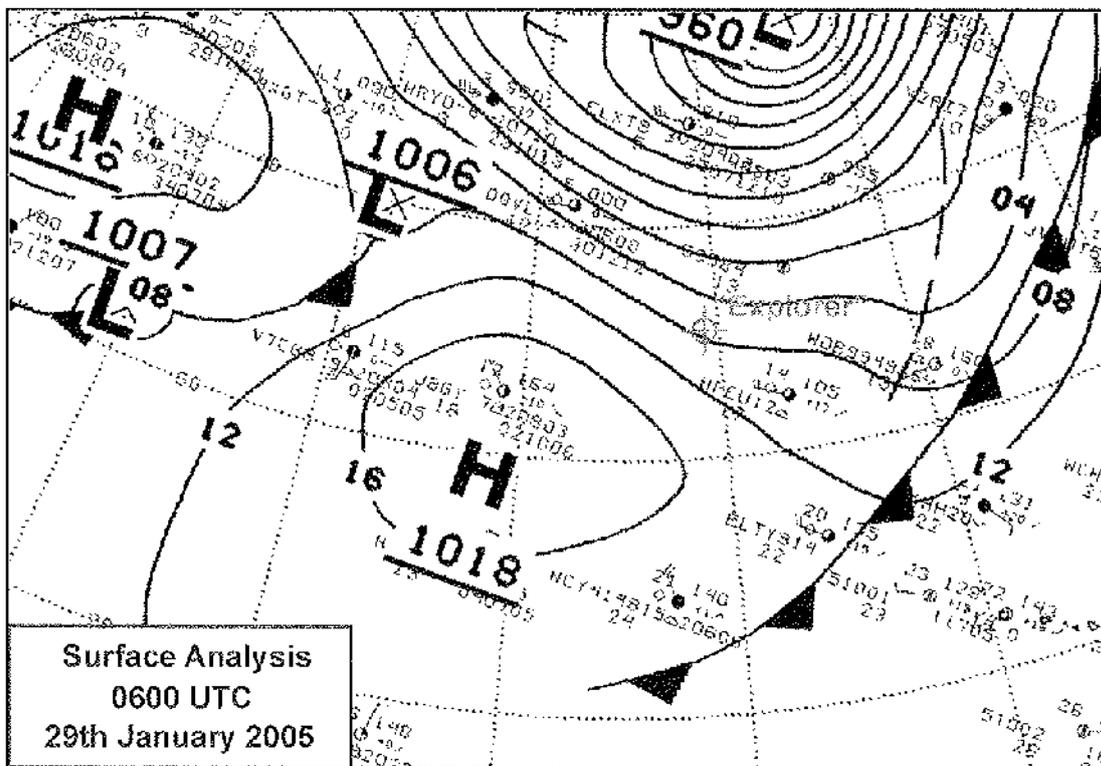


Fig. 5.22. Surface Analysis at 0600 UTC 29<sup>th</sup> January 2005

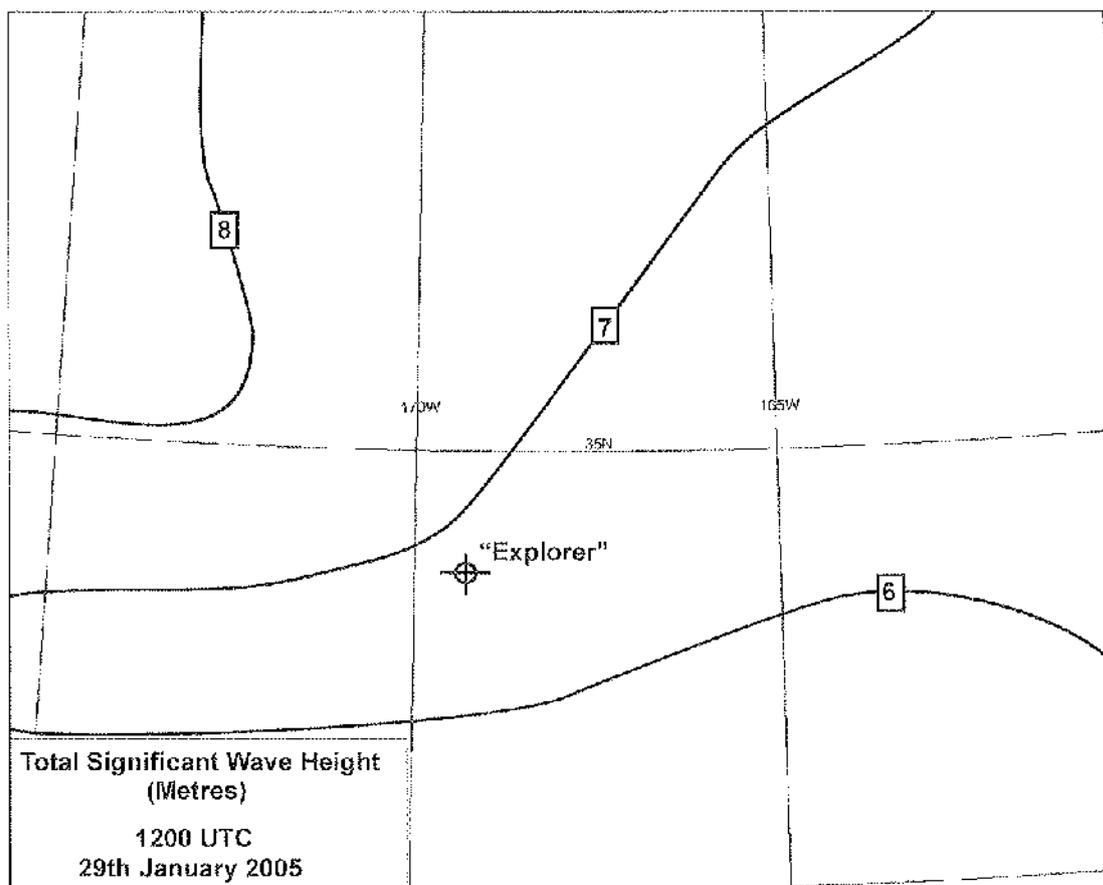


Fig. 5.23 Total Significant Wave Height at 1200 UTC 29<sup>th</sup> January 2005

5.13 Sunday 30<sup>th</sup> January 2005

5.13.1 The high pressure centre was dominant by this time with light winds at the "Explorer" (see Fig. 5.24).

5.13.2 The NW swell continued to be very persistent with the total significant wave height decreasing very slowly to 4-5 metres.

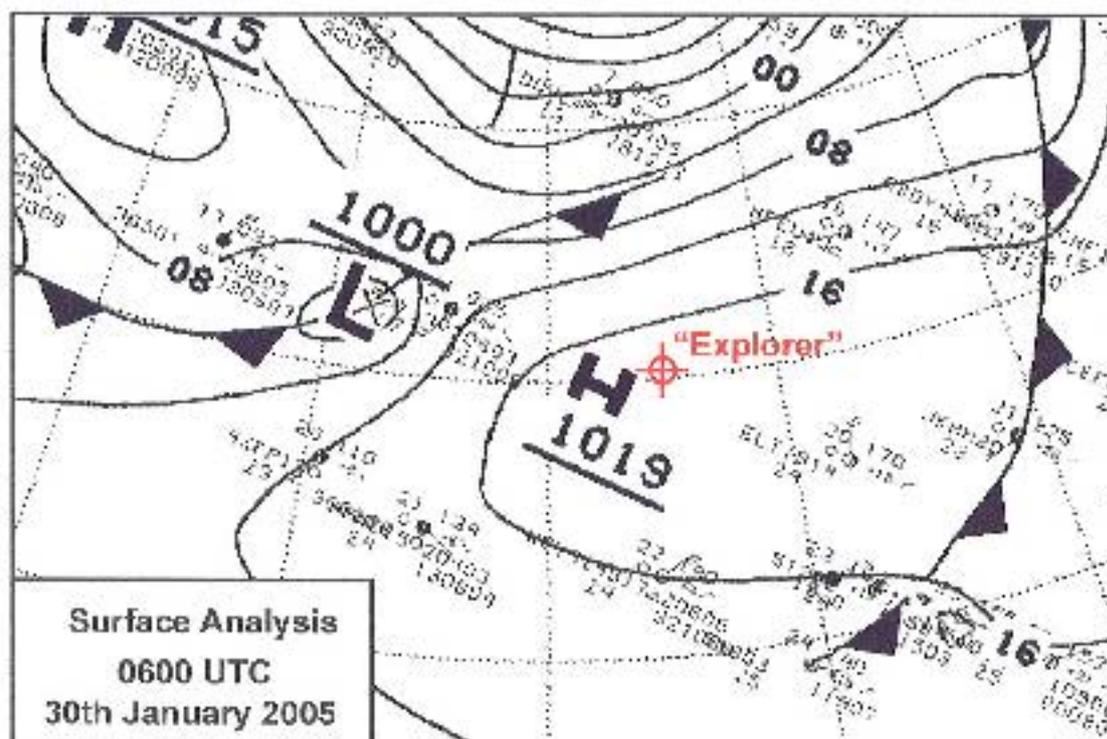


Fig 5.24. Surface Analysis at 0600 UTC 30<sup>th</sup> January 2005

## 6. WEATHER EXPERIENCED BY M/S "EXPLORER"

6.1 The following table is my best-estimate of the conditions experienced by the "Explorer" based on an appraisal of all the available data.

Date/Time (UTC) Jan 2005	Wind		Total Sig Wave (metres)	Sea		Dominant Swell		
	Direction	Speed (knots)		Height (metres)	Period (seconds)	Direction	Height (metres)	Period (seconds)
20/0000	SW	10-15	4½-5	1-1½	6	SW	4½-5	12
0600	SW	8-12	4½-5	½-1	5	SW	4-4½	12
1200	WSW	5-10	4-4½	½-1	5	SW	3½-4	11
1800	SSE	18-22	3½-4	1-1½	6	SW	2½-3	11
21/0000	SE	33-38	3½-4	2½-3	7	SW	1½-2	10
0600	SSW	25-30	4½-5	3-3½	7	SW	1½-2	10
1200	SSW	33-38	6-6½	5-5½	9	SW	2½-3	11
1800	SW	23-28	5½-6	4-4½	8	SW	2½-3	10
22/0000	WSW	15-20	4-4½	2-2½	7	SW	2½-3	9
0600	W	17-22	3-3½	2-2½	7	SW	2-2½	9
1200	WNW	18-23	3½-4	2½-3	7	W	2-2½	11
1800	W	15-20	3½-4	1½-2	6	W	2½-3	11
23/0000	SW	8-12	3½-4	½-1	4	W	3½-4	10
0600	SSE	25-30	3-3½	2½-3	7	W	3-3½	10
1200	SW	13-18	3½-4	1½-2	6	SW	3-3½	9
1800	WSW	15-20	4-4½	1½-2	6	SW	3½-4	10
24/0000	WSW	13-18	4½-5	2-2½	6	WSW	4-4½	11
0600	W	18-23	5½-6	2½-3	6	WSW	4½-5	12
1200	WSW	23-28	6-6½	3-3½	7	WSW	5-5½	14
1800	W	22-27	7-7½	3-3½	8	WSW	5-5½	14
25/0000	WSW	17-22	7-7½	3-3½	8	W	5½-6	14
0600	W	22-27	6-6½	2½-3	8	W	5½-6	14
1200	W	22-27	6-6½	3-3½	7	WNW	5-5½	12
1800	W	25-30	7½-8	3-3½	7	WNW	5½-6	12
26/0000	SW	15-20	7-7½	2-2½	7	NW	6-6½	12
0600	S	33-38	6-6½	3½-4	8	NW	5-5½	12
1200	SW	25-30	5-5½	3½-4	8	NW	3½-4	12
1800	W	38-43	7½-8	5-5½	9	NW	4½-5	12
27/0000	W	33-38	9½-10	5-5½	9	W	7-7½	13
0600	WNW	28-33	8½-9	4-4½	8	W	7-7½	13
1200	NW	12-18	7½-8	1½-2	6	W	7-7½	12
1800	NW	40-50	8½-9	5-5½	9	W	6½-7	12
28/0000	WNW	38-43	7-7½	4½-5	9	W	4½-5	13
0600	WNW	30-35	7½-8	4½-5	9	W	5-5½	13
1200	W	28-33	7½-8	3½-4	9	WNW	6-6½	13
1800	WNW	30-35	7-7½	4-4½	8	WNW	5½-6	13
29/0000	WNW	25-30	7-7½	3½-4	8	NW	5½-6	12
0600	WNW	27-32	7-7½	3½-4	8	NW	5½-6	12
1200	WNW	27-32	6½-7	3½-4	8	NW	5½-6	13
1800	NW	18-23	6½-7	2½-3	7	NW	5½-6	13
30/0000	NW	10-15	6-8½	1½-2	5	NW	5½-6	12
0600	VRBL	<10	5½-6	<½	5	NW	5½-6	12
1200	SE	8-12	5-5½	<½	6	NW	5-5½	12
1800	SSE	8-12	4½-5	½-1	5	NW	4-4½	12

## 7. CONCLUSIONS

- 7.1 In this Section all dates and times are in UTC, except where explicitly stated otherwise.
- 7.2 The recommended route in "Ocean Passages for the World" for a westbound voyage from Vancouver to Hakodate is a near-great circle passing either north of the Aleutian Islands or close south of them. This is the shortest route and it keeps north of the latitudes where the most persistent westerly winds and heavy head seas occur. The route taken by the "Explorer" was much further south than the recommended route and it was almost inevitable that she would experience lengthy spells of very strong head winds and high head seas. There may, of course, have been sound operational reasons for taking this route.
- 7.3 The "Explorer" encountered short spells of gale force winds and relatively heavy seas on 21<sup>st</sup> Jan 2005 but conditions improved again on 22<sup>nd</sup> Jan.
- 7.4 The main spell of persistent strong head winds and heavy head seas developed during 24<sup>th</sup> Jan. It was then more or less unbroken (for a westbound vessel) right through to 29<sup>th</sup> Jan. The conditions did not become unusually severe for the North Pacific Ocean in January. The strongest winds were Force 10 for a time on the evening of 27<sup>th</sup> Jan. The highest total significant wave height of around 10 metres occurred earlier the same day. This spell of several days of persistent heavy weather is quite typical of what is likely to be experienced in January over the route taken by the "Explorer".
- 7.5 The most significant event during the spell of heavy weather appears to have been the sudden onset of a long, high westerly swell (7-7½ metres in 13 seconds) during the evening of 26<sup>th</sup> Jan. In ship's time this was during the late morning of the 27<sup>th</sup> (the first day with that date). Accompanied by a severe westerly gale this was a very significant deterioration in conditions. While I have no information on the motion responses of the vessel it is very

likely that this deterioration in sea conditions resulted in a sudden and marked increase in the motions of the vessel. Similar sea conditions then persisted through most of 27<sup>th</sup> Jan (UTC). For a short time on the evening of the 27<sup>th</sup> they were accompanied by winds up to Force 10.

This report is intended for the sole use of the party or parties to whom it is addressed and no liability of any nature whatsoever shall be assumed to any other party in respect of its contents.

NORMAN LYNAGH WEATHER CONSULTANCY

Signed:   
Mr. N. Lynagh, CMet, FRMetS, MAE, DABFE, MRIN

Date: 31<sup>st</sup> March 2005

## REFERENCES

1. Meteorological Office, Met.O.1012, (1993), "Forecasters' Reference Book", Bracknell, Berkshire, UK.
2. Hydrographer of the Navy, (1987), "Ocean Passages for the World", Fourth Edition, Hydrographic Department, Ministry of Defence, Taunton, Somerset, U.K.



