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Cruise Ship Hull Inspection After Action Review

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Date: June 29, 2002

Location: Port of Miami, Florida USA

Operation: Ship Hull Inspection Demonstration

ROV Pilot: Bob Christ

Vessel Inspected: Norwegian Sun

Underwater Visibility: Approximately 6 feet (2 meters)

NCL POC: Matt Lewis, Head of Security

Introduction:

VideoRay was approached by Norwegian Cruise Lines, through its dealer Diving Technologies (of Sunrise, Florida), to demonstrate its ability to complete underwater security and maintenance inspections of its cruise ships while in port or underway. VideoRay representatives Bob Christ and Scott Bentley along with Rudy Mola of Diving Technologies met with NCL representatives at Terminal 1 of the Port of Miami to discuss then demonstrate capabilities.

Operational Demonstration:

The demonstration took place at 2 locations – The VideoRay 2002 submersible (sub) was operated on the starboard side of the vessel from the pier with the control box set up in the back of a Chevrolet SUV on the pier. The VideoRay Pro II system was operated from on-board the vessel on the port side from a water-level passenger door. Both systems were powered by vessel power through an extension cord run to a 110 VAC power source near the passenger door.

The starboard side demonstration sub (VR 2002) was placed in the water and run on the surface to just below the starboard side aft thruster. The operator then followed weld seams towards the keel of the vessel then swept toward the stern quickly. Operation of a Remotely Operated Vehicle (ROV) Inspection System requires some type of vessel diagram in order to navigate the major landmarks of the vessel. The VideoRay operator easily followed seams and roadmaps below the waterline with speeds of up to 2.5 knots (4+ km/hr.). The sub was able to fight the .5 knot (1 km/hr.) current easily while inspecting the underside of the vessel.

Operationally, once the planning of this operation is conducted, the author of this report

have minimal tether lay below the vessel. Necessary also in the long run will be an acoustic positioning system to assist in navigation below the vessel.

The port side inspection was conducted with a standard VideoRay 2002 (for specifications, please refer to http://www.videoray.com/Products/products_intro.htm) using as a display an inexpensive 19-inch television screen. The auto depth function on the VideoRay 2002 worked splendidly in assisting the operator to run the camera along an even depth to assure coverage of the area in question. Example of this capability was the ability to gauge the visibility of the water then decide upon how far to space the vertical grid search lines on the vessel. We were able to descend to 5 feet (1.7 meters) then fun horizontally along the hull with ease. We then descended to 10 feet (3.4 meters) then ran the search grid in the opposite direction. The need for a ship's diagram became immediately apparent due to searching limitation of finding major landmarks beneath the vessel. The VideoRay 2002 functioned as a basic "flying eye" beneath the vessel.

From discussions with the head of security with NCL, it appears that the major security threat would not be to the smooth hull surfaces but the many through-hull fittings as well as the thruster housings. Since these areas would allow for protection from water-flow potentially dislodging any type of parasite attached via magnet or soft attachment, they would be the easiest to successfully hide underwater explosives and contraband. Therefore, the examination of these areas is necessary on a very frequent basis. As demonstrated, the VideoRay 2002 can easily navigate into these spaces by simply traveling on the surface to a known reference point, following a visual grid line (usually a weld seam or other landmark on the hull) then locating visually for inspection the items of interest on the ship's hull.

The second demonstration was conducted from the port side waterline passenger door amidships from aboard the vessel with a VideoRay Pro II system with a LCD display as well as MiniDV recorder mounted into the control box. For specifications on the VideoRay Pro II, please refer to http://www.videoray.com/Products/products_intro.htm. The MiniDV recorder was a Sony GV-D1000 with digital capture capability for both JPEG as well as MPEG digital file captures. The objective of the second demonstration was to locate one of the bow thrusters then display the detail within the thruster assembly. The entire operation was saved to digital MiniDV tape for later dissemination. The tape of that operation was copied onto VHS and forwarded to the NCL Head of Security. Digital stills and digital videos were also taken down to memory stick housed in the GV-D1000 then transferred to laptop for uploading to the web. We have stored the digital images at the following location: http://scott.bentley.com/miami0701/MSSONY/MOML0001/ which contains test files during the brief as well as 2 digital captures of the middle bow thruster.

The sub traveled on the surface to the hull marking for the middle bow thruster then submerged. We then followed the underwater seam to the opening of the middle bow thruster on the port side of the vessel. The vessel was laying starboard side to the pier at the Port of Miami with the bow facing East. We were able to examine extreme detail of the items in the bow thruster area including (as referenced as MPEG files):

1) http://scott.bentley.com/miami0701/MSSONY/MOML0001/MOV00007.MPG (Please notice in this file the condition of the bolts on the variable pitch bow thruster assembly – the heading and depth of the submersible is referenced on the bottom left-hand side of the screen as is the date and time on the top left-hand side of the screen). The sub here is facing starboard and slightly aft while taking this film clip.
2) http://scott.bentley.com/miami0701/MSSONY/MOML0001/MOV00009.MPG This clip shows the initial insertion of the sub into the bow thruster. The beginning of the clip shows the

forward edge of the bow thruster opening then pans into the bow thruster heading to the site of the clip in 1) above.

3) http://scott.bentley.com/miami0701/MSSONY/MOML0001/MOV00010.MPG This clip shows a sacrificial anode on the forward edge of the bow thruster opening slightly port of centerline (again, please notice the heading and depth).

Results and Summary:

The demonstration proved the initial capabilities of ship hull inspection with the VideoRay Remotely Operated Inspection system. The low-cost version of the VideoRay system (VideoRay 2002 - approximately $12,000 USD per system) provided a basic ability to look beneath the vessel. The Pro II system (VideoRay's professional version – base cost of approximately $20,000 USD per system) provided the ability to dig into and out of enclosed places (with the standard rear-facing low-lux CCD camera). It also showed its ease of handling (with the standard on-screen heading/depth/date/time function), provided the expandability to accommodate VideoRay's operational acoustical underwater positioning and gave the ability to capture images, video and still digitally for uploading to the Internet within seconds of capture.

The advantages of this method over deployment of divers is as follows:

1) Safety – the obvious safety advantages of placing the VideoRay at risk as opposed to divers is clearly seen.
2) Expertise of Operator – Divers may not have the expertise to see maintenance problems easily spotted by a trained engineering department eye gathered during a security sweep. Also, mechanical problems encountered during the course of a voyage could be captured digitally for immediate transfer to the home office for expert dissemination the situation.
3) Cost Advantage – From discussions with NCL Head of Security, the average cost of a security sweep with divers in Miami is approximately $2,500 USD. The cost of deploying the same divers at remote locations in the Caribbean expand to $6,000+ USD. Cost savings from delays due to sequencing the divers to the vessel location or operational/training/equipment limitations cannot be assessed in this report.
4) Increased Security through Higher Frequency of Inspections – The marginal cost of each inspection is essentially $0. This would allow for more frequent inspections of the hull allowing for a higher level of security.

Also suggested during the demonstration by other members of the cruise line industry would be to generate a future revenue stream through rental income to passengers for operation of the VideoRay system while in port.

Steps to Implementation:

The suggested method of adapting this system within standard operating procedures would be as follows:

1) Purchase one system along with training
2) Develop techniques to operationally deploy the system in various scenarios in the most effective/least resource intensive manner
3) Implement this system throughout the fleet.