Port Canaveral Section 203 Feasibility Study

Engineering Appendix

Attachment A

June 2008 Letter from the Canaveral Pilots Assoc.
Port Canaveral 2003 STAR Center Report
Port Canaveral 2007 STAR Center Report
Port Canaveral 2009 STAR Center Report

Rev Date: 10/30/2009

CANAVERAL PILOTS ASSOCIATION

P.O. Box 816 • Cape Canaveral • FL 32920
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First in Safety

Capt. B. Borgie, Capt. D. Brown, Capt. D. Callan, Capt. S. Gasecki, Capt. R. Grimison, Capt. B. McMillin, Capt. L. Mello, Capt. D. Richard, R. Lacko, Business Mgr.

RECEIVED JN 6 CPA

Mr. Jon Brazee
Director of Engineering
Canaveral Port Authority
Cape Canaveral, FL 32920

June 4, 2008

Dear Mr. Brazee:

Subject: Section 203 Feasibility Study

The Canaveral Pilots Association is pleased to take this opportunity to provide additional comments regarding the navigation improvements outlined in the Section 203 Feasibility Study for Port Canaveral. As you are aware, four members of the Canaveral Pilots Association participated in a simulation for this Feasibility Study in March and April of 2007 at the RTM Star Center and they provided evaluation forms concerning the results of the simulation project.

The purpose of this letter is to provide additional comments to those evaluations, especially in consideration of the fact that the simulation used a Genesis class cruise ship model and as of this date, there are no plans to permanently home port a Genesis class ship at Port Canaveral. However, it is the opinion of the Canaveral Pilots that based on contracts that have been signed between various cruise ship companies and the Canaveral Port Authority, as well as the ongoing construction of a new tank farm and tanker terminal on the north side of the port, the navigation improvements as simulated and detailed in the Feasibility Study are necessary for Port Canaveral regardless of whether or not a Genesis class vessel is home ported here in the short term, and are needed for the immediate future of safe navigation at Port Canaveral.

The Canaveral Port Authority has signed a contract with Royal Caribbean to bring a Freedom class cruise ship vessel to Port Canaveral in 2009. The Freedom class vessels are 339 meters (1112 ft.) in length and 38.6 meters (127 ft.) in beam at the waterline. By comparison, the Genesis class is 361.5 meters (1186 ft.) in length and 47 meters (154 ft.) in beam. The differences between the two classes are 22.5 meters (74 ft.) in length and 8.4 meters (28 ft.) in beam. The Canaveral Pilots do not believe that these differences warrant any decreases in the dimensions of the navigation improvements described in the Feasibility Study for the following reasons.

Since November, 2003 we have had home based at Port Canaveral a Voyager class vessel which is 312 meters (1021 ft.) in length and 38.6 meters (127 ft.) in beam. Our experience in handling this vessel for over four years has given us a good understanding

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of channel dimension requirements for vessels over 1000 feet in length and has confirmed the channel widening improvements that we recommended and were completed for that class of vessel. Those 2003 channel improvements located on each side of the Trident Turning Basin entrance, at the east, north side corner of the Middle Turning Basin, at the south side of the West Access Channel, and on the north side of the West Access Channel to the west of North Cargo Pier 4, effectively give us a current channel width in those areas of 450 feet or more. We have found that in wind conditions from 15 to 35 knots we are using this increased channel width and based on that experience we believe that the 500 foot channel widening is necessary for the Freedom class, which is 91 feet longer than the Voyager class.

Furthermore, the increased size of the vessels and increased utilization of cruise terminal berths in the West Turning Basin coming online between 2009 and 2012 based on signed contracts with cruise ship companies, as well as the increased utilization of North Cargo Piers 1 and 2 due to the new tanker facility currently under construction will result in changes in the use of other berths at Port Canaveral that will have an impact on the effective channel width in the existing channel configuration. For example, the increased berth utilization in the West Turning Basin will result in the Port Authority berthing port-of-call cruise ships at the South Cruise Terminals located parallel to the Inner Reach. Larger ships berthed at these facilities will result in smaller passing distances between large ships transiting the Inner Reach and vessels at the berths causing an increased possibility of surge. These larger ships berthed on the south side of Inner Reach will also cause a decrease in the available maneuvering room located to the south of the federal project limit off of the South Cruise Terminal berths because these berths are not normally used for large cruise ships. The proposed navigation improvements described in the Feasibility Study are needed to alleviate these problems.

Similarly, the new tanker terminal on the north side will result in increased utilization of South Cargo Pier 1 and North Cargo Piers 3 and 4 for large cargo vessels. This increased use of South Cargo Pier 1 affects vessels transiting the Inner Reach and is especially of concern due to the location of South Cargo Pier 1 at a critical maneuvering area where under the existing channel configuration transiting vessels have to make an adjustment from the centerline of the Inner Reach to the centerline of the West Access Channel. When this adjustment is made in moderate to high wind conditions from 15 to 35 knots, the extra leeway needed to account for set is often substantial and is further justification for a 500 foot channel for a vessel the length of the Freedom class. Every one degree of leeway applied to account for the wind force effectively increases the beam of ships the sizes of the Voyager, Freedom, and Genesis classes by between 18 to 20 feet per degree. It is not uncommon to use up to 10 degrees of leeway and even more when entering the Middle Turning Basin. The increased utilization of North Cargo Piers 3 and 4 located parallel to the West Access Channel in an area that has historically proven to be the most

susceptible to surge between moored vessels and large transiting cruise ships, impacts the channel width requirements as well as the need for the West Turning Basin Corner Cut-off.

The experience of the Canaveral Pilots in handling the Voyager class vessel for over four years also confirms our belief that the recommended Feasibility Study navigation improvements at the West Turning Basin Corner Cut-off, the West Turning Basin Widener in to the barge canal, the 1725 foot Turning Circle in the West Turning Basin, the Middle Reach Widener and the Section 203 Widener between Outer Reach and Middle Reach are needed for the Freedom Class vessel. The comments provided by the four pilots on the simulation evaluation forms are relevant to the Freedom class even with the difference in dimensions to the Genesis class. The need for adequate room to apply substantial leeway in high wind conditions, to provide for adequate passing distances between transiting vessels and moored vessels, to allow for appropriate rates of turn, and to provide adequate turning circles for maneuvering off the berths all confirm the need for the proposed navigation improvements.

A more detailed analysis of the differences between the Voyager, Freedom and Genesis classes provides additional insight as to why the Canaveral Pilots believe that these proposed navigation improvements are applicable to both the Freedom class as well as the larger Genesis class. The design displacement tonnages of the three classes are 62,716, 71,019, and 106,000 metric tons, respectively. The propulsion horsepower for both Voyager class and Freedom class is 19,713 per pod for a total of 59,139. The Genesis class has horsepower of 26,820 per pod for a total of 80,460. Bow thruster horsepower for each class totals 16,029, 17,700, and 29,504 respectively. Side wind sail area for each class in square feet is 119, 523, 140,923, and 168,664 respectively.

The Freedom class is essentially a longer version of the Voyager with approximately the same propulsion horsepower and thruster power as Voyager but with more displacement tonnage, greater sail area, and greater length overall. The Genesis displacement tonnage, sail area, and length overall are even more than the Freedom, however the increase in propulsion horsepower and thruster horsepower are significant enough that the vessel can be handled adequately under the improved channel configuration in the expected wind conditions. The increase in bow thruster horsepower of Genesis is approximately 1.8 times that of Voyager while the increase in propulsion horsepower is approximately 1.4 times that of Voyager. This compares with an increase in displacement tonnage between the two classes of approximately 1.7, an increase in side wind sail area of 1.4, and an increase in LOA of about 1.2. An additional design feature of the Genesis class is that the vessel has three azipods as opposed to the Voyager and Freedom which have two azipods and one fixipod. This means that the third pod cannot be directed in any direction except ahead and astern on Voyager and Freedom. The third pod on Genesis

can be directed in any direction thus providing the ability to provide greater thrust in a desired direction during maneuvering.

For these reasons we believe that the improvements needed to handle the Freedom class are also adequate for the larger Genesis class. In summary, the Freedom class is a longer version of the Voyager class with the same propulsion horsepower but with a significant increase in length, displacement, and sail area. The navigation improvements recommended by the Feasibility Study provide the increased dimensions needed to handle the Freedom class. The Genesis class is even larger than Freedom but has significant increases in propulsion horsepower, thruster power, and an improved pod arrangement. We believe the recommended improvements would also allow for the Genesis class to be handled safely at Port Canaveral and our participation in simulating the Genesis class confirmed this opinion.

In regards to the dredging improvements we are in agreement that the requested increases to the project depths in the channels and turning basins are necessary and should not be reduced. The 1422 foot turning circle in the Middle Turning Basin is needed for the maneuvering of tankers in and out of the berths at North 1 and 2. The increases in project depths for the channels and the Middle Turning Basin are needed to support the tanker terminal project as well as to minimize surge to moored vessels by transiting vessels. Our pilot guidelines require a minimum of 2' 06" under the keel when a vessel is underway in the channels and basins. These increases in project depths will provide the ability for deep draft vessels to transit the harbor without tide restrictions that currently exist. This is especially important as the port generates increased cruise ship and tanker traffic that is already under contract. This is even more important to provide for the delivery of critical fuel supplies in the event of hurricanes or other national emergencies, especially in light of the fact that one of the reasons the new terminal is being constructed is as a result of a direct call by government officials for additional fuel facilities in Florida to be available in case of emergencies.

Finally, we would like to give our support once again to the installation of ranges for vessels navigating outbound Port Canaveral through the West Access Channel, Inner Reach, and Middle Reach. We have been recommending and requesting the installation of these ranges since 1996 and feel very strongly that outbound ranges would provide a needed increased safety margin especially as the size and number of vessels transiting the harbor increases.

The Canaveral Pilots Association strongly recommends that the navigation improvements proposed in this Feasibility Study be funded and implemented in their entirety. Port Canaveral will soon be home to a Freedom class cruise ship, a class that is currently the

largest in the world. Over the next four years the port will see an increase in the number of cruise ships home ported here that are similar in size to the Freedom class. Additionally, the port will see a significant increase in large, deep draft tanker traffic as the new tanker facility comes on line in the near future. We are keenly aware that these navigation improvements must compete for budgetary approval in an increasingly competitive environment. Accordingly, we have very carefully considered our recommendations so as not to include frivolous or unnecessary improvements. The comments we provide in this letter as well as those provided on the simulation evaluation forms are what we consider necessary to provide for safe navigation at Port Canaveral for ships that have already been firmly contracted by the Port Authority. In short, these are not visionary improvements looking toward some abstract point in the future with the hope that ships will come, but rather are improvements necessary to support ships that are already coming in the very near future.

Sincerely,

Captain Richard Grimison
Co-Chairman
Canaveral Pilots Association

Cc: J. Stan Payne, CEO, CPA
Capt. Steve Gasecki, Co-Chairman
All pilots
File

Port Canaveral Berth Access Project

FINAL REPORT

Prepared For:
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Cape Canaveral, Florida 32920

Prepared By:
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RTM CENTER for ADVANCED
MARITIME OFFICERS TRAINING

RTM STAR Center

SIMULATION, TRAINING, ASSESSMENT & RESEARCH

Ft. Lauderdale, FL
Toledo, OH

7 May 2003

Mr. Gary Ledford
Vice President, Regional Manager
Gee & Jenson / CH2M Hill
730 Mullet Road Unit A
Cape Canaveral, Florida 32920

Dear Mr. Ledford,

Enclosed is a copy of the Port Canaveral Berth Access Study dated 5 May 2003. Please note, the back cover contains a CD ROM that contains an electronic copy of the Summary Report narrative in PDF format, and Excel files containing all recorded parameter log numerical data collected by Run number. It has been a pleasure working with you, and especially Ms. Sandra Rice, and of course, the Port Canaveral Harbor Pilots, on this project. I hope our combined efforts yielded all the data necessary for your project, and hope that RTM STAR Center can provide our services in any future projects.

Professionally yours,

Howard Straub
Research Coordinator

The STAR Center and CAMOT admits students of any race, color, national and ethnic origin or sex.
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5 May 2003

Summary Report

Port Canaveral Berth Access Simulation Study

INTRODUCTION

This report describes a shiphandling simulator study that evaluated the operation of the "VOYAGER OF THE SEAS" class passenger vessel ("VOYAGER Class") arriving and departing at Port Canaveral. The tests were conducted at the RTM STAR Center in Dania Beach, Florida using a state of the art Full Mission Bridge simulator with a 360° horizontal field-of-view. The objectives of the test were threefold:

1) Evaluate the operability of the "VOYAGER Class" passenger vessel under existing channel configuration and moderate to high wind conditions.

2) Evaluate the operability of the "VOYAGER Class" passenger vessel under the same wind conditions, with waterway improvements that include dredging shoal areas outside the channel boundary at up to six different locations along the Inner Reach and West Access Channel of Port Canaveral.

3) Evaluate the operability of the "VOYAGER Class" passenger vessel with the improvements mentioned in number (2) above. In addition, with widening of the navigational channel along the inner harbor channel to 500 feet from Inner Reach to West Basin. Also, increasing the width of the channel accessing West Turning Basin by removing the landmass in the southeast corner of the West Turning Basin and construction of an outbound channel range.

OVERVIEW OF THE SIMULATION PROGRAM

The on-line simulation consisted of a series of inbound and outbound transits in Port Canaveral where participants, conned (directed) the simulated ship from the wheelhouse. The participants included Port Canaveral Pilots and a shipmaster from Royal Caribbean Cruise International (RCI) with expertise in the operation of the "VOYAGER OF THE SEAS" class vessel. The simulator provided a realistic computer generated image (CGI) out-the-window view of Port Canaveral. Each simulated transit was evaluated by the participating mariners and RTM STAR Center's staff. It required three (3) days to complete the on-line testing which was conducted in February 2003.

Participants

The subjects included four (4) Port Canaveral Pilots and a vessel Master from Royal Caribbean International (RCI). The Pilots participated in the majority of the simulation runs with the RCI Master performing a very limited number of runs for demonstration purposes. The shipmaster served primarily as an advisor to discuss the use of the azipod-fixipod propulsion system and to demonstrate its use where necessary.

Representatives of the engineering firm of Gee & Jenson observed most of the simulation exercises and represented the Canaveral Port Authority during this study. Gee & Jenson's representative provided valuable insight into the project details and design rationale.

Members of the STAR Center's Research staff observed all simulated transits, noted results and conducted debriefings after each exercise. STAR Center provided an experienced helmsman to execute the orders to the helm.

Simulator Bridge

The wheelhouse of the full-mission shiphandling simulator represents the bridge of a large passenger cruise vessel. The STAR Center's simulator bridge is equipped with the Litton-Sperry Marine Vision Technology Integrated Bridge System (IBS), which is the identical equipment on the bridge of all the "VOYAGER Class" passenger vessels. The equipment suite on the bridge is representative of that found on today's cruise ships, and includes the controls and indicators suitable to the type of main propulsion, e.g. conventional propeller-rudder systems or multiple azipod systems with or without fixipods. The use of the "VOYAGER Class" ship response model required that indicators and controls for two (2) outboard azipods and a centerline fixed pod ("fixipod") be configured on the simulator bridge.

Two (2) control consoles are provided in the wheelhouse:

- One for operations in the at-sea mode; the podded propulsion units are operated using RPM control throttles but rely on a helmsman to control the direction of the azipod units in tandem in the conventional steering mode.
- A second bridge wing console for low speed maneuvering and berthing; the controls permit the Master or Pilot to take direct control of both steering and speed by providing directional and RPM control of each azipod in a single unit, with the fixipod controlled by a separate RPM throttle. Bow thruster controls are included on this console. Other modes of operation from this console provide for a computer-controlled integration of all directional and speed controls, or combinations of directional units into a single mini-wheel.

The control instrumentation is augmented by various displays and indicators showing wind velocity, Doppler speed display of ground and water track, depth under keel display, heading, time, azipod angle and power usage, among other information. The integrated bridge console includes standard ship's Radar and ARPA units, and a CRT-based display unit repeating many of the indicator outputs, centrally located for viewing by the person at the conn. An electronic charting system (ECDIS) is included in the IBS console showing the Master or Pilot a real-time display of the vessel's position, course, and heading plotted on a chart of the waterway.

The Pilots maneuvered the "VOYAGER Class" vessel utilizing the centerline perspective view for most of the simulation runs. When maneuvering in and around the cruise terminal berth the Pilot would normally take up a position on the bridge wing in order to see clearances between the ship's side and the pier or mooring dolphin. The simulator operator can quickly alter the observer's eye-point in the visual scene, providing a perspective from either bridge wing, on demand. This gives the Pilot the ability to maneuver the ship with a realistic visual point-of-view without the need to duplicate the distances and structures of bridge wings. The bridge wing perspective is viewed from the center of the simulator wheelhouse.

Ship Response Mathematical Model

The "VOYAGER Class" ship response model was utilized for all on-line runs. The vessel's dimensions and other particulars are presented in Table 1 below.

TABLE 1 – Particulars of the "VOYAGER Class" Vessel

Ship Name	**Voyager of the Seas**
Tonnage	137,276 GRT
Length Overall (LOA)	311.0 m (1,020.1 ft)
Beam	38.6 m (126.6 ft)
Modeled Draft	8.6 m (28.2 ft)
Propulsion Type	Diesel Electric
Propeller Type / Number	Azipods / 2 outboard, Fixed Pod / 1 centerline
Speed, Dead Slow	2.0 knots
Speed, Maximum	23.0 knots
Shaft Horsepower (each pod)	19,713 hp
Bow Thrusters	4 x 4,023 hp
Stern Thrusters	none (2 Azipods)

The "VOYAGER Class" vessel has a pod propulsion arrangement consisting of two rotatable, azimuthing pods ("azipods") outboard at the stern, and a centerline mounted fixed pod unit ("fixipod") between the azipods. Pods are shrouded propeller housings. The "VOYAGER Class" vessel is equipped with four (4) bow thrusters. There are no rudders or stern thrusters. The ability to set the movable azipods at the stern into various configurations precludes the need for stern thrusters in this vessel.

The "VOYAGER Class" vessel was selected from RTM STAR Center's library of ship response mathematical models to represent an entirely new vessel of the same class, the "MARINER OF THE SEAS", that is expected to begin operations into Port Canaveral late in 2003.

Simulator Geographic Model of Port Canaveral

A geographic database of Port Canaveral with passenger terminal CT-10 and the proposed channel improvements was prepared based on design drawings and information provided by the port and engineering consultants Gee & Jenson. The cruise ship terminal berth, landmass, cultural features and navigational aids in Port Canaveral and the immediate area were depicted in the model by means of visual, radar, map, and bathymetric databases. These features provide the required navigational and visual references to the shiphandler during the simulation runs.

Important hydrographic features that interact with the ship were modeled in the simulator. These features include waterway depths, channel banks, and current. A current model was used for a small number of runs, representing the maximum northerly setting current during high wind conditions. The maximum value used for this wind-driven current was 0.75 knots coupled with wind from the south at 25 knots or higher. However, because the current, which runs parallel to the coastal shoreline is shielded from the Inner Reach by the jetty, current was not determined to be a significant factor in this study. The water current flow inside the harbor is negligible.

The most significant effects in the simulated runs were wind and the extent of shoal areas along the port's channel boundary as represented in each of the three (3) configurations that were examined in this study (see description below). The wind directions and speeds that would have the largest impact on the transit of large cruise vessels, due to their high wind profile, are beam winds from the north and the south directions.

An accurate representation of environmental and bathymetric conditions is essential for any operational evaluation to be valid. The environmental conditions were selected to replicate the maximum credible, adverse wind conditions that the vessels could experience in this port under normal operations. Wind conditions that provided a marginal degree of maneuvering safety were looked at in order to develop recommendations for transit restrictions when severe winds are present or forecast.

Harbor Channel Configurations

The channel configurations that were examined in this study included a range of channel widths, dredging of shoal areas at or just outside the channel boundaries, changes to aids to navigation, and a major reconfiguration of the Western Turning Basin.

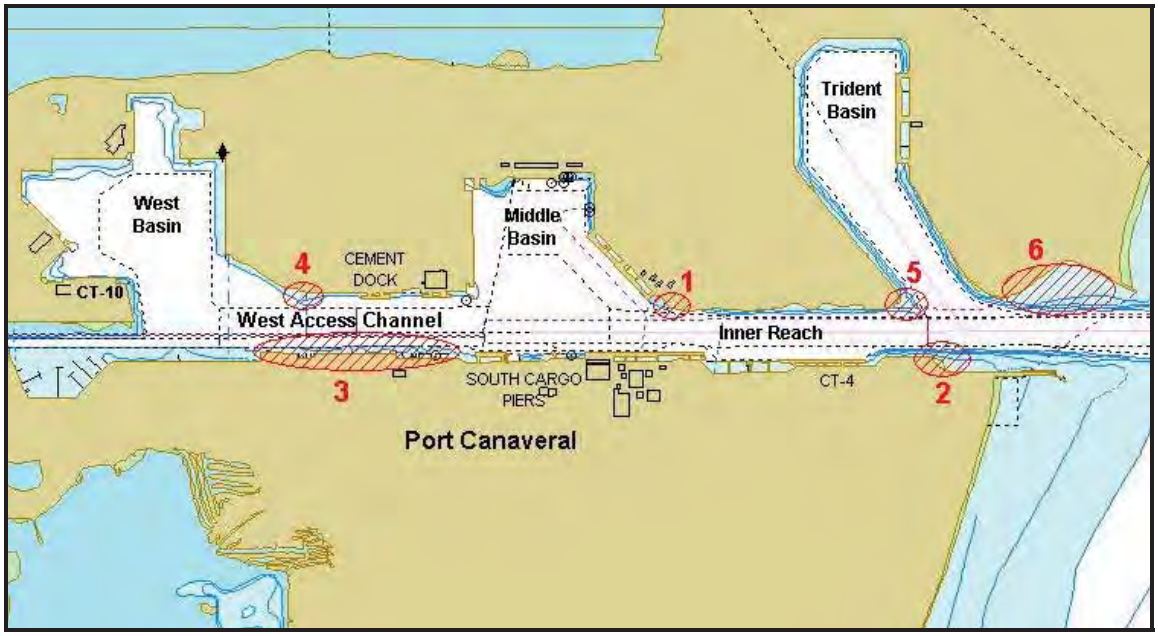
Existing Channel Configuration

The initial runs were conducted with the existing, unimproved channel database. This provided the test subjects with familiarization with the geographic database and visual scene as depicted on the simulator, and with the study vessel itself, with which only one of the subjects (an RCI shipmaster) had previous experience. Simulated exercises in the existing channel were conducted with the moderate and high wind conditions in order to provide a baseline for the subsequent runs in the improved channel configurations. Since the evaluation is concerned primarily with channel improvements to the port's inner harbor, runs that were inbound to the port commenced somewhat before the turn in the Entrance channel in order that the vessel's speed on entering the harbor entrance (at the jetty) would be realistic. The speed of the vessel at the entrance is directly related to the residual speed coming out of the turn and given the limited distance for the Pilot to reduce speed for entering the harbor.

Configuration A – Near-Term Channel Improvements

The second condition examined is the channel configuration following a proposed dredging project that would remove shoal areas at or in the vicinity of the navigable channel boundary at six (6) locations within Port Canaveral from the Inner Reach to West Basin. These improvements were recommended by the Canaveral Pilot Association with the objective of enabling a transiting cruise vessel to pass vessels along the waterway and adjacent to the channel at a greater distance, and reducing the effects of surging on those vessels. The surge effects are a result of the movement of large cruise vessels into the port at transit speeds that may be necessary for steering control under the various environmental conditions that are encountered.

Figure 1 – Near-Term Dredging Projects in Port Canaveral



Dredging at locations (2), (5) and (6) will provide an additional safety margin for large cruise ships entering the port and carrying a "crab angle[1]" to compensate for any crosswind condition, and particularly with a northerly beam wind. The removal of shoal areas near the channel boundary will permit the vessel to keep to the north side of the Inner Reach, and to reduce speed on approaching the Trident Basin, which in turn will help to reduce surge effects. The resulting increase in the volume of the channel due to dredging these areas may be expected to have a further damping effect on surge because the water "slug" pushed ahead of the vessel and following the vessel as it transits the waterway will have a greater area in which to flow.

Dredging at the southeast corner of Middle Basin at area (1) will permit the inbound transiting ship to turn up early into the opening at Middle Basin, providing additional clearance to the vessels berthed at the south cargo piers. The vessel would be able to carry a substantial "crab angle" at this point, which represents the most constricted part of the channel. The larger "crab

[1] Crab angle or drift angle. Difference between the course steered and course made good usually caused by current or wind.

angle" for leeway is the tradeoff for transiting at a reduced speed with high crosswinds for these vessels with large sail areas.

Dredging in the harbor at locations on the north and south boundaries near West Basin (areas (3) and (4) in Figure 1), has the additional goal of making the turn into West Basin (where the destination berth, CT-10 is located) easier for ships the length of the "VOYAGER Class": 311.0 m (1,020.1 ft).

The dredging at locations (3) and (4) respectively, would facilitate egress and ingress to West Turning Basin by:

- enabling the cruise ship to carry a larger "crab angle" for leeway in high wind conditions; it permits the stern of the cruise vessel to pass closer to the southern boundary of the channel with a greater margin of safety when transiting inbound, and
- enabling the ship to "flatten" its turn slightly into, or out of, the West Basin by passing closer to the corner on the north side of the West Access Channel, west of the cement dock.

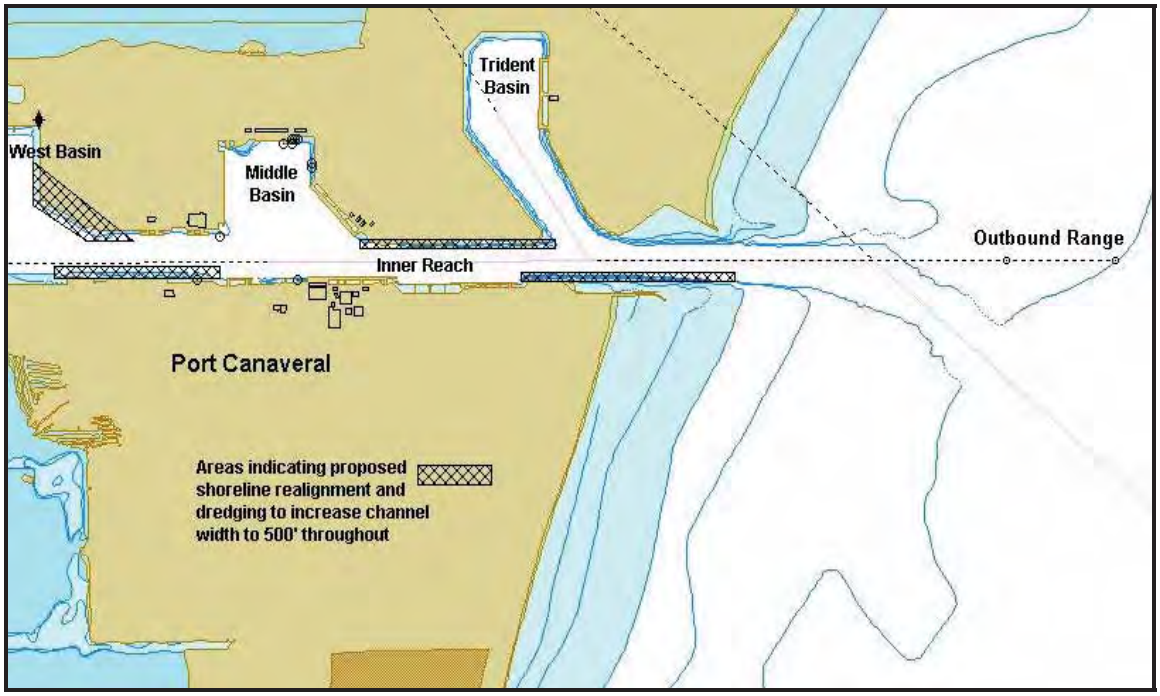
This project will require the removal and/or relocation of navigation aids on both sides of the channel where the dredging is performed. The bathymetric database used to test this configuration represents the underwater conditions that would result from the proposed dredging of shoal areas. The resulting impact on the hydrodynamic response of the simulated ship model would be apparent to the shiphandler in the reduction of bank effects due to increased clearance between the ship and the shoal areas at the channel boundaries. There were no apparent differences in the visual database between this configuration and the existing port condition, except for the relocation or removal of aids to navigation.

Configuration B – Proposed Long-Term Channel Improvements

The final channel configuration that was examined included long-term proposals for improvement of the waterway in Port Canaveral (Figure 2). The changes include:

- dredging and realignment of the shoreline along the north side of the Inner Reach, resulting in the widening of the harbor channel to 500 feet along its entire length to West Basin (area A),
- the widening of West Basin entrance to the eastward by cutting away of the southeast corner and further dredging, providing a broader and flatter entry into the turning basin (area B),
- dredging along the south boundary of the Inner Reach near the port entrance, and of the West Access Channel (West Portion) opposite the West Basin to reduce the shoal area (area C),
- simulation of an outbound channel range to be used for departures, consisting of two (2) range light structures located offshore outside the harbor entrance and aligned with the Inner Reach.

Figure 2 – Proposed Long-Term Waterway Improvements



This project requires the removal and/or relocation of navigation aids on both sides of the channel to mark the new boundaries of the navigable channel. The bathymetric database used to test this configuration represents the underwater conditions that would result from the proposed dredging of shoal areas and widening of the navigation channel. These changes would be apparent to the shiphandler in the reduction of bank effects due to increased clearance between the ship and the shoal areas at the channel boundaries. The visual database was modified to show the surface realignment of the bounding landmass and the widening of the West Basin opening.

Wind Modeling

Wind forces were incorporated into the scenarios to demonstrate a realistic effect on the "VOYAGER Class" ship response model during the simulated maneuvers. Wind forces are calculated based on the instantaneous wind velocity relative to the ship's speed and heading, using the aerodynamic coefficients that represent the model's wind profile. The conditions that were tested in this study included moderate wind (15 knots) and high wind conditions (25 knots and higher) from either of two directions, north and south. The channel inside Port Canaveral runs due east and west, therefore these represented both the average and the worst credible cases of actual wind conditions acting on the beam that might impact on transits of large cruise ships in the port, based on the participating Pilots' experiences. It was determined from discussions with the Pilots that winds from other directions would not have a significant impact on harbor transits.

The wind forces during the study were observed by the Pilots to be realistic. The Pilots stated that the wind direction having the most effect on vessel maneuvers in the harbor would be a southerly wind, due to the necessity of tracking along the south side of the channel to allow for leeway. The south side is where most of the vessel berths are located along the channel bringing the transiting ship in close proximity with the moored vessels.

The following crosswind conditions were simulated for inbound and outbound transits of the "VOYAGER Class" vessel:

from the North	from the South
15 knots	15 knots
25 knots	25 knots
40 knots	30 knots
- -	35 knots

The 25-knot wind condition was the most frequently used, representing usual conditions that might be expected during the passage of squalls. Winds of 30 and 35 knots were examined to try to identify the upper limits at which the transit of the harbor would be marginally safe under existing and improved channel configurations. The 40-knot wind condition was only used to determine whether the "VOYAGER Class" vessel could be safely moved off the berth and whether there was reserve power under those conditions.

Testing Procedures

The general test program was based on requirements put forward by Gee & Jenson / CH2M Hill, representing the Port Authority of Port Canaveral. After STAR Center reviewed the test program requirements, scenarios were generated to replicate moderate and credible worst case scenarios, concentrating primarily on wind conditions as the major factor. Bathymetric data / design criteria for the dredging projects and other channel improvements were provided by Gee & Jenson. This information was used to develop the geographic, hydrographic, and visual databases used during the simulation program representing test conditions other than the existing channel condition (for which the databases were already available).

The on-line runs evaluated inbound and outbound operation of the "VOYAGER Class" vessel under the command of a Port Canaveral Pilot. Most inbound runs that examined the transit of the Inner Reach began seaward of buoy "7", or in the turn of the entrance channel, approaching buoy "9". While several of these runs ended alongside the berth at cruise terminal CT-10 in the West Basin, most were stopped short of the berth or just before completing the turnaround of the ship off the berth to save time.

Several runs were begun in the West Access Channel approaching the cement dock, in order to permit the subject to turn the vessel around and back into the berth. Since the docking and turning of the ship in West Basin was not a primary objective of this study, the number of runs that proceeded all the way to the berth was reduced.

The outbound runs began alongside the dock at CT-10, and continued until the ship was abreast of the entrance jetty or in the entrance channel. Table 2 is a list of exercises, conducted during the test program. This table shows the key variables that define each scenario, Run Number, Transit Direction, Start Position, Test Subject ID, Current Condition, Wind Condition, and Comments.

Table 2 – Project Run Matrix

						Comments
Day 1 (2/12/03) – Existing conditions database –						
1	I/B	Buoys 7&8	P2	0	0	Database validation and familiarization with visuals, ship response model and Pod propulsion controls
2	I/B	Buoys 7&8	P5	0	N 15	
3	I/B	Inner Reach	P4	0	N 25	
4	I/B	Buoys 7&8	P3	N 0.75	S 25	
5	I/B	Buoys 9&10	P1	N 0.75	S 35	
6	O/B	CT-10 Berth	P2	0	N 25	
Day 2 (2/13/03) – Modification A database – Pilot Recommended Improvements						
7	I/B	Buoys 9&10	P5	0	N 15	
8	I/B	Buoys 9&10	P3	0	N 25	
9	I/B	Buoys 9&10	P1	0	S 15	
10	I/B	Buoys 9&10	P2	N 0.5	S 25	
11	I/B	Buoy 13	P2	0	S 25	OBJECTIVE: Tests of azipod positions for high wind trackkeeping in channel
12	I/B	Buoy 13	P2	0	S 25	
13	I/B	Buoys 9&10	P5	0	S 15	OBJECTIVE: maintain 5 kn. speed during harbor transit
14	O/B	CT-10 Berth	P3	0	S 25	
15	O/B	CT-10 Berth	P1	0	N 25	
16	I/B	Inner Reach	P2	0	S 25	
17	I/B	Inner Reach	P5	0	N 25	
18	O/B	CT-10 Berth	P4/P2	0	N 40	OBJECTIVE: lift vessel off berth in 40 kn wind; Master turns over to Pilot after leaving the berth
Day 3 (2/14/03) – Modification B database – Future Port Enhancements						
19	I/B	Buoys 9&10	P3	0	S 25	
20	O/B	CT-10 Berth	P1	0	S 25	
21	I/B	Buoys 9&10	P2	0	S 30	
22	O/B	CT-10 Berth	P3	0	S 30	
23	I/B	Buoys 9&10	P1	0	N 15	
Day 3 (2/14/03) – Reload Existing Conditions Database						
24	I/B	Buoys 9&10	P2	0	N 25	
25	I/B	Buoys 9&10	P3	0	S 15	
26	O/B	CT-10 Berth	P1	0	S 25	
27	O/B	CT-10 Berth	P2	0	N 15	Night run outbound

A total of 27 simulated transits were conducted at the STAR Center in Dania Beach, Florida over a three-day period. The Full Mission Bridge Simulator, which provides a 360° degree field-of-view from the wheelhouse, was used for the Port Canaveral simulation study. Four (4) Pilots, each with many years of experience handling vessels in Port Canaveral, were participants in the study. In addition, an RCI Master who has significant expertise aboard the "VOYAGER Class" cruise vessel, participated to the extent that he coached the Pilots in the use of the azipod-fixipod propulsion system, and demonstrated on several runs various configurations of the azipods for the most effective maneuvers.

As the Run Matrix in Table 2 shows, the exercises are grouped into four sessions over the three days where the geographic database was the constant in the session. In each session, both inbound and outbound transits were made, while varying the wind condition between runs. The simulation exercises were monitored by a representative from the engineering firm of Gee & Jenson on behalf of the Port Canaveral Authority, and also by STAR Center personnel who made direct observations from the simulator wheelhouse.

For each simulator run the ship response model was initialized at its starting location with a channel position, speed, and heading that was appropriate to the simulated wind and current conditions, as well as the Pilot's preferences based on procedures used for maneuvering large passenger ships at the port. There were three locations for initializing inbound transits depending on the objective of the particular run:

- approaching the turn in the entrance channel from one to several ship-lengths seaward of buoy "9",
- after the turn approaching the jetty entrance (abeam buoy "12"),
- approaching the West Basin (abeam the cement dock).

Outbound runs were made from the passenger ship berth, CT-10 in the West Basin. A total of eight (8) outbound runs were made and the vessel was situated starboard side to alongside the berth (bow out) for all but one (1) of those runs. The single port side undocking was conducted in order to evaluate backing out of the berth and turning the vessel around in the basin on departure, although normal procedures would never leave the ship in this position except in an emergency or unusual circumstances according to the participants.

An individual Pilot conned the vessel with one of the other participants performing duties of the ship's Watch Officer, such as control of the throttles or providing information from the radar display on demand. A competent Helmsman was provided to steer the vessel. The vessel was operated in two modes during the simulation exercises:

1) Harbor Transit: While inbound or outbound in the harbor channel, the Pilot issued verbal helm and throttle (or specific ship speed) orders which were executed by a Helmsman and a Watch Officer, respectively. In this mode the azipods operated in tandem for directional control and the vessel was steered by the Helmsman from a steering stand in the same manner as a conventional ship with rudders. Throttles for the azipods and the single fixipod could be operated individually or joined together, at the option of the Pilot. The Pilot either operated the throttles himself, or issued verbal

commands to the Watch Officer to control the throttles separately as would be done on a conventional twin-screw vessel.

2) Low Speed Maneuvers: When the ship entered the West Basin (inbound), or until the ship turned into the channel from the basin (outbound), the Pilot assumed direct control of both steering and propulsion (taking over steering from the Helmsman). In this direct mode each azipod unit could be individually controlled in both azimuth and RPM, and the fixipod could be controlled in RPM by its own dedicated throttle control. This control mode is manifested in a special bridge wing console from which the Pilot or shipmaster would have direct control of the ship during low speed maneuvers and docking/undocking. The Pilot might control the bow thrusters, or might issue commands to the Watch Officer to do so.

Each run was terminated when the objectives were met, and the ship was in a stable position.

Data Collection

The procedures that were followed for the on-line simulation section of this evaluation remained consistent throughout the study. These procedures include a briefing of the participants before each exercise commences regarding environmental conditions, the ship's status and location, the channel configuration being examined, and the run's objectives or destination. Extensive data collection takes place throughout the on-line simulator sessions (as described below), and a final debriefing is held at the conclusion of the program. These procedures insure the complete gathering of real-time man-in-the-loop simulation data required for later analysis.

The simulator automatically records information during each simulation run, such as the vessel's trajectory, speed, heading, information relating to control settings, and forces acting on the vessel. This data is used to generate a track plot for each of the runs which shows the vessel's (Ownship's) position with respect to the navigation channel, landmass, and other vessels throughout the exercise.

The Pilot or Master who has the conn of the simulated vessel during a run is asked to complete a post-run evaluation form immediately following the exercise. This form asks the participant to provide his/her evaluation of the just-completed run, using a 5 point scoring system to record performance items such as:

- adherence to the intended track line,
- vessel controllability,
- assessment of overall safety of the task,
- task difficulty, and
- level of stress generated by the exercise.

The responses from these forms are considered in the final analysis of the simulated transits.

The participating mariners are asked to summarize their opinions and comments in a "Final Evaluation Form" after all simulator testing had been completed. The comments extracted from these forms are used in the formulation of the conclusions and recommendations appearing in this report.

The RTM STAR Center's project team observes the runs and keeps observational notes regarding the action of the Pilot or Master who has the conn during each exercise, and records any comments that may provide insight into the participants' strategies or performance. These notes often provide useful information that may influence the interpretation of results. The combination of the track plots, recorded numerical data, questionnaires, and observer notes enable a comprehensive analysis of the simulator exercises to be performed.

SIMULATION RESULTS

For ease of discussion, the results are presented in the following logical segments:

- Existing Channel Configuration
- Configuration A – Near-Term Channel Improvements
- Configuration B – Proposed Long-Term Channel Improvements (Assumes near-term channel improvements are accomplished)

Before discussing the results, a few statements about Pilot intentions, normal procedures and strategies should be discussed. The worst wind conditions were examined: crosswinds from either the north or south direction.

The consensus among the participants was that a southerly wind is worse than a northerly wind at the same speed. This is due to the fact that most of the vessels at berths along the channel in Port Canaveral would be moored on the south side, and the entering or departing ship would hug the south boundary of the channel to the extent possible, to allow for being set across the channel by the wind. In addition, this tactic is to insure that the stern of the vessel tracks in safe water, and the Pilot tries to keep the vessel's stern tracking along the channel centerline. As a result, when high crosswinds are present, due to the large wind profile of these cruise ships, the preferred track is on the windward side of the channel. With a southerly wind, this places the transiting ship very close to the moored ships along the south side of the channel between the jetty entrance and the West Basin. The "crab angle" that is carried due to the wind has the net effect of greatly increasing the ship's beam, and the fact that the Pilot's viewing point is so far forward (nearly over the bow) on a vessel that exceeds 1000 feet in length, means that it is very difficult to judge where the stern is at all times.

The problem of surging is a significant safety issue at Port Canaveral. Surging of the moored vessels along the channel results from the large underwater profile of the cruise ship and the water it displaces in a narrow channel. The approach of the vessel pushes ahead of it a pressure wave of water. A second flow of water follows behind the ship as it passes along the channel. Pressure differences created by venturi effects between the transiting ship and the moored ship may cause the vessel in the berth to be pulled off the dock and then pushed back, while pressure waves preceding the transiting ship may move the berthed vessel longitudinally along the dock. If these effects are not minimized and/or the moored ships' lines are not properly tended, the mooring lines may part and the ship may move into the channel. All of these effects are exacerbated by the speed of the transiting ships and the distance off the moored ship when passing alongside.

Considering the "crab angle" (which is the difference between the ship's heading and the course made good) and its impact on the effective breadth of the transiting ship as it moves down a narrow channel, the amount of the "crab angle" is directly related to the wind velocity and inversely related to the ship's speed through the water. The Pilot must balance the need to keep the forward speed of the ship low to reduce the surge effect, but must retain good steering control. The "crab angle" in a high wind will increase as the vessel's speed is reduced, with the result of reducing the clearance at which the transiting ship may pass ships at berth and shoal areas along the channel boundary.

Tactics

Position in the channel: In the effort to keep the vessels' stern in the middle of the channel (to protect the propellers), the Pilot directed the ship along the windward side of the channel in a strong crosswind during these exercises. In doing so, the ship's bow will track along the channel boundary while the stern tracks along or near the channel centerline.

When the wind is from the north, and in order to obtain more clearance from vessels berthed on the south side of the channel at the South Cargo Piers, the Pilot will often direct the transiting ship up into the opening of the Middle Basin, essentially tracking along the north boundary of the channel until past Middle Basin because there is no shoal water to be concerned with in the opening on that side. It was observed that this tactic was also employed occasionally when the wind was 25 knots or greater from the south, though once past Middle Basin the Pilot quickly moved the vessel to the south, or windward side of the channel again. The narrower opening of the Trident Basin was used in the same manner with northerly winds of 25 knots, though not as often. The primary reason for this tactic when abreast of Middle Basin is because the Inner Reach becomes narrower at the South Cargo Piers as the southern channel boundary shifts somewhat to the north. This is the most constricted part of the channel.

Speed during transit: It was observed that on inbound transits, the speed of the "VOYAGER Class" vessel could be reduced rapidly from about 9 knots at the harbor entrance abeam the jetty, down to 7 knots or less when passing the cruise ship berthed at CT-4. The target speed (based on Pilots' statements) of 6 knots is to be achieved by the time the ship is abeam Middle Basin and the South Cargo Piers, however the speed was usually at 6 knots or below upon passing the Navy pier. With the exception of the first day's runs (see explanation next section) the Pilots had little difficulty keeping the transit speed at 6 knots or below during most of the inner harbor transit.

When outbound in the channel from the berth, the vessel was capable of quickly increasing speed to a safe transit speed of about 6 knots. This speed, or a little less depending on the wind condition, was maintained until abeam of the Navy pier, outbound, at which time the Pilot began increasing speed. By the time the vessel was out of the harbor and in the entrance channel the ship was making 10 knots or better.

Existing Channel Configuration

Transits into and out of Port Canaveral were conducted in the existing channel database on the first and last days of this program. No groundings, collisions, allisions, or other mishaps were observed during these exercises.

The initial runs that were conducted on the first day in the existing channel were not typical of a transit of a very large passenger vessel. The first few runs were used as familiarization for the participants with the visual database, and the simulated ship's response to wind, current, and control forces. Subsequent runs on the first day exhibited the Pilots' unfamiliarity with the azipod-fixipod configurations that are available with the "VOYAGER Class" vessel, and these runs represented a true learning experience. It should be noted that most of the cruise ships entering port are operated under the control of the ship's Master who has the most expertise with the peculiarities of the ship and its propulsion and steering. Due to the Pilots' unfamiliarity with this class of ship, the simulated transits, though conducted without incident, were made at a somewhat higher speed over the ground than would be considered safe, particularly in view of the number of moored vessels that occupied the berths alongside the inner channel of the port.

The stated optimum speed for transit of the harbor with the number of moored ships that were simulated in these exercises is about 6 knots (maximum), in order to minimize the surge effects that can pull a ship off a dock and part its mooring lines. By their own admission in the final evaluation comments, the Pilots failed to maintain a safe speed on a number of these initial runs. The reason for this was the unfamiliarity with the best configuration of the propulsion units necessary to stabilize the vessel under the simulated high wind conditions. As a result, higher than normal speeds were used at a number of locations in the channel to control the ship's head and to minimize the "crab angle" that would be carried to compensate for leeway under the crosswind conditions that were experienced.

On the third day of the on-line simulation sessions the existing channel configuration was revisited. As a result of their acquired experience with the vessel's handling characteristics and control equipment at this time, the Pilots were able maintain transit speeds that were within the desired criteria for a safe transit with minimum damage potential. When the "VOYAGER Class" passenger vessel maintained a 6-knot speed in the channel, "crab angles" of 2.5° to 3° were observed with 15 knots of wind, and 4.5° with wind at 25 knots. Minimal clearances to some of the berthed vessels would likely have resulted in undesirable surging effects.

Runs conducted into the turning basin (West Basin) and requiring the vessel to turn around and back into the berth at CT-10 were for the most part uneventful under all wind conditions (north 15 and 25 knots; south 15, 25 and 35 knots). During the single inbound run on Day 1 using a 35-knot wind condition, the Pilot experienced difficulty using the azipod controls and as a result the transit speed for this run was unrealistically high.

Outbound runs from the berth were problematic at the point of turning from the West Basin into the West Access Channel. When the wind was northerly there was a tendency to cut the southeast corner of the basin rather closely in an effort to track down the windward or north boundary of the channel. This was particularly the case with winds of 25 knots out of the north. The dredging proposed at the southeast corner under Configuration A condition would facilitate cutting this corner under these conditions.

Little difficulty was observed with southerly winds when leaving the West Basin. The vessel was eased over to the south (windward) side of the channel, and maintained position along the

southern half of the channel throughout, though this brought the ship in close proximity with the moored vessels along the southern edge. The transit speed was kept to 6 knots or less outbound until the ship passed the Navy pier, after which the Pilot began to increase speed.

A single undocking and departure was attempted with winds of 40 knots from the north. The objective was to see if the "VOYAGER Class" passenger vessel had the power to lift off the berth in such winds. The RCI Master handled the undocking, turning over the conn to one of the Pilots once the vessel was clear of the berth. The undocking operation was marginal as the ship was slowly lifted clear of the berth, but bow thrusters had to be used at maximum power for the operation with no reserve. The outbound transit under the 40-knot north wind condition was made at excessive speeds, nearly 9 knots throughout the channel, and with large "crab angles" of 4° to 5°. The Pilot stated that such a transit could only be done safely at high speeds with no moored ships along the channel.

Configuration A – Near-Term Channel Improvements (Dredging Projects)

The Pilots made full use of nearly all the areas that were dredged, defining this channel configuration, refer to Figure 1. They were pleased with the results and with their performance. In using all of the areas they were able to maintain good clearances to berthed ships, and to the shoal areas outside of the channel when the environmental conditions required operation of the ship along the edge of the channel. The dredged areas permitted the following modifications to the normal transit, which had been exhibited under existing conditions of the channel:

- Carrying a larger "crab angle" in some locations along the channel and maintaining a slightly lower transit speed under high wind conditions.
- Maintaining a greater distance to some of the moored vessels by enabling the transiting vessel to track further along the opposite channel boundary because shoal areas were removed in locations (1), (5) and (6).
- Turning sooner into the West Basin because of dredging applied to the east corner at location (4). This allowed the vessel to be held further on the north side under north wind conditions, enabled the Pilot to make a "flatter" or more gradual turn into the West Basin, and also meant that the stern had greater clearance when turning into the basin due to dredging at location (3).

The dredging projects simulated under this configuration permitted the ship to remain on the north side of the channel longer, making good use of the basin entrance at the West Basin and to a lesser extent, the narrower Trident Basin, where removal of shoal areas at the entrance was performed. This permitted greater clearances to be maintained toward the vessels at the South Cargo Piers.

In 30-knot wind conditions, "crab angles" of 7° to 8° were observed while maintaining a transit speed of 6 knots or less in the Inner Reach. Under these wind speeds, a "comfortable" transit speed for the vessel was achieved at about 6.2 knots, with a corresponding "crab angle" of 6°. Adequate clearance to moored vessels was achieved by utilizing the extra channel width that was afforded due to the dredging outside the channel boundary; the stern was kept in good water even though it was tracking along the channel edge rather than the centerline.

One run was conducted with the objective of trying to maintain an inner harbor transit speed of 5 knots or less. This was accomplished successfully, however the trade-off was a "crab angle" of 4.5° in order to maintain the speed at a maximum of 5 knots in the channel with a south wind of only 15 knots. The Pilot made good use of the dredged areas to keep the stern in safe water and to maintain good clearances between shoals and berthed vessels. Distance to moored vessels was somewhat close in some instances, but was compensated by a reduced transit speed, so that the surge effect should have been no greater than usual.

Similar tactics and performance were noted for both inbound and outbound transits. No groundings, collisions, allisions, or other mishaps were observed during these exercises under this channel configuration. Pilot comments during these runs indicated that the proposed dredging was having the desired effect on their performance with the "VOYAGER Class" passenger vessel, and that it enhanced the safety of navigation, particularly with wind speeds of 25 knots and higher acting across the channel.

Configuration B – Long-Term Proposed Channel Improvements

The waterway improvements that were simulated in this configuration condition provided a further margin of safety for the transit of large passenger ships such as the "VOYAGER Class" response model that was used in this program. Further widening of the navigation channel to a uniform width of 500 feet provides for greater clearances to moored vessels and can be expected to have a significant impact on the reduction of surging effects caused by large ships in transit. The additional width along the channel would permit the Pilot to maintain higher "crab angles" and thus keep the transit speed to the 6 knots and below considered optimum for both safety and controllability under a wide range of environmental conditions.

Channel Widening along Inner Reach: Although the navigation channel still shifts 50 feet northward under this configuration, the cutting away and realignment of the shoreline between the Trident Basin and Middle Basin, allowing a full 500 feet of channel width, eliminates the constriction that currently governs the tactics employed in transiting the Inner Reach. This part of the future enhancement will improve trackkeeping under conditions of northerly cross-channel winds, where the Pilot utilizes the northern edge of the channel during transits, to allow for leeway.

Channel Widening in the West Access Channel: The dredging along the south side of the West Access Channel provides a greater margin of safety for turning a large passenger vessel into and out of the basin. The proposed 500 foot wide channel, through the West access channel area, will formally adopt the Southern dredge boundary as the new channel's Southern boundary, and relocate the Northern boundary approximately 12.5 feet North of the existing channel's Northern boundary. The increased width at the south side of this section of the channel, may allow the stern to swing along the channel's southern boundary with more confidence while turning the ship into the West Basin, because of the greater clearance to shallow water, and to moored vessels as well. It will likely have less impact on departures from West Basin because it was observed that the Pilot will generally hold the track closer to the north side (current location of buoy "18") on exiting. The "crab angle" necessary in high crosswinds is minimized on departures because the ship is increasing speed, which results in improved steering control.

Cutoff of the Eastern Corner of West Basin: It was observed that the removal of land and the widening of the West Basin entrance west of the cement dock had little impact on the tactics employed to enter the turning basin and turn the ship around for berthing. The dredging that was performed under the previous configuration (Configuration A) had provided some relief from the sharp turn required into West Basin. The track plots from runs conducted with Configuration B, where the West Basin opening is significantly widened, show no difference from the previous day's runs with regard to how the ship entered the basin during inbound transits. However, on departures where the wind was from the north, the Pilot often utilized the additional maneuvering room afforded by this modification to "flatten" the turn out of West Basin and to align the ship on the northern side of the channel for the outbound run.

Outbound Range Lights: The Pilots expressed a need for the establishment of a steering range on the Inner Reach for outbound transits. This enhancement to the waterway was examined as part of the long-term future improvements condition. The range was embraced by the Pilots as essential for track keeping, especially for night departures, based on comments from the Final Evaluation questionnaire.

SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

This section will summarize the observations and recorded performance under each channel configuration examined during the study. In addition, it includes the comments and recommendations attributed to the Pilots who participated in the study.

Existing Channel Conditions

There is a general consensus that the "VOYAGER Class" passenger vessel can transit the waterway safely under the existing channel configuration, so long as winds are moderate, or if somewhat higher winds are present, then the winds at least are not blowing across the channel. High crosswinds will have a significant impact on the passage of a large passenger ship (in excess of 1000 feet LOA), due to the combined requirement to maintain a safe speed while minimizing the amount of channel width taken up by the vessel during its passage. High crosswind conditions can be tolerated by the "VOYAGER Class" passenger vessel, however the tradeoff between the "crab angle" carried, transit speed, and the problem of minimizing surge effects on moored vessels in the harbor is such that only a wider channel will alleviate the problem.

The responses of the participants to the Final Evaluation questionnaire can be summarized by the statement that under existing channel conditions, transits by the "VOYAGER Class" passenger vessel are deemed only marginally safe where crosswinds are somewhat greater than 15 knots. This is influenced by the presence of ships moored at berths along the waterway. The margin of safety can only be improved by transiting at a higher speed, with increased incidence of surge effects as the result. Limiting wind conditions for safe harbor transits with the "VOYAGER Class" passenger vessel (for initial planned operations), are in the range of 20 to 25 knots of wind from the north or south direction, for both inbound and outbound transits. These restrictions are expressed in the Final Evaluation made by the participants at the conclusion of the program.

The West Basin as currently configured, is adequate for maneuvering a vessel of the "VOYAGER Class" into and out of the proposed berth at CT-10 during light to moderate wind conditions. The ship itself has exceptional power in the azimuthing propulsion system and bow thrusters. As a consequence, docking and undocking, even under the extreme conditions examined in this study (up to 35 knots of wind), did not pose any significant problems.

Near-Term Channel Improvements – Dredging of Specific Locations

The Pilots were unanimous in their approval of the conditions simulated in this channel configuration. These improvements consisted of specific dredging projects eliminating shoals outside of the channel boundaries at six (6) locations along the waterway (Figure 1). There is no surprise in the general approval, as these enhancements were recommended by the Canaveral Pilot Association.

Performance under higher wind conditions was improved because the effective widening of the navigation channel, resulting from shoal removal at these locations, facilitated the use of the entire channel and larger "crab angles" are permitted when necessary. As a result, lower transit speeds could be maintained within the limits desired to reduce surging effects on vessels at berths along the waterway. The safety of the vessel entering and leaving the West Basin is considered much improved by the dredging at the southeast corner of the basin's entrance (west of the cement dock) and along the south boundary of the West Access Channel. In the former case, the vessel's bow can be positioned higher in the channel and the turn started earlier, while in the latter case, the vessel's stern is kept in clear water while turning into the basin because the distance to the shoal area has been increased.

The results of the channel dredging examined in this configuration mean that the effective widening of the channel where dredging is contemplated will contribute to the reduction of surge effects.

- Removal of the shoals at the dredging locations, makes transit speed reductions with increased "crab angles" possible. –and-

- The shoal removal results in an increase in channel volume through which the pressure wave caused by the water flow ahead of and following the transiting vessel can move at a reduced velocity, and consequently a reduction of surge effects is possible.

The participants' recommendations on transit-limiting wind conditions with these channel improvements in place are in the range of 30 to 35 knots from the north or south direction.

Long-Term Channel Improvements – Dredging, Shoreline Removal, and an Outbound Channel Range

Channel Widening Project: The shoreline realignments combined with the increase in width of the navigation channel to 500 feet over the entire length from the port entrance to West Basin, further enhances the benefits that were achieved by the dredging projects alone, as observed under the Configuration A condition. Tracking of the ship along the north side of the channel

with northerly crosswind conditions will be enhanced, and this in turn provides an additional safe distance when passing abreast of ships moored on the south side of the channel. Under similar high south wind conditions, the vessel may be directed by the Pilot further toward the centerline when passing vessels in berths along the waterway than is currently done because the increased room available at the north boundary of the channel provides an additional margin of safety for the stern when the ship is carrying a significant "crab angle" due to the wind forces acting on it.

These improvements will mitigate, to a large extent, the channel constriction upon approaching the South Cargo Piers, where delicate maneuvering is necessary in order to maintain a safe distance, as well as a safe speed and good channel position to prevent damage to moored vessels. Wind limits for the "VOYAGER Class" passenger vessel operating in Port Canaveral were recommended to be the same as for the channel with the near-term improvements. Winds acting on the beam of these high-profile vessels have a large impact on the ability to control the vessel's heading in a narrow channel where the transit speed must be restricted for the safety of other vessels. The proposed 500-foot channel will provide greater safety and convenience in an environment of ever larger mega-vessels.

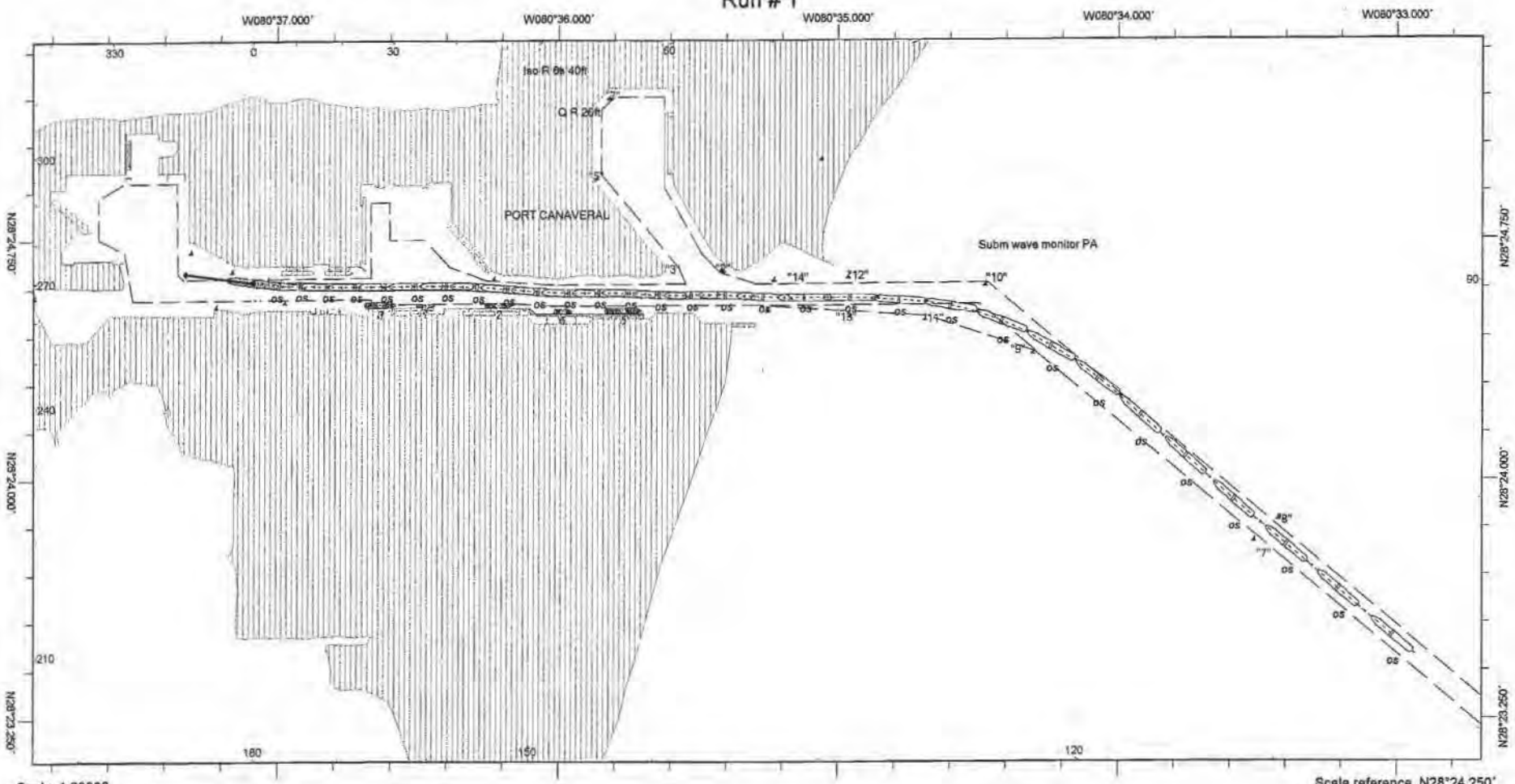
Recommended Operational Restrictions Due to Wind Velocity: While the "VOYAGER Class" passenger vessel is well-equipped and powered to make a safe transit in winds somewhat higher than 35 knots on the beam, it would require traveling at a higher speed than would be acceptable because of the available channel width (even at 500 feet) and the presence of moored vessels along the harbor channel. Therefore, the channel enhancements cannot realistically be expected to produce recommendations for a higher operational wind limit with Configuration B than with Configuration A. Winds of 30 to 35 knots acting on the ship's beam have been found to be about the upper practical operational limit for these ships in a number of similar studies, because of the relationship between "crab angle" and transit speed which is a common factor in nearly all narrow channel transits. Pilot comments indicate that the ship may make an uneventful transit at a safe and reasonable speed with wind as high as 40 knots, so long as it is acting on the bow or stern where a minimal profile is presented (i.e., west or east wind direction). However, 40 knots of wind would be problematic during docking and undocking maneuvers.

It should be noted that these recommendations on operational limits based on wind velocity should be considered as guidelines for initial operations, subject to further refinement as experience is gained by the Pilots with the actual vessel in the port.

Steering Range for the Outbound Transits of the Inner Reach: The participants were in unanimous agreement on the need for range structures to be positioned outside the port to assist with trackkeeping along the Inner Reach on departure. This enhancement was deemed as essential for night operations. The channel range will be particularly useful for passenger vessels whose conning position is located very near the bow of the vessel. The extreme length of vessels such as the "VOYAGER Class" passenger vessel tested in the study (over 1000 feet LOA), and the large "crab angles" that can be carried in crosswinds above 15 knots, makes for difficult determination of the ship's actual position in the channel and the amount of clearance of the stern to other vessels, buoys, and shoal areas, particularly at night.

Enlargement of the West Basin Entrance: The expansion of the opening into West Basin that would be accomplished by cutting off the southeast corner and dredging the area does not seem to provide a significant benefit to the maneuvers of the "VOYAGER Class" passenger vessel to the cruise ship pier, CT-10. The participants indicated that the West Basin's dimensions are currently sufficient for turning and berthing maneuvers. The benefit gained by dredging the corner west of the cement dock (location 4 in Configuration A) does, however, increase the margin of safety into and out of West Basin for all vessels.

Run # 1



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Comments: Wind: None Pilot: # 2
Current: None

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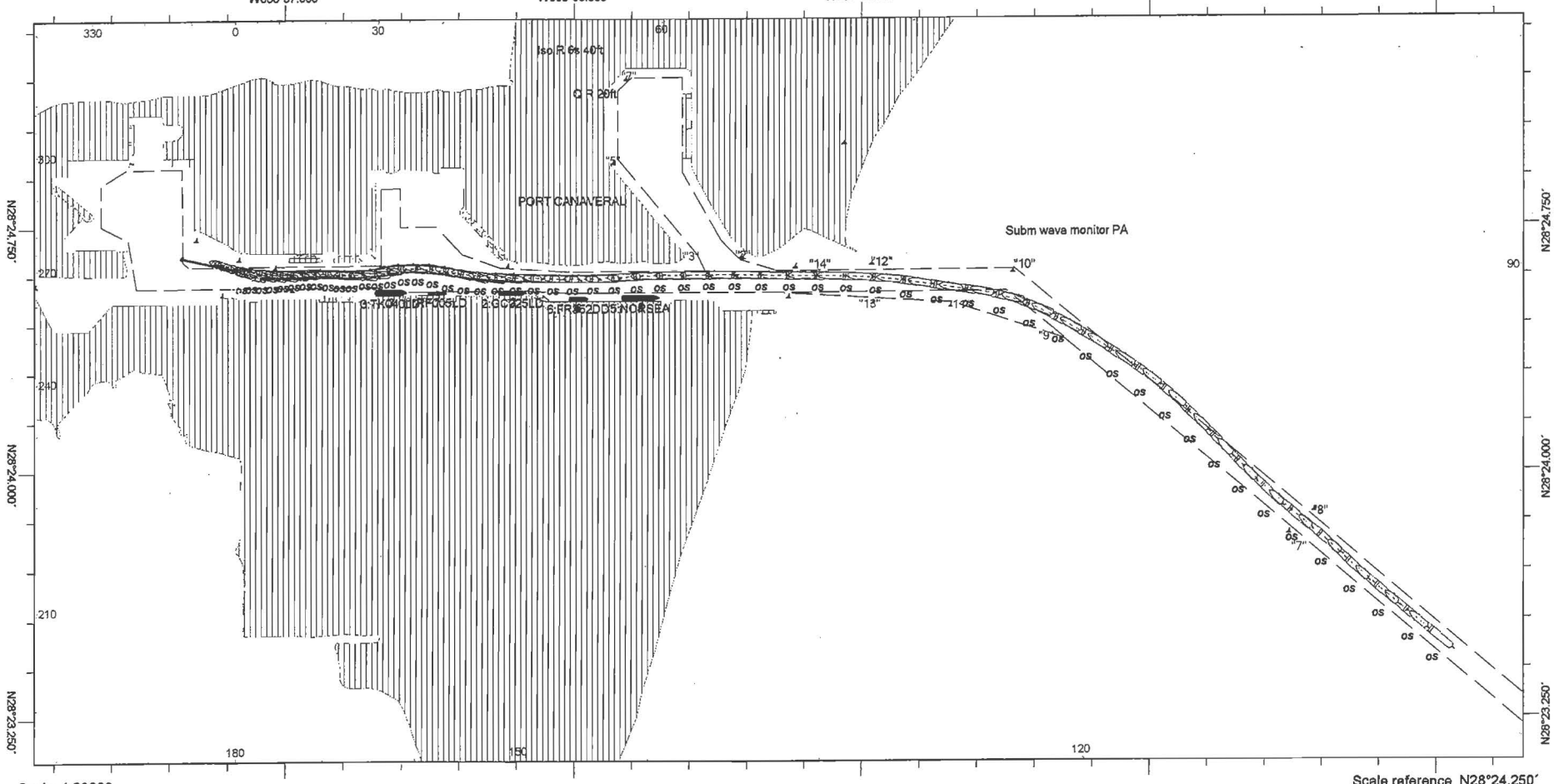
Heading marker period (s)	60
Shape outline every	01:00

Run # 2



Scale 1:23000

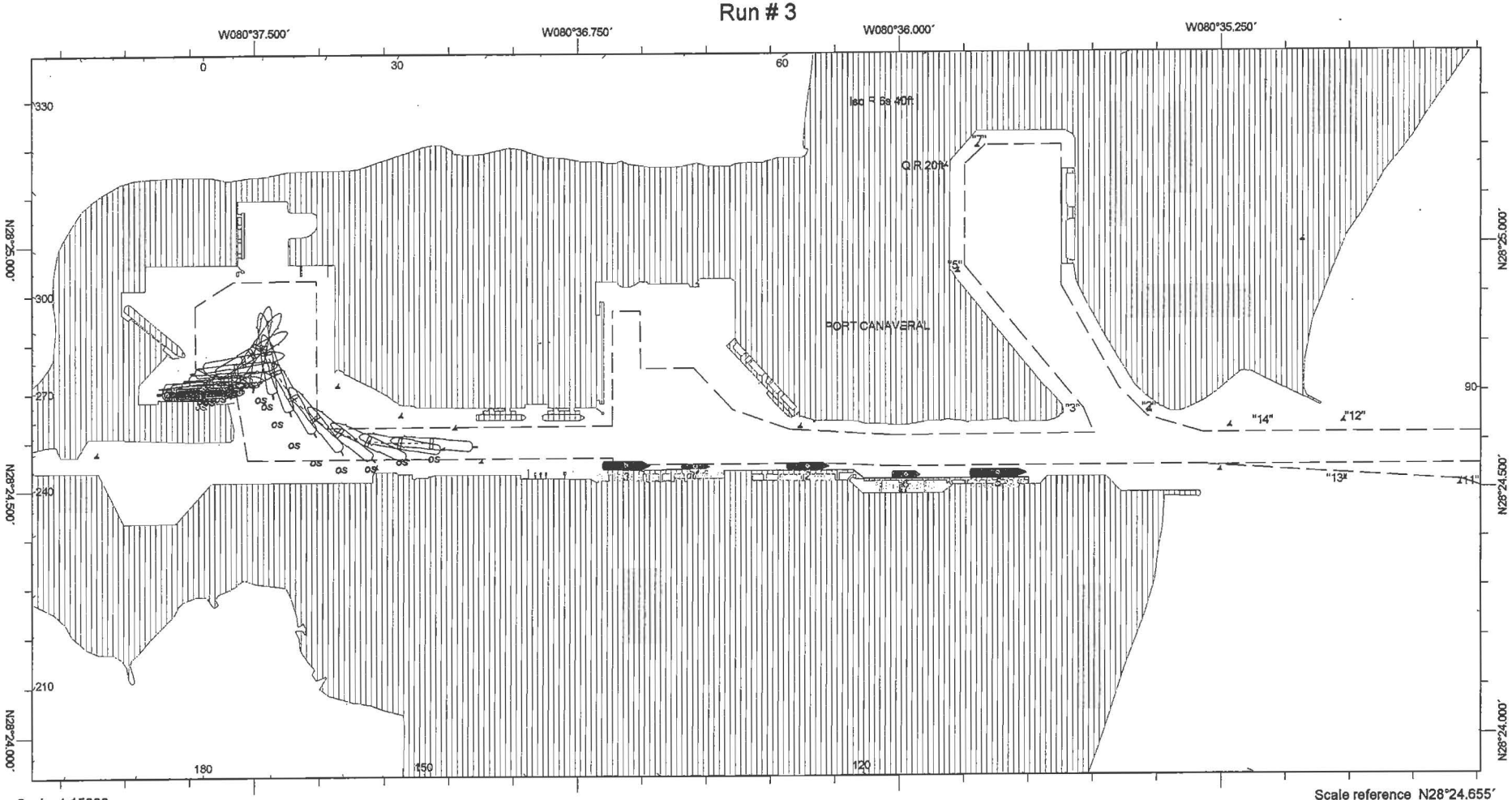
Scale reference N28°24.250′

Commente: Wind: 000 at 15 kts Pilot: # 5
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sempls period (s)	30
Course marker every	01:00
Heading marker period (s)	30
Shape outline every	00:30

Run # 3



Scale 1:15000

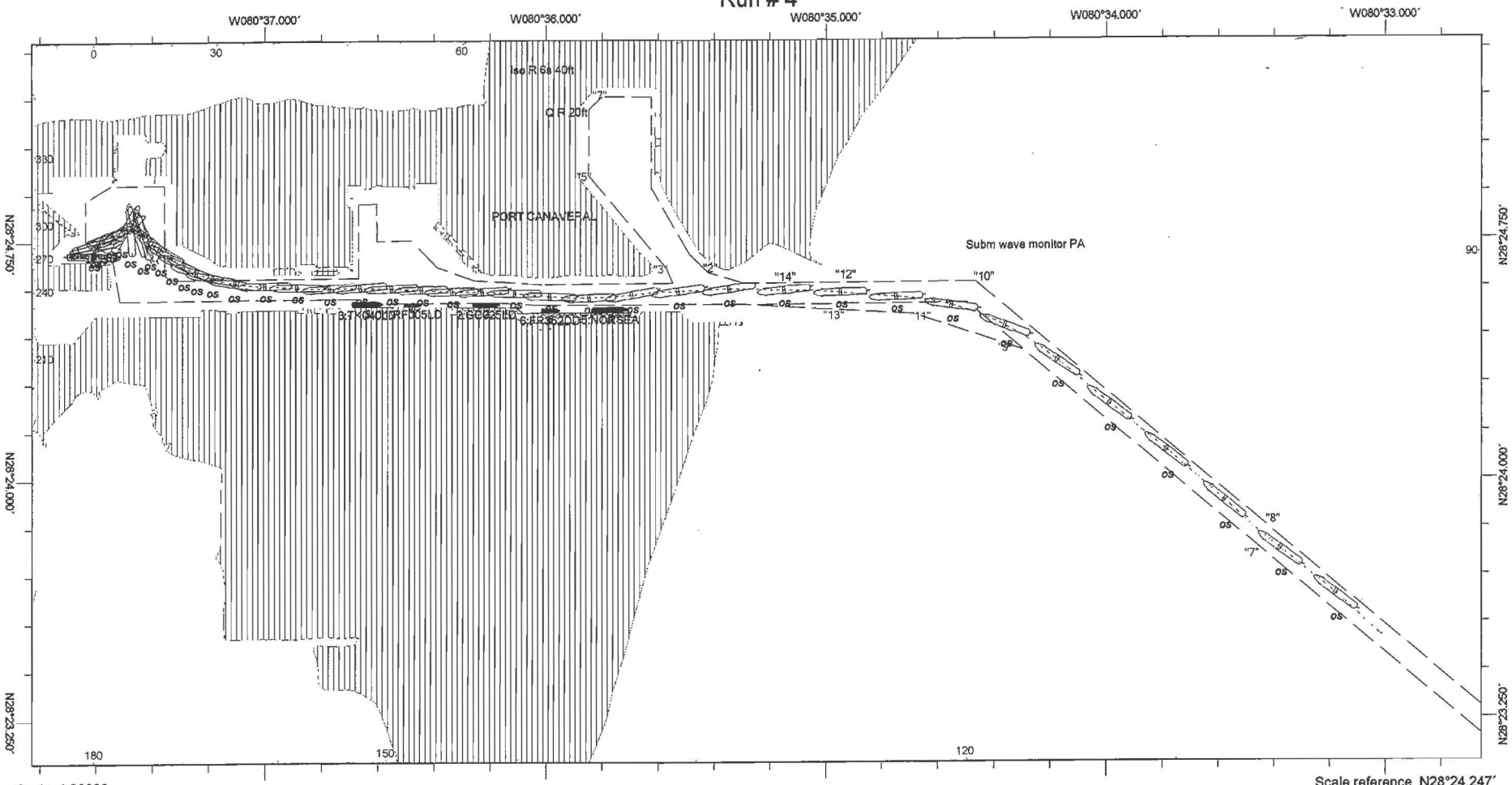
Comments: Wind: 000 at 25 kts Pilot: # 4
Current: None

0.1 0.000 0.125 0.250 0.375 0.500 n.mile
200 0 250 500 750 1000 m

Scale reference N28°24.655′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 4



Scale 1:23000

Scale reference N28°24.247′

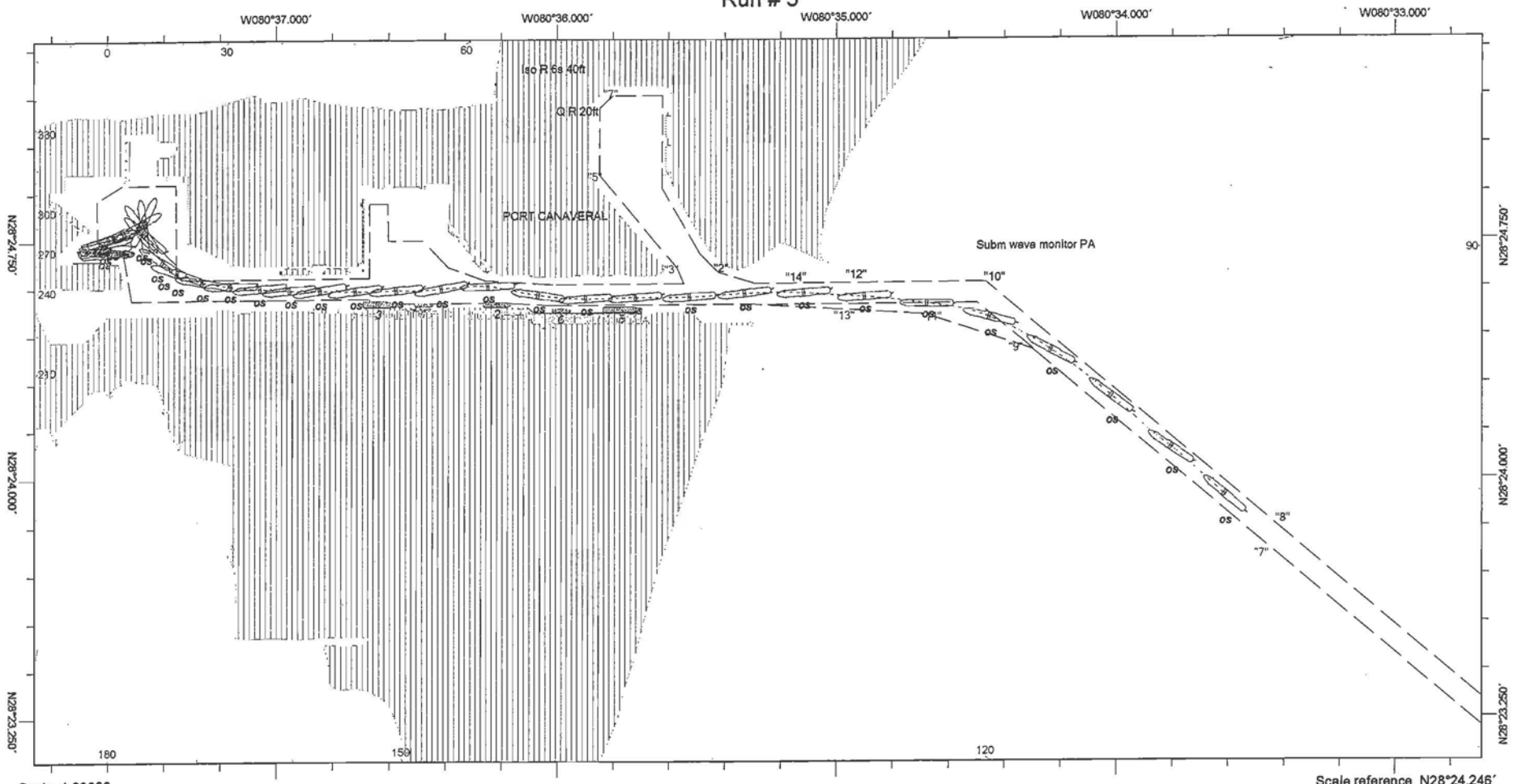
Comments: Wind: 180 at 25 kts Pilot: # 3
Current: Northerly

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 5



Scale 1:23000

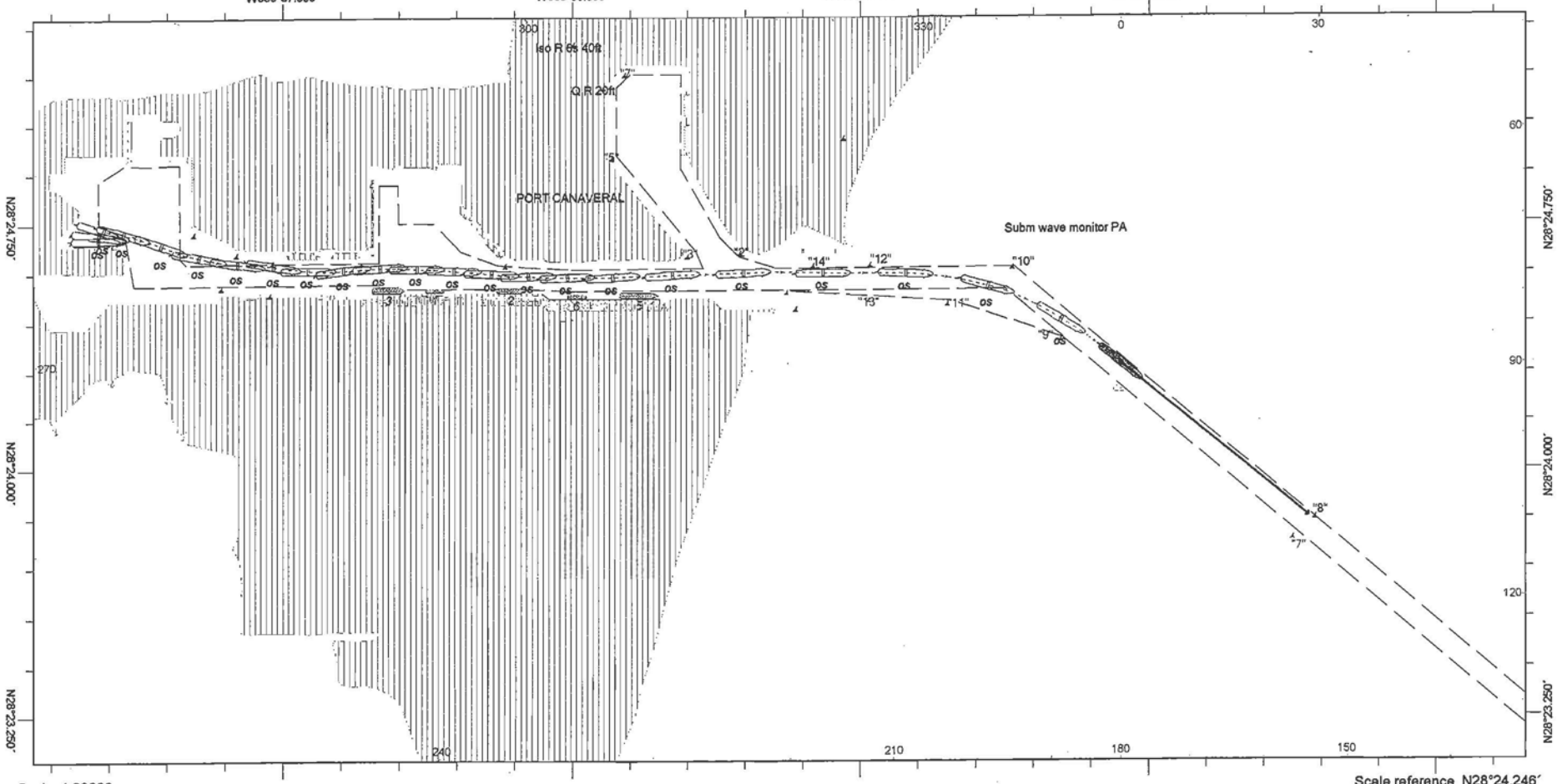
Scale reference N28°24.246′

Comments: Wind: 180 at 35 kts Pilot: # 1
Current: Northerly

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 6



Scale 1:23000

Scale reference N28°24.246′

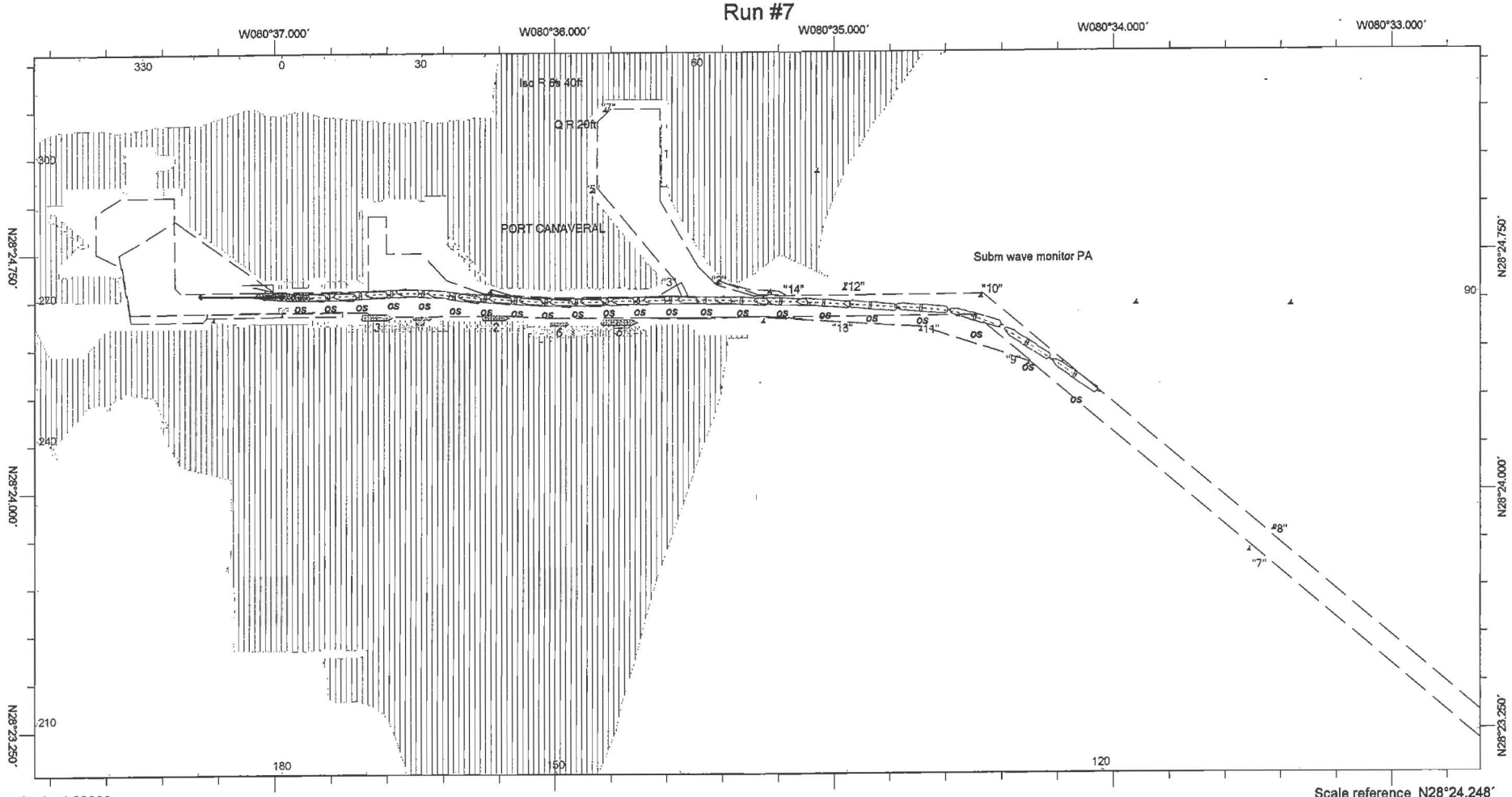
Comments: Wind: 000 at 25kts Pilot: 2

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #7



Scale 1:23000

Scale reference N28°24.248′

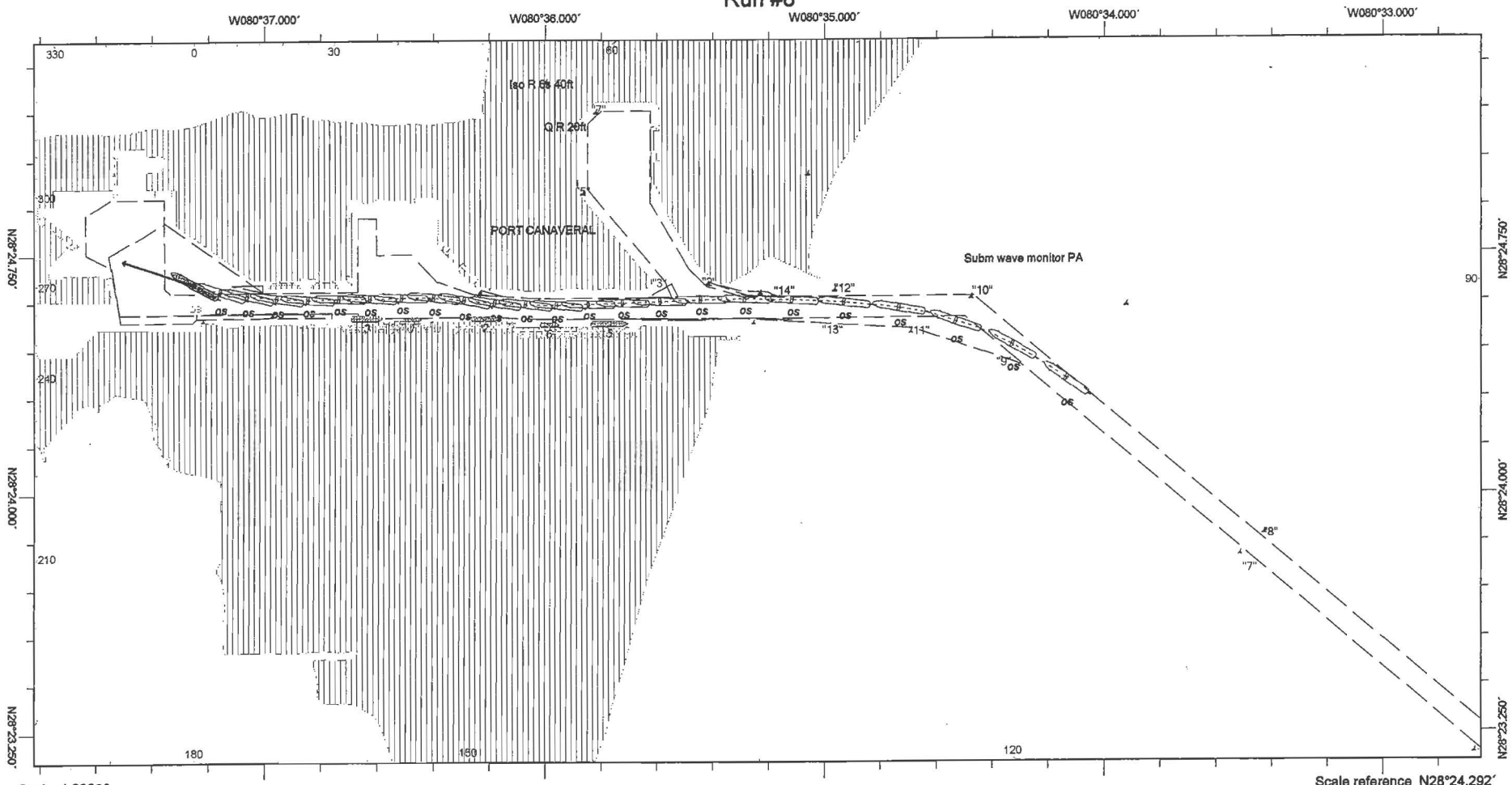
Comments: Wind: 000 at 15 kts Pilot # 5
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #8



Scale 1:23000

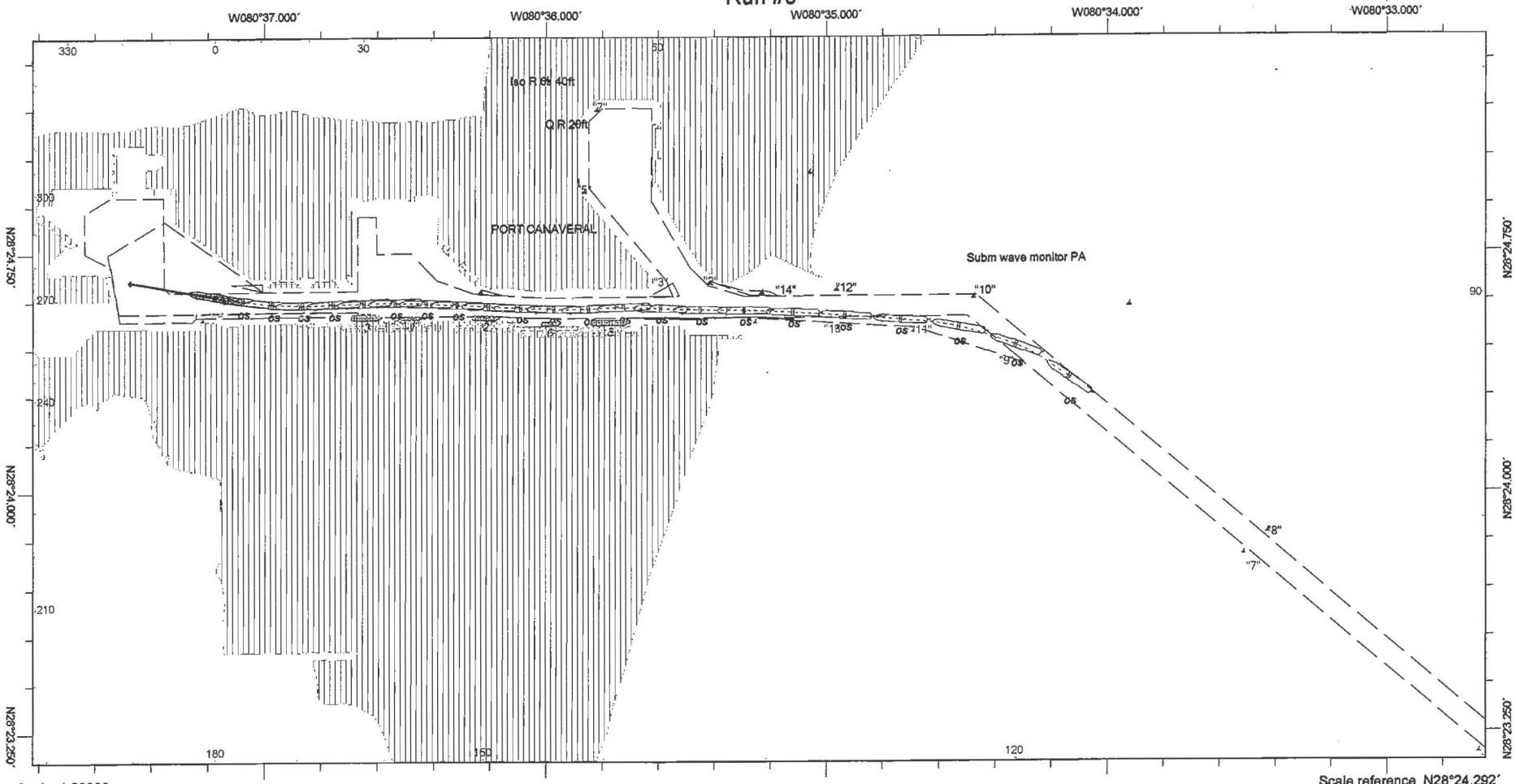
Scale reference N28°24.292′

Comments: Wind: 000 at 25 kts Pilot # 3
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #9



Scale 1:23000

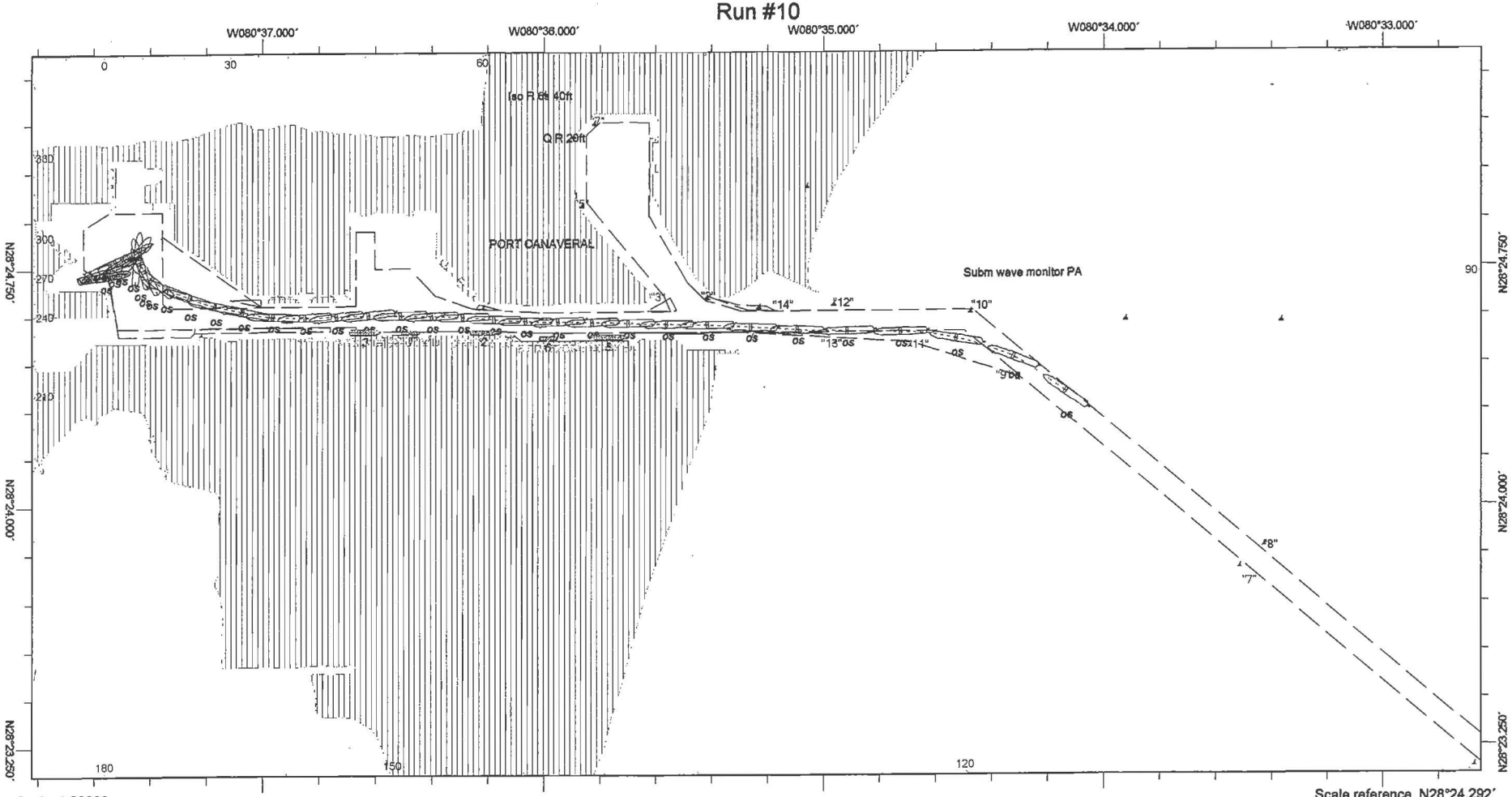
Comments: Wind: 180 at 15 kts Pilot # 1
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Scale reference N28°24.292′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #10



Scale 1:23000

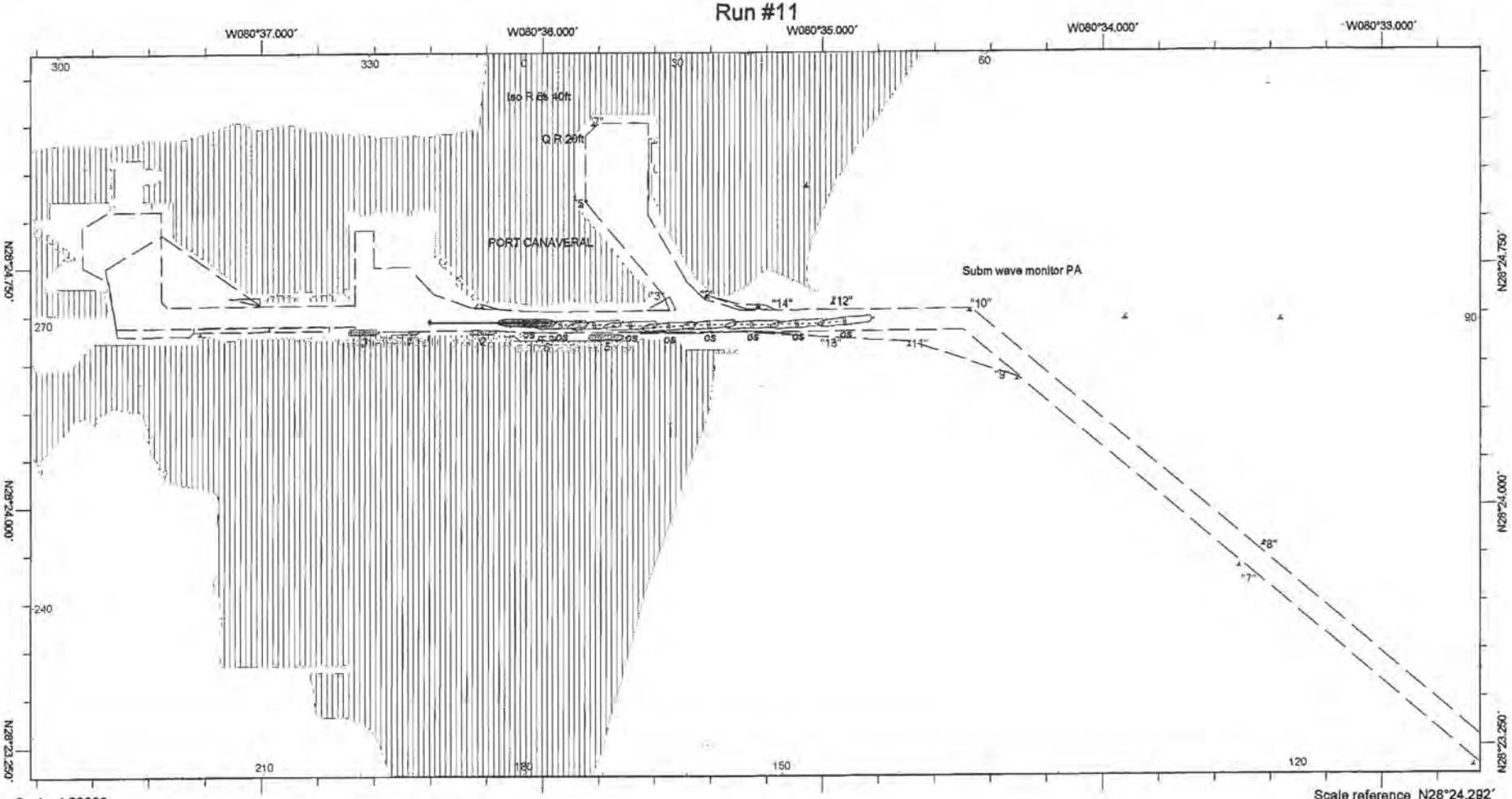
Comments: Wind: 180 at 25 kts Pilot # 2
Current: Northerly

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Scale reference N28°24.292′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #11



Scale 1:23000

Scale reference N28°24.292'

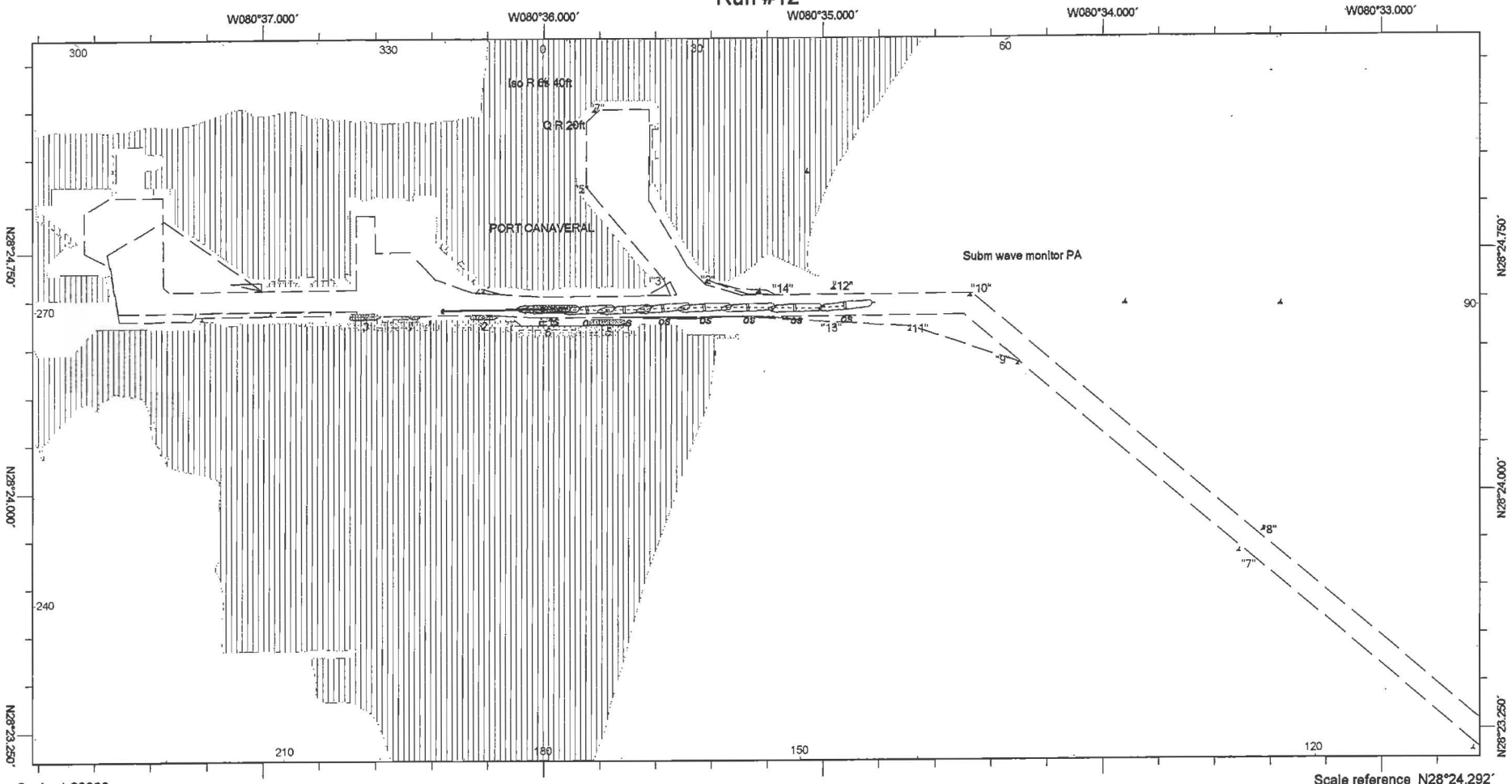
Comments: Wind: 160 at 25 kts Pilot # 2
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #12



Scale 1:23000

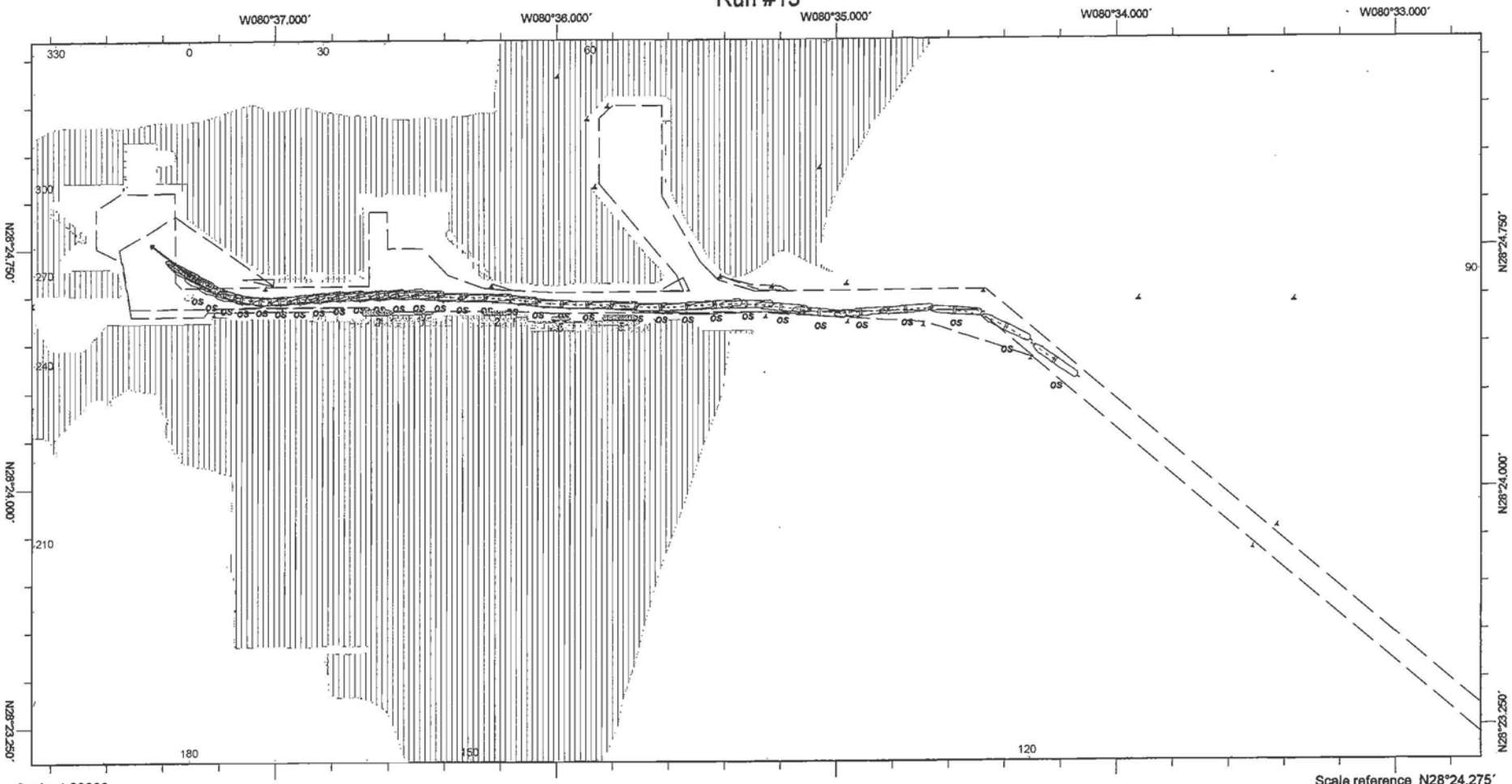
Scale reference N28°24.292′

Comments: Wind: 180 at 25 kts Pilot # 2
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	80
Shape outline every	01:00

Run #13



Scale 1:23000

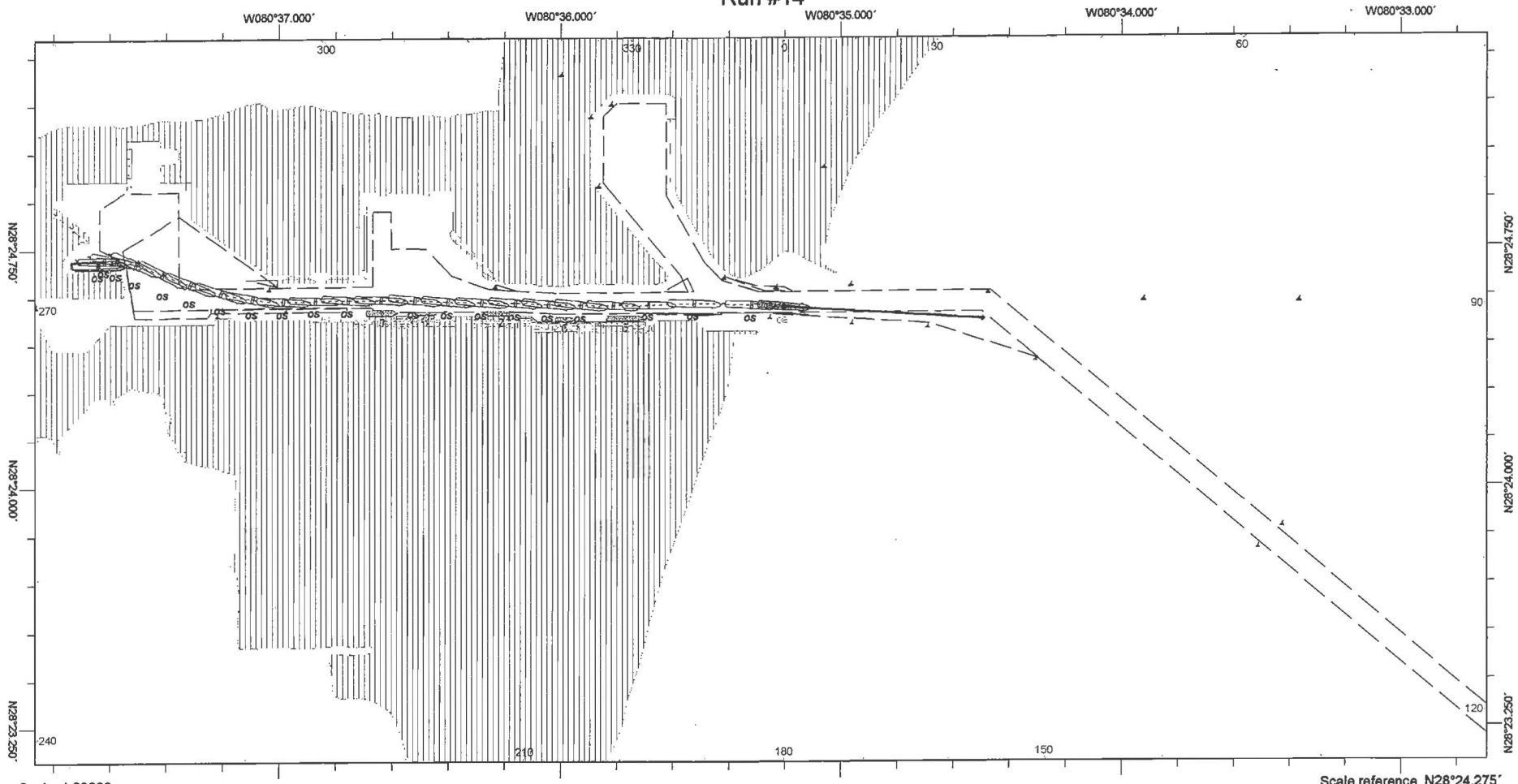
Comments: Wind: 180 at 15kts Pilot: # 5
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Scale reference N28°24.275′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #14



Scale 1:23000

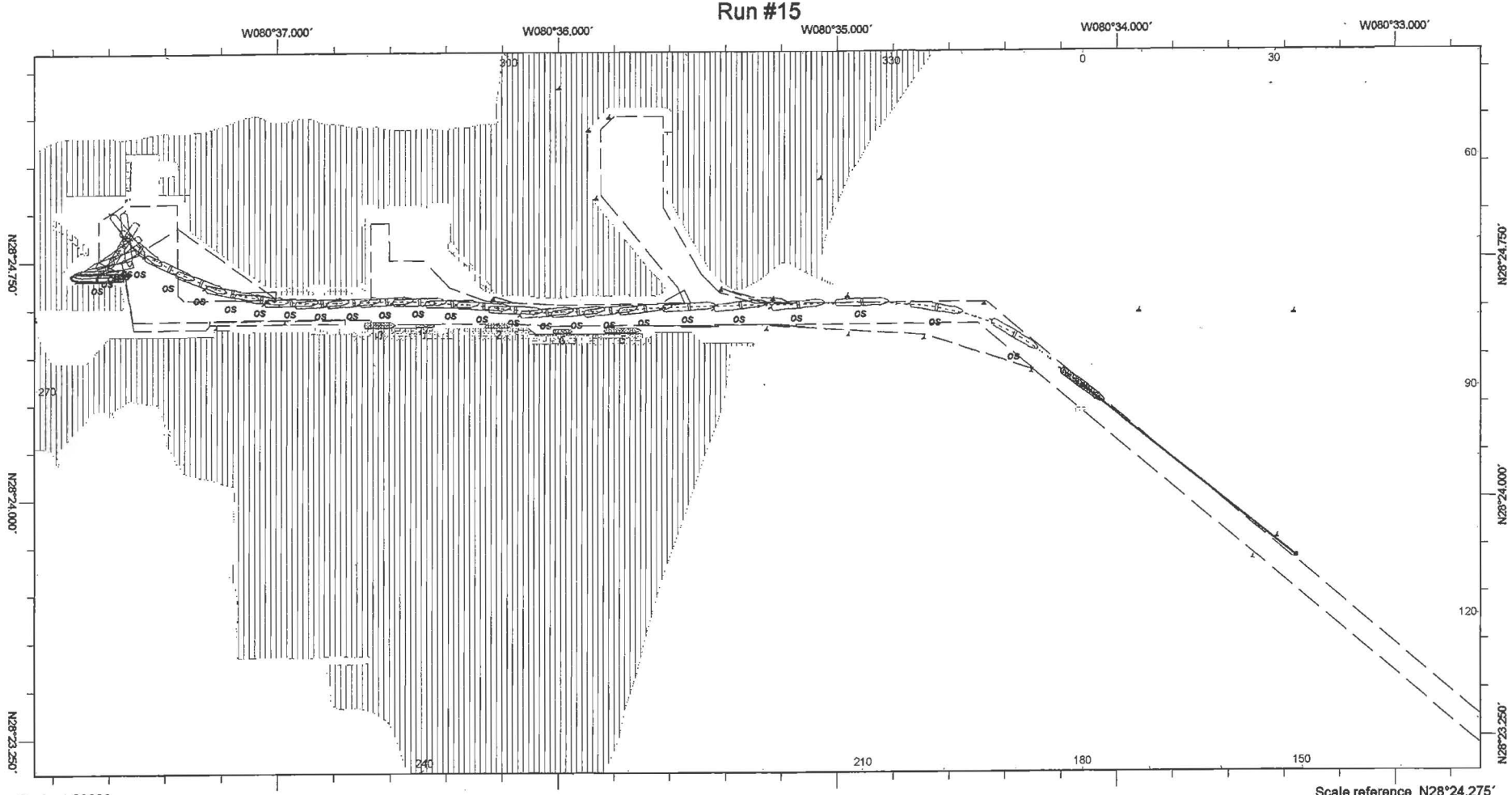
Comments: Wind: 180 at 25kts Pilot: # 3
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Scale reference N28°24.275′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #15



Scale 1:23000

Scale reference N28°24.275′

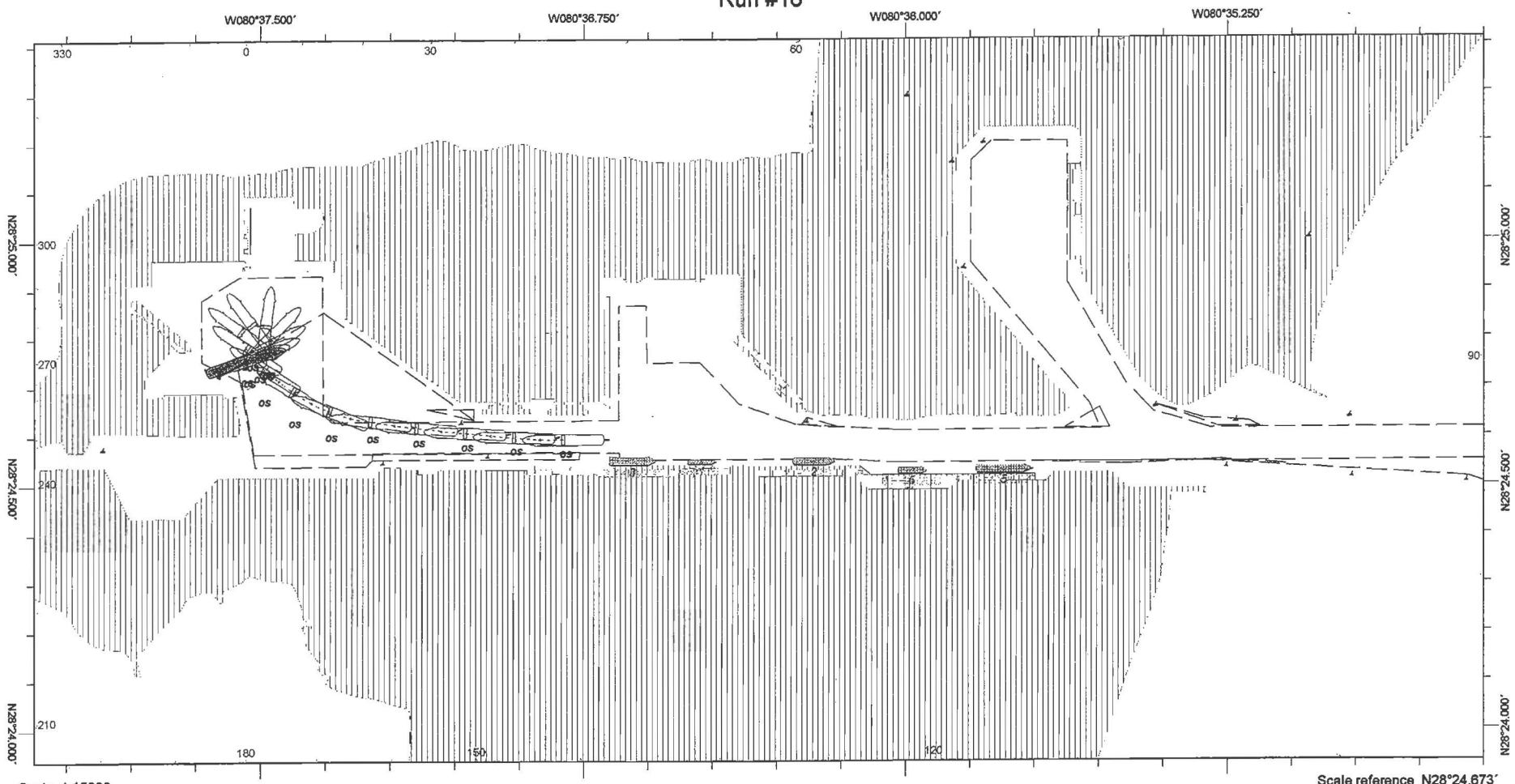
Comments: Wind: 000 at 25kts Pilot: # 1
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #16



Scale 1:15000

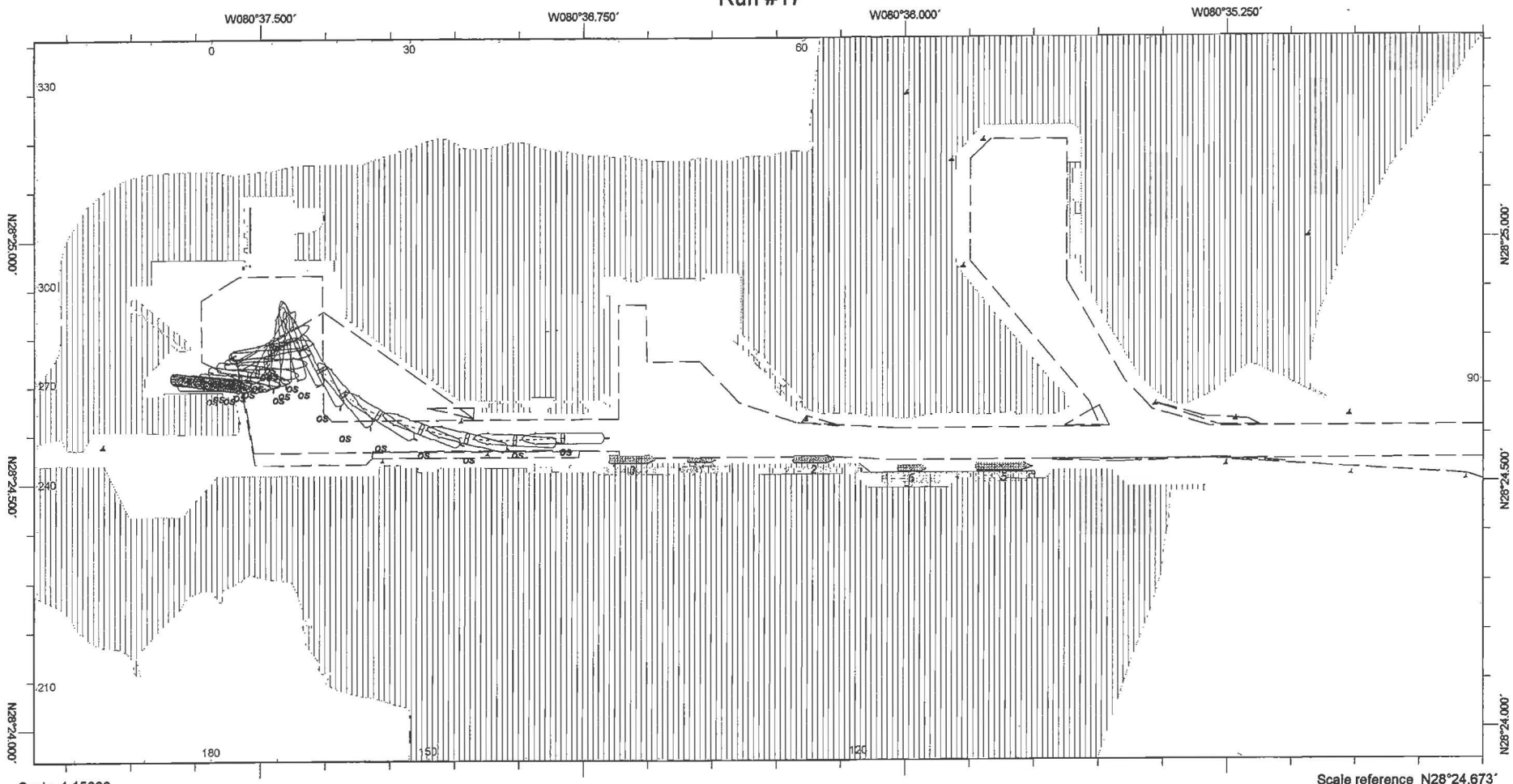
Comments: Wind: 180 at 25kts Pilot: # 2
Current: None

0.1 0.000 0.125 0.250 0.375 0.500 n.mile
200 0 250 500 750 1000 m

Scale reference N28°24.673′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #17



Scale 1:15000

Comments: Wind: 000 at 25kts Pilot: # 5
Current: None

0.1 0.000 0.125 0.250 0.375 0.500 n.mile
200 0 250 500 750 1000 m

Scale reference N28°24.673′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run #18

Scale 1:15000

Comments: Wind: 000 at 40kts Pilot: # 4
Current: None

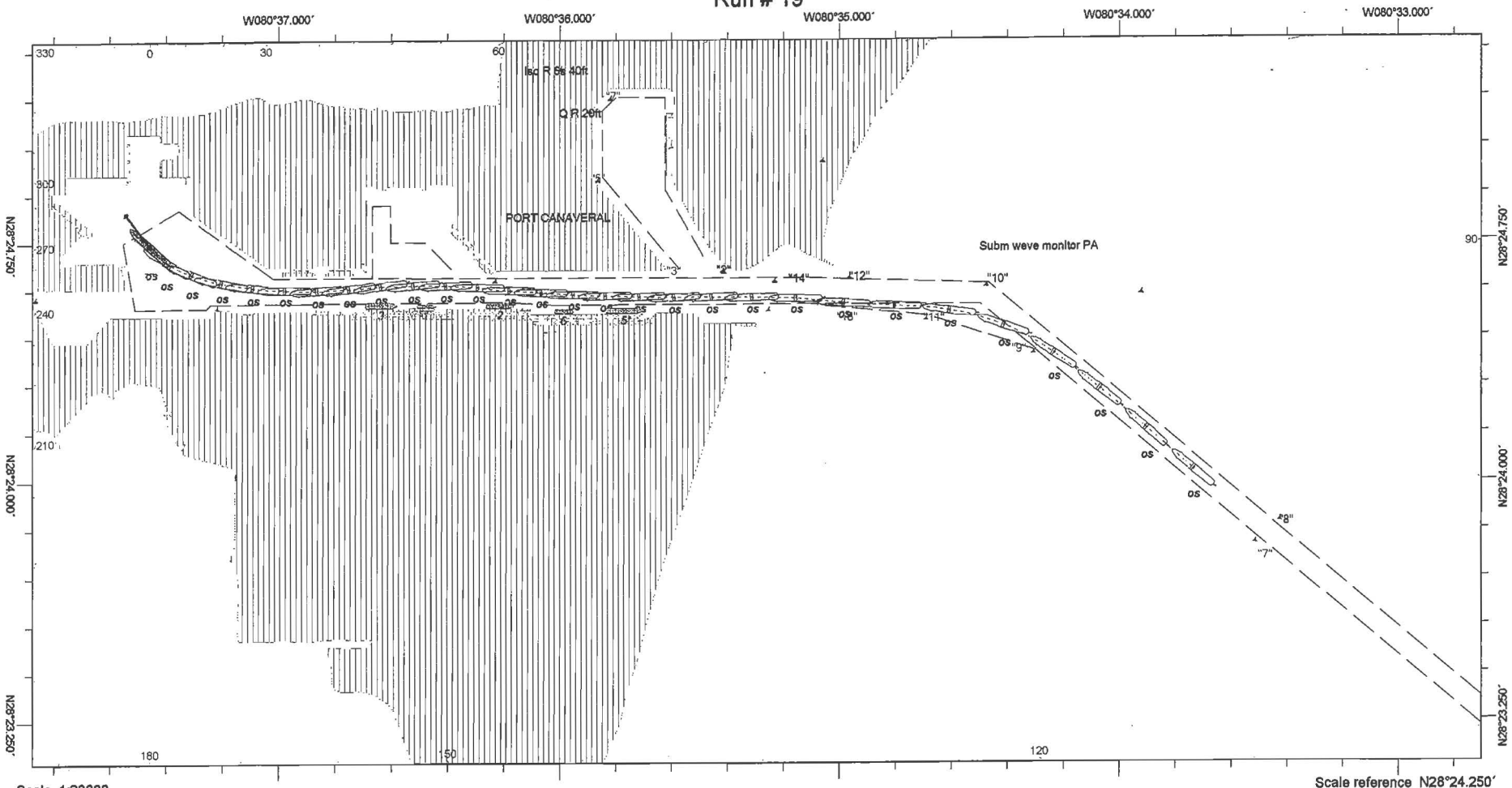
0.1 0.000 0.125 0.250 0.375 0.500 n.mile

200 0 250 500 750 1000 m

Scale reference N28°24.673′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 19



Scale 1:23000

Scale reference N28°24.250′

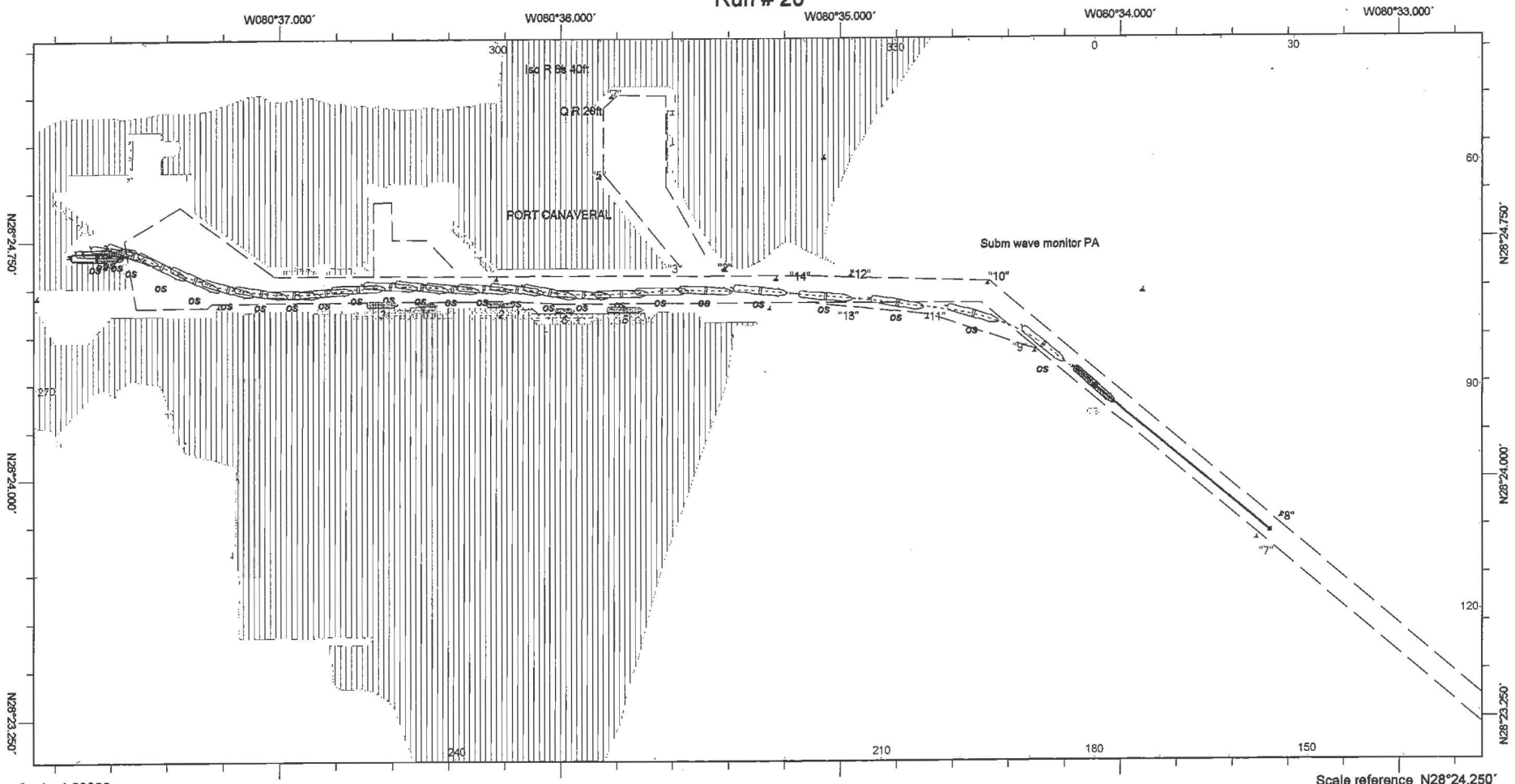
Comments: Wind: 180 at 25kts Pilot # 3 Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 20



Scale 1:23000

Comments: Wind: 180 at 25kts Pilot # 1 Current: None

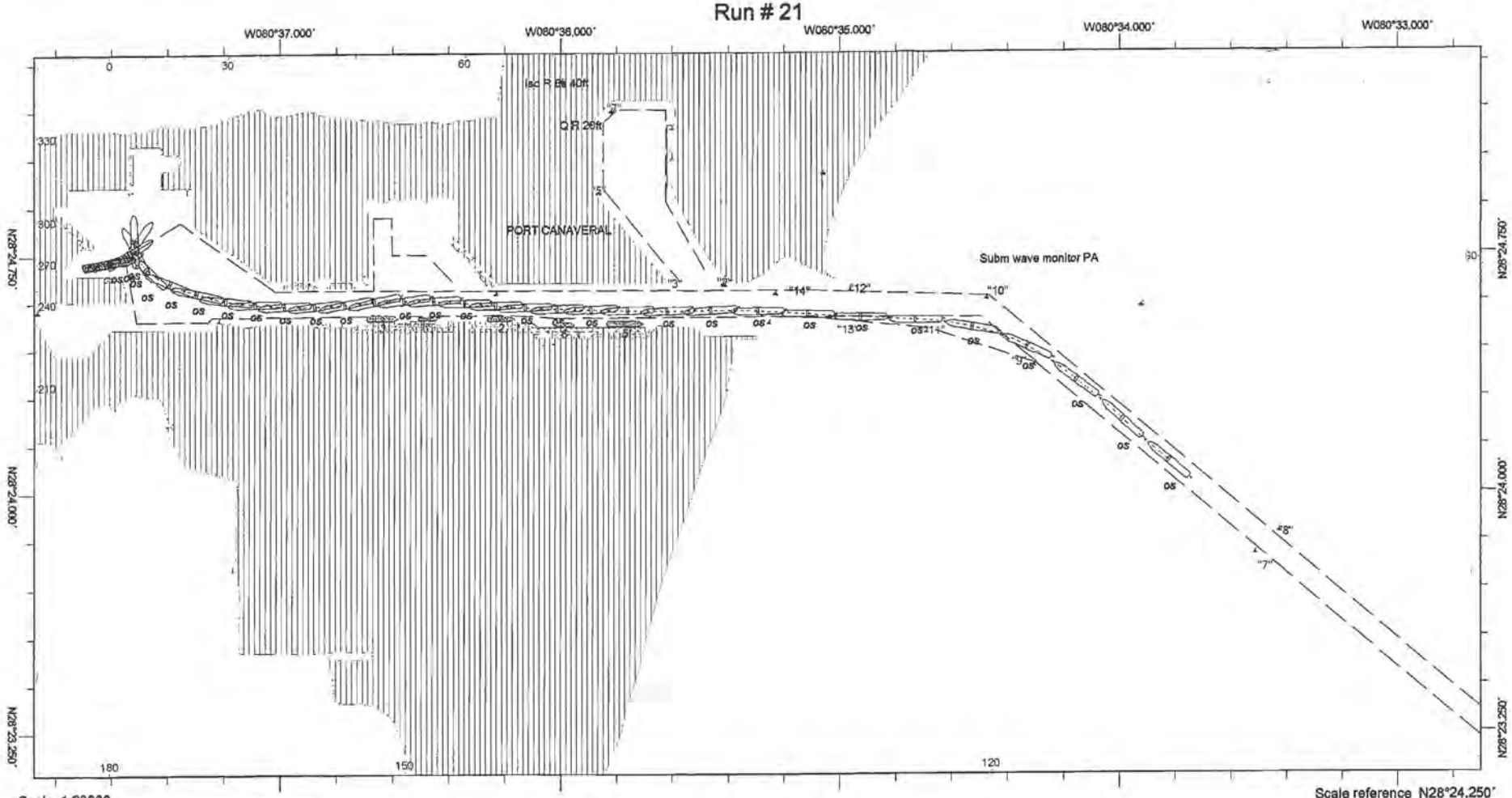
0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Scale reference N28°24.250′

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 21



Scale 1:23000

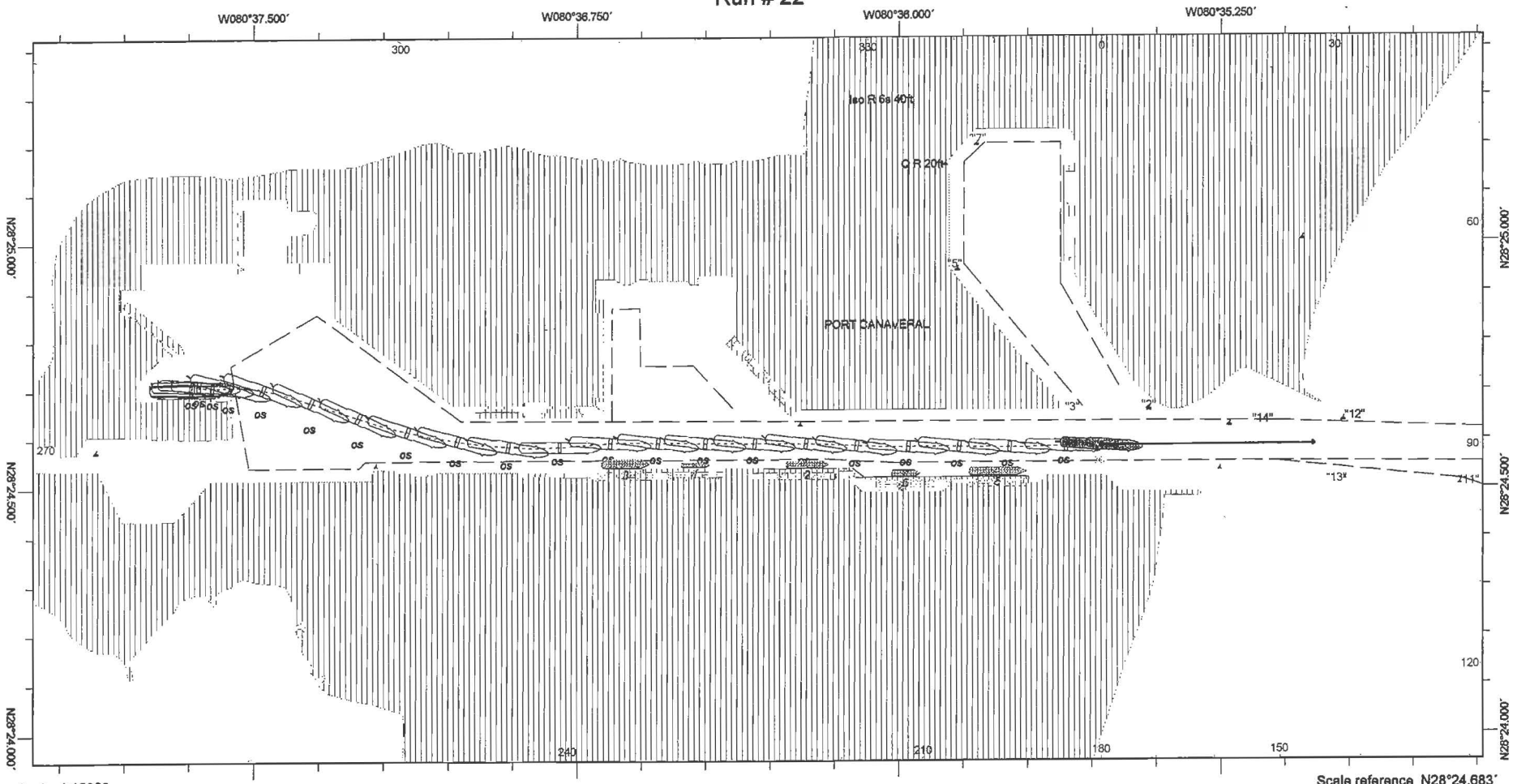
Comments: Wind: 180 at 30kts Pilot # 2 Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 22



Scale 1:15000

Scale reference N28°24.683′

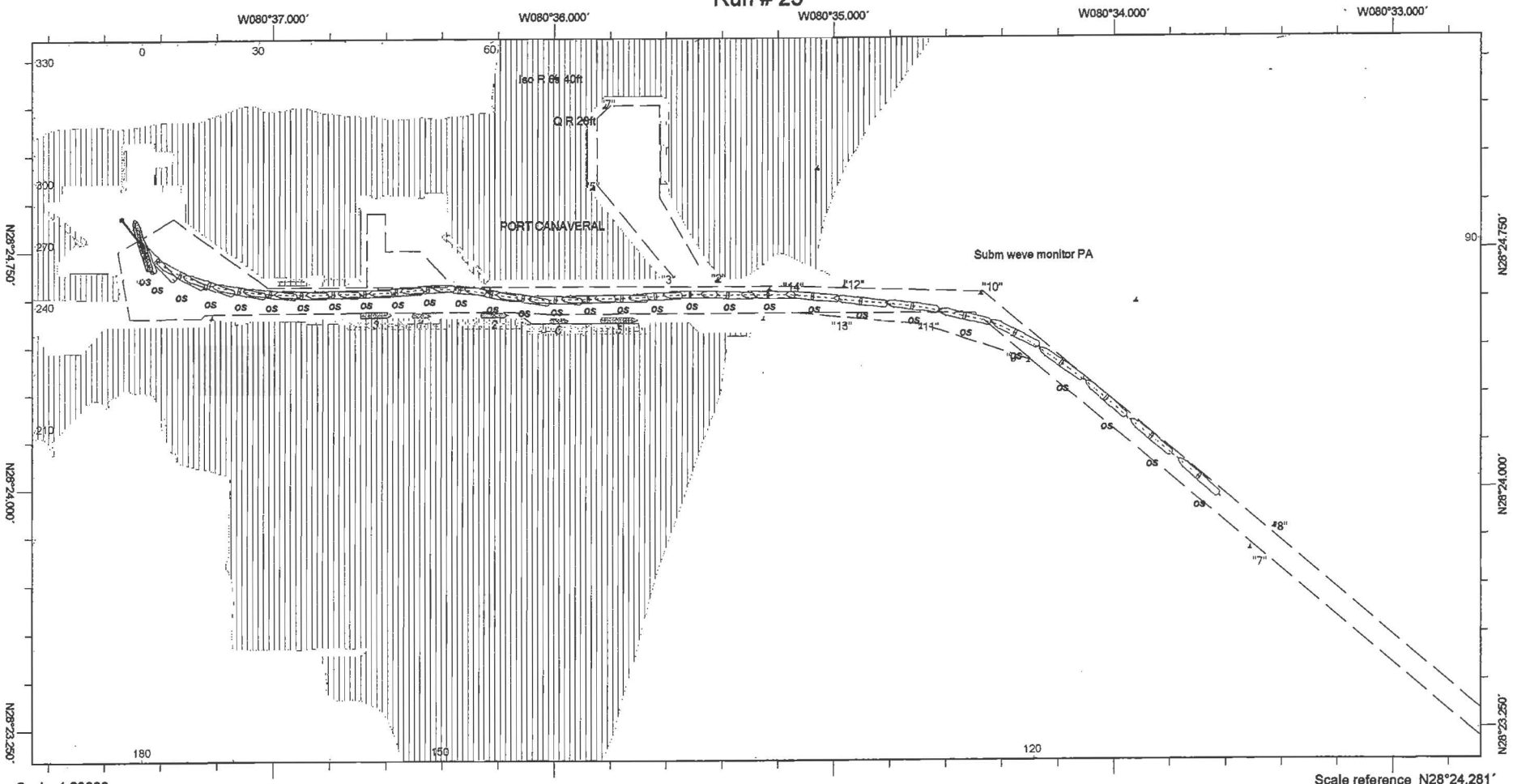
Comments: Wind: 180 at 30kts Pilot # 3
Current: None

0.1 0.000 0.125 0.250 0.375 0.500 n.mile

200 0 250 500 750 1000 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 23



Scale 1:23000

Scale reference N28°24.281′

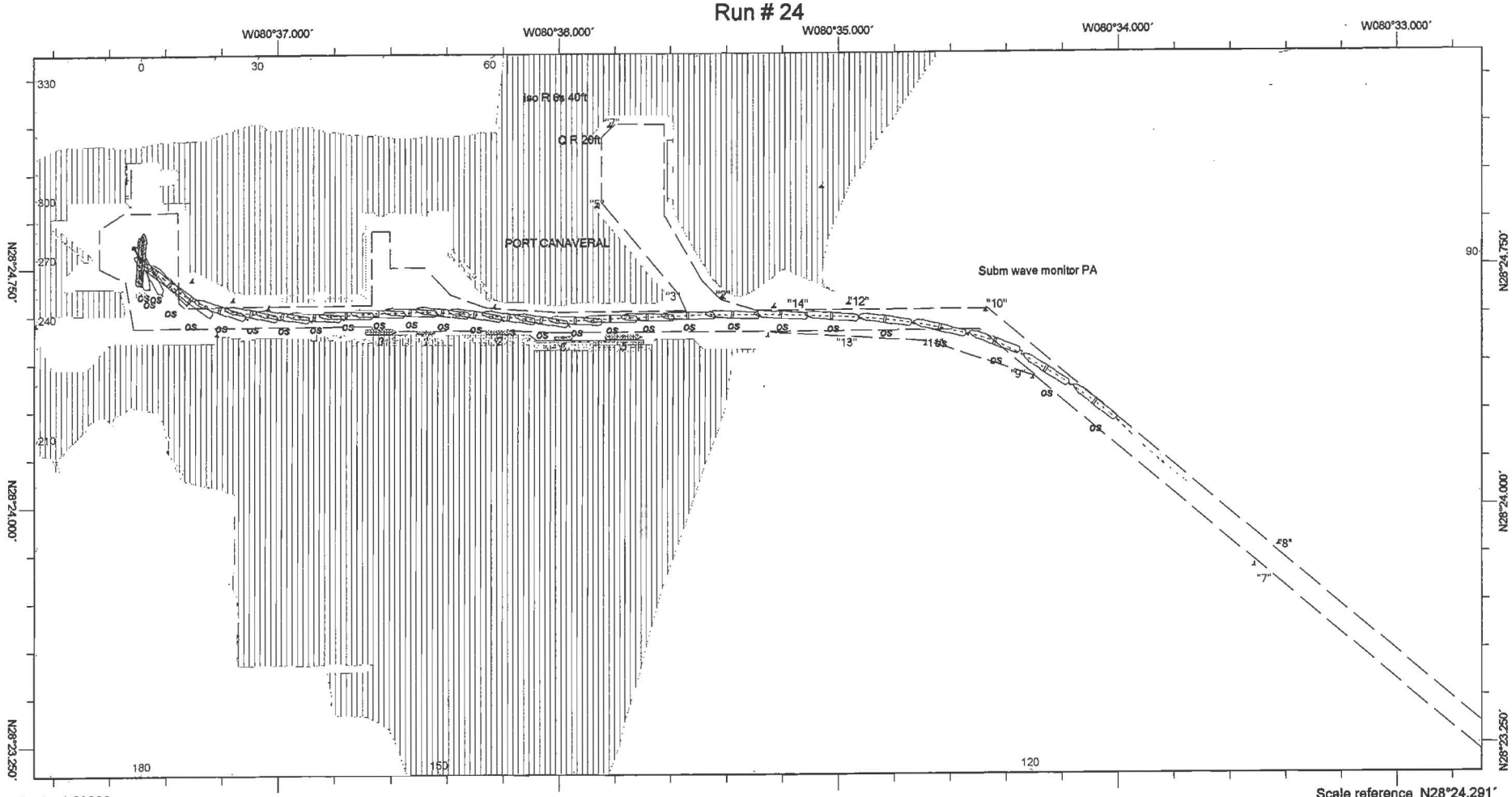
Comments: Wind: 000 at 15kts Pilot # 1
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 24



Scale 1:23000

Scale reference N28°24.291'

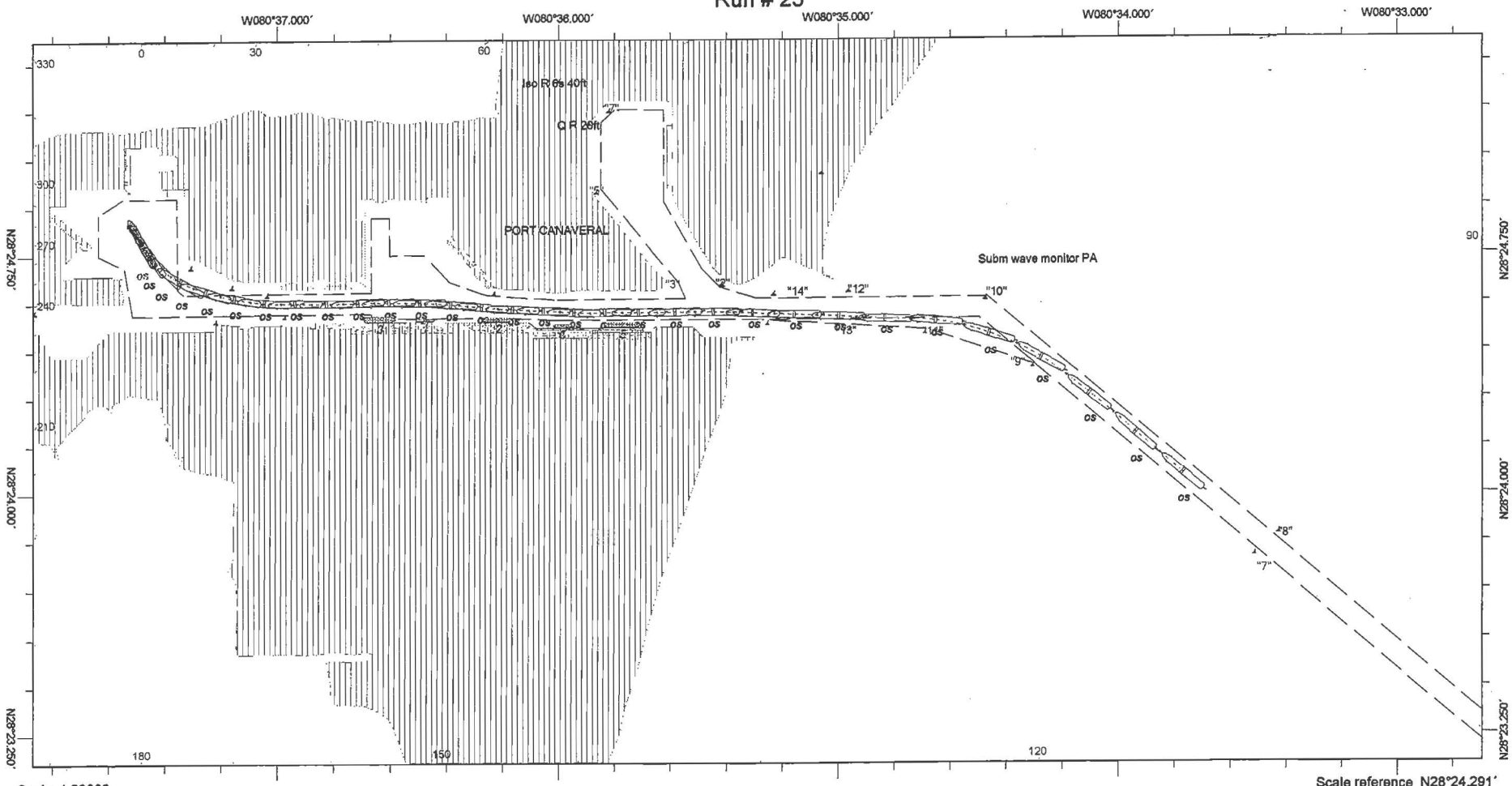
Comments: Wind: 000 at 25kts Pilot: #2
Current: None

0.125 0.0 0.2 0.4 0.6 0.6 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 25



Scale 1:23000

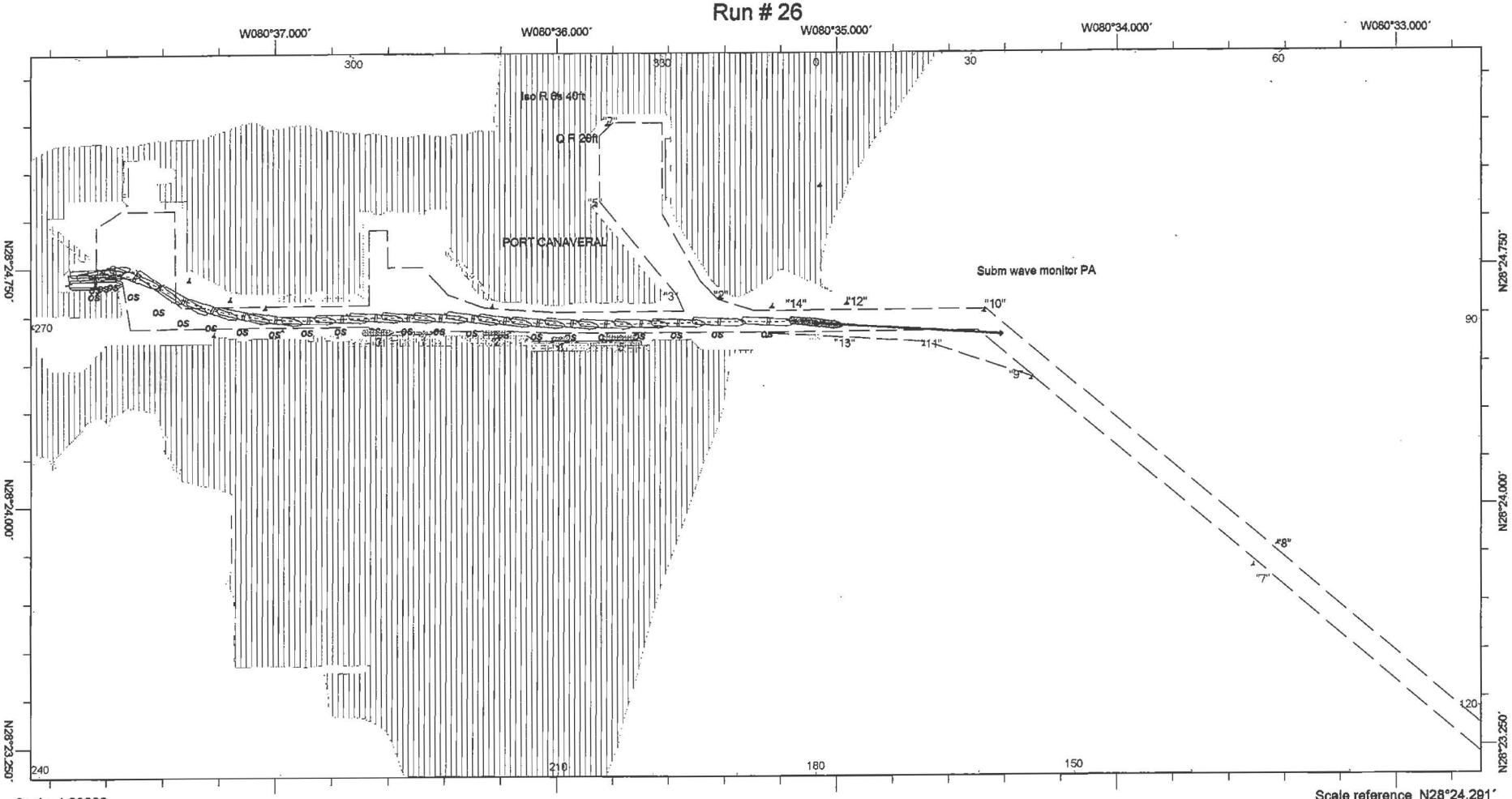
Scale reference N28°24.291′

Comments: Wind: 180 at 15kts Pilot: #3
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Run # 26



Scale 1:23000

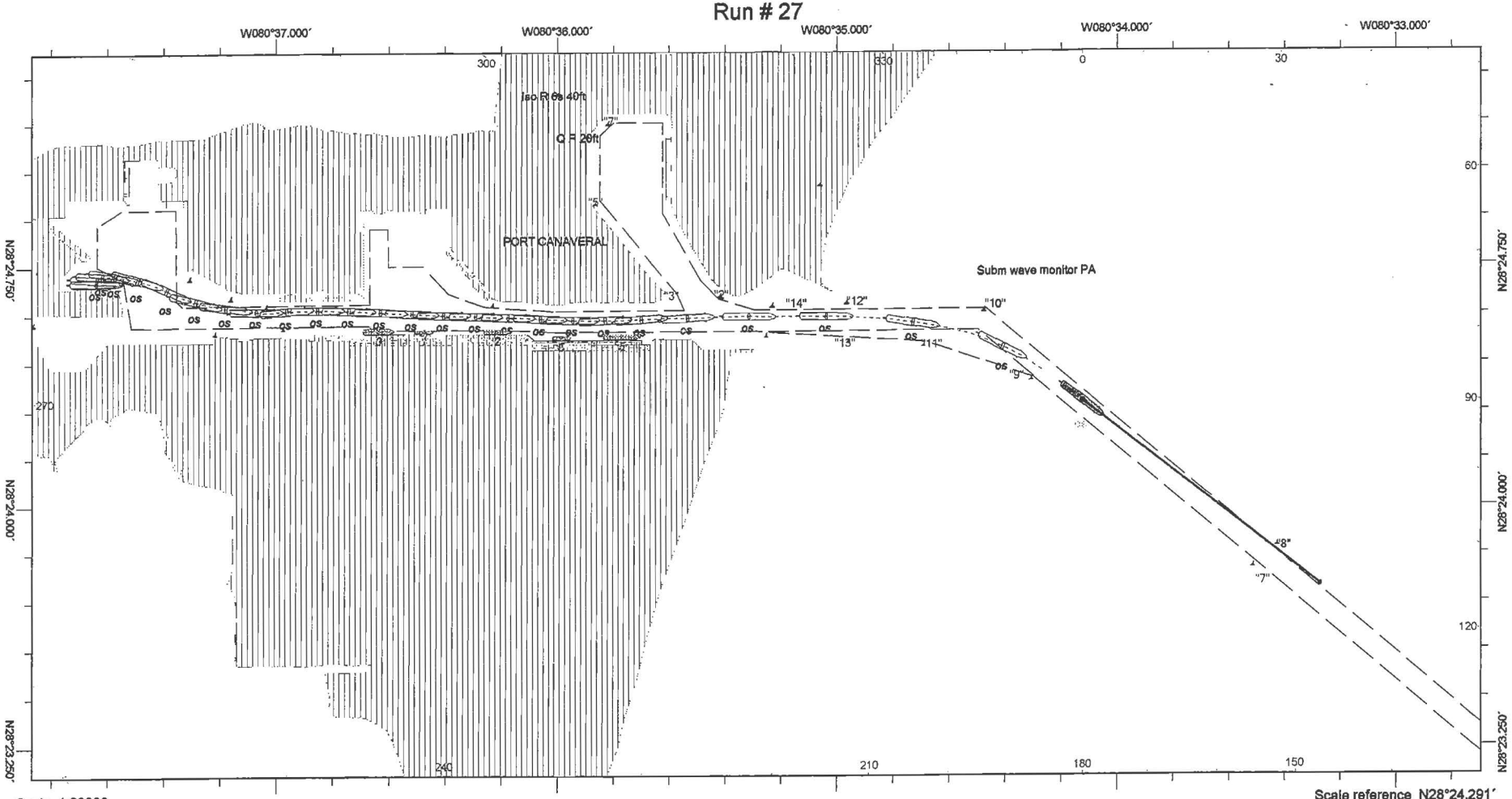
Scale reference N28°24.291'

Comments: Wind: 180 at 25kts Pilot: #1
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile
250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading merker period (s)	60
Shape outline every	01:00

Run # 27



Scale 1:23000

Scale reference N28°24.291′

Comments: Wind: 000 at 15kts Pilot: #2
Current: None

0.125 0.0 0.2 0.4 0.6 0.8 n.mile

250 0 500 1000 1500 m

Line sample period (s)	30
Course marker every	01:00
Heading marker period (s)	60
Shape outline every	01:00

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 12 FEB 2003

Run #: 1

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory	
Vessel Trackline						
- Vessel position with regard to centerline	5	4	3	2	1	
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1	
- Vessel position with regard to ships at the berth	5	4	3	2	1	
- Maneuvering room at turning basin	5	4	3	2	1	DNA
Vessel Controllability						
- Engine reserve	5	4	3	2	1	DNA
- Rudder reserve	5	4	3	2	1	
- Course Control	5	4	3	2	1	
- Speed Control	5	4	3	2	1	
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~	DNA
- Thruster reserve	5	4	3	2	1	DNA

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: CONCERN FOR SURGE AT BERTHS – OK FOR CALM WINDS – TOO FAST IN EXISTING CHANNEL

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all
Stress Level	5	4	3	2	1

Comments:
NONE

Additional Comments: THANK YOU!

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 5

Run #: 2

Date: 12 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: WITH TRNING & EXPERIENCE ON THIS CLASS VSL SAFETY FACTOR WILL RISE.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:
DID NOT TRY TO SLOW FOR BERTHED VSLS. TRIED TO EVALUATE "WEATHER VANING" OF VSL. NOT WHAT I ANTICIPATED! THEREFORE, SPD. EXCESSIVE INSIDE HBR.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 4

Date: 12 FEB 2003

Run #: 3

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
- Use of Tugs	5	4	3	2	1
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: _____

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Date: 12 FEB 2003

Run #: 4

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Ship speed excessive to retain control - need better control (should not be a problem) try to (8 Kts @ CT-3) reduce to (6.5 Kts)

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	(4)	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	(1)

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Run #: 5

Date: 12 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~ NA	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Winds 35 Knots - South; current North @ 3/4 Knot. Had to keep speed 14 kts. up to #9, then 13 kts. to 270', then 11 through jetties. past E. Basin. This speed was needed to control ship, but would cause excessive damage due to surging other ships. (over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	(3)	2	1

Comments: Very difficult "if" speed was down to 6 Knots as not to surge ships.

	Extremely High				Not at all Difficult
Stress Level	5	(4)	3	2	1

Comments: Had to use bow thruster transiting channel (Twice).

Additional Comments: Did well (w/ too much speed) controlling vessel in channel. I did not do well in West basin due to inexperience of Azipod control.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 12 FEB 2003

Run #: 6

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
- Use of Tugs	5	4	3	2	1
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: EXCESSIVE SPEED — SINCE ISLANDS HAD TO GO TOO FAST IN EXISTING CHANNEL TO NOT GO AGROUND

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 5

Date: 13 FEB 2003

Run #: 7

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: _____

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

POSITION OFF SHIPS @ N3 & N4 COULD HAVE BEEN MORE TO SOUTH. SPD COULD HAVE BEEN ABOUT 0.3 KTS SLOWER.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Date: 13 FEB 2003

Run #: 8

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Weather Vane seemingly excessive - No Stbd rudder used on 270° courses - lots of hard port with "offset engines"

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Run #: 9

Date: 13 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory	
Vessel Trackline						
- Vessel position with regard to centerline	5	4	3	2	1	
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1	
- Vessel position with regard to ships at the berth	5	4	3	2	1	
- Maneuvering room at turning basin	5	4	3	2	1	NA
Vessel Controllability						
- Engine reserve	5	4	3	2	1	
- Rudder reserve	5	4	3	2	1	
- Course Control	5	4	3	2	1	
- Speed Control	5	4	3	2	1	
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~	NA
- Thruster reserve	5	4	3	2	1	

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Safe w/ safe speeds IN Port.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	(3)	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	(3)	2	1

Comments:

Additional Comments: Kept vessel to windward using newly dredged area @ Jetty park + along south side of channel @ buoys 15 + 19.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 13 FEB 2003

Run #: 10

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	* 4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~ DNA
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: * GOOD WITH IMPROVEMENTS

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	(4)	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	(3)	2	1

Comments: EXPERIENCE!

Additional Comments: CHANNEL IMPROVEMENTS ENSURE SAFETY –

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 5

Run #: 13

Date: 13 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: EXPERIMENTING WITH SLOW SPD. ABSOLUTELY SAFE AT 5.0 KTS IN S WIND 15 KTS PROVIDED IMPROVEMENTS RECOMMENDED BY PILOTS ARE IN PLACE.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

IN ORDER TO ACHIEVE 5.0 KT INBND W/ 15 KT S WIND VESSEL SHOULD BE DOWN TO 10 KTS AT BUOY 9.
TO BE AT 5.0 TO W/BASIN THE IMPROVEMENTS RECOMMENDED BY PILOTS ARE NECESSARY

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Run #: 14

Date: 13 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Good use on, using newly dredged area on southside in vicinity of #15 & #19 — However needed full Port Azipod to make turn

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Run #: 15

Date: 13 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~ NA
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: _____

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments: Sail from CT-10 · Port side to berth. Turn + head to sea. Wind N. @ 25, then 50 @ Jetty. Kept ship on N edge of channel. Maintained 6.0 Kts in harbor by using dredged areas, especially @ E. Basin entrance. Handled 50 Knots wind w/ increased RPM.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 13 FEB 2003

Run #: 16

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: 25 KTS - SOUTH WIND - VERY COMFORTABLE.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	(3)	2	1

Comments: PLENTY OF POWER ON SHIP —

	Extremely High				Not at all Difficult
Stress Level	5	4	3	(2)	1

Comments:

Additional Comments: DREDGING IMPROVEMENTS MAKE THIS SAFER!

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 5

Date: 13 FEB 2003

Run #: 17

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: SAFE HOWEVER I WOULD LIKE MORE EXPERIENCE ON THIS CLASS B/H DOCKING S/S TO CT-10 W/ 25 KTS N

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:
STARTED EXERCISE IN POOR POSITION FOR N WIND. RECOMMENDED DREDGING NECESSARY. VSL DID NOT REACT AS EXPECTED TURNING INTO W/BASIN

PILOT/MASTER CHANGEOVER

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 4

Run #: 18

Date: 13 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: 40' N WINDS MAKE FOR DIFFICULT CONDITION FOR MANOUVERING.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all
Stress Level	5	4	3	2	1

Difficult

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Run #: 19

Date: 14 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Able to contuol ship in safe position @ all times @ a safe speed - Wider channel allows keeping more distance from moored vessels to alleviate surge

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	(3)	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	(1)

Comments:

Additional Comments: Wider channel allows less vessel speed for alleveing surge

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Date: 14 FEB 2003

Run #: 20

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~ NA
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: Wind S. @ 25. Weather vane effect very strong while transitting harbor @ 6.0 knots, had to keep 15° rudder to hold steady course, therefore leaving little reserve rudder if ship weather vanes too much. (over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments: Must not break concentration at all, due to weathervane effect.

Additional Comments: Due to additional dredging ship could be navigated away from other ship moored at O. berths, there by lessening surging effects.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 14 FEB 2003

Run #: 21

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	** 4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	* 3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: * - I BELIEVE IN REAL TIME - THIS WOULD BE: 4/5

ALSO - ** - DUE TO ADDITIONAL ROOM ALONG SOUTH SIDE IN WEST CUT, THIS MANEUVER IS A 4/5 FOR SAFETY - THIS IS TRUE IN DAY 2 SCENARIO.

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments: 5- ~~25~~ 30 KTS is VERY EXTREME & UNSAFE.

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments: CHANNEL IMPROVEMENTS MAKE IT SAFE @ 30KT SPEED.

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 3

Run #: 22

Date: 2/14 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

30 Kt outbound South Wind

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: @ 6.0 Kts – Hard "rudder" barely can control the weathervane.
w/ hard over – 55 RPM – loss of control due to weathervane
" " " – 70 RPM – control restored

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 1

Run #: 23

Date: 14 FEB 2003

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~ HA
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: _____

(over)

	Extremely Difficult				Not at all Difficult
Task Difficulty	5	4	3	2	1

Comments:

	Extremely High				Not at all Difficult
Stress Level	5	4	3	2	1

Comments:

Additional Comments:

Port Canaveral Berth Access
Run Evaluation Form

Pilot # 2

Date: 14 FEB 2003

Run #: 24

Circle the number that best describes the run just completed:

	Extremely Satisfactory				Not at all Satisfactory
Vessel Trackline					
- Vessel position with regard to centerline	5	4	3	2	1
- CPA to channel boundaries and/or buoys at the entrance	5	4	3	2	1
- Vessel position with regard to ships at the berth	5	4	3	2	1
- Maneuvering room at turning basin	5	4	3	2	1
Vessel Controllability					
- Engine reserve	5	4	3	2	1
- Rudder reserve	5	4	3	2	1
- Course Control	5	4	3	2	1
- Speed Control	5	4	3	2	1
~~- Use of Tugs~~	~~5~~	~~4~~	~~3~~	~~2~~	~~1~~
- Thruster reserve	5	4	3	2	1

	Absolutely Safe				Not at all safe
Overall Safety	5	4	3	2	1

Comments: WITH NO CHANNEL IMPROVEMENTS - 25KTS IS ACCEPTABLE ON SIMULATOR BUT AT UPPER MARGIN FOR SAFETY - VERY LITTLE RUDDER RESERVE FOR GUSTS.

(over)