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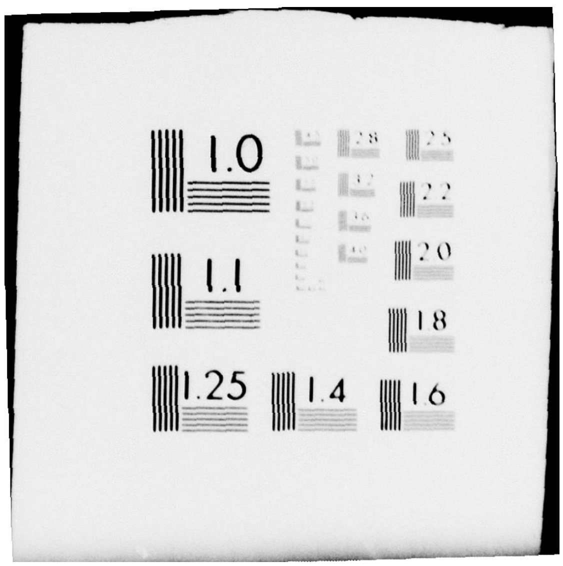
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DAVID W. TAYLOR NAVAL SHIP
RESEARCH AND DEVELOPMENT CENTER
Bethesda, Md. 20084

STACK GAS INVESTIGATION FOR A DOCK LANDING SHIP (LSD 41) REPRESENTED BY MODEL 5380

by

E. E. WEST

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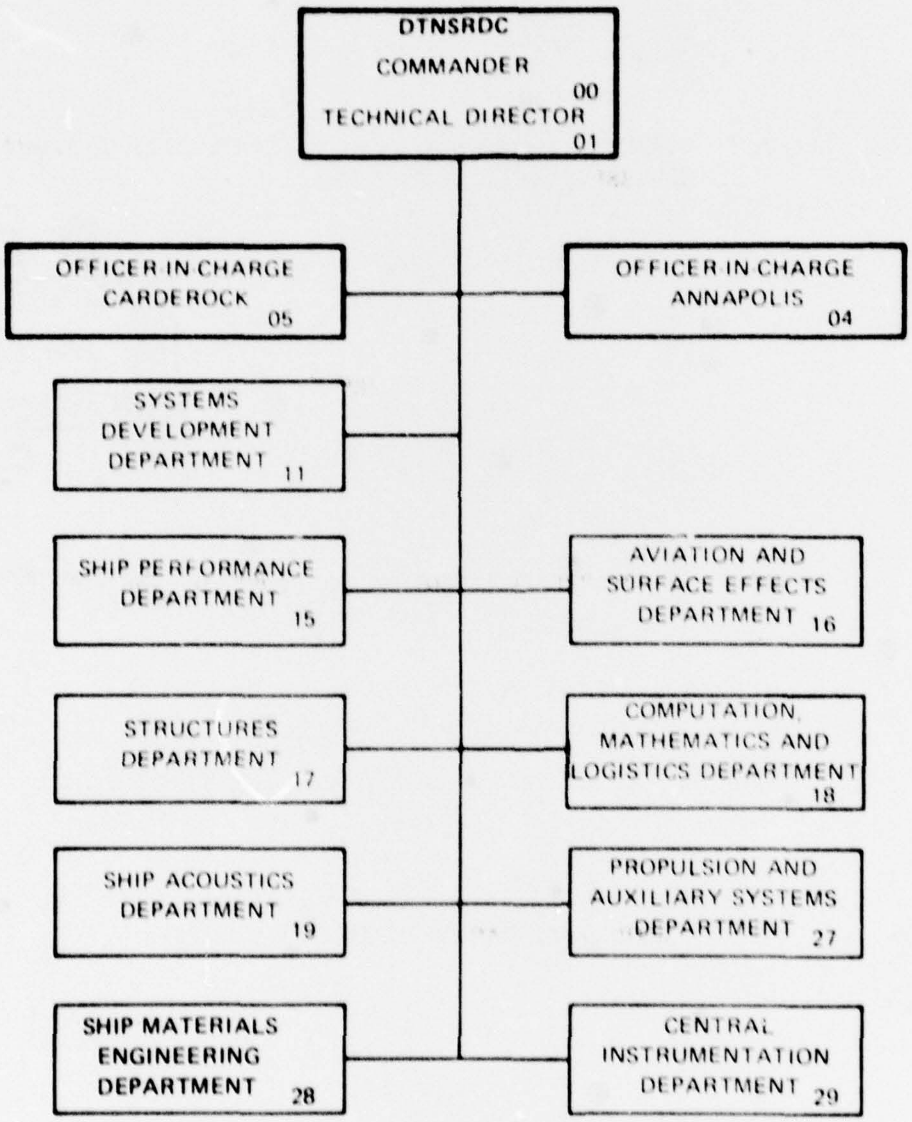

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Model experiments were conducted to determine the influence of the air flow around the ship on the exhaust gas plume from the main and auxiliary stacks of a new class of LSD. Observations and photographs were made of a dye and water mix representing the exhaust gases. Stack heights as well as various exhaust gas velocity to wind velocity ratios were investigated at various headings. The results of the experiments indicate that at most headings if the velocity ratio is 3.0 or above, the exhaust gases clear the turbulent zone and the superstructure of the model.

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ABSTRACT

Model experiments were conducted to determine the influence of the air flow around the ship on the exhaust gas plume from the main and auxiliary stacks of a new class of LSD. Observations and photographs were made of a dye and water mix representing the exhaust gases. Stack heights as well as various exhaust gas velocity to wind velocity ratios were investigated at various headings. The results of the experiments indicate that at most headings if the velocity ratio is 3.0 or above, the exhaust gases clear the turbulent zone and the superstructure of the model.

ADMINISTRATIVE INFORMATION

This investigation was authorized by the Naval Ship Engineering Center (NAVSEC) in Work Request N65197-79-WR-91500 dated 6 October 1978. The DTNSRDC Work Unit is 1524-683.

INTRODUCTION

The Naval Ship Engineering Center (NAVSEC) initated a model experimental program at the David W. Taylor Naval Ship R&D Center (DTNSRDC) to aid in the evaluation of a proposed design for the LSD 41 class. As part of this program, the Center was requested to investigate the stack gas plume patterns of the new class of LSD and determine what stack heights or stack gas velocities are necessary to prevent the gases from being an obstacle to helicopter operation and visibility of the crew. This report covers the results of this phase of the program.

PROCEDURES

Model 5380, representing the 580-ft (176.8 m) LSD 41 class ship above the waterline, was constructed to a linear ratio of 72.5 and in accordance with NAVSEA Drawing 53711-802, General Arrangement Inboard Profile, dated 17 July 1978 (Preliminary Issue) and Drawing 53711-802, General Arrangement Outboard Profile dated 1 November 1977, (Preliminary Issue). Photographs of the model are shown in Figure 1.

A sketch of the stack locations is given in Figure 2. The port stack consists of an arrangement of two 3-ft (0.9 m) diameter main and two 1.5-ft (0.4 m) diameter auxiliary uptakes enclosed in one housing aft of the midship deck opening. The original design height of the top of the port main and auxiliary uptakes is 74.4 feet (22.7 m) above the waterline. The dimensions given herein are full-scale ship dimensions. The starboard stacks are forward of the deck opening. The main consists of two 3-ft (0.9 m) diameter uptakes in a casing. The two auxiliary 1.5-ft (0.4 m) diameter uptakes are in a casing about 32 feet (9.8 m) forward of the starboard main stacks. The original design height of the top of the starboard main and auxiliary uptakes is 102.4 feet (31.2 m) above the waterline.

In addition to the design or original stack heights, a 10-ft (3.05 m) increase and a 20-ft (6.1 m) increase in stack height was observed during the experiment. Wind bearings or headings of 0, 45, 90, 135, and 180 degrees to port and to starboard were investigated at each stack height.

The model was installed on a ground board and then inverted in the circulating water channel. A solution of water and dye was pumped through the stacks at controlled velocities in order to represent the stack gas. Ratios of the stack gas discharge velocity to the relative wind velocity (V_S/V_W) of 1.0, 2.0, 3.0 and 4.0 were observed and photographed at each condition.

An investigation was made to establish the height of the turbulent zone created by the superstructure of the model. Dye was injected through a tube at various vertical positions forward of the bridge to indicate the flow over the model superstructure.

PRESENTATION OF RESULTS

The turbulent zone created by the superstructure of the model can be seen in a series of photographs in Figure 3. Dye was injected through a tube at a full-scale distance of 60 feet (18.3 m) forward of the bridge and at various vertical distances above the 02 deck level which is 44 feet (13.4 m) above the waterline.

The results of the experiment with the stacks at the original or design height are shown in Figures 4 through 8. After examining the results of all the velocity ratios the stack gas velocity ratio selected for reporting was 3.0. A velocity ratio of 3.0 will give a velocity to the smoke from either stack so that it will clear the turbulent zone at all headings except 90,135 and 180 degrees.

Figure 4 shows the plume from the starboard stacks of the model at headings of zero 45, 90, and 180 degrees. At these headings a velocity ratio of 3.0 forces the plume of the starboard stack to clear the turbulent zone and the decks.

The plume from the port stack is shown in Figures 5 and 6. Figure 5 shows the headings of 0, 45, and 135 degrees where the plume clears the turbulent zone and the deck with a velocity ratio of 3.0. The port stack plume did not clear the turbulent zone with a velocity ratio of 3.0 when the wind headings were 90 and 180 degrees. This condition is shown in Figure 6 along with the higher velocity ratio of 4.0. With the higher velocity ratio, the plume of the port stack does clear the turbulent zone and decks at the 90 and 180 degree headings.

Figures 7 and 8 show the starboard stacks with a wind heading of 135 degrees and the four velocity ratios 1.0, 2.0, 3.0 and 4.0 that were observed. Because of the high boundary of the turbulent zone created by the 135 degree heading the plume from the starboard stack does not clear the turbulent zone with a velocity ratio of 4.0.

The 135 degree wind heading is repeated in Figure 9 with the starboard stack height increased 10 feet (3.05 m) above the design height. With the higher stack and a velocity ratio of 4.0 the plume clears the turbulent zone. When the stacks are increased to 20 feet (6.1 m) above the design height as shown in Figure 10, a velocity ratio of 3.0 is adequate for the plume to clear the turbulent zone.

CONCLUSION

The original design stack height is high enough to discharge the exhaust gas plume above the turbulent zone of the superstructure in most wind conditions when the velocity ratio of 3.0 is used. However, when the relative wind direction is 135 degress, the exhaust gas from either port or starboard stacks does not clear the turbulent zone. By increasing the stack height by 10 feet (3.05 m) and by increasing the velocity radio to 4.0 the exhaust gas plume may be made to clear the turbulent zone in all wind conditions.

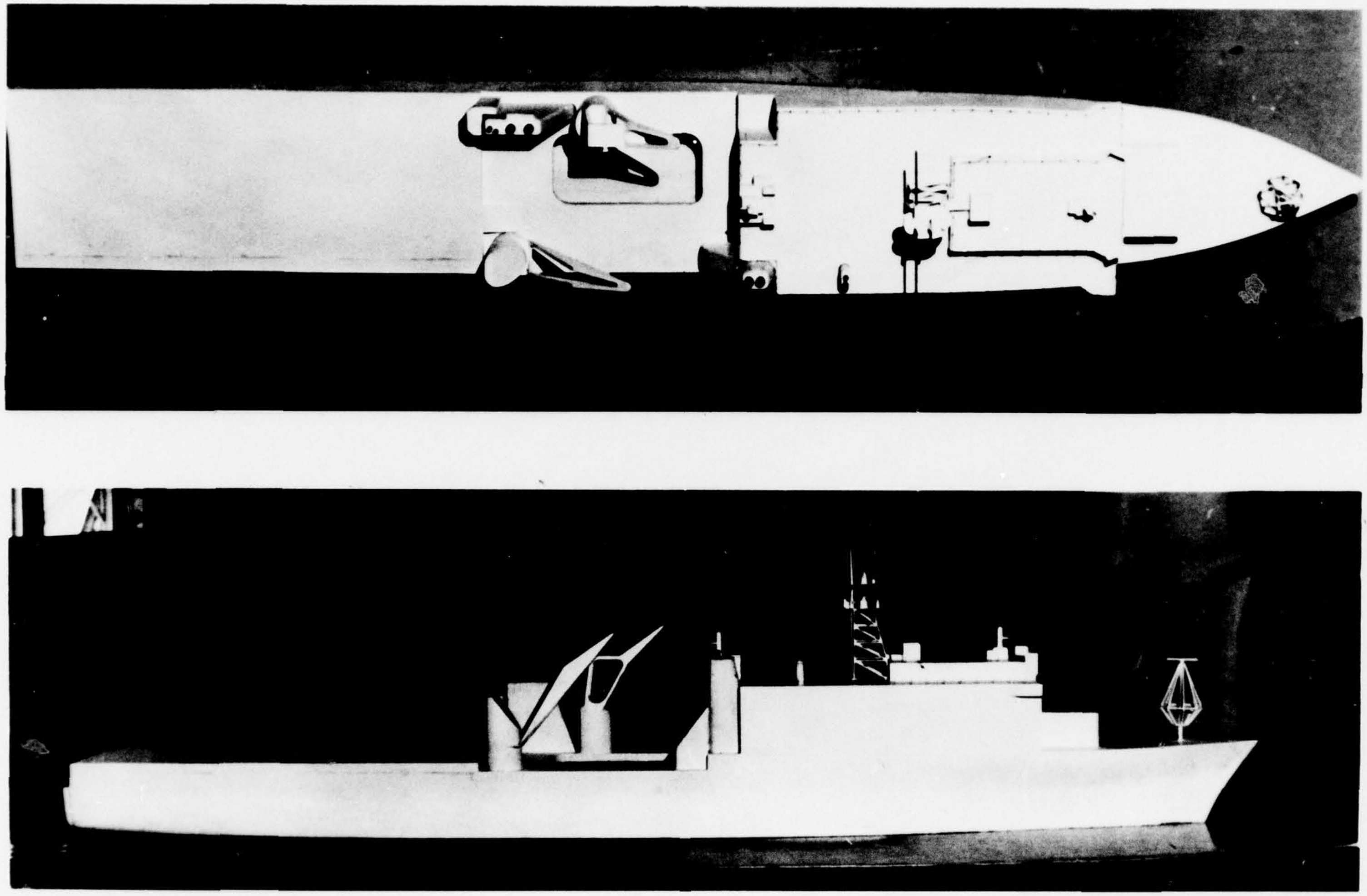


Figure 1 - Model 5380 Representing LSD 41 with Stacks at Design Height

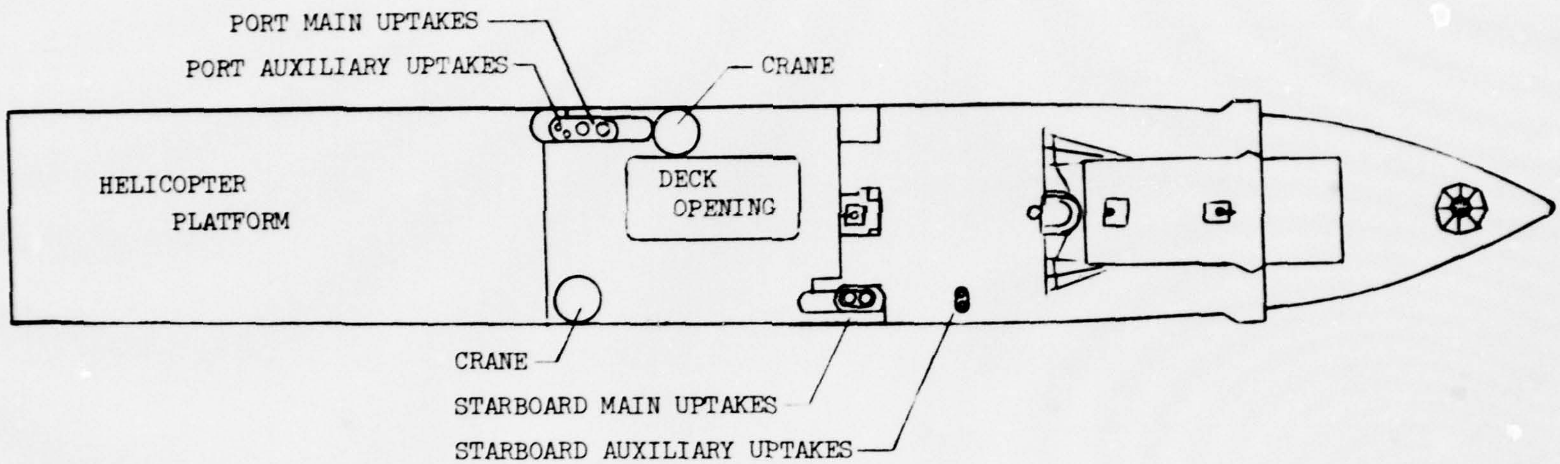
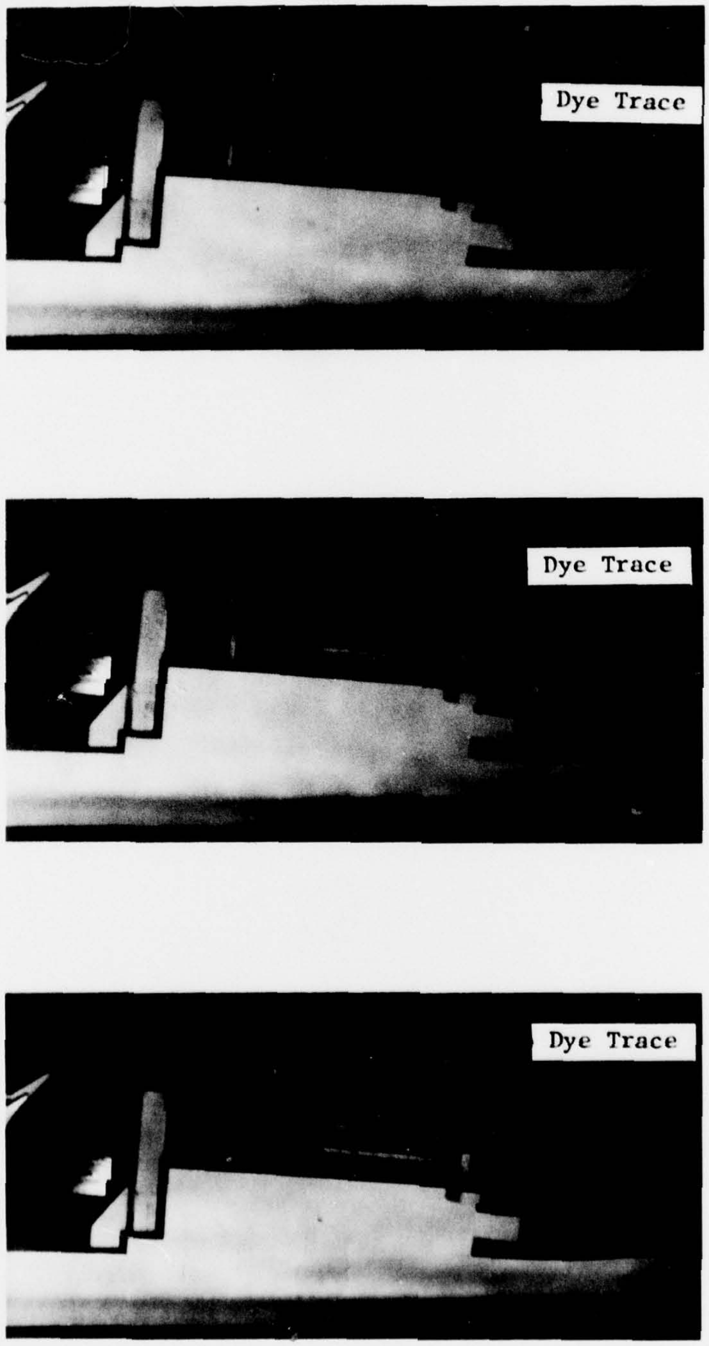


Figure 2 - Sketch Showing Stack Locations

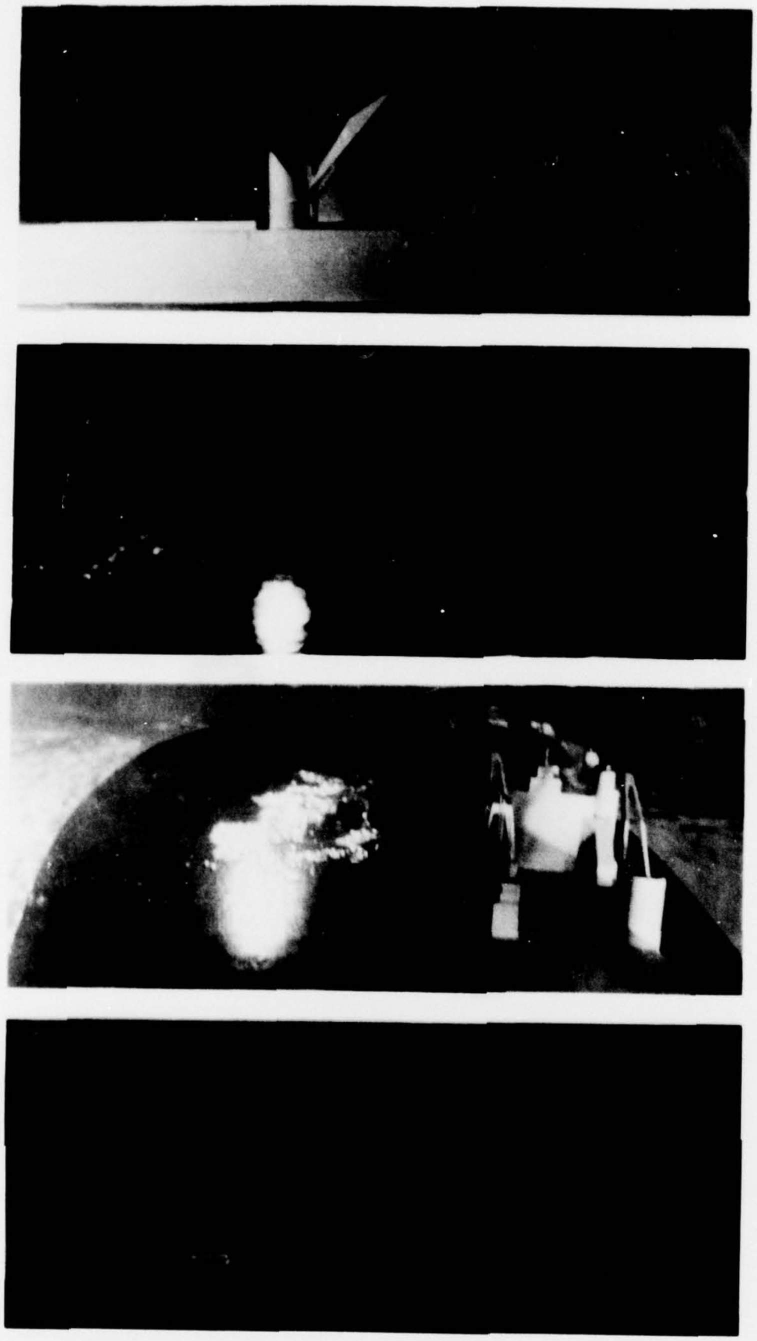


PROBE 71 ft (21.6 m)
ABOVE WATERLINE

PROBE 99 ft (30.2 m)
ABOVE WATERLINE

PROBE 120 ft (36.6 m)
ABOVE WATERLINE

Figure 3 - Investigation of the Boundary of Turbulent Zone Due to Superstructure



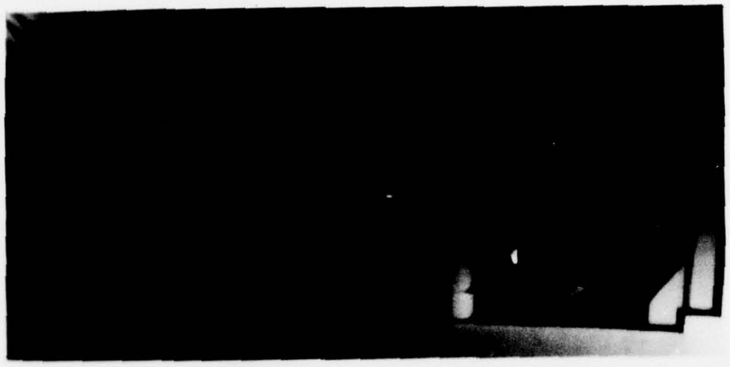
RELATIVE WIND BEARING
0 DEGREES

RELATIVE WIND BEARING
45 DEGREES

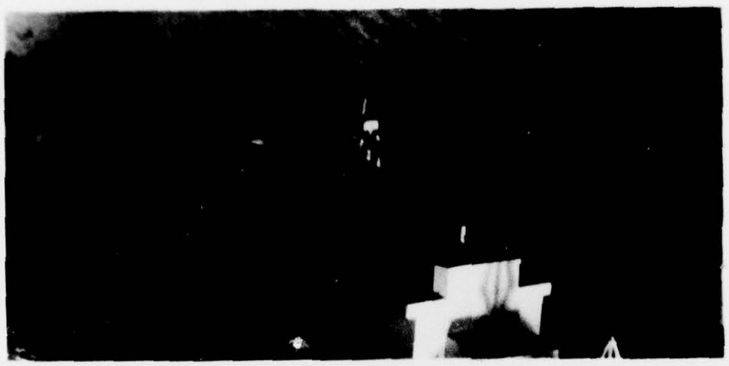
RELATIVE WIND BEARING
90 DEGREES

RELATIVE WIND BEARING
180 DEGREES

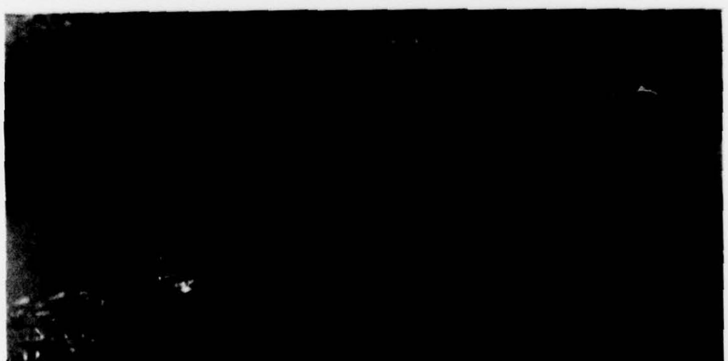
Figure 4 - Starboard Stacks at Design Height with Velocity Ratio of 3.0



RELATIVE WIND BEARING
0 DEGREES



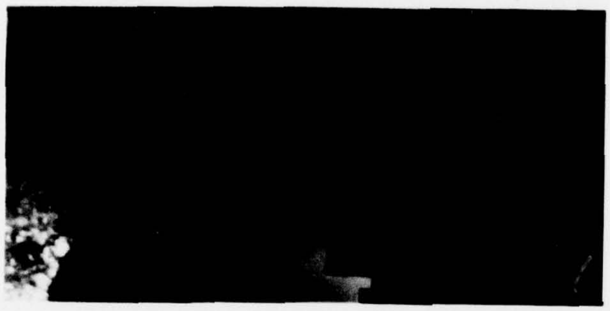
RELATIVE WIND BEARING
45 DEGREES



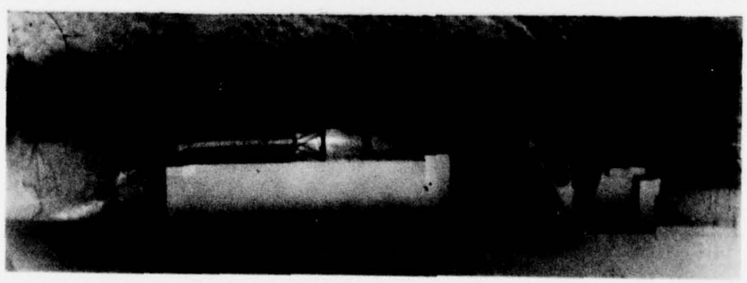
RELATIVE WIND BEARING
135 DEGREES

Figure 5 - Port Stacks at Design Height with Velocity Ratio of 3.0

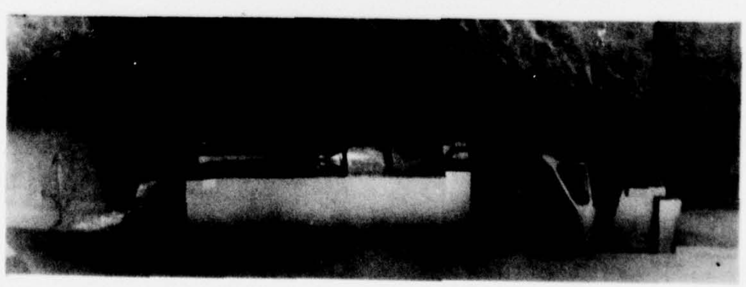
RELATIVE WIND BEARING
90 DEGREES
VELOCITY RATIO = 3.0



RELATIVE WIND BEARING
90 DEGREES
VELOCITY RATIO = 4.0

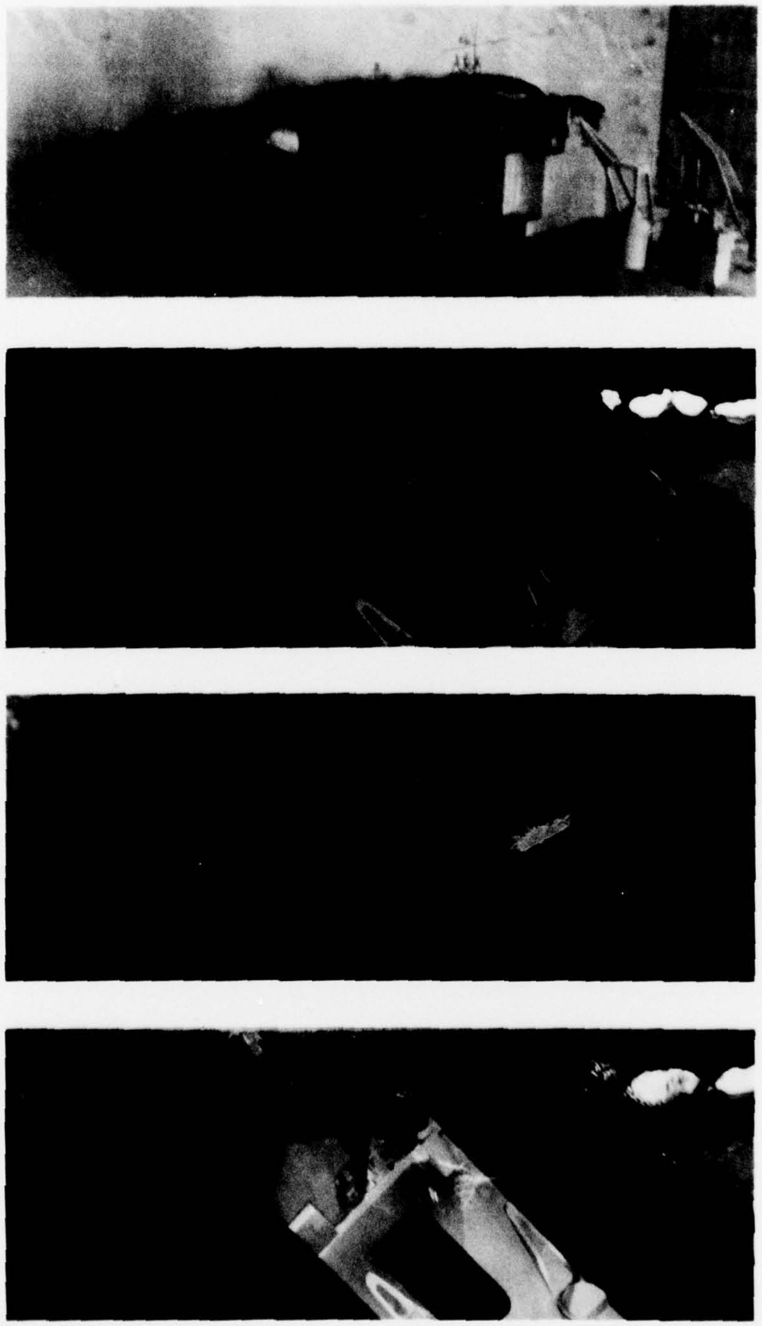


RELATIVE WIND BEARING
180 DEGREES
VELOCITY RATIO = 3.0



RELATIVE WIND BEARING
180 DEGREES
VELOCITY RATIO = 4.0

Figure 6 - Port Stacks at Design Height with Velocity Ratios of 3.0 and 4.0



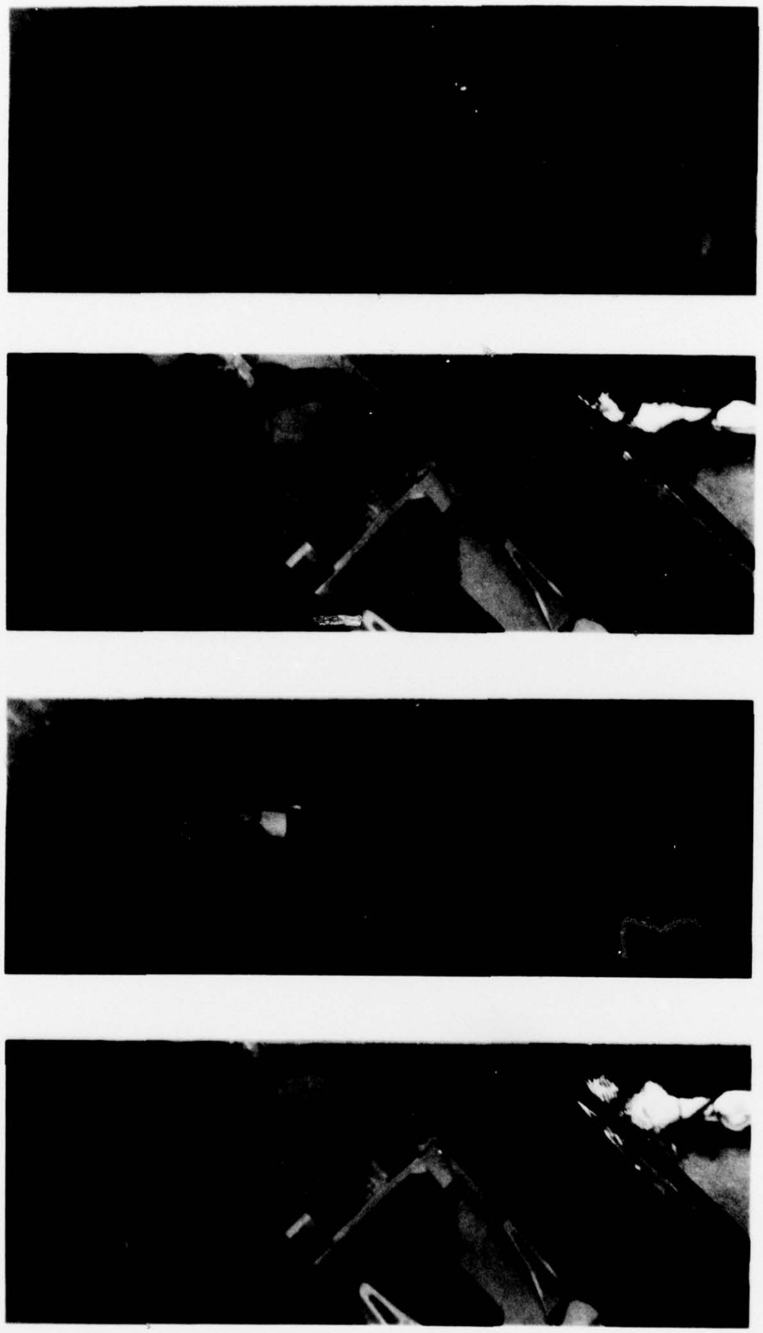
VELOCITY RATIO = 1.0

VELOCITY RATIO = 1.0

VELOCITY RATIO = 2.0

VELOCITY RATIO = 2.0

Figure 7 - Starboard Stacks at Design Height with a Relative Wind Bearing of 135 Degrees Velocity Ratio of 1.0 and 2.0



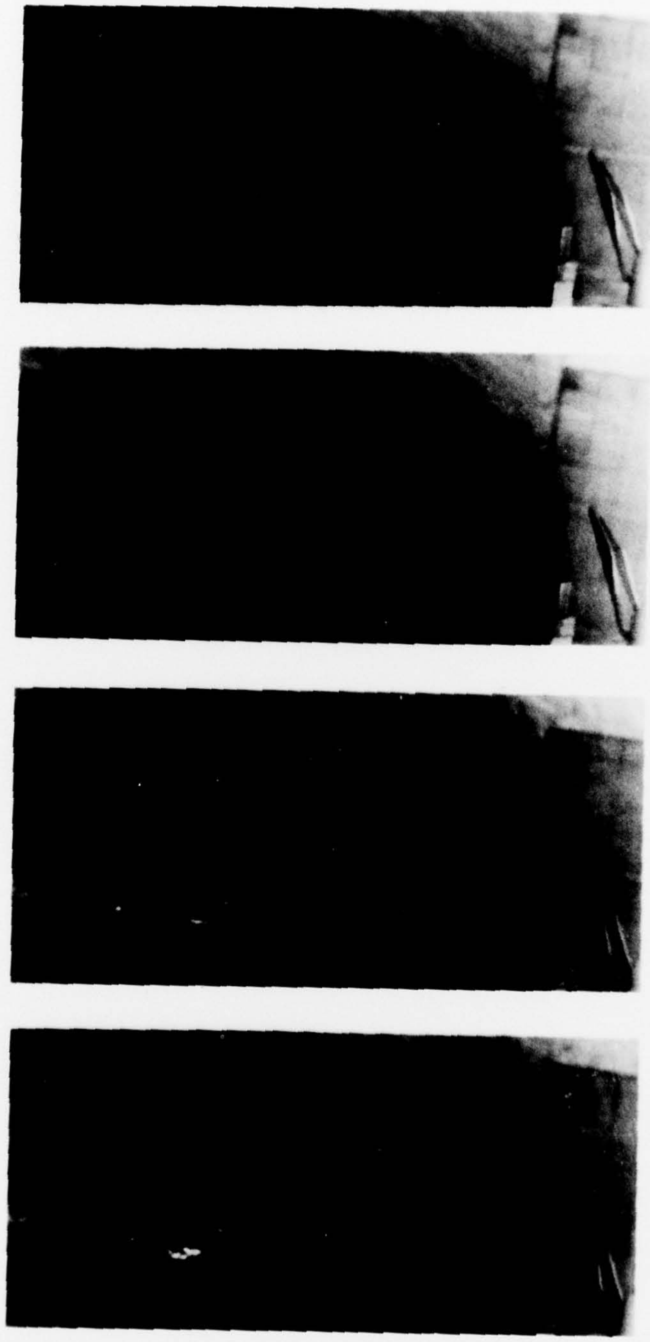
VELOCITY RATIO = 3.0

VELOCITY RATIO = 3.0

VELOCITY RATIO = 4.0

VELOCITY RATIO = 4.0

Figure 8 - Starboard Stacks at Design Height with a Relative Wind Bearing of 135 Degrees Velocity Ratios of 3.0 and 4.0



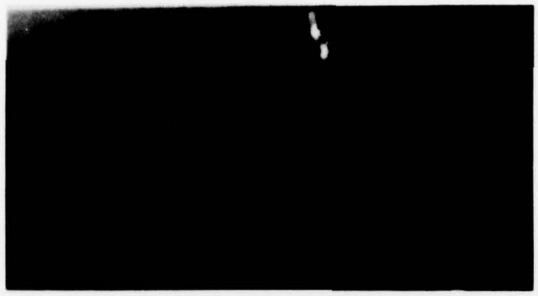
VELOCITY RATIO = 1.0

VELOCITY RATIO = 2.0

VELOCITY RATIO = 3.0

VELOCITY RATIO = 4.0

Figure 9 - Starboard Stacks Extended 10 Feet above Design Height with a Relative Wind Bearing of 135 Degrees



VELOCITY RATIO = 1.0

VELOCITY RATIO = 2.0

VELOCITY RATIO = 3.0

VELOCITY RATIO = 4.0

Figure 10 - Starboard Stacks Extended 20 Feet above Design Height with a Relative Wind Bearing of 135 Degrees

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