UNDERWATER FACILITIES
INSPECTIONS
AND
ASSESSMENTS
AT
NAVAL STATION
MAYPORT, FLA.

JULY 1980

PERFORMED FOR:
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CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

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### Abstract
The objective of the underwater facility assessments conducted at the U.S. Naval Station in Mayport, Florida is to provide a generalized structural condition report of selected facilities within the activity. The facilities are Carrier Berth C-A, Carrier Berth C-2, the Bulkhead East of Carrier (Cont).
BLOCK 19 (Con't)

Berth C-2, Bravo Wharves B-1, B-2 and B-3, Destroyer Berths D-1, D-2, D-3 and D-44 and the Small Craft Berth. Each facility was inspected by a team of engineer/divers using a combination of visual/tactile and ultrasonic techniques. Critical elements were photo-documents.

All facilities inspected appear to be in fair to good condition. No facility was observed to have advanced structural deterioration or damage such that its structural capacity to function should be downgraded. All facilities inspected exhibited some degree of corrosion. Generally the amount of corrosion observed was directly proportional to age. However, Carrier Berth C-1 experienced some localized high corrosive activity.

Several facilities experienced structural damage. These are Carrier Berth C-1, Destroyer Berth D-1 and the Small Craft Berth. In each of this three facilities, one hole was observed in the bulkhead below mean low water. The most critical structural problem is the loss of fill through these holes. It is recommended the holes be patched.

With the exception of the above listed deficiencies, the facilities inspected appear to be in a condition predictable for the environment and age of the facilities. All facilities should be protected from further corrosion.
The scope of the inspection at the Naval Station in Mayport, Florida and the detail to which it was performed and reported was tailored specifically to the conditions at this facility. This report or the procedure associated with its formation is not intended to be a standard for inspections or reports covering other activities. Attempts are being made, however, toward establishing standards for procedures and formats for inspection and assessment reports. Through these standards, inspections performed by different persons, on many facilities and under a wide range of conditions can be effectively compared. It is expected that the inspections and assessments of the Mayport facilities, like previous operations mandated under the underwater portion of the Specialized Inspection Program, will contribute significantly toward achieving that objective.

It should be noted that the choice of the level of inspection and the procedural detail to be employed will be an engineering judgement made separately for each activity/facility to suit its unique situation and needs. Accordingly, the procedures used at Mayport Naval Station, rather than serve as a detailed model for inspections elsewhere, will provide guidance with general applicability to future inspections.
EXECUTIVE SUMMARY

The objective of the underwater facility assessments conducted at the U.S. Naval Station in Mayport, Florida is to provide a generalized structural condition report of selected facilities within the activity. The facilities are Carrier Berth C-1, Carrier Berth C-2, the Bulkhead East of Carrier Berth C-2, Bravo Wharves B-1, B-2 and B-3, Destroyer Berths D-1, D-2, D-3 and D-4 and the Small Craft Berth. Each facility was inspected by a team of engineer/divers using a combination of visual/tactile and ultrasonic techniques. Critical elements were photo-documented.

All facilities inspected appear to be in fair to good condition. No facility was observed to have advanced structural deterioration or damage such that its structural capacity or function should be downgraded. All facilities inspected exhibited some degree of corrosion. Generally the amount of corrosion observed was directly proportional to age. However, Carrier Berth C-1 experienced some localized high corrosive activity.

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With the exception of the above listed deficiencies, the facilities inspected appear to be in a condition predictable for the environment and age of the facilities. All facilities should be protected from further corrosion. Refer to the following Executive Summary Table for an overview of each facility's construction and recommendations.
## U.S. NAVAL STATION

**MAYPORT, FLORIDA**

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<th>Structural Type</th>
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<td>1951</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Inspect bulkhead Station 20+35 and steel from further</td>
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<td>Protect steel fr</td>
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<td></td>
<td></td>
<td></td>
<td>in five years.</td>
</tr>
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<td>Carrier Berth C-2</td>
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<td>746</td>
<td>Diaphragm cell wall</td>
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<tr>
<td>Bulkhead East of Carrier Berth C-2</td>
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<td>326</td>
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<td>400.5</td>
<td>Anchored Bulkhead</td>
<td>Repair hole at C Inspect wale fas structural condi from further cor thickness of steel from further condi</td>
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<td>from further cor thickness of steel from further condi</td>
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* Length of Facility based on CEC Stationing.
### Executive Summary Table

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<th>Structural Type</th>
<th>Recommendations</th>
<th>Estimated Repair Cost (Dollars)</th>
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<td>Repair hole at CEC Station 23+70. Inspect bulkhead between CEC Station 20+35 and 21+50. Protect steel from further corrosion. Measure thickness of steel annually.</td>
<td>$470/Hole</td>
</tr>
<tr>
<td>Diaphragm cell wall</td>
<td>Protect steel from further corrosion. Measure thickness of steel in five years.</td>
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<tr>
<td>Anchored bulkhead</td>
<td>No Recommendations. Repair effort in progress.</td>
<td>N/A</td>
</tr>
<tr>
<td>Diaphragm cell wall</td>
<td>Annually inspect pavement above CEC Station 36+70 for subsidence.</td>
<td>N/A</td>
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<tr>
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<td>$470/Hole</td>
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This report is a product of the Underwater Inspection Program conducted by the Ocean Engineering and Construction Project Office (FPO-1), Chesapeake Division, Naval Facilities Engineering Command (NAVFACENGCOM) under NAVFAC's Specialized Inspection Program.

Mandated under Contract No. N62477-80-C-0102, this program provides for task oriented engineering services in support of the inspection, analysis and design and monitoring of repairs for the submerged portions of selected Navy Waterfront Facilities. All services required to produce this report were provided by Childs Engineering Corporation of Medfield, Massachusetts under Task No. 3 of this Underwater Inspection Program.

The efforts expended and costs required to perform these underwater facility inspections varies greatly with the number of piles or area of bulkhead selected for scrutiny. It is imperative that this portion be sufficiently representative of the total facility condition to assure that a structural assessment of the overall facility can be made. Costs and efforts also vary greatly with other factors peculiar to each facility or activity such as:

- Type and quantity of biofouling to be cleaned for different levels of scrutiny, both visual and with instruments
- Pile material, quantity, and distribution
- Tidal range - area exposed at low tide for boat inspection
- Time and type of last inspection
- Local environmental factors - salinity, pollution level, temperature, etc., affecting rates of corrosion and animal and plant life.
1.1 TASK DESCRIPTION

The scope of work required under this portion of the program provides a general structural assessment including repair-ability, if necessary, of the underwater portion of designated bulkheads located at the Naval Station in Mayport, Florida.

1.2 REPORT CONTENT

In this report the inspection procedures, the results of the inspection and analysis of the findings are addressed. Each facility examined within the Naval Station is described as to its location, function, construction, inspection condition and condition assessment. Recommendations for each facility are also included. Structural assessment calculations and cost estimate breakdowns can be found in the Appendix. Also as supplementary information, a brief description of the Naval Station is provided to define its location, mission, existing and proposed facilities, hydrographic and topographic features and other pertinent data.
SECTION 2.0 ACTIVITY DESCRIPTION

The purpose of this section is to provide a general description of the Naval Station in Mayport, Florida. Included in this section will be brief discussions on the Naval Station's location, mission, history, existing facilities, climatological and meteorological data and hydrology. This information is provided to supplement the later sections of this report and to support all considerations necessary to accurately assess the structural condition of facilities inspected in this survey.

2.1 LOCATION OF ACTIVITY

Naval Station Mayport is located on the Atlantic seacoast approximately 30 miles south of the Georgia border at Latitude 30°24'N and Longitude 81°26'W (see Figure 1). Situated on the south bank of the St. Johns River, the Navy Base lies approximately 16 miles east of downtown Jacksonville in the town of Mayport, Florida (see Figure 2).

2.2 MISSION OF FACILITY

The mission of Mayport Naval Station is "to provide support to its tenant commands. This involves 116 specific tasks which are performed by the station. The more important tasks include:

1) The operation of a harbor for berthing ships under Navy control and visiting ships of friendly powers.

2) The operation of an airfield and air terminal.

3) The provision of utilities and services in support of berthed ships.

4) The provision of logistic support for assigned ships and units.

5) The provision of operational and personnel support services.

6) The provision of handling assistance and safety supervision to ships receiving or discharging ordnance.

7) The provision for storage and transshipment of ordnance and weapons within station capabilities.
From: MASTER PLAN, NAVAL STATION MAYPORT, FLA., NAVAL FACILITIES ENGINEERING COMMAND, SOUTHERN DIVISION, JUNE 1975.
8) The provision of fuel storage.

9) The provision of administrative support to base and tenant operations.

10) The provision of pilot and tugboat services for ship movements to, from, and within Mayport harbor.

2.3 HISTORY OF FACILITY

The Mayport facility was initially conceived as an aircraft carrier basin in 1939 and officially commissioned as a U.S. Naval Section Base in 1942. An aircraft landing field was incorporated in 1943. The facility served as a Sea Frontier Base until it was commissioned in 1944 as a U.S. Naval Auxiliary Air Station. In 1946 NAAS Mayport was decommissioned and placed in a "caretaker" status. It was reactivated in 1948 and used primarily for berthing of crash boats and as a carrier landing practice field. In 1952 the first carrier berth (known as C-1) was completed and in 1955 Mayport became the headquarters for Carrier Division Two. Improvements and expansion were made in the late 1950's and the Base placed under command of the Chief of Naval Operations. The facility functioned as an advanced staging area and provided fleet support during the Cuban missile crisis in 1962. In 1967 the station was assigned to the Commander-in-Chief, U.S. Atlantic Fleet. Currently, Mayport Naval Station is implementing an updated 1975 version of their Master Plan to meet 1972 SER requirements for expansion and improvement of physical and operational characteristics.

2.4 EXISTING ACTIVITIES

Today Naval Station Mayport is the homeport for five major components of the Atlantic Fleet. These are Carrier Group 6, Cruiser-Destroyer Group 12, Destroyer Squadrons 14 and 24, and Service Squadron 2.
Major tenants of the Station are Helicopter Anti-Submarine Wing One (HAS-One), the Fleet Training Center, the Fleet Maintenance Assistance Group (FMAG), and the Supervisor of Shipbuilding, Conversion, and Repair (SUPSHIPS). Figure 3 shows a plan view of the Naval Station.

Currently, there is approximately 7,700 feet of steel sheet pile bulkhead available for the berthing and servicing of a variety of ships, including aircraft carriers, destroyers, escort ships, destroyer tenders and fleet tugs. This does not include the A-1 berthing area which is undergoing reconstruction at this time. The present berthing conditions for the existing facilities are similar to the proposed conditions for these same facilities illustrated on the "Proposed Berthing Plan", Figure 4.

2.5 CLIMATOLOGICAL AND METEOROLOGICAL DATA

"The Mayport/Jacksonville area lies near the northern limit of the trade winds. Prevailing easterly breezes moderate summer and winter temperatures. The annual mean temperature is 68°-70° with an average summer maximum (during July and August) between 85°-88°. Mean winter temperatures (December through February) range from 52° to 55°.

The area experiences approximately 48 inches of rainfall per year, mostly in the form of summer thundershowers. Relative humidity averages 80 percent. Hurricanes rarely affect the area since, at this latitude, they tend to parallel the coastline at a distance or to dissipate much of their force overland before reaching the Jacksonville vicinity.

Average annual sunshine is 62 percent of maximum. This contributes to excellent flying conditions with "Visual Flight Rules" in effect about 90 percent of the year."

2.6 HYDROLOGY

"The naval station lies in a flat area ranging in elevation from 0 to 20 feet above mean sea level. The land consists of a mixture of hardwood hammocks, coastal beach and dunes, salt water marsh, and dredged fill. Natural drainage follows several tidal creeks on a westward course to Chicopit Bay and the St. Johns River."
From: MASTER PLAN, NAVAL STATION, MAYPORT, FLA., NAVAL FACILITIES ENGINEERING COMMAND, SOUTHERN DIVISION, JUNE 1975
ST. JOHNS RIVER

TURNING BASIN 42'

KEY
ARC - CABLE REPAIR SHIP
AD - DESTROYER TENDER
AE - AMMUNITION SHIP
AO - OILER
AR - REPAIR SHIP
ARS - SALVAGE SHIP
ATF - FLEET OCEAN TUG
CV - AIRCRAFT CARRIER
DD - DESTROYER
DDG - GUIDED MISSILE DESTROYER
DE - ESCORT SHIP
DLG - GUIDED MISSILE FRIGATE
MSO - OCEAN MINESWEEPER

FROM: MASTER PLAN, NAVAL STATION, MAYPORT, FLA., NAVAL FACILITIES ENGINEERING COMMAND, JUNE 1975.
Although it is directly adjacent to the mouth of the St. Johns River, the Naval Station berthing area is in a basically marine environment. Tide level ranges for the Mayport area are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Low Water</td>
<td>0.0</td>
</tr>
<tr>
<td>Mean Tide Level</td>
<td>2.3</td>
</tr>
<tr>
<td>Mean Tide Range</td>
<td>4.5</td>
</tr>
<tr>
<td>Spring Tide Range</td>
<td>5.3</td>
</tr>
</tbody>
</table>

The Naval Station requires regular dredging due to a considerable inflow of silt. The turning basin is kept dredged to a depth of 42 feet below mean low water. In July, 1980, average depths along the bulkheads inspected varied from 21.4 feet to 31.0 feet, with an overall average depth of 27.2 feet below mean low water.
SECTION 3.0 INSPECTION PROCEDURE

3.1 LEVEL OF INSPECTION

From July 21 through July 30, 1980, a team of engineer/divers and technician/diver performed a Level I on-site underwater inspection of selected bulkheads at the Naval Station in Mayport, Florida. Level I underwater inspections assess the general condition of a structure utilizing visual/tactile inspection techniques. For bulkhead-type structures, visual/tactile observations of the structure's condition at mudline, mid-depth, and splash zone levels are performed. This level of inspection is designed to give a general condition assessment of the structure and should identify any areas that have been mechanically damaged or are in advanced states of deterioration.

3.2 INSPECTION PROCEDURE

Past experience combined with engineering theory, the level of inspection to be performed, the type of structure being inspected and the actual on-site conditions dictate the inspection procedures to be used.

Under Task No. 3 of the Underwater Inspection Program, the scope of work included approximately 6,000 LF of steel bulkhead to be visually and tactically inspected from the concrete cap or base of the concrete encasement to the mudline for gross structural damage, holes, either corrosion or mechanical, and any loss of fill. The fender and utility systems were beyond the scope of this Level I inspection. Also no inspection was performed on areas made inaccessible by any fender system associated with the structure.

Before each facility was inspected, the bulkheads were first stationed. This was accomplished by using U.S. Navy stationing
at specific reference points as base points, usually corners of berths (see Figure 5). Childs Engineering Corporation (C.E.C.) Stations were then marked every 20' along the center-line of the concrete cap using a 200' steel tape. This stationing, referenced as C.E.C. Stations on the facility sketches located in the appropriate sections of this report, was used to locate any conditions noted during the inspection. Although C.E.C. Stations did not always match with U.S.N. stationing, C.E.C. stations can be translated to U.S.N. stationing by back-tracking to the U.S.N. stations from which they were derived.

A dive team consisting of two divers and one tender/note-keeper performed the on-site inspection. Past experience has proven this arrangement to be efficient as well as safe. With one diver covering the area within 5'-15' of the mudline and the second diver covering the remaining portion of the wall, the inspection was advanced laterally along the bulkhead. Figure 6 shows both divers' inspection path. This approach was chosen for several reasons. First, both divers can progress in the same direction while remaining in close proximity and without interfering with each other. Although the second diver covers a larger area than the first, both divers progress at approximately the same rate. Visibility usually decreases with depth, therefore, with less visibility, the amount of area the first diver can cover, relative to the second diver, is less. Secondly, this procedure decreases the amount of up and down movement of both divers. This minimizes the need to continually equalize body pressures with surrounding hydrostatic pressures.

Starting at a known station, both divers proceeded along the bulkhead for a prearranged distance. Both divers made a mental note of general conditions and did not surface until they had covered this distance or unless specific notes or measurements needed to be relayed to the tender/note-keeper.
FROM: Y&D DRAWING ENTITLED "SHEET PILE BULKHEADS - PLAN"
P.W.D. DRG. NO. 747
Each facility was closely examined in areas where problems might exist. Close examination included removal of marine growth and coating, or corrosion by-products to bare metal in selected areas of the wall. Two common causes of problems are corrosion and failures due to overstressing of the structures. Based on classical corrosion curves, as shown in Figure 7, areas of maximum corrosion usually occur at or around mean low water (MLW), within 2' of the mudline, in the splash zone and in areas where a differential oxygen concentration cell is set up. This latter case can occur at the interface or boundary areas between concrete and steel. As a result, the steel just below the concrete is sacrificed to protect the steel under the concrete.

To document the corrosive activity, corrosion profiles were taken at selected stations along each berth. These baseline recordings were obtained using an ultrasonic thickness gauge with underwater probe and cable. Small areas of biofouling were removed to expose bare metal at various elevations throughout the height of the bulkhead. Photo #1 shows a typical area cleaned for ultrasonic thickness measurement. The number of readings per station and per facility was based on experience and from corrosion profiles obtained during the inspection.

Besides concentrating the inspection in areas where high corrosive activity exists, efforts were focused in areas where overstressing of anchored bulkheads and diaphragm cell structures can occur. These areas include the portion of the wall near the mudline on both types of structures and the Y-connections on the diaphragm cells. At the mudline, large overburden forces are exerted and at the Y-connections of diaphragm cells, overstressed conditions can usually be first noticed. Figure 8 shows most of the forces acting on sheet pile sections. Structural assessment calculations found in the Appendix show the stress at the Y-connection of a diaphragm cell and the
ZONE 1
ATMOSPHERIC
CORROSION

ZONE 2
SPLASH ZONE
ABOVE HIGH
TIDE

ZONE 3
TIDAL

ZONE 4
CONTINUOUS
SUBMERGED

ZONE 5
SUBSOIL

RELATIVE LOSS IN METAL THICKNESS
CORROSION PROFILE OF STEEL PILING - FIVE YEARS EXPOSURE IN SEAWATER


<table>
<thead>
<tr>
<th>GRAPHIC SCALE</th>
<th>N/A</th>
</tr>
</thead>
</table>

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NAVY STATION
NAPOLEON, FLORIDA

CORROSION PROFILE FOR STEEL PILING

FIG. 7
SOIL FRICTION SHEAR (PRIMARILY ON PILING BETWEEN CONNECTIONS AND ACTING IN EITHER DIRECTION DEPENDING ON PILE LOCATION IN CELL)

INTERLOCK FORCE

MOMENT DUE TO INTERLOCK ALIGNMENT

MAX. CELL BULGE AND INTERLOCK LOAD

SOIL PRESSURE IN HORIZONTAL PLANE

SOIL LINE

END BEARING IF DRIVEN TO ROCK OR HARD STRATUM

FORCES AND MOMENTS ACTING ON SHEET PILING SECTIONS

approximate location of maximum stress in an anchored steel sheet pile wall.

Photographic documentation was obtained of typical and irregular conditions when harbor water clarity permitted. Soundings were taken every 100' along each facility.

3.3 INSPECTION EQUIPMENT

Equipment used for inspection purposes included a Krautkramer D-meter ultrasonic steel thickness gauge with DMR probe and 75' of cable, a Nikonos III underwater camera with Oceanic 2001 strobe, dive lights, 100' sounding tape, 200' metal tape, 6' folding rule, chipping hammers and dive knives.

Choice of equipment was made as a result of past experience. Most equipment must be straightforward, easy to handle, carry and use and must prove reliable under hard use.

Ultrasonic thickness gauging is preferred over other techniques (such as drilling test holes) since it is non-destructive, easy to handle, fast and reasonably accurate.
SECTION 4

FACILITIES INSPECTED

Throughout the inspection of Naval Station Mayport, marine growth profiles were noted for each facility. In general, all experienced similar conditions regardless of their age. Marine growth consisted of hairlike algae protruding out a maximum of 2" away from the wall at the water surface and decreasing to 1" near the mudline. Worms with calcareous tubes appeared to be the most prevalent organisms and formed a dense coating over each structure. Photos #2 and #3 show the typical marine growth observed at Naval Station Mayport. Corrosion nodes and patches of orange oxidation were common but sporadically located. These areas were not specifically associated with advanced stages of corrosion. The nodes and patches were also more common within 5' of the base of the concrete encasement. In Photo #4 a typical example of a corrosion node is shown.

In the older structures, such as Carrier Berths C-1 and 2, deposits of hard black corrosion by-product were common behind the outer calcareous layer. In these cases gas pockets were formed next to the steel. Examples of this corrosion buildup and an orange oxidation patch is shown in Figure 9.

Other typical conditions include cosmetic spalling of the base of the concrete encasements and at the expansion joints. In some instances steel reinforcement is exposed.

In the remaining portion of this section, each facility inspected at Naval Station Mayport is referenced separately. A description of its construction, specific observed conditions, an assessment of these conditions and recommendations for repairs are included for each facility.

4-1
4.1 CARRIER BERTH C-1

4.1.1 Description

This bulkhead is located on the northern edge of the Naval Station turning basin (see Figure 4) and runs from C.E.C. Stations 17+17.5 to 24+62 (see Figure 10). At the time the inspection was performed, a carrier was alongside this facility.

The facility was constructed around 1951 and is a diaphragm cell wall. Y-connections between cells are mechanically fastened. A distance of 30.74'± separates each diaphragm. The front or exposed cell wall consists of PSA-28 steel sheet pile sections while the back and diaphragm wall consist of PSA-23 sheet pile sections. The front steel sheet pile sections were driven to elevation -52.75' and were designed for a dredge depth of elevation -37.0' at the base of the wall and to elevation -42', 11.25' offshore. A reinforced concrete cap and curbing runs the length of the facility. From just below the cap to elevation -4.0', the front cell walls are encased with reinforced concrete. The encasement consists of precast concrete panels of 4,000 psi concrete backfilled in-place with 3,000 psi concrete. The steel reinforcing is 20,000 psi (see Figure 11).

References: Bureau of Yards and Docks
"Mooring Facilities"
Y&D Drawing No. 499243, 499244

Bureau of Yards and Docks
"Sheet Pile Bulkheads Sta. 0+00 to Sta. 24+11.50 North Bulkhead"
P.W.D. Drawing No. 748

4.1.2 Observed Inspection Condition

Only one hole was found in the bulkhead, a 1" corrosion hole, located on the outside corner cell at CEC Sta. 23+70, elevation -5.5' (see Photos #5 and #6). Further west,
PLAN
Scale: 1" = 60'

ELEVATION
Scale: 1" = 60'

GRAPHIC SCALE IN FEET

CHEMPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

CHIPS Engineering Corporation

CARRIER BERTH C-1

FIG. 10
at the same elevation on this corner at CEC Sta. 23+97, there is a 3' x 3' steel plate attached with two mechanical fasteners (see Photos #7 and #8). It appears to be the repair for another hole. A substantial amount of fill in the cell has apparently emptied out of the hole as evidenced by a large area of settlement in the pavement on top of the cell.

The worst corrosion was seen within 10' of the base of the concrete encasement. Ultrasonic steel thickness measurements were taken at three (3) locations, indicating a range of metal loss from 21-37% (see Appendix). If there was any coating originally placed on the steel, what remains has been obscured by marine growth and corrosion by-products.

Soundings show a dredge depth of 17.0' to 31.5' below mean low water to exist along the bulkhead face.

No inspection was performed between CEC Sta. 20+35 to 21+50. A 2000 gallons per minute (gpm) fire pump intake was located on the bulkhead within this area. The Chief Engineering Officer aboard the carrier occupying this berth indicated:

- no grate existed on the intake
- the fire pump could not be shut down
- a 50' berth should be given on either side for safety.

4.1.3 Structural Condition Assessment

The purpose of this section is to present a qualitative description of the structural condition of the facility based on the inspection data.

In general, Carrier Berth C-1 is in fair condition. Soundings indicate mudline to be well within the design dredge limits. However, of all the berths inspected at
Naval Station Mayport, this facility exhibited the greatest amount of corrosion. Since this berth is the oldest facility inspected in this survey, the amount of corrosion observed is not unusual.

Ultrasonic thickness measurements indicate that maximum metal loss has occurred within ten (10) feet below the base of the concrete encasement. A corrosion hole and what appeared to be the repair for another hole were observed within this area. Both holes were located at the west corner of this facility. In addition, ultrasonic thickness measurements indicate the greatest metal loss has occurred at the westernmost portion of this bulkhead. Based on this information, this apparently accelerated corrosion area appears to have been caused by a localized condition. Further investigation indicated that just west of this facility, a discharge from a power plant exists. Effluent released from this discharge is reported to be fairly acidic and could cause this localized high corrosion activity. The fact that corrosion holes were not observed elsewhere supports this assumption.

Settlement of the pavement associated with loss of fill through this hole appears to be the most critical structural problem. Areas of maximum stress occur below the elevation of the hole (see Figure 8). In that area, 70% of the original steel thickness still remains.

4.1.4 Recommendations

The purpose of this section is to recommend actions which should be taken to correct existing problems discovered by the inspection.
The hole located at CEC Sta. 23+70 at el. -5.5' should be patched to stop the loss of fill behind the wall and the corresponding settlement of the pavement. There are several techniques which could be employed to patch this hole and stabilize the backfill. The most cost effective solution is to use a mechanically fastened steel plate similar to the existing patch observed at CEC Sta. 23+97 and shown in Photos #7 and #8. The cost to repair this hole is $470.00. See Appendix for the repair cost estimate. Also, due to the occurrence of this localized high corrosive activity, it is recommended that the steel thickness be measured annually so that preventative actions can be taken prior to the time when the metal loss becomes critical. Protecting the steel from corrosion is an immediate preventive recourse.

Lastly, to complete the overall assessment of this bulkhead, the portion between CEC Sta. 20+35 and 21+50 should be inspected to assess its general condition.
4.2 CARRIER BERTH C-2

4.2.1 Description

The bulkhead is located on the northern edge of the Naval Station turning basin (see Figure 4), and runs from CEC Stations 3+26 to 10+72 (see Figure 12). At the time the inspection was performed, this berth was not occupied.

The bulkhead was constructed around 1958 and like Carrier Berth C-1 is a diaphragm cell wall. A distance of 30.74'± separates each diaphragm. The front cell wall consists of PSA-28 steel sheet pile sections. The front steel sheet pile sections were driven to elevation -56.75' and were designed for a dredge depth of elevation -45.0' at a distance of 5' away from the base of the wall. A reinforced concrete cap and curbing runs the length of the facility. From just below the cap to elevation -4.0', the front cell walls are encased with reinforced concrete. The encasement consists of precast concrete panels of 4,000 psi concrete backfilled in-place with 3,000 psi concrete. The steel reinforcing is 20,000 psi (see Figure 13).

References: Bureau of Yards & Docks, Sixth Naval District U.S.N. Base, Charleston, S.C.
"Second Carrier Berthing Pier"
Y&D Drawings No. 832778, 832781, 832786

Bureau of Yards & Docks
"Sheet Pile Bulkheads Sta. 0+00 to Sta. 24+11.50 North Bulkhead"
P.W.D. Drawing No. 748

4.2.2 Observed Inspection Condition

In general, no major structural damage or deterioration was observed. Any coating originally placed on the steel has broken down and varying degrees of corrosion were observed. A concrete encasement protects the wall from the deck down to el. -4.0', and the worst corrosion (6" - 8" areas) was seen within 5' of the base of the encasement. There was sporadic occurrence of 1" - 6" deposits of hard black corrosion by-product and frequently, gas pockets

4-13
CROSS-SECTION

- **Concrete Cap**
  - EL. 12.67'

- **Concrete Skirt**

- **MLW EL. 0.0**

- **EL. -4.0**

- **Steel Sheet Piling**

---

**Graphic Scale**

**Not To Scale**

---

**Chesapeake Division**

**Naval Facilities Engineering Command**

**Naval Station**

**Diagnostic, Florida**

**Carrier Berth C-2**

**Fig. 13**
were found under the corrosion and coating. Unlike the other diaphragm cell walls, y-connections appeared to be welded instead of mechanically fastened.

Ultrasonic steel thickness measurements were taken at four (4) locations along the wall, indicating a range of metal loss from 0 - 39%, but averaging around a 12% loss (see Appendix). According to the readings, the worst corrosion occurred within 6' - 8' of the base of the encasement.

Soundings showed depths of 17' - 35' below mean low water at the bulkhead face.

4.2.3 Structural Condition Assessment

Based on the conditions observed at this facility, Carrier Berth C-2 is in fair to good condition. No mechanical damage was noted and only a moderate amount of corrosion has taken place. Ultrasonic thickness measurements indicate moderate corrosion areas are limited to within 6' - 8' below the concrete encasement. These areas are not located in the zone of maximum stress and at this time, the amount of steel remaining is sufficient to withstand the associated stresses. Soundings indicate dredge depths to be within design limits.

4.2.4 Recommendations

The purpose of this section is to recommend actions which should be taken to correct problems discovered by the inspection.

At this time, no repairs are recommended. However, protection of the steel from corrosion is recommended to prolong the life of the structure. Steel thickness measurements should be
taken in five years to document any further metal loss due to corrosion.
4.3 BULKHEAD EAST OF CARRIER BERTH C-2

4.3.1 Description

The bulkhead is located on the northeastern edge of the Naval Station turning basin (see Figure 4) and runs from C.E.C. Stations 0+00 to 3+26 (see Figure 14). It functions as part of the carrier berth and can be used for mooring small craft, barges and the like.

The bulkhead is an anchored steel sheet pile wall constructed of PZ-32 sections, with a reinforced concrete cap and curb. An inside steel wale is fastened to the wall at el. +4.0' at each inside flange and is anchored by a concrete deadman 50' away. Spacing of the tie rods is 10.5' o.c. A fender system consisting of closely spaced timber posts protects the wall from the concrete cap to approximately el. -2.5'.

4.3.2 Observed Inspection Condition

The following conditions were observed during our inspection of the bulkhead east of carrier berth C-2 (see Figure 15):

1) At CEC Sta. 2+07, the web of this pile is distorted (bulged out) from the mudline up 12';

2) At CEC Sta. 1+64, a hole, 8" wide x 4' high (top el. -5.0') was found in the web;

3) At CEC Sta. 1+62, a rip was observed at the web/flange intersection in the first Z section sheet pile just east of the corner pile (see Photo #9). It originated at el. -5.0' and continued to mudline (21' long). A maximum displacement of 64" was measured at the mudline. The side east of the rip was displaced outward with respect to the side west of the rip. Mounding of the sandy granular fill extended 10' away from the wall before the bottom became silty.
CEC STA 2+07

Bulge in Web of Sheet Pile

EL-2.5 Bottom of Timber Fender System

Hole in Web

Bulge in Web of Sheet Pile

Shallow Point in Mudline

CEC STA 1+64

CEC STA 1+6
OBSERVED STRUCTURAL DAMAGE

NOT TO SCALE
In addition to the structural damage mentioned above, soundings were taken every 10' along the wall and at 10' intervals (to a maximum of 40' away) away from the wall from CEC Sta. 2+40 to 0+80. The results can be found on Figure 16 and indicate shallow areas at CEC Stations 2+07 and 1+64 and a shallow ridge between 20-30' away from the wall running parallel to the wall.

Ultrasonic thickness measurements were taken at one (1) location along the wall (CEC Sta. 1+62), indicating a metal loss of 0-10% on the flanges and 12-50% on the webs.

Photos #10 and #11 show extent of damage to this bulkhead above the water surface.

4.3.3 Structural Condition Assessment

The purpose of this section is to generally assess the cause of the damage observed at the bulkhead east of Carrier Berth C-2, based on information noted in this inspection and contained in Gee and Jenson's report of November 16, 1979 entitled "Report on Bulkhead East of Berth C-2, Nava. Station, Mayport, Florida".

From this information, it appears that the damage observed at this bulkhead initially resulted from an outward movement of the toe of the wall. This movement caused by inadequate toe stability, formed a ridge of soil approximately 20'-30' away from the wall parallel to wall (see Figure 16). Once this happened, a rip in the wall at CEC Sta. 1+62 and the bulge at CEC Sta. 2+07 were formed, the fill behind the wall was lost, and the deadman failed resulting in the bulkhead leaning altogether. The order in which these events occurred is not known. The hole observed at CEC Sta. 1+64 apparently resulted from impact since ultrasonic thickness readings indicate only moderate corrosion to have occurred.
<table>
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<tr>
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<th>-23.0</th>
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<th>24.0</th>
<th>25.0</th>
<th>26.0</th>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3.4 Recommendations

No recommendations are made for this facility since repair efforts are already in progress.
4.4 WHARVES B-1, B-2 and B-3

4.4.1 Description

These three wharves form a continuous bulkhead which comprises the western edge of the Naval Station turning basin (see Figure 4). Starting with Wharf B-3 in the north and going south to Wharf B-1, the bulkhead runs from CEC Stations 31+36 to 51+20 (see Figures 17-19). It functions as a berthing area for small craft, destroyer tenders, as well as destroyer squadrons.

The bulkhead was constructed around 1968 and is a diaphragm cell wall. Y-connections between cells appear to be mechanically fastened. A distance of 30.74'± typically separates each diaphragm. The front cell wall consists of PSA-28 steel sheet pile sections with reinforced concrete cap and curbing. A reinforced concrete encasement runs from below the cap to elevation -3.8' on the front cell wall (see Figure 20). The front steel sheet pile sections were driven to elevation -56.75' and were designed for a dredge depth of -42.0', 10' away from the wall. The design live load is equal to 500 psf or HS 20-44 A.A.S.H.O. highway truck load. The concrete has a design compressive strength of 3,000 psi, except that the bulkhead encasement is 3,500 psi and 4,000 psi for precast concrete. Reinforcing steel is intermediate hard or rail steel grade.

References:

Bureau of Yards and Docks
"Sheet Pile Bulkheads Elevations - Sta. 24+11.50+ to Sta. 57+14.55+"
P.W.D. Drawing No. 749
PLAN
SCALE: 1" = 60'

ELEVATION
SCALE: 1" = 60'

GRAPHIC SCALE IN FEET

MLW EL. 0.0

CEC & USN STA 31+36

34+30
35+00
34+00
33+00
32+00
31+36

EL - 29.5
EL - 30.0
EL - 34.5
EL - 33.0

12.67

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

LAGOON, NA

CHLES Engineering
Corporation
301 Huron Ave.

WHARF B-3
FIG. 17
PLAN
Scale: 1" = 60'

ELEVATION
Scale: 1" = 60'

MLW EL 0.0

<table>
<thead>
<tr>
<th>44+45</th>
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</tr>
</tbody>
</table>

D-METER STA N/A
PLAN
Scale: 1" = 60'

ELEVATION
Scale: 1" = 60'

graphic scale in feet

Chesapeake Division
Naval Facilities Engineering Command

Wharf B-2
Fig. 18
PLAN

SCALE: 1" = 60'

ELEVATION

SCALE: 1" = 60'

GRAPHIC SCALE IN FEET

CHEMPEAKE DIVISION

NAVAL FACILITIES ENGINEERING COMMAND

WHARF B-1

FIG. 19
CROSS-SECTION

**Concrete Cap**
EL. 12.67'

**Concrete Skirt**

**MLW EL. 0.0**

**EL. -3.8**

**Steel Sheet Piling**

---

**Graphic Scale**

**Not To Scale**

---

Charrette 10347

4-30

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CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

WOOLSEY, SC

WATERFRONT DISTRICT

WHARVES BRAVO

FIG. 20
4.4.2 Observed Inspection Condition

Currents and eddies were strong (approximately 1 knot) at the north end of the bulkhead, with water flowing west from Carrier Berth C-1 and then south along B-3.

At CEC Station 31+60, there is a steel sheet pile column, separate from the bulkhead. There were corrosion nodes throughout its length, and area corrosion and pitting (1/2" x 1/16" deep) at elevation -2.0'. In the splash zone, coating was broken down and minor area corrosion was evident.

The coating throughout 95% of the bulkhead itself was intact and strongly adherent to the steel. Ultrasonic steel thickness measurements were taken at four (4) locations, indicating a range of metal loss from 0-4% (see Appendix).

The only structural damage observed occurred at CEC Station 36+70, at a Y-connection between two cells. The Y-connection had split away from the first sheet pile of the northern cell for the full observable distance between the concrete encasement and the mudline. The split was repaired apparently by the addition of steel channels and chemical grout. Although no further damage is evident, gaps were observed between the steel channels and the sheet pile sections (see Figure 21).

Soundings showed the dredge depth to range from el. -33.0' at CEC Sta. 32+00 to el. -10.0' at CEC Sta. 51+00 with a maximum of el. -33.5' at CEC Sta. 38+00.
CELL STA 36+70

Base of Concrete Encasement

EL 38'

Split at Interlock

CELL NO. 47

Y-Connection Pile

CELL NO. 48

Steel Channel Placed Over Split and Welded to Neighboring Piles, Chemical Grout Behind, Steel Plate Behind Split Interlock

Mudline

Y-Connection Pile

Chemical Grout

Steel Plate

Cell No. 47

Cell No. 48

PSA 28

At EL -10.0' Gap, No Weld Present (Gap is Not Present for Total Length)

Steel Channel Welded to Steel Sheet Pile

Split Y-Connection and Repair

Graphic Scale

Not To Scale

Chesapeake Division
Naval Facilities Engineering Command
Baltimore, MD

Wharf B-3

Fig. 21
4.4.3 Structural Condition Assessment

Bravo Wharves B-1 and 2 are in very good condition. No structural damage was observed in these two berths. On all three Bravo Wharves (B-1, 2 and 3), ultrasonic thickness measurements indicate only 4% of the original metal thickness has been lost to corrosion.

Soundings indicate the dredge depth on all these wharves to be within design limitations.

On Bravo Wharf B-3, an unusual condition was observed at CEC Sta. 36+70. Here the Y-connection at cell no. 47 is split away from the next northern cell. Two NAVFAC drawings numbered 5033542(-3) and entitled "Repair Pier Bravo" document our findings. According to the drawings, the failure occurred at the time of construction. Repairs were made by welding and jetting steel channels to and behind, respectively, the damaged connection. Additional repairs were performed at a later date (date unknown). These were accomplished by welding additional steel channels to the damaged connection and chemical grouting behind them.

At the time our inspection was performed, gaps were observed between the steel channels and the steel pile sections (see Figure 21). This condition indicates either some movement has occurred since repairs were made or, the actual repair was not performed in accordance with the drawings. However, no evidence of recent movement was observed, indicating that the repair is adequate to resist the associated stresses at this time.

No other unusual conditions were noted on Bravo Wharf B-3.
4.4.4 Recommendations

No repairs are recommended. However, the pavement surface above the repaired y-connection at CEC Station 36+70 should be annually inspected to determine if any further separation of the connection occurs. Subsidence of the pavement could indicate additional separation requiring an underwater inspection to be performed.

The condition of the coating on the steel at this time is sufficient to provide at least five more years of protection. Additional protection should be provided when the coating breaks down.
4.5 DESTROYER BERTHS D-1, D-2, D-3 AND D-4

4.5.1 Description

These four berths form a continuous bulkhead which comprises the southern boundary of the Naval Station turning basin (see Figure 4). Starting with the westernmost Berth D-1 and going southeast to Berth D-4, the bulkhead runs from CEC Stations 61+13 to 81+86.5 (see Figures 22-25). It functions as a berthing for ships up to destroyer-class in size.

The bulkhead was built around 1959 and is an anchored steel sheet pile wall. It is constructed of PZ-38 sections, with reinforced concrete cap and curbing. Tie rods, spaced 9' o.c. and steel wale, running on the inshore side of the wall, are located at elevation -2.5'. The sheet pile sections were driven to elevation -49.0' and designed for a dredge depth of elevation -30.0' at the base of each berth. The design surcharge for these berths is equal to 400 psf. A reinforced concrete encasement runs from below the cap to elevation -3.5' (see Figure 26). The concrete has a design compressive strength of 3,000 psi, except for the encasement which is 4,000 psi. Design stress for tie rods and wales is 20,000 psi and for sheet piles is 23,000 psi (20,000 + 15% allowable increase).

References: Bureau of Yards & Docks
"Destroyer Slips"
Y&D Drawings No. 833160 and 833164

Bureau of Yards and Docks
"Sheet Pile Bulkheads Elevations - Sta. 57+24.5' to Sta. 86+32.4' South Bulkhead and D.D. Slips"
P.W.D. Drawing 750
PLAN
Scale: 1" = 60'

ELEVATION
Scale: 1" = 60'

MLW EL 0.0

Cec USN Sta 67+33

D-Meter Sta 66+00 63+60

67+33 67+00 66+00 65+00 64+00 63

MLW EL 0.0

Mudline

EL - 27.5 EL - 26.0 EL - 30.0 EL - 31.0

Elevation

4-36
PLAN

Scale: 1" = 60'

ELEVATION

Scale: 1" = 60'

CHEL STA 61+13

63+60

55+00  64+00  63+00  62+00  61+13

EL +11.0

MLW EL 0.0

-30.0  EL -31.0  EL -25.5  EL -27.0  EL -24.5

GRAPHIC SCALE IN FEET

1" = 60'  10  50  100

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

DESTROYER Berth D-1  FIG. 22
PLAN
Scale: 1" = 60'

ELEVATION
Scale: 1" = 60'

D-METER STA
71+00 70+00

MLW EL 0.0

Mudline

EL -23.5 EL -22.5 EL -23.5 EL -25.0

EL +11.0

69+00
PLAN
SCALE: 1" = 60'

MLW EL 0.0
Mudline
EL -20.0
EL -25.0
EL -26.0
EL -27.0

ELEVATION
SCALE: 1" = 60'

Cec Sta 81+86.5
D-Meter Sta
79+80
4.5.2 Observed Inspection Condition

For the Destroyer Berths D-1, -2, -3 and -4, no major structural damage or deterioration was observed. The coating on the pile sections appears to be fairly intact throughout 80% of the bulkhead. However, there are sporadic occurrences of corrosion nodes and area corrosion (6"-8"Ø) throughout, with the heaviest concentration just under the concrete encasement. There is also sporadic occurrence of gas pockets between the steel and a black corrosion buildup on the surface. Pitting of the steel was common, with a maximum size of 1/2"Ø x 1/16" deep. Ultrasonic thickness measurements on steel sheet piling were taken at eight (8) locations, indicating a range of metal loss for the flange of 0-23% and for the web of 0-29% (see Appendix).

One structural anomaly was observed at D-1. At CEC Sta. 61+92, a 1/2" gap at a butt joint between two sheet piles was observed at elevation -4.0'. The tide was receding at the time and water was escaping through this gap. It appeared that the gap had been there since construction of the wall (see Figure 27).

Some deterioration of the base of the concrete encasement was seen between the north corner of Berth D-2 and CEC Sta. 70+00. The base of the encasement showed cosmetic spalling throughout its length. More severe spalling occurred at the expansion joints in this area, to the point that reinforcing steel and the steel sheet piling behind the encasement were exposed.

Soundings along the destroyer berths ranged from el. -22.6' to el.-31.0'.
CEC STA 61+92

PLAN

BASE OF CONCRETE ENCASEMENT

EL-3.5'

ELEVATION

INCOMPLETE BUTT JOINT

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

DESTROYER BERTH D-1

Fig. 27
4.5.3 **Structural Condition Assessment**

Destroyer Berths D-1, -2, -3 and -4 all appear to be in good condition. No major structural damage was observed in any of these four berths. Minor corrosion has occurred, but ultrasonic thickness measurements indicate a maximum of only 29% of the original metal has been lost. The greatest amount of metal loss was not located in the maximum stressed areas (see Appendix).

At CEC Sta. 61+92, an unusual condition was observed at elevation -4.0'. Here a 1/2" gap existed at a butt joint between two pile sections. No evidence of recent failure was noted. Apparently, this anomaly occurred during construction and resulted from the upper pile not being driven far enough down to meet the lower pile. A joint of this type is usually made with a full penetration weld covering the full length of the joint. However, any loss of fill behind the wall would be the most critical problem resulting from this condition. The joint is not in an area of maximum stress for this type of wall (see Structural Assessment Calculations in Appendix).

Dredge depths along the destroyer berths were within design limits.

4.5.4 **Recommendations**

It is recommended that the incomplete joint observed at CEC Sta. 61+92 (Destroyer Berth D-1) at el. -4.0' be repaired to prevent any further loss of fill and subsequent subsidence of the pavement. The cost to repair this gap with epoxy compound covering welded wire fabric is $470.00. See Appendix for the repair cost estimate computation.
In addition, the steel bulkhead should be protected from further corrosion. Steel thickness measurements should be taken in five years to document any further metal loss due to corrosion.
4.6 SMALL CRAFT BERTHING

4.6.1 Description

This 400' long section of bulkhead is located at the southeasternmost edge of the Naval Station turning basin (see Figure 4). Running east from the southern edge of Berth D-4, from CEC Stations 81+83 to 85+83.5, the bulkhead functions as a small craft berthing area (see Figure 28).

The bulkhead is an anchored steel sheet pile wall, with reinforced concrete cap and curbing. From CEC Stations 81+83 to 82+83±, there is a reinforced concrete encasement that runs from below the cap to elevation -3.5'.

This part of the wall was built around 1959 along with the destroyer berths. There is no encasement on the remainder of the bulkhead, which appears to have been built around 1961. The entire bulkhead is comprised of PZ-38 sections with an inside anchoring wale fastened to the wall with 1¾" bolts on each inner flange at elevation -2.5'.

The sheet pile sections were driven to elevation -49.0' and designed for a variable dredge depth not to exceed -30.0' at the base of the bulkhead (see Figure 29).

References: Bureau of Yards & Docks
"Sheet Pile Bulkhead and Revetments"
Y&D Drawings No. 912981 and 912983.

Bureau of Yards & Docks
"Sheet Pile Bulkheads Elevations -
Sta. 57+24.5± to Sta. 86+32.4± - South
Bulkhead and D.D. Slips"
P.W.D. Drawing No. 750

4.6.2 Observed Inspection Condition

The coating was intact throughout most of the bulkhead. In the splash zone section of the wall without a concrete encasement, the coating
exhibited some cracking and about 10% of the steel surface was exposed. The most severe corrosion, which was minor, was found at or just below mean low water if there was no encasement, or just below the concrete encasement, if it was present. Ultrasonic steel thickness measurements were taken at one (1) location, indicating a range of metal loss of 0-6% for the flange and 0-11% for the web (see Appendix). However, the wale to bulkhead fasteners, where visible, showed signs of moderate corrosion. Bolt nuts exhibited pitting, edges were rounded and the threads appeared smooth. Hexagonal nut heads measured 3" in diameter from face to face.

Depths along this bulkhead ranged from el. -26.0' at CEC Sta. 81+83 to el. -1.0' at CEC Sta. 85+83.5.

In this berthing area, the only structural damage observed occurred at CEC Sta. 82+65 at elevation -6.5'. Here a 6"Ø hole in the web was found with a piece of timber extruding from the hole. No subsidence in the pavement behind the hole was observed.

4.6.3 Structural Condition Assessment

Like most of the berthing areas inspected, the small craft berthing bulkhead appeared to be in good condition. Only small areas of the pile coating had broken down with just minor deterioration of the steel occurring (see ultrasonic thickness measurements in Appendix). An assessment of the wale fasteners, however, cannot be made. Visual observation indicates moderate corrosion has taken place, yet no documentation of original bolt head sizes was found to assess the degree.

In the area where the hole was noted, loss of fill is the most critical problem that could occur since its location is not in an area of maximum stress.
Depths along the face of this berth were measured to be less than its design depth.

4.6.4 Recommendations

The purpose of this section is to recommend actions which should be taken to correct problems discovered in the inspection.

To prevent the continual loss of fill and eventual subsidence of the pavement, the hole at CEC Sta. 82+65 at el. -6.5' should be patched. There are several techniques which could be employed to patch this hole and eliminate the loss of fill. The range in costs for the repairs is estimated between $450.00 and $500.00, depending on the repair technique employed.

A more detailed inspection of the wale fasteners is recommended. This inspection should document the degree of corrosion that has occurred so that the structural condition of these fasteners can be assessed.

Protect the steel bulkhead from further corrosion. Measure steel thickness in five years to document any additional metal loss.
<table>
<thead>
<tr>
<th>TITLE</th>
<th>PAGE</th>
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</thead>
<tbody>
<tr>
<td>Foot Notes</td>
<td>A-1</td>
</tr>
<tr>
<td>Repair Cost Estimates</td>
<td>A-2</td>
</tr>
<tr>
<td>Structural Analysis</td>
<td>A-3</td>
</tr>
<tr>
<td>Ultrasonic Thickness Measurements</td>
<td>A-7</td>
</tr>
</tbody>
</table>
FOOTNOTES


2. MASTER PLAN, NAVAL STATION, MAYPORT, FLORIDA, pp. 6.

3. MASTER PLAN, NAVAL STATION, MAYPORT, FLORIDA, pp. 6.

REPAIR COST ESTIMATE

CARRIER BERTH C-1

1) Patch hole in wall by mechanically fastening steel plate over hole.
   Material Cost = $50 (113 sq. in. hole)
   Diver clean hole, place plate and fasten @ 2 holes/day
   Diver, Tender and Gear $840/day
   Total Cost/hole repair = (\frac{840}{2} + 50) = $470/hole*

DESTROYER BERTH D-1

1) Patch hole in wall with epoxy compound and welded wire fabric.
   Material Cost = $50 (15 sq. in. hole)
   Diver clean hole, install mesh and place epoxy @ 2 holes/day
   Diver, Tender and Gear $840/day
   Total Cost/hole = (\frac{840}{2} + 50) = $470/hole*

SMALL CRAFT BERTHING

1) Patch hole in wall by mechanically fastening steel plate over hole.
   Material Cost = $30 (28 sq.in. hole)
   Diver clean hole, place patch and fasten
   Diver, Tender and Gear $840/day @ 2 holes/day
   Total Cost/hole repaired = (\frac{840}{2} + 30) = $450/hole*

2) Patch hole with epoxy covering weld wire fabric
   Material Cost = $75 (28 sq.in. hole)
   Diver clean hole, install resin and place epoxy at 2 holes/day
   Diver, Tender and Gear $840/day
   Total Cost/hole repaired = (\frac{840}{2} + 75) = $495/hole*
   *These costs are based on repairing 2 holes of similar size per day.
NAVSTA MAYPORT

Facility: Diaphragm Cell Bulkhead

600 psf

Assume

1. Surcharge = 600 psf
2. \( \gamma_d = 120 \text{pcf} \)
3. \( \gamma_s = 70 \text{pcf} \)
4. \( K_a = 0.38 \)
5. No Bollard Forces

Point of Maximum Stress occurs at \( \frac{1}{4} \) to \( \frac{1}{3} \) above Mudline

Soil Pressure @ \( E_L = -25' \) \( P = 1440 \text{ psf} \)

Lateral Unit Soil Pressure

Forces on a 120° Wye for Diaphragm Cells

Theoretically the 120° Wye Connection has approximately equal loads on all three legs.
Wye connection on Diaphragm Cell

Dimensions taken from Naval Draw: 1778275

Interlock force: \( T_a = \frac{1}{2} P \times f \) (1% linearly)

\[ \frac{1}{2} P \times 1440 \text{ psf} \times 30.74 \text{ ft} \]

\( T_a = 3.69 \text{ kips} \)

Force on Wye connection: \( T'_a = T_a + \text{soil pressure on Wye connection} \)

\[ C^2 = a^2 + b^2 - 2ab \cos C, \quad B_1 = \frac{a^2 + c^2 - 2ac \cos B_1}{2} \]

\[ C = 14.32^\circ, \quad B_1 = 33.5^\circ \]

**Breaking into Components and Summing Forces**

\[ P_x = P \cos 56.5^\circ \]

\[ P_y = P \cos 56.5^\circ = \left( \frac{1}{2} \times 14.32 \times 1440 \right) \cos 56.5^\circ = 0.95 \text{ in} \]

\[ T_a = T_a + 2P_y = 3.69 + 2(0.95) = 5.59 \text{ in}^2 \]

**Force on Wye Connection**: 5.59 in² > 3.69 in² Interlock Force

*To as calculated may not represent the actual maximum stress on a 170 Wye connection. Stresses may be higher due to bending and realignment of forces due to bulging of the cell.*
Assume:
1. Surcharge = 600 psf
2. \( y_d = 120 \) psf
3. \( y_s = 70 \) psf
4. \( k_a = 3 \)
5. Neglect Passive Earth Pressures

![Diagram of NAVSTA MAYPORT Facility: Anchored Bulkhead]

**Soil Pressure**
- Per ft²
- \( 600 \times 0.3 = 180 \) lbs
- \( 120 \times 0.3 \times 11.0 \times 180 = 576 \) lbs
- \( 70 \times 0.3 \times 35.0 \times 576 = 1311 \) lbs

**Anchor Pull**
- \( 180 \times 11 \times \left( \frac{1}{12} \times 35 \right) = 80190 \)
- \( 396 \times \left( \frac{1}{12} \times 35 \right) = 84216 \)
- \( 576 \times \left( \frac{1}{3} \times 35 \right) = 352800 \)
- \( 735 \times \left( \frac{2}{3} \times 35 \right) = 150063 \)

**Total Anchor Pull**
- \( 667269 + 32.5 = 20531 \) lbs

**Max Moment Occurs at Point of Zero Shear**

\[ 20531 \times 6384 \times 6285 \times \frac{7142}{2} = 0 \]

\[ y = \frac{17.4}{2} \text{ or } E_d = -19.9 \]
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: C-1  LEVEL OF INSPECTION: 1
STATION: 18+50 (cec)

ORIGINAL THICKNESS: 5.00"

READINGS IN INCHES

Base of Concrete Encasement - 4.0'

ELEVATION  |  THICKNESS
-4.0'      |  0.355
-6.0'      |  0.395
-8.0'      |  0.335

MUDLINE

FORM 200-1  A-7

CHILD ENGINEERING CORPORATION
Box 333
MEDFIELD, MA 02052
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: C-1
LEVEL OF INSPECTION: 1
STATION: 20+35 (C6C)

READINGS IN INCHES

ORIGINAL THICKNESS: .500"

Base of Concrete
Encasement -4.0'

ELEVATION   |   THICKNESS
-------------|-----------
-4.0'       | .345      
-6.0'       | .320      
-8.0'       | .360      

MUDLINE
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY C-1  LEVEL OF INSPECTION 1

STATION 22+80 (LEC)

READINGS IN INCHES

ORIGINAL THICKNESS: 0.500"

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4.0'</td>
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</tr>
<tr>
<td>-6.0'</td>
<td>Too pitted</td>
</tr>
<tr>
<td>-8.0'</td>
<td>Too pitted</td>
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<tr>
<td>-13.0'</td>
<td>Too pitted</td>
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<tr>
<td>-18.0'</td>
<td>0.315</td>
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<td>-23.0'</td>
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<tr>
<td>MUDLINE</td>
<td>0.350</td>
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</table>
**ULTRASONIC STEEL THICKNESS MEASUREMENTS**

**FACILITY**: C-2  
**LEVEL OF INSPECTION**: 1  
**STATION**: 9+50(LEC)  
**READINGS IN INCHES**

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<tbody>
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<td>-6.0'</td>
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<td>.470</td>
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<td>.485</td>
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<tr>
<td>MUDLINE</td>
<td>.465</td>
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</table>

**ORIGINAL THICKNESS**: .500"
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: C-2
LEVEL OF INSPECTION: 1
STATION: 8+30 (CEC)

READINGS IN INCHES

ORIGINAL THICKNESS: .500"

ELEVATION  
-4.0'  
-6.0'  
-8.0'  
-13.0'  

THICKNESS  
.490  
.460  

MUDLINE
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY C-2

LEVEL OF INSPECTION 1

STATION 7+00 (sec)

READINGS IN INCHES

ORIGINAL THICKNESS: 6.00"

Base of Corr Trench - 4.0'

ELEVATION

-4.0' •  .475

-6.0' •  .430

-8.0' •  .435

-13.0' •  .445

-18.0' •  .470

-23.0' •  .470

MUDLINE 29.0' •  ORIGINAL THICKNESS
**ULTRASONIC STEEL THICKNESS MEASUREMENTS**

**FACILITY:** C-2  
**LEVEL OF INSPECTION:** 1  
**STATION:** 4+30 (CEC)  
**READINGS IN INCHES**

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4.0'</td>
<td>.480</td>
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<tr>
<td>-6.0'</td>
<td>.485</td>
</tr>
<tr>
<td>-9.0'</td>
<td>Original Thickness</td>
</tr>
</tbody>
</table>

**ORIGINAL THICKNESS:** 5/16"
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: CARRIED BERTH C-7
LEVEL OF INSPECTION 1

STATION 1462 (CEC)

READINGS IN INCHES

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
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<tbody>
<tr>
<td>-1.1'</td>
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<tr>
<td>-3.1'</td>
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<tr>
<td>-5.1'</td>
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<tr>
<td>-7.1'</td>
<td>1.450</td>
</tr>
<tr>
<td>-9.1'</td>
<td>1.710</td>
</tr>
</tbody>
</table>

ORIGINAL THICKNESS: 1.500"
WEB = 1.275"
FLANGE = 1.500"

ORIGINAL THICKNESS: 0.325" (CEC)
ORIGINAL THICKNESS: 0.320"

Accessories: 3/16" (Galv.)
### Ultrasonic Steel Thickness Measurements

**Facility:** B-1  
**Level of Inspection:** 1  
**Station:** 44+95 (C.E.)

**Readings in inches**

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.8'</td>
<td>.500</td>
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<tr>
<td>-5.8'</td>
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<tr>
<td>-7.8'</td>
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<tr>
<td>-12.8'</td>
<td>.490</td>
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<tr>
<td>-17.8'</td>
<td>.490</td>
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<tr>
<td>-22.8'</td>
<td>.490</td>
</tr>
<tr>
<td>-27.8'</td>
<td>.490</td>
</tr>
<tr>
<td>-32.8'</td>
<td>.490</td>
</tr>
</tbody>
</table>

**Original Thickness:**

- -3.8' = .500 in.
- -5.8' = .490 in.
- -7.8' = .490 in.
- -12.8' = .490 in.
- -17.8' = .490 in.
- -22.8' = .490 in.
- -27.8' = .490 in.
- -32.8' = .490 in.

**Baseline:** Concrete Encasement - 3.8'
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY B-3

LEVEL OF INSPECTION 1

STATION 32+30 (EFC)

READINGS IN INCHES

ORIGINAL THICKNESS: 5/00

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.8'</td>
<td>0.480</td>
</tr>
<tr>
<td>-5.8'</td>
<td>0.490</td>
</tr>
<tr>
<td>-7.8'</td>
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<tr>
<td>-12.8'</td>
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<tr>
<td>-17.8'</td>
<td>0.485</td>
</tr>
<tr>
<td>-22.8'</td>
<td>0.485</td>
</tr>
<tr>
<td>-27.8'</td>
<td>0.485</td>
</tr>
</tbody>
</table>

BASE OF CONCRETE ENCASMENT -3.8'

MUDLINE -33.8'

ORIGINAL THICKNESS
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY   B-3
STATION   34+80 (c.c.)
LEVEL OF INSPECTION   1

ORIGINAL THICKNESS: 0.500"

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
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</thead>
<tbody>
<tr>
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<td>-17.8'</td>
<td>0.495</td>
</tr>
<tr>
<td>-22.8'</td>
<td>0.495</td>
</tr>
</tbody>
</table>

ORIGINAL THICKNESS: 0.500"

Mudline
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: B-3  LEVEL OF INSPECTION: 1
STATION: 36+85 (cec)

READINGS IN INCHES

ORIGINAL THICKNESS: .500"

ELEVATION  THICKNESS

-3.8'  ORIGINAL THICKNESS

-5.8'  ORIGINAL THICKNESS

-7.8'  ORIGINAL THICKNESS

-12.8'  ORIGINAL THICKNESS

-17.8'  ORIGINAL THICKNESS

-22.8'  .495

MUDLINE: -28.8'  .490
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: D-1
STATION: 60+00 (LEC)

ORIGINAL THICKNESS:
- Flange = 0.500"
- Web = 0.375"

Base of Concrete Embankment = 3.5'

ELEVATION

-3.5'  |  WEB  |  THICKNESS
-5.5'  |  FLANGE  |  ORIGINAL THICKNESS 0.390
-7.5'  |  |  Too Pitted
-12.5' |  |  Too Pitted
-17.5' |  |  Too Pitted
-22.5' |  |  Too Pitted
-27.5' |  |  ORIGINAL THICKNESS 0.335

MUDLINE

4.70  |  Ti-Ti

DATE: 7-25-80
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: D-1

STATION: 63+60 (LEC)

LEVEL OF INSPECTION: 1

ORIGINAL THICKNESS:
- Flange: .500"
- Web: .375"

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Web</th>
<th>Flange</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.5'</td>
<td>.415</td>
<td>.270</td>
</tr>
<tr>
<td>-5.5'</td>
<td>.490</td>
<td>.300</td>
</tr>
<tr>
<td>-7.5'</td>
<td>.475</td>
<td>.270</td>
</tr>
</tbody>
</table>

Base of Concrete Encasement: -3.5'

MUDLINE
### Ultrasonic Steel Thickness Measurements

**Facility Area of D-2**

**Station** 71+00 (CEC)

**Readings in Inches**

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.5'</td>
<td>0.475</td>
</tr>
<tr>
<td>-5.5'</td>
<td>0.375</td>
</tr>
<tr>
<td>-7.5'</td>
<td>0.460</td>
</tr>
<tr>
<td>-12.5'</td>
<td>0.435</td>
</tr>
<tr>
<td>-17.5'</td>
<td>0.315</td>
</tr>
<tr>
<td>-25.5'</td>
<td>0.315</td>
</tr>
</tbody>
</table>

*Original Thickness: Flange = 0.500", Web = 0.375"*

**Base of Concrete**

**Elevation:** -3.5'

**Thickness:** 0.475"

**Original Thickness:** 0.335"

**Too Pitted:** 0.315"
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: AREA OF D-2

STATION: 7000 (CEE)

LEVEL OF INSPECTION:

READINGS IN INCHES

ORIGINAL THICKNESS:

Flange = 0.500"
Web = 0.375"

Base of Concrete
Engagement -3.5'
Elevation

THICKNESS

-3.5'
-5.5'
-7.5'

WEB

FLANGE

MUDLINE

Original thickness too pitted
Original thickness
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: AREA OF: D-2

STATION: 67+40 (CEC)

LEVEL OF INSPECTION: 1

READINGS IN INCHES

ORIGINAL THICKNESS:
  flange = .500"
  web = .375"

MUDLINE

ELEVATION THICKNESS

- 3.5'  •  •
- 5.5'  •  •
- 7.5'  •  •

To o Pitted, Thickness

ORIGINAL THICKNESS: .365

TOO PITTTE, .305
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: D-3

STATION: 7300 (C.E.)

LEVEL OF INSPECTION: 1

ORIGINAL THICKNESS:
- Flange = 0.500"
- Web = 0.375"

READINGS IN INCHES

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>WEB</th>
<th>FLANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.5'</td>
<td>A60</td>
<td>N/A</td>
</tr>
<tr>
<td>-5.5'</td>
<td>A25</td>
<td>0.00</td>
</tr>
<tr>
<td>-7.5'</td>
<td>A95</td>
<td>0.00</td>
</tr>
<tr>
<td>-12.5'</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td>-17.5'</td>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>

MUDLINE: 2.45
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY D-3

STATION 76-20

LEVEL OF INSPECTION 1

READINGS IN INCHES

ORIGINAL THICKNESS:
flange = .500 in
web = .375 in

ELEVATION   THICKNESS

-3.5'       2.95
-5.5'       2.95
-7.5'       2.95

MUDLINE

Elevation of concrete Encasement -3.5'
## Ultrasonic Steel Thickness Measurements

**Facility:** D-4  
**Level of Inspection:** 1  
**Station:** 79+80  

**Original Thickness:**
- Flange: 1.500 in
- Web: 0.375 in

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.5'</td>
<td>N/A</td>
</tr>
<tr>
<td>-5.5'</td>
<td>3.50</td>
</tr>
<tr>
<td>-7.5'</td>
<td>2.80</td>
</tr>
</tbody>
</table>

Original Thickness: 405  

**Mudline:**
- Baseline of concrete encasement: 3.5'

Note: N/A - Too Pitted
ULTRASONIC STEEL THICKNESS MEASUREMENTS

FACILITY: SOUTH BULKHEAD  LEVEL OF INSPECTION: 1
STATION: 22+96 (CEC)  READINGS IN INCHES

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>THICKNESS</th>
<th>PITED</th>
<th>ORIGINAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0'</td>
<td>0.500&quot;</td>
<td></td>
<td>0.500&quot;</td>
</tr>
<tr>
<td>-2.0'</td>
<td>0.375&quot;</td>
<td></td>
<td>0.375&quot;</td>
</tr>
<tr>
<td>-4.0'</td>
<td>0.375&quot;</td>
<td></td>
<td>0.375&quot;</td>
</tr>
<tr>
<td>-6.0'</td>
<td>0.375&quot;</td>
<td></td>
<td>0.375&quot;</td>
</tr>
<tr>
<td>-11.0'</td>
<td></td>
<td></td>
<td>0.365</td>
</tr>
<tr>
<td>-14.0'</td>
<td></td>
<td></td>
<td>0.340</td>
</tr>
<tr>
<td>-21.0'</td>
<td></td>
<td></td>
<td>0.335</td>
</tr>
</tbody>
</table>

MUDLINE -26.0'  PITED: 0.495  ORIGINAL: 0.495
END
DATE
FILMED
6-86