11460
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06 MAR 97

From: Commander, Naval Facilities Engineering Command, NAVFAC Criteria Office (Code 15C)
To: Distribution

Subj: INTERIM TECHNICAL GUIDANCE (ITG) - CVN DREDGE DEPTH CRITERIA

Ref: (a) COMNAVSEASYSCOM ltr 11460 Ser 03D3/242 dtd 3 Jan 95
(b) OPNAVINST 11010.20E, Part 5

Encl: (1) CVN Dredge Depths - Interim Technical Guidance with attachments

1. Purpose: The purpose of this guidance is to define dredge depth criteria for Nimitz Class Aircraft Carriers. This criteria establishes consistency in application to waterway dredging projects and will be incorporated into existing military criteria noted in paragraph 4.

2. Background: In San Diego, California, the Navy relied on a more quantitative approach to determine the required dredge depths for several Military Construction Projects relating to CVN homeporting. This method saved the Navy over $20 million when compared to the Design Manual 26.1 method. This document is a summary of the method.

Reference (a) delineated the water depth requirements for Nimitz Class Aircraft Carriers transiting to and moored at homeports, ports of call, and shipyards. It specified the minimum water depth required while the ship is in the waterway; however, it did not specify dredge depth requirements. The minimum water depth required to operate carriers in inner channels and turning basins on the way to and at piers at home ports is between 49 and 50 feet depending on harbor salinity. These numbers are similar for ports of call. Due to the reduced displacement when visiting shipyards, the minimum water depth required to operate carriers in inner channels and turning basins on the way to and at piers at shipyards is between 46 and 47 feet depending on harbor salinity.

Applying these requirements to determine dredge depths requires additional port specific information.

a. Reference (a) states that “the dredging project depth can be traded off with tides to obtain the necessary water depth in inner channels and turning basins with the corresponding operational conditions.” Therefore, planners should consider channel accessibility and operational restrictions imposed when selecting a design water level above the extreme low water.

b. Reference (a) states further that, "shallower and/or narrow channels and/or higher speeds will require greater allowance for squat." Since narrow channel widths and greater speeds result in greater ship sinkage during transit (squat), and thus deeper water, planners should also include these effects.

c. Reference (a) also states that "port specific fouling clearance studies can be performed if requested and funded" to possibly reduce the 6.0 foot fouling clearance criteria. The clearance criteria was derived from condenser fouling studies on stationary ships berthed at NAVSTA Norfolk, VA in 1980. Locations that exhibit more or less potential for fouling may require more or less clearance to prevent it.

d. Lastly, reference (a) states that "ship motions analyses of the remaining home ports and shipyards will be completed...after receipt of funding." The motion analyses that NAVFAC prepared for Mayport and San Diego predicted days of access and generated nomographs for other locations. For channels subjected to significant waves, engineers and planners must evaluate these wave effects on ship motions.

Therefore, as noted in reference (a), facility engineers and planners should determine dredge depth requirements by including the additional considerations of design water level, channel width and ship speed impacts, dynamic effects of sea chest intake fouling, and wave effects. Additionally, they should include effects from sedimentation and dredging tolerances.

Reference (b) designates responsibilities of the Chief of Naval Operations, Lead Activities, Shore Activities having assigned water areas, Public Works Centers and Public Works Lead Activities, Naval Facilities Engineering Command and Engineering Field Divisions, and Major Claimants regarding dredging coordination.

3. Criteria: The cognizant activity should determine the dredge depth requirements as noted in reference (b). Base these requirements on reference (a) including the effects of design water level, channel width, ship speed, sea chest fouling, significant wave heights, sedimentation, and dredging tolerances according to enclosure (1).

4. Action:

a. Lead Activities and Shore Activities having assigned water areas – determine dredge depth requirements for Nimitz class aircraft carriers according to enclosure (1).

b. NAVFAC Headquarters, Engineering Field Divisions (EFDs) and Engineering Field Activities (EFAs).

(1) Provide technical advice and assistance to lead activities and shore activities having assigned water areas.

(2) Plan, design, and construct channels in compliance with the guidance stated herein.

c. NAVFAC Criteria Office

(1) Revise the following criteria to incorporate the guidance stated herein:

Design Manual 26.1, "Harbors"
NAVFAC P-80, "Facility Planning Criteria for Navy and Marine Corps Shore Installations"

(2) Provide technical advice and assistance to lead activities, shore activities having assigned water areas, EFDs and EFAs.

5. Coordination: This ITG has been coordinated with CNO, COMNAVFACENGCOM, COMNAVSHORLANT, COMNAVAIRLANT, CINCPACFLT, COMNAVAIRPAC, and COMNAVSEASYSCOM. See distribution below for specific codes.

6. Points of Contact: For clarification or additional information related to this subject, please contact the NAVFAC Criteria Office, Code 15C. The NAVFAC Criteria Office point of contact is Mr. David Curfman, P.E., DSN 262-4203/757-322-4203, Fax 757-322-4416, Internet *curfman@efdlant.navfac.navy.mil*.

R. D. CURFMAN
By direction

Distribution:
CNO N44/N43
CNO N88
COMNAVFACENGCOM Codes 00CE/15/30

06 MAR 97

Subj: INTERIM TECHNICAL GUIDANCE (ITG) - CVN DREDGE DEPTH CRITERIA

LANTNAVFACENGCOM Codes 20/405
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**CVN DREDGE DEPTHS**
**INTERIM TECHNICAL GUIDANCE**
4 March 1997

1. This guidance explains the determination of minimum dredge depth requirements for U.S. Navy nuclear-powered aircraft carriers (Nimitz or CVN 68 Class). The requirements presented herein provide consistency and reliability in the determination of acceptable dredge depths for channels and berths used by active Nimitz class aircraft carriers. The NAVFAC Criteria Office will address reserve status condition of CVNs when required. Deviation from this minimum criteria requires a waiver from the NAVFAC Criteria Office which will be coordinated with cognizant Major Claimants, Naval Sea Systems Command, and Chief of Naval Operations.

2. Ideally, engineers and planners should base ship channel designs on physical model testing, risk analysis, and ship simulator analysis. However, time and funding constraints may prevent this process. In any event, the requesting activity should determine the required dredge depths for Military Construction Projects. Dredge depth requirements for Nimitz class aircraft carriers depend on the type of waterway to be dredged. Four categories exist based on the magnitude of wave-induced and speed-induced ship movement:

a. Outer channels – entrance channels or waterways subject to significant wave action, that is, wave energy resulting in vertical ship motions greater than 0.5 feet under design conditions.

b. Inner channels – interior protected channels or waterways subject to minimal wave action, that is, wave energy resulting in vertical ship motions less than 0.5 feet under design conditions.

c. Berths – water areas where ship velocity approaches zero, such as anchorages, slips, and pier and wharf berths that are subject to minimal wave action under design conditions; generally includes turning basins except as noted below.

d. Special berths – defined as berths subject to significant wave action under design conditions.

3. The following definitions apply:

a. Datum – the horizontal plane from which the dredge depth requirement is referred, normally the local tidal datum of Mean Lower Low Water (MLLW).

b. Design depth – the distance below the datum that must be maintained for safe navigation and berthing, also called the advertised, nominal, or project depth.
This depth usually appears on Navigational Charts.

c. Contract depth – the distance below the datum that is initially dredged by the contract and includes advanced maintenance dredging requirements but not the dredging tolerance (allowable overdepth). Also called the required depth, it is the depth noted on the DD-1391 Project Documentation and indicates the minimum depth required under the dredging contract.

d. Permitted depth – the distance below datum to the lowest depth authorized by the regulatory agencies and normally includes the dredging tolerance (allowable overdepth). Planners and engineers should use this depth to determine estimated dredging quantities.

4. Determine required dredge depths using sound engineering practice. The design depth is determined by summing the following parameters:

a. Minimum water depth requirement – the minimum water depth that must be available for safe operation. For existing locations, use COMNAVSEASYSCOM ltr 11460 Ser 03D3/242 dtd 3 Jan 95 (Attachment (a)) implemented as follows for design water level, squat, ship motions, and underkeel clearances. For locations not addressed in Attachment (a), contact the NAVFAC Criteria Office for assistance.

b. Design water level – the distance above the datum from which the dredge depth is calculated:

(1) Outer channels – use 0 feet. The design water level should equal the datum to provide enough water depth and ensure that the ship can transit when required.

(2) Inner channels and turning basins – use a water level that ensures safe passage to the berth or basin. This water level should be selected by the Activity based on optimizing cost and operation. Ship operators generally accept some minor operational restrictions and transit shallow channels at mid to high tide levels. Therefore, the design water level should be selected so that the carrier can transit from deep water to the berth, or vice versa, as frequently as expected without encroaching on the minimum water depth requirement noted in Attachment (a). The user should identify for the planner the expected ship transit speed and desired days of accessibility, realizing that slow transits at low tide levels result in excessive dredge depths.

An example of this procedure is as follows:

(a) Determine level of accessibility; e.g. minimum of 339 days per year of access to homeports and 300 days per year of access to shipyards and ports of call. These accessibility levels equate to operational restrictions of approximately 2 consecutive days per month of encroachment on the underkeel clearance for homeports and 5 consecutive days per month for shipyards and ports of call, respectively.

(b) Based on local traffic and regulations, assume an average ship speed through channel; e.g. 5 knots.

(c) Using assumed transit speed and navigational charts, calculate the time required to accomplish the transit from the outer channel to the turning basin or berth.

(d) Using the calculated transit time, days of accessibility, and the charts in attachment (a), determine the channel depth requirement.

(e) Subtract the water depth requirement from the channel depth requirement to obtain the design water level. This number will usually be negative and thus result in a design water level above MLLW.

(3) All berths, except turning basins – use 0 feet. Since 6 feet of clearance is provided, as noted later, the design water level may equal the datum (MLLW).

c. Squat – the downward displacement of a vessel while underway. Attachment (a) incorporates squat for infinitely wide channels with ship speeds equal to or less than 10 knots. Ship squat greatly increases when CVNs transit channels less than 600 feet in width or move at speeds faster than 10 knots. To determine squat for conditions other than those addressed in Attachment (a), use the method contained in NAVFAC Design Manual (DM) 26.1, “Harbors” dated July 1981. All channels normally used by aircraft carriers in the U.S., except the Southern Branch, Lower Reach, of the Elizabeth River, Norfolk, VA (450 feet at narrowest point) and the Entrance Channel, Mayport, FL (500 feet at narrowest point), are wide enough to be considered infinitely wide. For these narrow channels, the squat increases by 2 feet. The water depth requirement determined above should be modified to incorporate any difference in calculated squat.

(1) Outer channels – assume ship speed of 15 knots.

(2) Inner channels – base on local traffic and regulations, as a minimum assume an average ship speed through channel of 10 knots and include the effects of narrow channels as noted above.

(3) Berths and special cases – assume ship speed of zero.

d. Ship motion – vertical excursion of vessel from waves. Attachment (a) addresses ship motions only for San Diego and Mayport. For other locations, use nomographs in Attachment (b). $H_S$ is defined as the significant wave height. Each set of nomographs reflects the direction of the significant wave relative to the direction of the CVN in transit; i.e., Following Seas are collinear with and in the same direction of ship movement, Quartering Seas are those that approach the aft quarter of the ship at 45 degrees, Beam Seas impact broadside to the ship, Bow Seas are those that approach the forward quarter of the ship at 45 degrees, and Head Seas are collinear with but opposite to the ship movement. The wave height and period should be transformed to and through the channel entrance using local wave data or Army Corps of Engineers reports entitled, "Wave Information Studies of U.S. Coastlines" (Studies 1-30).

(1) Outer channels **--** use $H_s$ for periods greater than 10 seconds with a 6 days/month recurrence interval unless directed differently by the Activity. Exclude hurricane waves.

An example of this procedure is as follows:

(a) Determine the wave climatology. Using available data determine the significant wave height, direction, and period. Transform waves into harbor based on shoaling, refraction, and diffraction, etc.

(b) Based on local traffic and regulations, assume an average ship speed through channel; e.g. 14 knots.

(c) Using the calculated wave climatology, assumed ship speed, and the charts in Attachment B, determine the predicted vertical ship motion for all applicable directions.

(2) Inner channels and berths – use $H_S = 0$.

(3) Special cases – use $H_S$ for periods greater than 10 seconds with a 25 yr. recurrence interval, unless directed differently by the Activity. Include hurricane waves if the berth is expected to be occupied during that extreme event.

e. Clearance – distance from the lowest point on the vessel to the design depth. For berths, turning basins, and inner channels, Attachment (a) incorporates a 6 foot clearance to prevent ingestion of benthic biota. This clearance when combined with installed discharge diffusers reduces the possibility of condenser fouling. Additional studies may reduce the requirement and can be performed if funded. The designer must collect all historical data available regarding fouling of condensers to ascertain the extent of the problem. The NAVFAC Criteria Office is available to assist in analyzing this data. Notwithstanding, at berths the designer must ensure that a minimum of 2 feet of clearance is provided at Extreme Low Water. See table below for other categories:



**<u>RECOMMENDED CLEARANCES</u>**

| LOCATION CATEGORY | SOFT BOTTOM | HARD BOTTOM |
|---|---|---|
| 1. Outer channel | 3.0 feet for 50 feet depth<br>4.4 feet for 54 feet depth<br>5.5 feet for > 58 feet depth | 4.0 feet for < 52 feet depth<br>5.5 feet for > 58 feet depth |
| 2. Special berths | 6 feet (min.) coupled with discharge diffusers | 6 feet (min.) coupled with discharge diffusers |

5. Determine the contract depth by adding the advanced maintenance dredging requirement to the design depth requirement. The advanced maintenance dredging is the additional depth to reduce life-cycle maintenance costs by decreasing the frequency of dredging. Base the quantity on the anticipated local channel sedimentation rates corresponding to the anticipated dredging cycle. Unless an economic analysis is performed, use a dredging frequency of not less than 3 years, but based on local conditions. Include a minimum of 1 foot advanced maintenance dredging to prevent contractor change orders for differing site conditions on future maintenance dredging contracts. This minimum also provides the Contracting Officer field flexibility if the contractor does not achieve the contract depth in spot locations. The dredging tolerance, or overdredge, is the additional depth below the contract depth paid for by the dredging contract. The contract permits this additional depth because of inaccuracies in the dredging process. It is normally either +1 or +2 feet. Local conditions and anticipated dredging equipment may warrant a different value. NAVFAC Textbook DM 38.2, “Dredging Equipment” provides additional information.

6. Determine the permitted depth by adding the dredging tolerance, or overdredge, to the contract depth. Material samples for environmental testing should be accomplished at least to this depth.

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
2631 JEFFERSON DAVIS HIGHWAY
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IN REPLY REFER TO
11460
Ser 03D3/242
3 Jan 95

From: Commander, Naval Sea Systems Command
To: Chief of Naval Operations (W44) Chief of Naval Operations (WB8)

Subj: CVN 68 CLASS WATER DEPTH REQUIREMENTS

Ref: (a) NAVSEA ltr 11460 Ser PMS312/792 of 30 Apr 91
(b) NAVSEA ltr 11460 Ser 03D3/144 of 9 Aug 94
(c) COMNAVAIRLANT ltr 4700 Ser N431F/01400 of 19 May 94

Encl: (1) CNV 68 C1ass Home Port Water Depth Requirements
(2) CVN 68 Class Shipyard Water Depth Requirements
(3) CVN 68 Class Shallow Water Navigation Improvements

1. NAVSEA has determined the water depth requirements for CVN 68 Class aircraft carriers in home ports, ports of call, and shipyards. The pier and channel depths requirements previously provided in reference (a) are superseded. These water depth requirements augment those previously provided for San Diego in reference (b), and respond to the reference (c) request for Norfolk Naval Shipyard.

2. Enclosure (1) provides water depth requirements for home ports. Attachment (1) of enclosure (1) also applies to ports of call. The ship’s mean draft used for home ports corresponds to the limiting displacement and is considered the proper basis for dredging since it will permit operations of a fully loaded ship. Enclosure (2) provides water depth requirements for shipyards. The ship’s mean draft used for shipyards was reduced based on the assumption that only 55% of the sbip's loads (aircraft, fuel, personnel, stores, etc) would be onboard. Each enclosure describes and quantifies the components that contribute to the CVN 68 Class draft and clearance; the governing depth requirements for the pier, turning basin, inner channel, and outer channel for each home port and shipyard; general tide information for each home port and shipyard; and a graphical representation of the relationship between the number of days of access to the turning basin and inner channel, the length of the tide window, and the dredging project depth for the governing depth requirement of each home port and shipyard.

3. While at the pier, in the turning basin, or in the inner channel of a home port or a port of call, it is recommended that there be a minimum of 50 feet of water depth. While at the pier, in the turning basin, or in the inner channel of a shipyard, it is recommended that there be a minimum of 47 feet of water depth, assuming the ship has been offloaded. Entering a shipyard without offloading should be treated as a port of call. These water depth requirements are governed by the sea chest fouling

Attachment (a)

Subj: CVN 68 CLASS WATER DEPTH REQUIREMENTS

clearance criterion established as a result of sea chest fouling problems at Norfolk. Port specific fouling clearance studies can be performed it requested and funded. Note that this criterion also provides clearance for divers (5 feet) while at the pier. The dredging project depth can be traded off with tides to obtain the necessary water depth in inner channels and turning basins with the corresponding operational restrictions; however, tide tradeoffs cannot be used at piers. Localized pier dredging in way of sea chests can save 2 feet of dredging costs outside of the sea cheat area; however, operational restrictions may result (e.g. less transit time in tide window and limited diver access). In ports with large amounts of debris on the bottom, locally dredged areas will tend to collect debris requiring more frequent maintenance dredging.

4. In the outer channel, wave action usually dominates the depth requirements and can have a large variance. A ship motions analysis was performed for the outer channels of San Diego and Mayport to account for the statistical nature of the tides and wave action. The ship motions analyses of the remaining home ports and shipyards will be completed within 6 months after receipt of funding. Dredging to support unrestricted access is clearly unaffordable. Consequent1y, the selection of a project depth is a tradeoff between cost, operational requirements, and the risk of grounding.

5. Many of the factors that affect channel transit are operational issues such as operating schedule and contingencies; port operations; ship displacement, trim, list, and speed; as well as weather and tides. Actual transit situations will vary and will involve different combinations of these factors. Consequently, a given transit could require more or less water depth. Enclosure (3) describes efforts underway or proposed to improve onboard shallow water navigation aids that predict ship’s motion, provide real time channel condition measurement, improve ship's draft and attitude indication, and provide a load management system.

6, The NAVSEA point of contact is W. Page Glennie, NAVSEA 03D37, (703) 4I8-8876.

M. S. FIREBAUGH
Deputy Commander for Engineering

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Subj CVN 68 CLASS WATER DEPTH REQUIREMENTS

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**CVN 68 CLASS HOME PORT WATER DEPTH REQUIREMENTS**

Attachments:

(1) CVN 68 Class Home Port and Ports of Call Draft and Clearance Requirements
(2) CVN 68 Class Water Depth Requirements for Norfolk Operating Base
(3) Sewell's Point Tide Access, 50 foot Depth Requirement
(4) CVN 68 Class Water Depth Requirements for San Diego
(5) San Diego Inner Channel Tide Access, 50 foot Depth Requirement
(6) CVN 68 Class Water Depth Requirements for Everett
(7) Everett Tide Access, 50 foot Depth Requirement
(8) CVN 68 Class Water Depth Requirements for Bremerton
(9) Rich Passage Tide Access, 50 foot Depth Requirement
(10) CVN 68 Class Water Depth Requirements for Mayport
(11) Mayport Tide Inner Channel Access, 50 foot Depth Requirement



Enclosure (1)

**CVN 68 Class Home Port and Ports of Call Draft and Clearance Requirements**

| | | | | | |
|---|---|---|---|---|---|
| STATIC DRAFT | | | | | |
| Mean | 40.8 ft<br><br>103,800 tons (CVN 68-75)<br>104,200 tons (CVN 76) | | | | – Accounts for:<br>Actual operating condition (+2000 tons)<br>Service life weight growth (+70 tons/year)<br>Unreported weight<br>Assumes weight is added in best location.<br>Assumes good ship weight control. |
| Trim | 0.25 degrees | Bow<br>Sea Chest<br>Rudder | 2.3 ft<br>0.8 ft<br>2.1 ft | | – Based on operational experience. Instances of greater trim do occur, but rarely when the ship is at or near the limiting displacement. |
| List | Pier | 2 degrees | Bilge Keel<br>Sea Chest | 2.3 ft<br>1.4 ft | – Based on operational experience. Instances of greater list do occur, but rarely when the ship is at the limiting displacement. |
| | Channel | 0 degrees | | | – Assumed ship is leveled prior to transit.<br>TYCOM confirmation needed |
| Appendages | 9 inches | | | | – All of the CVN 68 Class except CVN 70 have discharge sea chest diffusers.<br>– Assumed to be overshadowed by trim. |
| Salinity & Temperature | 0.5 feet<br>(50% salinity reduction & $10^{o}$ temperature rise) | | | | – This calculation is port, season, and tide specific.<br>– Assumed constant. |
| **Dynamic Draft** | | | | | |
| Wind & Waves | Outer Channel | | See Note | | – This calculation is port specific.<br>– See indiv. port summary sheet for details. |
| | Inner Channel | | 0 ft | | – Protected harbor. |
| | Pier & Turning Basin | | | | |
| Squat | 10 kts | Forward | 0.9 ft | | – Based on wide channel that is 50 ft deep.<br>– Shallower and/or narrower channels a/o higher speeds will require a greater allowance for squat |
| | | Aft | 1.3 ft | | |
| | | Sea Chest | 1.0 ft | | |
| Heel | 1.4 degrees | Bilge Keel | 1.6 ft | | – Based on operational experience, 10 kts and 10 degrees rudder. |
| | | Sea Chest | 0.8 ft | | |
| **Clearance** | | | | | |
| Fouling | 6 ft | | | | – Based on operational experience at NOB and NAVFAC study and applies to soft bottoms and bottoms with loose sea growth.<br>– Assumes diffusers are installed. |
| Grounding | Soft Bottom | | 2 ft | | – NAVFAC deterministic standard. |
| | Hard Bottom | | 3 ft | | |
| | | | | | – Proposed probabilistic standard. |



Enclosure (1) Attachment (1)

**CVN 68 Class Water Depth Requirements for Norfolk Operating Base**

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 40.8 | 40.8 | 40.8 | 40.8 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | 0.5 |
| Motions (b) | - | - | - | (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 49.5 | 49.5 | 49.9 | (f) |

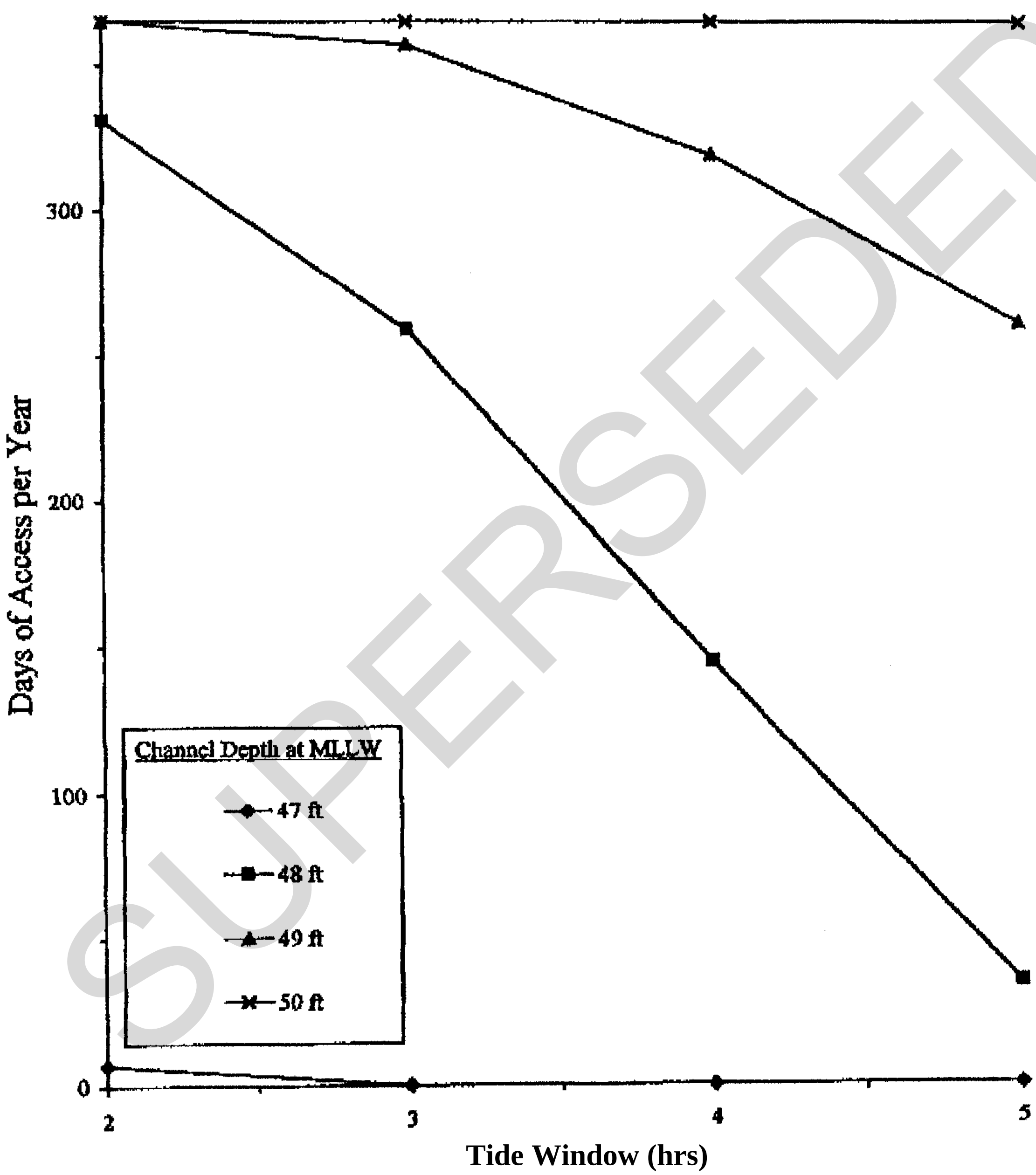
Notes:
(a) Harbor contains fresh water inlet.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; good estimate.
(d) Operational experience.
(e) Standard clearances.
(f) Analysis not complete.

**NOB Tide Data**

| | |
|---|---|
| Mean Higher High Water | 2.8 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -3.5 feet |

Enclosure (1)
Attachment (2)

**Sewell's Point Tide Access**
**50 Foot Depth Requirement**




Enclosure (1)
Attachment (3)

## CVN 68 Class Water Depth Requirements for San Diego

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 40.8 | 40.8 | 40.8 | 40.8 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | - | - | - | - |
| Motions (b) | - | - | - | 4.2/27.7 (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 49.0 | 49.0 | 49.4 | 50.4/73.9 (g) |

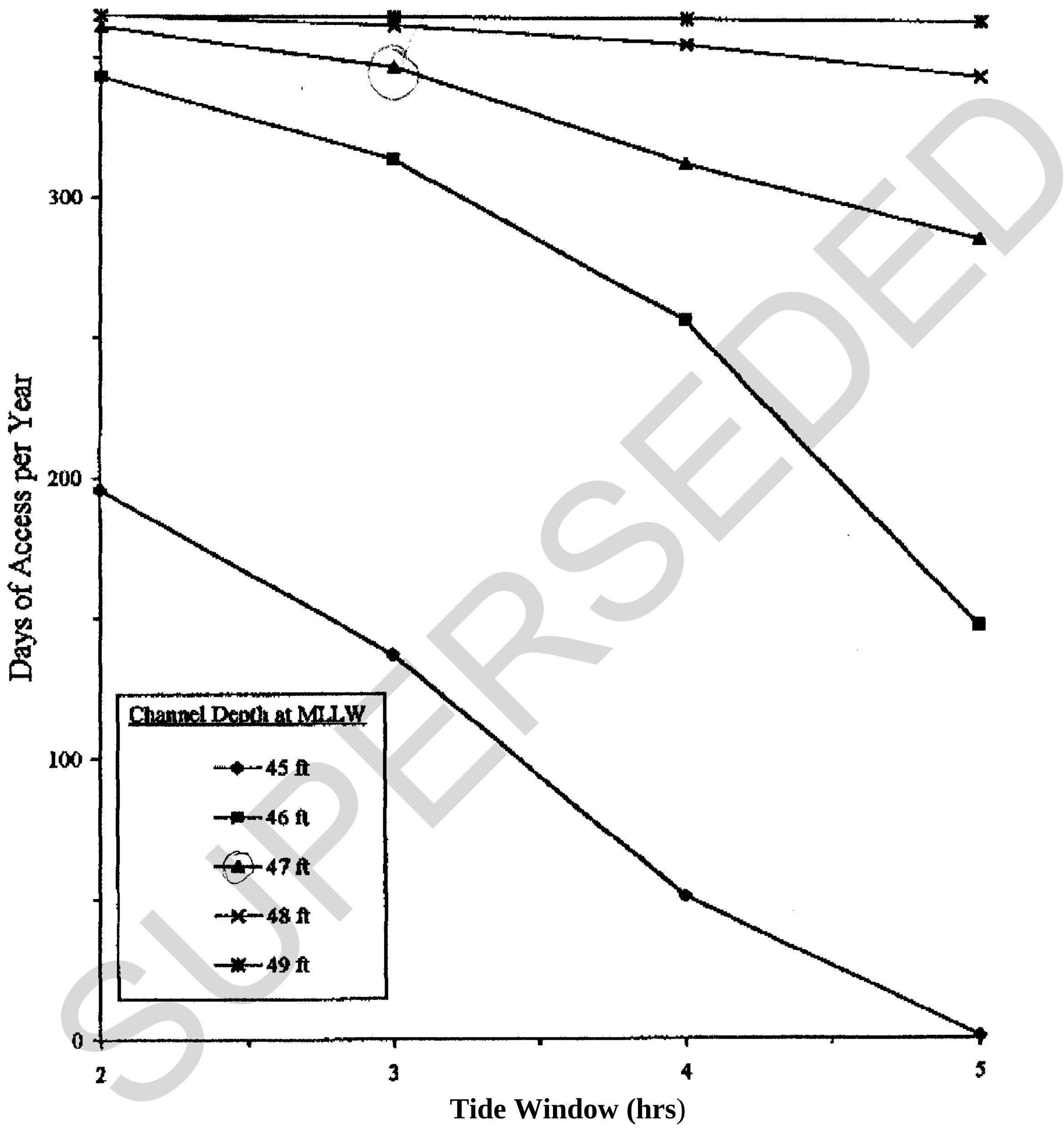
Notes: (a) Sa1t water port; no correction required.
(b) Unprotected harbor; significant wave action.
(e) Based on wide, 50 ft deep channel; good estimate.
(d) Operational experience.
(c) Standard clearances.
(f) Weighted average and extreme values.
(g) A water depth of 74 feet provides unrestricted access.

## San Diego Tide Data

| | |
|---|---|
| Mean Higher High Water | 5.8 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -2.0 feet |

Enclosure (1)
Attachment (4)

**San Diego Inner Channel Tide Access**
**50 Foot Depth Requirement**




Enclosure (1)
Attachment (5)

## CVN 68 Class Water Depth Requirements for Everett

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 40.8 | 40.8 | 40.8 | (f) |
| Trim | 0.8 | 0.8 | 0.8 | |
| List | 1.4 | 1.4 | | |
| Appendages | | | | |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | |
| Motions (b) | | | | |
| Squat (c) | | | 1.0 | |
| Heel (d) | | | 0.8 | |
| Clearance (e) | 6.0 | 6.0 | 6.0 | |
| **TOTAL** | 49.5 | 49.5 | 49.9 | |

Notes:
(a) Harbor contains fresh water inlet.
(b) Protected harbor; no significant wave action,
(C) Based on wide, 50 ft deep channel; need more information.
(d) Operational experience.
(e) Standard clearances,
(f) Unrestricted outer channel due to deep depth.

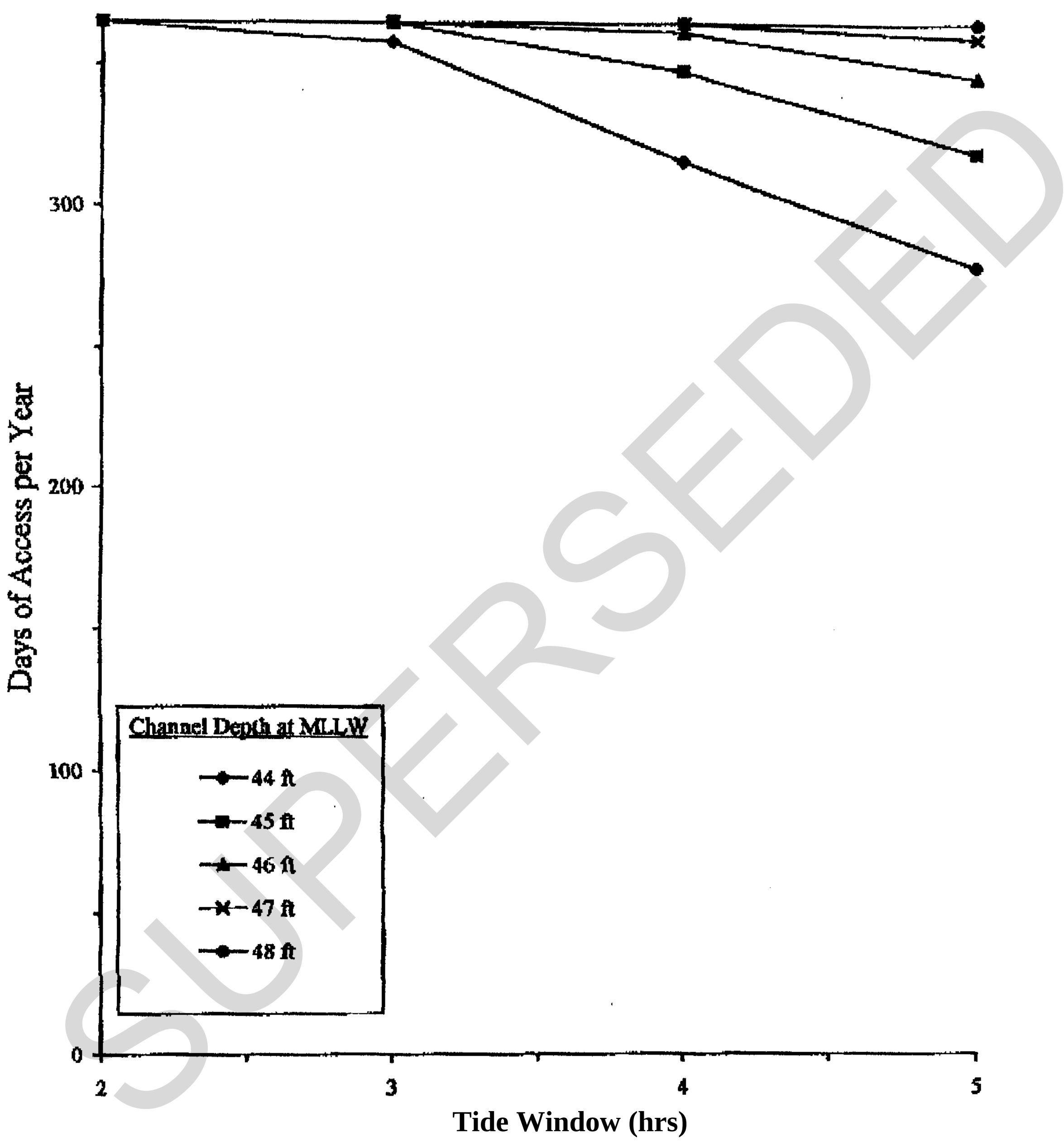


## Everett Tide Data

| | |
|---|---|
| Mean Higher High Water | 11.1 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -4.5 feet |

Enclosure (1)
Attachment (6)

**Everett Tide Access**
**50 Foot Depth Requirement**




Enclosure (1)
Attachment (7)

## CVN 68 Class Water Depth Requirements for Bremerton

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 40.8 | 40.8 | 40.8 | (f) |
| Trim | 0.8 | 0.8 | 0.8 | |
| List | 1.4 | 1.4 | - | |
| Appendages | - | - | - | |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | |
| Motions (b) | - | - | - | |
| Squat (c) | - | - | 1.0 | |
| Heel (d) | - | - | 0.8 | |
| Clearance (e) | 6.0 | 6.0 | 6.0 | |
| **TOTAL** | 49.5 | 49.5 | 49.9 | |

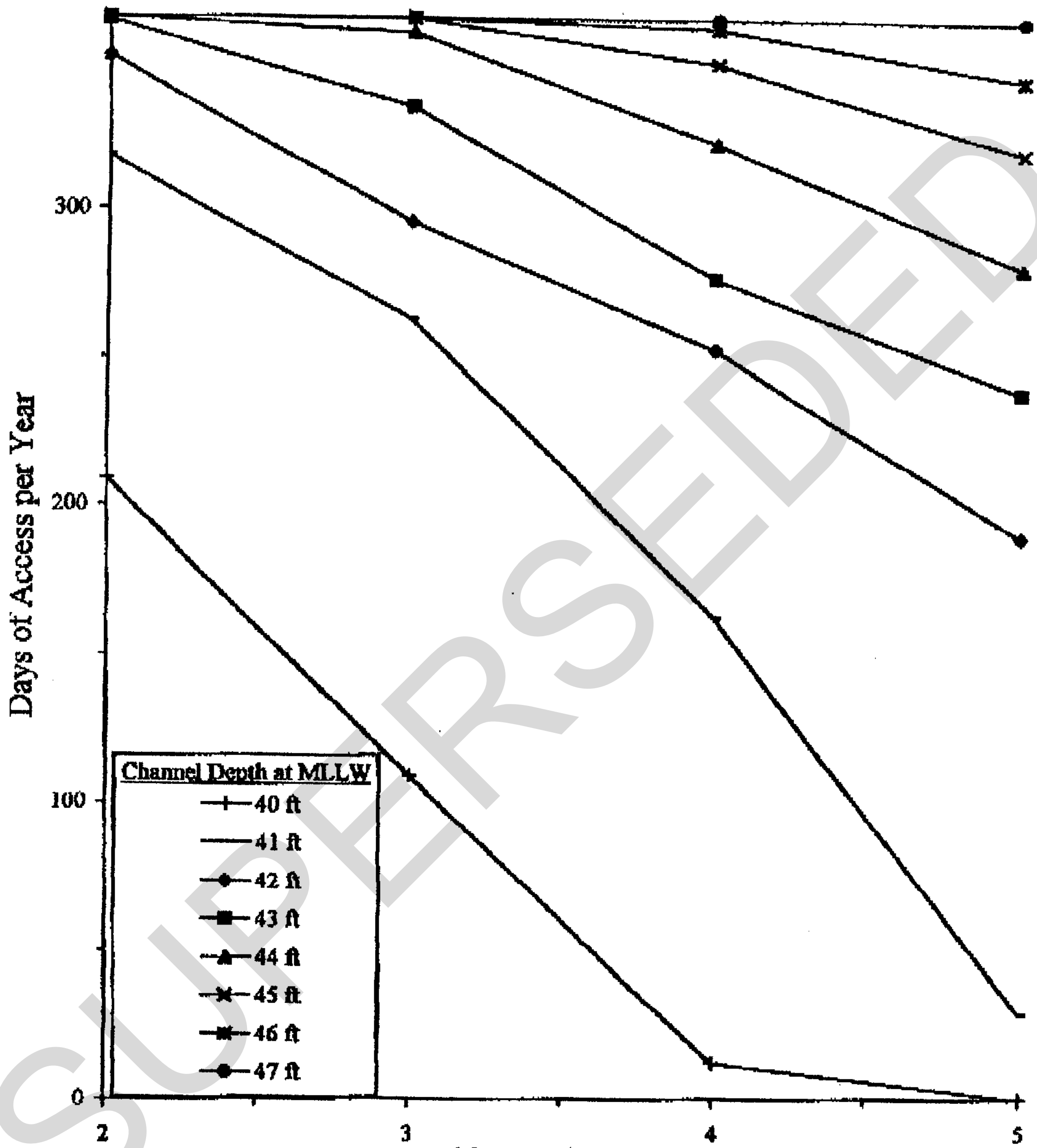
Notes:
(a) Harbor contains fresh water inlet.
(b) Protected harbor; no significant wave action.
(c) Based on wide, 50 ft deep channel; need more information.
(d) Operational experience.
(e) Standard clearances.
(f) Unrestricted outer channel due to deep depth.

## Bremerton Tide Data

| | |
|---|---|
| Mean Higher High Water | 11.7 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -4.7 feet |

Enclosure (1)
Attachment (8)

**Rich Passage Tide Access**
**50 Foot Depth Requirement**




**Tide Window (hrs)**



Enclosure (1)
Attachment (9)

## CVN 68 Class Water Depth Requirements for Mayport

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 40.8 | 40.8 | 40.8 | 40.8 |
| Trim | 0.8 | 0.8 | 0.8 | 0.8/2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | 0.5 |
| Motions (b) | - | - | - | 0.5/14.3 (f) |
| Squat (c) | - | - | 1.0 | 1.0/1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 6.0/2.0 |
| **TOTAL** | 49.5 | 49.5 | 49.9 | 49.6/61.0 (g) |

Notes.
(a) Harbor contains fresh water inlet.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; need more information.
(d) Operational experience.
(e) Standard clearances.
f) Weighted average value at sea chest and extreme value at rudder.
(g) A water depth of 61 feet provides unrestricted access.
The minimum water depth (50 feet) is governed by fouling.

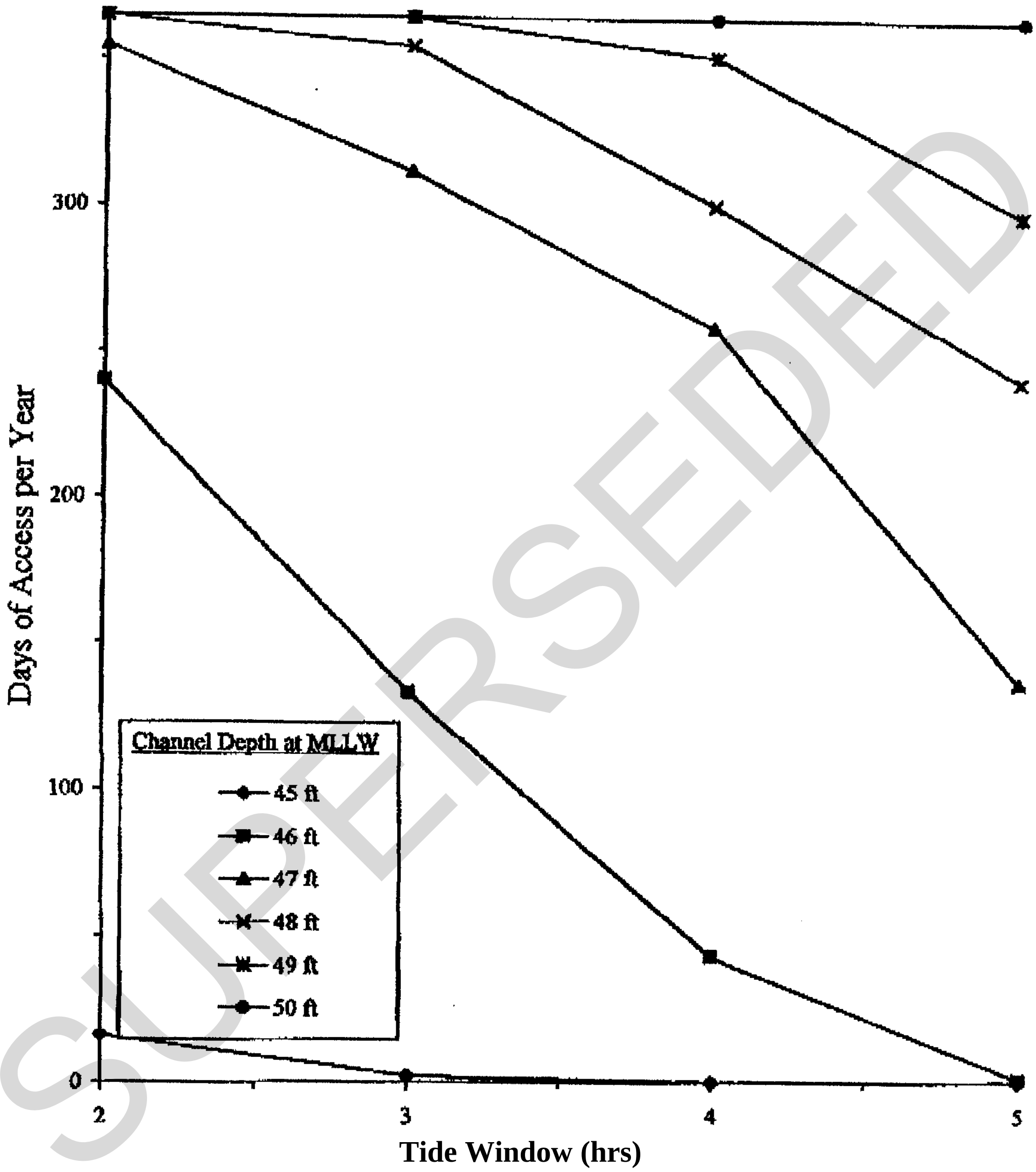


## Mayport Tide Data

| | |
|---|---|
| Mean Higher High Water | 5.4 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -3.0 feet |

Enclosure (1)
Attachment (10)

**Mayport Inner Channel Tide Access**
**50 Foot Depth Requirement**






Enclosure (1)
Attachment (11)

**CVN 68 CLASS SHIPYARD WATER DEPTH REQUIREMENTS**

Attachments:

(1) CVN 68 Class Shipyard Draft and Clearance Requirements
(2) CVN 68 Class Water Depth Requirements for Norfolk Naval Shipyard
(3) Elizabeth River Tide Access, 47 foot Depth Requirement
(4) CVN 68 Class Water Depth Requirements for Newport News Shipbuilding
(5) Sewell's Point Tide Access, 47 foot Depth Requirement
(6) CVN 68 Class Water Depth Requirements for Puget Sound Naval Shipyard
(7) Rich Passage Tide Access, 47 foot Depth Requirement
(8) CVN 68 Class Water Depth Requirements for Pearl Harbor Naval Shipyard
(9) Pearl Harbor Inner Channel Tide Access, 47 foot Depth Requirement
(10) CVN 68 Class Water Depth Requirements for Long Beach Naval Shipyard
(11) Terminal Island Tide Access, 47 foot Depth Requirement



Enclosure (2)

# CVN 68 Class Shipyard Draft and Clearance Requirements

| | | | | | |
|---|---|---|---|---|---|
| STATIC DRAFT | | | | | |
| Mean | 37.9 ft<br><br>94,800 tons (CVN 68-75)<br>95,200 tons (CVN 76) | | | | – Accounts for:<br>Actual operating condition (+2000 tons)<br>Service life weight growth (+70 tons/year)<br>Unreported weight<br>Variable loads at 55% full load capacity.<br>Assumes weight is added in best location.<br>Assumes good ship weight control. |
| Trim | 0.25 degrees | Bow<br>Sea Chest<br>Rudder | 2.3 ft<br>0.8 ft<br>2.1 ft | | – Based on operational experience. Instances of greater trim do occur, but rarely when the ship is at or near the limiting displacement. |
| List | Pier | 2 degrees | Bilge Keel<br>Sea Chest | 2.3 ft<br>1.4 ft | – Based on operational experience. Instances of greater list do occur, but rarely when the ship is at the limiting displacement. |
| | Channel | 0 degrees | | | – Assumed ship is leveled prior to transit.<br>TYCOM confirmation needed |
| Appendages | 9 inches | | | | – All of the CVN 68 Class except CVN 70 have discharge sea chest diffusers.<br>– Assumed to be overshadowed by trim. |
| Salinity & Temperature | 0.5 feet<br>(50% salinity reduction & $10^{o}$ temperature rise) | | | | – This calculation is port, season, and tide specific.<br>– Assumed constant. |
| **Dynamic Draft** | | | | | |
| Wind & Waves | Outer Channel | | See Note | | – This calculation is port specific.<br>– See indiv. port summary sheet for details. |
| | Inner Channel | | 0 ft | | – Protected harbor. |
| | Pier & Turning Basin | | | | |
| Squat | 10 kts | Forward | 0.9 ft | | – Based on wide channel that is 50 ft deep.<br>– Shallower and/or narrower channels a/o higher speeds will require a greater allowance for squat |
| | | Aft | 1.3 ft | | |
| | | Sea Chest | 1.0 ft | | |
| Heel | 1.4 degrees | Bilge Keel | 1.6 ft | | – Based on operational experience, 10 kts and 10 degrees rudder. |
| | | Sea Chest | 0.8 ft | | |
| **Clearance** | | | | | |
| Fouling | 6 ft | | | | – Based on operational experience at NOB and NAVFAC study and applies to soft bottoms and bottoms with loose sea growth.<br>– Assumes diffusers are installed. |
| Grounding | Soft Bottom | | 2 ft | | – NAVFAC deterministic standard. |
| | Hard Bottom | | 3 ft | | |
| | 1/100 | | | | – Proposed probabilistic standard. |

Enclosure (2) Attachment (1)

## CVN 68 Class Water Depth Requirements for Norfolk Naval Shipyard

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 37.9 | 37.9 | 37.9 | 37.9 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | 0.5 |
| Motions (b) | - | - | - | (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 46.6 | 46.6 | 47.0 | (f) |

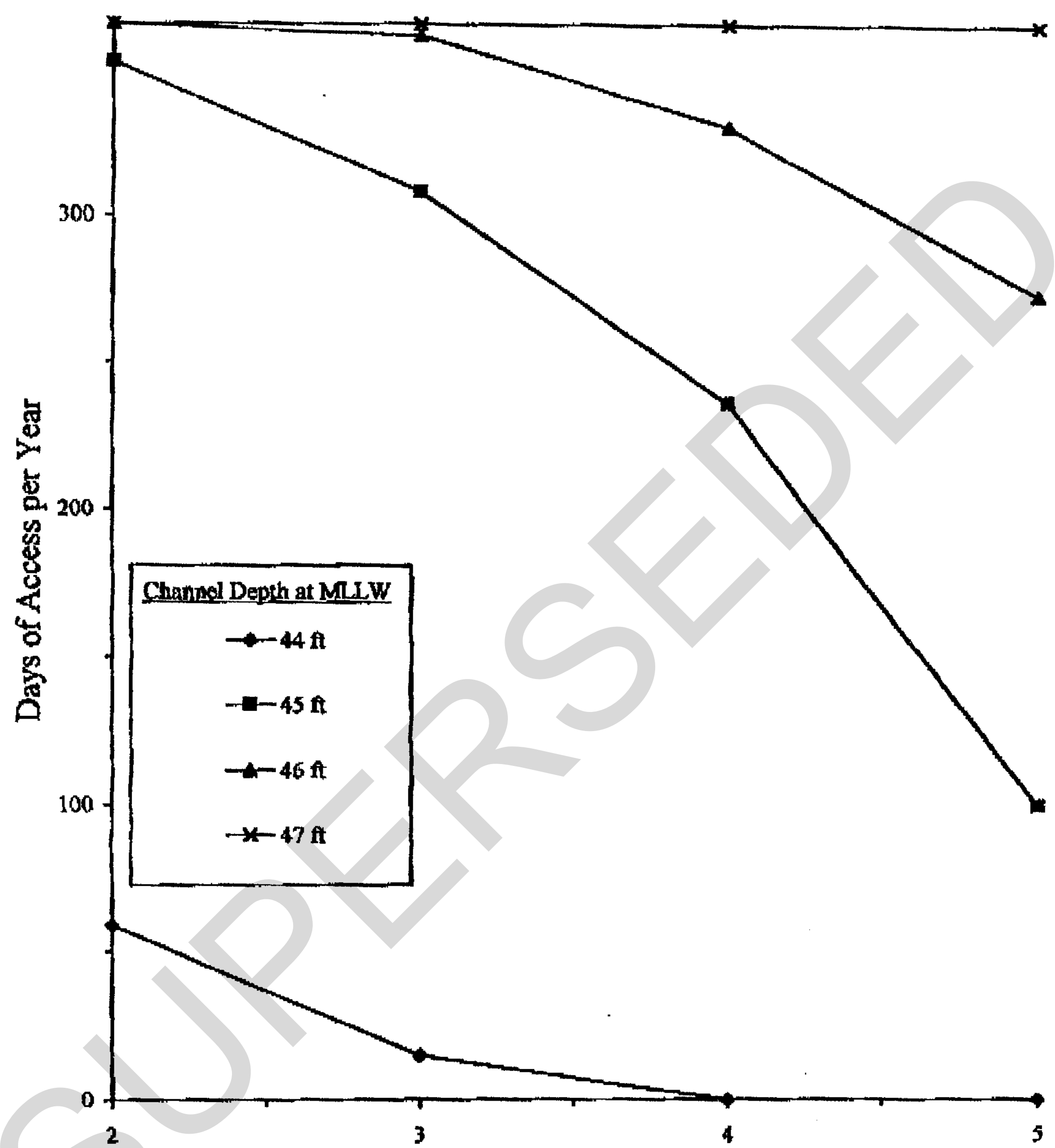
Notes:
(a) Harbor contains fresh water inlet.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; good estimate.
(d) Operational experience.
(e) Standard clearances.
(f) Analysis not complete.

## NNSY Tide Data

| | |
|---|---|
| Mean Higher High Water | 3.2 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -3.5 feet |

Enclosure (2)
Attachment (2)

**Elizabeth River Tide Access**
**47 Foot Depth Requirement**






Enclosure (2)
Attachment (3)

***************-COMM.JOURNAL-******************* DATE JAN-O8-1997 ***** TIME 16:25 *** P.01

MODE = MEMORY TRANSMISSION START=JAN-08 15:53 END=JAN-08 16:25
FILE NO.= 145

| NO. | COM | ABBR/NTWK | STATION NAME/ TELEPHONE NO. | PAGES | PRG.NO. | PROGRAM NAME |
|---|---|---|---|---|---|---|
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| 002 | OK | 2 | 918084715870 | 031/031 | | |

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757-322-4866

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From: David Curfman

Command: NAVFAC Criteria Office, Code 15C
Phone: 757-322-4203
Fax: 757-322-4416

Date: 1/8/97
Pages including cover: Part 1 (16), Part 2 (31)

Following is the draft criteria for dredging CVN berths and channels. If you have any comments, let me know ASAP. Otherwise, I will send it out in 2 weeks.

## CVN 68 Class Water Depth Requirements for Newport News Shipbuilding

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 37.9 | 37.9 | 37.9 | 37.9 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | 0.5 |
| Motions (b) | - | - | - | (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 46.6 | 46.6 | 47.0 | (f) |

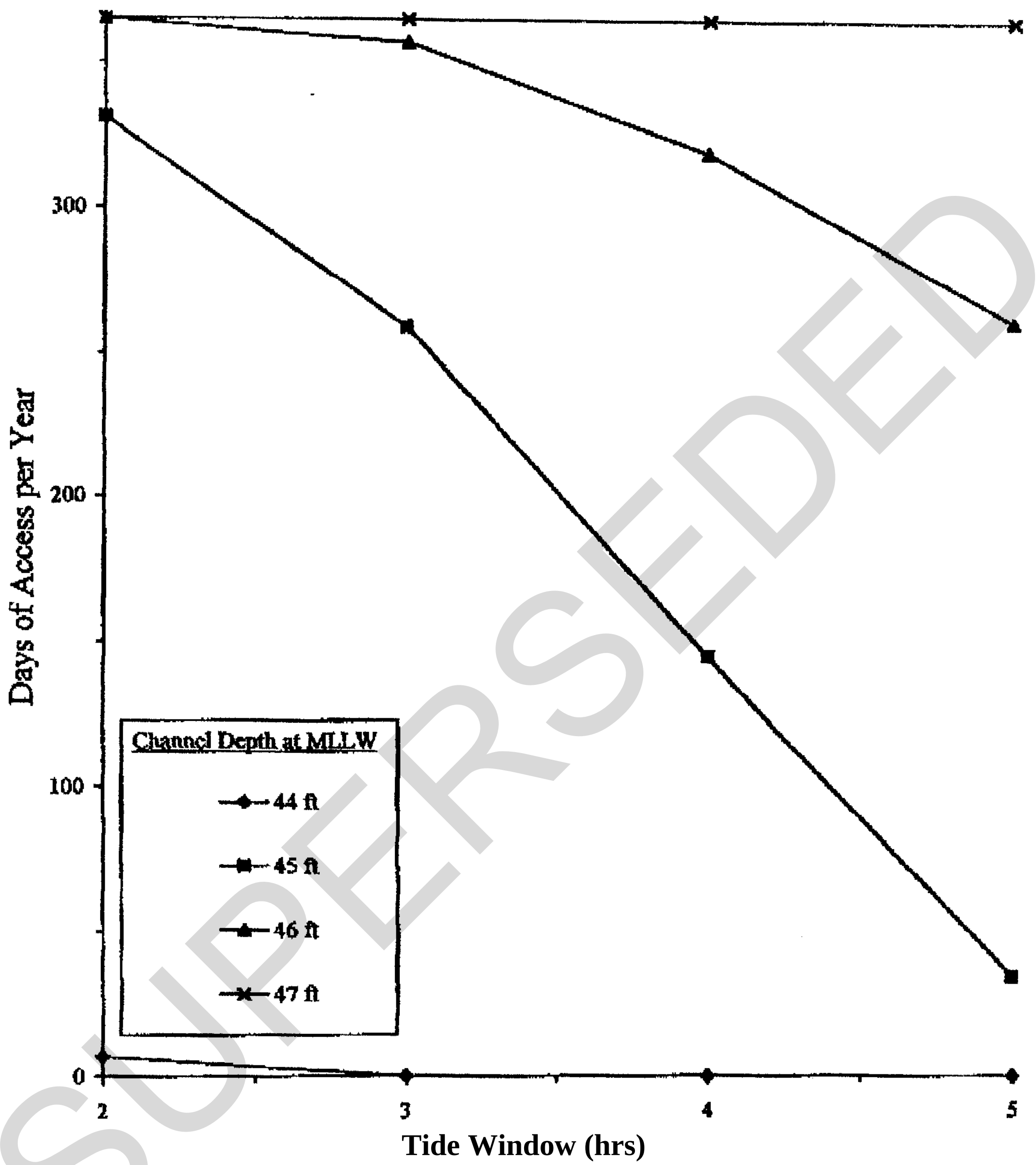
Notes:
(a) Harbor contains fresh water inlet.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; good estimate.
(d) Operational experience.
(e) Standard clearances.
(f) Analysis not complete.

## Newport News Tide Data

| | |
|---|---|
| Mean Higher High Water | 2.9 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -3.5 feet |

Enclosure (2)
Attachment (4)

**Sewell's Point Tide Access**
**47 Foot Depth Requirement**






Enclosure (2)
Attachment (5)

## CVN 68 Class Water Depth Requirements for Puget Sound Naval Shipyard

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 37.9 | 37.9 | 37.9 | (f) |
| Trim | 0.8 | 0.8 | 0.8 | |
| List | 1.4 | 1.4 | - | |
| Appendages | - | - | - | |
| Salinity & Temp (a) | 0.5 | 0.5 | 0.5 | |
| Motions (b) | - | - | - | |
| Squat (c) | - | - | 1.0 | |
| Heel (d) | - | - | 0.8 | |
| Clearance (e) | 6.0 | 6.0 | 6.0 | |
| **TOTAL** | 46.6 | 46.6 | 47.0 | |

Notes:
(a) Harbor contains fresh water inlet.
(b) Protected harbor; no significant wave action.
(c) Based on wide, 50 ft deep channel; need more information.
(d) Operational experience.
(e) Standard clearances.
(f) Unrestricted outer channel due to deep depth.

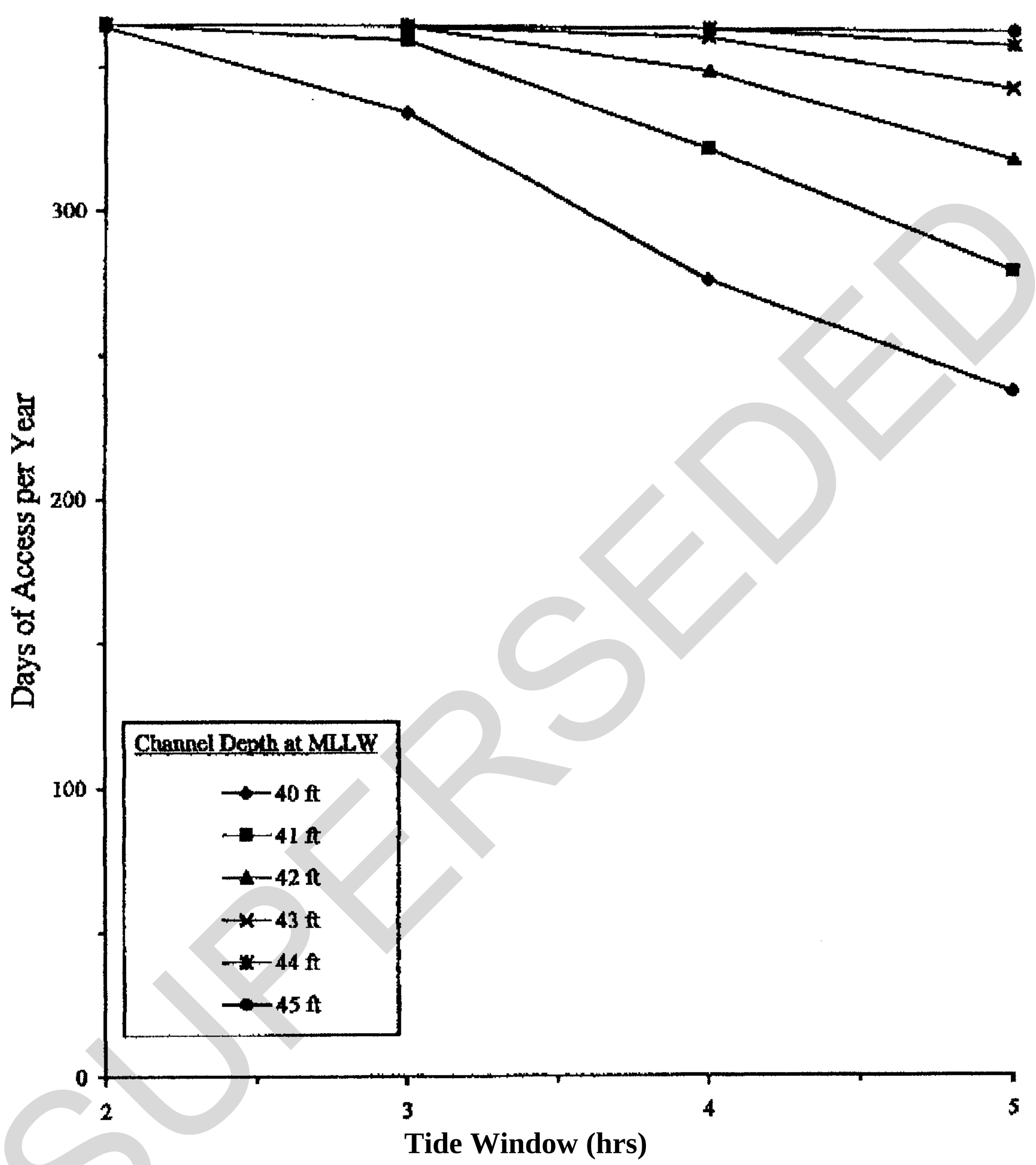


## Bremerton Tide Data

| | |
|---|---|
| Mean Higher High Water | 11.7 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -4.7 feet |

Enclosure (2)
Attachment (6)

**Rich Passage Tide Access**
**47 Foot Depth Requirement**




Enclosure (2)
Attachment (7)

# CVN 68 Class Water Depth Requirements for Pearl Harbor Naval Shipyard

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 37.9 | 37.9 | 37.9 | 37.9 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | - | - | - | - |
| Motions (b) | - | - | - | (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 46.1 | 46.1 | 46.5 | (f) |

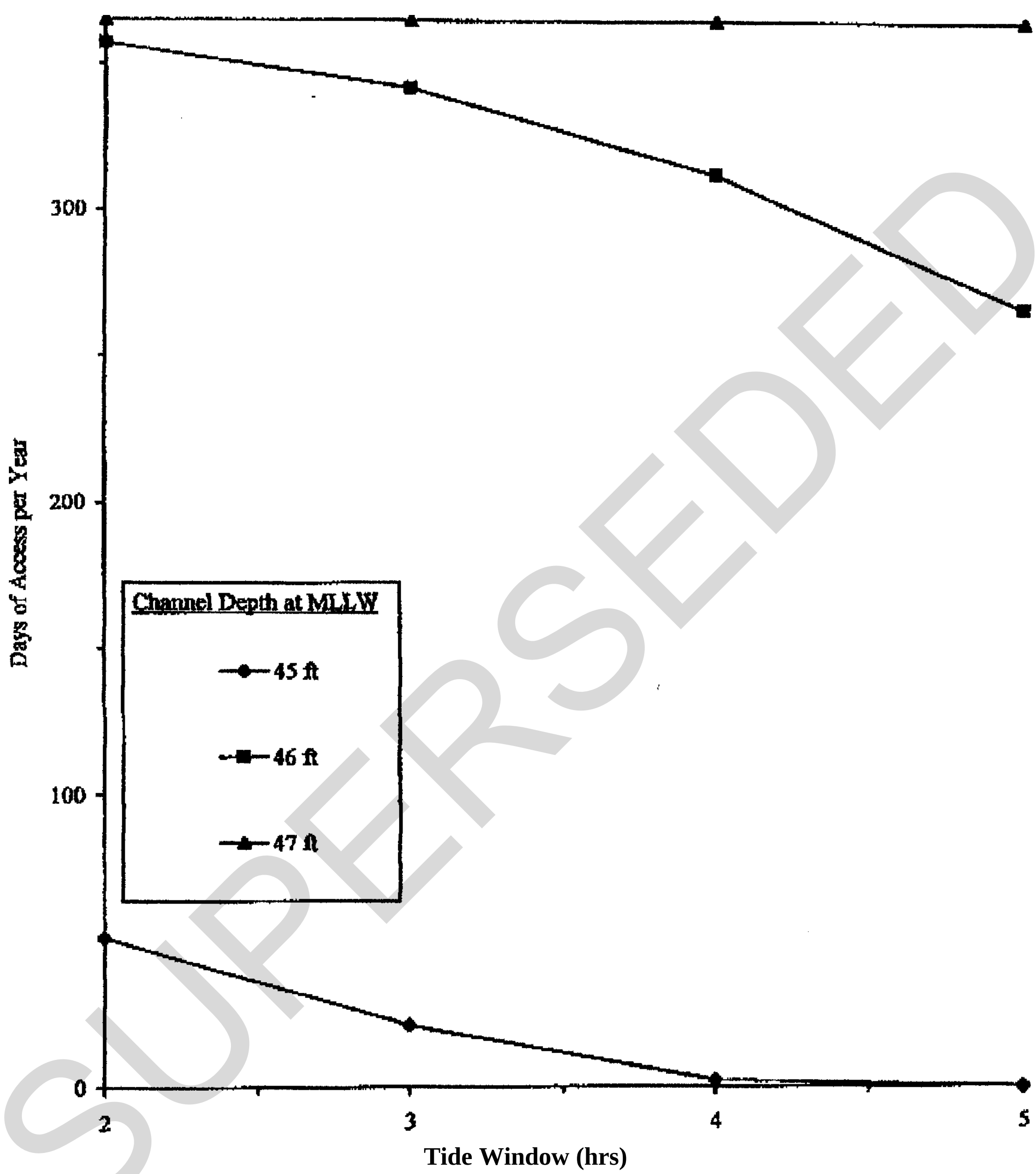
Notes: (a) Salt water port; no correction required.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; need more information.
(d) Operational experience.
(e) Standard clearances.
(f) Analysis not complete.

## Pearl Harbor Tide Data

| | |
|---|---|
| Mean Higher High Water | 2.0 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -1.6 feet |

Enclosure (2)
Attachment (8)

## Pearl Harbor Inner Channel Tide Access
## 47 Foot Depth Requirement






Enclosure (2)
Attachment (9)

# CVN 68 Class Water Depth Requirements for Long Beach Naval Shipyard

| | Pier | Turning Basin | Inner Channel | Outer Channel |
|---|---|---|---|---|
| Draft | 37.9 | 37.9 | 37.9 | 37.9 |
| Trim | 0.8 | 0.8 | 0.8 | 2.1 |
| List | 1.4 | 1.4 | - | - |
| Appendages | - | - | - | - |
| Salinity & Temp (a) | - | - | - | - |
| Motions (b) | - | - | - | (f) |
| Squat (c) | - | - | 1.0 | 1.3 |
| Heel (d) | - | - | 0.8 | - |
| Clearance (e) | 6.0 | 6.0 | 6.0 | 2.0 |
| **TOTAL** | 46.1 | 46.1 | 46.5 | (f) |

Notes:
(a) Salt water port; no correction required.
(b) Unprotected harbor; significant wave action.
(c) Based on wide, 50 ft deep channel; good estimate.
(d) Operational experience.
(e) Standard clearances.
(f) Analysis not complete.

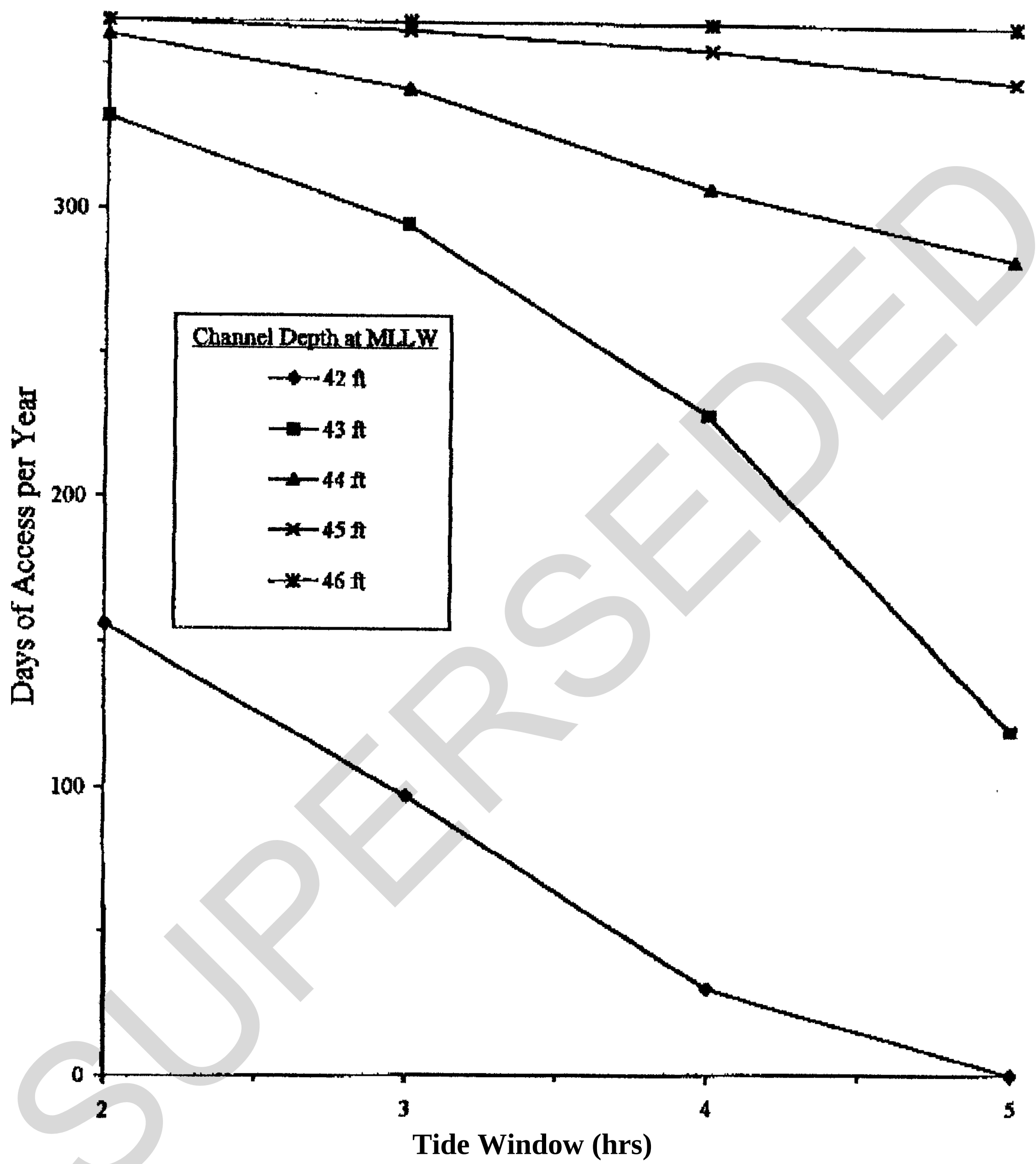


## Long Beach Tide Data

| | |
|---|---|
| Mean Higher High Water | 5.3 feet |
| Mean Lower Low Water | 0.0 feet |
| Extreme Low Water | -2.5 feet |

Enclosure (2)
Attachment (10)

**Terminal Island Tide Access**
**47 Foot Depth Requirement**






Enclosure (2)
Attachment (11)

# CVN 68 CLASS SHALLOW WATER NAVIGATION IMPROVEMENTS

Due to the deep draft of the CVN 68 Class aircraft carriers, port and shipyard access can be restricted, in order to minimize the cost and environmental impacts of deep dredging, actual ship loading, tides, and favorable weather conditions can be used. Utilizing these factors affects operational issues such as operating schedule and contingencies as well as ship loading and speed. Actual transit situations will vary and will involve different combinations of these factors. Current dredging plans will not provide unrestricted access to CVN 68 Class home ports and shipyards. To reduce the risk of grounding, it is recommended that shallow water navigation aids be improved.

The wave and motion determination process in shallow water is complex. Wave conditions are port dependent; each port must be individually studied for an accurate assessment. The most extreme CVN motions are generated from seal swells originating from storms hundreds of miles away; consequently, they are difficult to detect. Waves and swells are predicted from the Fleet Numerical Oceanographic Center or observed by the crew. Waves seen in or predicted for the open ocean may not be that which are experienced at any given port. Local land and bottom effects and changes due to wind, tides, and currents are not included.

This plan improves onboard shallow water navigation aids by:

(a) Providing a channel guidance system.
(b) Providing real time channel condition measurement.
(c) Improving ship's draft and attitude indication.
(d) Providing a load management system.

These systems and other supporting systems would be integrated as appropriate to facilitate overall functionality and minimize cost.

<u>Channel Guidance System</u>

NAVSEA has developed and tested an onboard CV Channel Guidance System (CVCGS). This system aids in the determination of under keel clearances and the probability of grounding while operating in ports. It is a PC computer program which calculates depth requirements based on data from the ship's force concerning load and trim conditions. Environmental conditions are down loaded from Fleet Numerical or input from the ship's navigator. Ship motions, under keel clearance, and probability of grounding predictions are then calculated for channel transits. The CVCGS has been validated by ship model tests and full scale wave measurements. This system will be sent to all CVs by the and of FY95.

Enclosure (3)
Page 1 of 3

Channel Condition Measurement

The Environmental Monitoring and Operator Guidance System {EMOGS) incorporates analysis capabilities of the CVCGS. However, instead of using predicted information from Fleet Numerical and the navigator, EMOGS uses real time wave and tide data from sensors installed in the channel. Because this is a far more accurate prediction of waves and variable water levels, substantial risk reductions are realized. The following table shows the accessibility levels of CVCGS and EMOGS associated with different dredge depths for San Diego and Mayport. An EMOGS type system is successfully being used by SUBLANT at Kings Bay, Georgia for SSBN 726 Class transits. EMOGS is recommended for channels not dredged for unrestricted operations and are subject to wave action, particularly swells. EMOGS is a facilities improvement cost tradeoff with dredging.

**OUTER CHANNEL ACCESSIBILITY**
FOR A RISK OF EXCEEDING DREDGE DEPTH 1 IN 100 TIMES

| CHANNEL DEPTH (feet) | DAYS PER YEAR | |
|---|---|---|
| | CVCGS | EMOGS |
| SAN DIEGO: | | |
| 55 | 227 | 333 |
| 59 | 295 | 355 |
| MAYPORT: | | |
| 47 | 254 | 262 |
| 50 | 362 | 363 |

Without guidance of any sort in avoiding extreme wave conditions, risk may increase to 1 in 2.

Draft and Attitude Indication

Currently, the CVN 68 Class only has one Remote Draft Indicator and list and trim inclinometers. The Profile Draft Indicator has been removed because it contained about a pint of mercury. Consequently, the ship does not have the ability to accurately determine the ship's draft, list, and trim. Installation of two more Remote Draft Indicators would provide the ability to triangulate accurate draft, list, and trim values. Based on simple geometry, the ship could then accurately determine the extreme draft point. A JCF and ECPs are being prepared to add two Remote Draft Indicators.

Enclosure (3)
Page 2 of 3

Load Management System

The CVN 68 Class carries roughly 20,000 tons of loads (aircraft, fuel, personnel, stores, etc.). There are some 415 tanks and voids and some 245 storerooms and magazines. The amount of material continuously being brought onboard, moved, and being consumed is large. Aircraft carrier operations require the flight deck to be as level as possible. There is a list control system to account for aircraft movement. A system similar to those used on tankers (commercial and AOEs) would provide the ship with a tool to better track and manage loads. This would enable the crew to minimize displacement list, and trim; thereby, minimize operational restrictions. A load Management system is being investigated by the CVN 76 IC effort.



Enclosure (3)
Page 3 of 3

## NOMOGRAPHS OF CVN 68 MOTION IN SHALLOW WATER

Background

Shallow water motion transfer functions where developed for the CVN 68 class ship to aid in predicting the ship's underkeel clearance for a variety of different entrance channels. The motion transfer functions were validated by model tests conducted at the US Army Corps of Engineers Waterways Experiment Station.

Description

The nomographs of CVN 68 motion in shallow water were developed by combining the shallow water motion transfer functions with a variety of wave and ship operating conditions. The waves used in calculating ship motions were developed to simulate the shallow water environments. The modal wave periods ranged from 6 to 14 seconds and the significant wave height ranged from 1 to 10 feet. The wave energy was spread using the idealized JONSWAP spectrum which is consistent with fetch limited conditions generally found in shallow water, and the energy was spread +/- $90^{o}$ to simulate shortcrested seas.

The ship operating conditions used for these nomographs were the following. The ship speeds were 6, 10, and 14 knots which covers most transit conditions for CVN 68 class ships. The ship-to-wave heading on the nomographs are head, bow, beam, quartering and following seas. Defining these headings, head seas are directly at the bow of the ship, bow seas are $45^{o}$ off the bow, beam seas are directly at the beam or side of the ship, quartering seas are $45^{o}$ off the stern, and following seas are directly off the stem.

The vertical motion and velocity at the bow and stern of the ship is calculated for each of these conditions. The extreme motion expected in 100 transits is then calculated from the vertical motion and velocity using a statistical formula generated by Ochi (1973). The largest resulting vertical motion is then used in the nomographs.

Reference

Ochi, M.K., "On Prediction of Extreme Values," Journal of Ship Research, Vol. 17 (1973).



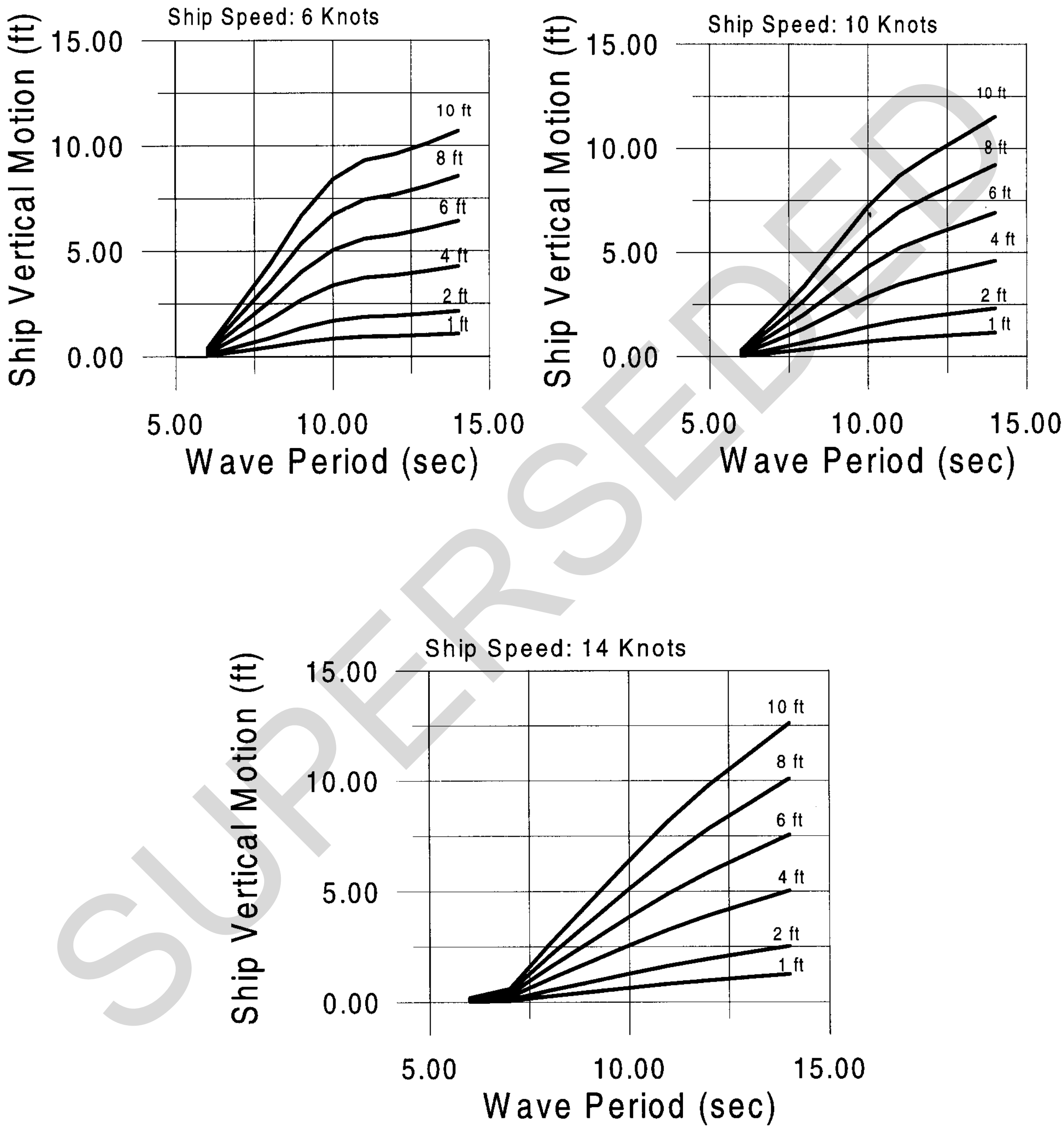
Attachment (b)
ENCLOSURE (1)

CVN 68 VERTICAL MOTION BY WAVE HEIGHT AND PERIOD

Vertical Motion Represents Extreme in 100 Transits

Curves represent significant wave height in feet

## HEAD SEAS

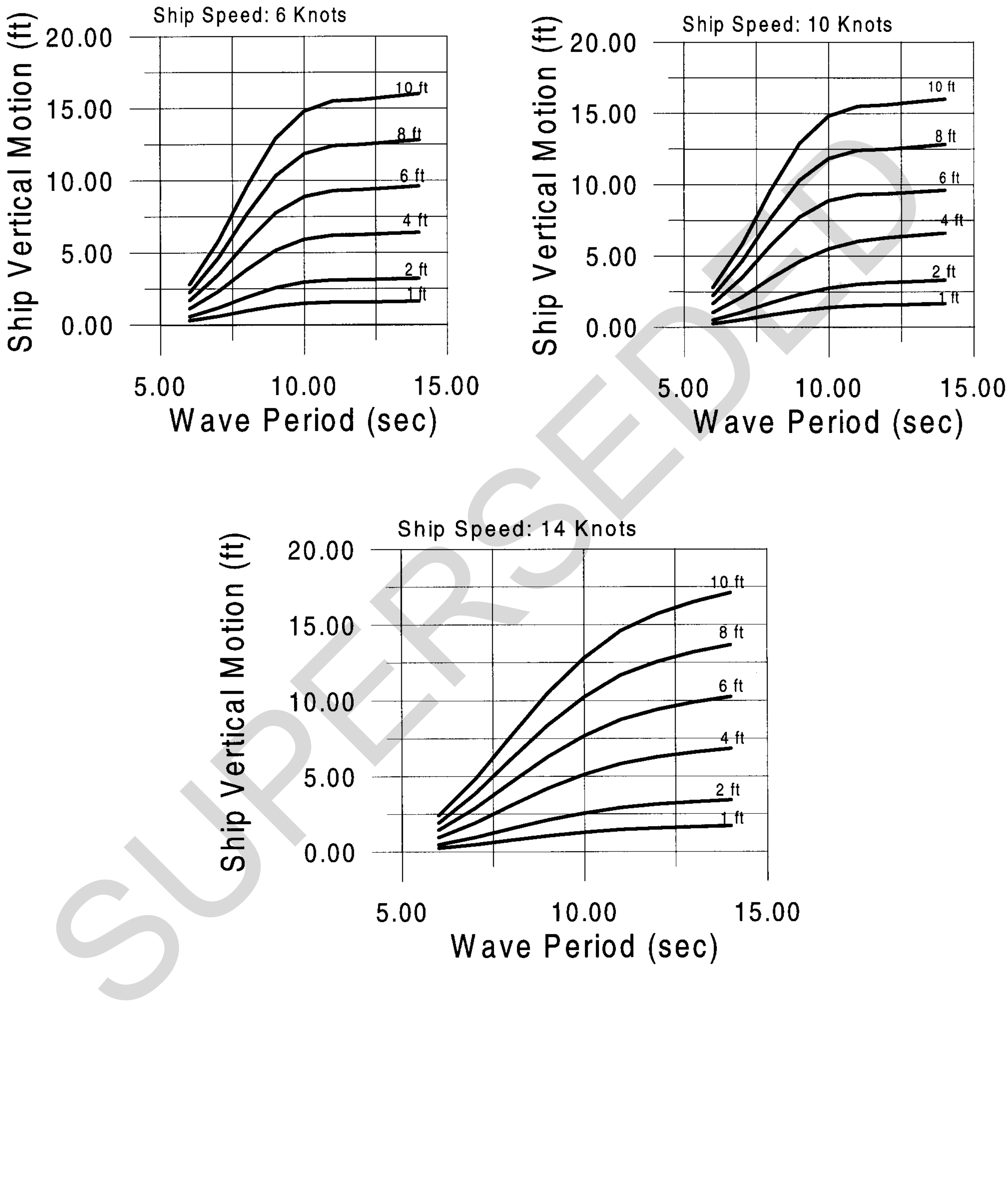





CVN 68 VERTICAL MOTION BY WAVE HEIGHT AND PERIOD

Vertical Motion Represents Extreme in 100 Transits
Curves represent significant wave height in feet

## BOW SEAS

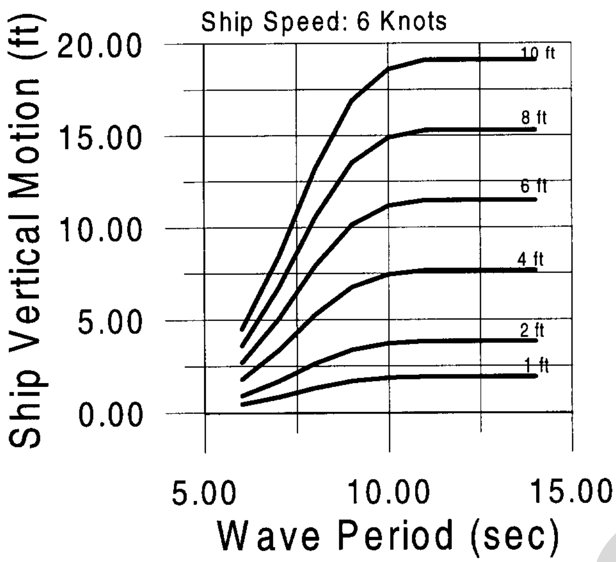


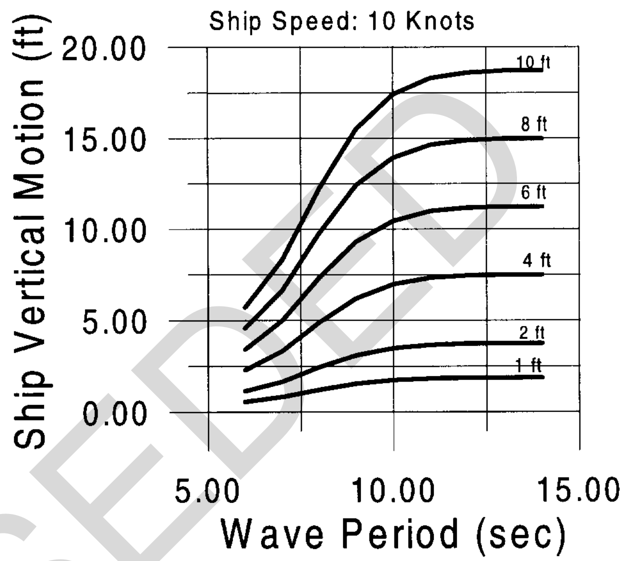
CVN 68 VERTICAL MOTION BY WAVE HEIGHT AND PERIOD

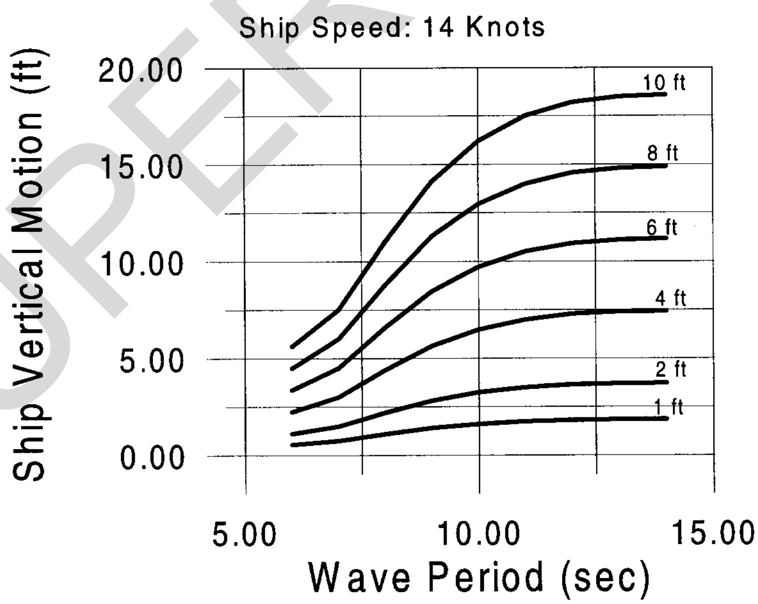
Vertical Motion Represents Extreme in 100 Transits

Curves represent significant wave height in feet

## BEAM SEAS



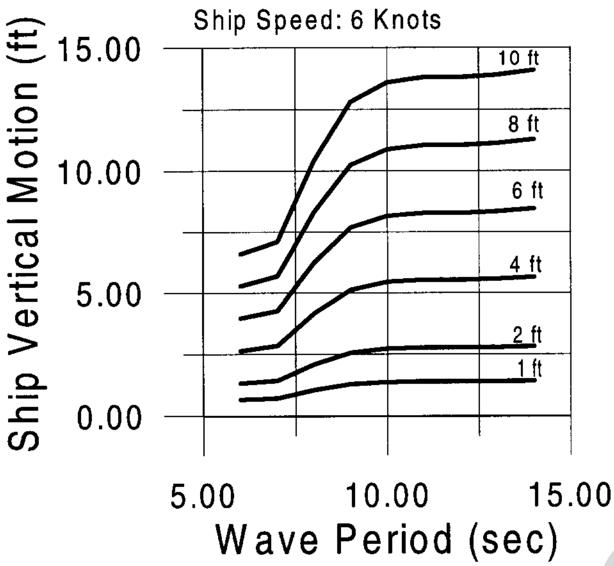



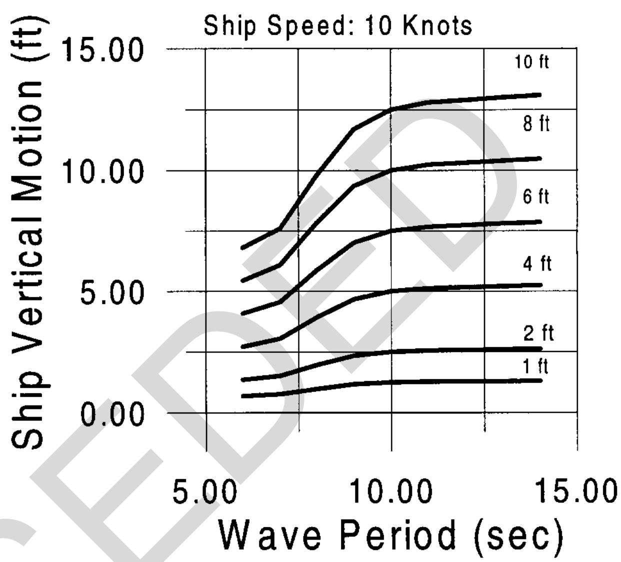
CVN 68 VERTICAL MOTION BY WAVE HEIGHT AND PERIOD

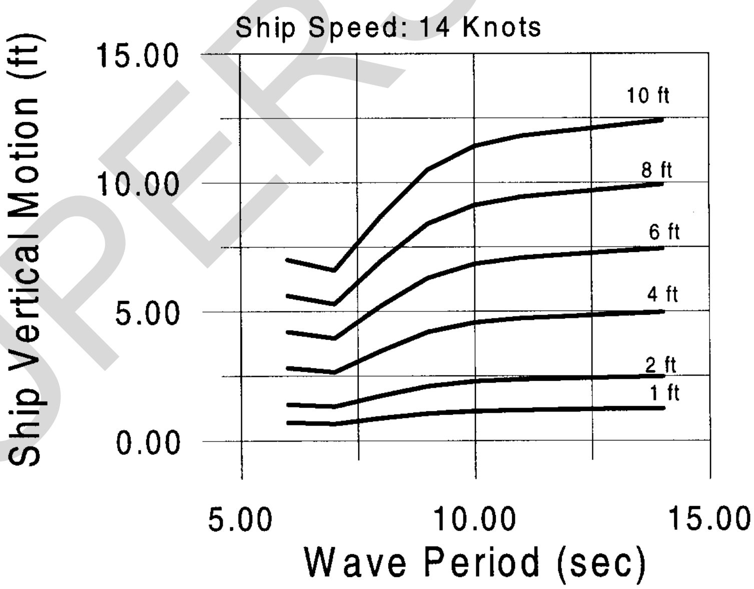
Vertical Motion Represents Extreme in 100 Transits

Curves represent significant wave height in feet

## QUARTERING SEAS



CVN 68 VERTICAL MOTION BY WAVE HEIGHT AND PERIOD

Vertical Motion Represents Extreme in 100 Transits

Curves represent significant wave height in feet

**FOLLOWING SEAS**