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AN INITIAL SURVEY OF ENVIRONMENTAL EFFECTS UPON AMPHIBIOUS OPERATIONS

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AN INITIAL SURVEY OF ENVIRONMENTAL EFFECTS UPON AMPHIBIOUS OPERATIONS

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1. INTRODUCTION

During the 1967-68 northeast monsoon season, NAVWEARSCHFAC personnel visited units of the SEVENTH Fleet Amphibious Force (TF-76) and amphibious vessels under the operational control of COMNAVSUPPACT Danang, in connection with a study of environmental effects upon amphibious operations. The purpose of these visits was to identify those facets of amphibious operations wherein environmental influences predominate and which are critical to successful accomplishment, and to ascertain the availability of data sources suitable for determining quantitative relationships between operational effectiveness and environmental severity.

Subsequently, a draft report setting forth tentative conclusions resulting from these SEASIA area visits in descriptive terms was informally forwarded to several PHIBPAC and PHIBLANT Staffs for comment and/or criticism as deemed appropriate. COMPHIBGRU FOUR Staff took an active interest in this matter, and contributed substantially to the material presented herein.

This preliminary survey contains little that is not known to well experienced Amphibious Force personnel. Nevertheless, interviews with PHIBFOR NAVWEASERV personnel indicate that this qualitative resume of weather effects would be helpful to newly assigned meteorologists, and that general availability of this report within PHIBFOR could enhance the tailoring of weather forecasting services to specific operational requirements. Accordingly, to the extent that PHIBFOR NAVWEASERV personnel may find this initial survey a useful supplement to the basic amphibious warfare library (NWP 22 together with NWIPs 22-1 through 22-5, the Landing Force Manual, and the Joint Surf Manual (COMPHIBLANTINST 3840.1E/COMPHIBPACINST 3840.3B)), publication is considered warranted.

2. OVER-THE-BEACH OPERATIONS

2.1 Over-The-Side Offloading

One of the basic evolutions common to nearly all types of amphibious ships is that of over-the-side loading of landing craft, including launching/ recovering craft and loading/backloading troops and cargo. The environmental parameter most critical to this evolution is doubtlessly the state of the sea; namely, the existence of sea and/or swell of short period and a combined height of 5-6 feet or greater.[1]

If the need to complete an over-the-side evolution is great enough, it can generally be accomplished. However, an adverse sea and/or swell in the transport area may limit the load of each landing craft, thereby requiring more trips thus greater exposure to the environment as well as hostile fire. Consequently, a larger force may be required to complete the amphibious assault successfully. Additionally, loading time and the risk of cargo damage or personnel injuries are increased.

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[1] There is overwhelming evidence that ship swell observations are generally unreliable, and that ship sea observations are, on the average, a 200% to 300% underestimation of the actual wave heights. The extent to which these observational deficiencies are reflected in the 5-6 foot "limit" cited here is not known at this time. Waves of this size are much more likely to be observed correctly from the landing craft, than from the bridge or even main-deck level of LPAs or LKAs. In this regard, action is being taken to include ship pitch and roll routinely in the Ship Weather Observation Sheets (OPNAV Form 3144-1), in order that data may be available to assess the accuracy and effects of reported sea and swell heights. For example, a report of 4-foot waves by a 528-foot LKA is inconsistent with a simultaneous observation that the ship is pitching 1° -- the latter would suggest a sea and/or swell of at least 9 feet.

Since these evolutions are often accomplished at anchor, and since the sea will usually be from the same quadrant as the wind, the sea will ordinarily be on the bow. In marginal conditions, it is preferable that the wind and sea be kept on the bow opposite the loading side, thus providing a lee while keeping the rolling of the ship within acceptable limits. Ordinarily, loading occurs on both sides, so this would appreciably slow the operation. There are a variety of line and boat-handling techniques as well as ship manuevers that can help overcome adverse weather. However, for some of these, personnel numbers and state of training may then impose secondary limits.

If a large swell is forecast into the area from a direction other than that of the wind, it may present a critical operational problem. The effects of wind, precipitation and cold are always a factor in any evolution which involves line handling; but, except in the case of extremes, these weather factors will not constitute nearly the hazard presented by the sea.

Again, if a given craft can surmount the sea and surf and reach the beach, it can be loaded -- or at least half loaded. Timely forecasts of unfavorable weather are obviously essential for forehandedness in preparatory action or the adoption of alternative plans.

2.1.1 Boom Launching

When launching craft from the deck of the ship or from the hold, the critical factor, so long as the boat is above water, is the ship's rolling. Where rolling cannot be minimized by keeping the sea/swell on the bow, craft suspended from the boom may swing severely. Normally, the swinging is controlled by tending lines, but rapid swinging may not be controllable simply because line handlers might not be able to take and release turns on the lines fast enough to hold the boat steady. Once swinging has started, "grounding" may be the only means of stopping it. As the boat reaches the water, a sudden roll of the ship or rise of the boat may cause the boat to take the weight of the hook, which can penetrate the boat hull. Crew training can lessen the probability of such an incident, but the hoist cannot generally react quickly enough to prevent this. Basically, the greater the load, the slower the reaction time. In this situation the hazard to the boat and crew is obvious.

2.1.2 Cargo Handling

When cargo is loaded into boats alongside, the problem with short-period swell is much the same as for launching the boat. However, the load must be held in position over the boat for longer periods of time, while the crew positions the cargo in its designated place. Again, either ship's roll or the rising and falling of the boat increases the difficulty in controlling the load (whether palatized gear or vehicles). The hoist, itself, may not be able to compensate for rapid, sea-induced, vertical motion.

2.1.3 Net Debarkation

Over-the-side loading by nets is difficult, hazardous and time-consuming if the ship and landing craft are being pulled apart then slammed together by the ship's roll and/or the craft's motion in the water. The nets are suspended from the ship's loading station and held manually along the inboard side of the boat, first by the crew and then by earlier loaded troops. The object of the manual net manning is to keep the net taut and preclude its sagging between ship and boat. Should the net sag into this space while troops are embarking or debarking, there is a very real probability of serious personnel injuries. On ships with high loading stations (i. e., LPAs), the nets hang at a steep angle and are therefore easier to hold nearly vertical. On ships with a low loading position (i.e., LSTs), on the other hand, the relative motion of craft and ship cause a greater departure of the net from the vertical, making it more difficult for the men in the boat to hold a loaded net taut when the vessels part and the net approaches a horizontal position.

2.2 Well-Deck Launching

Well-deck launching may be performed with a dry deck for tracked vehicles (LVTs, etc.) or a flooded deck for landing craft. When the sea is on the bow or stern, sympathetic swells (fore and aft) will be set up in a flooded well deck which may exceed the existing exterior sea in both height and steepness, being more closely akin to surf. Although this wave action causes the craft to periodically "bottom" with a crash, appreciable damage is not commonly the result. Far more hazardous is the situation where the ship has her deck flooded while lying in the trough of a relatively steep swell, causing heavy rolls. Unless the craft can be held fast by lines, lateral motion and the resulting crash into the wing walls may cause damage to both the craft and the ship. This situation is likely to occur when an LSD or LPD is laying boats along the Line of Departure (LOD) for a landing, since the LOD is typically parallel to the beach and shoaling will cause the swell to parallel the beach also. Lateral sloshing is usually minimized by "marrying" LCM-8s together, to reduce the excess space between craft and ship. Tracked vehicles may be kept grounded to preclude sideways motion.

Underway launching of LVTs from LPDs/LSDs is an effective technique,[1] and similar launchings for landing craft are under study. Here, ship movement tends to reduce the roll problem. The limiting environmental parameter is sea/swell height, due to its effect on the ship's stern gate. Good wave forecasts are important when this technique is to be used; for high-speed approaches enhance the technique, and a moderate sea can cut back the speed made good of amphibious ships sufficiently to disrupt schedules. Similarly, hydrography is a very important parameter, since passage over a shoal can both accentuate the swell and cause surges in the well.

2.3 Causeway Operations

Causeway operations can become quite critical to an assault. The trimmed slope of a combat-loaded TERREBONE PARRISH class LST is

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[1]See COMPHIBLANT/CGFMFLANT/COMPHIBPAC/CGFMFPAC Joint TACNOTE 1-67, Underway Launch of LVTs from LSD/LPD.

about 1:47. Should the beach be of a gentler slope, LST beaching is precluded; because regardless of the condition of the ramp, the ship will ground out by the stern or foul a screw. When beaching is not possible, the best alternative is causeway operations. Causeway operations consist of 3 phases: splash and assembly; transport; and beaching. The maximum effective surf for causeway beaching operations is about six feet. A combined significant wave height in excess of about 4 feet will hinder splash and assembly. Here again, seamanship and training determine to a large extent the feasibility and the probability of delays in completing this operation; but forewarning of inclement weather is also vital to the advance preparations which may enhance improved performance.

2.4 Surf

The most critical environmental parameter in a surface-borne amphibious landing is surf. In general, surf conditions determine whether, and if so with what craft, a surface-borne amphibious assault will be carried out.

2.4.1 Surf Observations

Once advanced-force operations have commenced (e.g., show of force, evacuation, mine counter measures, UDT surveys, marine reconnaissance, etc.), a source of surf observations (SUROBS) is available. As with any parameter, an observation is valuable as a basis for the next forecast, and for assessing the validity of the reasoning which led to the last.

Of the various sources of SUROBS which may be available, there must be some appreciation as to the relative reliability of these observations. These sources in order of reliability (in the opinion of the writer, assuming all have had adequate training in observing surf), are:

1. Underwater Demolition Team, SEAL Team or Marine Reconnaissance Team;

2. Beachmaster Unit (immediately after transiting surf);

3. Boat Group Commander during landing;

4. Observer on beach in immediate vicinity of the landing zone;

5. Observer on another beach in the objective area;

6. Observer within visual range of landing zone.

The UDT will have difficulty in reconnoitering the beach in surf that is above 6 feet. Ideally, there should be a marker in the surf zone to give the observer a visual reference (height scale) for estimating breaker height. This is usually not possible; but as a substitute the beach observer can raise or lower his eye level until the horizon is obscured by the surf, to get an idea of how far a wave is above mean-water level. Perhaps 1/3 should then be added, to compensate for that portion of surf below mean-water level as well as parallax error.

A great deal has been written about the number of waves to observe or the amount of time to spend on an observation, that will not be treated here. An impression gained, which may or may not be valid, is that the width of the surf zone is grossly underestimated by the typical beach observer.

(Agree, however with one or two helo flights good estimate can be made on surf zone width and no of waves

The longshore, or littoral current can only be estimated by throwing floating objects into the surf zone and timing their drift along the beach. This should be done several times for each observation and averaged, since the littoral current is usually quite variable in time and space.

It appears that perhaps the most difficult of all parameters to observe is the angle between the beach and the surf. This is usually small near the beach, and when it is large off shore it will be changing rapidly beachward through the surf zone to the beachline.

It is important to remember, that except for concave bottom-contoured beaches, surf height will always exceed deep-water wave height if the orientation of the beach is such that it is not sheltered. As noted previously, it is generally agreed that most shipboard wave observers will seriously underestimate the actual wave height. Hence, surf estimates which are based upon shipboard wave-height observations are apt to be on the low side.

The concept of effective surf appears to work, but the surf characteristics entered into the computations must be accurate. Wind appears to be the most reliably observed parameter, and therefore surf based on estimates of sea/swell using wind speed, duration and fetch considerations should generally prove superior to estimates based upon observed "deep-water" sea/swell observations. An exception would be those occasions where accurate deep-water observations are available.

2.4.2 Surf Forecasts

Reliable SUROBS will often not be available to facilitate verification and appropriate adjustment of preliminary surf forecasts, and the decision to initiate the successive phases of the landing operation may completely depend upon unsubstantiated surf forecasts. These forecasts should be made using wind speed, fetch and duration considerations from existing and prognostic wind fields, with the predicted deep-water sea/swell treated as a lower limit estimate of the unrefracted surf. It should be recalled, however, that current surf-prediction techniques are based upon a model which assumes a sloping beach. Not only are there pronounced sandbars off many beaches along the East Coast of Vietnam, but those bars may be expected to change location in severe storms or during the period of heavy river runoff which occurs in fall and early winter. It is also important to note, that within the tropics reliance should not be placed upon the geostrophic approximation for determining winds to be used for wave prediction; and that whereas numerical surface-wind forecasts should be treated with caution at all latitudes, they are especially subject to error in the tropics. There are empirical study for RVN [illegible] Burroughs Martin + [illegible]

Refraction does occur in surf, especially where the hydrography is irregular and does not consist of straight-and-parallel contours, and should be applied to surf forecasts. Amphibious Objective Studies, NIS and other country studies frequently contain descriptive information concerning refraction. Old files may contain previously computed refraction coefficients which could be useful; but these should carefully be examined to ensure that there has been no substantial updating of inshore bathymetry, which might indicate invalidity of these earlier coefficients. Until computerproduced refraction coefficients become available for all beaches of concern, be prepared to produce these coefficients graphically. In this case, working seaward from the selected beach is the most efficient approach.

It is important to remember that not only the open ocean and its deep-water waves, but the immediate objective area must be watched for influences which may significantly affect the effective surf. On warm afternoons the sea breeze may have a pronounced effect. The typical change is in the character of the surf, in that a sea breeze tends to reduce the percentage of plunging breakers while increasing the percentage spilling. Of course, the sea breeze may add to the significant breaker height by generating a local sea. The nocturnal land-breeze effects are just the opposite, tending to diminish the height but increase the percentage of plunging breakers.

2.5 Tides and Currents

In some amphibious operations, tides or currents may become the predominant factors. The importance of either comes to the forefront because of difficulty in their prediction.

2.5.1 Currents

The longshore current or littoral drift plays a heavy role in the computation of effective surf, as it is readily seen that broaching is far more likely with a strong longshore current. However, an unpredicted deep-water current may completely disrupt the critical scheduling necessary for a well executed landing. Even currents of less than one knot can have a pronounced effect upon the ability of groups of landing craft to effect a timely rendezvous. It is evident, therefore, that whenever feasible the acquisition of beach intelligence information should provide for a determination of inshore currents in the amphibious objective area. In this regard, techniques dependent upon aerial photographic or infrared surveys are generally satisfactory for current determination in the required accuracy, where these may be employed. However, note should be taken of the probability of seasonal as well as synoptic variations in these currents, due to changes in prevailing surface winds.

2.5.2 Tides

Tides often expose or conceal sandbars and reefs; and if incorrectly predicted may completely change the anticipated character of the beach, by effectively moving the surf zone into an area with different gradients or composition. One major pitfall is the misconception that a prediction of the astronomical tide (from an almanac) is sufficient.

There are several types of variations in the level of the ocean which the amphibious meteorologist should be aware of. These are often referred to as "overtides"; but the term is in some respects a misnomer, for these features are going to occur regardless of the tide and may result in either an increase or a decrease in the water level. (See "Storm Surge Prediction," NWRF 36-0668-138, June 1968).

2.5.2.1 Secular Effects

This literally means "one in an age"; but evidentally oceanographers don't use that time frame, for in some instances secular effects have been observed several times a year. These are rather abrupt, unannounced and unexplained changes in the overall water level for one tide, a month of tides, or even longer. The result may either be a raising or lowering of the water level. The difference between the observed and astronomical tides due to secular effects may be as much as a foot, and greater differences have occurred; but lesser differences are more likely.

2.5.2.2 Annual Effects

These are somewhat similar to secular effects, except that they occur gradually rather than abruptly and seem to follow some sort of a progression. The cause of water-level changes due to annual effects is also unknown. These too may appear as either a decrease or an increase in the water level, of approximately the same magnitude as secular effects.

Inasmuch as there is no satisfactory explanation for either secular or annual effects, it is only through a comparison of the actual water level and the computed astronomical tide for that place and time that their existence may be determined. Thus, it is important that pre-assault beach reconnaissance provide for observation of the water level with respect to some known datum. However, since influences such as current effects, wind setup and wave setup (see below), can produce comparable variations in the water level, such observations must carefully be evaluated with respect to the possibility of other contributory effects before a prediction of the "H-hour tide" can be issued with confidence.

2.5.2.3 Current Effects

The mean current effects are normally computed and included in the predicted tide tables contained in published almanacs. Any change in these currents, or a current established by an intense storm, will cause a change in tidal heights.

Several days are required for the wind to establish a motion in the water mass of sufficient magnitude to cause an appreciable change in an existing current or the formation of a new one. In the northern hemisphere, the mean mass transport is to the right. The direction of transport is almost 90° to the right of the wind in the deep ocean, but it tends to become more nearly parallel to the bottom contours as the water becomes shallow (< 300 feet). This causes the water level to increase along a coast to the right of the current, or decrease if the coast is to the left. These effects occur from a distant storm or wind-fetch area, and should be added to any local wind effects; however, there is at present no satisfactory method of predicting the distance for which a current will persist after the wind has stopped, or the water mass has left the area of strong winds.

2.5.2.4 Wind Effects

Due to wind stress, the surface water layer is transported forward and to the right of the wind (45° in a deep, undisturbed and therefore unrealistic ocean). At depths less than 300 feet, the direction of transport is more nearly parallel to the bottom contours. This causes the water level to rise along a coast to the right of a strong and persistent wind, and in the region where the wind-fetch area impinges upon the coastline.

Variations in water level due to waves, wave setup and wind setup are qualitatively discussed in "Storm Surge Prediction," NWRF 36-0668-138, June 1968.

3. TROOP FACTORS

During and after landing, the landing force has some unique problems due to the weather. These may be classified as (1) landing phase and (2) in-country phase.

3.1 Landing Phase

The conditions and duration of the transit and of the subsequent landing have an effect upon the fighting condition of the troops upon arrival at the beach. This is particularly true in a surface-borne operation. As an example, during one recent assault landing in Vietnam, Marines were loaded into LCM-8s and were waterborne in rough seas for nearly 8 hours because of landing delays of one kind or another. Merely riding an LCM-8 for that period of time could be fatiguing; but this was at night and these man were combat loaded, crowded, in heavy seas, and wetted and chilled from blowing spray and occasional waves breaking into the boat. As a result, by the time they were landed they were mostly seasick, soaked, fatigued, cold and, in general, in poor fighting condition for their first three to four hours ashore. Fortunately, the landing was unopposed. Hence, the problem is not only a question of whether they can be landed with safety commensurate with the importance of the mission, but will they be completely functional as a fighting group when they arrive -- or will they have recuperative time before they see action?

If the landing is to be accomplished by vertical assualt, most of these problems are eliminated; but air sickness, nausea induced by inhaling JP-5 exhaust fumes or mental stresses due to a natural trepidation often associated with flight, particularly when aggravated by vibration or turbulence and prolonged crowding under conditions of either excessive heat or cold at night, can be equally debilitating. Thus, in this as in any other phase of naval operations, it is mandatory that extremes of weather be predicted well in advance, so that troop loading -- and correspondingly, the time required to transport a given quantity of troops or material -- can be adjusted accordingly.

3.2 In-Country Phase

In Vietnam, troop problems fall into two extremes; (a) extremes of sun and heat, and (b) extremes of rain. These are generally seasonal problems along the East Coast of Vietnam. The former is primarily associated with the southwest monsoon of summer, and the transition period between the northeast and southwest monsoons. The latter is common during the northeast monsoon of winter, although either extreme can occur for short periods during any season. Prolonged heat with relatively heavy protective clothing as well as a combat load can quickly sap the strength of the best conditioned troops. Heat exhaustion is a common troop problem under such conditions, probably aggravated by a pride in these young men that will not permit them to slow down until they drop. The logistical problem of carrying drinking water is not inconsequential.

The other major problem is that of moderate to heavy continuous rain.

Rain without break will take its toll in fatigue and morale, as well as contribute to diseases resulting from prolonged dampness. Occasional showers or rains with periodic "drying-out" breaks are not considered to be seriously detrimental to the ability of troops to operate. Rain also effects such things as trafficability, and flooding may either eliminate low-lying helo landing areas or cut off ground access to them.

Almost as bad as persistent rains may be days on end with fog or low stratus, as can occur in the deep mountain valleys during all seasons and along the East Coast from early fall until late spring. There is the possibility that gloomy weather per se for prolonged periods could affect troop morale, but a realization that air resupply or reinforcement and close-air support will then not be possible is probably the greater factor.

4. VERTICAL ENVELOPMENT

Low ceilings and visiblities are the most important limiting factors for helicopter operations. This limitation is partly imposed by the customary hazards of instrument flight over rough terrain, and by the difficulty of effecting an approach without ground - based navigational aids in near zero ceiling/visibility conditions. When helicopters are required to let down thru a low ceiling, they must then be more widely separated in time and space for safety. This compounds the problem of landing a sufficiently large force within the geographical and time requirements necessary to ensure mutual support, for in such conditions effective close-air support is unlikely. Another consideration, is that when the helicopters must transit hostile terrain, a measure of protection may either be sought in flying low to avoid missiles or remaining relatively high and/or in clouds to avoid small-arms fire. Thus, in this phase of the operation, environmental effects would largely depend upon the anticipated enemy weaponry.

Wind and ship motion may occasionally affect the capability of an LPH or LPD to launch or recover helo's; but the consensus seems to be that when conditions become this extreme, other phases of the amphibious operation would have long since been cancelled. Logistic helo operations from LSTs are frequently cancelled due to weather, and this is true to a lesser extent for all other amphibious ships with a small platform. COMPHIBPAC is now engaged in a study to determine the amount of interference inherent in simultaneous helo/boat operations on LPH and LPD types, to support the design phase of the LHA program.

5. CLOSE-AIR SUPPORT

Close-air support will be adversely affected if objective area ceilings and visibilities are low. However, since such support may come from distant carriers or air fields, the weather at these locations will also have to be considered. Weather effects upon close-air support of an Amphibious Assault are essentially the same as those upon conventional air-strike operations. A discussion of weather factors in air-strike operations is contained in NAVWEARSCHFAC SECRET Technical Paper 3-67, "A Preliminary Report on the Influence of Weather Upon Carrier Air-Strike Operations (U)," June 1967, and in the forthcoming NAVWEARSCHFAC SECRET Technical Paper 27-68, "A Provisional Evaluation of Weather Effects Upon Carrier Air-Strike Operations (U)."

6. SUMMARY

Since classical amphibious operations comprise virtually all facets of modern naval warfare, it is to be expected that these operations will be subject to the environmental limitations which affect each component operation. Thus, any of the common environmental phenomena can be limiting to some extent. On the other hand, it would be unrealistic to believe that all conditions must be favorable for the successful attainment of an amphibious objective; for by their very diversity, amphibious operations offer a wide variety of alternatives. In any case, it is clear that PHIBFOR NAVWEASERV personnel must be well prepared professionally.

The single parameter that most affects amphibious operations is the state of the sea, with surf of equal importance for surface-borne landings. Either can be one of the more difficult forecasting problems, because of complications imposed by hydrography and deficiencies in current capabilities to predict the surface wind field over the area of influence within desired accuracies. To further complicate the problem, the parameters being forecast are not now being accurately measured. Hence, forecast verification is not always a gratifying experience.

Realization of a noteworthy improvement in forecasting reliability is necessarily dependent upon an improvement in observational capabilities. The relatively near future promises both shipboard and airborne wave-height recorders. The former can provide deep-water wave measurements, while the latter can additionally provide measurements through the surf zone. These measurements will hopefully furnish both the initial state and forecast-verification data in the accuracy required to develop prediction models which can in turn produce reliable sea, swell and ultimately surf forecasts. In the interim, availability of these wave-height recorders should preclude the issuance of a seriously over optimistic amphibious assault forecast. Pending the arrival of these new black boxes, it is possible to obtain appreciable improvements through a vigorous observer-training program. Concur totally!!

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