Naval War College Review

Volume 46
Number 4 *Autumn*

Article 6

1993

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WHEN ADMIRAL CHESTER W. NIMITZ took command of the remnants of the U.S. Pacific Fleet on 31 December 1941, he could not have foreseen the dramatic events that would culminate in the Navy's spectacular victory at Midway six months hence. Although a great deal has been written about the intervening carrier raids and the Battle of Midway itself, the critical contribution of fueling at sea during this period has been frequently overlooked. Yet fleet oilers, mostly those of the new *Cimarron* (AO 22) class, accompanied every major task force during this period, providing underway refueling for both the carriers and their escorts. (See table.) West of Pearl Harbor there were no advanced bases or protected anchorages that could have been used for this purpose. Fast carrier task forces, however, were prodigious users of fuel, and it is doubtful whether these raids could have been conducted had the Navy not perfected the technique of fueling at sea prior to the commencement of hostilities.[1] Admiral Nimitz's role in developing the procedures used in refueling ships at sea is not generally known, even though he was one of its earliest pioneers.

Nimitz first became acquainted with the problems of fueling at sea while serving aboard the USS *Maumee*, commissioned on 23 October 1916 as the Navy's second fleet oiler.[2] Because of his prior experience with diesels, Nimitz, then a lieutenant, had been appointed to supervise the construction and installation of the ship's engines, the *Maumee* being the first large U.S. naval vessel equipped with this type of power plant. After the ship was completed,

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The author gratefully acknowledges the assistance of Professor William N. Still, Jr., of East Carolina University, who was instrumental in locating the records of the USS *Maumee* cited herein.

Lieutenant Nimitz was assigned to the *Maumee* as executive officer and chief engineer.[3] This arrangement—a billet combining traditional "line" duties with engineering duty—was not unusual for naval vessels such as the *Maumee*, which had a relatively small crew.

After an extended shakedown cruise, the *Maumee* participated in fleet training exercises in the Caribbean, where she was actively engaged in the business of delivering oil and water to all types of vessels, both large and small.[4] Under the prevailing doctrine, fueling between ships at sea was conducted only in protected waters with the vessels moored together. As the *Maumee*'s crew gained proficiency during the exercise in the use of their specialized fueling gear, they began to discuss the possibility of refueling ships while underway and made tentative plans to test this concept. The ship was much too busy supporting the fleet to conduct experiments at sea.

Once the ship returned to port however, the men of the *Maumee*, under the command of Lieutenant Commander (later Captain) Henry C. Dinger, began serious efforts to devise an acceptable means of refueling destroyers at sea while underway.[5] Although preliminary experiments with this important innovation had previously been conducted between the USS *Arethusa* and the destroyer *Warrington*, they had been attempted only in a calm sea.[6] The *Maumee*'s crew began by obtaining blueprints of the various classes of destroyers showing the location of fuel filling valves, chocks, bitts, and strong points for towing. After careful study, they made up sketches indicating the fueling gear and towing rigs that would be needed for each class. It seemed only a matter of time before the United States would be drawn into the conflict then raging in Europe, and the problem of getting destroyers across the Atlantic may have been foremost in the minds of the *Maumee*'s officers as they worked out the details of the means proposed for refueling these ships.

When war was declared on 6 April 1917, the Secretary of the Navy immediately ordered a division of U.S. destroyers, under Commander Joseph K. Taussig, across the Atlantic to assist the hard-pressed British fleet in combatting the German submarine threat, which was close to strangling the British Isles. Shortly thereafter, the *Maumee* was sent to a position in mid-Atlantic to serve as a mobile fueling station for the destroyers that followed after, which did not (unlike Taussig's ships) have sufficient range to cross the Atlantic without refueling en route.[7]

Before the *Maumee* put to sea, Nimitz was assigned responsibility for preparing the equipment that would be needed during the forthcoming operation. He was assisted by Lieutenant (j.g.) G.B. Davis, Chief Boatswain's Mate M. Higgins, and Lieutenant F.M. Perkins, the Destroyer Force Engineer, who had come aboard to assist. Together they devised a means for refueling destroyers while underway, one that required the *Maumee* to tow the destroyer alongside so that fuel lines could be secured between the vessels—a procedure known as the

riding-abeam (later called the "broadside") method. The fueling gear they devised consisted of a ten-inch towing hawser, two six-inch breast lines, and a number of fifty-foot lengths of three-inch-diameter rubber fuel hose. The team decided to pump fuel through two hoses at the same time to increase the rate of flow and thereby reduce the time needed to refill each destroyer's tanks. The hoses would be attached to the regular fueling connections on the *Maumee*, the other end passed to the other ship and inserted into the open manhole of the fuel bunker to be filled. To keep them clear of the sea, the hoses would be supported by a wooden hose carrier, or saddle, suspended from the oiler's cargo booms. These would be rigged in or out and up or down as necessary to facilitate the fuel transfer.[8]

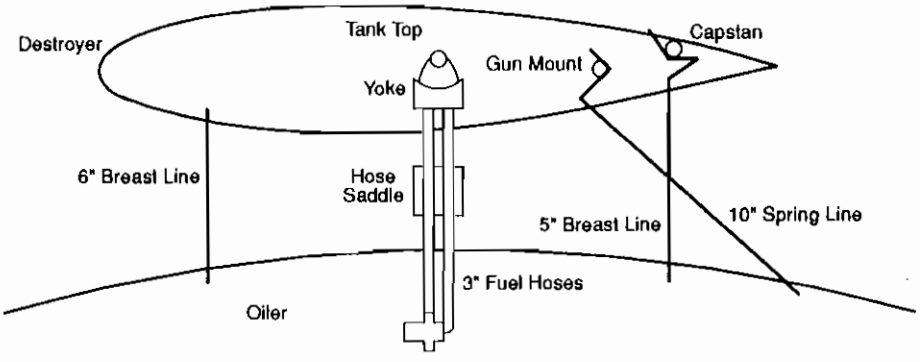
The first ships the *Maumee* met were those of the Fifth Destroyer Division.[9] All were 750-tonners, with a limited fuel capacity.[10] Using the procedures and equipment devised by Nimitz's team, *Maumee* successfully refueled the entire division (the *Patterson*, *Jenkins*, *Drayton*, *Paulding*, *Trippe*, and *Warrington*) in a single day. This marked the first time that fueling at sea had been used during a wartime operation. It was also the first time that the transfer of fuel oil between ships underway had been attempted in anything but a flat calm. Sea conditions during the operation were moderate, with a long cross swell that caused *Maumee* to roll from ten to twenty degrees, with considerable pitching. Although conditions were far from ideal, the *Maumee* was able to transfer almost twenty thousand gallons of fuel (at the rate of thirty-two thousand gallons per hour) to each destroyer. Despite the fact that all the crews were "green," the times from approach to disconnect averaged just seventy-five minutes for each destroyer, even though a hose carried away while the last ship was being fueled. The entire operation was completed in ten hours and thirty-five minutes—an extraordinary feat considering the inexperience of the crews and the poor sea conditions.[11]

Although Nimitz credits Captain Dinger for the conception, design, and execution of this important achievement, Nimitz himself was mentioned for his role in preparing and operating the gear employed.[12] Promoted to lieutenant commander while aboard the *Maumee*, he was soon transferred back to submarine duty, becoming chief of staff to the Commander Submarine Force Atlantic Fleet, a position he held throughout the remainder of the war. Nimitz would not become involved with fueling at sea again until another twenty years had passed.

During the intervening years the Navy would perfect the riding-abeam method for refueling destroyers at sea, a procedure continually refined and practiced throughout the 1930s. Attempts were also made to apply this method for larger vessels, but these were quickly discontinued in accord with the recommendations of the officer in charge of the initial exercises.[13] During the middle 1920s, the Navy did conduct experiments with an alternative approach to fueling capital ships, an arrangement known as the over-the-stern method.

Though some success was achieved, this approach proved of limited value due to the small amount of fuel that could be transferred through the single hose then in use.[14] The Bureau of Construction and Repair was authorized to "continue experiments [of this method] with a view to increasing the rate of delivery of fuel"; however, no additional work seems to have been undertaken before the project was officially terminated in 1931.[15]

When Nimitz reached the rank of rear admiral in 1938, no further progress had been made on the problem of fueling large vessels at sea, even though it had been advocated by one of the Navy's most senior officers, Admiral William V. Pratt. In 1929, when Commander in Chief U.S. Fleet, Admiral Pratt had recommended that "battleships and aircraft carriers . . . be equipped and trained



The Riding-Abeam ("Broadside") Method

After an original obtained from the U. S. Naval Historical Center

J. R. Nunez, Jr.

for oiling at sea from tankers by the riding abeam method."[16] There is no record, however, that the Navy took any action whatsoever concerning this suggestion. In fact, the complete absence of any further effort to test the broadside method on battleships, carriers, or heavy cruisers during the early 1930s suggests that most officers within the Department considered such an operation simply too hazardous to attempt under any conditions. It must be noted though, that the Navy was then operating under such austere budget constraints that funds even for routine repairs and maintenance were severely limited. Needless to say, no captain wanted to be responsible for incurring damage to his ship that would involve additional repair costs. It is easy to understand how this climate could dissuade any commanding officer from practicing a potentially dangerous maneuver such as then envisioned for refueling large vessels at sea using the broadside method.

The first indication of a change in the Navy's attitude came in the fall of 1938, when it became increasingly obvious that when war came, cruisers and aircraft carriers would be required to conduct offensive operations far from base. In October of that year, the Chief of Naval Operations (or CNO), Admiral William D. Leahy, issued a memorandum to the commander in chief of the U.S. Fleet requesting that he undertake all steps (including the acquisition of equipment) necessary to develop means for fueling battleships, carriers, and cruisers from tankers while underway.[17] The impetus for this action appears to have originated within the War Plans Division of the Office of the CNO, which had prepared a lengthy draft of Leahy's memo in September.[18] Apparently, War Plans had become at that time particularly concerned with the problem of fueling cruisers and carriers, "especially when operating or maintaining station in areas distant from [their] own bases."[19] What triggered the war planners' anxiety is not entirely clear; there is considerable evidence, however, that the high rate of carrier fuel consumption was at the heart of the matter.

This shortcoming had first surfaced during Fleet Problem XV of 1935. While participating in this exercise, the USS *Lexington* (CV 2) became critically low on fuel after just five days of operations.[20] During Fleet Problem XVI as well, conducted the following year, the *Saratoga* (CV 3) consumed copious amounts of fuel—as much as ten percent of her total capacity in a single day—when operating aircraft.[21] The latter exercise, which involved extensive movements of the fleet from its bases on the West Coast to Midway Island and back, revealed in general that flight operations by carriers accompanying the fleet resulted in extremely high fuel consumption for the ships involved. In order to launch and recover aircraft, a carrier had to steam at relatively high speed and, necessarily, into the wind—thus usually on a course different from that of the main units of the fleet. After recovering aircraft, she would need to maintain high speed again in order to catch up. Steaming at high speeds, of course, used up enormous amounts of fuel. At twenty-five knots, a carrier's normal speed for operating aircraft in light winds or for trying to overtake the fleet, the fuel consumed by the *Saratoga* exceeded thirty tons per hour![22] At this rate, her steaming radius was only 4,421 nautical miles, much less then the ten thousand miles (at ten knots) specified by her designers.[23] As a result of these problems, the General Board recommended that the fuel capacity of both the *Lexington* and *Saratoga* be increased.[24] It is likely that in the interim, someone in War Plans decided that the carriers would have to be refueled at sea.

Admiral Claude C. Bloch, Commander in Chief U.S. Fleet, wasted no time in responding to Leahy's memo. On 27 October 1938, he instructed the commanders of the Battle Force and the Scouting Force to submit plans and recommendations for refueling the respective ship types assigned to their commands.[25] Admiral Edward C. Kalbfus, Commander Battle Force, responded with a suggestion that a preliminary study of the information already available

on refueling large vessels be made and that a conference be held to outline the scope and procedures of the prospective tests.[26] While data was being collected, Admiral Bloch assigned responsibility for conducting the tests to Rear Admiral Nimitz, who was now commander of Battleship Division One.[27] Nimitz, who would be left on the West Coast when the fleet cruised to the Caribbean in the spring of 1939 for Fleet Problem XX, was instructed to conduct the new tests at that time using units of Task Force Seven left behind with him.[28]

The selection of Nimitz for this task was quite fortunate, for he was probably the only flag officer then in the Navy who had personally planned and conducted fueling operations at sea. Within two weeks of Bloch's order, he had prepared a detailed study of the problem of fueling large vessels at sea, with references to

"In fact, the complete absence of any further effort to test the broadside method . . . during the 1932–1937 period suggests that most officers . . . considered such an operation simply too hazardous. . . ."

no less than sixteen documents, some going back as far as 1925.[29] Citing the fleet's familiarity with the broadside method for fueling at sea and the limited capability of the over-the-stern method, Nimitz recommended "that the fueling experiments . . . be limited to the fueling of a heavy cruiser at sea under favorable conditions by the 'Broadside' (or some approximation thereto) method."[30]

Nimitz's recommendation to try the broadside approach is not surprising, considering his prior experience aboard the *Maumee*. Reading his report, however, one is struck by the careful manner in which Nimitz structured his argument for testing this method. As remarked previously (see note 13), the broadside method was still considered extremely hazardous for any ship larger than a destroyer. The fact that none of the considerable correspondence regarding procedures to be used mentions any method other than the over-the-stern approach indicates the extent to which this attitude prevailed throughout the fleet. Nimitz's report is particularly revealing because it demonstrates his prudence in overcoming this unfounded bias as well as his willingness to accept the inherent risk of an untried procedure.

The recommendations put forth by Admiral Nimitz proved remarkably insightful. Instead of trying to adapt the over-the-stern method, as commanding officers of the "fleet train" tankers universally proposed, Nimitz had the foresight and courage to approach the problem afresh and suggest that the broadside method be tried instead. Despite the greater risk of collision, Nimitz felt that it was important to test the broadside method because of its potential to deliver fuel at a much higher rate than appeared possible using the over-the-stern approach. It would significantly shorten fueling time, a considerable concern

when one recognizes that the relatively slow speeds and straight courses required during the operation greatly increased the danger of attack by submarine.

Admiral Nimitz proposed to test the broadside method in April using the oiler *Brazos* (AO 4) and either the heavy cruiser *Chester* (CA 27) or *Vincennes* (CA 44).[31] No records of this exercise have been located. It is known, however, that during the winter of 1938–1939, extensive station-keeping tests were conducted between the *Chester* and the *Mugford* (DD 389).[32] The ease with which the latter were accomplished appears to have paved the way for the fueling exercises that were subsequently scheduled between the oiler *Kanawha* (AO 1) and the aircraft carrier *Saratoga*.

In the early morning of 13 June 1939, the *Saratoga* departed the port of Long Beach in company with the *Kanawha*, headed for a position off the California coast where the ships intended to test the feasibility of the broadside method to refuel the *Saratoga* while underway. The two ships had spent the previous day at sea practicing the procedures and maneuvers required, though without actually attempting the transfer of fuel. Upon reaching the fueling area on the 13th, the *Kanawha* approached *Saratoga* to a position close alongside so that the necessary lines and hoses could be transferred between the ships. At 10:43 A.M., a breast line was passed to the *Kanawha* and made fast; it was quickly followed by a towing line, a telephone line, and two fuel hoses. Pumping of fuel oil from the *Kanawha* to *Saratoga* commenced shortly after 11:00 and continued without interruption for several hours, the two ships steaming in company at seven knots and making at least one course change during the process. A separate hose for gasoline was also conveyed to the *Saratoga* so that this fuel too could be pumped aboard. When the *Kanawha* cast off at 1:48 P.M., the practicality of the broadside method for fueling aircraft carriers at sea had been conclusively demonstrated.[33]

The broadside method used to fuel *Saratoga* was quickly adopted by the fleet for fueling cruisers, aircraft carriers, and battleships, but the shortage of oilers limited further development of this technique for large vessels. Although the Navy had begun to acquire new oilers of the fast *Cimarron* class, budgetary constraints severely limited the number of ships that could be procured until the "Two Ocean Navy" bill of the late spring of 1940. After the passage of this bill, five more of these "National Defense" tankers were acquired from the Maritime Commission and quickly added to the fleet. The need for oilers was so great at this time that their fitting-out was given first priority, over new construction.[34] Four of the five tankers acquired from the Maritime Commission were rapidly converted for naval use and commissioned as fleet auxiliaries before the year 1940 was out. By the beginning of 1941, seven *Cimarron*-class oilers had been commissioned—the *Cimarron* (AO 22), *Neosho* (AO 23), *Platte* (AO 24), *Sabine* (AO 25), *Kaskaskia* (AO 27), *Sangamon* (AO 28), and *Santee* (AO 29)—with another, the *Salamonie* (AO 26), undergoing conversion.

Early Operations Involving Fleet Oilers

Task Force (Carrier)	Oiler	Action	Strike Date
TF 14 (*Saratoga*)	*Neches*	Relief of Wake	December 1941 (Cancelled because of fueling problems)
TF 11 (*Lexington*)	*Neches**	Strike on Wake	January 1942 (Cancelled after *Neches* loss)
TF 8 (*Enterprise*) TF 17 (*Yorktown*)	*Platte* *Sabine*	Strikes on the Marshalls and Gilberts	1–2 February 1942
TF 16 (*Enterprise*)	*Sabine*	Bombardment of Wake	24 February 1942
TF 17 (*Yorktown*) TF 11 (*Lexington*)	*Guadalupe* *Platte* *Tippecanoe* *Neosho* *Kaskaskia*	Strikes on Salamaua and Lae on New Guinea coast	10 March 1942
TF 18 (*Hornet*) TF 16 (*Enterprise*)	*Cimarron* *Sabine*	Tokyo raid	16 April 1942
TF 11 (*Lexington**) TF 17 (*Yorktown*)	*Kaskaskia* *Tippecanoe* *Neosho**	Battle of Coral Sea	7–8 May 1942
TF 16 (*Enterprise*, *Hornet*) TF 17 (*Yorktown**)	*Platte* *Cimarron* *Guadalupe*	Battle of Midway	6–7 June 1942

*Sunk by enemy action

With the exception of the *Tippecanoe* and *Neches*, both of which were built in 1920, all listed oilers were of the new (eighteen-knot) *Cimarron* class.

As more oilers were added to the Pacific Fleet, it became possible to schedule practice fueling exercises with them. Unfortunately, the rapid expansion of the fleet after April 1940, coupled with the added logistic support required to maintain the fleet at its unaccustomed base at Pearl Harbor, continued to strain the Navy's oiler capacity. Nevertheless, the *Kaskaskia* was able during her first year of operation to test her fueling gear off Johnston Island (southwest of Oahu) in fueling exercises with a battleship, a heavy cruiser, several destroyers, and a submarine.[35] The added knowledge gained during this and similar exercises was applied to improving the equipment and further refining the broadside method for fueling large ships at sea.[36] Instructions later issued for broadside fueling indicate that one of the vessels involved (usually the larger) was to tow the other alongside at a comparatively close distance, i.e., forty to eighty feet. This operation was not considered a dead-weight towing task but rather an "*exercise in position keeping* aided by a towline."[37] Although the towline was intended to act as in aid in station-keeping, experienced crews quickly learned that they could make do without it, leaving just the fuel hoses, their handling lines, and a thin telephone wire between the two ships.[38] Without a towline, one vessel would maintain position on the other by adjusting her engine speed and using "seaman's eye" to correct for small changes in course or for drift due to wind so that the two vessels could be maintained on the same course and speed. While this required excellent seamanship, it simplified the process of connecting the two ships, reducing the time and effort involved so that a number of ships in succession could be rapidly fueled.

The perfecting of fueling at sea during these operations opened the door for the wide-ranging carrier raids conducted during the first months of the war. Nimitz's contribution to developing this revolutionary aspect of naval logistics should not be overlooked; it is unlikely that the procedures used to refuel carrier task forces at sea would have been developed had he not had the confidence and foresight to recommend new tests of the broadside method for large ships. It is uncertain what effect such a failure would have had on the early carrier operations, but it seems unlikely that these raids would have been conducted without the timely development of the fueling-at-sea procedures finally demonstrated by ships assigned to Task Force Seven.[39]

Notes

1. The first of these attacks, a planned raid on Wake, had to be canceled when the oiler accompanying the task force, the *Neches*, was torpedoed and sunk by a Japanese submarine. See Samuel Eliot Morison, *History of United States Naval Operations in World War II*, v. 3 (Boston: Little, Brown, 1948), p. 260.
2. The *Maumee* was later designated "AO 2."
3. Chester W. Nimitz, "The Navy's Secret Weapon" (reprint), *Petroleum Today*, Spring 1961.
4. *Ibid.*
5. *Ibid.*
6. Deck Log of USS *Arethusa*, 22 February 1913 to 31 August 1913. Washington: National Archives, Record Group 24 (hereafter RG 24, NA). The entry for 13 April confirms that a test of fueling at sea was

conducted with the *Warrington* on that date in "clear and pleasant weather." Few details were given, although it appears that the tests were conducted with a 2-1/2-inch fuel hose using a method first used by the British. For details see Spencer Miller, "Refueling Warships at Sea," The Society of Naval Architects and Marine Engineers (SNAME) *Transactions*, v. 22, 1914, p. 176. The *Arethusa* was the Navy's first tanker (as opposed to fleet oiler), purchased in 1898 to transport bulk lubricating oil. She was eventually designated AO 7.

7. These were the "750-tonners" authorized in 1908–1910. Taussig's division was composed of the newer "1,000-tonners."

8. H. C. Dinger, letter from USS *Maumee*, no. TC-60, dated 2 June 1917, as quoted by Albert Gleaves, Commander Destroyer Force, letter to Destroyer Force dated 9 June 1917. Washington: Navy Department Library (Naval Historical Center), microfilm reel 13, WWI, ME-11 (hereafter Dinger Letter). Photocopies furnished the author courtesy Prof. William Still, East Carolina University.

9. Deck Log of USS *Maumee*, 23 October 1916–31 December 1917, RG 24, NA. The entry for 28 May 1917 summarizes the events described by Dinger, thus establishing this date as the first time that the *Maumee* conducted fueling at sea while underway. Nimitz's memory of the event, recalled more than forty years later in an article published by *Petroleum Today*, appears to be faulty, as the author has found no evidence that Tanssig's ships (the first destroyers to cross) were refueled at sea. Although the author has not consulted *Maumee*'s log, Dinger's letter and Nimitz's description of the weather conditions indicate that the Fifth Division must have been the first ships refueled by the *Maumee* at sea. Unfortunately, Dinger's letter does not include the date of the fueling operation described therein.

10. Norman Friedman, *U.S. Destroyers: An Illustrated Design History* (Annapolis, Md.: Naval Institute Press, 1982), chap. 2.

11. Dinger Letter. Although only two hoses were used, Lt. Cdr. Dinger reported that it would be possible to obtain a transfer rate of up to 100,000 gallons per hour if additional hoses were rigged—an accurate projection later validated by the *Brazos* (AO 4) when, during Fleet Problem XIV (1934), she deployed seven fuel hoses at one time while fueling two destroyers simultaneously, one along each side.

12. Dinger Letter.

13. "In the opinion of the Commanding Officer, fueling alongside of any ships longer than destroyers would prove impracticable in any but flat calm. Swells of any magnitude would result in damage to hull or rigging." Deck Log, USS *Cuyama* (AO 3), 11 January 1924, as repeated in a memo by J.R. Sullivan, Commanding Officer, USS *Cuyama*, to Commander Base Force, 9 December 1938. Washington: National Archives, Record Group 313, U.S. Fleet, Base Force Gen. Adm. Files 1931–39[38], Secret & Confidential, File S55-1 (hereafter Base Force File S55-1).

14. Fueling-astern tests (four in number) conducted between the *Kanawha* and *Arizona* between 1924 and 1926 relied upon a four-inch hose suspended between the ships on a long cable wound around a special tension engine needed to keep the fuel hose from dipping into the sea. The transfer rate thus obtained, about 15,000 gallons per hour, was limited by the relatively small diameter of the hose and the great length required. This rate was significantly less than the 50,000 gallons per hour minimum considered acceptable by the fleet for normal operations. The physical difficulties involved in handling multiple or larger-diameter hoses was never satisfactorily addressed, leading to the abandonment of this method of fueling at sea for all but emergency purposes.

15. Chief of Naval Operations to Chief of Bureau of Construction and Repair, 14 April 1927; Commander in Chief Battle Fleet (CinCBatFlt) letter S55-1(1)/FF2(1725) of 27 March 1929, described in a pencil note attached to Director of War Plans memorandum to Director of Material Division, "Fueling at Sea," 16 April 1931. Washington: National Archives, Record Group 19, Bureau of Construction & Repair, Gen. Corr. 1925–40, File S55-(9) (hereafter C&R File S55-(9)), v. 2.

16. Chief of Naval Operations to Chief of Bureau of Construction and Repair, 14 April 1927.

17. William D. Leahy, Chief of Naval Operations, to Commander in Chief U.S. Fleet, "Fueling at Sea—Large Vessels," 20 October 1938. C&R File S55-(9), v. 5.

18. Chief of Naval Operations to Commander in Chief U.S. Fleet, "Fueling at Sea, Large Vessels," undated but attached to SecNav letter 1569 of September 1938. Washington: Naval Historical Center, WPD File, Box 78. Copy furnished author by Edward S. Miller of Stamford, Conn.

19. *Ibid.*

20. Norman Friedman, *U.S. Aircraft Carriers: An Illustrated Design History* (Naval Institute Press, 1981), p. 49.

21. *Ibid.*, p. 51.

22. USS *Saratoga* Trial Data, in George H. Rock, "Some Observations on the Design of Airplane Carriers," SNAME *Transactions*, v. 36, 1928, p. 69.

23. Friedman, *Aircraft Carriers*, p. 50. See also data for USS *Lexington* (CV 2), the class leader.

24. *Ibid.*, p. 51.

25. Commander in Chief U.S. Fleet to Commander Battle Force/Commander Scouting Force, "Fueling at Sea Large Vessels," 27 October 1938. C&R File S55-(9), v. 5.

26. Edward C. Kalbfus, Commander Battle Force, to Commander Base Force, "Fueling at Sea—Large Vessels," 10 November 1938. Base Force File S55-1.

27. Commander in Chief U.S. Fleet to Commander Task Force Seven (ComBatDiv One), 25 November 1938. C&R File S55-(9), v. 5.

28. *Ibid.*

29. Chester W. Nimitz, Commander Task Force Seven (Commander Battleship Division One), to Commander in Chief U.S. Fleet, "Fueling at Sea—Large Vessels," 13 December 1938. Base Force File S55-1. (Conspicuously absent was any reference to the negative comments of the *Cuyama*'s commanding officer in 1924 (see note 13), though Admiral Nimitz must have been intimately familiar with the details of this operation since they were extensively quoted by him a few days later. See Commander Task Force Seven to Commanding Officers, USS *Vincennes*, *Chester*, and *Brazos*, 17 December 1938, Base Force File S55-1.)

30. *Ibid.*

31. *Ibid.*

32. Statements by Admiral Arleigh Burke, commanding officer of the *Mugford* during these exercises, as cited in Marvin O. Miller, John W. Hammet, and Terence P. Murphy, "The Development of the U.S. Navy Underway Replenishment Fleet," *Transactions of the Society of Naval Architects and Marine Engineers*, v. 95, 1987.

33. Deck Log of USS *Kanawha* (AO 1), 1 January 1939 to 31 December 1939, RG 24, NA. Experiments to develop fueling-at-sea gear for use between destroyers and CVs had been conducted by the destroyer *Tarbell* and the *Saratoga* in 1930. It appears likely that such gear was subsequently installed on board the *Saratoga*, thus providing the capability to pass the various lines and hoses to *Kanawha* as *noted in the latter's deck log* referenced herein. (See Commandant [Mare Island, N.Y.?] to Chief of the Bureau of Construction and Repair, date-stamped 5 February 1931. C&R File S55-(9)). This would also explain why station-keeping exercises were conducted between the *Chester* and the *Mugford* whereby the *Mugford* was used to simulate the actions of the approaching ship as opposed to the ship to be fueled.

34. Chief of Naval Operations to Bureau of Ships, subject: *Esso Richmond*, *Esso Trenton*, *Seakay*, 19 October 1940. Washington: National Archives, Record Group 80, Records of the Secretary of the Navy, Gen. Corr., File QS1/L4.

35. Bill Upton, Chief Boatswain's Mate USN, Ret., 21 January 1992, correspondence to the author. (Mr. Upton served aboard USS *Kaskaskia* (AO 27) between 1940 and 1943.)

36. Upton to author, 13 January 1992. The importance of this exercise and the subsequent improvements described by Mr. Upton made to the fueling rig is hard to assess. Mr. Upton's account of the difficulties encountered by the *Kaskaskia*, combined with an examination of photographs of fueling-at-sea operations in the Pacific during World War II, provides ample evidence of the problems experienced by oiler crews when attempting to conduct these operations in heavy seas. It may be that the lack of adequate fueling gear contributed to the problems encountered by Admiral Fletcher in his attempts to refuel from the *Neches* during the abortive operation to reinforce Wake. If such were the case, then the success of later operations can probably be attributed to the modifications suggested by *Kaskaskia*'s crew as a result of their experience off Johnston Island. For example, see the photograph of the *Neosho* fueling *Yorktown* in heavy seas, in Morison, v. 4.

37. Commander in Chief U.S. Fleet (P-2), "Fueling At Sea Instructions," November 1944, p. v, Washington: Naval Historical Center, Operational Archives Branch, Fleet Records of World War Two, File FX-40. (Emphasis original.)

38. This procedure eventually evolved into the so called "close-in method," a terminology that was not adopted until after the introduction of the wire-span method—also known as the "Elwood" method—first tested in December 1944.

39. While it is conceivable that these raids could have been conducted using the astern method, the increased risk of submarine attack would have caused great concern. It is likely that the added risk would have mitigated against its use, especially in light of the subsequent loss of the *Neches* and torpedo damage to the *Saratoga*—both casualties occurring while the vessels involved were steaming at relatively low speeds in a known war zone.

Ψ

Fuel stands first in importance of the resources of the fleet. Without ammunition, a ship may run away, hoping to fight another day but without fuel she can neither run, nor reach her station, nor remain on it, if remote, nor fight.

Alfred Thayer Mahan