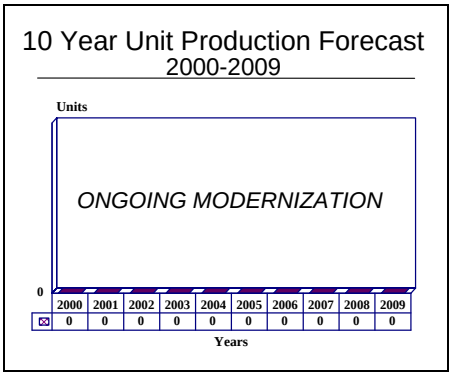
AOE-6 Supply Class - Archived 12/2001

Outlook

- Production program complete
- Will be supplemented by new class of fleet replenishment ships
- Self-defense capabilities may be upgraded
- Primary role remains supporting fast carrier operations



Orientation

Description. Fast combat support ship for under way replenishment of joint task groups (AOE).

Sponsor
United States Navy
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Contractor
National Steel & Shipbuilding Company (NASSCO)
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Status. In service; maintenance and systems upgrading.

Total Produced. Four

Pennant List

Ship	Builder	Launch Date	Commission Date
AOE-6 *Supply*	NASSCO	10/1990	2/1994
AOE-7 *Rainier*	NASSCO	9/1991	1/1995
AOE-8 *Arctic*	NASSCO	10/1993	9/1995
AOE-10 *Bridge*	NASSCO	8/1996	8/1998

Mission. These ships are intended for high-speed forward deployment to provide aircraft carrier and amphibious battle groups with petroleum products, ammunition, food, spare parts and other cargo.

Price Range. The unit price of the latest ship ordered was US$365.8 million in Fiscal Year 1998 dollars. The total life-cycle cost of these ships was pegged at US$568.95 million each in FY95.

Technical Data

	Metric	US
Dimensions		

	Metric	US
Length Overall:	229.7 m	753 ft 8.5 in
Beam:	32.6 m	107 ft
Draft:	11.9 m	37 ft 10 in
Displacement		
Light:		19,700 tons
Full Load:		48,800 tons
Performance		
Maximum Speed:	46 km/h	25 kt
Range:	18,500 km at 31 km/h	10,000 nm at 17 kt
Crew:	40 officers, up to 627 enlisted	
Military Lift Capability		
Dry Cargo Stowage		
Cargo Ordnance Holds:		800 tons
Chill/Freeze Hold:		400 tons
Non-Reefer Bulk:		250 tons
Bottled Gas:		800 bottles
Liquid Cargo Stowage		
DFM/JP-5:		156,000 barrels
Lube Oil:		55-gallon barrels (550)
Cargo Water:		20,000 gallons
	Type	**Quantity**
Cargo Transfer:		
Fueling at Sea (FAS) Stations:		1
10-ton Cargo Booms:		4
Vertical Replenishment:	UH-46E Sea Knight helicopters	3
Cargo Control Center		1
Cargo Fuel Control:		1
Electronics		
Radars		
Air Search:	Mk 23 TAS	1
Surface Search:	SPS-67	1
Fire Control:	Mk 91	2
Navigation:	SPS-64(V)9	1
Electronic Warfare		
ESM/ECM:	SLQ-32(V)3	1
Decoy Launchers:	Mk 36 SRBOC	4
Torpedo Decoy:	SLQ-25 NIXIE	2
Underwater Telephone:	WQC-2	
Fathometer:	UQN-4	
Communications		
SATCOM:	OE-82, SSR-1, WSC-3	
TACAN:	URN-25	
Armament		
Missiles		
SAM:	NATO Sea Sparrow	2x8
Guns		
CIWS:	Phalanx Mk 15	2
Machine Guns:	25 mm L87 Mk 38	2

	Type	Quantity
	M-2HB.50 caliber (12.5 mm)	4

Propulsion

Gas Turbines:	General Electric LM-2500	4x26,500 shp
Propellers:	Fixed pitch 6-blade	2x23 in
Generator Engines:	Caterpillar 3608 diesels, Kato gens.	5x2,500 kW
Reduction Gear:	Cincinnati Gear & SSS-Tosi	2
Reversible Converter Couplings:		4

Design Features. The AOE-6 design is a modified version of the older AOE-1 Sacramento class oilers. One of the key differences is the change from steam turbine to gas turbine propulsion, making them the world's largest gas turbine-powered ships. The superstructure of both classes is very similar with the exception of the funnel, which is modified in the AOE-6 to reflect the greater intake requirement of its gas turbines.

Internally, the cargo capacity, both liquid and solids, is slightly smaller on the AOE-6, probably a reaction to greater attention to today's environmental concerns. The rated top speed of both classes is 26 knots (although both classes are reported to have achieved top speeds in the 30-32 knot bracket). The total installed power is similar at about 105,000 horsepower.

The LM2500 gas turbines are installed in sets of two, in two acoustic housings (fore and aft).

One distinctive feature of the AOE-6 class is the use of a reversible converter coupling (RCC) in the propulsion gear, allowing reverse operation of the system with fixed-pitch twin propellers. The unit, supplied by SSS-Tosi, is installed together with an SSS clutch system on each pair of the gas turbines. The turbine drives through a Cincinnati Gear reduction and combining gear, and the SSS-Tosi unit is integrated into that structure. The synchronous Tosi gear is a fully automatic (self-shifting) freewheel device and uses gear teeth for the transmission of power, instead of friction plates, hydraulics, or electromagnetic devices. No clutch slip can occur because the clutch engagement is initiated by a pawl and ratchet mechanism. The transmission uses the normal type of locked-train, double-helical gearing that is specified on US Navy gas turbine ships in the first place, making the componentry more compatible with the rest of the Fleet.

This is one of the first applications of such a coupling arrangement on a relatively large, high-performance naval vessel. It is yet to be seen whether the use of a reverse gear in lieu of controllable-pitch propellers produces cost savings sufficient to justify the use of the same technology in other warships of similar size and weight. It had been estimated by the shipbuilder at the outset that the complexity of the reduction gear would entail added maintenance on the drivetrain, as compared to the more standard controllable-pitch propeller configuration. However, the use of fixed-pitch propellers offset some of the estimated increases in maintenance, and no major difficulties were encountered with the first ships of the class.

The Supply class was built in modules, with the piping sections, ventilation ducting and shipboard hardware installed along with major machinery items, such as main propulsion equipment, generators, and electrical panels. These pre-outfitted sections were then brought together to form a complete hull. Thanks to this building technique, the first of the class, the AOE-6, was nearly 50 percent complete when it was launched on October 6, 1990.

The following four years were reportedly spent on finishing the ship's electrical wiring, plumbing and ventilation systems, and equipment and hardware installation. During the final phases of its construction, the AOE-6 performed a series of dockside and sea trials to demonstrate its capabilities and to ensure product quality.

Operational Characteristics. The ship is designed to function as a high-speed cargo carrier, combining the functions of the earlier AE, AFS and AOR supply ships in one platform. The AOE-6 class provides a vital capability for front-line operation of carrier task forces. In effect, these ships are the final link in shifting fuel, munitions and other consumables from distant base areas to the warships operating in harm's way. Their speed, capacity and under way replenishment abilities make them exceptionally valuable assets; on the other hand, the same characteristics make these ships prime targets for the enemy.

The Supply class can use one of two methods to replenish the other ships of the battle group. Some ships can maneuver alongside and receive fuel, stores, ammunition, food, and personnel through Connected Replenishment (CONREP). Other ships can receive the same products except fuel through helicopter delivery

(VERTREP, Vertical Replenishment). Up to four ships can be serviced simultaneously, while the AOE-6 is carrying out its own self-defense, electronic surveillance and battle group command and communications functions. The ship requires less manning than others of similar size, thanks to extensive automation and highly developed engineering and technological solutions. Consequently, the ship is one of the showcases of the US Navy's new philosophy of doing "more with less," and has a staff with a higher level of expertise.

The AOE-6 class can take a load of 156,000 barrels of fuel oil, 1,800 tons of ammunition, 400 tons of provisions, and 250 tons of general cargo. The ships have three refueling rigs on the port side and two on the starboard side. Three tensioned cargo replenishment rigs are on each side. A sliding padeye rig on the starboard side serves as an additional under way replenishment rig. Thirty percent of the fuel tank capacity is for Distillate Fuel Marine for ships and 40 percent for JP-5 aviation fuel, and 30 percent is convertible to either type as needed.

Each of the four cargo holds has two elevators and a series of pallet conveyors to aid in cargo stowage. Forklift trucks move cargo in the holds and on deck. Three UH-CH-46E Sea Knight helicopters give the ships a vertical replenishment capability.

AOE Supply Class

Source: US Navy

Variants/Upgrades

Smart Ship. No variants or upgrades to this class exist as of yet. However, the USS *Rainier* (AOE-7) is being used to test the so-called Smart Ship concepts which are expected to eventually allow reductions in manpower. Smart Ship is a concurrent development to the AEGIS program family.

AOE (X). This is the new oiler-type vessel likely to replace the AOE-6 class in the future. It is currently in the conceptual stage. The US Congress is allocating funding for this ship type from similar development projects that concern other US Navy surface ships, including the LPD-17 class amphibious ship, the CV(X) future carrier program, and the SC-21/Arsenal Ship concept. The overall aim is to develop all future programs in concert so that their electronic warfare capabilities and the roles of individual ships in the larger operating scene are well coordinated.

Design work on the AOE(X) continues in fiscal year 1998 under Program Elements number 0603563N and 0603564N. In FY97, the combined ADC(X)/AOE(X) effort was renamed the AOE(X), suggesting a slight shift in emphasis of the program and of the future ship class intended to be generated by these studies. In FY99, development of the AOE SLE Contract Design is expected to continue, having evolved to Contract Design stage late in FY98.

Program Review

Background. The Naval Sea Systems Command (today: NAVSEA) began feasibility studies for a new AOE class in December 1981 and completed them in May 1982. Preliminary design studies commenced that same month, ending in November 1982. Engineering studies, completed in March 1983, considered six different propulsion alternatives: steam turbines, slow-speed diesels, medium-speed diesels, gas turbines, gas turbines with a Rankine Cycle energy recovery heat recycling system, and a diesel or gas turbine (CODOG) or a combined diesel and gas turbine (CODAG) configuration. The engineering studies team chose the gas turbine plant for the ship's prime mover since it offered the required combination of speed, endurance and reliability all in one package.

The contract design studies for the new ship began in early 1983. The Ship Characteristics Improvement Board approved these studies in May 1983. The Chief of Naval Operations approved the characteristics in July 1983. The contract design phase ran from June 1983 to December 1984. Several prospective shipbuilders received the design in 1984. The FY85 US Navy Five-Year Shipbuilding Plan called for the first ship in FY86. The FY86 five-year plan pushed the order back to FY87. The Navy began ordering long-lead items for the AOE-6 in FY86, including under way replenishment equipment and electronic systems. Contract design was completed in February 1986.

The Navy asked for US$612.7 million for the AOE-6 in its FY87 budget. Following a major debate, Congress decided to approve US$499 million for the AOE-6 in FY87. A Request for Proposals for the detailed design and construction of the AOE-6 was issued in October 1986. Ten bids were requested and four bids received; these were from Avondale Shipyards, Pennsylvania Shipbuilding, Ingalls Shipbuilding, and National Steel and Shipbuilding Company (NASSCO). The last firm submitted the winning bid. The Navy awarded NASSCO a US$290.9 million contract (N00024-87C-2002) on January 27, 1987. The contract contained options for three more fast combat support ships.

The Navy's FY89 budget requested US$363.9 million for the AOE-7. This was a US$61.5 million decrease from the figure given in the original FY88/FY89 budget request, which postulated a FY89 request of US$425.4 million. The Navy's FY88 Five-Year Shipbuilding Plan, which was re-released with only slight changes in February 1988, called for one AOE in FY89, with the last two to be ordered in FY91. This compressed the original FY87 plan, which called for one per year in FY89, FY90 and FY91.

Steel fabrication work for the first of the series was begun on June 23, 1988, with the official keel laying conducted on February 24, 1989. Meanwhile, the Navy awarded NASSCO a contract modification (N00024-87C-2002) worth US$242.7 million on November 3, 1988, to build the second ship of the series, the AOE-7. In early January 1989, Morrison-Knudsen management proposed that the Avondale Industries shipyard complete the two now unfinished AOE ships in case it had to close down NASSCO. The Navy was against this, fearing that if Avondale received a contract to build the AOE ships, Congress might oppose its giving Avondale any additional T-AO-187 oiler contracts. After Morrison-Knudsen failed to continue discussions, Avondale backed off from any agreement.

In mid-February 1989, the Navy and Morrison-Knudsen reportedly reached an agreement, releasing the company from contractual obligations, and guaranteeing NASSCO sufficient funds to complete the AOE ships. In May 1989, NASSCO arranged an employee buyout from Morrison-Knudsen. The owner of the shipyard is now NASSCO Holdings Incorporated.

The Navy requested US$356.6 million for the AOE-8 in FY90. Both the House and Senate conferences approved this request, and the ship was included in the final budget. When the Navy issued its FY90 Five-Year Shipbuilding Plan in January 1989, it showed planned requests for one AOE ship per year from FY90 through FY94. In testimony given before Congress in early 1989, the Navy indicated that it wanted a force of at least 14 AOE ships, or one for each carrier battle group. These plans were not changed by the revised defense budget issued in April 1989.

In December 1989, the Navy executed the option in the original contract to build the third ship of the class. The third ship was originally due to be commissioned in July 1993, but this date slipped until November 1994 and still further to September 1995. The Navy's 1991 Four-Year Shipbuilding Plan called for one ship in FY91 and three more in FY93. A new Six-Year Shipbuilding Plan was issued with the FY92 budget; in that plan, the Navy called for one more ship in FY92.

In early 1991, Congress gave the Navy permission to reprogram US$237 million from the US$389 million appropriated for the fourth of the AOE-6 class ships. In requesting the reprogramming, NASSCO stated that if it did not receive payment for the increased cost, it would

have to close its doors. This money is to be split to cover claims on the first three ships. The US$237 million was split as follows: US$77 million for the AOE-6, US$79 million for the AOE-7, and US$81 million for the AOE-8. The Navy then estimated the price per ship at US$540 million.

The USS *Supply* commissioned in February 1994, with the second ship following in January 1995. The program is at least two years behind schedule and is still slipping, albeit at a slower pace. The Navy requested US$500 million in the FY91 budget for the fourth ship of the class. In negotiating with Congress, the funding was approved and authorized to pay for cost overruns on the first three ships. The Navy requested funding for the fourth ship again in the FY92 budget. Congress did not approve the funding. Based on the recommendations of the Inspector General of the Department of Defense, Congress recommended that the program be completed at three. In spite of this recommendation, the fourth and final ship of the class was funded in FY93 at a unit cost of US$365.8 million. This ship, the AOE-10 USS *Bridge*, entered service officially on August 5, 1998. Attention has now switched to a possible AOE(V) design which will be built in the far term.

Funding

The US government has funded the AOE program through the Navy's Naval Sea Systems Command. A follow-on fast combat support ship is one part of the Ship Preliminary Design and Feasibility Studies (PE#0603564N) and Ship Concept Advanced Design (PE#0603563N) program elements, which also include the designing of other future US Navy combat vessels.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
National Steel and Shipbuilding Co (NASSCO)	$365.8	January 1993 – Construction of the fourth ship of the AOE-6 class, AOE-9, including options for the installation of the Phalanx Mk 15 and NATO Sea Sparrow defense systems. (N00024-93C-2303)
Metro Machine Corp	150.3	September 1999 – Phased and dry-dock phased maintenance (value indicated includes options if exercised; contract also covers AOE-1).

Timetable

Month	Year	Major Development
Dec	1981	AOE-6 feasibility studies initiated
May	1982	AOE-6 feasibility studies completed
Nov	1982	Preliminary design work begun
Mar	1982	Propulsion plant studies completed
May	1982	Design approved by Ship Characteristics Improvement Board
July	1982	Design approved by Chief of Naval Operations
Dec	1984	Contract design completed
Jan	1987	AOE-6 ordered
Dec	1991	Defense Department Inspector General distributes Program Audit Report
FY	1993	Last ship of the series funded
Aug	1996	Last ship (AOE-10) launched
Aug	1998	AOE-10 (*Bridge*) enters service

Worldwide Distribution

US. 4

Forecast Rationale

The AOE program was originally intended to provide 12 ships, one for each fast carrier group. This plan has since been scaled back to four ships that will replace the four old steam turbine-powered AOEs. The result is likely to be an operational restriction on the ability of the fast carrier forces to refuel at sea and increased their reliance on port facilities. These may not be secure and this dependence has associated costs, as was demonstrated by the attack on the destroyer USS *Cole*.

This attack led to criticism of the decision to fuel the *Cole* in Aden and resulted in calls for increased provision for fueling at sea. To some extent this call is inappropriate since the conditions that led to the decision to use Aden, a prolonged run at high speed that left the short-legged destroyer in a critical fuel state, made it unlikely that a tanker would be conveniently located. Nevertheless, this is the sort of high-profile incident that does bring about changes in policy, and a supplement to the US under way replenishment fleet could be the result. However, such a change is likely to implemented by recommissioning existing ships held in reserve rather than building more highly specialized AOEs.

The follow-on AOE(X) class is in development, and will be funded by Congress over the next few years. According to USN shipbuilding plans, that ship should be ordered around FY03. Given the expected hump in shipbuilding expenditure in the coming years, it is quite possible that this program will be delayed so that scarce funds can be diverted to other projects.

Ten-Year Outlook

No new production is projected – only modernization and upgrade activity of the onboard systems will continue throughout the forecasting period; the forecast chart has therefore been omitted.

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