Type 45 Daring Class

Outlook

- No additional construction planned
- Ships exceeded expectations, but number in class inadequate
- Naval procurement pattern uncertain, but does not include additional Type 45s

Orientation

Description. A large multirole destroyer primarily intended for AAW missions.

Sponsor

Ministry of Defence
DE&S Secretariat
Spur 5, E Block
Ensleigh
Bath BA1 5AB
U.K.
E-mail: DESSEC-Internet@mod.uk

Licensees. No production licenses have been granted or are being contemplated.

Status. In service.

Total Produced. Six ships commissioned.

Application. A multifunction area air-defense escort within a Task Force or Carrier Group, providing the Royal Navy's future AAW destroyer force.

Price Range. The total cost of the Type 45 Daring class program was originally stated as $9.4 billion for 12 ships, giving a unit cost of approximately $780 million. Following the reduction of the class to eight units, the estimated unit cost increased to $1 billion. The final reduction to six ships increased the estimated unit cost still further, to an estimated $1.2 billion.

Pennant List

Number & Name	Builder	Launch Date	Commission Date
D 32 *Daring*	BAE Systems (Yarrow)	2/2006	7/23/2009
D 33 *Dauntless*	BAE Systems (Yarrow)	1/2007	6/3/2010
D 34 *Diamond*	BAE Systems (Yarrow)	11/2007	5/6/2011
D 35 *Dragon*	BAE Systems (Yarrow)	11/2008	7/2011
D 36 *Defender*	BAE Systems (Yarrow)	10/2009	7/2012
D 37 *Duncan*	BAE Systems (Yarrow)	9/2010	3/22/2013

Type 45 Daring Class

Contractors

Prime

BAE Systems plc	http://www.baesystems.com, 6 Carlton Gardens, Stirling Sq, London, United Kingdom, Tel: + 44 1252 373232, Fax: + 44 1252 383991, Prime
BAE Systems, Maritime	http://www.baesystems.com/our-company-rzz/our-businesses/maritime/locations, 1048 Govan Rd, Glasgow, United Kingdom, Tel: + 44 141 959 1207, Fax: + 44 141 958 0642, Lead Contractor
Vosper Thornycroft (UK) Ltd	223 Southampton Rd, Paulsgrove, Portsmouth, Hants, United Kingdom, Second Prime

Subcontractor

BAE Systems, Platforms & Services, Munitions	http://www.baesystems.com, Radway Green, Nr Crewe, Cheshire, Cumbria, United Kingdom, Tel: + 44 1270 882 261, Fax: + 44 1270 866 666, Email: media@baesystems.com (4.5-inch L55 Mk 8 Gun)
BAE Systems plc	http://www.baesystems.com, 6 Carlton Gardens, Stirling Sq, London, United Kingdom, Tel: + 44 1252 373232, Fax: + 44 1252 383991 (Command System)
DCNS Naval Facilities	http://www.dcnsgroup.com, PO Box 30, Ruelle, France, Tel: + 33 5 45 24 30 00, Fax: + 33 5 45 24 33 33, Email: dcn-equipements-navals@dcn.fr (Sylver Vertical Launcher System)
Repaircraft plc	http://www.repaircraft.com, The Common, Cranleigh, Surrey, United Kingdom, Tel: + 44 1483 273536, Fax: + 44 1483 278078, Email: hq@repaircraft.co.uk (Hull Structure Components)
Rolls-Royce Naval Marine Inc, (Bird Johnson Co)	http://www.rolls-royce.com, 110 Norfolk St, Walpole, MA 02081 United States, Tel: + 1 (508) 668-9610, Fax: + 1 (508) 660-6152 (WR-21 Gas Turbine)
Wallop Defence Systems	http://www.esterline.com/defensetechnologies, Craydown Ln, Nr Stockbridge, Middle Wallop, Hampshire, United Kingdom, Tel: + 44 1264 781456, Fax: + 44 1264 782084, Email: enquiries@wallopdefence.com (Decoy Launchers)

Comprehensive information on Contractors can be found in Forecast International's "International Contractors" series. For a detailed description, go to www.forecastinternational.com (see Products & Services; Companies, Contractors, Force Structures & Budgets) or call + 1 (203) 426-0800.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

	Metric	U.S.
Specifications		
Length (overall)	152.4 m	500.0 ft
Beam (waterline)	21.2 m	69.6 ft
Draft	5.7 m	18.7 ft
Displacement		
Light	5,800 tonnes	
Full load	7,450 tonnes	
Performance		
Speed		
– Max		29 kt
– Cruising		18 kt
Range		7,000 nm at 18 kt
Crew	31 officers, 160 enlisted	

Type 45 Daring Class

	Type	Quantity
Armament		
Guns		
Medium caliber	4.5-inch L55 Mk 8	1
CIWS	Phalanx Mk 15 Block 1B	2
Light	30mm	2
Missiles		
Long-range SAM	ASTER 30	32
Point defense SAM	ASTER 15	16
Torpedo tubes	Lightweight (324mm)	2x 2
Torpedoes	Stingray	24
Helicopter	Merlin HMA.1	1
Electronics		
Radars		
Air/surface search	Type 1046 (S-1850M)	1
Target acquisition	Type 1045 (Sampson)	1
Surface search	Type 1048	1
Fire control	EOGCS (electro-optical)	2
Navigation	Type 1047	2
Electronic Warfare		
ESM	Outfit UAT	2
ECM	Type 695	2
Decoy launchers	Outfit DLH(2)	4
	Outfit DLF(2)	4
Torpedo decoys	Type 2170 (SLQ-25A(V) J-SSTD)	2
COMINT	COBLU	1
Sonar	MFS-7000	1
Propulsion		
IEP gas turbines	WR-21 ICR	2x 18,000 kW
Diesels	(generators, w/2 motors)	4x 2,600 kW
Shafts		2

Design Features. The design feature that has attracted the most attention is the size of the Type 45 destroyer. At the time the design was frozen, the ship displaced 7,350 tons at deep load and 152 meters in length. This made it considerably larger than the Type 42 it replaces. A major factor in this size decision was that the Type 42 had been severely compromised by politically inspired restrictions on its size, which had cramped the design and limited combat effectiveness. In fact, the originally conceived size proved to be inadequate, and further expansions increased its deep-load displacement to as much as 8,000 tons.

Designed for missions of up to 45 days, the Type 45 has an unrefueled range of 7,000 nautical miles at a speed of 18 knots, and a maximum speed of 29 knots. The selected speed has also been the grounds of some criticism, with allegations that it is too slow and that a higher speed was essential. These accusations neglect the fact that the Royal Navy is standardized around these speeds; operational experience showing that higher speeds are undesirable.

The basic goal of the Type 45 design is to make the ship as economical as possible to run and maintain without compromising combat effectiveness. The large hull eases the overhaul and/or replacement of equipment and systems, and allows for the efficient use of internal space. A significant factor in its design is the adoption of the newly developed Lloyd's Naval Ship Rules (NSRs) for hull structure. To comply with these rules, plans for the principal structural arrangements of the vessel were submitted to Lloyd's Register for approval. This allowed the ships to be insured against pollution and accidental damage, a major consideration in today's environment.

The overall design of the Type 45 is a direct result of the demands made by its PAAMS (Principal Anti-Air Missile System). It reflects the same lessons as the U.S. Arleigh Burke and Ticonderoga classes, where design was essentially determined by the SPY-1/AEGIS class systems. The large radars needed to operate the PAAMS required a high level of stability (that is, a stiff ship in which roll was reduced by the maximum level

Type 45 Daring Class

consistent with safety). In addition, the heavy Sampson radar had to be carried high to maximize the distance at which threats could be identified. The adoption of a vertical launch system (VLS) design also meant that the hull had to have beam and depth margins adequate to accommodate the tubes. Hydrodynamic demands required the hull to be lengthened in order to maintain speed without excessive power demands. These considerations dictated a ship that was nearer 7,000 tons than the 4,000 tons of, for example, the Type 23 frigate.

Another factor that drove up hull size was the need to suitably accommodate the crew to 21st century standards. Accommodation on the Type 45 is luxurious compared with the preceding Type 42 class. Instead of large mess decks, junior rates have six-berth cabins. Senior rates have four- or two-berth cabins, and officers have shared or individual cabins. All cabins are unisex, for flexible male/female crew ratios. The ship's complement is about 190 crew, with space for up to 235.

This additional accommodation space, in theory, allows for about 45 members of specialist teams and their equipment for military or paramilitary missions or disaster relief. A much-publicized attachment for these ships is a 30-strong (60 in austere conditions) Royal Marine or Special Forces detachment complete with weapons, equipment, and boats. However, a cautionary note must be sounded. All ships show growth in crew size over time, and it will not be long before the ship's regular complement fills the additional space allocated. This is an interesting application of Parkinson's Law that suggests crews expand to fill the space allocated to them.

Other important design features include the large hangar able to accommodate a Merlin HMA.1 helicopter and a flight deck sized to accept a Chinook HC.4 helicopter. These aviation arrangements significantly increase the flexibility of the ship.

The power/propulsion spaces and the 48-cell missile silo absorb so much internal volume in the Type 45 that the operations room is not installed deep in the hull. Instead, it follows U.S. practice and is on the main deck below the foremast. This has also been the subject of criticism, although it should be noted that the Royal Navy was one of the last to retain the deep-buried command center concept and paid a significant cost in terms of cramped facilities as a result.

The Type 45 initially carried 48 SYLVER A50 launchers, but the ship is designed to carry up to 64 SYLVER silos. In addition, the silos themselves are carried within a one-deck-level-deep deckhouse that provides adequate volume for the installation of larger silos should the change become necessary in the future. The deckhouse mounting also provides added protection for the silos against wave damage in the event of the ship encountering severe weather.

The Type 45 design draws heavily on the successful Type 23 frigate, including the general arrangements of the ship and many of its onboard systems. As is standard with modern warships, the demands of "stealth" features have been incorporated in the design, particularly to reduce radar cross-section (RCS) and thermal emissions. The sheer line of the forward hull is flat, a feature last seen on the King George V class battleships. The most recent frigates have a sheer line that ramps down from the bows to the superstructure. One innovation is that all of the mooring equipment has been moved to a lower deck, where it is hidden by panels that are opened only when the ship is docking. In addition, the number of sea boats on the Type 45 is reduced in favor of rigid inflatable boats (RIBs), and those that remain are hidden behind removable panels. These "garages" for the ship's boats are located on both sides of the ship's aircraft hangar.

The Type 45 produces a much lower acoustic signature than older frigates to prevent detection by hostile submarines. In theory, this improves both its survivability and capability when operating in an ASW role; however, the limited ASW fit on the Type 45 is such that its participation in ASW operations is an emergency assignment only. The annual running cost will be about $25 million, excluding refits. The class is designed for a service life of 25 years.

The main armament of the Type 45 destroyer is the PAAMS, featuring a mix of 48 ASTER 15 and ASTER 30 surface-to-air missiles (SAMs). The Type 45 destroyer specification stipulates that the ship be capable of performing both point defense and area defense tasks in the face of current and next-generation anti-ship missiles. These missiles pose a variety of threats, having a wide variety of flight profiles. Benchmarks of the proposed threats include missiles that are sea-skimming, aero-ballistic, supersonic, stealthy, or highly maneuverable, and any mix of the above. In addition, the PAAMS is required to handle attacks that could come from any direction and be either single missiles or salvoes. Initially, the ASTER missiles are carried in DCN SYLVER vertical launch cells; however, sufficient weight and space are provided for the substitution of the more flexible Lockheed Martin Mk 41 VLS in the future.

Plans called for the Type 45 to be fitted with an Inner Layer Missile System (ILMS) such as Starstreak or RAM (Rolling Airframe Missile). This was a step down from the original plan to install a powerful secondary battery of vertical-launch Seawolf missiles. In any event, all plans for an additional point defense missile

system were deleted, reportedly on grounds that ASTER 15 fulfilled this role adequately and would not require the installation of additional launchers. A proposal to install Raytheon Phalanx Block 1B mounts as a last-ditch close-in weapon system (CIWS) to destroy "leakers" has also faded away, although it is reported that the ships are being built on a "for-but-not-with" basis for these systems. This means that no guns will be installed, but the ships will be built ready to receive them; the fit would only take a few days. It is a reasonable guess that the Phalanx systems will be taken from the Type 42s once they are withdrawn from service. There have also been reports that the Sea RAM system may be installed on the Type 45. This system replaces the Phalanx's 20mm gun with an 11-missile-round launcher assembly loaded with RAM Block 1 guided missiles. A Sea RAM system was tested on HMS *York* in 2003, adding weight to such suggestions.

Initially, the Type 45 is not fitted with any surface-to-surface guided weapon (SSGW), as this is not a formal requirement. However, the design provides for the capability to install the Boeing Harpoon Block II SSM in two quad launchers, if required. Thus, the Harpoon will be easy to install later.

Despite much speculation, the installation of Tomahawk Land Attack Missiles (TLAMs) on the Type 45 has been largely theoretical, and there are currently no plans to do so, as land attack capability is not a formal requirement. A serious problem with any such installation is that the ASTER SAM is only cleared for SYLVER. Changing from DCN SYLVER to Lockheed Martin Mk 41 launchers may not only allow for TLAM, but also prevent the Type 45 from carrying ASTER SAMs. The cumulative effect of these design problems combined with the shortage of funding for the Royal Navy is that mounting land attack missiles on the Type 45 may no longer be considered plausible.

The Type 45's main gun is the new Mod 1 version of the elderly Vickers (now BAE Systems) Mk 8 design. This incorporates various minor changes to improve reliability and maintainability and reduce weight. It has a new angled low-profile shield and is capable of firing new high-explosive extended-range ammunition with a maximum range of 27 kilometers. When the program was originally conceived, the Royal Navy had been pushing hard for a better gun than the old Mk 8 and proposed the installation of a new 155mm weapon that could provide additional anti-surface capability, including the ability to fire extended-range guided munitions.

The most obvious contender was the U.S. 155mm Advanced Gun System – currently under development – but this was considered by the Ministry of Defence to be too expensive and complex. A low-cost, low-risk navalized variant of an army land-based 155mm gun was the most likely option. However, experiments with the German MONARC system (the installation of a PzH-2000 155mm turret on a frigate) showed that such solutions were unsatisfactory due to the problems in handling the shells in a seaway. As a result, the proposal to up-gun the Type 45s has been discarded, with even the procurement of secondhand 127mm Mk 45 guns being too costly.

The Daring class is fitted with a hull-mounted medium-frequency search-and-attack sonar. An Invitation to Tender for the sonar system was issued by the prime contractor in February 2001. A new off-the-shelf system was considered to offer the best value for the money, but the MoD was also seriously considering the option of fitting refurbished Type 2050 sets removed from paid-off ships (Type 22 Batch 2s). Eventually, the EDO MFS-7000 was selected. It appears that the primary role for these sonars is mine avoidance, with ASW being a secondary concern. Ship-mounted Stingray torpedoes fired from Cray torpedo launchers are also specified for these ships, although fitting is being deferred from early units as an economy measure.

The Type 45's anti-submarine warfare capability is provided by the Lynx HMA.8 helicopter. Eventually, PRISM deck-handling equipment may be fitted to allow the operation of an EH101 Merlin HMA.1. Both aircraft carry Stingray anti-submarine torpedoes; the Lynx is also capable of carrying the Sea Skua anti-ship missile.

The Type 45s are also equipped to carry the Surface Ship Torpedo Defense (SSTD) system of towed and expendable acoustic decoys, although again, early ships are not equipped with this system. In the long term, all Type 45s will be fitted to deploy enhanced SSTD countermeasures. Whether funding will permit these acquisitions remains to be seen, but the prognosis is not good.

The combat management system (CMS) of the ships is produced by BAE Systems Combat and Radar Systems under a contract worth about GBP50 million, and includes a Fast Ethernet-based data transfer system that was separately contracted for about $10 million. The CMS is a fully integrated system that enables the command team to carry out the operational roles undertaken by their ship. It will generate the tactical picture, perform threat evaluation and weapon assignment, and control the other combat system equipment, including PAAMS. Economy has been achieved by exploiting experience with the surface ship command system and the ADAWS (action data automation weapons systems) on the Surface Ship

Type 45 Daring Class

Combat System (Outfit DNA) already in service aboard the Type 23 frigates. The system uses commercial off-the-shelf (COTS) hardware and operating systems.

The Type 45 uses an integrated electric propulsion (IEP) system centered on the use of advanced WR-21 gas turbine generator sets. Installing these provided something of a design challenge since they are more than a single deck in height and thus required a new engine room design. The generator sets provide the electrical power to drive the ship's main propulsion motors while also powering all electrically driven equipment. The engineering crew has full flexibility to transfer power from one application to another. Some developmental work on this system was performed with the Albion class LPDs. The Type 45 installation marks a midpoint between the Albion's early setup and the integrated full electric propulsion (IFEP) system planned for the Queen Elizabeth class aircraft carriers.

The Type 45s have a two-unit, twin-shaft powertrain configuration, each unit having a Rolls-Royce/Northrop Grumman WR-21 ICR gas turbine generator unit in the forward engine room and a 20-MW electric induction motor in the aft engine room. This is a damage control arrangement intended to allow the ship to continue functioning on one train when the other has been hit or suffers some other form of casualty. Although rated at 25 MW, the WR-21 units for the Type 45 will deliver 21.5 MW. Emergency power is provided by two 2-MW diesel generators that occupy the forward engine room compartment. This is a questionable arrangement that does not provide for distributed power generation in the event of a serious machinery casualty. This deficiency was blamed for the loss of HMS *Sheffield* during the Falklands campaign.

Operational Characteristics. The primary role of the Type 45 is anti-air warfare, although the ships have a limited self-defense anti-submarine capability. The Type 45 will provide the backbone of the Royal Navy's anti-air warfare capability. These requirements mean that the ship has to be capable of worldwide operations across the full spectrum of maritime and climatic environments. Modern conditions also dictate that the Type 45 be capable of coordinating operations with naval forces from other countries, including some that would not have fallen under previous definitions of NATO or coalition allies. An original demand, that they be capable of undertaking a wide range of missions with varying levels of command, has been largely abandoned as a result of funding cutbacks, and these ships are now primarily AAW platforms with little capability in other areas. However, they do remain capable of undertaking a number of command and control roles due to their sophisticated command systems. These roles cover the full spectrum of activities, from diplomacy to war.

The Type 45 is configured to operate in support of a force of lightly armed or unarmed vessels, as a unit in a task force or a carrier group, and as a single unit in non-combat operations. The Type 45 is designed to provide the layered air defense system that has been shown (by bitter experience, not least in the Falklands) to be the basis of effective air warfare operations. This multi-layered defense combines long-range air surveillance, airborne early warning, combat air patrol, and medium- and short-range missile defense. This means that air defense is probably the most expensive of all surface warfare operations. While PAAMS provides the critical medium layer essential to continuous, all-around area protection, and is critical for maritime power projection in support of joint task force operations, the elimination of point defense capability in the Type 45s is still a matter of grave concern.

The Type 45 is well suited to accommodate the extreme command and control requirements of maritime AAW. The ship is well equipped to provide both local and fleet-wide air warfare coordination duties and to de-conflict the demands of varying members of a task group. This is particularly the case where a significant non-combatant presence is in effect and political demands are such that neutral ships or aircraft must not be hit. Finally, in non-combat operations, or the coyly named "operations short of war," the Type 45 is capable of providing search-and-rescue operations, disaster relief, maritime surveillance and policing, and any other defense diplomacy tasks for which current warships are regularly assigned. These tasks, collectively known as showing the flag, are usually estimated to provide up to 80 percent of a warship's operational assignments.

The original design specification was for a speed of 28 knots, but the Type 45s have comfortably exceeded 30 knots during their runs over the measured mile. HMS *Daring* reached this speed in little over two minutes from a standing start. This constitutes a remarkable performance for a ship of this size. More impressively, none of the almost 800 compartments within the hull suffered from excessive vibration when the ship's machinery was operating at full power. This is almost unheard of; nearly all first-of-class trials reveal at least some level of vibration at full power. To have avoided this problem on a first set of trials is a great testament to the design and construction of the ship.

Variants/Upgrades

Preplanned Product Improvement. The Type 45 design was originally intended to evolve from batch to batch and was built with growth in mind. The design allows sufficient margins to accommodate alternative weapons and their launcher systems as new technologies are developed.

The armament and weapons systems of the Type 45 have been divided into an initial core Batch 1 baseline, plus an Incremental Acquisition Plan (IAP) of desirable features, which have been prioritized and will be added as funding becomes available. Generally, the philosophy is to recognize short-term budget constraints, build in capability, and then seek out the extra money needed to add in the capability.

The PAAMS ASTER VLS missile silo has been raised by one deck so that, in the future, the DCN SYLVER missile launchers can be replaced by deeper launchers (such as the Lockheed Martin Mk 41 VLS) that are able to accommodate a greater range of weapons.

Medium-Size Vessel Derivative. The MSVD was one of the options that emerged from the wreckage of the Future Surface Combatant (FSC) project in late 2004. BAE Systems had already proposed several variants of the basic Type 45 design, including the land attack variant, a slightly stretched cruiser-size development of the Type 45.

The design was modified by the addition of an amidships hull plug to accommodate a 16-cell VLS silo, presumably for Tactical Tomahawk or Naval SCALP. Another stern hull plug would have extended the flight deck to enable the operation of heavy-lift helicopters and unmanned aerial vehicles (UAVs). The S-1850 search radar would have been deleted. The resulting design offered improved range and speed; the latter is more of a result of its finer lines than its more powerful machinery. Accommodation and facilities for the embarked military force were improved.

The MSVD plan was dropped in late 2006 when the Sustained Surface Combatant Capability (S2C2) pathfinder program was established. Eventually, the S2C2 high-end component became the Type 26 frigate (see separate report in this service). This design owes little if anything to the Type 45 destroyer.

Program Review

Background. The origins of the Type 45 Daring class destroyer date to 1984-1985, when the British finally concluded that the basic design faults in the Type 42 destroyers were too fundamental to be corrected. Those ships were deemed not worthy of upgrade and were assumed to have a short (22-year) service life. Plans were drawn for a successor.

Planning was initially undertaken as part of the NATO frigate program, an attempt to develop the new ship as a collaborative venture among eight countries. This program was designated the NFR-90 and was abandoned in 1990 when it became evident that the principal weapons systems of the ship being developed were lacking in standardization, and that the number of national variants negated any chance of substantial savings.

The British Navy never had faith in the NFR-90 program and had instituted a parallel development program. This was officially an interim program aimed at replacing the first group of Type 42 destroyers, which were already starting to deteriorate because of various design and construction flaws.

Type 23 Derivatives

The Type 23 frigate was explored as the basis for a new design. The usual long series of design alternatives were examined, ranging from a minimal modification of the existing Type 23 design (retaining the hull size) to a new, very impressive design that was substantially larger than the previous 4,250-ton ship. Overall, this design would have displaced more than 7,200 tons light (approximately 8,600 tons standard). It was questionable, though, whether such a large design would gain Treasury approval.

Accordingly, a further series of design studies were aimed at incorporating all the advantages gained with the 7,200-ton design in a smaller, cheaper hull. The design resulting from these studies would be considered a low-cost, fallback design in the event the 7,200-ton ship fell victim to the Treasury ax. The major change was a reduction in displacement from 7,200 tons to 6,000 tons. This was achieved by reducing the machinery spaces to a single unit, cutting back the installed power from 110,000 to 61,000 shp, and reducing speed from 33 to 28 knots (more as a result of

Type 45 Daring Class

the shorter hull than the power loss). The fore and aft Type 911 trackers were deleted, and the fore and aft ASTER magazines consolidated into a single 64-round silo. Otherwise, the weapons suite remained unchanged. During the design process, the Spey turbines were replaced by the new Westinghouse WR-21 (replacing much of the lost engine power), and the engine room was rearranged to permit reversion to twin funnels. These changes increased displacement to 6,400 tons and speed to 29 knots.

Going Joint

In December 1991, the French and British governments announced that exploratory talks would be initiated with the aim of establishing a joint air-defense frigate program. This was designated the Anglo-French Future Frigate, or A3F, program. However, the similarities between the two projects were superficial only. The British required a very high-capability warship, one that could prosecute anti-submarine and anti-surface operations while operating under the threat of heavy air attack. The French required a much simpler ship, one that could defend itself against a relatively low-scale air attack. Capability against anything greater would be provided by the aircraft carrier *Charles de Gaulle*. In U.S. Navy terms, the British wanted an upgraded CG-47, the French a downrated FFG-7.

The meetings of the A3F steering committee were unproductive. The British had already done extensive design analysis and had their proposals worked out. The French design team had just begun work and was still trying to formulate its basic approach. As an interim measure, the French team submitted the AAW version of the La Fayette class frigate developed for the Saudi Arabian Navy as its proposal for the A3F design. That was unacceptable to the British, as was a 5,500-ton enlarged La Fayette displayed at the Le Bourget naval exhibition that was inaccurately described as the design for Project Horizon. These would prove to be the first of a series of acts that substantially undermined any basis of trust in the A3F and Project Horizon negotiations.

Part of the problem was that the preferred British 7,200-ton design was too large, at 175 meters overall, for quantity construction in French shipyards. The smaller 6,000-ton design was within the capability of the French shipyards and was stipulated as being the baseline from which A3F would be configured. With the overall parameters of the ship established, meetings on the A3F continued throughout 1992. A Preliminary Joint Program Office was formed in November 1992. In December 1992, the Italian Navy signed a tripartite staff requirement for a next-generation frigate, and then joined the A3F project as a full participating member on January 29, 1993. The designation A3F was retired, and the project became the Common New Generation Frigate (CNGF) with the working title Project Horizon.

U.K. National Program Suspended

With the institution of Project Horizon, British work on a U.K.-only ship to satisfy this requirement formally ceased, and the existing Type 84 design work was suspended. All efforts now concentrated on Project Horizon. In April 1993, the first of a series of Memorandums of Understanding was signed, covering the establishment of a Joint Program Office in London and the appointment of a project manager. It was agreed that final design authority would reside with the Royal Navy Department of Naval Construction at Bath. A decision to issue Invitations to Tender for the PAAMS and command management systems was made in June 1993. Further minor design changes were then incorporated. The idea of installing a Seawolf secondary battery was discarded, because the Seawolf missile was regarded as having only marginal capability against the Russian hypersonic anti-ship missiles. In its place, a new system designated VSRAAD was specified.

Delays in the CNGF program now meant that the first ship would not be commissioned until December 2002 at the earliest. Thus, a new window of opportunity would be opened for adoption of a more advanced technology system for the Multi-Function Radar (MFR) prime sensor for the PAAMS, and the need for the Anglo-Italian European Multifunction Phased Array Radar (EMPAR) was eliminated. The British suggested that a jump could be made to the active-array Tri-Mode Synthetic Aperture Radar (TRISAR), now named Sampson.

Forming a Joint Management Company

A number of system disputes arose during the negotiating process. These stemmed from the different operating concepts of the navies in question and from the dissimilar design principles used by the various drafting offices. The disputes were wide ranging and covered such elements as the AAW missile system, the primary multifunctional radar, the electronic warfare and communications suites, and the superstructure layout. Some of these disputes were resolved by the provision of transparent interfaces to the overall command system so that the partners could install their system of choice. Others remained intractable and contributed to the eventual downfall of the program.

In 1994, contractors were selected to oversee the design of the new frigate. On July 11, 1994, the defense ministers of the U.K., Italy, and France signed the joint Memorandum of Understanding that laid down the

timetable and basic principles for development of the Project Horizon CNGF. A major surprise in this announcement was the news that Italy was increasing its requirement from four ships to six, with the additional pair to replace the four 1970s-vintage Lupo class frigates. This agreement was finalized by a preliminary document, signed the same day, which financed the work on the first segment of the design definition phase.

At this point, the whole program began to show signs of unraveling again. The first indication of trouble was a reported difference in the operational requirements for the electronic warfare system. The Italian Navy and its prime supplier, Elettronica, were committed to the use of cross-eye jamming, a technique British and French studies failed to validate. In addition, the Sea Gnat munitions preferred by the British and Italian navies were incompatible with the French Sagaie launching system.

Although the International Joint Venture Company responsible for Project Horizon was formally established in London on February 21, 1995, delays in signing the appropriate developmental MoUs pushed the project back by eight months, severely jeopardizing the December 2002 in-service date. The consultant support agency contract was awarded by the JPO in March 1995, the winning competitor being the Chorus Consortia comprising British Maritime Technology of the U.K., CISDEG of Italy, and SRTI Systemes, a part of the information technology group of Thomson-CSF (now Thales).

Storm Clouds Gathering

Suspicions that not all was well were confirmed in March 1995 when the U.K. MoD abruptly classified the in-service date for Project Horizon. There were also reports that the program costs were spiraling, with estimated total procurement costs of $14.6 billion as opposed to the official estimate of $10.4 billion. Sources close to the program were now talking about a minimum three-year delay, with ships unlikely to see service before late 2005.

The next stage of this dispute reflected an even greater conflict with the agreements surrounding Project Horizon. French DGA procurement executive Henri Conze, in a letter to the Dutch Secretary of State for Defense Procurement, wrote that the Dutch SMART-L radar would be installed on all 22 Project Horizon frigates if the Dutch government selected the Eurocopter Tiger to fulfill its attack helicopter requirement. While SMART-L was one of the radars being considered as a possible substitute for the ASTRAL long-range search radar that was then specified, the Project Horizon agreements specifically stated that such equipment specifications would be based on competitive tendering. These agreements specifically prohibited promising Project Horizon contracts to support other defense sales efforts.

The Conze letter breached both stipulations. It caused an immediate outburst in British circles, with the magazine *Armed Forces Journal International* describing British defense sources as being "incandescent with rage." This dispute was further fueled by an apparent refusal by the French authorities to take the matter seriously. In retrospect, it appears probable that the British decision to withdraw from Project Horizon dated from this display of bad faith.

British National Program Relaunched

In parallel with the Conze affair, the British launched the T23R (Next Plus One) frigate program. Technically, this was aimed at defining a follow-on design for Project Horizon as a replacement for the remaining Type 22 and early Type 23 frigates. However, the timing, more than 20 years before the replacement ships become operational, was unprecedented. British naval industry sources denied any connection between T23R and the problems afflicting Project Horizon, stating that the first orders for T23R were not expected until after 2010. This would be well after the Project Horizon production run. Nevertheless, there was intense suspicion in some quarters that T23R was a "black" U.K. national program intended as a substitute for Project Horizon when the multinational venture collapsed.

In August 1995, the National Audit Office released a damning report on the delays in the Project Horizon CNGF program. It specifically cited the inability of British, French, and Italian officials to work together or to agree on system requirements, design practices, or work-share arrangements as the primary causes of significant delays. This report was the first official British government acknowledgement of the severe program delays. By September, delays of 18 months were finally confirmed, with questions of the missile and launch system for PAAMS and the explosive issue of the long-range search radar unresolved. One report placed the total procurement value at $24.8 billion.

In March 1996, Project Horizon moved a little closer to fruition when a series of three intergovernmental MoUs were signed. These covered the final agreements for funding development of the PAAMS, the initial production of PAAMS, and the design definition process of the CNGF. There was some disquieting information in these agreements. A close reading of the planned production quantities suggested that the Italians were committed to only four of the six ships they had publicly stated that they would acquire, and the French,

Type 45 Daring Class

two out of four. Only the British requirement remained firm at 12.

Horizon Recedes into Distance

By May 1996, all evidence pointed to a four-year slippage in the Project Horizon program. An analysis of missile and radar development program contracts showed little chance of the systems being ready before the end of 2006. Even allowing for progressive installation of equipment during the first-of-class trials, the first ship for each navy was unlikely to be delivered before 2005.

In early 1997, the project was in serious danger, with continued disagreements over missiles – the French preferring their ASTER, while the British remained open to using existing, off-the-shelf systems, including those from the U.S. The standby Mk 41 VLS was also offered as an alternative, and the reaction was not entirely negative. These doubts were theoretically resolved during the year when the British formally signed on for ASTER, but this measure was too little too late.

By 1998, it was widely accepted that Project Horizon was doomed. According to reports, the British and French delegations were barely on speaking terms, and the French director of the JPO was under severe criticism from France for taking an allegedly pro-British attitude. Major fundamental issues of the design remained unresolved, and the differences between the partners prevented any real progress. In April 1999, the ax fell. In a vaguely worded document, the U.K. Ministry of Defence announced that it was withdrawing from Project Horizon and proceeding with its own design of an air defense ship.

The British Bail Out

This new program was first called the Anti-Air Warfare Warship (AAWW), and bore the new Type 45 classification. The key point of the new design was to use as much proven and in-service technology as possible to cut development time and risks to a minimum. The announcement of the new program marked the start of a running war between Marconi (later BAE Systems), Vosper Thornycroft, and the U.K. MoD over work share and division of responsibility.

By mid-1999, the new schedule was firmly in place. The design orders were to be placed in late 2000, with the first-of-class to be running trials by 2007. The originally planned 12 ships would be ordered in four batches of three hulls each. The first-of-class would be built by Yarrow and the second by Vosper Thornycroft; the builders of the rest would be selected in a competitive bidding process. Initial drawings of the new Type 45 showed it to have a blend of features from the original and now-defunct Type 84 combined with those developed for the CNGF.

Producing a New Design

Throughout 1999 and into 2000, the U.K. MoD stressed the need for speed and cost efficiency in the design process. Radical changes and improvements were specifically ruled out. The Type 45 was to be equipped with derivatives of systems already in service on U.K. warships. This policy was pursued faithfully, and occasionally, ruthlessly. PAAMS was retained for the design to reduce the need for new work on the hull, which would have been required for the Mk 41 VLS.

By December 1999, Marconi Electronic Systems (MES) was confirmed as the prime contracting office for the new ships. A week later, MES was taken over by British Aerospace to form part of the new BAE Systems. The urgency behind the Type 45 program was underscored by the retirement of the first Type 42 destroyer, HMS *Birmingham*, reportedly necessitated by its severe structural decay. One major decision made during this period was to adopt turboelectric propulsion rather than the originally planned CODLAG (combined diesel-electric and gas-turbine propulsion). This was justified on grounds of simplicity and the successful design effort on HMS *Ocean*. The design contract for the new propulsion system was awarded in May 2000.

The original designs for the Type 45 destroyer bore a close resemblance to the Project Horizon design, but successive iterations diluted that resemblance. Type 45 quickly became a much larger ship than Project Horizon. By mid-2000, the latest version of the design weighed 7,200 tons and featured a number of changes to the superstructure, including a new stealthy mast design from BAE Systems.

Construction Contracts Placed

In July 2000, the U.K. MoD confirmed that the construction contracts for the first batch of Type 45 destroyers would be awarded by the end of the year. It was also announced that the first pair of ships would be named HMS *Daring* and HMS *Dauntless.* The first ship would be built by the BAE Scotstoun Yard (formerly known as Yarrow), and the second would be built by Vosper Thornycroft. The WR-21 produced by Northrop Grumman and Rolls-Royce was formally accepted for the ships in November 2000. The contract for the first three ships was awarded to BAE Systems on December 21, 2000.

These plans were disrupted in January 2001 when BAE Systems made an unsolicited offer to build all 12 ships at its Scotstoun Yard, with the benefit to the Royal Navy of a substantial reduction in costs. There had

already been hints of problems between BAE Systems and Vosper Thornycroft over work-share issues and the capability of Vosper Thornycroft to perform the work on its allocated destroyer. Vosper Thornycroft had announced that it was closing its Woolston Yard and would be moving operations to Portsmouth, where more space was available.

By February 2001, the dispute had boiled down to whether the U.K. MoD wished to maintain a competitive shipbuilding strategy and, if so, whether the levels of shipbuilding in the U.K. would support such a strategy. Eventually, the British government came up with a startling and totally unexpected answer to this question. Following a detailed study by the RAND organization, the British ordered three additional Type 45 destroyers in July 2001, bringing the total to six. It later emerged that the contractual increase was for the hull platform only. The three (Batch 2) hulls were contracted for, but many of their systems were not.

The construction arrangements changed. Instead of Vosper Thornycroft building one destroyer of the first batch and competing for the rest, all six destroyers would be built at BAE Systems' Scotstoun Yard. However, Vosper Thornycroft would build sections for all six ships. The same arrangement would apply to the six ships still to be ordered.

With the order for the next group of three ships (named *Dragon, Defender,* and *Duncan*) in place, the apparent spate of activity in the Type 45 program slowed. Subsequent work centered on selecting the remaining ship systems, most notably the ship's sonar. Originally, the Type 45 class was to be equipped with the same Thales Underwater Systems TMS-4110 medium-frequency hull sonar specified for the tri-national CNGF. The negotiations on this component were time-critical because they determined the design of the bow module. However, the U.K. MoD was unable to reach agreement with Thales Underwater Systems, and the competition was thrown open to other bidders. Eventually, the EDO MFS-7000 sonar was selected.

First Metal Cut

In April 2003, BAE Systems reached a key milestone and commenced production of the Type 45 destroyer. In a ceremony at the BAE Systems Govan shipyard, Lord Bach of Lutterworth, minister for defense procurement, activated a plasma-cutting machine and cut the initial piece of steel for the first of the new vessels. According to a revised construction plan, all six vessels then on order would be assembled and launched on the Clyde, with modules being built on the Clyde and at VT Group (formerly Vosper Thornycroft) in Portsmouth. *Daring* was launched in February 2006 and started sea trials in August 2007. It should be noted that this was exactly in accordance with the original timeline of 1999when the Type 45 program was initiated.

Program Cut Back

In July 2004, the British government released its latest defense white paper, titled, "Delivering Security in a Changing World – Future Capabilities." This document delivered a wide-ranging series of defense cuts affecting all three armed services and reported the following on the Type 45 destroyer program: "In the light of the reduced conventional threat, our revised concurrency assumptions and improved networked capability, we assess that we need fewer of these platforms. Consequently, we have a requirement for eight Type 45 destroyers and will need 25 destroyers and frigates overall."

In effect, this meant that only two additional Type 45 destroyers would be ordered. Inevitably, changes to the build schedule have cost implications, and in February 2005, it was reported that BAE Systems was seeking compensation from the MoD for the additional costs incurred because of the reduced production run. The question of build numbers did not end there. In November 2004, the FSC project intended to replace the Type 22 Batch 3 and Type 23 frigates was effectively canceled. While disguised under a mass of British "bureaucratese," the project had ultimately become too broad in scope and perceived as unrealistic. FSC was replaced by two programs: the near-term Medium-Size Vessel Derivative (MSVD) and the far-term Versatile Surface Combatant (VSC).

The MSVD was viewed as an off-the-shelf solution, with a lead candidate being a development of the land attack variant of the Type 45 destroyer. This would essentially trade off the long-range air defense capability of the existing Type 45 design in favor of an enhanced land attack capability resulting from the installation of a new 155mm gun and additional missile tubes in an enlarged hull. The MSVD plan was dropped in late 2006 when the Sustained Surface Combatant Capability (S2C2) Pathfinder program was established, eventually resulting in the Type 26 frigate program.

This left the problem of the hull-only orders for Type 45-04 to -06. In June 2005, BAE Systems submitted revised pricing for the completion of the Batch 2 units and scheduled final two units (T45-07 and -08). This tender failed to receive a response, and in December 2006, BAE Systems rebid for the completion of some or all of the Batch 2 units and one or two additional units. This latter inclusion reflected a growing unease about funding for hulls number 7 and 8. Eventually, orders for the full equipment of units four through six were placed in 2006.

Type 45 Daring Class

From late 2005, the MoD only mentioned "up to eight" Type 45 destroyers, and inadequate funding meant the chance that the T45-07 and -08 would ever be ordered was decreasing. By mid-2006, there were growing rumors that the MoD was looking hard at the savings associated with canceling HMS *Duncan* and even HMS *Defender*. This cancellation would be helped by a prospective sale to a foreign country. Saudi Arabia was one country listed as a prospective purchaser of Type 45 hulls. By March 2007, reports were suggesting that HMS *Defender* and HMS *Duncan* might indeed be sold to Saudi Arabia to allow early delivery and relieve MoD funding pressures. Then, the priced options for 2007 and 2008 would be exercised to provide replacements. A final decision on T45-07 and -08 was expected at the end of 2007 – several years later than originally expected. In fact, by mid-2008, orders for the remaining pair of ships still had not been placed, and it was generally accepted that the two ships had been canceled, de facto.

Further Program Reductions

Meanwhile, doubts continued over the size of the British surface combatant fleet. It was steadily reduced by a succession of reviews until it dropped to, at best, a total of 23 frigates and destroyers. It was tacitly accepted that the seventh and eighth Type 45 destroyers would never be ordered, and it appeared as if the surface fleet would consist of six Type 45s, 13 Type 23s, and four Type 22s without any established plan for the replacement of the last two classes. By 2008, even these plans were looking doubtful, and two of the remaining Type 42 destroyers were put to sea with their Sea Dart missile systems disabled, simply to add to the number of vessels in the fleet. A potential replacement for the Type 23 and Type 22 class frigates was unlikely to enter service before 2020.

At the end of 2007, the National Audit Office announced that the Type 45 destroyer would not be introduced to service until November 2010, a delay of 11 months from the estimate a year earlier. The cause of the delay was reported to be integration problems between the command and air warfare systems. In addition, the cost of the six ships on order was increased by $733 million after contract renegotiations reflected a program reduction from eight units to six. On June 19, 2008, the British government made the long-expected announcement that the option for the seventh and eighth Type 45s would not be exercised, and only six Type 45 destroyers would be built.

In December 2008, HMS *Daring* was formally handed over to the MoD in a ceremony at the Scotstoun shipyard on the Clyde. This was a preliminary step before the transfer to her home port of Portsmouth in January 2009. On taking station there, she undertook several months more of exhaustive trials and training before being declared ready for operational service. On July 23, 2009, HMS *Daring* was formally commissioned.

In March 2009, it was revealed that the Daring class destroyer's new Sea Viper air defense missile system would not be available until 2011. However, the MoD claimed it could be deployed earlier in an emergency. The ability to link ships' weaponry and sensors is not yet available. Partly as a result of this revelation, the Type 45 program was excoriated once more by the Public Accounts Committee over the failure by the MoD to adequately manage the Type 45 program. The report described the Type 45 as suffering from inexcusable delays and cost overruns. HMS *Daring* could enter service, but without advanced ASTER air-defense missiles or key communications systems (Bowman and Skynet). The committee called the situation a disgrace.

HMS *Daring* commissioned on July 23, 2009, amid reports that a fundamental design flaw had been discovered with the ASTER missile, traced to what the British MoD described as "production weaknesses" that could be remedied by "minor redesign work." A subsequent series of tests revealed that the fault had been corrected. HMS *Dauntless* commissioned in June 2010 and was followed into service by HMS *Diamond* in May 2011. HMS *Dragon* entered the fleet in May 2012 and HMS *Defender* in July of that year. At that time, the sixth and last ship, HMS *Duncan,* was undergoing sea trials. It was delivered to the Royal Navy on March 22, 2013, and entered service in December 2013.

HMS *Daring* on Sea Trials

Source: Royal Navy

Funding

This program is funded by the U.K. Ministry of Defence.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Northrop Grumman	3.62	Jun 2009 – Contract to provide technical support services for the integrated platform management systems (IPMS) installed on the Royal Navy's new Type 45 warships. Sperry Marine will establish a test and technical support facility at its U.K. engineering center in New Malden. The test facility will include a complete shore-based IPMS reference set. Northrop Grumman Sperry Marine also provides ongoing maintenance, repair, spares management, upgrades, and training under an interim support contract for the IPMS aboard HMS *Daring*.
BVT Surface Fleet	509.0	Sep 2009 – In-service support of the Royal Navy's six new Type 45 Daring class anti-air destroyers. The contract runs from January 2010 through January 2017.
Thales UK	-	Mar 2010 – Six-ship, seven-year support contract for the Royal Navy's Daring class destroyers' fully integrated communications system. The multimillion-pound contract requires Thales to guarantee the availability of the communications systems fitted to these new ships.

Type 45 Daring Class

Contractor	Award ($ millions)	Date/Description
Thales UK	-	May 2010 – Provision of interactive 3-D media to be used for training maintainers of the long-range radar on the new Royal Navy Daring class (Type 45) destroyers.
Rolls-Royce	33.0	May 2011 – In-service support for the Royal Navy's Type 45 destroyers' Rolls-Royce WR-21 gas turbines. The initial contract is for six years. However, options are in place for extensions to cover the entire life of the vessels – in excess of 30 years.
BAE Systems	73.5	Jul 2011 – Support of the Sampson Multi-Function Radars on board the fleet of six Royal Navy Type 45 destroyers. The new contract covers all of the Sampson radars, both in-service and those not yet in service. The contract also provides technical support, a spares and repairs service, and maintenance through the joint MBDA/BAE Systems waterfront team at the Type 45's home port of Portsmouth Naval Base. The team will also provide ongoing support at the Maritime Integration and Support Center in Portsmouth and an MFR test facility at BAE Systems' Cowes site on the Isle of Wight during each radar's service life.

Timetable

Month	Year	Major Development
	1984	Type 42 replacement programs initiated
	1986	Modified Type 23 designs proposed
	1989	U.K., France leave NATO Frigate Replacement (NFR-90) program
	1990	NFR-90 collapses
	1991	Enlarged Type 23 designs proposed
	1991	British Navy designs 7,200-ton ship
Early	1991	France, U.K. sign Joint Statement of Need for future frigates
Dec	1991	A3F program initiated
Apr	1992	Italy enters program as an observer
Jul	1992	A3F program breaks up in disarray
Aug	1992	Political initiative saves A3F, stating commitment to cooperation
Nov	1992	Agreement on acquisition strategy; preliminary Joint Program Office founded; decision made on the main weapon system: SAMP/N=LAMS
Dec	1992	Italy formally joins program, signs common staff requirement; CNGF inaugurated
Jan	1993	Common acquisition strategy endorsed by the three countries
Mar	1993	Joint Program Office founded in London
Jul	1993	MoU signed by all three navies involved in the program
Jul	1994	Initial development MoU signed for design, drawing, build (not PAAMS)
Feb	1995	Eurosam submits preliminary PAAMS FSED estimate; Horizon International Joint Venture Company (IJVC) Ltd formally established
Mar	1996	Design definition contract signed with IJVC
Oct	1996	Two-year combat system project definition contract awarded
Apr	1999	Multinational CNGF program canceled
May	1999	British Type 45 program initiated
Dec	2000	First group of three Type 45 destroyers ordered
Jul	2001	Second group of three Type 45 destroyers ordered
Apr	2003	First steel cut on HMS *Daring*
Feb	2006	HMS *Daring* launched
Aug	2007	HMS *Daring* starts sea trials
Nov	2010	HMS *Daring* enters operational service
May	2011	HMS *Diamond* commissioned
July	2012	HMS *Defender* commissioned
Mar	2013	HMS *Duncan* delivered

Worldwide Distribution/Inventories

U.K. Six ships in service.

Forecast Rationale

All the Type 45 destroyers ordered for the Royal Navy are now in service and the project has been concluded. No more ships of this class will be ordered for the Royal Navy. Although the class remains theoretically available to export customers, all marketing efforts have now been placed behind the Type 26 "Global Combat Ship."

The tragedy of this class is that it was so long in development that by the time the ships were being built, changes in government priorities meant the resources needed to complete the class in full had been reassigned.

In a larger sense, the problems with the Type 45 program are becoming increasingly common across the world. Technical complexity and risk combined with the sheer cost of modern defense programs are slowing down the execution of such projects. At the same time, operational and strategic requirements are changing at an ever-increasing rate, driven by communications technology and data dissemination developments. It is becoming increasingly more difficult to produce warship designs in a timely manner and see them in service while the rationale for their development is still valid. This is, of course, not a dilemma restricted to the warship construction industry.

The solution to this dilemma is not easy to see. The current trend toward building ships that have a relatively simple, basic fit that can be supplemented by "mission packages" is one approach that has promise, in that it allows the operational capability of existing ships to be changed relatively quickly. Whether this approach is appropriate to ships that have to face the extreme upper end of the threat spectrum has yet to be determined.

The Type 45 program is now complete. The ships have a long life ahead of them, but activity will be restricted to modernization and upkeep. No new ships of this class are likely to be built. This report will, therefore, be archived next year.

* * *