DARPA -- Arsenal Ship Lessons Learned

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1.0 -- Executive Summary

1.1 -- Introduction

This report captures many of the lessons learned in executing the first two phases of the Arsenal Ship program, a period of about 22 months. It focuses on acquisition process-oriented lessons, rather than individual consortia technology initiatives which are proprietary in nature. This report was written by the Arsenal Ship Joint Program Office (biographies at Tab M), and the views expressed do not necessarily reflect DARPA or Navy concurrence.

The first two phases of the Arsenal Ship Program provided an excellent return on the Navy's and DARPA's investment. These two phases successfully demonstrated that industry, involved early in the ship design process, could develop an optimum mix of performance capabilities that could be accommodated within affordability constraints; successfully demonstrated teaming between combat system integrators and shipyards; and introduced innovative concepts in reduced manning, automated damage control, topside integration, and modular design.

1.2 -- Background

The basic requirement for the Arsenal Ship, established in a joint Navy DARPA Memorandum on March 18, 1996 (Tab A), was to satisfy joint naval expeditionary force warfighting requirements in regional conflicts by providing the theater commander with massive firepower, long range strike, and flexible targeting and possible theater defense through the availability of hundreds of vertical launch system (VLS) cells. To meet this warfare requirement affordably, the Arsenal Ship concept and design was to be straightforward and simple. Detailed requirements and concept of operations were defined in separate documentation (nine pages total), however, key elements for the Arsenal Ship included:

- Provide approximately 500 VLS calls, with the capability to launch Navy and joint weapons to support the land campaign;

- Integrate the combat system with Cooperative Engagement Capability (CEC) links to serve in, or as, the off-board control;

- Appropriate ship design features for survivability and ship self defense which could be incorporated at a later date if needed;

- Low ownership Costs through the use of innovative maintenance and operational methods, procedures, and technologies;

- Crew size not to exceed 50 personnel. The design objective will be to minimize crew size to the maximum extent below 50 which is technically feasible.

In the face of limited budget levels, the use of acquisition reform initiatives and streamlined contracting methods were paramount to meet the basic requirements of the Arsenal Ship in an affordable manner. To accomplish this, a non-acquisition category demonstrator ship was to be developed, in the water and ready for testing by October 2000, and which would have been convertible to a fleet asset at a future date.

In addition, cost was viewed as an independent variable, and early industry involvement with the development of a cooperative industry-government team was viewed as key to achieve Arsenal Ship goals. To minimize cost, off-the-shelf systems were to be used exclusively. Any development of new systems required the approval of ASN (RD&A). The cost of acquiring the first ship was not to exceed $541 million including the cost of concept development and competition. These funds were to be provided jointly by the Navy and DARPA with contributions of $371 million and $170 million respectively.

The non-ACAT Arsenal Ship demonstration program was created to evaluate sea-based massed precision firepower, while minimizing the risks in acquisition of approximately six ships. To ensure that the program remained affordable, a firm acquisition cost threshold for the production ships was established (Unit Sailaway Price $450M goal, $550M cap in FY96 $). A corresponding Life Cycle Cost threshold was also established (Operating and Support annual cost of $13.7M/ship [roughly a third of DDG-51]. This program was conducted using DARPA's Section 845 Agreements Authority so as to allow industry wide latitude in satisfying the Navy's requirements within this threshold. Agreements were structured to allow tradeoffs between cost and performance. Program success was to have been judged by the extent to which the Arsenal Ship met operational requirements.

A second purpose for this demonstration program was to accelerate the Navy's ongoing acquisition reform activities focused on buying improved ships at a lower cost. To this end, the joint program was to focus on exploiting DARPA's culture and experience in prototyping system programs. The Navy and DARPA anticipated the production Arsenal Ship contracts would serve as a model for future streamlining.

This joint Navy/DARPA demonstration program was conducted under DARPA lead, as articulated in a joint 28 May 1996 memorandum (Tab B), with an envisioned transition of leadership to the Navy in the testing and production stages of the program. The program was managed by a joint Navy/DARPA program office with the Program Manager reporting to DARPA. A small program office was mandated. DARPA, Naval Sea Systems Command

(NAVSEA), and the Office of Naval Research (ONR) each provided two billets. It was expected that the program office would grow to a maximum of three billets each as the program grew to maturity. The Navy developed a concept of operations (CONOPS) (Tab C), and a Ship Capabilities Document (SCD) (Tab D), which the program office used to guide the Phase I and II trade studies conducted by industry. The Program Manager developed a program plan including major decision milestones, and a DARPA to Navy program transition plan.

Organizationally, the Arsenal Ship Program Manager reported to two committees for guidance and direction: the Steering Committee and the Executive Committee.

The Steering Committee included:

Director, TTO -- DARPA (Chair)
Deputy Assistant Secretary of the Navy (DASN, Ships)
Assistant Director, TTO for Maritime Programs -- DARPA
Director, Surface Warfare Plans/Programs/Requirements Branch
- OPNAV (N863)
PEO for Surface Combatants
Office of Naval Research (ONR33)

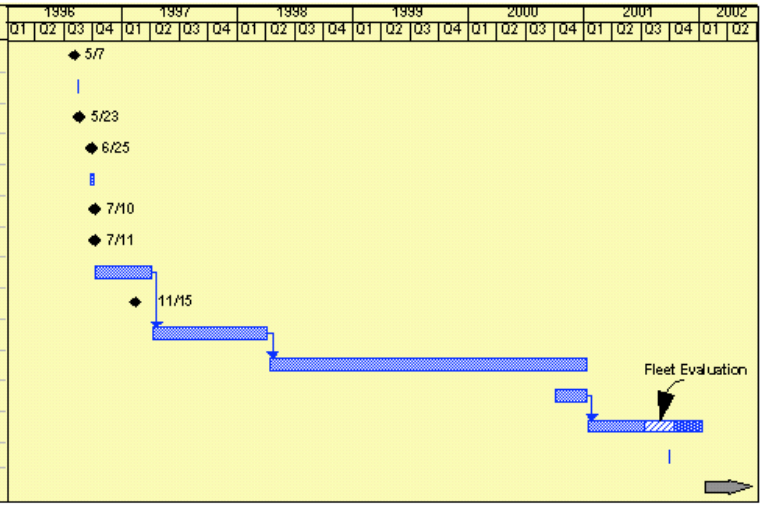
The Executive Committee included:

Director, DARPA (Chair)
Assistant Secretary of the Navy (RD&A)
Director of Surface Warfare (N86)
Commander, NAVSEA
Chief of Naval Research

The program was divided into six phases. Phase I was a six month Concept Definition effort for multiple industry consortia. Phase II was a twelve month Functional Design effort, originally for two consortia (expanded to three based on the robust designs of 3 teams. Phase III was to be a 33 month Detailed Design and Construction of the Demonstrator Ship, by one consortia. Phase IV was to be a twelve month Demonstration/testing phase, followed, if successful, by exercising the Phase V(a) Production option, Phase V(b) Conversion of the Demonstrator to production option, and the Phase VI Service Life Support of the class for the lifetime of the ships. The initial industry funding and schedule is arrayed below:

Initial Schedule & Funding Profile

Task Name	Start	Finish
Industry Program Brief	5/7/96	5/7/96
Industry Discussions	5/13/96	5/14/96
Final Program Solicitation Issued	5/23/96	5/23/96
Phase I Proposals Due	6/25/96	6/25/96
Phase I Proposal Evaluation	6/25/96	7/9/96
Phase I Source Selection Briefing	7/10/96	7/10/96
Phase I Contract Award	7/11/96	7/11/96
Phase I Concept Definition	7/11/96	1/9/97
Phase II Proposal Due	11/15/96	11/15/96
Phase II Functional Design	1/10/97	1/9/98
Phase III Detail Design, Construction	1/12/98	10/11/00
Phase IIIb Test Evaluation Planning	6/30/00	10/11/00
Phase IV Demonstrations	10/12/00	10/11/01
Phase V - Option Exercise	7/2/01	7/6/01
Phase VI - Service Life Support	TBD	TBD



Fiscal Year Funding Profile

Phase I (Multiple Awards)	**$1M ea**						
Phase II (Two Awards)		**$15M ea**					
Phase III } **(One Award)**			**$167M**	**$119M**	**$103M**		
Phase IV						**$25M***	

* **Phase IV T&E distribution between Gov't and Contractor to be determined**

Figure 1 -- Initial Schedule & Funding Profile

Five Teams were awarded Phase I agreements on July 11, 1996, under the 10 USC 845 Other Agreements Authority, with the potential to execute through Phase VI of the program. This Other Agreements Authority excepted the program from the Federal Acquisition Regulations (FAR) and any military specifications and standards. The scope of Section 845 Prototyping Authority is explored fully in a DARPA General Counsel October 24, 1996, memorandum (Tab E). USD(A&T) implementation of 845 Other Agreements Authority within the Services (Section 804 of the FY97 Authorization Act) is included at Tab F.

Three Teams were awarded Phase II agreements for Functional Design effort on January 9, 1997. In April 1997, the original Arsenal Ship Demonstrator concept was expanded by the Navy and DARPA to include risk reduction efforts for the Surface Combatant of the 21st Century (SC-21) (Tab G) and the Demonstrator's name was changed to the Maritime Fire Support Demonstrator (MFSD) (Tab H) to reflect this expansion.

The FY98 Appropriation Act appropriated $35 million of the requested $150.2 million for Maritime Fire Support Demonstrator. On 24 October 1997, the Secretary of the Navy reluctantly determined that continuation of MFSD into Phase III and further phases was unachievable (Tab I). Phase II activities were completed and the Arsenal Ship Joint Program Office closed operation on 31 December 1997 (Tab J).

1.3 -- Lessons Learned

1.3.1 ***Acquisition Streamlining Works.*** The process being followed by Arsenal Ship demonstrated a 50% reduction in acquisition time for the design portion of the ship compared to the traditional design approach. The Industry Teams were prepared to complete the detail design and build the ship in 33 months, again about half the normal time. This was primarily enabled by using an industry led acquisition operating under Section 845 authority, with industry having full trade space and responsibility for the design.

1.3.2 ***Price As Established (PAE) Spurs Innovation and Drives Down Acquisition Cost But Increases Risk.*** Price as established (PAE) was the approach taken throughout the Arsenal Ship Program. Price here means industry cost to manufacture and a reasonable profit (or return of investment to the company). A price goal was established early in the program. All designs were monitored by the contractor teams to ensure an affordable item at a price including all non-recurring and recurring costs to manufacture and a reasonable return on corporate investments or in other words, profit. All other aspects of the government desired capabilities were tradable against the price goal. This is different from Cost as an Independent Variable (CAIV). Cost as independent variable (CAIV) assumes two things; first, the government is monitoring and controlling the trade decisions to ensure affordability, and second, cost is only one of several factors to be traded. Requirements creep is most certain. CAIV in present government literature means a government program manager yardstick to consider trades against requirements.

After several months, all competitive teams were to fix their own price against their design or PAE. During later phases more trades could result. The contractor team should have responsibility for all trade decisions and be encouraged to use the trade space within the government's desired capabilities to ensure an acceptable and capable product that meets PAE. PAE focused the design trades on mission essential performance, without requiring the use of legacy systems as GFE (Government Furnished Equipment). This resulted in designs that were engineered at a total system level, highly integrated, commercially-based, and low cost, while at the same time introducing new systems with some attendant risk. Industry Teams were prepared to meet the goal of $450M for the average production ship cost, about 1/3 less than early Navy estimates for the production ship. Risk reduction programs were key to achieving the PAE goals and worked effectively. Under the Arsenal Ship acquisition strategy, substantial elements of the risk were transferred from Government responsibility to Industry. In short, competing teams concluded "zero risk is unaffordable."

1.3.3 ***Low Manning is Readily Achievable.*** Manning is the largest single factor in life cycle cost, and accounts for roughly 40% of the annual operating and support costs of Navy ships. Reduced manning is the key to lower life cycle costs. The enablers to achieve lower manning among the Industry Teams included: commercial ship operating and maintenance practices, insertion of COTS technologies such as integrated bridge system; nested, remote sensors; and high levels of controls and C4I integration. The Arsenal Ship goal of less than 50 crew was easily achieved by the Industry Teams (who averaged 22 crew). Preliminary Navy estimates for Arsenal Ship were 269 crew.

1.3.4 ***An Industry Design Competition Could be More Meaningful Than a Government AOA (Assessment of Alternatives).*** Industry Teams produced an array of design solutions that were

achievable and affordable, with better cost information than is possible within the Government's data base. Since the designs were optimized for each Team's production capabilities and facilities, industry design alternatives were available at lower cost than Government designs, and had been measured against producibility metrics, so designs were at a much higher state of maturity.

1.3.5 ***Industry is Fully Capable of Designing and Developing Complex Navy Ships.*** The majority of design and production skills needed to produce Navy ships was assembled as a natural part of the teaming of the full service consortia. Industry Teams were able to find needed technical expertise for almost all design areas in the commercial marketplace. In selected cases (principally survivability, and weapons effects), some Government R&D Center expertise was obtained by industry under individual contract. During the downselect process, losing Team members became available to join the winners to develop even stronger Teams. This was encouraged in the Agreement between the Government and the Industry Team.

1.3.6 ***Significant Cost Savings in Development and Acquisition Programs can Only be Achieved Through Program Stability.*** Industry's willingness to invest its time, talent and resources to compete for 845 type agreements is strongly influenced by the clarity and stability of the program, as well as the ability to realize return on investment. The Arsenal Ship Joint Program Office left the CONOPS and key elements of the Arsenal Ship unchanged through the first two phases; this stimulated about a $5 million per team investment (Consortia IR&D) in Phase I, and approximately $15 million per team investment in Phase II. The potential for achieving a reasonable return on investment for production Arsenal Ships, as well as future production SC-21 vessels rounded out Industry's motivation for their investment strategy.

1.3.7 ***Technology is Already Available for Breakthrough Performance.*** Technologies still "under study" by the Government were readily incorporated in the Arsenal Ship designs based on COTS products. Areas of particular strength include: reduced manning; automation; information systems; communications/connectivity; propulsion machinery; fire fighting; maintenance and logistics. Effective passive survivability and signature reduction technologies derived from previous Government programs are also available in the Marine and Aerospace industry. Combined, these resulted in improved performance with major savings for both acquisition and service life costs at little technical risk.

1.3.8 ***Minimal Government Direction is a Key Factor to Success.*** In a typical Government acquisition program, extensive specifications, cost and schedule requirements, and oversight (DoDI 5000.2, as interpreted by program offices and oversight staffs) can result in an overly constrained environment and unachievable objectives. Further, large Government program offices provide multiple opportunities for redirection, levying of additional requirements, confusion and delay in administering acquisitions. Arsenal Ship, with a minimal set of technical objectives (9 pages of goals with no thresholds), coupled with an office size of six Government employees, kept industry's trade space open, communications direct, and delays to a minimum. Significant trust and mutual respect was a direct consequence of the more open and coherent dialog with Industry.

1.3.9 ***Adequate Time is Needed for Industry Team Formation and Growth.*** Much energy was spent by industry in the first two months of Phase I sorting out Team membership and Team

relationships. At the start of Phase II, the average Team size increased from about 50 to over 200 people in a short time frame, which caused different design maturation rates among the Teams. The phases of the program were structured to allow seamless transition from one phase to the next. Industry did not take full advantage of the downselect decision period to position themselves for the next phase. Had they done so, the Phase transition would have been much smoother. Without this, an additional 2 months for Phase II would have permitted all three consortia to fully mature their functional design.

1.3.10 ***Competitive Design Solutions are a Package Deal.*** All aspects of the Industry Team's competing designs were not equal in performance, but each Team met the PAE goal without containing any fatal design flaws. Achieving a notional "best possible ship" by having the Government attempt to integrate various aspects of each Industry design would have resulted in

(a) holdback of the most innovative ideas from competing Teams

(b) a Government directed solution, undermining the industry-based design responsibility and

(c) a program that would not meet its PAE goal.

The Government must understand (and participate in the underlying trades which lead to the winning design), and then accept the solution as the best compromise that can be achieved within the PAE constraint.

1.3.11 ***Section 845 permits "fly before buy" for Naval Ships with no lost time to full production.*** The Defense Science Board's 1996 Task Force on Defense Acquisition Reform (Phase III) highlighted the time to field the average major weapon system at 16 to 18 years. Surface Navy ships have been no exception. Traditional surface combatant acquisition programs require five years to complete concept, functional and contract design, after a five to seven year research and development cycle. Following award of lead ship, production of the first vessel averages five years. Two years after lead ship award, the follow ship contract is let, when the lead ship has barely started construction, committing the Navy to procurement of many ships before the first one is even delivered.

Using Section 845 authority, and involving industry at the inception of the program, cut the development cycle in half. The Arsenal Ship demonstrator would have been available for testing after just four years of design and production. The production decision could then be based on actual test data, allowing a ship to be acquired in a "fly before buy" fashion, reducing cycle time and accelerating technology insertion into the fleet.

1.3.12 ***R&D Funding must be properly balanced with production costs.*** Industry's limit of $389M for development of the demonstrator ship was extremely challenging as compared to the average production cost goal of $450M. Industry pushed some software development to the production ship to reduce demonstrator ship non-recurring costs, with attendant reduction in demonstrator capabilities and increased production risks.

1.3.13 ***Industry lead for acquisition is a permanent "fork in the road".*** Industry's freedom to balance the PAE tradespace equation necessarily includes their ability not to choose Government

developed systems. This has implications for the Government's R&D investment strategy, the infrastructure currently in place to support subsystem development (Participating Managers [PARMS]), and equipment configuration control (outsourced and privatized to industry or centralized with the Government). The net effect could be to lower total Life Cycle Costs by attacking infrastructure as well as taking advantage of the commercial marketplace.

2.0 -- Program

2.1 -- Acquisition Strategy

2.1.1 *Background*

The DARPA High Altitude Unmanned Aerial Vehicle Program (Tier II+) provided the model for the Arsenal Ship acquisition strategy. Tier II+ was the first to use DARPA's Section 845 authority, granted to DARPA in the FY 94 Authorization Act.

Like Tier II+, the Arsenal Ship acquisition strategy was a multi-phase competitive procurement, with each phase reducing the number of competitors and increasing the maturity of the design for both the Demonstrator and production ships. The central element of the strategy was to use competition, with each of the Industry Teams committing to an irrevocable offer for the production ships at the end of Phase II. Phase I's Concept Design was awarded to all qualified full service Teams who could potentially perform all phases of the program. Phase II was to be awarded to two Industry Teams for the Functional Design (similar to Contract Design in maturity). The downselect decision instead awarded three Industry Team agreements based on three very robust Industry designs. Phase III, detail design and construction for the Demonstrator, as well as a priced option for five production ships, was to be awarded to one Industry Team.

Industry was encouraged to form teams to include all of the requisite analysis, design, build capability, and life cycle support required to execute the entire program. The intent was to encourage the creation of a Team where individuals applied their expertise irrespective of company affiliation. This could manifest itself as a joint venture, a limited partnership, or other corporate structure. The classic Prime/Sub relationship was not precluded, but alternative teaming arrangements were suggested as a way to break down corporate stove pipes, as well as achieve efficiencies and save costs.

The use of the Other Transactions Authority eliminated most of the procurement regulations, including those in FAR/DFARS (see Tab E). This allowed a streamlining of the process and shortening of the schedule, especially the time taken to conduct source selection by the Government. It should be noted that even though most of the "rules" are waived by the authority, a review of DoDI 5000.1 showed that the spirit and intent of DoD acquisition policy was being followed. Specific procedures prescribed in DoDI 5000.2 were not emulated.

Concept of Operations (CONOPS) and Ship Capabilities Documents (SCD) were provided as goals (Tabs C and D). The stated philosophy of "no requirements" effectively put responsibility for cost and performance on each Industry Team, and gave them the trade space necessary to achieve PAE goals.

A PAE range of $450M to $550M was established for the average Unit Sailaway Price (USP) of the five production ships. USP and the manning limit of 50 people were treated as the program's only hard requirements.

2.1.2 ***Lessons Learned***

2.1.2.1 ***Effective competition motivated the Industry Teams to meet the program goals of cost and performance.*** Clearly the three Phase II Teams felt the competitive pressure of the other consortias and worked hard to create a competitive advantage. It is doubtful that consortia full effectiveness or corporate CEO level participation could have been achieved without the benefit of competition.

2.1.2.2 ***Industry could effectively form teams containing the requisite capability to perform the contract.*** The three Teams awarded Phase II agreements created effective organizations that operated mostly as a single unit. However, the members did not lose all of their corporate identity. This was manifest in the degree to which individual company cost data was closely guarded.

2.1.2.3 ***The shortened source selection process allowed the multi-phase process to work.*** Historically, the largest issue with pursuing a multi-phase program was the schedule penalty mandated by a lengthy source selection process, often lasting over six months. For Arsenal Ship, slightly less than two months were scheduled for both the Phase II and III downselects, with the selection date cast in concrete and put on all of the principals' schedules months in advance. Government access to Team's designs throughout their development, rather than only at source selection time, was critical to being able to execute the evaluation on a short schedule. The climate of rapid prototyping within DARPA, the willingness to explore new concepts, and the focused support by Director, DARPA, greatly facilitated this process.

2.1.2.4 ***One of the advantages of using the Agreements Authority was deleting "protest avoidance" from the process.*** Many of the rules established by the acquisition community over the years to avoid litigation have become cumbersome and detrimental to an efficient process. Although the integrity of the individual Arsenal Ship Team design and business data were jealously guarded, the "fairness" rules [1], for example, were eliminated, a fact which greatly improved the ability of the Government to support and communicate with the individual Teams.

> *1* ***The so-called "fairness" rules require the government to provide the answers to one team's questions to the other teams. Being a version of "Other Transactions", Section 845 agreements are not protested in the General Accounting Office. Protests to the Agency and protests to Court (where the standard is illegality or arbitrariness) while available under Section 845, are deemed more predictable and less threatening than the GAO process.***

2.1.2.5 ***When cost is the only requirement, it is essential that both the development budget and PAE goal be achievable and balanced.*** The $450M PAE goal for average production USP turned out to be a good number and universally supported by industry. Industry's limit of $389M for development of the demonstrator ship was extremely challenging as compared to the average production cost goal of $450M. Industry pushed some software development to the

production ship to reduce demonstrator ship non-recurring costs, with attendant reduction in demonstrator capabilities and increased production risks.

2.1.2.6 ***A streamlined acquisition process can significantly reduce the time and cost of bringing the product to market.*** The process being followed by Arsenal Ship demonstrated a 50% reduction in acquisition time for the design portion of the ship compared to the traditional design approach. The Industry Teams were prepared to complete the detail design and build the ship in 33 months, again about half the normal time. This was primarily enabled by using an industry led acquisition operating under Section 845 authority, with industry having full trade space and responsibility for the design.

2.1.2.7 ***One power of Section 845 Authority was in changing the mindset of the participants.*** The acquisition process currently in place incentivizes risk averse behavior, and stifles innovation. True acquisition reform and streamlining is possible if all the rules are taken away first and then reinserted on a case basis, such as for security and explosive safety. If each exception to the conventional rules must be justified, streamlining will not occur. Section 845 lets good business decisions govern.

2.1.2.8 ***Developing a long term vision and fully disclosing it to industry at the outset sets the stage for the entire program.*** In order for industry to plan for and invest in a program it has to know the Government's plans. Industry can seek this through the back door or Government can put the word out openly and consistently. Arsenal Ship sketched the program vision in two industry day sessions early, and then reinforced the vision themes at each industry interaction.

2.1.2.9 ***Allowing industry to set requirements increases design innovation.*** By not invoking any requirements, the Government gave Industry the total trade space for the overall design and the subsystems selection. Consequently, the use of new technologies integrated in different ways was facilitated, especially in the areas of communication, information systems and topside integration. Opening the development filters permitted the next logical step from the Goldwater Nichols Act of 1986; joint warfighting design at program inception.

2.2 -- Contracts (Agreements) and Legal

2.2.1 *Background*

2.2.1.1 *Key Events*

Phase I

Draft Solicitation and Industry Briefing	7 May 96
Industry Discussions	14 May 96
Final Phase I Solicitation	23 May 96
Phase I Proposals Received	25 June 96
Phase I Selections Announced	11 July 96
Negotiations Concluded (Agreements executed -- five Teams)	Aug 96

Phase II

Draft Solicitation	13 Sept 96
Final Phase II Solicitation	3 Oct 96}
Phase II Proposals Received	15 Nov 96
Phase II Selections Announced	10 Jan 97
Negotiations Concluded (Agreement mods executed (3 Teams)	Feb 97

Phase III

1st Draft Solicitation	16 Jun 97
Draft Phase III Model Agreement Modification	15 Jul 97
Commence Phase III Agreement Mod negotiations	Aug 97
2nd Draft Solicitation	1 Aug 97
Final Phase III Solicitation	15 Sept 97
Cancellation of Program/Solicitation	30 Oct 97
Phase III Proposals Due	14 Nov 97
Phase III Award Scheduled	16 Jan 98

2.2.1.2 ***Approach.*** The contracting approach for the Arsenal Ship program was to utilize P.L.103-160 Section 845, Other Transactions Authority. This authority was provided to DARPA by the Congress in FY94 and has since been passed on to the military services by PL 104-201 Section 804. DARPA had experience with using 845 authority on other R&D prototyping projects. The Arsenal Ship Program's acquisition strategy was modeled after DARPA's Tier II+ program for Unmanned Aerial Vehicles. Use of Section 845 Authority allows for the procurement of prototypes outside FAR and DFARS regulations. Additionally, the Arsenal Ship Program was designated as a "non-ACAT" program (Tab A), relieving it from the requirements of DoDI 5000.2. The Contracting Officer was free to negotiate terms and conditions specific to the individual needs of the program.

There were several motivating factors that support use of Section 845, including: 1) enticing non-traditional DoD companies, at both the prime and subcontract level, into the business; 2) facilitating insertion of commercial technology; 3) encouraging innovation, and; 4) decreasing the overall time and cost to design, build and deliver a ship.

The solicitations for each Phase of the program contained a "model agreement" with notional terms and conditions appropriate for that particular phase. Industry Teams were free to propose their own terms and conditions to the agreement based upon their particular circumstances. Agreements were then negotiated with each Team individually.

2.2.2 ***Lessons Learned***

2.2.2.1 ***Non-traditional DoD companies are willing to do business with the Government using Section 845 Other Transactions.*** During Phase I of the program, one non-traditional company participated at the prime contract level. They proposed the use of a unique construction technique to which it owns patents. Use of Section 845 definitely provided an avenue for this

Team to propose use of its proprietary technology because FAR/DFARS rights were not invoked during the competitive process. Additionally, non-traditional DoD companies also participated at the subcontractor level. Hopefully, this will lead to new business relations between traditional and non-traditional DoD companies and facilitate the introduction of the latest commercial technologies into Government acquisition.

2.2.2.2 ***Industry retention of most data rights under Section 845 facilitated innovation.*** Section 845 allowed for modified data rights which encouraged innovation during competitive phases. Industry Teams were allowed to retain data rights in the event they were unsuccessful during any downselect process. Teams were eager to put forth their best efforts without the fear that their innovations would be taken by the Government and distributed to other Teams. The Government clearly stated its intent with regard to data rights at the onset of the program -- i.e., should the Team be chosen to construct the MFSD/Arsenal Ships, the Government wants rights to all data necessary only to maintain, modernize and support the ships. Rights to data would be defined by what the data is used for, instead of who paid for or prepared the data, as is the case under FAR/DFARS data rights clauses. Defining rights by their usage, as opposed to whether the Government paid for the rights, was believed to be a better approach to facilitating proper use of the data.

2.2.2.3 ***The intent to eliminate Government Furnished Equipment (GFE) facilitated innovation during the competitive phases of the program and could dramatically reduce the Government's risk of claims.*** No GFE was envisioned under the Arsenal Ship Program. This allowed for maximum design flexibility and took the Government out of its GFE responsibility role. This approach allowed for extensive review of new ways to satisfy the Government's technical requirements while potentially reducing production, maintenance and installation costs. Elimination of GFE placed the Industry Team in charge of the final product and greatly reduces opportunities for claims related to poor specifications, late GFE, inoperable GFE, etc. Some Teams discussed the potential use of GFE for particular systems if it appeared that it would be more economical for the Government to purchase a system through a quantity buy. The Arsenal Ship program was concluded before the full implications of such an approach could be explored or negotiated.

2.2.2.4 ***Access to data created under traditional Government contracts for legacy systems is extremely difficult.*** Because of the Arsenal Ship's operational interdependency on Government legacy systems already in the fleet, access to data on these legacy systems was necessary in order for industry to perform design trades and engineering development. Access to data on Government legacy systems proved to be extremely difficult and time consuming despite extensive efforts by the Industry Teams and the ASJPO. The experience indicates that despite data rights provided by the FAR/DFARS, Government offices either questioned the Team's rights/ability to utilize any of Government's data or simply refused to provide it to other Government agencies for use on their programs. As a result, industry had to make assumptions regarding legacy system operations or even in some cases reverse engineer aspects of their design to ensure compatibility with legacy systems. Such action is time consuming, inefficient, potentially costly and underscores that traditional data rights clauses are counter productive.

2.2.2.5 ***The implications of an "irrevocable offer", which fixed the cost of production units, provided tremendous leverage to the Government and incentive to the Industry Teams to***

design to cost. At the conclusion of Phase II, all competing Teams were to provide an irrevocable offer to build five production Arsenal Ships at a fixed price. The detailed design of this Arsenal Ship would be defined during the Phase III construction of the MFS Demonstrator. Industry Teams were driven to propose the best capability for the money as a result of competition. However, they were also driven to develop a design that was realistic for the cost as a result of the irrevocable offer. If the design proved too expensive, the Industry Team would lose money on the production ships. However, if the design lacked in capability, the Industry Team ran the risk of not being continued in the program. These dynamics were created to facilitate true PAE design development and credibility in cost estimating. All Industry Teams viewed the Irrevocable Offer seriously from a contractual stand-point. The Irrevocable Offer drove Industry Teams to develop the most realistic, vice optimistic, cost estimates because they were contractually committed for these estimates at a fixed price. Negotiations of contractual language pertaining to the Irrevocable Offer were extremely complex and time consuming.

2.2.2.6 ***Negotiation of Section 845 Agreement terms and conditions facilitates greater understanding between the parties.*** Use of Section 845 Other Agreements Authority, provides both Government and Industry with the opportunity to deviate from traditional DoD terms and conditions when it is appropriate for the circumstances. With such opportunity comes a great responsibility to fully understand all technical and business aspects from which the Industry Team is operating. It allows both sides to analyze why a particular procurement can or cannot be performed under traditional terms and make exceptions to such terms if it will facilitate development under the program that will ultimately benefit both the Government and Industry. As a result, negotiations may become very complex and require understanding of industry's motives and concerns in order to determine what is in the best interest of the Government. It is extremely important that legal and technical personnel, as well as contracting personnel are actively involved in the negotiation process.

2.2.2.7 ***Effective implementation of Section 845 authority required close teamwork among the Government's contracting, legal and technical team members.*** The lack of established rules or regulatory guidance inherent in the use of Section 845 authority necessitated close communication between the Government contracting, legal and technical team members. Two major attributes contributed to this successful working relationship. First, the small size of the program office allowed for rapid access to the necessary team members, especially the program manager, for discussion and decision. Second, the team members in the ASJPO were specifically selected for their ability to be open-minded, flexible and willing to experiment with the authority granted under Section 845. These attributes were particularly important in the contracting and legal team members, whose personnel have been traditionally viewed as impediments. The support provided by DARPA General Counsel and DARPA Contracts Management Office, was invaluable.

2.3 -- Role of Government

2.3.1 *Background*

2.3.1.1 *ASJPO Relationship to Industry Teams*

ASJPO objectives differed by program phase. During Phase I, the strategy for engagement was guided by the objective to permit uninhibited concept exploration and innovation by Industry Teams. To this end, Government involvement was structured as "objective" in nature, that is, data or calculation results were made available to the Teams but no advice of any kind was provided. The resulting industry-led efforts produced the desired significant innovation as characterized by:

- Major system innovations
- Independent, highly competitive cost estimates
- Introduction of commercial practices
- Aggressive schedules
- Effective teaming of systems integrators and shipbuilders

These accomplishments, coupled with the compressed schedule, effectively locked in the innovative concepts at the total system level and most of the associated life cycle cost benefits expected.

The objective for Phase II was to ensure successful functional design development that would result in highly desirable competitive proposals for construction. This objective demanded a more pro-active involvement to ensure the development of a ship that the fleet would evaluate positively in all areas. This approach could be taken without jeopardizing the Phase I success because:

- Remaining trade-offs were primarily at the subsystem level with limited cost impact
- Operational (user) input is more important as design detail unfolds
- Government had specific areas of expertise not generally available from industry (e.g., survivability)
- Under Section 845 Agreements, industry was not required to take Government advice

This last competitive phase was the best opportunity to encourage industry to improve weakness in their programs, improving the chances that the "all or nothing" operational test would prove a success and move us into the Arsenal Ship production during Phase V. Thus, ASJPO conveyed its views as a continuing "report card" during the process, rather than when it was too late after the final downselect. In addition, with such a tight schedule, time was of the essence in letting industry know where to focus additional effort rather than experiment with paths that have proven unsound in the past. ASJPO's role during Phase II was thus to:

- Interact in a supportive way on a minimally invasive basis during reviews, technical interchange meetings, and internal team meetings. Coach each Team to be the best they can be within the context of their approach.
- Encourage consideration of out-of-the-box opportunities for technology insertion and business practice reform. Provide real-time feedback.

- Facilitate access for Teams to Government offices, information and software.

- Continuous involvement of ASJPO personnel in the design reviews and open discussions increased understanding of the approach, allowed for identification, disclosure and correction of major deficiencies and shortened the evaluation process following formal proposal submission. It also increased productivity on both sides.

ASJPO questions got the Industry Teams thinking, and stretched their decision space. Great care was taken not to imply direction. The ASJPO core members quickly embraced this new role and used it to great advantage. Training external Government personnel brought in to provide analysis and technical advice to adjust to this non-traditional role was an on-going process. This new role on the part of the Government was viewed as crucial to the success of the program.

The Industry Team members faced a similar cultural shift. It took some initial convincing on the part of the ASJPO before the Industry Teams believed that the program office was serious in pursuing a more flexible and commercial-like way of doing business.

During Phase III it was anticipated that a very close working relationship with the single winning Industry Team would evolve, including on-site ASJPO representatives who would answer questions and facilitate getting Government data, coordinating program functions with other Government activities (such as WSESRB, fleet operational testing, INFOSEC security, testing ranges, etc.), and perhaps even participate directly in software development via the Government R&D Centers. However, the responsibility for defining the best product for the fleet would remain with the Industry Team.

2.3.1.2 *ASJPO relationship to support Contractors and Government R&D Centers*

ASJPO recognized prior to the initiation of Phase I that specific expertise in analysis of ship motions, survivability, signature measurement, C4ISR, Life Cycle Management and ship production was needed to augment the Program Office. Contractual arrangements were negotiated with several private companies including: SYNTEK, Vail, SPC, and LMI. Additionally, task statements were put in place at NSWC Carderock, NSWC Dahlgren (to include Coastal Systems Station), NAWC China Lake (to include Point Mugu), NSWC Port Hueneme Division East Coast Operation, NCCOSC NRaD, JHU/APL, and NRL, to provide support to the ASJPO. These particular private industry Government Laboratory personnel were identified as source selection assistants, and were barred from interacting with Industry IPTs. All personnel included in internal ASJPO activities submitted Financial Disclosure Statements which were screened and approved by DARPA General Counsel for potential conflict of interest.

2.3.1.3 *Government R&D Centers relationship to Industry Teams*

ASJPO made available to the Industry Teams, government services that could not be obtained from private industry. A Phase I Memorandum of Agreement (MOA) (Tab K) was negotiated between NSWC and ASJPO that outlined the allowable interaction with industry during the first phase of the program. This allowed the Laboratories to provide objective products and services, non exclusively.

In Phase II, the relationship between the Industry Team and the Laboratories was expanded (Tab L) to include lab participation on Industry IPTs. Great flexibility was provided by the MOA; however, because of R&D Center concern with the legal restriction that they not compete with private industry, R&D Center personnel were slow to start work on industry IPTs. To alleviate this problem during Phase II, funding ($450k per Team) was made available at the R&D Centers directly from ASJPO to support each Industry Team. Industry Teams developed Statements of Work for this support since the Government itself (ASJPO) was providing the funds, the R&D Centers felt much more at ease with industry requests. This arrangement avoided any competition with industry and worked extremely well.

2.3.1.4 *ASJPO and Industry Team relationship to PARMs*

Within the trade space available to the Industry Teams to satisfy Arsenal Ship design goals, was the opportunity to select legacy Navy systems. The use of legacy systems in many cases was more attractive than developing new ones based on investment required, and because these systems have passed the WSESRB, OPTEVFOR and other safety/operational checkpoints in other developmental programs. These systems could be obtained either as Contractor Furnished Equipment (CFE), or purchased through the Navy PARMS. PARMs (PARticipating Managers) are the Government program offices responsible for individual Navy systems such as ATWCS, CEC, and SSDS. Systems of primary interest to Arsenal Ship Teams were ATWCS, AFATDS, and CEC.

The PARMs were receptive to making hardware available to the Arsenal Ship Teams, but expressed concerns about requests for the release of source code software to Industry Teams. They cited the difficulty in maintaining configuration control, plus the apparent liability of the PARM for performance anomalies in his system but was not under its control. As a consequence, PARMs were unwilling to release Government owned software for Arsenal Ship program use.

These concerns were the subject of an Arsenal Ship Offboard Systems Working Group, discussed in the C4I section of this report. Although not resolved during Phase II, it was hoped that a good working relationship could be developed during Phase III when only a single Industry Team would have interest in modifying source code. Initiatives in ATHENA working groups would likely have facilitated this process.

2.3.2 *Lessons Learned*

2.3.2.1 *A small Government program office is sufficient when the total system design responsibility is in industry's hands.*

The six Government personnel and six technical SETA proved adequate to monitor the consortias' progress, without imposing excessive oversight. By maintaining a daily consortia calendar across the teams, ASJPO could be physically present at the majority of design interactions by the teams. By locating access to their Integrated Product Design Environments (IPDE) at ASJPO, real time accessing of trade studies, IMS, IMP, 2D and 3D CAD/CAM models permitted virtual presence for those periods when ASJPO could not be physically present.

2.3.2.2 ***Industry welcomes openness of Government feedback.*** Industry was solicitous of Government feedback, to avoid revisiting errors of previous design efforts (which cost time and money), and to hear directly from the customer on likes/dislikes. They welcomed the openness of ASJPO comments on their progress. This relationship was enabled by two aspects of the Agreement; no claim provisions and no unilateral Government direction.

2.3.2.3 ***Providing expertise and "lessons learned" to Industry is a new Government role.*** Much as it was difficult for industry to accept full design responsibility at the beginning of Phase I, it was equally difficult for the Government to provide advice rather than give direction. Government retains a wealth of knowledge and operational experience that is indispensable to industry's design/build process. ASJPO called on technical specialists to provide briefings on survivability, combat systems interfaces, and Joint warfighting C4ISR. Access to intelligence reports, studies, and government designs were also facilitated by ASJPO. The guidance to Government personnel was that information exchange was acceptable, but that design mandates were not.

2.3.2.4 ***Government intervention was required in obtaining data, access, and equipment.*** Industry does not have authority to compel PARMs or System Command headquarters to provide information and access to data or equipment. ASJPO frequently had to exercise such authority.

2.3.2.5 ***Safety and security cannot be delegated to industry.*** Industry's responsibility for and integration of all aspects of the design/build product requires a special interaction with the Government Program Office in the case of safety and security. The Program Office is ultimately responsible for personnel and ordnance safety. Extant Government agencies (WSESRB and INFOSEC, for example) do not respond to private industry, but are chartered to respond to the Program Manager. In this special relationship, the Government must fully understand the design, and certify its safety.

2.3.2.6 ***Direct funding of R&D Centers by the Program Office is essential to performance of some tasks.*** Due to legal restrictions on Government R&D Centers "not to compete" for services available from private industry, direct Government funding is needed to provide flexibility for some industry tasking. For example, combat system engineering is available from a variety of industry sources; however, for a specific system, this may not be true. In this case, the Government must identify work-arounds to facilitate competition.

2.3.2.7 ***The Government team should have expertise, insight into, and understanding of Teams' business decisions as well as technical decisions.*** In some cases the Industry Teams made design decisions because they were either the developer of a system/software, because they could not get detailed information about a system/software developed by others, or because their real market for a particular system is another program. The Government team needs to understand the motivations which underlie specific design decisions in order to assess if those design trades yield the best solution.

2.4 -- Funding

2.4.1 ***Background***

The funding for the Arsenal Ship program was initially laid out in the Memorandum of Agreement (MOA) for the Joint Navy/DARPA Arsenal Ship Demonstration Program between Mr. Larry Lynn (Director, DARPA), Mr. John Douglass (ASN(RDA)), and RADM D.J. Murphy, USN (N86) in May 1996 (see Tab B). The cost of the R&D program for the Arsenal Ship Demonstrator was determined to not exceed $520 million including the cost of concept development and competition. The Navy DARPA joint funding profile was:

	FY96	**FY97**	**FY98**	**FY99**	**FY00**	**FY01**	**Total**
Navy	$4.0	$25.0	$141.0	$90.0	$80.0	$10.0	$350.0
DARPA	$1.0	$15.0	$47.0	$50.0	$36.0	$21.0	$170.0

In the same MOA the Navy agreed to provide its share of the funds to DARPA at the beginning of each fiscal year.

In January 1997, during the Phase I to Phase II downselect, three team's designs were determined to be of such value as to warrant their continuation into Phase II. The cost of adding a third Industry Team to Phase II was calculated to be $21M which the Navy agreed to fund. The $21M was split funded between FY97 ($9M), and FY98 ($12M).

During the PR-99 review process, the Navy redistributed $50M from FY98 to FY99; the overall Navy total of $350M remained the same. A dialog with industry determined that this revised funding stream could be accommodated without impacting the delivery and test schedule of the Demonstrator.

2.4.2 *Lessons Learned*

2.4.2.1 ***Funding Navy Research and Development (R&D) Centers/University Affiliated Research Centers (UARC) to Support Industry was necessary.*** Money sent to R&D Centers from ASJPO on behalf of the Industry Teams was necessary to maintain each Team's competitive edge and to allow for specific support. R&D Centers were allowed to perform any kind of support work without regard to "non-competitive" rules of accepting money directly from industry.

2.4.2.2 ***The ability of a University Affiliated Research Center (UARC) to support Industry needs to be broadened.*** Industry relationships with UARCs are much more difficult to establish than those Government Laboratories with DBOF funding. UARC's, much more than DBOF laboratories have been concerned with maintaining their appearance of objectivity with its many customers. The legal barriers of industry UARC interaction need to be more fully explored in the future to enable a much needed dialog.