



Special Notice N00014-17-SN-0007
Special Program Announcement for 2017 Office of Naval Research
Research Opportunity:
“Future X-Band Radar (FXR) Science and Technology”

I. INTRODUCTION

This announcement describes a research thrust entitled, “Future X-Band Radar (FXR) Science and Technology” to be launched under the Office of Naval Research (ONR) Broad Agency Announcement N00014-17-S-B001 entitled, “Long Range Broad Agency Announcement (BAA) for Navy and Marine Corps Science and Technology” which can be found at <https://www.onr.navy.mil/Contracts-Grants/Funding-Opportunities/Broad-Agency-Announcements.aspx>. The research opportunity described in this announcement currently falls under the following sections of BAA, N00014-17-S-B001: Section I, entitled, “General Information”, subsection F entitled, “Research Opportunity Description”; the “Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)(Code31)” item, paragraph 2 entitled, “Electronics, Sensors and Network Research”. The submission of proposals, their evaluation and the placement of research contracts will be carried out as described in that BAA.

The purpose of this announcement is to focus attention of the scientific community on the (1) area to be studied, and (2) the planned timetable for the submission of full proposals.

II. TOPIC DESCRIPTION

Background

Note: The Statement of Work provided with the Government Furnished Information (see Section XI entitled, “Distribution of Government Furnished Information (GFI)” provides further detail on the Background, Objective and Scope of this effort.

The FXR effort is entering a Technology Development and Risk Reduction phase that will mature technologies that the Surface Navy could leverage for its next generation, X-band multi-function radar. FXR will subsume the functional capabilities of AN/SPQ-9B as well as add new capabilities. The new radar system will be back-fit on existing ships and forward fit for new ship construction. Although a functional replacement for AN/SPQ-9B, the threats and combat operational environment for this radar are new conditions dictating performance.

Science and Technology (S&T) development is crucial to properly advance and evaluate industry’s ability to deliver the necessary functionality within affordability, performance, size, weight, power, and cooling (SWAP-C) constraints. Technology assessment, risk reduction and industry engagement is needed, from study through prototype efforts, to help mature key FXR technologies and refine the specific performance requirements to enable a successful and timely acquisition phase that meets the notional schedule which is driven by the FXR In-Yard Need Date (IYND) in Fiscal Year (FY) 2027.

ONR Code 312, in partnership with Program Executive Office (PEO) Integrated Warfare Systems (IWS) 2.0, is seeking full proposals for an FXR S&T development study.

Objective

The objective of this announcement is to (1) develop baseline FXR system concept(s); (2) estimate and substantiate SWAP-C and effective isotropic radiated power (EIRP) under a flyaway cost constraint; (3) assess current technology and propose new technology development required to achieve capability; (4) assess performance; (5) conduct trade studies; and (6) optionally perform additional trade studies.

The results of these activities with industry will help the Government inform potential FXR technology investments and assess risk of draft FXR requirements in particular with respect to the combination of SWAP-C, EIRP and acquisition cost.

Scope

FXR will support multiple ship classes for ship self-defense and situational awareness as defined by the draft FXR System Requirements Document (SRD) provided as Government Furnished Information (GFI) and available upon request per Special Notice N00014-17-SN-0006 Amendment 0002.

It is anticipated that other implementations will include integration with other elements in the combat system. The system will be designed with a lower power mode for safe operations in harbors for tactical situational awareness and force protection.

The Government considers X-band as the most suitable operating band for this radar. With limited availability of other maritime radiolocation radio frequency (RF) spectrum, other bands will not be considered.

Tasks

The offeror shall perform the following tasks. It is expected that some of the work in these tasks will be interrelated.

1. Radar System Concept Development;
2. SWAP-C and EIRP Estimation and Proposed Technology Development under a Flyaway cost constraint;
3. Performance assessment;
4. Trade studies and System Level Specification Refinement; and
5. Additional Trade Studies

Radar System Concept Development:

The United States Navy is interested in concepts for a low-cost, light-weight, X-band, active phased array radar referred to as FXR. FXR will support surface warfare gun engagement and anti-ship cruise missile defense. In order to extend the radar horizon, the Navy is interested in concepts suitable for installation at heights high above the waterline, near or at the top of ship masts, on current and future surface combatants as well as other platforms currently designated for AN/SPQ-9B. To this end, FXR on-array weight is potentially a focus area for technology development. Array acquisition cost may also drive the need for technology development in particular with respect to high efficiency X-band transmit/receive (T/R) modules, power amplifiers (PAs) and associated packaging.

The Offeror shall develop a concept or concepts to design, develop, and deploy an X-band shipboard radar system that meets the requirements documented in the draft FXR SRD.

Open and Modular Subsystems: The Offeror shall define a modular system architecture that enables future capability growth and technology insertions with minimal impact. Trades shall identify specific candidate software modules and hardware components, and define their corresponding interfaces. The FXR external interface shall also be a standard interface that facilitates integration with additional ships and combat systems.

SWAP-C and EIRP Estimation and Proposed Technology Development under a Flyaway cost constraint:

As part of the FXR baseline system concept and architecture, the offeror shall include all associated estimates and substantiation for SWAP-C, Equivalent Isotropic Radiated Power (EIRP), and production costs. The design concept shall include the following:

- 1) A description of the system concept and architecture necessary to meet technical requirements supporting the functional and performance requirements in the SRD including EIRP. The concept shall meet the environmental requirements (natural and manmade) of a Navy shipboard radar system as defined in the SRD. The concept shall include features to operate through a 120-day mission without critical failure.
- 2) SWAP-C estimates and substantiation.
 - a. New ship construction, estimate and substantiation of topside weight, size and location. Substantiation should include the percentage of actual, design, and engineering estimates to support associated weight uncertainty estimates. Concepts may take advantage of opportunities on specific platforms for distribution of weight versus elevation between transmit and receive functionality.
 - b. Cooling: Since cooling capacity of ships is a constraint, the use of improved technologies to reduce the heat load on ship service cooling is a particular focus area. Designs featuring higher efficiency technologies in power amplification, receiver components, advanced cooling, efficient signal processing, and other engineering innovations to control heat load are desired.
 - c. For back-fit in existing ships and installation on other platforms, commonality of antenna/sub-array/subsystems with the forward-fit system is highly valued and desired to the extent practical and shall be included in the design concept.
- 3) Identification of key radar technologies that enable performance identified in the SRD. The Offeror shall provide a self-assessment of maturity of each key radar technology and path to achieve sufficient maturity for the production system.

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- 4) The desired per unit procurement cost is less than \$30M flyaway costs. The Offeror shall provide a cost analysis of the concept radar system including Non-Recurring Engineering (NRE) and Recurring Engineering (RE) costs. The Offeror shall provide cost estimates for the technology maturation plans developed in paragraph number 3 above.
- 5) A description of the Offeror's industrial capabilities to mature technology, produce and deliver FXR.
- 6) For the Offeror's radar system concept (paragraph number 1 above) , utilizing the technology matured as proposed in paragraph number 3 above provide a Blake Chart including transmit power, transmit antenna gain, receive antenna gain, all ohmic and non-ohmic losses, and the system noise temperature. For ease of reference, it is preferred that the reference point for antenna gains and noise temperature be the plane directly in front of the antenna aperture. The Blake Chart should characterize the sensitivity of a horizon search processing interval used at the required elevation and for a specified azimuth. The Blake chart sensitivity should be calculated using representative waveforms designed to meet the horizon search requirements for firm track range and clutter suppression. The horizon search waveform must address all applicable requirements in the SRD and any derived requirements to fulfill the horizon search function. This includes processing interval and dwell times within the constraints of the derived search frame time, and resolution of range and Doppler ambiguities. The losses resulting from this ambiguity resolution process, including the effect of blind ranges and blind Doppler frequencies, must be included. Furthermore, a detailed breakdown of all processing losses including antenna beam shape losses, pulse compression weighting, range straddling, Doppler straddling, Doppler weighting, Constant False Alarm Rate (CFAR) loss, beam shape, array scan losses, and jammer residue must be included and substantiated. A Blake Chart is required for this exemplar for each different concept or configuration of a system. Blake charts must account for environmental conditions and jamming identified in the SRD.

Performance Assessment:

The following aspects of radar performance shall be investigated and presented to the Government at a Technical Interchange Meeting (TIM). A Concept Radar System Performance Study Report shall be submitted addressing each enumerated item below:

1. The offeror shall perform a study assessing the performance of the concept radar system.
2. The Offeror shall report SWAP-C, EIRP, and receive sensitivity allocations to radar subsystems and associated components.

Trade Studies and System Level Specification Refinement:

The Offeror shall execute trade studies that assess Cost & Ship Integration, Size, Weight, Power, and Cooling (SWAP-C) impacts and document those impacts for the following trade studies:

1. Industry Proposed Requirement Changes (FXR SRD Challenge) – Offerors shall provide a red-lined version of the FXR SRD that includes recommendations for refinement and revisions to the Draft FXR SRD including consideration of SWAP-C, EIRP, and acquisition cost. The Offeror shall provide cost impact and schedule risk for compliance with selected requirements and recommendations where relaxation could result in substantial development savings, recurring cost savings, reduction of development schedule, or avoidance of technical risk. The Government will assess the impact of all proposed SRD revisions, and adjudicate all recommendations to ensure operational performance requirements can be met with minimal cost and schedule risk.
2. Cost & Ship Integration – Offerors shall develop trade studies for mounting options that include impact to SWAP-C, assessment of impact to reliability, maintainability and accessibility, and impact to the ship including any piping, cabling and HVAC support transiting the mast. Trade studies shall also include concepts for minimizing below decks equipment footprint.
3. Operating Bandwidth – studies shall address optimization of operating bandwidth to address low-elevation multipath effects while ensuring RF interoperability with other sensors and emitters. Sources of interfering RF to FXR and potential victims of FXR RF will be on ownership and other platforms.

Additional Trade Studies:

If the Government assesses significant margin and acceptable risk with respect to the combination of SWAP-C, EIRP and acquisition cost, then the Government would be interested in learning what additional capabilities the following studies would bring to an FXR concept. However, the execution of these optional studies will depend upon the availability of Government funds. Therefore, offerors may propose options and associated period of performance (POP) for the conduct of the following trade studies of particular Government interest. The Government may exercise these options based on the Government assessment of results of paragraphs entitled, “Radar System Concept Development” and “Performance Assessment”, and paragraph numbers 1-3 in the trade studies section above. Note that the FXR Development S&T Study also has options for work beyond the base award. Offerors may propose options.

Digital Beamforming / Signal Processing

- a. Trades shall address cost, ship fit, dynamic range, linearity, signal processing and spiral growth in capability. Array and beamforming trades may consider element level and subarray digital beamforming options, partial (e.g., single dimension) or full digital beamforming, and on-array versus off-array digital beamforming.
- b. Electronic Protection (EP) architecture trades to include considerations of array architecture and signal processing impacts.
- c. Design trades that would allow for spiral development of signal processing algorithms/modes, including approaches for data collection to support ongoing signal processing algorithm development.

Array polarization – Studies shall explore antenna polarization options to address potential FXR mission areas and future growth.

Instantaneous Bandwidth – address the bandwidth required to meet accuracies and resolution for all FXR functions including AAW Search and Track, SuW Search and Track, Periscope Detection and Discrimination, Electronic Protection, and Non-Cooperative Target Recognition.

Receiver Damage Protection, Receiver Linearity and Instantaneous Dynamic Range

Trade studies shall address receive linearity, instantaneous dynamic range, and power consumption across architecture (AESA, partial digital beamforming, element-level digital beamforming) and receive chain technologies.

- a. Trades studies shall identify receiver chain component configuration options (including amplifiers, filters, and limiters) to address requirements to prevent damage and operate without degradation in presence of other high power emitters.
- b. Trade Studies shall include assessment of the feasibility to meet these requirements concurrently with derived sensitivity requirements.
- c. Spectral Roll Off and Spurious Emissions – studies shall address the feasibility and design impacts of system level requirements to control transmitted frequency spectrum.

The following is the list of deliverables for the X-Band effort. The Government reserves the right to reduce the list of deliverables based on available funding. Monthly Technical and Financial Reports; Red-lined version of the SRD; A baseline system concept and architecture description with associated estimates and substantiation for industrial capabilities, SWAP-C estimates and substantiation including the percentage of actual, design, and engineering estimates to support associated SWAP-C uncertainty estimates, EIRP estimates and

substantiation including scenarios, environmental and system Blake Chart assumptions and estimates, and an analysis of NRE and RE costs; Technology maturation plans and cost estimates; A Concept Radar System Performance Study Report with Technical Performance Measure assessment; System Trade Studies Reports; and Final Report

III. FULL PROPOSAL SUBMISSION & AWARD INFORMATION

Full proposals should be submitted under ONR Long Range BAA N00014-17-S-B001 by 13 November 2017 at 2PM Eastern Standard Time (EST). Full proposals submitted after that date will be considered as time and availability of funding permit.

ONR anticipates that only contracts will be issued for this effort.

Full proposals should be submitted in accordance with BAA Section IV entitled, "Application and Submission Information" Paragraph B entitled, "Content and Format of White Papers/Full Proposals" and subparagraph ii entitled, "Full Proposals" and prepared using the templates and guidance posted on the ONR website. The Technical Proposal/Content shall be single spaced and not exceed 20 pages. The cover page, resumes, bibliographies, project schedule, and table of contents are excluded in the page count. For contract proposal submissions, 2 hardcopies and one (1) electronic Submission on CD-ROM are requested. The Technical Content of all proposals shall include a description of the offeror's industrial capability to mature key FXR technology, develop and prototype an FXR system, produce and deliver FXR units, integrate with AEGIS Baseline 10, and sustain FXR in the Fleet.

ONR plans to fund up to four (4) Firm Fixed Price FXR Development S&T Development Study base awards with a value of \$150,000 each using research funds subject to the limitations of fiscal year funding. If an Offeror has capability and/or technology that draws from multiple business centers within the company, the contributions from each center shall be contained in the single proposal submission to ONR.

The period of performance of the base awards will be no more than two months.

Although ONR expects the above described program plan to be executed, ONR reserves the right to make changes.

The estimated start date of selected projects is subject to date of final award and availability of fiscal year (FY) funds. Note that FY funds are generally received no earlier than November of the FY. The award(s) will be made for the full performance period.

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Special Instructions for Classified Responses.

Proposals submitted under this notice are expected to be unclassified; however, classified proposals are permitted up to GENSER SECRET. If a classified proposal is submitted and selected for award, the resultant award will be unclassified.

Classified proposals shall be submitted directly to the attention of ONR's Document Control Unit at the following address and marked in the following manner:

OUTSIDE ENVELOPE

(no classification marking):

Office of Naval Research
Attn: Document Control Unit
ONR Code 43
875 North Randolph Street
Arlington, VA 22203-1995

The inner wrapper of the classified proposal shall be addressed to the attention of the cognizant Technical Point of Contact (TPOC), ONR Code 312 and marked in the following manner:

INNER ENVELOPE

(stamped with the overall classification of the material)

Program Name: FXR Development S&T Study
Office of Naval Research
ATTN: Dr. Bradley Binder
ONR Code: 312
875 North Randolph Street
Arlington, VA 22203-1995

All response submissions will be protected from unauthorized disclosure in accordance with FAR Subpart 15.207, applicable law, and DoD/DoN regulations. Offerors are expected to appropriately mark each page of their submission that contains proprietary information.

In either case of an unclassified or classified proposal submission, it is the responsibility of the submitting individual to ensure he/she receives an email confirming receipt from the TPOC (listed below).

VI. SIGNIFICANT DATES

EVENT	DATE	Time -Eastern Daylight Time (EDT)
Special Notice N00014-17-SN-0006 for FXR Industry Day & Amendments	ISSUED	N/A
Transmission of GFI to industry requestors	PENDING	N/A
Industry Day	Held September 13, 2017	9:00AM – 11:30AM Eastern Daylight Time
Deadline to request GFI	October 02, 2017	2:00PM EDT
Proposals Due	13 November 2017	2:00PM Eastern Standard Time
Award	16 February 2018*	N/A

*Tentative Date

VII. POINTS OF CONTACT

Comments or questions submitted should be concise and to the point. In addition, the relevant part and paragraph of the Special Notice should be referenced.

Questions of a **business** nature, shall be submitted to:

Name: Lynn Christian
Title: Contracting Officer
Division: ONR Code 252
Address: 875 North Randolph Street
Arlington, VA 22203-1995
Email: lynn.christian@navy.mil

Questions of a **technical** nature shall be submitted to:

Name: Dr. Brad Binder
Title: Program Officer
Division: ONR Code 312, C4ISR
Address: 875 North Randolph Street
Suite 1112
Arlington, VA 22203-1995
Email: ONR.NCR.312.LIST.ISR-
GROUP@NAVY.MIL

Name: Dr. Trevor Snow
Title: Program Officer
Division: ONR Code 312, C4ISR
Address: 875 North Randolph Street
Suite W1126B
Arlington, VA 22203-1995
Email: ONR.NCR.312.LIST.ISR-
GROUP@NAVY.MIL

Questions of a **security** nature should be submitted to:

Name: Torri Woodfolk
Title: Industrial Security Specialist
Division: Security Department, Code 43
Address: One Liberty Center
 875 North Randolph Street
 Arlington, VA 22203-1995
Email: Torri.powel@navy.mil
(Please note that the e-mail address does differ from the PoC's name.)

VIII. ADDRESS FOR THE SUBMISSION OF FULL PROPOSALS

Primary Point of Contact	Secondary Point of Contact
Office of Naval Research Attn: Dr. Brad Binder ONR Department Code 312 875 North Randolph Street STE 1112 Arlington, VA 22203-1995	Office of Naval Research Attn: Dr. Trevor Snow ONR Department Code 312 875 North Randolph Street STE W1126B Arlington, VA 22203-1995

IX. SUBMISSION OF QUESTIONS

Any questions regarding this announcement must be provided to the TPOCs and the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this Special Notice will be addressed in the form of an Amendment and will be posted to the following web pages:

Federal Business Opportunities (FEDBIZOPS0 Webpage – <https://www.fbo.gov/>; and

ONR Special Notice Webpage – <https://www.onr.navy.mil/en/Contracts-Grants/Funding-Opportunities/Special-Notices>

Classified questions shall be handled through the ONR Security POC. Specifically, any entity wanting to ask a **classified** question shall send an **unclassified** email to the ONR Security POC with a copy to both the Technical POC and the Business POC stating that the entity would like to ask a **classified** question. **Do NOT email any classified questions.** The Security POC will contact the entity and arrange for the **classified** question to be asked through a secure method of communication.

X. International Traffic in Arms Regulation (ITAR) Considerations

Offerors should be aware of recent changes in export control laws. Offerors are responsible for ensuring compliance with all International Traffic in Arms Regulation (ITAR) (22 CFR §120 et. seq.) requirements, as applicable. In some cases, developmental items funded by the Department

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of Defense are now included on the United States Munition List (USML) and are therefore subject to ITAR jurisdiction. Offerors should address in their proposals whether ITAR restrictions apply or do not apply, such as in the case when research products would have both civil and military application, to the work they are proposing to perform for ONR. The USML is available online at:

<http://www.ecfr.gov/cgi-bin/text-idx?node=pt22.1.121>.

Additional information regarding the President's Export Control Reform Initiative can be found at:

<http://export.gov/ecr/index.asp>.

XI. DISTRIBUTION OF GOVERNMENT FURNISHED INFORMATION (GFI)

Potential offerors can receive the Government Furnished Information (GFI) listed below (in accordance with Standard Distribution D and above ITAR restrictions) on request to Lynn Christian at Lynn.Christian@navy.mil. The request on company letterhead shall include company name, company cage code, company classified mailing address, a current DoD contract number along with the government Point of Contact (POC) for that contract and the contact information for your Joint Certification Program POC. The ONR will use this information to verify eligibility to receive Distribution D, export controlled and classified information. Requests for exceptions to the Distribution D DoD contractor requirement may also be submitted to Ms Christian. Potential Offerors do not need to request the below GFI if they have already requested GFI under ONR Special Notice N00014-17-SN-0006.

- 1) FXR System Requirements Document (classified document)
- 2) Technical Performance Measures (TPM) List
- 3) FXR Interface Functional Description (IFD)
- 4) RF Surveillance Research General (RSRG) Security Classification Guide (SCG)
- 5) Statement of Work
- 6) Industry Day Slides