Statement of Work
Autonomous Bathymetric Capabilities for a Large Unmanned Surface Vessel
Dated: 10 September 2020

1.0 SCOPE. Develop an autonomous hydrographic survey capability on an unmanned surface vessel (USV) surrogate that provides an on-water asset for further autonomous testing, experimentation and concept of operations (CONOPS) development for an open ocean hydrographic USV capability. The system will be delivered to and operated by the Naval Oceanographic Office (NAVOCEANO), under the cognizance of Commander, Naval Meteorology and Oceanography Command (CNMOC). The work includes improvements to software and/or vehicles to make CNMOC's hydrographic surveys more autonomous through integration with the ISS-60 survey system with various manned and unmanned vessels. This contributes toward improving the Mississippi Gulf Coast's stature as a center of excellence for advancing Unmanned Maritime Systems (UMS) development as outlined in the Commercial Engagement Through Ocean Technology Act of 2018 (CENOTE 2018), P.L. 115-394. This project is envisioned as a cost plus fixed fee award of BA-4 (Demonstration and Validation) funds with a two-year period of performance.

1.01 JUSTIFICATION: CNMOC is responsible for world-wide hydrographic surveys in support of safe navigation and other military operations. The current backlog of survey requirements necessitates the development of autonomous methods of survey data collection.

1.02 SECURITY CLASSIFICATION. Comply with security classification of ISS-60 technical specifications, source data and operational databases.

2.0 REFERENCE DOCUMENTS.

2.01 International Maritime Organization (IMO) Convention on the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS)

2.02 U.S. Code of Federal Regulations (CFR) Title 33 (Navigation and Navigable Waters)

2.03 North Atlantic Treaty Organization (NATO) Standardization Agreement 4194 (STANAG 4194)

2.04 Standards and Recommended Practices for Small Craft, American Boat and Yacht Council Inc. (ABYC)

3.0 REQUIREMENTS. The Contractor shall:

3.01 Evaluate candidate vessels to assess suitability for use within this effort.

3.02 Equip a vessel, as selected by the Government, with:

3.02.1 The command and control interfaces necessary for both autonomous and manned operations.

3.02.2 The hydrographic, oceanographic and meteorological sensing equipment to enable collection and processing of bathymetric and hydrographic data at IHO and fleet mission standards.

3.03 Provide vessel hull, engine, electrical, and mechanical repairs to ensure suitability and seaworthiness as needed to complete demonstration and testing.

3.04 Develop and integrate software that enables autonomous vessel operation. The autonomy software shall facilitate both the safe maritime operations of the vessel as well as the effective completion of hydrographic survey missions. The system must be operable in at least three (3) modes: Manned Operations (on-board operator control), Remote Operations (off-board operator control) and Supervised Autonomous Operations (vessel controls its own

operations). The development and integration architecture must support the integration of future academic, commercial, or Government developed autonomous behaviors.

3.05 Ensure that the safe maritime operations functions of the system enable:

- 3.05.1 Enhanced situational awareness of the operational environment and health/status of systems within the vessel.
- 3.05.2 Operation and navigation of the vessel including hazard avoidance, obstacle avoidance, grounding avoidance, collision avoidance, allision avoidance, and observance of the nautical rules of the road in accordance with COLREGS.
- 3.05.3 Functional operational maneuvering tasks including object following, loitering, and emergency behaviors.
- 3.05.4 Troubleshooting and diagnostic monitoring of the survey software, navigation status, and vessel mechanical health in simulated and operational environments.
- 3.05.5 Remote operation of mechanical functions required for safe and efficient operation of the vessel, including signaling and voice communications with approaching vessels.
- 3.05.6 Vessel maneuverability when the hydrographic sensor suite is inactive.

3.06 Ensure that the effective hydrographic survey functions of the system enable:

- 3.06.1 The vessel to safely conduct extended (multi-day) hydrographic surveys autonomously in day, night and reduced visibility conditions.
- 3.06.2 Collection of data that satisfies IHO and fleet mission standards.
- 3.06.3 The ability to follow prescribed survey plans without operator intervention with minimal cross-track error through Sea State 4 (as defined NATO STANAG 4194.)
- 3.06.4 The capability to determine and execute the safest and most efficient path to complete an assigned survey mission, taking into account safe navigation, safe operations in traffic, and data collection requirements (coverage and uncertainty).
- 3.06.5 The capability to identify potential targets/hazards and execute survey plans to further investigate those items.
- 3.06.6 The efficient resumption of a survey mission after the vessel has executed any avoidance maneuvers.

3.07 Integrate the autonomous operations and hydrographic survey software with the ISS-60 (version 3.x), including enabling control of the autonomous survey system through the ISS-60 vice a separate GUI. Any components required to interface with the ISS-60 system must be approved in the Department of the Navy Application and Database Management Standard System. Software updates to ISS-60 must be IAW the framework defined in IEEE Std. 12207-2008. All integration efforts must consider the concurrent development of the version 3.14 builds and remain backward compatible with software versions and sensors that remain in service onboard the T-AGS vessels, Hydrographic Survey Launches, and testing platforms.

3.08 Enable the system to support automated operation and deployment/recovery of hydrographic, bathymetric and meteorological instruments where applicable.

3.09 Enable the system to support autonomous data processing for select oceanographic and hydrographic data.

3.10 Provide a shore-side control station that emulates the on-board control capability, displays enhanced situational awareness information to highlight significant events and data quality issues for supervisory personnel, and has redundant communications capabilities. The system shall be able to control remote operations of the vessel from a distance of up to 30 nautical miles. Alterations to Government facilities are not permitted.

3.11 Ensure that Information technology components and systems will adhere to DoD cybersecurity requirements as defined in DoD Instruction 8500.01, OPNAV Instruction

5239.1D and applicable Security Technical Information Guides. Data transmitted to a Navy information system must be protected in accordance with National Institutes of Standards (NIST) Special Publication (SP) 800-53.

3.12 Ensure the system can protect all data at rest using a DoD-accepted encryption algorithm with minimal impact system response.

3.13 Ensure the system can support the integration of NSA approved type 1 encryption device and encryption key with minimal impact system response.

3.14 Ensure all development and integration efforts follow systems engineering principles.

3.15 Ensure the vessel meets Coast Guard safety standards.

3.16 Ensure all designs and installations are compliant with the standards referenced in Section 2.0 of this Statement of Work.

3.17 Provide the final design, including overall dimensions and weights for each piece of equipment, to the Government for approval prior to hardware integration.

3.18 Comply with NAVOCEANO and Navy personnel security procedures for access to Government facilities.

3.19 Conduct rigorous lab and at-sea tests. All testing events require a detailed test plan, which shall be approved by the Government prior to each event.

3.20 Conduct multiple demonstrations of the integrated system in operation.

3.21 Provide autonomous suite operator training to NAVOCEANO personnel.

3.22 Provide operational documentation including maintenance and troubleshooting manuals, operational checklists, manuals and specifications for individual commercial off the shelf components, engineering drawings and system schematic diagrams, complete parts list, spare parts list including price, and maintenance schedule.

3.23 Provide an inventory tracking report for all Government Furnished Equipment.

3.24 Provide a project report including recommendations on CONOPS.

4.0 REPORTS, DATA AND DELIVERABLES. The Contractor shall provide inputs to deliverables in accordance with Contract Data Requirements Lists.

CDRL	Data Delivery	Due Date
A001	Plan of Actions and Milestones	30 days after award
A002	Contractor's Progress, Status and Management Report	Monthly after award
A003	Program Status Review/ Draft Presentation / Meeting Minutes	Quarterly / 5 days prior to each review / 15 days after each review
A004	Test Plans	14 days prior to testing event
A005	Operational Documentation	45 days after completion of SAT
A006	Project Report	90 days after completion of SAT
A007	Training / Training Material	Scheduled within 14 days of final delivery / material due 10 days prior to training event
A008	Source Code	At completion of each testing event
A009	ISS60 Documentation	45 days after completion of SAT
A010	Inventory Tracking Report	Monthly after award

5.0 GOVERNMENT FURNISHED EQUIPMENT/INFORMATION. The Government anticipates providing a demonstration and validation vessel, and access to applicable Government facilities including the Boat Operations Branch. The Government shall provide an ISS-60 testbed.