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Department of Energy WindSentinel Loan Program Description

December 2016

WJ Shaw
MH Sturges

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operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

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Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Acronyms and Abbreviations

AEP	annual energy production
CF	compact flash
CTD	conductivity, temperature, depth
DAS	data acquisition system
COP	Conference of Parties
DOI	U.S. Department of the Interior
LCOE	levelized cost of energy
MSL	Marine Sciences Laboratory
OCS	outer continental shelf
PNNL	Pacific Northwest National Laboratory
RFA	request for applications
WEA	wind energy area

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1.0 Introduction

The U.S. Department of Energy (DOE) currently owns two AXYS WindSentinel buoys that collect a comprehensive set of meteorological and oceanographic data to support resource characterization for wind energy offshore. The two buoys were delivered to DOE's Pacific Northwest National Laboratory (PNNL) in September, 2014. After acceptance testing and initial performance testing and evaluation at PNNL's Marine Sciences Laboratory in Sequim, Washington, the buoys have been deployed off the U.S. East Coast. One buoy was deployed approximately 42 km east of Virginia Beach, Virginia from December, 2014 through June, 2016. The second buoy was deployed approximately 5 km off Atlantic City, New Jersey in November, 2015. Data from the buoys are available to the public. Interested parties can create an account and log in to <http://offshoreweb.pnnl.gov>.

In response to a number of inquiries and unsolicited proposals, DOE's Wind Energy Technologies Office is implementing a program, to be managed by PNNL, to lend the buoys to qualified parties for the purpose of acquiring wind resource characterization data in areas of interest for offshore wind energy development. This document describes the buoys, the scope of the loans, the process of how borrowers will be selected, and the schedule for implementation of this program, including completing current deployments.

1.1 Buoy Context: The National Offshore Wind Strategy

In 2016 DOE and the U.S. Department of the Interior (DOI) jointly released a National Offshore Wind Strategy, that identified key strategic areas in which the two agencies could collaboratively act to support the development of the U.S. offshore wind industry. The document reflects input provided by stakeholders through workshops and comments, and is organized around several strategic themes. Each theme identifies current gaps in information or support needed by the U.S. offshore wind industry and actions the agencies can take to fill them.

The strategic theme of particular relevance to the buoys is "Reducing Costs and Technical Risks". Within this theme, the following knowledge gaps were identified:

- Collecting Metocean Data through Validated Methods
The U.S. Outer Continental Shelf (OCS) and the Great Lakes have very limited observations supporting wind energy because of the difficulty of making such observations in the harsh marine environment. To date, the only multi-seasonal observations of winds at hub-height in the OCS have been provided by the DOE buoys. The lack of data creates uncertainty in siting, design criteria, projected performance, and regulation, and this uncertainty ultimately increases the cost of energy. Traditional meteorological towers are very expensive in the offshore environment, buoys offer a much less expensive path to obtaining key wind resource information. If formally validated and accepted by the financial community, the buoys also offer a cost-effective path to bankable pre-construction resource assessments.
- Standardizing Metocean and Geophysical and Geotechnical Data Collection Methods
Under DOI requirements, certain metocean data are required to be submitted as part of the Facility Design report for each project. Existing DOI requirements for metocean data collection are general and allow a wide variety of data collection methods. Through experience with buoy data collection,

DOE can support the development of standard data collection guidelines that would help provide consistency in project designs and help developers determine the effort required to provide the data.

- Understanding Intraplant Flows

The impact on reliability and annual energy production of disturbed wind flows within wind plants, including turbulent wakes, is not yet well understood and yet has a potentially significant effect on the cost of energy. The offshore environment for these flows is different from the onshore environment because of the dynamic nature of the ocean surface and the presence of unique coastal circulations. Accurate modeling of intraplant flows required good characterization of the inflow conditions, and the DOE buoys can provide direct measurements of this inflow and the associated ocean conditions.

To address these gaps, DOE is committed to supporting both the development of standards for data collection and the collection itself of needed metocean data. The buoys will play a key role in this activity.

1.2 Buoy Description

Figure 1.1 is a photo of one of the buoys shortly after its delivery to PNNL. The centerpiece of the instrumentation suite for each buoy is a motion-corrected lidar system that can provide profiles of the wind speed and direction from the surface to 200 m. In addition to a lidar, each buoy collects ocean temperature, salinity, current, and wave data as well as near-surface air temperature, humidity, and wind speed and direction. The buoys have been deployed at DOE's direction, for a year, in different regions of the U.S. to collect hub-height offshore wind data in support of the U.S. offshore wind industry. The data produced by the buoys represent the first publicly available multi-seasonal hub-height data to be collected in U.S. coastal waters. The buoys consequently provide an important new opportunity to characterize the wind resource using observations in regions targeted for wind development.



Figure 1.1. One of Two DOE WindSentinel Buoys

The WindSentinel buoys feature a comprehensive set of atmospheric and oceanographic measurements needed for offshore wind resource characterization. The system provides great flexibility for user definition and control of averaging intervals for all instrumentation. In general, observations will be recorded at the highest rate available for each instrument to allow maximum flexibility in subsequent analysis. In most cases, this is a sampling rate of at least once per second. Meteorological and oceanographic instruments on the two buoys are identical and are listed in Table 1.1.

Table 1.1. Meteorological and Oceanographic Instruments on Each of DOE’s WindSentinel Buoys

Sensor Type	Manufacturer	Model
Wind Profile (6 range gates to ~200 m above MSL)	OADS	Vindicator III
Wind Speed (2)	Vector Instruments	A100R
Wind Direction	Vector Instruments	WP200
Temperature, Relative Humidity	Rotronic	MP101A
Barometer	RM Young	61302V
Pyranometer	Licor	LI-200
Water Temperature	AXYS	YSI
Conductivity, Temperature, Depth (CTD)	Seabird	SBE 37SMP-1j-2-3c
Wave	AXYS	TRIAXYS NW III
Current Profile (ADP)	Nortek	Aquadopp 400 kHz
Tilt/Compass	MicroStrain	3DM GX3 25

Data collection on the buoys is managed by an AXYS Watchman 500 data acquisition system (DAS), which records data from all meteorological and oceanographic instruments as well as buoy system diagnostic information. These raw data are stored on a compact flash (CF) card. The DAS also processes the data to produce 10-min averages, which are also stored on the CF card. The data are transferred to shore via cell phone (high-bandwidth when close to shore) or satellite (low bandwidth). Complete data recovery requires physically exchanging the CF card during regular maintenance visits to the buoy. Each WindSentinel buoy has extensive documentation of all of its systems, including metocean sensors, power, data collection, communications, and safety.

Each buoy is also equipped with a wind turbine, solar panels, and a diesel backup generator. The wind turbine and the solar systems provide the basic power for operations while the backup generator serves as a stop-gap source.

2.0 Buoy Loan Program

2.1 Loan Program Overview

2.1.1 Loan Program Objectives

Both the wind industry and the R&D community have indicated that the lack of wind resource data offshore is a significant barrier to the development of offshore wind energy in the U.S. DOE has made a significant investment in lidar buoys in an effort to reduce this barrier. The investment to deploy the buoys is also significant. The buoy loan program represents an opportunity for organizations with an interest in offshore wind energy and DOE to work together both to provide valuable offshore data to the community as a whole and to focus the data collection on areas of acknowledged high priority. The objectives of this program are to do the following:

- Keep the buoys mostly at sea, collecting data valuable to the wind energy industry.
- Provide excellent resource characterization through multiple seasons at each deployment site
- Provide free access to all data collected by the buoys to the wind industry, research communities, and any other interested parties
- Operate the program in a way that is responsive both to industry data needs and to DOE programmatic objectives
- Structure the buoy loan program so that it is sustainable and beneficial for the lifetime of the buoys

2.2 Loan Program Framework

DOE will proactively work with interested parties to enable the loan of its lidar buoys. The loan program framework is based on the assumption that borrowing partners will deploy the buoys for approximately one year to support data collection and analysis over an annual weather cycle. Partners will assume complete responsibility for the funding, deployment logistics, maintenance, and safe retrieval of each buoy while its loan is active. Borrowers will be required to return the buoy to DOE in the same functional condition in which they received it. DOE will not provide funds to the borrowers of the buoys to support their proposed deployment.

DOE will periodically announce opportunities through a public Request for Applications. Interested qualified parties will be encouraged to prepare applications for consideration by DOE. Applications will be reviewed, scored, and the selected partner will be invited to negotiate bailment agreements for the loan.

2.3 Application Process

2.3.1 Request for Applications

Periodically DOE will initiate a call for applications from potential partners. Both buoys are scheduled to become available in the first part of calendar year 2017; timing is dependent on the pace of

repairs and acquisition of long lead replacement parts. An open-call for applications is targeted for the end of calendar year 2016. The timing of subsequent solicitations will depend on the agreements negotiated in this first round; however, the anticipated duration of the agreements is expected to be a year. The solicitations will be scheduled to allow adequate time to prepare and process applications, select partners, confirm site selection, perform designs and permitting, and other upfront activities.

Applicants will be required to provide a proposal that addresses three critical areas:

- Pre-qualification
- Project scope and benefit
- Buoy deployment plan

Proposals will be reviewed by the applicant selection team and graded based on the criteria described in this plan. The selected partner will be notified and bailment negotiations will occur. If an agreement cannot be reached, the next ranked qualified applicant on the list will be engaged. Specific instructions regarding application content will be provided in the Request for Applications. The sections that follow provide a general description of information that applicants will need to provide.

2.3.2 Application Content

2.3.2.1 Pre-Qualification Requirements

PNNL anticipates that the lease-free loan of a buoy to be of significant benefit to partners with an interest in offshore wind energy. At the same time, executing a successful deployment requires substantial resources on the part of the borrower. The pre-qualification requirements represent the critical elements demonstrating sufficient resources that must be met before the application can be considered to be viable. The pre-qualification requirements are described in more detail below. If an applicant does not meet the pre-qualification requirements, the proposal will not be considered further. The following elements constitute the pre-qualification requirements:

- Demonstration of ability to fund the full lifecycle of the project
This implies the ability of the applicant to articulate the costs associated with critical components of the deployment including pre-deployment design and permitting; deployment, O&M, and recovery; restoration work post-deployment; and realistic contingencies for the anticipated site. Cost estimates will be credible if based on substantial comparable experience or credible consultation. The applicant will be required to demonstrate resources adequate to cover these costs.
- Demonstration of technical ability to support operations
The applicant must demonstrate in-house expertise and resources sufficient to execute the deployment, or alternatively, specifically identify contracting options for filling this role.
- Agreement to share all data from the deployment
The buoys are federally funded resources therefore, applicants must confirm that they will share all data collected during the deployment with DOE for eventual public dissemination either directly via buoy communications or within a week following the physical recovery of data storage cards. This includes data collected from any instruments provided by the borrower. Data from native buoy instrumentation should be provided as soon as it is available. The data must be provided in a mutually

agreeable standard format. Applicants may negotiate specific information management terms for business reasons as part of agreements (e.g., data in the DOE archive may be withheld from public dissemination for a reasonable and mutually agreed time following recovery of the buoy).

2.3.2.2 Project Scope and Benefit

This section of the application provides the justification for the loan. The applicant will address the following in their project proposal:

- Objectives
Discuss the objectives of the deployment and why the data are needed. The application should state how the data will advance the development of U.S. offshore wind energy and how the deployment supports the National Offshore Wind Strategy.
- Description of Proposed Deployment Site
Provide information describing the proposed deployment location, duration, and how these support the stated objectives. The applicant should also note any synergies with other resource characterization efforts.
- Technical Discussion
Provide a detailed description of how the data will be used, noting technical problems to be addressed and providing details of how they plan to use the buoy data to address these.
- Technical and Logistical Qualifications
Provide evidence of the applicant team's technical experience and ability to effectively use the data as well as evidence of the ability to manage the logistics of deployment.
- Dissemination of Results
Description of how the borrower will disseminate the results of the use of the buoy data for the benefit of the offshore wind energy community.

2.3.2.3 Buoy Deployment Plan

The Buoy Deployment Plan submittal is the applicant's opportunity to demonstrate completeness of understanding of the scope, risks, logistics, and requirements of a buoy deployment. The plan shall cover the following topics in detail:

- Partner organization and stakeholders
- Site selection
 - Selection criteria
 - Permitting requirements and strategy
 - Mooring design process
- Buoy communications systems setup and operation
- Deployment logistics
 - Elements of deployment

- Staff and contractor responsibilities
- Monitoring of buoy health
- Maintenance approach
- Retrieval, repair, and turnover to DOE
- Health and Safety
- Data management plan
 - Data acquisition
 - Security
 - Analysis
 - Dissemination to DOE and PNNL
- Emergency response plan
- Project management plan
 - Project organization
 - Work breakdown structure
 - Schedule
 - Budget
 - Reporting
- Other issues specific to this proposed deployment

The subject plan shall also include relevant assumptions and technical bases to demonstrate understanding of the scope and support budget and schedule estimates.

The applicant should expect to revise the Buoy Deployment Plan if selected pending bailment agreement and review and comment by stakeholders. The final revised plan may be required to close out bailment negotiations.

2.4 Partner Selection Criteria

Consistent with buoy loan objectives, the loan program will be managed so that is responsive both to the wind industry and DOE programmatic objectives. DOE will retain discretion in the selection of partners. In addition to programmatic needs, partners will be selected according to the qualifications and criteria described below. Proposals to use the buoys should directly address the following criteria and will be evaluated and ranked on that basis.

2.4.1 Pre-Qualification Criteria

Borrower applications shall include a confirmation and rational basis for meeting the pre-qualification criteria. If these criteria are not met, the application will not be considered further. The pre-qualification criteria are:

- Demonstration of ability to fund full lifecycle of project including:
 - Pre-deployment design and permitting
 - Deployment, operations and maintenance throughout the deployment
 - Restoration of buoy to full functionality after deployment as defined by a reference checklist to be provided with the request for application.
 - Contingency proportional to risks (unless otherwise noted assume minimum of 20% of total project cost)
- Demonstration of technical ability to support operations
- Confirmation of willingness to share all data from the deployment (regardless of originating instrument) in a format readily discernable to DOE and public users.
 - If needed, data collected on the buoy can be embargoed for a mutually agreed period; however, they must ultimately be made public
 - Derivative data from privately funded analysis of the observations collected on the buoy do not need to be made public or provided to the archive.

Once the pre-qualification criteria are confirmed to be met, the source selection team will review and consider the proposals based on the following application criteria. If the applicant cannot meet all the basic entrance criteria, the application is not evaluated further.

2.4.2 Application Criteria

2.4.2.1 Qualifications of Applicant

- Adequacy of Applicant's Deployment Plan
 - Completeness of plan
 - Site selection relative to DOE objectives
 - Sound permitting strategy, including realistic timelines
 - Plans to actively monitor, operate, and maintain the buoy
 - Data management. Plans to provide timely and safe transfer of all data, including those on the physically retrieved CF cards, to the DOE archive (via PNNL).
 - Resource, contract, and staffing plans to perform scope of work. Demonstrate ability to provide necessary resources.
- Experience
 - Qualifications of technical science team

- Subcontracting experience and capabilities. Qualifications of deployment, operations, maintenance, and logistics teams.

2.4.2.2 Technical Value

- Compatibility with DOE R&D Objectives
 - Degree to which proposed use and analysis supports the aims of the Wind Program’s Wind Vision and the National Offshore Wind Strategy
 - Degree to which the proposed deployment site is relevant to offshore wind energy development
 - Degree to which the proposed deployment fills significant data gaps
- Mix of research and resource assessment
 - Degree to which the proposed use addresses technical met/ocean issues as well as providing essential developer data
- Plans for sharing technical results. DOE places value on providing information to the public.
 - Plan and mechanisms for informing the public
 - Plan and mechanisms for informing industry and the research community.

2.4.2.3 Timelines

- Interest and ability to deploy for a full year or more in the same location. NOTE: DOE will consider other deployment durations as long as there is compelling justification consistent with DOE objectives.
- Flexibility relative to DOE timelines and priorities.

2.5 Partner Selection

Each application that is considered responsive (i.e., meets minimum entry requirements) will be considered by a partner selection team composed of the following individuals:

- Program Manager, DOE Wind Energy Technologies Office
- Offshore Wind Team Lead, DOE Wind Energy Technologies Office
- Buoy Deployment Project Manager, PNNL
- Buoy Deployment Principal Investigator, PNNL
- Contracts Representative, PNNL

The selection team will work to build consensus; however, the DOE program manager will have the final selection authority. The selection team will evaluate (score and weight) each application based on the effectiveness in meeting DOE programmatic objectives as described above.

3.0 Implementation

3.1 Work Breakdown Structure for Buoy Loan Management

The following sections describe the structure for PNNL's management of the buoy loan program.

3.1.1 Near-Term Buoy Deployment Program Scope

Near-term scope is aligned with closing out the current deployments in New Jersey and Virginia and initiating the planned buoy loan program. Near-term work scope is organized according to the following categories:

- Lidar buoy deployment project plan
- Initial setup of loan program
 - Request for applications
 - Loan program web interface.
- Buoy #120 (In temporary storage in Virginia as of 11/11/2016)
 - Recover latest data from flash cards and upload to offshoreweb.pnnl.gov.
 - Inspect and repair. Make ready and fully functional to support next deployment and transition to third party.
 - Implement initial transition to third party under loan program.
- Buoy #130 (Deployed off the coast of New Jersey as of 11/11/2016)
 - Complete one year deployment at Fisherman Energy (11/16).
 - Recover buoy to shore and secure.
 - Recover data from flash cards and upload to offshoreweb.pnnl.gov.
 - Inspect and repair. Make ready and fully functional to support next deployment and transition to third party.
 - Implement initial transition to third party under loan program.

3.1.2 Long-Term Buoy Deployment Program Scope

Long-term scope is aligned with overseeing the buoy deployment lifecycle for both buoys (#120 and #130). This includes facilitating the initial transition and deployments under the loan program; oversight of operations, maintenance, and data acquisition; pre-planning and contracting to support seamless transition to new partners; oversight of retrieval and maintenance, and transition to follow-on partners. The longer term work scope is organized according to the following categories for each buoy

- pre-deployment preparation (borrower)
- buoy deployment (borrower)
- deployment oversight and data support (PNNL)

- preparation for next deployment (solicitation and review of applications, partner selection, negotiations, final agreement (PNNL)).

3.2 Critical Schedule Considerations

The near-term action schedule is dependent on agreement on the terms of the Buoy Deployment Plans and ongoing buoy recovery and repair efforts. Figure 3.1 represents a notional near-term schedule. The duration of repairs is estimated based on assumed replacement part lead times. The schedule will be updated and as new information becomes available. Figure 3.2 represents a notional longer term schedule showing how actions required for future deployments begin mid-way through the current deployment window. Each application will likely result in different scope and timing. An integrated detailed project schedule has been developed and will be managed outside of this plan.

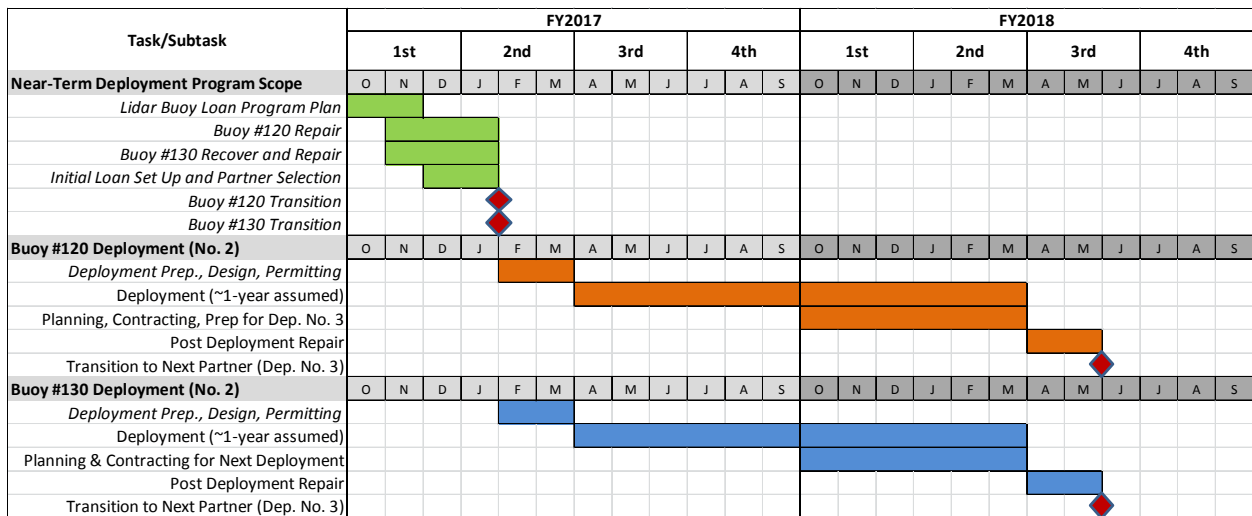


Figure 3.1. Notional Near-Term Schedule

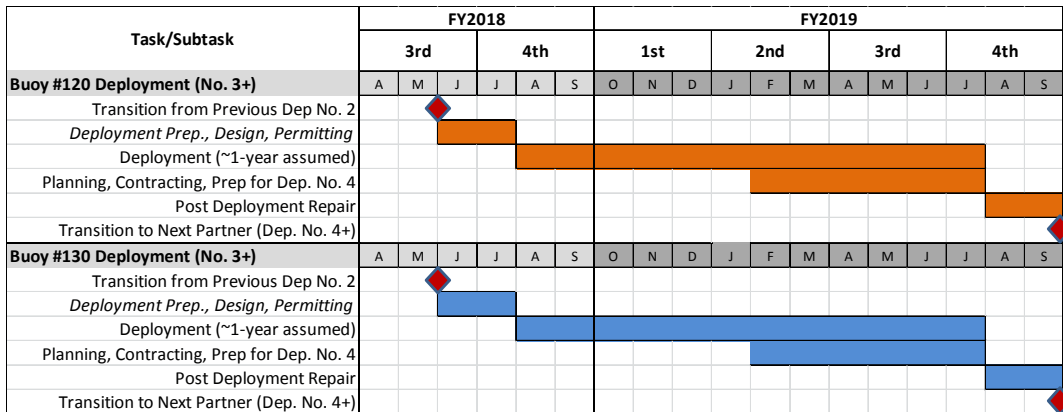


Figure 3.2. Notional Long-Term Schedule

It is acknowledged that buoys are easier to deploy in fair weather which typically aligns with the spring and summer, depending on location. The target duration of one year on station makes it difficult to

cycle through deployments such that all installation activities are within this window. After each deployment the buoy will require inspection, repair, and maintenance funded by the borrowing entity. In addition the buoy will be transitioned to the new borrower and transported to the new location where it will be staged and deployed. This transition time between deployments may range between one and four months depending on circumstances. This uncertainty will be managed during the bailment negotiations for each buoy. Each deployment negotiation will include an assessment of optimal timing to sustain efficient deployment and transition to future users.

3.2.1 Bailment Agreement

A bailment agreement will be used as the contract mechanism to document agreement with the partners. Under the bailment agreement, the partner (a.k.a., bailee) will agree to serve as primary caretaker of the buoy for the duration of the agreement and will agree to manage, operate, and maintain the buoy per manufacturer requirements. The agreement will also spell out liability and insurance commitments. Specific requirements will be clearly defined in the request for application (RFA).

A statement of work will be issued with the RFA. The candidate partner applications will be required to describe how the buoy will be managed to meet statement of work requirements.

3.2.2 Transition of Buoy to Partner

A system checklist will be used to document the transition of the buoy from one entity to another. The transition process will include verifying the condition and operability of the buoy prior to turn over. The receiving organization will review documentation and perform inspections to verify the as delivered condition. Once the checklist is filled out, all parties will sign off to indicate the completion of the transition. Mutually agreeable action items may be identified and managed by one or both parties. PNNL will facilitate the transition process on DOE's behalf.

3.2.3 Deployment Preparation

The partner selected will prepare for deployment by completing site selection activities, preparing designs and seeking permits. PNNL subject matter experts may be called upon to review partner submittals during this period. PNNL may also participate in inspections and readiness reviews if called out by the statement of work.

3.2.4 Deployment, Operations, and Maintenance

The deployment, daily operations, and maintenance will be performed by the partner in accordance with the statement of work, permits, and manufacturer documentation. The bailment agreement (and supporting documents such as a statement of work) will also include specific requirements for operations and maintenance.

3.2.5 Monthly Monitoring and Reporting

The statement of work will include requirements for partners to provide monthly reports on buoy status and system health. The statement of work will also include provisions for emergency response.

3.2.6 Data and Information Sharing

The collection and dissemination of buoy data for the benefit of the public and industry is critical to the program. Data will be made available for use through the following mechanisms:

- PNNL will implement and confirm data collection configuration of buoys prior to deployment.
- The system will be configured to save raw 1-second data to the onboard flash cards. These flash cards will be recovered by the buoy loan partner on a 6-month basis (typically performed as part of the 6-month maintenance interval).
- PNNL will work with partners to post all data on the offshoreweb.pnnl.gov site for public access.

3.2.7 End-of-Deployment Maintenance and Repair

At deployment completion, the selected partner will repair and restore the buoy to fully functional condition as verified by an acceptance checklist reviewed and signed off on by Battelle and the bailee. The beginning and end transitions will be managed through inspection and review and will be documented on a checklist. It is anticipated that the partner in possession of the buoy will be required to perform repairs to bring the buoy back up to fully functional condition after the deployment. Options for this repair will be negotiated with the bailment agreement; however, the responsibility for the repair costs will reside with the partner.

Ideally, the transition from one user to the next can be implemented seamlessly without intermediate custody. In certain circumstances, it may be necessary for PNNL to take possession of the buoy between campaigns.



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