Laboratório Nacional de Energia e Geologia, I. P. .

Unidade de Energias Renováveis e Eficiência Energética (UEREE)

Instalação de Sistemas Lidar Flutuantes em 4 zonas do PAER (provisório) no âmbito do *"Investimento PRR C21-i07.02 – "Estudos técnicos para potencial energético offshore - Estudos de recurso eólico, ondulação e correntes"*

Anexo 5 – Descrição dos Equipamentos e Trabalhos a efectuar

[excerto da memória descritiva: páginas 11 a 25]

2.1Localização dos Sistemas LiDAR Flutuantes (FLS)

Os sistemas de monitorização dos recursos renováveis offshore serão, de acordo com as condições de financiamento do projecto, instalados em 4 das 5 zonas identificadas no PAER (provisório) sujeito a consulta pública. Em face do recurso energético pré-identificado, e da representatividade espacial das regiões, foram seleccionadas as zonas de Viana-Sul, Leixões, Figueira da Foz e Ericeira.

As coordenadas de instalação de cada bóia, foram escolhidas tendo em consideração as menores profundidades em cada zona do PAER (provisório), bem como a necessidade referida de representatividade espacial do local de monitorização. Assim, os locais de instalação são os indicados na Tabela 2.4.

É de realçar que, sendo a solicitação do TUPEM para o conjunto dos 4 locais, a área de implantação indicada na plataforma (online) corresponde à área unitária ocupada por cada um dos sistemas LiDAR flutuantes, para que esta possa ser associada a cada par das coordenadas indicadas.

As dimensões da bóia são majoradas por uma quadrícula de 5x5 m2. No entanto, o sistema de amarração (através de uma corrente fixa a uma poia/sistema de ancoragem) permite-lhe um grau de liberdade de geometria circular, com um raio máximo de 300m, o que conduz a uma área de implantação para cada unidade de 0.283 km2, e um total de área ocupada de 1.131 km2.

FLS200 Unidade	LAT:	LONG:	Profundidade (m)
Lote 1	9° 6' 20.233" W	41° 43' 32.277" N	106.2
Lote 2	9° 13' 42.809" W	41° 3' 17.613" N	94.1
Lote 3	9° 30' 3.051" W	40° 11' 10.056" N	154.2
Lote 4	9° 37' 56.108" W	39° 5' 12.161" N	74.5

Tabela 2.4 – Coordenadas das bóias/sistemas LiDAR flutuantes

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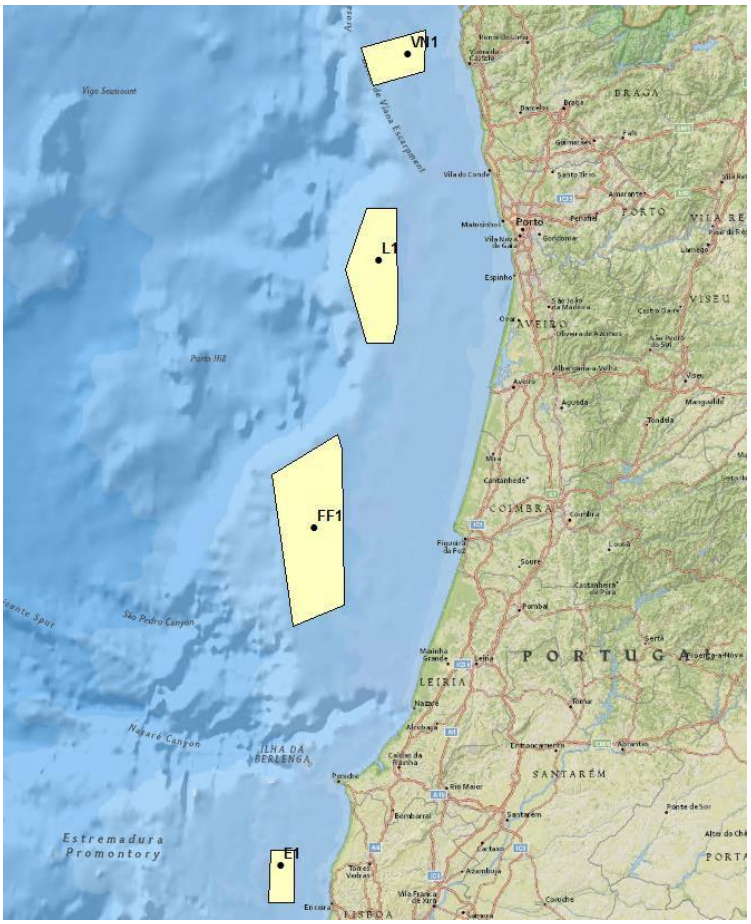

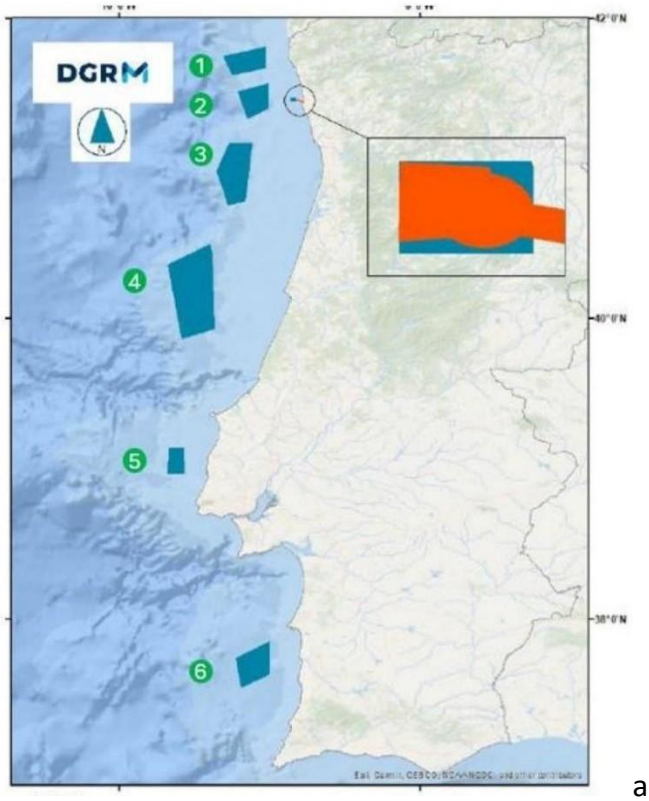

a)

b)

Figura 2.1- Locais de instalação(a) e zonas PAER provisório (b).

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3. Descrição dos equipamentos a instalar

Para a selecção dos fornecedores de serviços descritos na secção anterior, o LNEG levou a cabo um concurso internacional (por lotes), no qual foi seleccionado a empresa espanhola ***EOLOS Floating Lidar Solutions SL***, para a totalidade dos 4 lotes previstos: Viana-Sul, Leixões, Figueira da Foz e Ericeira.
É de realçar que, como estipulado no contracto estabelecido no âmbito do projecto PRR, é obrigação do LNEG monitorizar 4 dos 5 locais apresentados no PAER (versão provisória), o que levou à selecção das 4 zonas apontadas.

3.1 Especificações técnicas da bóia LiDAR flutuante FLS200

3.1.1. Design do equipamento

A bóia LiDAR FLS200 da EOLOS é um sistema de medição totalmente equipado e autónomo para vento, ondas e correntes oceânicas, baseado em tecnologia LIDAR, com instrumentação meteo-oceanográfica adicional.

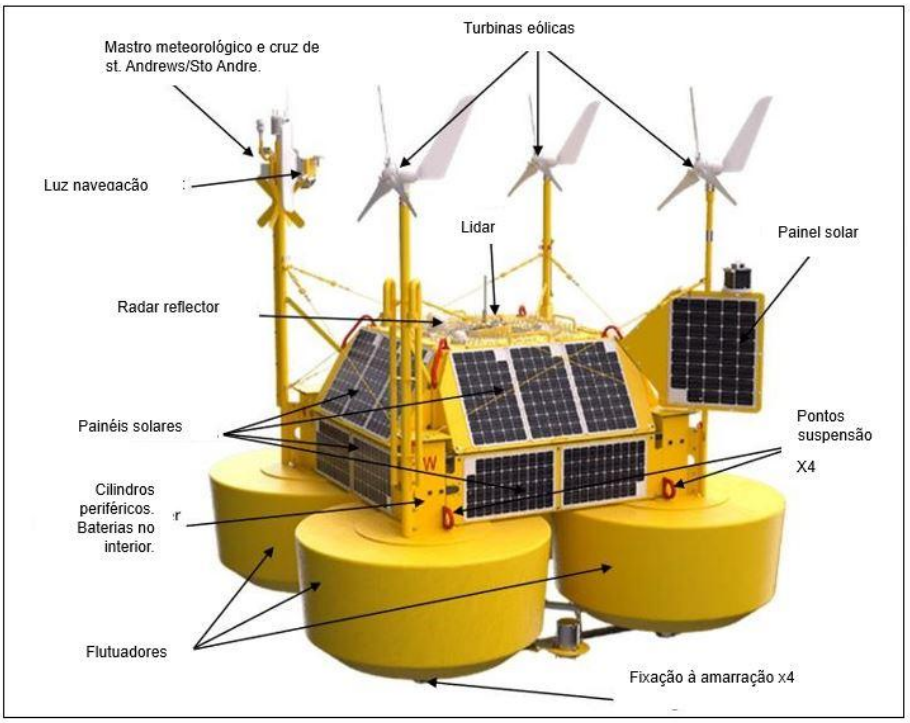

Figura 3.1- Bóia LiDAR FLS200 da EOLOS.

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Os principais critérios utilizados no design da boia FLS200 da EOLOS são:

1. **Facilidade de transporte**: envio (por mar ou transporte aéreo, conforme contrato) e implementação local.
2. **Estrutura modular:** é facilmente montada e desmontada. Um contentor padrão ISO permite o transporte rodoviário, marítimo e aéreo a preços competitivos, evitando requisitos de transporte especializado, para mobilizar a FLS200 desde a oficina da EOLOS em Barcelona até o porto final para montagem. Alternativamente, a EOLOS pode enviar a FLS200 a partir de qualquer porto de pré-validação se uma rota direta de reboque marítimo não estiver disponível. A FLS200 é um sistema totalmente autónomo e integrado:
   - As dimensões do sistema incluem todos os elementos necessários para realizar medições de vento, ondas e correntes e incorporam todos os requisitos de fornecimento e armazenamento de energia para alimentar esses elementos.
   - A boia é autónoma em termos de energia para períodos que duram uma campanha típica de recursos eólicos (1 ano). A manutenção preventiva programada é realizada para períodos mais longos de operação.

3. **Personalizada e robusta o suficiente para os ambientes offshore mais severos:**
   - Utilização de materiais capazes de resistir aos ambientes marinhos mais severos.
   - Capacidade de resistir a tempestades com alturas de ondas tipicamente encontradas em condições como as do Oceano Atlântico.

3.1.2 Sistema de energia da FLS200

O sistema de energia da FLS200 da EOLOS é totalmente redundante e autónomo, utilizando três fontes independentes de energia de carregamento, minimizando o risco de escassez de energia em qualquer condição meteorológica ou eventos imprevistos (como a falha de um dos sistemas de energia).
A boia FLS200 da EOLOS possui um sistema de distribuição de energia personalizado com os seguintes componentes:

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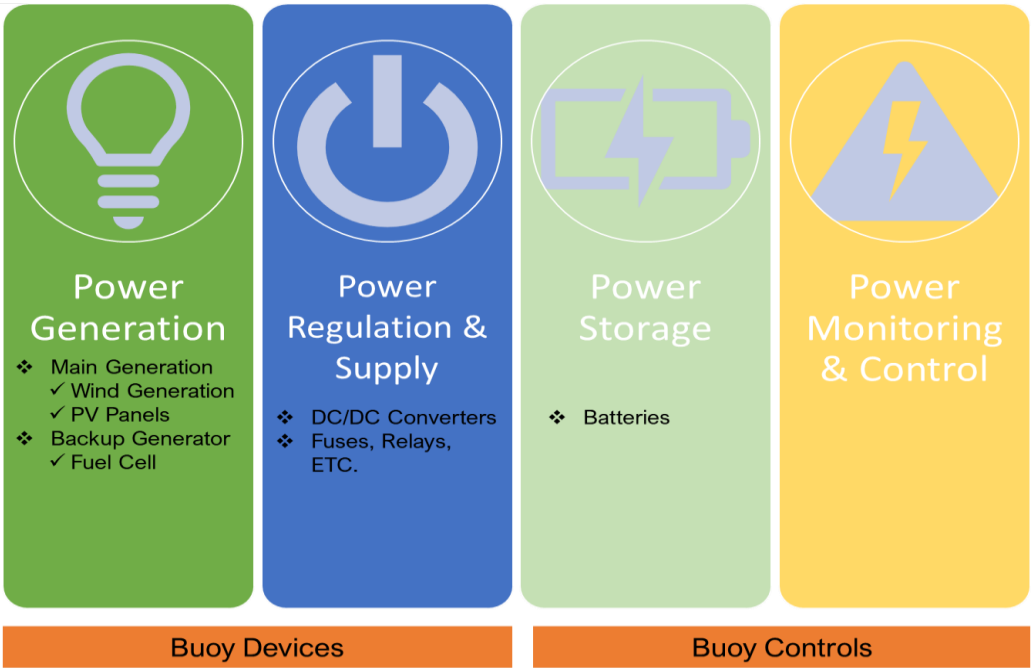

Figure3. 2: Esquema de Fornecimento de Energia

3.1.3 Proteção contra corrosão

Uso exclusivo de materiais resistentes a ambientes marinhos, como aço inoxidável AISI316L, alumínio de grau marinho, plásticos e borrachas de grau marinho, e inclui aplicações de pintura protetora quando necessário.

A aplicação da pintura em pó apropriada fornece uma proteção ampla contra a corrosão durante muitos anos. Toda a estrutura é revestida para que nenhum aço nu fique exposto. A pintura é necessária tanto para proteger os elementos da boia contra ambientes marinhos quanto para torná-la visível para embarcações próximas. A cor final é amarelo RAL 1023 para as partes não submersas, conforme indicado na convenção **IALA**. As partes submersas são pintadas com um revestimento antifouling ambientalmente seguro para evitar o crescimento excessivo de vida marinha.

• Flutuadores	• Pintura à base de poliuretano RAL 1023
• Aço inoxidável	• Amarelo RAL 1023
• Partes submersas	• Antifouling

Tabela 3.1: Características de proteção da pintura dos diferentes elementos da FLS200

Uso de ânodos de sacrifício de zinco espalhados pelas partes submersas da estrutura mecânica. Utilização de buchas de nylon para a isolação dos elementos metálicos submersos com diferentes composições (ferro-aço inoxidável), tudo em conformidade com a ISO 12944-5:2019.

3.1.4 Design contra contaminação e vandalismo

Para desincentivar o acesso indesejado de fauna selvagem e humana à boia, os seguintes métodos são implementados na FLS200:

- **Pássaros:** Espigões para dissuasão de aves são colocados na boia para evitar a contaminação. A tampa superior da FLS200 é mostrada na Figura 5.
- **Contaminação:** Utilização de pintura antifouling para minimizar o material orgânico incorporado e o crescimento de animais marinhos nos componentes submersos da FLS200.
- **Vandalismo:** Quatro portas trancadas com segurança, uma em cada lado, protegem os sistemas internos (LiDAR, comunicação e componentes eletrónicos). Estas portas suportam os painéis solares e impedem tentativas não autorizadas de acesso à FLS200.

Figure 3.3: Espigões para dissuasão de aves na tampa superior da FLS200

3.1.5 Sistemas de proteção mecânica e eléctrica

- **Conexões Impermeáveis:** Utilização de grau IP67 para os elementos da boia não submersos e IP68 para os submersos. Proteção contra a intrusão de água através de selos nas caixas de equipamento, compartimentos de baterias e conectores. Todos os conectores têm grau de vedação IP68. Uso de cabos com capas resistentes às intempéries e impermeáveis.
- **Choques e Vibrações:** O equipamento é altamente resistente a choques e vibrações.
- **Sobretensão:** Protetores de sobretensão em baterias ou elementos de produção de energia utilizando reguladores.
- **Inversão de Polaridade:** Proteção contra inversão de polaridade de todo o equipamento.
- **Consumo excessivo de energia / Curto-circuitos:** Proteção contra consumo excessivo de energia / curtos-circuitos usando fusíveis e Disjuntores Miniatura (MCB).
- **Anti explosão:** Compartimentos de baterias estão equipados com válvulas de pressão para evitar pressão interna excessiva, evitando a presença de oxigênio e minimizando o risco de explosões devido a possíveis fugas de

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hidrogênio. Existem procedimentos de segurança específicos para esta operação.

3.1.6 Dimensões e peso

A FLS200 pesa aproximadamente 3930 kg, totalmente montada e equipada.

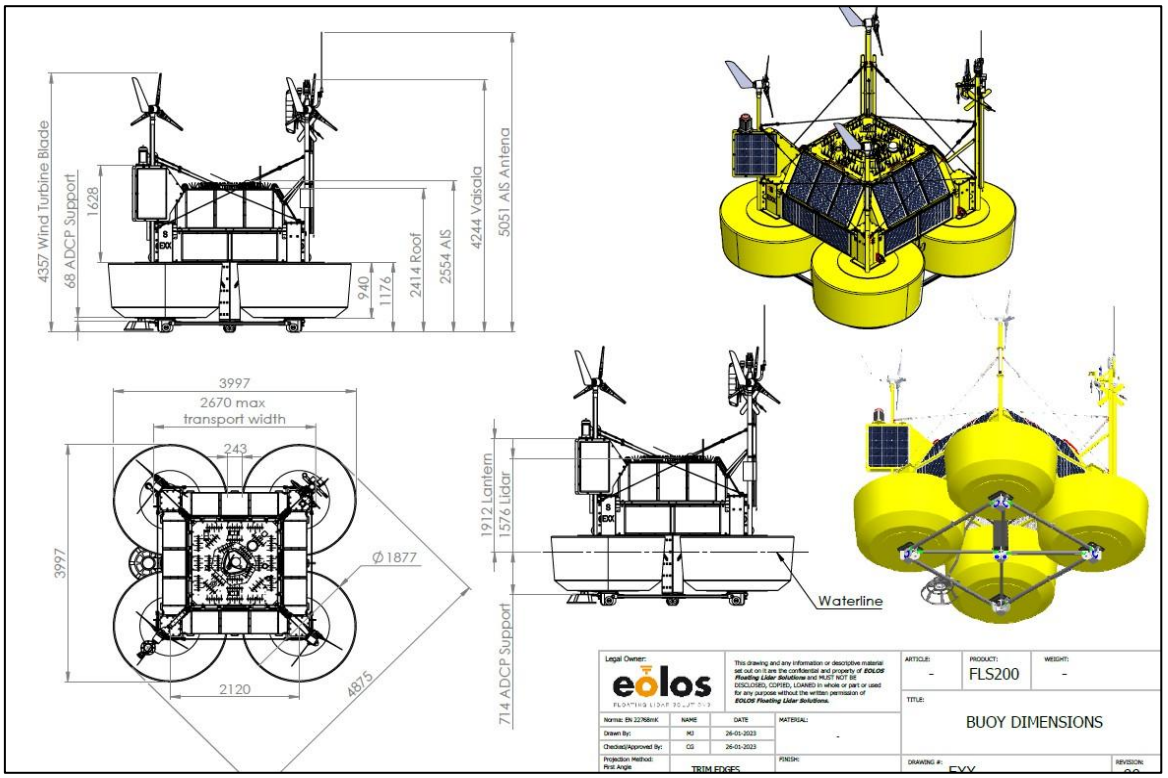

Figure 3.4: Dimensões da boia FLS200

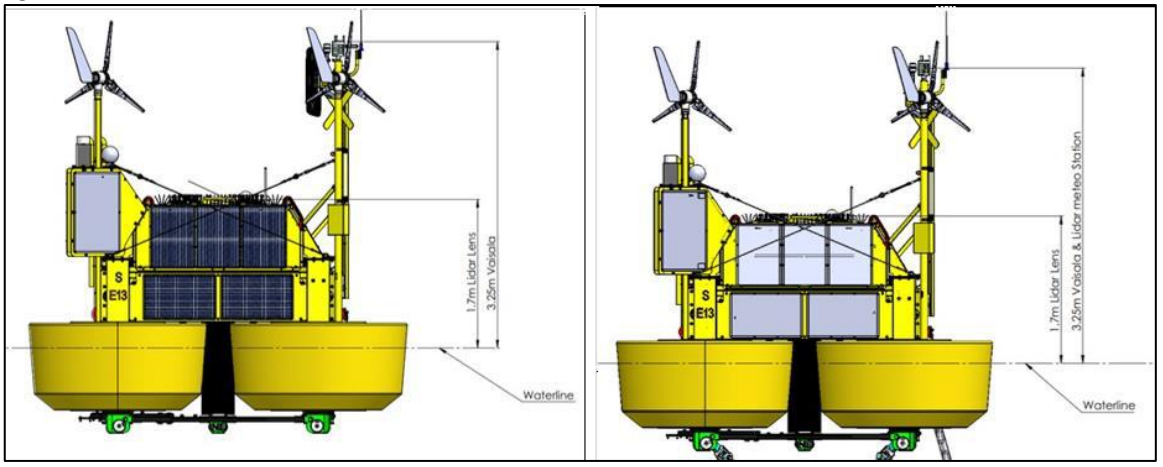

Figure 3.5: Dimensões da boia FLS200 vista lateral

3.1.7 Condições de operação e sobrevivência

A boia FLS200 da EOLOS foi projetada para suportar cargas marinhas presentes nos ambientes mais severos. Todas as unidades FLS200 da EOLOS são projetadas e

fabricadas para ter uma vida operacional mínima de 10 anos em ambiente offshore. O único fator limitante operacional é que a unidade FLS200 da EOLOS não deve ser implantada em áreas com ondas quebrando.

Os limites operacionais de temperatura para a FLS200 da EOLOS variam de -20ºC a +50ºC.

Para a fiabilidade dos dados de vento, os seguintes limites operacionais para o equipamento de medição podem ser definidos:

- Velocidade máxima operacional do vento do ZX LIDARS 300M: 70 m/s
- Velocidade máxima operacional do vento do Vaisala: 60 m/s
- Altura máxima das ondas: 20 m; Período: 1,5-33 s
- Correntes: ADCP: máximo 10 m/s

3.2 Instrumentação de dados

A FLS200 da EOLOS está equipada com os sensores descritos abaixo:

3.2.1 Sistema LiDAR

O feixe infravermelho do ZX LiDARs 300M ilumina aerossóis atmosféricos naturais, como poeira, pólen ou gotículas de chuva. Quando o feixe infravermelho atinge esses aerossóis, parte da luz é retroes palhada para um receptor. O vento afeta o movimento desses aerossóis e altera a frequência da luz retro espalhada. Essa mudança de frequência é medida por um fotodetector e, a partir dessas medições, a velocidade e a direção do vento são calculadas. O ZX Lidars 300M é um sistema LiDAR de onda contínua que fornece medições remotas de vento em dez alturas definidas pelo usuário, começando a partir de 10 m até 200 m, com capacidade para incluir até 300 m. Os dados de Alta Frequência (HF) são armazenados exclusivamente dentro do sensor (ZX LiDAR), enquanto todos os outros dados são enviados para registradores de dados através de conexões Ethernet e protocolos Modbus.

Figure3.6: ZX LiDAR 300M

Alcance:	10-300 m
Alturas de Medição:	10 alturas definidas pelo usuário
Taxa de Amostragem:	50 Hz
Taxa de Média:	Média verdadeira de 1 segundo Média de 10 minutos
Precisão da Velocidade do Vento:	0.1 m/s
Faixa de Velocidade do Vento:	< 1 m/s to 80 m/s
Variação da Direção:	< 0.5

3.2.2 Estações meteorológicas

VAISALA WXT536

O Transmissor Meteorológico **Vaisala WXT536** é um bloco de construção flexível e integrado para aplicações meteorológicas. Além do vento, oferece quatro dos parâmetros meteorológicos mais importantes: pressão atmosférica, temperatura, umidade e precipitação. O WXT536 excede o padrão marítimo IEC60945 e está conforme a certificação de tipo DNV-GL.

As suas especificações de medição são:

- **Velocidade do Vento:**
  - Faixa: 0 - 60 m/s
  - Tempo de Resposta: 0,25 s
  - Precisão: ±3% a 10 m/s
  - Resolução de Saída: 0,1 m/ss
- **Direção do Vento:**
  - Azimuth: 0 – 360 º
  - Tempo de Resposta: 0.25s
  - Precisão: ±3.0º at 10 m/s
  - Resolução de Saída: 1º

Figure 3.7: VAISALA WXT536

Figure 3.8: Airmar 200WX

Airmar 200WX

A Airmar 200WX é a estação meteorológica original escolhida pelo fabricante de LiDAR ZXLidars. Esta é a razão pela qual foi mantida na FLS200. Assim como Vaisala, oferece os parâmetros meteorológicos mais comuns além do vento.

3.2.3 Medições de correntes

A FLS200 equipa um sensor ADCP (Acoustic Doppler Current Profiler) da Signature, desenvolvido pela NORTEK. Este sistema, utilizando o princípio físico do efeito Doppler, pode medir a velocidade e a direção das correntes transmitindo ondas sonoras para a coluna d'água.

O ADCP NORTEK montado na EOLOS FLS200 mede a velocidade e a direção das correntes por 3 minutos com uma frequência de 1 Hz. As médias desses parâmetros são registradas a cada hora no sistema. As médias são então enviadas para o servidor da EOLOS e armazenadas internamente no ADCP.

Os parâmetros obtidos pelos ADCPs Signature da NORTEK são:

- Temperatura da água
- Pressão da água
- Atitude do sensor (rolamento, inclinação e orientação)
- Profundidade do local (distância até o fundo do mar)
- Velocidade da corrente de água em 22 níveis
- Direção da corrente de água em 22 níveis

Figure 3.9: NORTEK ADCP

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Perfilhador de correntes sugerido para o LNEG

Site	Profundidade da água	Perfil atual sugerido
Lote 1: Zone A	84m – 291m	Signature250
Lote 2: Zone B	93m – 378m	Signature250
Lote 3: Zone C	115m – 534m	Signature100
Lote 4: Zone D	53m – 124m	Signature250

Tabela 3.2: Perfilhador de Correntes Sugerido para o LNEG

3.2.4 Medições de ondas

A FLS200 possui um sensor AIM3 desenvolvido pela Automasjon og Data. Este sistema pode calcular parâmetros determinísticos e espectrais do estado do mar derivando o movimento da FLS200 através de acelerômetros incorporados. O AIM3 mede as acelerações em todos os 6 Graus de Liberdade (DoF) da FLS200, durante um período de amostragem de 20 minutos. Em seguida, calcula parâmetros típicos do estado do mar seguindo metodologias no domínio do tempo e da frequência. Ou seja, análise de cruzamento zero e derivação espectral, respetivamente. Abaixo está uma lista dos parâmetros:

- Altura significativa das ondas, tanto pela análise espectral quanto pela análise de cruzamento zero
- Altura máxima das ondas
- Período de pico espectral das ondas
- Período médio de cruzamento zero das ondas
- Tm-10
- Tm01
- Direção média das ondas
- Direção de pico das ondas
- Distribuição direcional

Figure3. 10: AIM3 - WAVE Sensor

- Espaço espectral direcional: Densidade de energia e direção média para cada bin de frequência

Os parâmetros das ondas são registados no sistema a cada hora ou a cada meia hora. Alguns deles são enviados para a estação costeira da EOLOS, enquanto outros são armazenados localmente na FLS200.

Além disso, um relatório exaustivo, que valida o monitoramento das condições das ondas com base em observações diretas e compara o desempenho da FLS200 da EOLOS e seu Sensor AIM3-WAVE com boias de ondas e mastros fixos RADAC, foi realizado pelo IH Cantabria.

3.2.5 Câmara a bordo

A EOLOS FLS200 inclui uma câmara minidome resistente a vandalismo, com classificação IK10.

Por favor, consulte o seguinte link para visualizar uma captura de vídeo dos dados do tufão Hinnammor - (South Korea, September 2022).

Figure3. 11: AXIS M3057-PLVE Mk II

* Consulte "*Annex 2. FLS200 Sensor Specifications"* nos anexos para obter uma descrição completa dos sensores no FLS200.

3.3 Limites meteorológicos para operações offshore

São considerados diferentes cenários em relação aos limites climáticos operacionais para operar o FLS200. Estão apresentados nas matrizes abaixo. Dentro de cada matriz, verde significa que podem ser realizadas operações.

O estado climático para o levantamento é também aplicável para a recuperação do peso total. O comandante tem a responsabilidade de decidir se o guindaste tem meios para elevar o peso no convés, dado o estado do mar no local. Além disso, os limites climáticos máximos podem ser ultrapassados em circunstâncias únicas. Nestes cenários, é de responsabilidade do EOLOS contactar o comandante do navio para chegar a um acordo sobre um plano operacional.

Ao longo de todas as operações, o comandante do navio tem a decisão final sobre se as operações podem ser realizadas em segurança.

Critérios Meteorológicos para Operações Portuárias

Durante as operações de elevação da boia no Porto, a velocidade máxima do vento é de 20 nós.

Os planos de **R**eliability, **A**vailability, **M**aintainability and **S**afety (**RAMS**) e de elevação são submetidos às autoridades portuárias caso sejam necessários.

Instalação e recuperação – Levantamento da boia

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Tabela 3.3: Limites climáticos para içamentos offshore

Implantação e recuperação – Boia rebocada

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Tabela 3.4: Limites climáticos para rebocar a boia

3.4 Amarração específica do local

A EOLOS tem competência interna para supervisionar o projeto de amarração específico do local. A EOLOS opta por subcontratar a **LMC (London Marine Consultants)** especializada para o projeto e certificação do projeto de amarração proposto.

A **LMC** é uma empresa de projetos de engenharia com sede em Londres, Reino Unido, especializada no design e fornecimento de sistemas de amarração para a indústria de energia offshore. A empresa está em funcionamento há mais de 25 anos e tem um longo historial de fornecimento de uma variedade de sistemas de amarração e terminais para unidades flutuantes de todos os tipos. Estes sistemas de amarração foram fornecidos apenas com base no projeto ou na base de **Engenharia, Aquisição e Construção (EPC)**, dependendo dos requisitos do cliente, e a empresa executou com sucesso projetos com valores que variam até mais de 110 milhões de dólares.

A **LMC** é uma das empresas de design de amarração offshore mais experientes do mundo, com um extenso historial no design de sistemas de torre, sistemas de amarração espalhados e sistemas de boias para as indústrias de petróleo e gás e de energias renováveis. Para além da London Marine Consulting, a EOLOS trabalha também com a InterMoor, CoreMarine e Proper Marine.

Estilos

- A análise de sensibilidade é realizada pelo EOLOS para estabelecer ângulos máximos de pitch-roll ->tilt.
- Boa correlação sob eventos extremos entre movimentos experimentais e simulações OrcaFlex.
- Os critérios de submersão foram também implementados pelo EOLOS.

Garantia de qualidade dos componentes e materiais

- A EOLOS reforçou a Garantia de Qualidade e o Controlo de Qualidade para os materiais e componentes de amarração que envolvem empreiteiros marítimos externos.

- A EOLOS utiliza apenas materiais referenciados, devidamente certificados, especialmente quando estão envolvidos terceiros na atividade de amarração.
- Novos critérios de fornecimento para componentes críticos para a qualidade, incluindo testes de carga, controlo de soldadura e certificação de materiais, são implementados pela EOLOS.
- Para soluções que envolvam corda, o EOLOS inclui novo diâmetro e proteção contra abrasão.

Organizacional e Operacional

- A equipa de amarração da EOLOS foi reforçada internamente com especialistas de engenharia.
- Novos parceiros de amarração e contratantes são incorporados pela EOLOS, além da London Marine Consulting LMC: InterMoor, CoreMarine e Proper Marine.
- As inspeções, manutenções e substituições de amarrações são reforçadas e a periodicidade durante a campanha é aumentada (a cada 6 meses) pela EOLOS.

Os resultados típicos para a EOLOS para esse trabalho incluem:

- Análise preliminar do projeto de amarração
- Análise dinâmica de amarração
- Análise de fadiga de amarração
- Desenhos de layout de amarração

Cliente		LNEG	
Documento ref.			
REVISÃO		0	
CRIAdo EM		24/11/2024	profundidade: 80-160 m
LOCAL		Lote 1, 2, 3, 4	
Item	Nº	Equipamento	Comprimento
			[m]
		FLS200 Conjunto de amarração padrão	
		EOLOS FLS200	
1	1	4to1- Montagem da Corrente	3
		AMARRAÇÃO BRIDLE	
2	1	Corrente estabilizadora de 28mm	10
3	1	38mm MONTAGEM SWIVEL (SWL 20.5t)	
4	2	28mm G2 CADEIA STUDLESS	40
5	2	215 kgf Boia de flutuabilidade liquida	
6	1	50mm G2 CADEIA STUDLESS	25
7	1	38mm G2 CADEIA STUDLESS	250
8	1	AGLOMERADO DE AÇO PESO 8,0 t	
		LINHA DE RECUPERAÇÃO AUXILIAR	
9	1	16 mm G2 CADEIA STUDLESS	10
Designed by:		A. Herrera	
Approved by:			
Date:		26/11/2024	

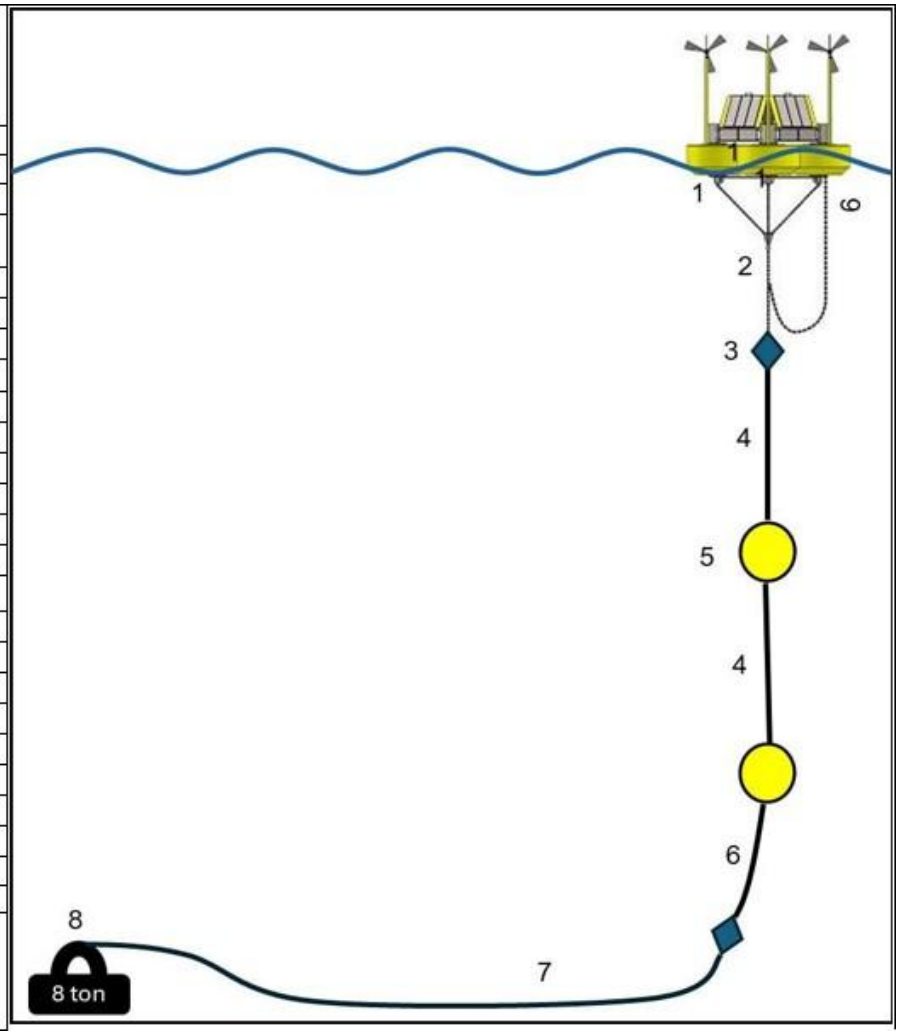

Figure3. 12: FLS200 – Amarração -padrão

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www.lneg.pt

3.5 Meios de Instalação

A instalação das bóias FLS 200 será efectuada com recurso aos navios FENIX ou VIGO cujas especificações são indicadas no Anexo A.

3.6 Trabalhos a realizar

O FLS200 e seu sistema de ancoragem associado serão instalados na área designada dentro da Zona Econômica Exclusiva de Portugal por um período de um ano. O FLS200 é totalmente autônomo e pode operar no mar em condições climáticas adversas, com movimento limitado dentro do raio de deriva do sistema de ancoragem (cerca de 200 metros). Durante este período, a EOLOS planeja realizar serviços na boia nas seguintes situações:

- Implantação do sistema.
- Manutenção preventiva do FLS200.
- Recuperação do FLS200 e do sistema de ancoragem.
- Manutenção corretiva, se necessário.

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ANEXO

Descrição detalhada dos trabalhos

(Áreas 1 a 4)

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EOL-LO101-V01-OPS

PROJECT EXECUTION PLAN
LOTE 1
VIANA DO CASTELO

PREPARED		**REVISED**		**APPPROVED**	
By	**Ignasi Andreu**	By	**Oriol Costillas**	By	**Felix Urrea**
Date	08/12/2024	Date	09/12/2024	Date	09/12/2024

VERSIONS		
Version	**Modification causes**	**Date**
01	**Document Creation**	08/12/2024

INDEX:

Figures

Tables

Acronyms/Abbreviations

PEP	*Project Execution Plan*
IPT	*Integrated Project Team*
FAT	*Factory Acceptance Test*
PAT	*Port Acceptance Test*
SAT	*Site Acceptance Test*
HAZID	*Hazard Identification*
HIRA	*Hazard Identification and Risk Assessment*
BOM	*Bill of Materials*
OWA	*Offshore Wind Accelerator*
RAMS	*Risk Assessment and Method Statement*
LNEG	*Laboratório Nacional de Energia e Geologia, I.P.*

1. Introduction

1.1. Overview

EOLOS Floating Lidar Solutions has been awarded Contract D26805 by the Laboratório Nacional de Energia e Geologia, I.P. (LNEG) to carry out a 1-year wind resource assessment campaign from Q1 2025 to Q1 2026. The wind resource assessment will be done primarily with the deployment of an EOLOS FLS200 metocean buoy (with serial number E02) off the coast of Viana do Castelo, Portugal.

Figure 1: Lote 1 (Viana do Castelo) site location on map.

1.2. Purpose

This Project Execution Plan (PEP) defines a proposal for the **Lote 1 (LO1)** project and describes planning, assumptions, constraints, roles, responsibilities, authorities, management interactions and interfaces necessary to successfully execute the project in a safe and efficient manner.

2. Mission & Objectives

2.1. Mission Specifications

The mission of EOLOS defined in this Project Execution Plan is to provide LNEG with 1 year of bankable meteorological, met ocean and environmental data through the deployment of the EOLOS FLS200 E02.

2.2. Project Objectives

- Provision of a validated metocean buoy for the whole duration of the campaign, delivering the highest practicable post-processed wind data availability.
- Maximise the quality data availability of all the relevant sensors included in the offer.
- Minimize environmental impact in the deployment area.
- Ensure that environmental, safety, health and security requirements are fully considered and appropriately implemented in project execution.

3. Organization & Responsibilities

3.1. EOLOS Representatives

NAME	POSITION	BACKUP
Felix Urrea	Director of Operations	Gastao Moura
Ignasi Andreu	Project Manager	Mike Serquina
Adrià Miquel	Chief Data Scientist	Giacomo Rapisardi
Lluís Raurich	Engineering Director	Raúl Rodríguez
Gastao Moura	O&M & HSE Manager	Jorge Garcia
Julian Harland	Contract Manager	Rajai Aghabi
Raúl Rodríguez	Fleet Engineering	Lluís Raurich
Jose Miguel Garro	Data Scientist	Sandra Coll
Raimon Targa	Project Reporting	Marc Borrell
Daniel Sanchez	Reliability Manager	Mario Berral
Juan Delgado	CFO	Rajai Aghabi

Table 1: EOLOS Personnel for the Project

3.2. CLIENT Representatives

Name	Position	Email
Ana Estanqueiro	Senior Researcher	ana.estanqueiro@lneg.pt
Teresa Simoes	Wind Resource Assessment	teresa.simoes@lneg.pt

Table 2: LNEG Personnel for the Project

3.3. EOLOS Project Team

EOLOS will be organised as follows to fulfil all aspects of the **LO1** project:

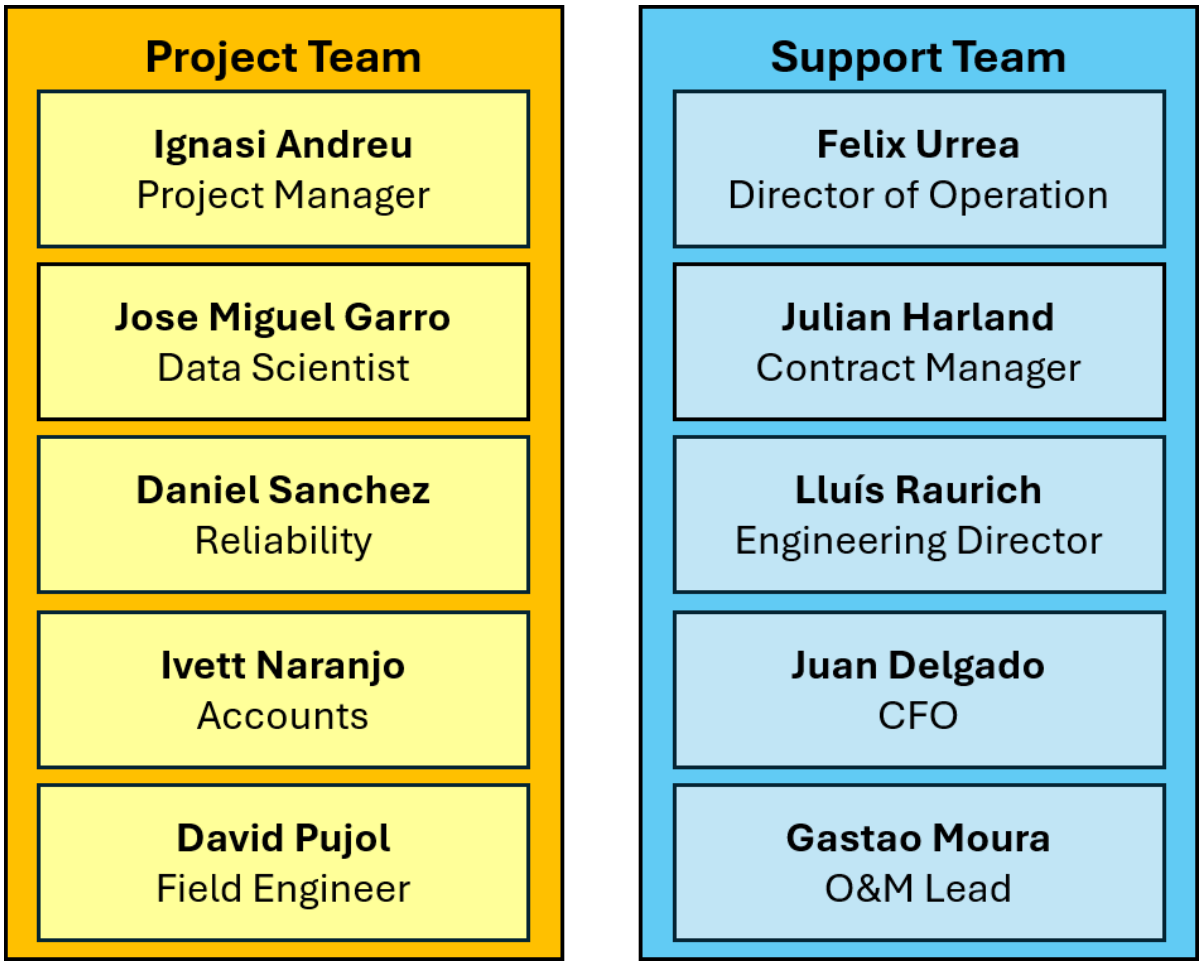

Figure 2: EOLOS Company Organisational Scheme

3.4. Project Interfaces

During the duration of the project, EOLOS must contact different stakeholder in order to successfully perform the object of the contract. The involved parties will be:

Stakeholder	Role	Managed by
Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM)	To grant the permits to deploy the FLS200 E02 at the Lote 1 site.	LNEG
Autoridade Marítima Nacional (AMN) - Coastguards	Supervise and coordinate the activities related to maritime safety, marine environmental protection and maritime rescue	LNEG and EOLOS, as applicable.

Frazer Nash	Third party validation consultant responsible to confirm the validation of the FLS200 unit against the LEG fixed reference as per the OWA Roadmap guidelines.	EOLOS
Aveiro port	Provide the facilities and lifting equipment required to assemble the FLS200, as well as the quayside where the vessel used for the marine operation will berth.	EOLOS
London Marine Consultants (LMC)	Provide an independent assessment and validation on the mooring design designed by EOLOS.	EOLOS
Dutch Marine Contractors (DMC)	Search and hire suitable vessels for the marine operations.	EOLOS
Wilhelmsen Port Services	Provide all the logistics for vessel entry at port, and contact point between Aveiro port authority and EOLOS.	EOLOS

Table 3: Project stakeholders

4. Project Description

4.1. Overall Project Description

The project goal is to perform a 1-year measurement campaign for the designated project coordinates with no declared extension. The unit FLS200 E02 will be tasked with acquiring accurate wind, metocean and environmental data for a period spanning 12 months.

EOLOS will conduct an internal testing and system verification, constituting a Factory Acceptance Test (FAT) for the unit assigned to the project, after its refurbishment at EOLOS premises located in Barcelona, Spain. The FAT comprises a comprehensive series of tests encompassing all sensors and configuration systems integral to its suitability and performance.

These tests include assessment of sensors, power units, control units, communications, navigational, and security systems. Rigorous mechanical inspections and verifications, coupled with thorough electrical and electronic assessments, form integral components of these tests.

A sample of this Factory Acceptance Test (FAT) can be found in the document: EOL-LO1O2-V01-OPS-FAT PAT SAT Examples [1], which also encompasses the Factory Acceptance Test (FAT), Port Acceptance Test (PAT) and Site Acceptance Test (SAT).

The technical phases of the project as seen from EOLOS' side:

- The EOLOS FLS200 E02 buoy - unit validated for its upcoming campaign with the third party pre verification report already available [2]-, has been allocated as the measurement system. Refurbishment and ex-works schedule are described in section 4.2.1 of the current PEP document.
- After the allocate unit is successfully tested in the EOLOS workshop, including the met ocean and environmental sensors in the buoy, the unit will be partially disassembled and packed for transportation to the assembly port in Aveiro.
- The buoy will then be completely assembled, and a Port Acceptance Test will be conducted at Aveiro port.
- If requested by LNEG, a quayside test in line with applicable guidelines like OWA/CT FLS Roadmap [3] and IEA RP18 [4] recommendations could be performed together with the other allocated FLS200 for the Lote 2, 3 and 4 projects, and a shore based LiDAR unit. The approximate duration of this sanity check is 1 week.
- Once the weather conditions and vessels are confirmed, buoys and materials are loaded onto the vessel in preparation for the deployment.
- The final deployment at the Lote 1 (Viana do Castelo) site is done by EOLOS with the buoy and mooring system on board the vessel. This marks commencement of the validation campaign.
- All above procedures are subject to the operations RAMS procedure.

4.2. Project Scheduling

4.2.1. Project Schedule and Contingencies Considered

Main activities and dates have been considered while taking into account, suppliers' deadlines, assembly, EOLOS experience and marine operation dates discussed and analysed with the O&M team.

As the validation campaign has already taken place, the scope is focused on the final measurement campaign at the Lote 1 site.

EOLOS submits the following Gantt chart highlighting those relevant milestones and identifying the critical paths impacting the planned schedule.

	Task Name	Duration	Start	Finish
1	**LOTE 1 (LO1)**	**93 days**	**Mon 18/11/24**	**Tue 18/02/25**
2	**FLS200 E02**	**93 days**	**Mon 18/11/24**	**Tue 18/02/25**
3	FLS200 E02 Refurbishment works	25 days	Mon 18/11/24	Thu 12/12/24
4	FLS200 E02 Factory Acceptance Test (FAT)	7 days	Fri 13/12/24	Thu 19/12/24
5	FLS200 E02 ExWorks	0 days	Thu 19/12/24	Thu 19/12/24
6	Contract Suspension*	50 days	Tue 03/12/24	Tue 21/01/25
7	FLS200 E02 Road Transport to Aveiro	3 days	Mon 03/02/25	Wed 05/02/25
8	FLS200 E02 Assembly at Aveiro port	5 days	Thu 06/02/25	Mon 10/02/25
9	FLS200 E02 Port Acceptance Test	1 day	Tue 11/02/25	Tue 11/02/25
10	Quayside Test	7 days	Wed 12/02/25	Tue 18/02/25
11	**Mooring System**	**68 days**	**Mon 18/11/24**	**Fri 24/01/25**
12	Reception of site metocean conditions	0 days	Mon 18/11/24	Mon 18/11/24
13	Reception of site depth	0 days	Mon 02/12/24	Mon 02/12/24
14	Mooring design analysis (1st draft)	8 days	Mon 25/11/24	Mon 02/12/24
15	Bill of material	0 days	Mon 02/12/24	Mon 02/12/24
16	Launch of PO for Clump Weight (CW)	0 days	Mon 16/12/24	Mon 16/12/24
17	Delivery time for CW	40 days	Mon 16/12/24	Fri 24/01/25
18	Launch of PO for Midline Floater (MF)	0 days	Mon 16/12/24	Mon 16/12/24
19	Delivery time for MF	40 days	Mon 16/12/24	Fri 24/01/25
20	Launch of PO for chains	0 days	Tue 07/01/25	Tue 07/01/25
21	Delivery time for chains	14 days	Tue 07/01/25	Mon 20/01/25
22	Buoy Ready for deployment	0 days	Tue 18/02/25	Tue 18/02/25

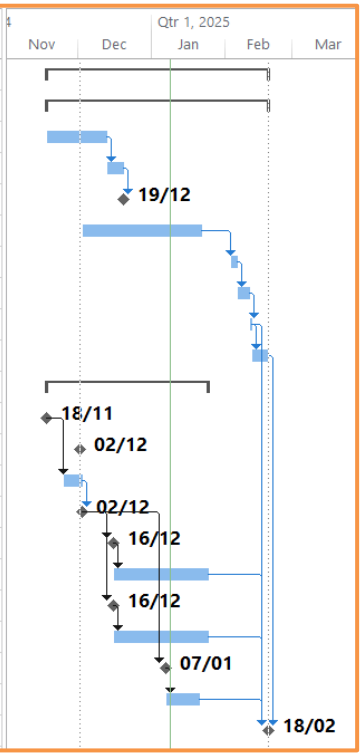

Figure 3: LO1 project schedule.

4.2.2. Risk Mitigation in the Scheduling

There are many risks that must be considered, ranging between low or high impact on the scheduling of the project. When it comes to offshore operations in harsh seas, remote areas and /or new regulations in countries and mapping areas, several factors can affect the above-mentioned timeline.

Risk can be categorized as follows:

1) Environmental risks: Those linked to adverse weather conditions, fisheries and other marine activities in the area.
2) Operational risks: Vessel's unavailability or unsuitability, accidents, deployment challenges.
3) Regulatory risks: Regulatory changes, delays on permitting.
4) Supply chain and logistics: Suppliers shortage, customs.

EOLOS aims to offer one FLS200 by making the equipment available at Aveiro port and ready for deployment by 18th of February 2025 and starting the campaign as soon as reasonably possible shortly after, depending on weather conditions and vessel availability.

The risk mitigation measures put in place to reduce the impact on scheduling are detailed on below table.

Category	Details	Mitigations/Proposals
Environmental Risks	Adverse weather conditions	Regular crosscheck between different forecast models: Windy, StormGeo and/or client specialized forecast.
Environmental Risks	Simultaneous OPS in the area	EOLOS liaise with LNEG to identify potential objections for the FLS200 deployment and engage with local stakeholders.
Operational Risks	Vessel's unavailability or unsuitability	Vessel's identifications is carried out before the contract signs off. If not, EOLOS work with specialized marine contractors with wide experience in floating LiDAR operations. Active and problem-solving mindset is encouraged between EOLOS and the vessel owners to clear any outstanding point that could impact the vessel unsuitability (such as on-site inspections).
Operational Risks	Accidents during deployment (or offshore operations)	EOLOS will send trained personnel in safety protocols and provide protective equipment. Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Operational challenges	Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Safety risks to personnel during offshore operations.	Risk assessment includes and establishes comprehensive safety protocols and risks management. The Emergency Response Plan details the procedure required in any incident.
Operational Risks	Environmental incidents.	EOLOS will ensure compliance with environmental regulations and monitor for potential spills.
Regulatory and Permitting Risks	Delays in obtaining necessary permits for offshore deployment.	EOLOS submit permit applications early and maintain communication with regulatory bodies. If permitting is not within Eolos scope, as is the case in this project, help will be offered to ease the process.
Regulatory and Permitting Risks	Changes in regulatory requirements affecting deployment	EOLOS and clients keep constant communication on the topic to identify actions that could help reduce the impact on regulations.
Logistics and Supply Chain Risks	Customs delays when importing equipment or	Engage multiple suppliers to increase flexibility and expedite customs processes.

	spare parts for deployment.	EOLOS works with multimodal logistics partners with large experience in worldwide shipments.
Supply Chain and Procurement Risks	Shortages of critical components or materials due to global supply chain disruptions.	Stock critical spare parts and maintain agreements with multiple vendors.

Table 4: Schedule risks mitigation measures.

4.2.3. Key Milestones to be considered

There are some key items and milestones to be noticed from the schedule above:

- EOLOS assumes February 3, 2025, as the earliest date on which the transport of the FLS200 E02 to Portugal can commence.
- EOLOS assumes February 11, 2025, as the earliest date on which the Port Acceptance Test could be performed.
- EOLOS assumes February 12, 2025, as the earliest date on which the quayside test on Aveiro port could be performed if requested.
- EOLOS assumes February 18, 2025, as the target date on which the FLS200 E02 could be ready for deployment on the Lote 1 site. The actual deployment date will depend on:
  - Suitable weather window to deploy the FLS200 at the Lote 1 site.
  - Vessel availability for any offshore operations

4.3. Floating Lidar Verification

The FLS200 E02 metocean buoy has been validated between the 15th of August and 23rd of September 2024 at the Lichteiland Goeree Platform against a Fixed Reference Lidar (FRL), applying the industry recommendations as set in the OWA Roadmap [3]. Frazer Nash, a third-party consultant was being provided with the reference and the FLiDAR data on a weekly basis until the key Performance Indicators were met.

On top of the verification, EOLOS and its entire fleet have been recognized and achieved “Stage 3 Commercial” status in 2022 (see EOLOS Stage 3 report [5]), the results have been reviewed and approved by an independent and accredited institute according to international guidelines. The quality of the system is demonstrated through a Classification report. The Classification report of the Floating Lidar measuring system is included in the offer (see EOLOS Stage 3 report) and made available to the Contracting Authority. Multiversum Consultancy, acting as independent third party has certified that the EOLOS FLS200 has achieved Stage-3 maturity.

The verifications campaign took place at the following coordinates:

Validation site	LAT:	LONG:	Depth (m)
Slot LEG_2 FLS200 E02	51° 55' 23,70" N	03° 39' 40,5" N	30 m
	51° 55.395' N	03° 39.675' N	
	51.92325° N	03.66125° N	

Table 5: Deployments coordinates at the LEG platform.

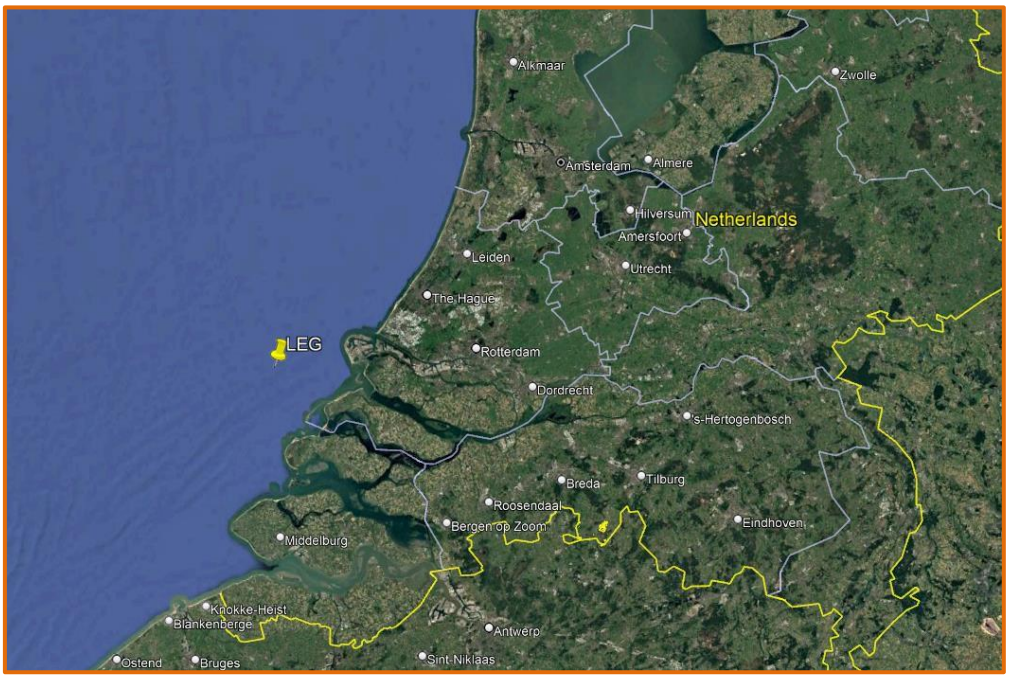

Figure 4: LEG platform location on the map.

4.4. Base Port

EOLOS has select a workshop at Aveiro port to conduct pre-operational work, buoy final assembly, and testing. This port will serve as the departure point for offshore operations and as a potential maintenance location if the buoy needs to be brought onshore.

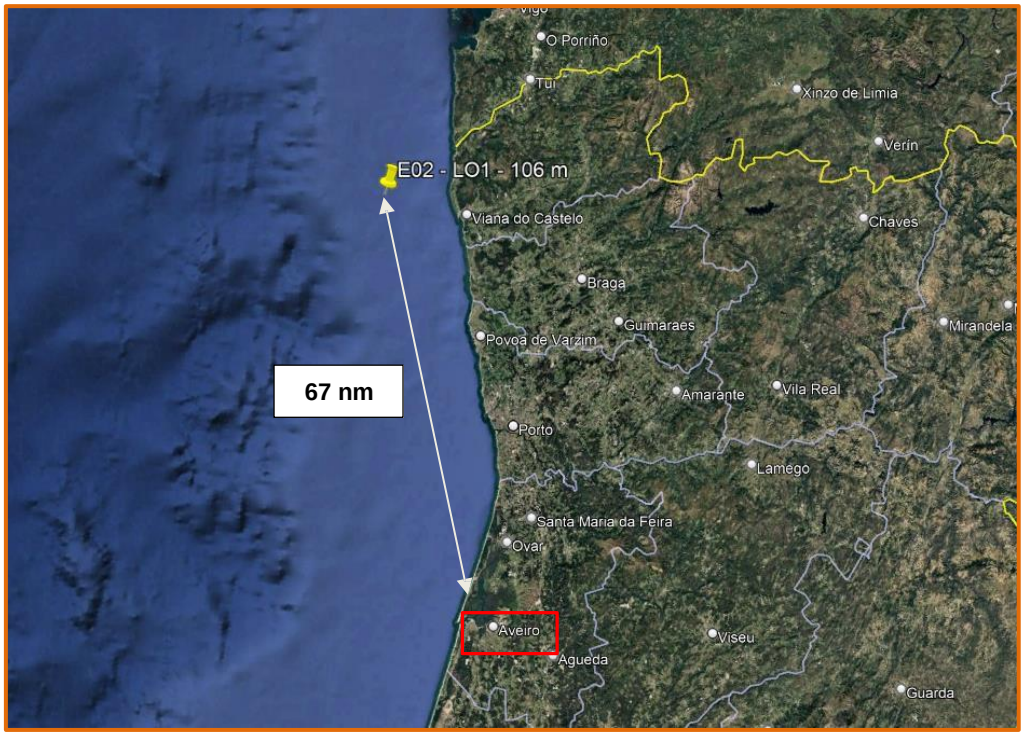

Figure 5: Aveiro location on the map.

It will be the centre of operations for the LO1 project, and all the activity needed to support O&M, including the storage of tools and spare parts.

The workshop location offers enough space to carry out the buoy assembly, disassembly and onshore maintenance. It also has sufficient lifting means to recalibrate sensors, transfer the buoy to/from vessels and trucks and perform various checks on the Port Acceptance Test methodology.

The covered space guarantees safe operations when electronic components must be accessed, modified or replaced.

The Aveiro port is suitable in terms of access to water and availability of tools, facilities and services. Specifications are the following:

- Location: Aveiro Port
- Storage/ assembly area: 200 m2
- Direct access to the water: Yes
- Lifting means available: Reachstaker, cranes and forklifts, capacity from 5 tons and above.

4.5. Project Coordinates

The measurement campaign for the Lote 1 (Viana do Castelo) project will take place at the following coordinates:

FLS200 Unit	LAT:	LONG:	Depth (m)
E02	41° 43' 32.277" N	09° 06' 20.233" W	106 m
	41° 43.53795' N	09° 06.33721' W	
	41.725632° N	09.105620° W	

Table 6: Lote 1 (Viana do Castelo) site coordinates.

Figure 6: Lote 1 (Viana do Castelo) site location on map.

5. Equipment

5.1. FLS200 Buoy

The EOLOS FLS200 unit is defined by two different parts:

1) the buoy itself with all measurement devices, as a generic product
2) the mooring line, which is design specific for each operational location.

The EOLOS FLS200 is described in two main document types, one for the buoy description and one for the mooring as follows:

3) *"As Installed"* [6] document including the technical description/specification of the buoys main equipment and sensors, with certificates of conformity or calibrations of the main measurement systems including Lidar, wave sensor, current profiler, IMU and Vaisala met station. The buoy main body is a generic device usable for different projects and locations.
4) *"Mooring Design Report_LO1 Site" [7]* document, with description of the specific mooring design for the deployment of the FLS200 units at the Lote 1 site.

EOLOS has its own mooring design department, responsible for ensuring survivability of the buoy in the most extreme conditions while keeping the buoy motions within reasonable limits to guarantee the quality of the measured data. Hydrodynamic simulations with the sea conditions are performed to guarantee an optimal design.

Alternatively, EOLOS also works with large, experienced companies such as *London Marine Consultants* (LMC) for mooring designs and BOMs definitions.

The EOLOS FLS200 LiDAR buoy is a fully equipped and autonomous wind, wave and ocean current measuring system based on LIDAR technology with additional meteo-oceanographic instrumentation.

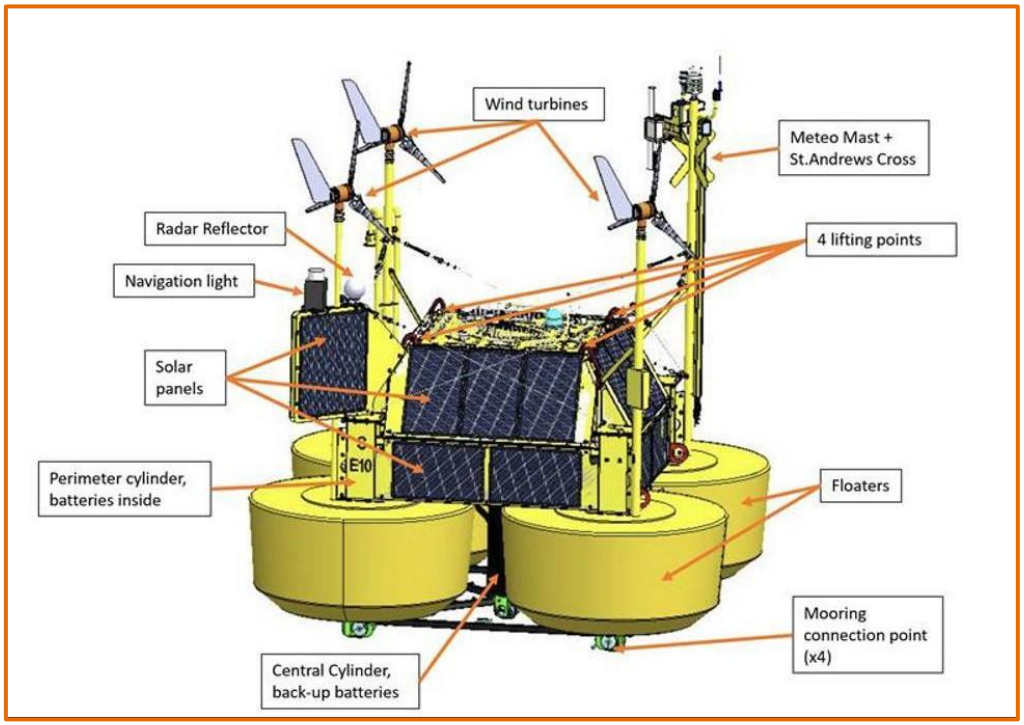

Figure 7: The EOLOS FLS200 LiDAR Buoy

The EOLOS FLS200 power system is fully redundant and autonomous, using three independent sources of charging power, minimizing the risk of a power shortage in any weather circumstance or unforeseen event (such as failure of one of the power systems).

The EOLOS FLS200 buoy has a custom power distribution system with the following components:

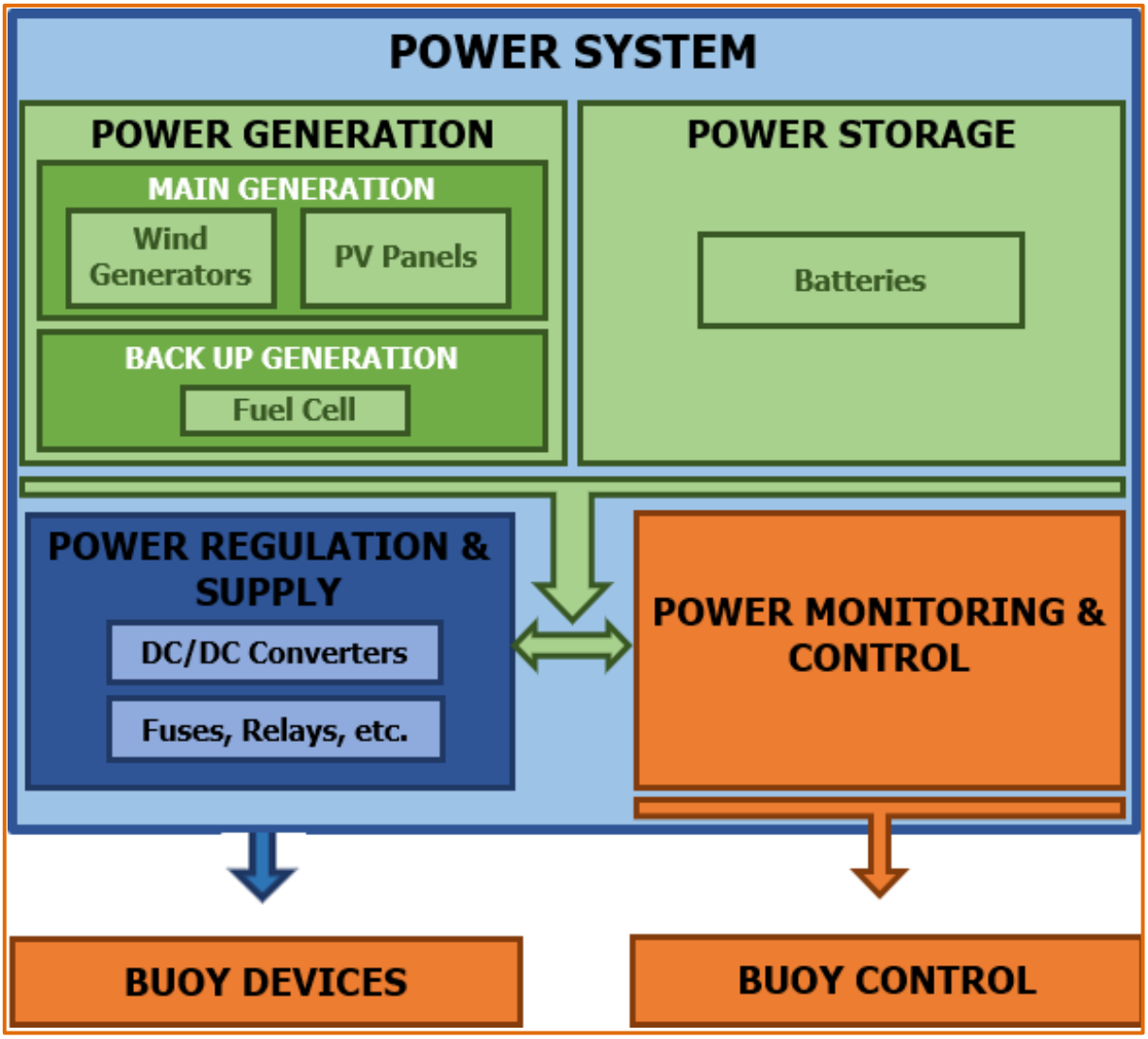

Figure 8: FLS200 energy supply schematic.

The FLS200 buoy is powered by: (i) wind turbine generators on the east, west, and south masts; (ii) 2 solar panel rings around the buoy cabin, with 2 additional panels on the south mast; (iii) batteries that are charged by the generation of (i) and (ii); and (iv) a methanol fuel cell for low-generation scenarios.

The FLS200 has been fitted with: (i) ZX LiDAR ZX300M, (ii) Vaisala meteorological station, (iii) Nortek current profiler Signature 250, (iii) A+D wave sensor, (iv) KVH Compasses, (v) Garmin GPS, and (vi) Li-Cor pyranometer.

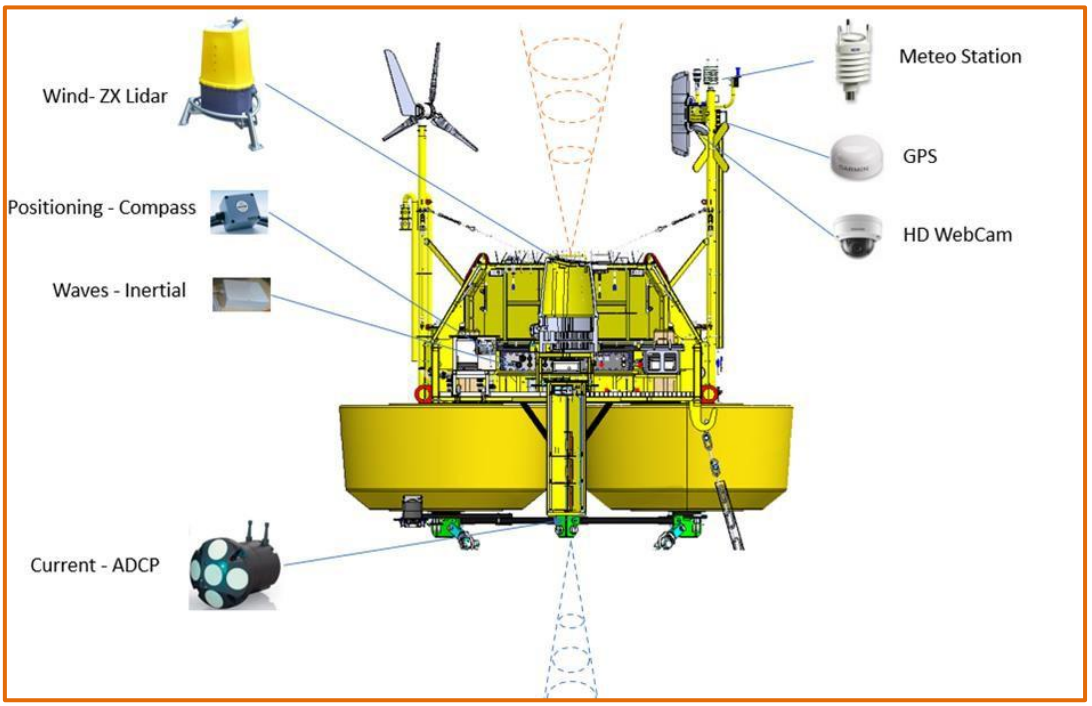

Figure 9: FLS200 E02 main sensors layout.

The measurement configurations of the Lidar device and the ADCP device are to be documented and approved by the Client in the Measurement Plan.

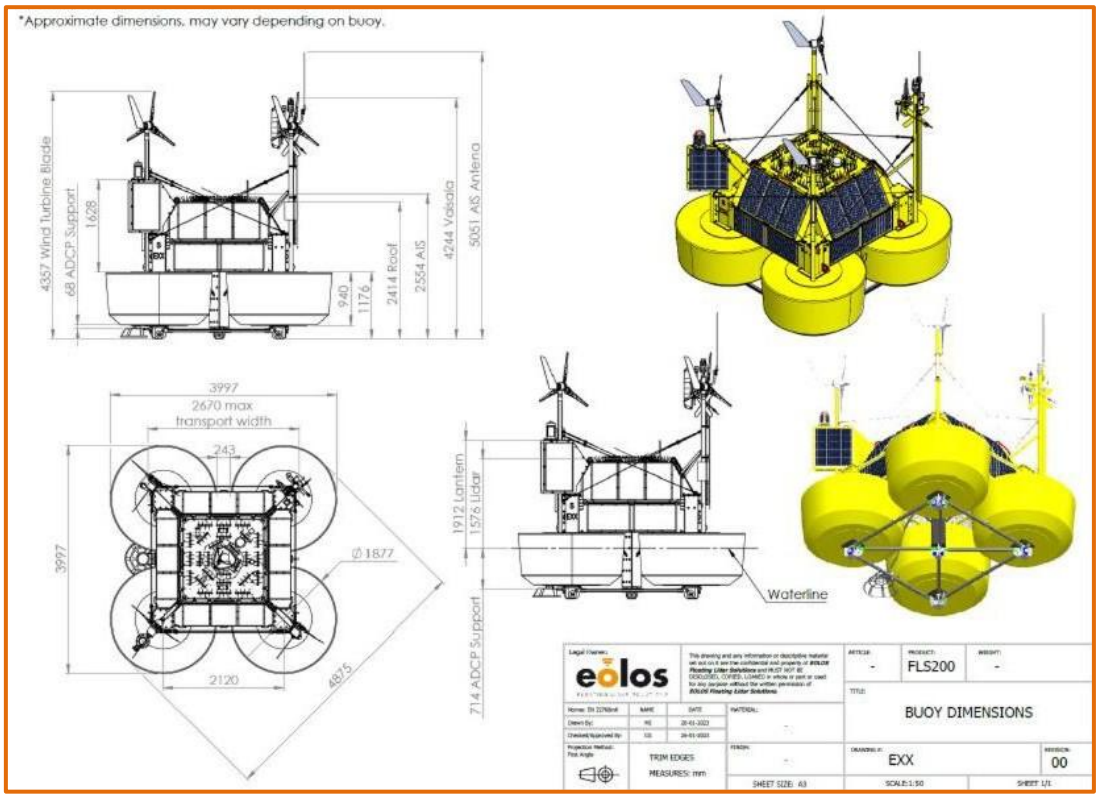

Figure 10: FLS200 technical drawings

5.1.1. FLS200 buoy mooring

5.1.1.1. Upper mooring (standard)

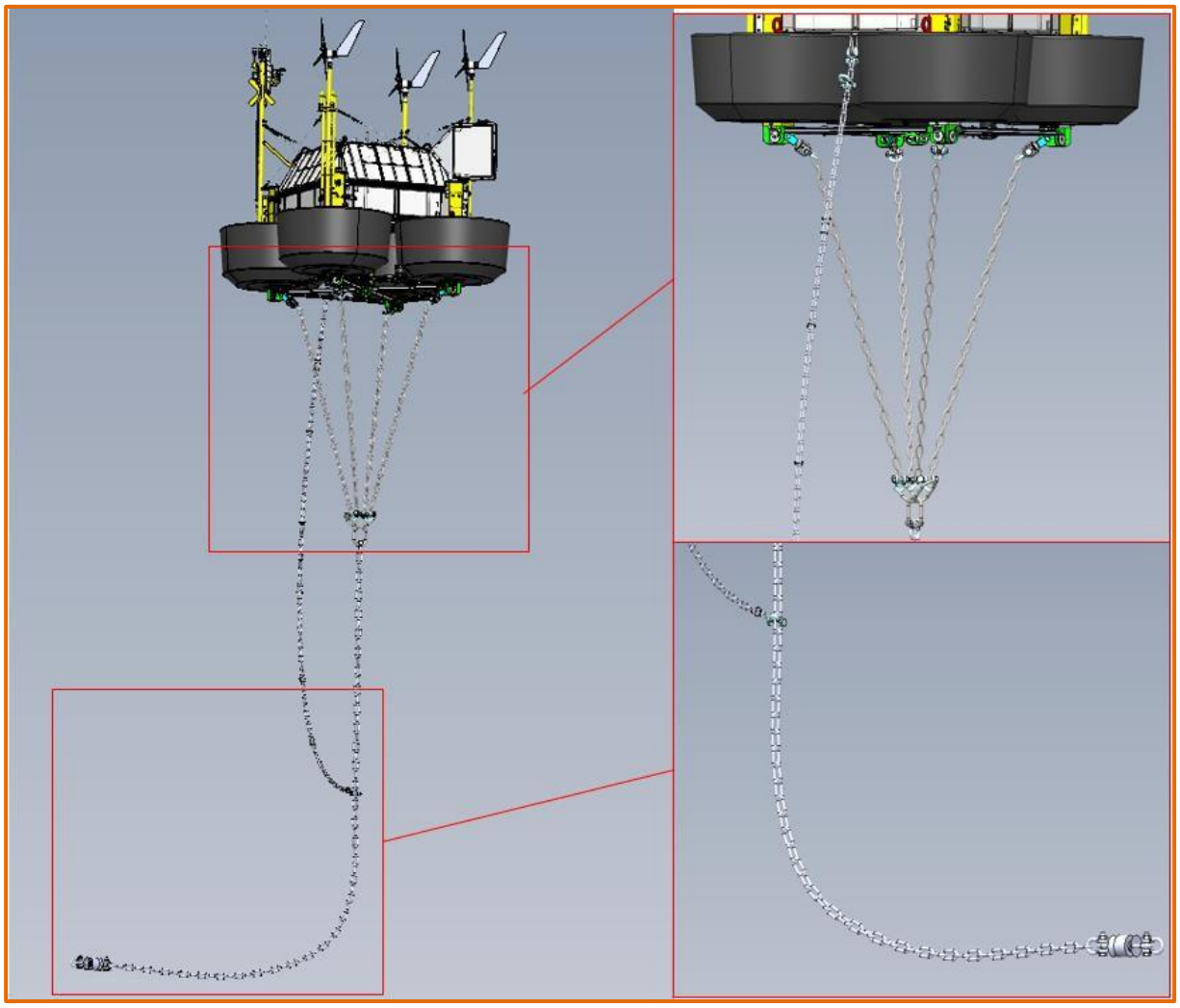

Figure 11: FLS200 upper mooring arrangement.

5.1.1.2. Lower mooring (site specific)

The site-specific mooring system is currently being designed by the EOLOS mooring department and it will be included in this Project Execution Plan once it has been completed. London Marine Contractors (LMC) has been designated as a third-party consultant to review and validate the EOLOS design.

6. Marine operations

Marine operations are critical for the success and development of the project. Proper planning and execution are essential to achieve an early and efficient deployment, minimizing delays, and maximizing data availability throughout the LNEG desired period. These operations include all activities related to transportation, deployment, maintenance, and recovery of the buoy, ensuring that the equipment is correctly positioned, functioning, and maintained to gather reliable data for the project duration.

6.1. Weather window identification

Detailed weather forecasts must be in place prior to all vessel operations. This includes deployment, recovery and offshore maintenances. This forecast report shall have a minimum forecast look ahead of 5 days, and can come from different sources:

- Windy: A weather forecasting tool that provides detailed meteorological information by aggregating data from multiple weather models. For this LO1 project the ECMWF Integrated Forecast System (IFS) will be used. It is a global numerical weather prediction model employing spectral methods for atmospheric dynamics and a semi-Lagrangian scheme for advection. It operates on a hybrid vertical coordinate system and utilizes 4D-Var data assimilation for optimal integration of observational data. The model's resolution typically reaches ~9 km (T1279) for deterministic runs and ~18 km (T639) for ensemble forecasts, with up to 137 vertical levels extending to the mesosphere.
- Storm Geo: Offers site-specific forecasts with reliability indexes that help improve the offshore operations planning. When crosschecked with Windy, it gives Eolos more certainty in harsh seas or during winter months.
- Other site-specific forecasts.

When the project requires and offshore operation, the project manager will inform the O&M lead of the imminent need for a vessel and team. The weather is then monitored by both, PM and O&M, until favourable conditions appear. As a general guide the following limits apply depending on the nature of the operation.

Transit or tow / Offshore lifts

- Max wave height [m]: 1.5 / 1
- Significant wave height[m]: 1.0 / 0.8
- Max wind speed[kn]: 15 / 13
- Max wind gusts [kn]: 19 / 17

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Table 7: Weather Threshold for EOLOS Operations

Surface current speeds are desired to be below 0.8 m/s. Special consideration must be made with respect the RAMS and actions to follow when the buoy is recovered/dropped as current might influence the positioning with respect the vessel.

The Beaufort scale is used to categorize the weather conditions reported in every operation at site which takes as input the wave height, wind speeds and environmental parameters to assign a value from 1 to 10. Any value above 4 is considered beyond the threshold set to safely conduct any operation.

The length of the weather window must match the estimated duration of the marine operation, including the time needed to halt it if necessary. Offshore servicing is critical, as the buoy is typically on deck with the mooring already deployed, making it more time-consuming to redeploy the buoy in the event of an unforeseen incident.

If a favourable weather forecast is available, and the length is appropriate for the task, the following steps apply prior to mobilisation to site:

a) 72 hours RAMS is prepared and sent to the client and the vessel.
b) 48 hours notify port authority of intended operations.
c) 24 hours all materials shall be loaded, inspected and prepared for transit to site.
d) 12 hours decision made to transit to site
e) 0 hours final weather forecast reviewed and go no go decision made.

6.2. Mitigation

EOLOS understands the dynamics and complex nature of offshore weather conditions, and this is expected to play a key role in the development of the project and the operations of deployment, maintenances and recoveries. Thus, EOLOS has an entire department (O&M) that closely monitors the weather through the above-mentioned sources and work side by side with the Project Managers to identify the needs of the project.

The potential drawbacks of sailing and operating under extreme weather conditions far exceed the benefits from taking the risks, and EOLOS operate under a policy of nil incidents and accidents throughout the entire campaign.

If offshore operations are scheduled, such as deployment of the system or preventive maintenances, Dutch Marine Contractors (DMC) is contacted to trigger the search of the vessel. This is done far in advance to locate vessels finishing other contracts to guarantee vessel availability by the time of operations. If weather conditions are not acceptable, but they are forecasted to end soon, EOLOS remains in standby until is safe to sail out.

Conversely, especially when corrective actions on the buoys must be done, EOLOS will is to lower the impact on the project. This is done by a negotiation with the Marine contractor and the vessel owners to ensure the following:

- Availability of slightly bigger vessels with DP and better behaviour to waves.
- Book high skilled and experienced vessels working with floating Lidars.

EOLOS maintenance schedules as seen in the section 6.4 Maintenance and Operational Methodology aim to foresee well in advance the upcoming operation, allowing the operational team to organise the logistics to have all material ready to service the buoys at any time. The goal is to service the buoys when weather is expected to be mild and reduce the offshore operations during winter months.

The Vessel Master will have the right and responsibility to make the final decision on whether the operation can be safely conducted based on his/her knowledge of the vessel capabilities and, his/her marine experience.

Figure 12: EOLOS FLS200 onboard a multicat.

6.3. Offshore operations strategy

The measurement campaign will last 12 months, and it typically includes the deployment, recovery and scheduled services at 6 months intervals. For this campaign, the tentative schedule would be:

- Deployment
- 6 months scheduled service
- Recovery

Marine operations will described in detail in the documents:

- RAMS for campaign deployment.
- RAMS for campaign recovery
- RAMS for maintenance

Each of these documents includes the different considerations, technical aspects, resources, and tools to execute the different operations and including risks already identified, its avoidance and mitigation.

When marine operations take place, EOLOS will report its outcome in the following documents:

- Deployment report
- Recovery report
- Maintenance report
- Daily Progress Report

6.4. Maintenance and Operational Methodology

Every works on the buoys is described in the operational plan developed by O&M department and specifically designed following the flow diagram presented in this section.

EOLOS reserves the right to move back and forth maintenance activities to optimize its operations, always under the premise to comply with HSE requirements and keep data availability to a maximum value.

The buoys are daily monitored by the data team and reference engineers, who notify everyone related to the project when there is anomalous behaviour or warnings raised by the system itself. EOLOS diligently plans unscheduled operations to fix whichever alarm must be mitigated. More details on monitoring can be found in the following sections.

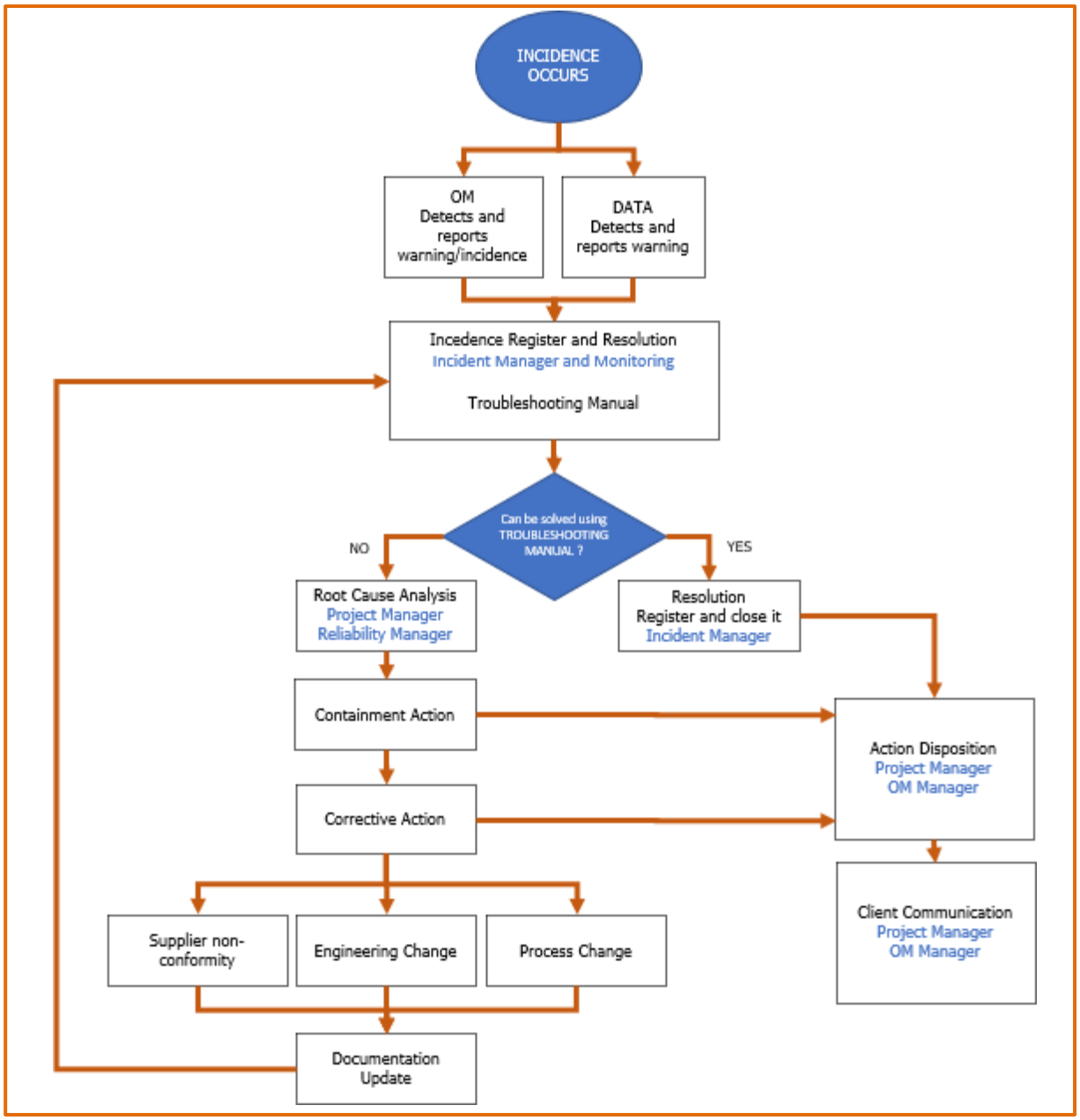

Figure 13: O&M flowchart.

6.5. EOLOS Operational Centre

EOLOS will work from its base port located at Aveiro to optimize the operations during the campaign.

Figure 14: EOLOS FLS200 buoy at port

6.6. Vessel for Marine Operations

EOLOS will ensure to hire local vessels (if available) through its marine contractor, Dutch Marine Contractors (DMC). A reduced number of multipurpose vessels can be used by EOLOS as part of the regular operation of deployment, recovery, and maintenance, with these being mainly Multicat vessel and Tugs fitted with offshore cranes, however, also crane barges and some offshore supply vessels could be used.

In order to provide evidence that the vessel status and capabilities fall within acceptable parameters of conformity, EOLOS stablishes a set of minimum requirements with respect vessel documentation listed below:

- CMID OVID, or equivalent inspection such as EOLOS suitability assessment.
- Hull and Machinery insurance.
- Protection and indemnity insurance.
- Crane specifications thorough examination - SWL testing.
- Safety management system (according to ISM or local flag).
- Safe manning document.

- Crew certification and list crane operator included:
  - SCTW.
  - Bosiet.
  - OWC.
- Ship registry certificate.
- Class certificate.
- Crew rest of hours.
- Vessel workboat certificate.
- Vessels contact details: mail, phone, SAT phone.

The minimum vessel capabilities are defined by EOLOS and transmitted to DMC to seek vessels for every operation. Considering the buoy characteristics, the vessel must have, as a minimum:

- Open deck (stern /bow)
- Crane capable of lifting >7 mT over the open deck
- Winch capable with a pull force >10 t
- Deck area > 50 m^2

Figure 15: Portuguese based tug vessel Castelo de Óbidos (Rebonave).

Figure 16: Spanish based multicat vessel Fenix Vigo (Northcom Diving).

7. Measurement campaign, data management, monitoring and data provision chain

The main goal of the project is to provide LNEG with a 1-year long metocean bankable data. Data measurements, management, processing and delivery are the most important aspect of the Lote 1 project.

7.1. Data acquisition

The measurements campaign will last 12 months, and data will be measured by deploying an FLS200.

The Measurement Plan is the standard EOLOS document that describes data conventions, sensors configurations, data files formats and data deliverables across the entire campaign.

The sensors that will be installed in the LO1 buoy are:

Sensor	Brand	Location
Lidar	ZX	FLS200
ADCP	Nortek	FLS200
Wave sensor	A+D	FLS200
Meteorological station	Vaisala	FLS200
Pyranometer	LiCor	FLS200

Table 8: Measurement sensors installed on the FLS200.

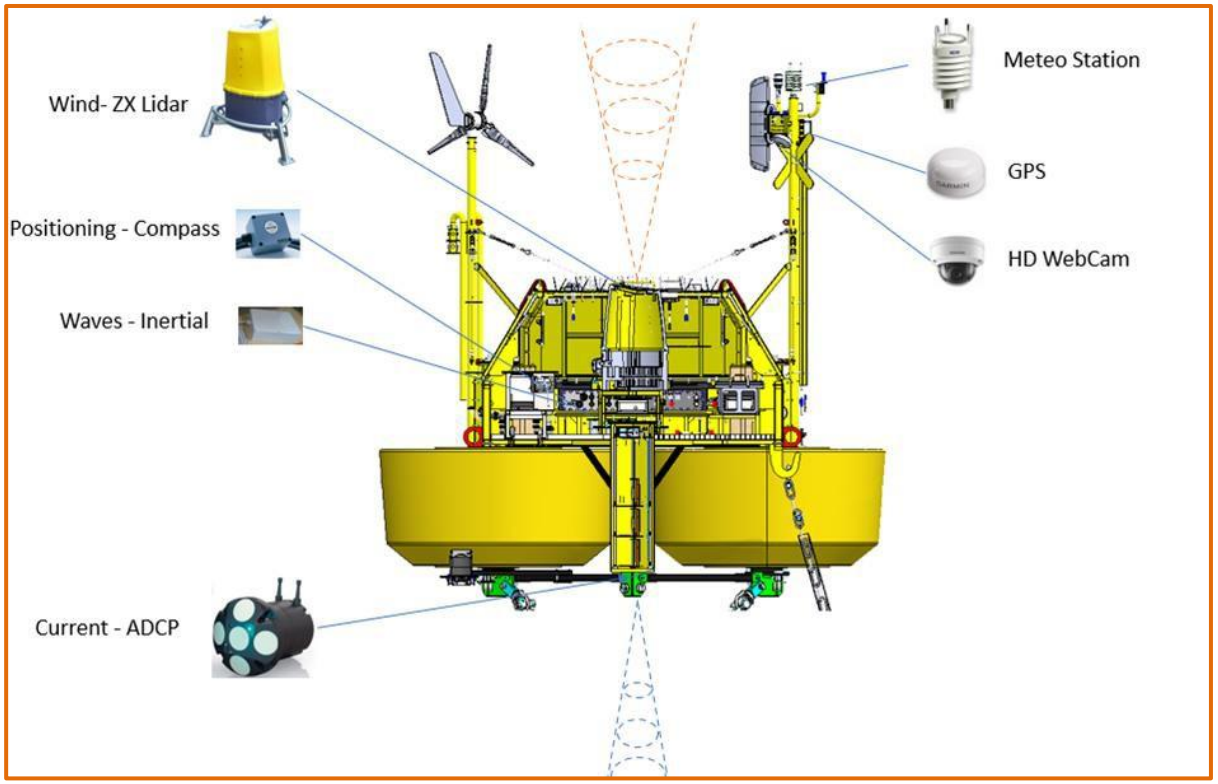

Figure 17: FLS200 main sensors layout.

Each sensor measures at regular intervals and frequency as described in the Measurement Plan, and can be subdivided into two sections:

- Data accessible remotely: These data are the average 10-min or 30-min files which are sent to EOLOS servers and are used for monitoring and updating data portals. Data sets are updated daily (every 48 h).
- Data stored within the system/sensors: These data include average and high frequency data. Datasets will usually be downloaded at regular intervals (scheduled maintenances) or at the end of the campaign, after the buoy recovery.

Data stored within the sensors (Lidar, wave and ADCP) also works as a backup copy that is recovered after accessing physically to the buoy.

The measurement principles of all the sensors mounted on the buoy EOLOS FLS200 are explained in more detail in the complementary document EOL-DOC93-V04-PROD-Sensors measurement principles and specifications [8].

7.2. Monitoring

The FLS200 system is composed of different subsystems, each with its own function and monitoring capability. Some subsystems may be designed to be monitored remotely onshore, with status messages or similar being sent via the internet.

These same subsystems may or may not be for measurement, i.e., producing quantitative observations to meet the project objectives. Malfunctions or outages detected in measurement subsystems will always cause an incident notification toward LNEG because they affect the data. Malfunctions or outages detected in non-measurement subsystems will not generate an incident notification toward LNEG if: (a) there is no effect on the data; and (b) there is a design redundancy still available.

Below table displays the subsystems and how monitoring works:

	Monitored remotely	**Not monitored remotely**
Measurement systems	Lidar ADCP Wave Meteorological station GPS Pyranometer	
Non-measurement systems	Communications: Neptulink (4G) Communications: Iridium Energy: Wind generators Energy: Solar panels Energy: Battery racks Energy: Fuel cell Dataloggers	AIS Lantern Corrosion protection Mooring TRBM structure

All those subsystems that are not monitored remotely are going to be accessed physically at the interval given in the O&M operations schedule. If data can be retrieved, it will be shared with LNEG.

There are various scenarios which may cause the buoy to travel outside of its drift radius (buoy adrift), most commonly due to mooring failure.

Any instance of buoy adrift sends an alarm to EOLOS Project Manager, Operations & Maintenance Manager, and Operations Director via the Smartone system. The alarm is repeated every hour while the buoy remains outside its programmed drift radius.

The section below shows how the FLS200 communicates with EOLOS HQ

7.3. Data management

The data flow at EOLOS follows the pattern as shown below:

Figure 18:

Data is measured by sensors deployed offshore by different devices. The sensors gather data in a raw format that is delivered to the FLS200 control units, the dataloggers. Data is then merged, packed and sent to EOLOS on-land servers by different telemetry system. If the buoy is closer to shore, 3G/4G communication is used, otherwise, the Iridium satellite antennas are used. Eolos has redundancy communications systems to avoid interruptions in data transmission. The following image shows which data can be recovered using several communications channels.

		Master	Slave	Lidar	Wave	ADCP
Telemetry	3G					
	Iridium					
In situ data recovery	Wi-Fi / cable					
	Internal memory					

Figure 19: FLS200 communication channels.

Once on land, the post processing is applied, which includes filtering to ensure data quality. Some of the filters are included in the sensors themselves, while others are implemented by EOLOS. Additionally, the Lidar measurements are corrected for tidal variation and the magnetic declination corrected to reference all measurements to true north.

More details on filtering and post processing can be found at EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan [9].

7.4. Data reporting and deliverables

Data will be delivered for the LO1 project at different intervals and in standard text format .dat, with the following names:

- *EOLOS_START-DATE_START-HOUR_END-DATE_END-HOUR_hour.dat*

If preferred by LNEG the data files can also be provided in .csv format.

7.4.1. Daily data reporting

Data will be automatically uploaded to Eolos connect portal.

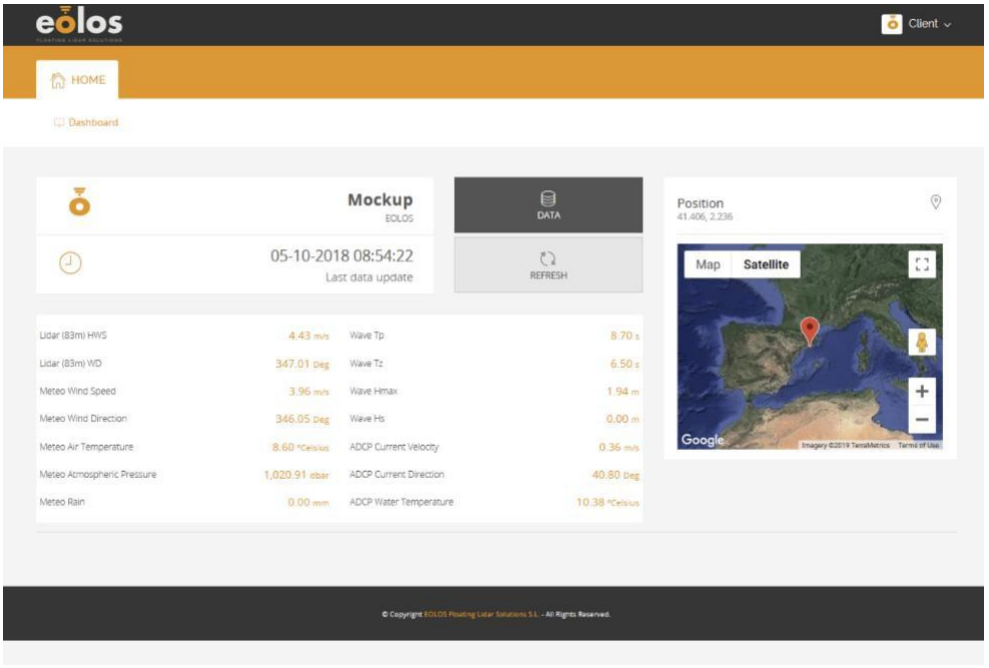

Figure 20: EOLOS Connect portal overview.

EOLOS Connect is a visualization portal only and no data can be downloaded.

The data files will be uploaded to the BOX (EOLOS cloud server) shared folder with LNEG:

01.PROJECT.DATA\EOL-LO1-PROJECT.DATA\E02\DAILY DATA

7.4.2. Monthly Reports

Monthly datasets will be uploaded to the BOX shared folder with LNEG:

01.PROJECT.DATA\EOL-LO1-PROJECT.DATA\E02\MONTHLY DATA

And monthly reports will be uploaded to the following BOX shared folder:

02.PROJECT.MANAGEMENT\E02-LO1\Monthly Report

7.4.3. End of campaign

Summary Report and datasets will be uploaded to BOX, following the same fashion as described in previous sections.

8. Project Document Control

Document control for the LO1 project will be the responsibility of the project manager, who will follow up across the entire project.

The documents are identified as IFI (Issued for information), IFA (Issued for Acceptance) or IFR (Issued for Review), and will be named with the following structure.

EOL [PROJECT NAME] [VERSION] OPS- [NAME OF THE DOCUMENT]

- Version 00 for internal use only, 01 and above for external communications.
- First page including Author and Revised by person.
- First page including version control.
- First page including date.
- First page including title and pages.

The Project Manager is the owner and responsible to create, archive, review and maintain the folder and its documents. Documents will be created by the core team and the support team depending on the technical/area of discipline and the PM will be communicated for the review and classification process.

8.1. Document deliverables

Documents are to be provided according to EOL-LO105-V01-OPS-Document Deliverables Plan [10].

9. Risk Management Environment, Safety & Health / Emergency Situations

The HSE plan needs to be placed to guarantee safety management on site during all operations. HSE detailed plan for the LO1 project is described in detail in:

1) EOL-LO106-V01-OPS-HSE Plan [11].

A detailed procedure to follow in case of potential emergency situations including all project emergency contacts and emergency considerations included in:

2) EOL-LO106-V01-OPS-Emergency Response Plan [12].

For all offshore operations, the following documents need to be fully read, understood, and agreed by main personnel on board of the operations vessel:

3) RAMS for FLS200 Operations.

9.1. INCIDENT AND EMERGENCY REPORTING

9.1.1. Buoy incidences

In case of technical malfunction incidents, LNEG will be informed by EOLOS at the Project Management level within the following due dates:

Action	Due Date	Deliverable
Verbal communication	Within 48 hours of alarm	Email
Indent notification report	Within 72 hours of alarm	Incident notification
Unscheduled visit after incident notification	Within 15 calendar days of notification (weather dependant).	RAMS ERP
Maintenance report after unscheduled visit	Within 15 calendar days of unscheduled visit.	Maintenance report

Table 9: Notification due dates for technical malfunctions

Technical incidents will be notified only:

1) If the incidence triggers maintenance.
2) If the incidence represents a danger to navigation.
3) If the incident affects communication/ dataflow.

9.1.2. Accidents

Emergency situations or accidents at or near the Lote 1 deployment location impacting people (LNEG, EOLOS, third party) or environment will be reported to LNEG at the Project Management level immediately.

The first and most important action after an incident will be securing safety of personnel. Immediately after LNEG and EOLOS will then initiate respective emergency response plans.

More details on the flow of information and procedures can be found at the Emergency Response Plan (ERP) and Health and Safety pan (HSE).

10. Project Quality

10.1. The FLS200 Buoy

Quality documentation related to the buoy and its hardware can be found in the following standalone documents:

- Factory Acceptance Test (FAT) Report
- Port Acceptance Test (PAT) Report
- Site Acceptance Test (SAT) Report

These are issued by EOLOS toward LNEG on a for Information basis (IFI).

EOLOS' priority is to deliver industry-credible data to the Client. To meet this objective, data management and delivery operates with two core documents:

- EOL-DOC114 Data Quality Control Procedures, which describes how EOLOS – independently, or based on instrument OEM know-how – assesses a data observation as valid or invalid (i.e., flagged).
- The Project-specific Measurement Plan, which details the specific measurement parameters customized to suit the relevant Client contract or Client needs.

10.2. Subcontracted Services

Marine operations are one of the most critical activities carried out by EOLOS in order to execute the measurement campaign. Therefore, in line with the EOLOS purchases procedure and the EOLOS standard Scope of Work for marine contractors, the minimum requirements for any work vessel contracted by EOLOS are:

a) CMID
b) Crane working diagram
c) Certificate of registry
d) Certificate of classification
e) Certificates of insurance
f) Evidence of insurance
g) Attestation of Cargo Gear Survey
h) Crew Certification (GWO, BOSIET, or STCW) – 4 modules (firefighting, sea survival, first aid, manual handling)
i) LOLER certification of lifting elements or crane through examination

11. Permits

11.1. Permit for deployment at site

LNEG is responsible for the process to acquire the permit (*Título de Utilizaçao Privativa do Espaço Marítimo* – TUPEM) to deploy the assets on site for the duration of the measurement campaign.

11.2. Navigational Aids Permit

EOLOS is responsible to acquire the AIS licence for the AtoN devices mounted on the buoy and will process it with the corresponding authorities.

12. Payment calculations

According to the Contract D26805 the following milestones should be paid:

Milestone	Description	Payment calculation
Project Execution Plan	EOLOS delivers to LNEG the Project Execution Plan within 20 days after the contract signature.	374,500.0 €
Deployment Report	After the successful deployment of the FLS200 E02 at the LO1 site, EOLOS provides LNEG with the Deployment Report.	74,900.0 €
Monthly Reports 1-12	Monthly invoices upon receiving the monthly datasets and associated report.	42,800.0 €/month
Recovery and final report	Upon completion of the data measurements campaign and issuing the final data report.	107,000.0 €

Figure 21: Contractual project invoiceable milestones.

Payment calculation for the monthly reports will be issued along with the monthly reports and the data sets after two weeks of the current month.

The following payment calculation will be used to determine the monthly rate to be paid upon reception of the monthly data sets and reports, based on the LiDAR wind speed and direction post-processed data availability at 140 meters (or another agreed reference height, which will be included in the Measurement Plan):

Wind Speed and Direction post-processed data availability at 140m	Payment
>85%	100% * Monthly fee

<85%	$$Penalties = Monthly\ fee * \left(\frac{Penalty * Unavailable\ time\ stamps}{Reference\ time\ stamps}\right)$$ Being • Penalty: 5% • Unavailable timestamps: In a period of 12 months, the number of time stamps not registered assuming as a reference one year of data recorded in a 10-min interval. • Reference time stamps: number of time stamps in a 30 day month, assuming in this case the value 4320.

References

[1] EOL-LO102-V01-OPS-FAT PAT SAT Examples.

[2] EOLOS Floating LiDAR E02 PdV Issue 1.

[3] OWA Roadmap for the Commercial Acceptance of Floating LiDAR Technology (2018).

[4] IEC 50.4.

[5] 3rd party assessment of Stage-3 maturity achievements of the EOLOS FLS-200 Floating LiDAR Buoy according to the “Carbon Trust Offshore Wind Accelerator Roadmap for the Commercial Acceptance of Floating Lidar Technology”, MV-3005-PV1-065-TN-001-C.

[6] EOL-LO103-V01-OPS-As Installed.

[7] EOL-LO104-V01-OPS- Mooring Design Report_LO1 Site.

[8] EOL-DOC93-V04-PROD-Sensors measurement principles and specifications.

[9] EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan.

[10] EOL-LO105-V01-OPS-Document Deliverables Plan.

[11] EOL-LO106-V01-OPS-HSE Plan.

[12] EOL-LO106-V01-OPS-Emergency Response Plan.

EOL-LO201-V01-OPS

PROJECT EXECUTION PLAN
LOTE 2
LEIXÕES

PREPARED		**REVISED**		**APPPROVED**	
By	**Ignasi Andreu**	By	**Oriol Costillas**	By	**Felix Urrea**
Date	08/12/2024	Date	09/12/2024	Date	09/12/2024

VERSIONS		
Version	**Modification causes**	**Date**
01	**Document Creation**	08/12/2024

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Figures

Tables

Acronyms/Abbreviations

PEP	*Project Execution Plan*
IPT	*Integrated Project Team*
FAT	*Factory Acceptance Test*
PAT	*Port Acceptance Test*
SAT	*Site Acceptance Test*
HAZID	*Hazard Identification*
HIRA	*Hazard Identification and Risk Assessment*
BOM	*Bill of Materials*
OWA	*Offshore Wind Accelerator*
RAMS	*Risk Assessment and Method Statement*
LNEG	*Laboratório Nacional de Energia e Geologia, I.P.*

1. Introduction

1.1. Overview

EOLOS Floating Lidar Solutions has been awarded Contract D26805 by the Laboratório Nacional de Energia e Geologia, I.P. (LNEG) to carry out a 1-year wind resource assessment campaign from Q1 2025 to Q1 2026. The wind resource assessment will be done primarily with the deployment of an EOLOS FLS200 metocean buoy (with serial number E10) off the coast of Leixões, Portugal.

Figure 1: Lote 2 (Leixões) site location on map.

1.2. Purpose

This Project Execution Plan (PEP) defines a proposal for the **Lote 2 (LO2)** project and describes planning, assumptions, constraints, roles, responsibilities, authorities, management interactions and interfaces necessary to successfully execute the project in a safe and efficient manner.

2. Mission & Objectives

2.1. Mission Specifications

The mission of EOLOS defined in this Project Execution Plan is to provide LNEG with 1 year of bankable meteorological, met ocean and environmental data through the deployment of the EOLOS FLS200 E10.

2.2. Project Objectives

- Provision of a validated metocean buoy for the whole duration of the campaign, delivering the highest practicable post-processed wind data availability.
- Maximise the quality data availability of all the relevant sensors included in the offer.
- Minimize environmental impact in the deployment area.
- Ensure that environmental, safety, health and security requirements are fully considered and appropriately implemented in project execution.

3. Organization & Responsibilities

3.1. EOLOS Representatives

NAME	POSITION	BACKUP
Felix Urrea	Director of Operations	Gastao Moura
Ignasi Andreu	Project Manager	Mike Serquina
Adrià Miquel	Chief Data Scientist	Giacomo Rapisardi
Lluís Raurich	Engineering Director	Raúl Rodríguez
Gastao Moura	O&M & HSE Manager	Jorge Garcia
Julian Harland	Contract Manager	Rajai Aghabi
Raúl Rodríguez	Fleet Engineering	Lluís Raurich
Jose Miguel Garro	Data Scientist	Sandra Coll
Raimon Targa	Project Reporting	Marc Borrell
Daniel Sanchez	Reliability Manager	Mario Berral
Juan Delgado	CFO	Rajai Aghabi

Table 1: EOLOS Personnel for the Project

3.2. CLIENT Representatives

Name	Position	Email
Ana Estanqueiro	Senior Researcher	ana.estanqueiro@lneg.pt
Teresa Simoes	Wind Resource Assessment	teresa.simoes@lneg.pt

Table 2: LNEG Personnel for the Project

3.3. EOLOS Project Team

EOLOS will be organised as follows to fulfil all aspects of the **LO2** project:

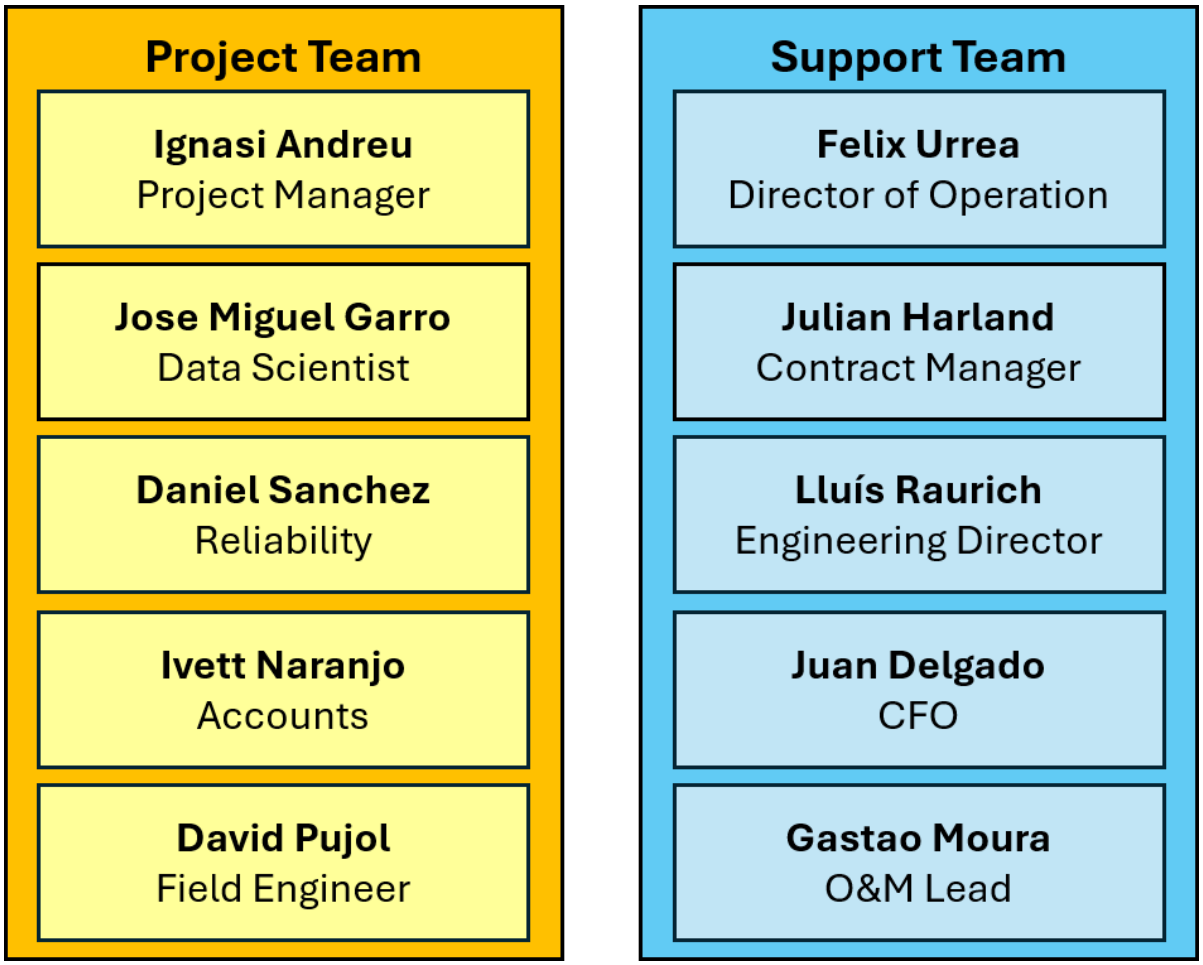

Figure 2: EOLOS Company Organisational Scheme

3.4. Project Interfaces

During the duration of the project, EOLOS must contact different stakeholder in order to successfully perform the object of the contract. The involved parties will be:

Stakeholder	Role	Managed by
Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM)	To grant the permits to deploy the FLS200 E10 at the Lote 2 site.	LNEG
Autoridade Marítima Nacional (AMN) - Coastguards	Supervise and coordinate the activities related to maritime safety, marine environmental protection and maritime rescue	LNEG and EOLOS, as applicable.

Aveiro port	Provide the facilities and lifting equipment required to assemble the FLS200, as well as the quayside where the vessel used for the marine operation will berth.	EOLOS
London Marine Consultants (LMC)	Provide an independent assessment and validation on the mooring design designed by EOLOS.	EOLOS
Dutch Marine Contractors (DMC)	Search and hire suitable vessels for the marine operations.	EOLOS
Wilhelmsen Port Services	Provide all the logistics for vessel entry at port, and contact point between Aveiro port authority and EOLOS.	EOLOS

Table 3: Project stakeholders

4. Project Description

4.1. Overall Project Description

The project goal is to perform a 1-year measurement campaign for the designated project coordinates with no declared extension. The unit FLS200 E10 will be tasked with acquiring accurate wind, metocean and environmental data for a period spanning 12 months.

EOLOS will conduct an internal testing and system verification, constituting a Factory Acceptance Test (FAT) for the unit assigned to the project, after its refurbishment at EOLOS premises located in Barcelona, Spain. The FAT comprises a comprehensive series of tests encompassing all sensors and configuration systems integral to its suitability and performance.

These tests include assessment of sensors, power units, control units, communications, navigational, and security systems. Rigorous mechanical inspections and verifications, coupled with thorough electrical and electronic assessments, form integral components of these tests.

A sample of this Factory Acceptance Test (FAT) can be found in the document: EOL-LO2O2-V01-OPS-FAT PAT SAT Examples [1], which also encompasses the Factory Acceptance Test (FAT), Port Acceptance Test (PAT) and Site Acceptance Test (SAT).

The technical phases of the project as seen from EOLOS' side:

- The EOLOS FLS200 E10 buoy has been allocated as the measurement system. Refurbishment and ex-works schedule are described in section 4.2.1 of the current PEP document.
- After the allocate unit is successfully tested in the EOLOS workshop, including the met ocean and environmental sensors in the buoy, the unit will be partially disassembled and packed for transportation to the assembly port in Aveiro.
- The buoy will then be completely assembled, and a Port Acceptance Test will be conducted at Aveiro port.
- If requested by LNEG, a quayside test in line with applicable guidelines like OWA/CT FLS Roadmap [2] and IEA RP18 [3] recommendations could be performed together with the other allocated FLS200 for the Lote 1, 3 and 4 projects, and a shore based LiDAR unit. The approximate duration of this sanity check is 1 week.
- Once the weather conditions and vessels are confirmed, buoys and materials are loaded onto the vessel in preparation for the deployment.
- The final deployment at the Lote 2 (Leixões) site is done by EOLOS with the buoy and mooring system on board the vessel. This marks commencement of the validation campaign.
- All above procedures are subject to the operations RAMS procedure.

4.2. Project Scheduling

4.2.1. Project Schedule and Contingencies Considered

Main activities and dates have been considered while taking into account, suppliers' deadlines, assembly, EOLOS experience and marine operation dates discussed and analysed with the O&M team.

As the validation campaign has already taken place, the scope is focused on the final measurement campaign at the Lote 2 site.

EOLOS submits the following Gantt chart highlighting those relevant milestones and identifying the critical paths impacting the planned schedule.

	Task Name	Duration	Start	Finish
1	**LOTE 2 (LO2)**	**93 days**	**Mon 18/11/24**	**Tue 18/02/25**
2	**FLS200 E10**	**87 days**	**Sun 24/11/24**	**Tue 18/02/25**
3	FLS200 E10 Refurbishment works	40 days	Sun 24/11/24	Thu 02/01/25
4	FLS200 E10 Factory Acceptance Test (FAT)	7 days	Fri 03/01/25	Thu 09/01/25
5	FLS200 E10 ExWorks	0 days	Thu 09/01/25	Thu 09/01/25
6	Contract Suspension	50 days	Tue 03/12/24	Tue 21/01/25
7	FLS200 E10 Road Transport to Aveiro	3 days	Mon 03/02/25	Wed 05/02/25
8	FLS200 E10 Assembly at Aveiro port	5 days	Thu 06/02/25	Mon 10/02/25
9	FLS200 E10 Port Acceptance Test	1 day	Tue 11/02/25	Tue 11/02/25
10	Quayside Test (if required)	7 days	Wed 12/02/25	Tue 18/02/25
11	**Mooring System**	**73 days**	**Mon 18/11/24**	**Wed 29/01/25**
12	Reception of site metocean conditions	0 days	Mon 18/11/24	Mon 18/11/24
13	Reception of site depth	0 days	Mon 02/12/24	Mon 02/12/24
14	Mooring design analysis (1st draft)	8 days	Mon 25/11/24	Mon 02/12/24
15	Bill of material	0 days	Mon 02/12/24	Mon 02/12/24
16	Launch of PO for Clump Weight (CW)	0 days	Mon 16/12/24	Mon 16/12/24
17	Delivery time for CW	40 days	Mon 16/12/24	Fri 24/01/25
18	Launch of PO for Midline Floater (MF)	0 days	Mon 16/12/24	Mon 16/12/24
19	Delivery time for MF	45 days	Mon 16/12/24	Wed 29/01/25
20	Launch of PO for chains	0 days	Tue 07/01/25	Tue 07/01/25
21	Delivery time for chains	14 days	Tue 07/01/25	Mon 20/01/25
22	Buoy Ready for deployment	0 days	Tue 18/02/25	Tue 18/02/25

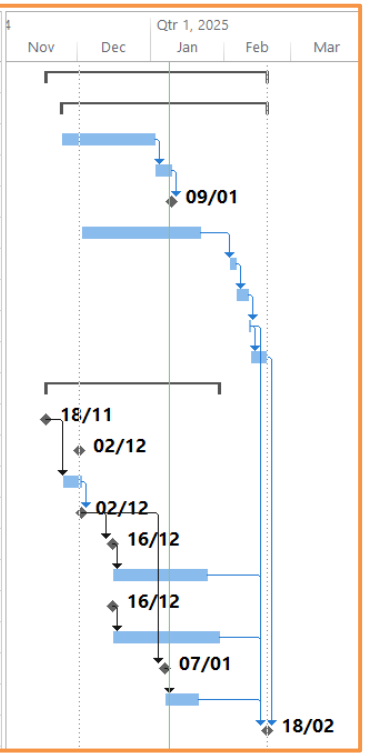

Figure 3: LO2 project schedule.

4.2.2. Risk Mitigation in the Scheduling

There are many risks that must be considered, ranging between low or high impact on the scheduling of the project. When it comes to offshore operations in harsh seas, remote areas and /or new regulations in countries and mapping areas, several factors can affect the above-mentioned timeline.

Risk can be categorized as follows:

1) Environmental risks: Those linked to adverse weather conditions, fisheries and other marine activities in the area.
2) Operational risks: Vessel's unavailability or unsuitability, accidents, deployment challenges.
3) Regulatory risks: Regulatory changes, delays on permitting.
4) Supply chain and logistics: Suppliers shortage, customs.

EOLOS aims to offer one FLS200 by making the equipment available at Aveiro port and ready for deployment by 18th of February 2025 and starting the campaign as soon as reasonably possible shortly after, depending on weather conditions and vessel availability.

The risk mitigation measures put in place to reduce the impact on scheduling are detailed on below table.

Category	Details	Mitigations/Proposals
Environmental Risks	Adverse weather conditions	Regular crosscheck between different forecast models: Windy, StormGeo and/or client specialized forecast.
Environmental Risks	Simultaneous OPS in the area	EOLOS liaise with LNEG to identify potential objections for the FLS200 deployment and engage with local stakeholders.
Operational Risks	Vessel's unavailability or unsuitability	Vessel's identifications is carried out before the contract signs off. If not, EOLOS work with specialized marine contractors with wide experience in floating LiDAR operations. Active and problem-solving mindset is encouraged between EOLOS and the vessel owners to clear any outstanding point that could impact the vessel unsuitability (such as on-site inspections).
Operational Risks	Accidents during deployment (or offshore operations)	EOLOS will send trained personnel in safety protocols and provide protective equipment. Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Operational challenges	Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Safety risks to personnel during offshore operations.	Risk assessment includes and establishes comprehensive safety protocols and risks management. The Emergency Response Plan details the procedure required in any incident.
Operational Risks	Environmental incidents.	EOLOS will ensure compliance with environmental regulations and monitor for potential spills.
Regulatory and Permitting Risks	Delays in obtaining necessary permits for offshore deployment.	EOLOS submit permit applications early and maintain communication with regulatory bodies. If permitting is not within Eolos scope, as is the case in this project, help will be offered to ease the process.
Regulatory and Permitting Risks	Changes in regulatory requirements affecting deployment	EOLOS and clients keep constant communication on the topic to identify actions that could help reduce the impact on regulations.
Logistics and Supply Chain Risks	Customs delays when importing equipment or	Engage multiple suppliers to increase flexibility and expedite customs processes.

	spare parts for deployment.	EOLOS works with multimodal logistics partners with large experience in worldwide shipments.
Supply Chain and Procurement Risks	Shortages of critical components or materials due to global supply chain disruptions.	Stock critical spare parts and maintain agreements with multiple vendors.

Table 4: Schedule risks mitigation measures.

4.2.3. Key Milestones to be considered

There are some key items and milestones to be noticed from the schedule above:

- EOLOS assumes February 3, 2025, as the earliest date on which the transport of the FLS200 E10 to Portugal can commence.
- EOLOS assumes February 11, 2025, as the earliest date on which the Port Acceptance Test could be performed.
- EOLOS assumes February 12, 2025, as the earliest date on which the quayside test on Aveiro port could be performed if requested.
- EOLOS assumes February 18, 2025, as the target date on which the FLS200 E10 could be ready for deployment on the Lote 2 site. The actual deployment date will depend on:
  - Suitable weather window to deploy the FLS200 at the Lote 2 site.
  - Vessel availability for any offshore operations

4.3. Base Port

EOLOS has select a workshop at Aveiro port to conduct pre-operational work, buoy final assembly, and testing. This port will serve as the departure point for offshore operations and as a potential maintenance location if the buoy needs to be brought onshore.

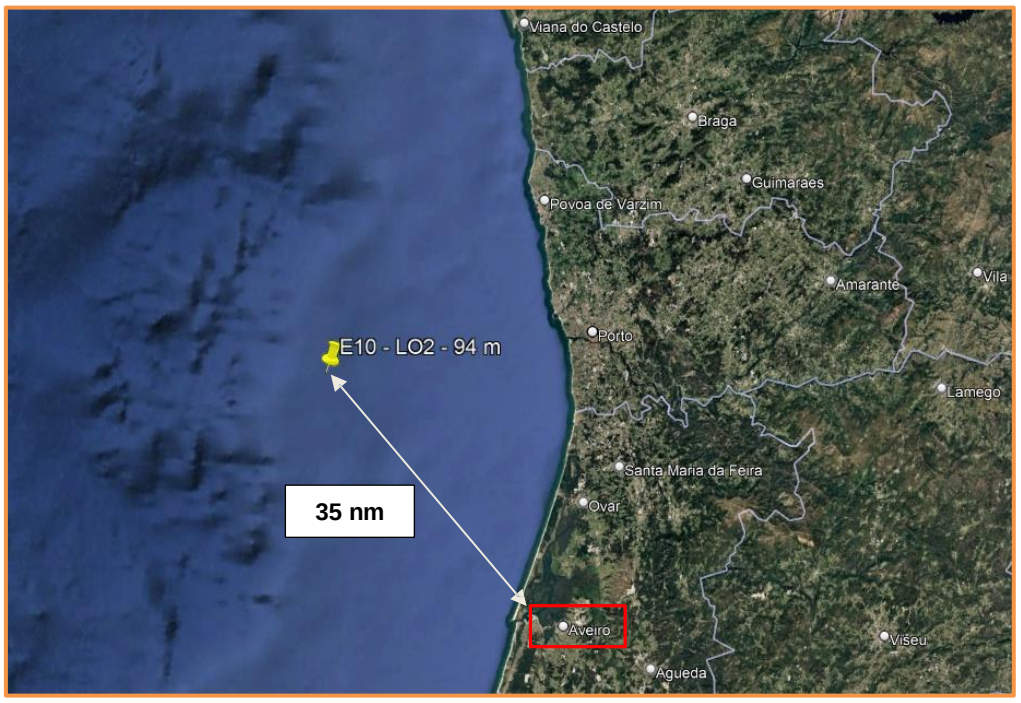

Figure 4: Aveiro location on the map.

It will be the centre of operations for the LO2 project, and all the activity needed to support O&M, including the storage of tools and spare parts.

The workshop location offers enough space to carry out the buoy assembly, disassembly and onshore maintenance. It also has sufficient lifting means to recalibrate sensors, transfer the buoy to/from vessels and trucks and perform various checks on the Port Acceptance Test methodology.

The covered space guarantees safe operations when electronic components must be accessed, modified or replaced.

The Aveiro port is suitable in terms of access to water and availability of tools, facilities and services. Specifications are the following:

- Location: Aveiro Port
- Storage/ assembly area: 200 m2
- Direct access to the water: Yes
- Lifting means available: Reachstaker, cranes and forklifts, capacity from 5 tons and above.

4.4. Project Coordinates

The measurement campaign for the Lote 2 (Leixões) project will take place at the following coordinates:

FLS200 Unit	LAT:	LONG:	Depth (m)
E10	41° 03' 17.613" N	09° 13' 42.809" W	94 m
	41° 03.29355' N	09° 13.71348' W	
	41.054892° N	09.228558° W	

Table 5: Lote 2 (Leixões) site coordinates.

Figure 5: Lote 2 (Leixões) site location on map.

5. Equipment

5.1. FLS200 Buoy

The EOLOS FLS200 unit is defined by two different parts:

1) the buoy itself with all measurement devices, as a generic product
2) the mooring line, which is design specific for each operational location.

The EOLOS FLS200 is described in two main document types, one for the buoy description and one for the mooring as follows:

3) *"As Installed"* [5] document including the technical description/specification of the buoys main equipment and sensors, with certificates of conformity or calibrations of the main measurement systems including Lidar, wave sensor, current profiler, IMU and Vaisala met station. The buoy main body is a generic device usable for different projects and locations.
4) *"Mooring Design Report_LO2 Site" [6]* document, with description of the specific mooring design for the deployment of the FLS200 units at the Lote 2 site.

EOLOS has its own mooring design department, responsible for ensuring survivability of the buoy in the most extreme conditions while keeping the buoy motions within reasonable limits to guarantee the quality of the measured data. Hydrodynamic simulations with the sea conditions are performed to guarantee an optimal design.

Alternatively, EOLOS also works with large, experienced companies such as *London Marine Consultants* (LMC) for mooring designs and BOMs definitions.

The EOLOS FLS200 LiDAR buoy is a fully equipped and autonomous wind, wave and ocean current measuring system based on LIDAR technology with additional meteo-oceanographic instrumentation.

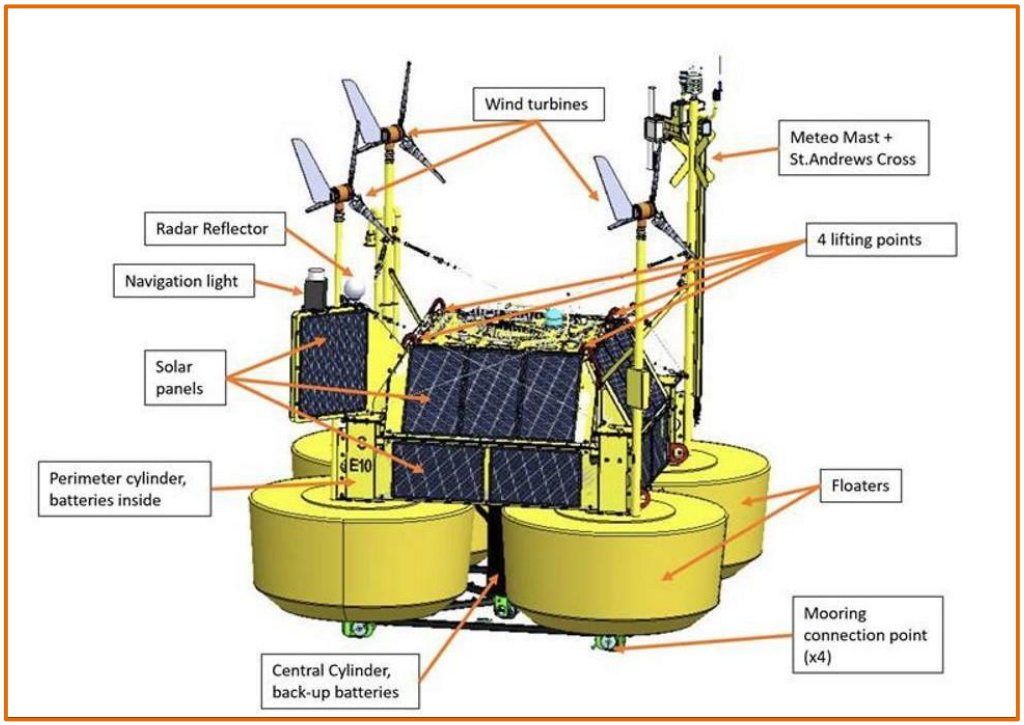

Figure 6: The EOLOS FLS200 LiDAR Buoy

The EOLOS FLS200 power system is fully redundant and autonomous, using three independent sources of charging power, minimizing the risk of a power shortage in any weather circumstance or unforeseen event (such as failure of one of the power systems).

The EOLOS FLS200 buoy has a custom power distribution system with the following components:

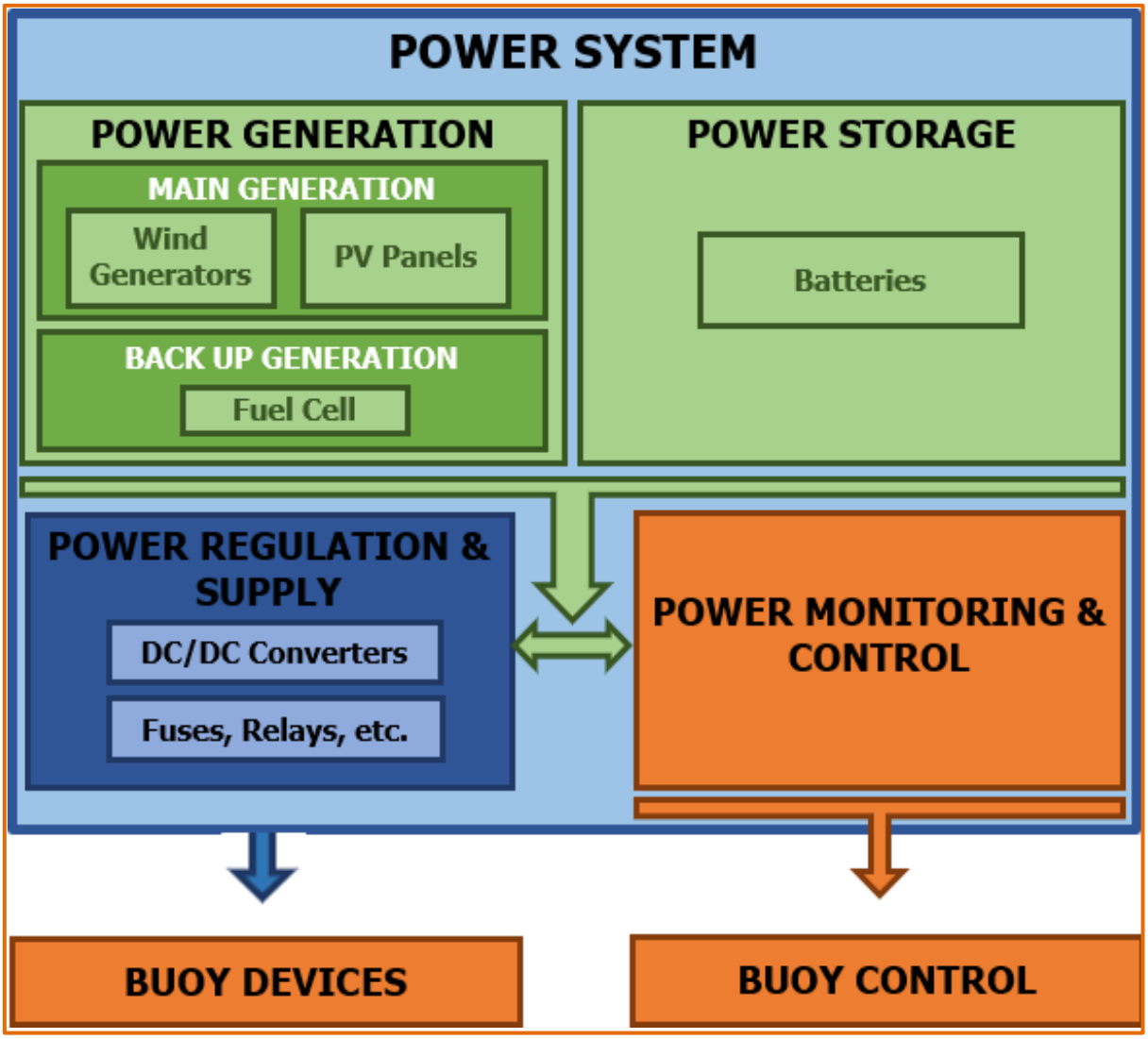

Figure 7: FLS200 energy supply schematic.

The FLS200 buoy is powered by: (i) wind turbine generators on the east, west, and south masts; (ii) 2 solar panel rings around the buoy cabin, with 2 additional panels on the south mast; (iii) batteries that are charged by the generation of (i) and (ii); and (iv) a methanol fuel cell for low-generation scenarios.

The FLS200 has been fitted with: (i) ZX LiDAR ZX300M, (ii) Vaisala meteorological station, (iii) Nortek current profiler Signature 250, (iii) A+D wave sensor, (iv) KVH Compasses, (v) Garmin GPS, and (vi) Li-Cor pyranometer.

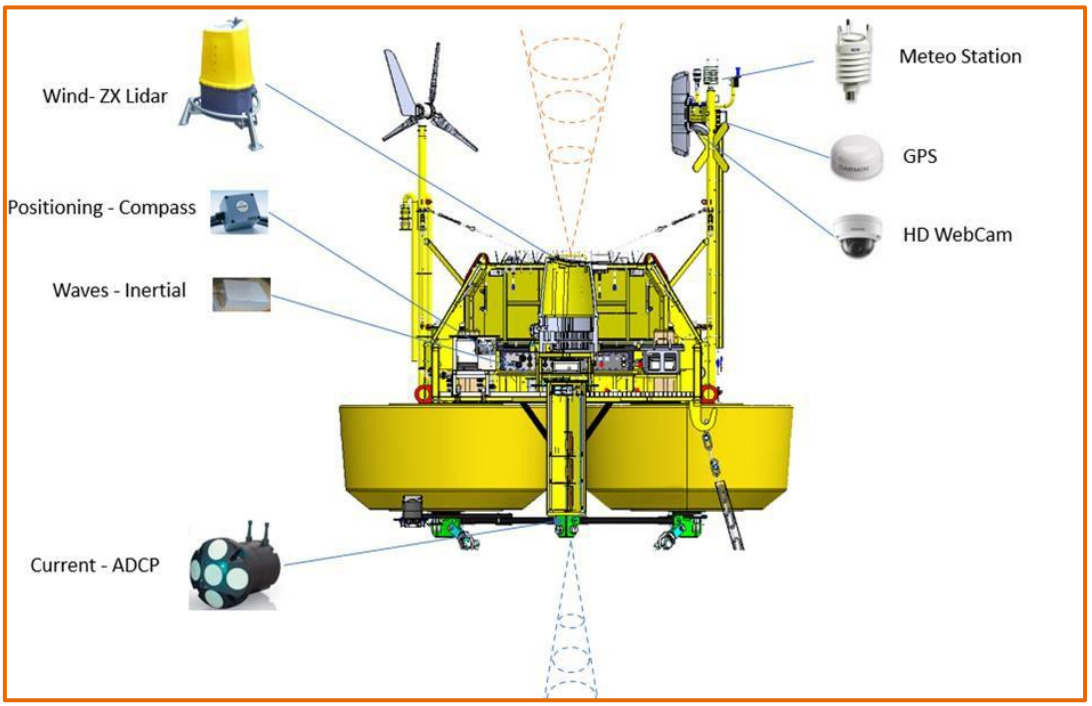

Figure 8: FLS200 E10 main sensors layout.

The measurement configurations of the Lidar device and the ADCP device are to be documented and approved by the Client in the Measurement Plan.

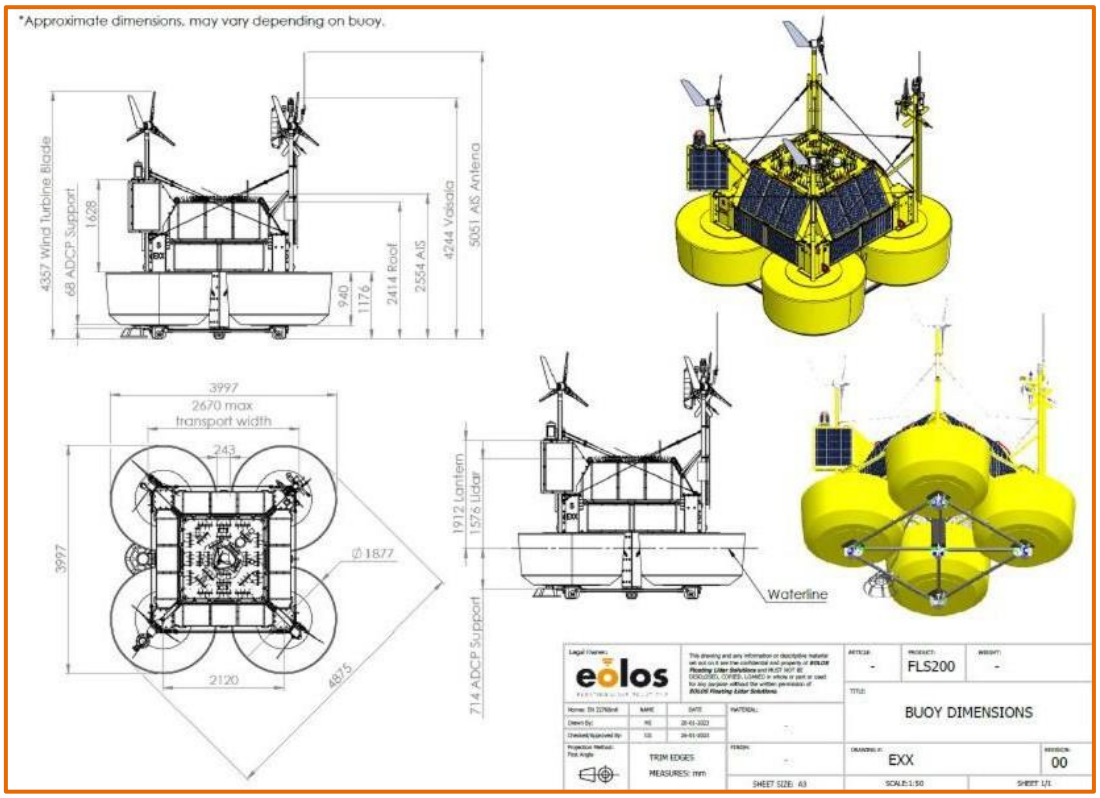

Figure 9: FLS200 technical drawings.

5.1.1. FLS200 buoy mooring

5.1.1.1. Upper mooring (standard)

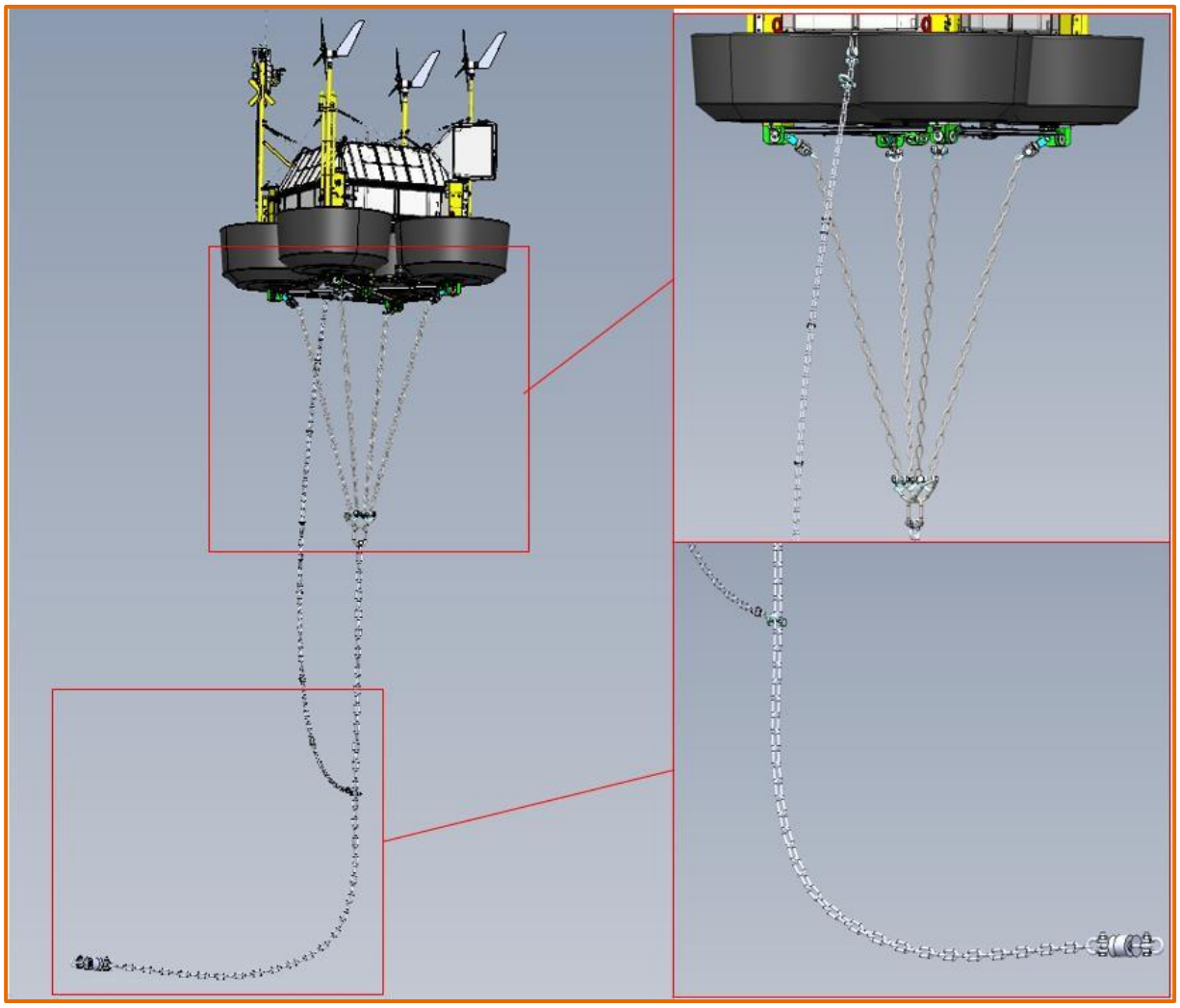

Figure 10: FLS200 upper mooring arrangement.

5.1.1.2. Lower mooring (site specific)

The site-specific mooring system is currently being designed by the EOLOS mooring department and it will be included in this Project Execution Plan once it has been completed. London Marine Contractors (LMC) has been designated as a third-party consultant to review and validate the EOLOS design.

6. Marine operations

Marine operations are critical for the success and development of the project. Proper planning and execution are essential to achieve an early and efficient deployment, minimizing delays, and maximizing data availability throughout the LNEG desired period. These operations include all activities related to transportation, deployment, maintenance, and recovery of the buoy, ensuring that the equipment is correctly positioned, functioning, and maintained to gather reliable data for the project duration.

6.1. Weather window identification

Detailed weather forecasts must be in place prior to all vessel operations. This includes deployment, recovery and offshore maintenances. This forecast report shall have a minimum forecast look ahead of 5 days, and can come from different sources:

- Windy: A weather forecasting tool that provides detailed meteorological information by aggregating data from multiple weather models. For this LO2 project the ECMWF Integrated Forecast System (IFS) will be used. It is a global numerical weather prediction model employing spectral methods for atmospheric dynamics and a semi-Lagrangian scheme for advection. It operates on a hybrid vertical coordinate system and utilizes 4D-Var data assimilation for optimal integration of observational data. The model's resolution typically reaches ~9 km (T1279) for deterministic runs and ~18 km (T639) for ensemble forecasts, with up to 137 vertical levels extending to the mesosphere.
- Storm Geo: Offers site-specific forecasts with reliability indexes that help improve the offshore operations planning. When crosschecked with Windy, it gives Eolos more certainty in harsh seas or during winter months.
- Other site-specific forecasts.

When the project requires and offshore operation, the project manager will inform the O&M lead of the imminent need for a vessel and team. The weather is then monitored by both, PM and O&M, until favourable conditions appear. As a general guide the following limits apply depending on the nature of the operation.

Transit or tow / Offshore lifts

- Max wave height [m]: 1.5 / 1
- Significant wave height[m]: 1.0 / 0.8
- Max wind speed[kn]: 15 / 13
- Max wind gusts [kn]: 19 / 17

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Table 6: Weather Threshold for EOLOS Operations

Surface current speeds are desired to be below 0.8 m/s. Special consideration must be made with respect the RAMS and actions to follow when the buoy is recovered/dropped as current might influence the positioning with respect the vessel.

The Beaufort scale is used to categorize the weather conditions reported in every operation at site which takes as input the wave height, wind speeds and environmental parameters to assign a value from 1 to 10. Any value above 4 is considered beyond the threshold set to safely conduct any operation.

The length of the weather window must match the estimated duration of the marine operation, including the time needed to halt it if necessary. Offshore servicing is critical, as the buoy is typically on deck with the mooring already deployed, making it more time-consuming to redeploy the buoy in the event of an unforeseen incident.

If a favourable weather forecast is available, and the length is appropriate for the task, the following steps apply prior to mobilisation to site:

a) 72 hours RAMS is prepared and sent to the client and the vessel.
b) 48 hours notify port authority of intended operations.
c) 24 hours all materials shall be loaded, inspected and prepared for transit to site.
d) 12 hours decision made to transit to site
e) 0 hours final weather forecast reviewed and go no go decision made.

6.2. Mitigation

EOLOS understands the dynamics and complex nature of offshore weather conditions, and this is expected to play a key role in the development of the project and the operations of deployment, maintenances and recoveries. Thus, EOLOS has an entire department (O&M) that closely monitors the weather through the above-mentioned sources and work side by side with the Project Managers to identify the needs of the project.

The potential drawbacks of sailing and operating under extreme weather conditions far exceed the benefits from taking the risks, and EOLOS operate under a policy of nil incidents and accidents throughout the entire campaign.

If offshore operations are scheduled, such as deployment of the system or preventive maintenances, Dutch Marine Contractors (DMC) is contacted to trigger the search of the vessel. This is done far in advance to locate vessels finishing other contracts to guarantee vessel availability by the time of operations. If weather conditions are not acceptable, but they are forecasted to end soon, EOLOS remains in standby until is safe to sail out.

Conversely, especially when corrective actions on the buoys must be done, EOLOS will is to lower the impact on the project. This is done by a negotiation with the Marine contractor and the vessel owners to ensure the following:

- Availability of slightly bigger vessels with DP and better behaviour to waves.
- Book high skilled and experienced vessels working with floating Lidars.

EOLOS maintenance schedules as seen in the section 6.4 Maintenance and Operational Methodology aim to foresee well in advance the upcoming operation, allowing the operational team to organise the logistics to have all material ready to service the buoys at any time. The goal is to service the buoys when weather is expected to be mild and reduce the offshore operations during winter months.

The Vessel Master will have the right and responsibility to make the final decision on whether the operation can be safely conducted based on his/her knowledge of the vessel capabilities and, his/her marine experience.

Figure 11: EOLOS FLS200 onboard a multicat.

6.3. Offshore operations strategy

The measurement campaign will last 12 months, and it typically includes the deployment, recovery and scheduled services at 6 months intervals. For this campaign, the tentative schedule would be:

- Deployment
- 6 months scheduled service
- Recovery

Marine operations will described in detail in the documents:

- RAMS for campaign deployment.
- RAMS for campaign recovery
- RAMS for maintenance

Each of these documents includes the different considerations, technical aspects, resources, and tools to execute the different operations and including risks already identified, its avoidance and mitigation.

When marine operations take place, EOLOS will report its outcome in the following documents:

- Deployment report
- Recovery report
- Maintenance report
- Daily Progress Report

6.4. Maintenance and Operational Methodology

Every works on the buoys is described in the operational plan developed by O&M department and specifically designed following the flow diagram presented in this section.

EOLOS reserves the right to move back and forth maintenance activities to optimize its operations, always under the premise to comply with HSE requirements and keep data availability to a maximum value.

The buoys are daily monitored by the data team and reference engineers, who notify everyone related to the project when there is anomalous behaviour or warnings raised by the system itself. EOLOS diligently plans unscheduled operations to fix whichever alarm must be mitigated. More details on monitoring can be found in the following sections.

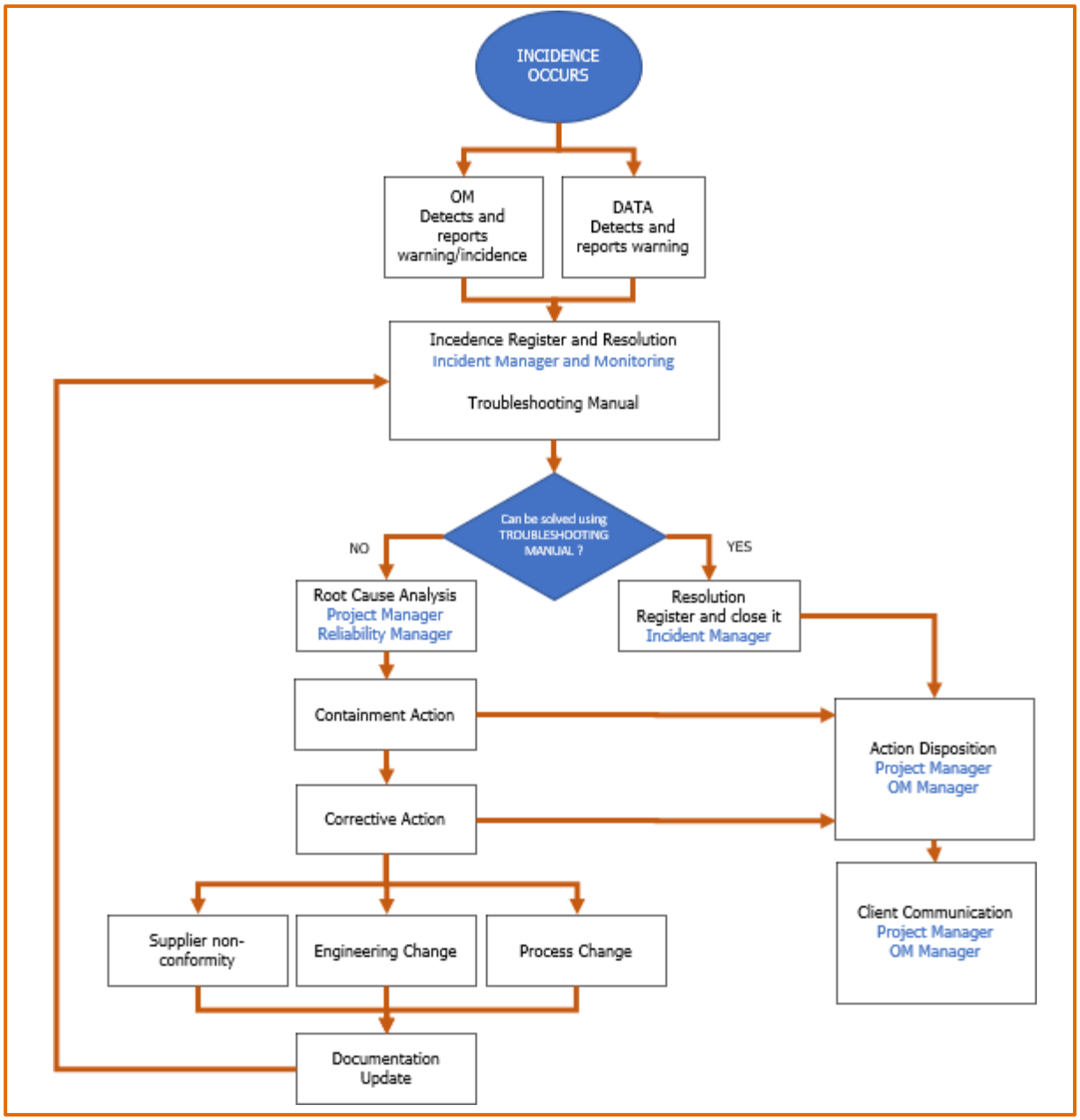

Figure 12: O&M flowchart.

6.5. EOLOS Operational Centre

EOLOS will work from its base port located at Aveiro to optimize the operations during the campaign.

Figure 13: EOLOS FLS200 buoy at port

6.6. Vessel for Marine Operations

EOLOS will ensure to hire local vessels (if available) through its marine contractor, Dutch Marine Contractors (DMC). A reduced number of multipurpose vessels can be used by EOLOS as part of the regular operation of deployment, recovery, and maintenance, with these being mainly Multicat vessel and Tugs fitted with offshore cranes, however, also crane barges and some offshore supply vessels could be used.

In order to provide evidence that the vessel status and capabilities fall within acceptable parameters of conformity, EOLOS stablishes a set of minimum requirements with respect vessel documentation listed below:

- CMID OVID, or equivalent inspection such as EOLOS suitability assessment.
- Hull and Machinery insurance.
- Protection and indemnity insurance.
- Crane specifications thorough examination - SWL testing.
- Safety management system (according to ISM or local flag).
- Safe manning document.

- Crew certification and list crane operator included:
  - SCTW.
  - Bosiet.
  - OWC.
- Ship registry certificate.
- Class certificate.
- Crew rest of hours.
- Vessel workboat certificate.
- Vessels contact details: mail, phone, SAT phone.

The minimum vessel capabilities are defined by EOLOS and transmitted to DMC to seek vessels for every operation. Considering the buoy characteristics, the vessel must have, as a minimum:

- Open deck (stern /bow)
- Crane capable of lifting >7 mT over the open deck
- Winch capable with a pull force >10 t
- Deck area > 50 m^2

Figure 14: Portuguese based tug vessel Castelo de Óbidos (Rebonave).

Figure 15: Spanish based multicat vessel Fenix Vigo (Northcom Diving).

7. Measurement campaign, data management, monitoring and data provision chain

The main goal of the project is to provide LNEG with a 1-year long metocean bankable data. Data measurements, management, processing and delivery are the most important aspect of the Lote 2 project.

7.1. Data acquisition

The measurements campaign will last 12 months, and data will be measured by deploying an FLS200.

The Measurement Plan is the standard EOLOS document that describes data conventions, sensors configurations, data files formats and data deliverables across the entire campaign.

The sensors that will be installed in the LO2 buoy are:

Sensor	Brand	Location
Lidar	ZX	FLS200
ADCP	Nortek	FLS200
Wave sensor	A+D	FLS200
Meteorological station	Vaisala	FLS200
Pyranometer	LiCor	FLS200

Table 7: Measurement sensors installed on the FLS200.

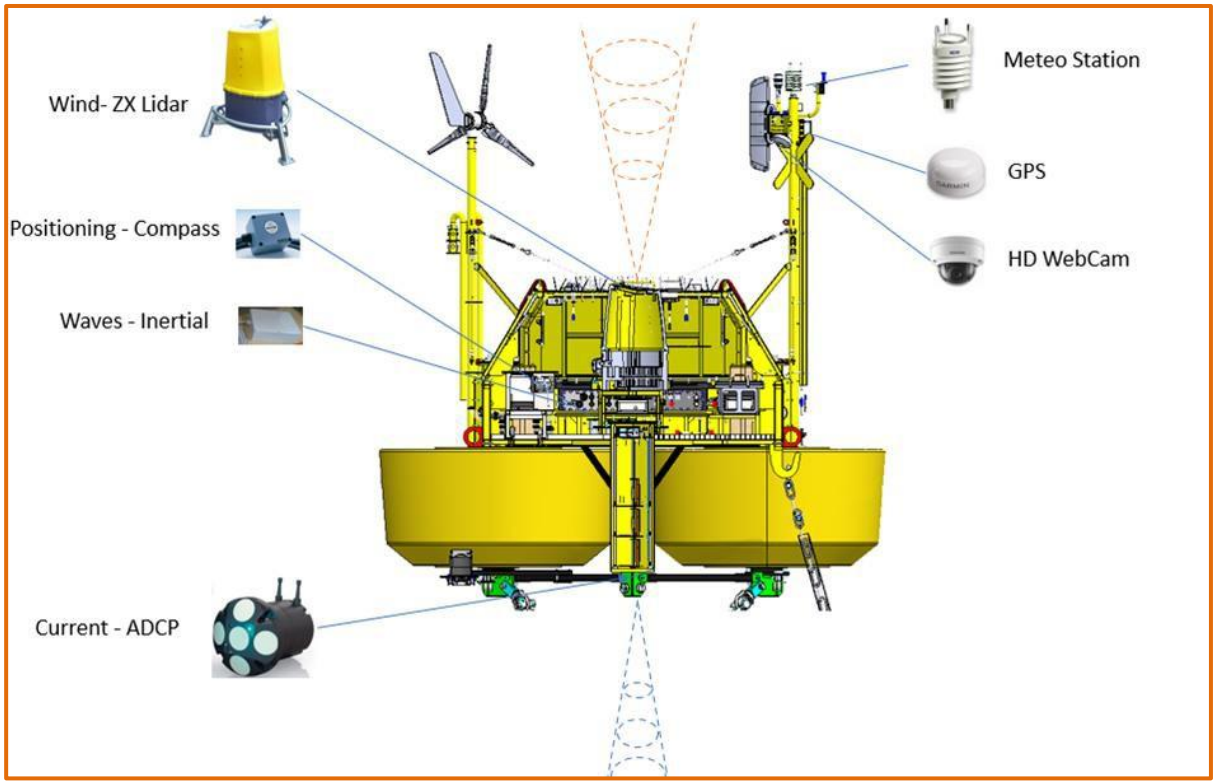

Figure 16: FLS200 main sensors layout.

Each sensor measures at regular intervals and frequency as described in the Measurement Plan, and can be subdivided into two sections:

- Data accessible remotely: These data are the average 10-min or 30-min files which are sent to EOLOS servers and are used for monitoring and updating data portals. Data sets are updated daily (every 48 h).
- Data stored within the system/sensors: These data include average and high frequency data. Datasets will usually be downloaded at regular intervals (scheduled maintenances) or at the end of the campaign, after the buoy recovery.

Data stored within the sensors (Lidar, wave and ADCP) also works as a backup copy that is recovered after accessing physically to the buoy.

The measurement principles of all the sensors mounted on the buoy EOLOS FLS200 are explained in more detail in the complementary document EOL-DOC93-V04-PROD-Sensors measurement principles and specifications [7].

7.2. Monitoring

The FLS200 system is composed of different subsystems, each with its own function and monitoring capability. Some subsystems may be designed to be monitored remotely onshore, with status messages or similar being sent via the internet.

These same subsystems may or may not be for measurement, i.e., producing quantitative observations to meet the project objectives. Malfunctions or outages detected in measurement subsystems will always cause an incident notification toward LNEG because they affect the data. Malfunctions or outages detected in non-measurement subsystems will not generate an incident notification toward LNEG if: (a) there is no effect on the data; and (b) there is a design redundancy still available.

Below table displays the subsystems and how monitoring works:

	Monitored remotely	**Not monitored remotely**
Measurement systems	Lidar ADCP Wave Meteorological station GPS Pyranometer	
Non-measurement systems	Communications: Neptulink (4G) Communications: Iridium Energy: Wind generators Energy: Solar panels Energy: Battery racks Energy: Fuel cell Dataloggers	AIS Lantern Corrosion protection Mooring TRBM structure

All those subsystems that are not monitored remotely are going to be accessed physically at the interval given in the O&M operations schedule. If data can be retrieved, it will be shared with LNEG.

There are various scenarios which may cause the buoy to travel outside of its drift radius (buoy adrift), most commonly due to mooring failure.

Any instance of buoy adrift sends an alarm to EOLOS Project Manager, Operations & Maintenance Manager, and Operations Director via the Smartone system. The alarm is repeated every hour while the buoy remains outside its programmed drift radius.

The section below shows how the FLS200 communicates with EOLOS HQ

7.3. Data management

The data flow at EOLOS follows the pattern as shown below:

Figure 17:

Data is measured by sensors deployed offshore by different devices. The sensors gather data in a raw format that is delivered to the FLS200 control units, the dataloggers. Data is then merged, packed and sent to EOLOS on-land servers by different telemetry system. If the buoy is closer to shore, 3G/4G communication is used, otherwise, the Iridium satellite antennas are used. Eolos has redundancy communications systems to avoid interruptions in data transmission. The following image shows which data can be recovered using several communications channels.

		Master	Slave	Lidar	Wave	ADCP
Telemetry	3G					
	Iridium					
In situ data recovery	Wi-Fi / cable					
	Internal memory					

Figure 18: FLS200 communication channels.

Once on land, the post processing is applied, which includes filtering to ensure data quality. Some of the filters are included in the sensors themselves, while others are implemented by EOLOS. Additionally, the Lidar measurements are corrected for tidal variation and the magnetic declination corrected to reference all measurements to true north.

More details on filtering and post processing can be found at EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan [8].

7.4. Data reporting and deliverables

Data will be delivered for the LO2 project at different intervals and in standard text format .dat, with the following names:

- *EOLOS_START-DATE_START-HOUR_END-DATE_END-HOUR_hour.dat*

If preferred by LNEG the data files can also be provided in .csv format.

7.4.1. Daily data reporting

Data will be automatically uploaded to Eolos connect portal.

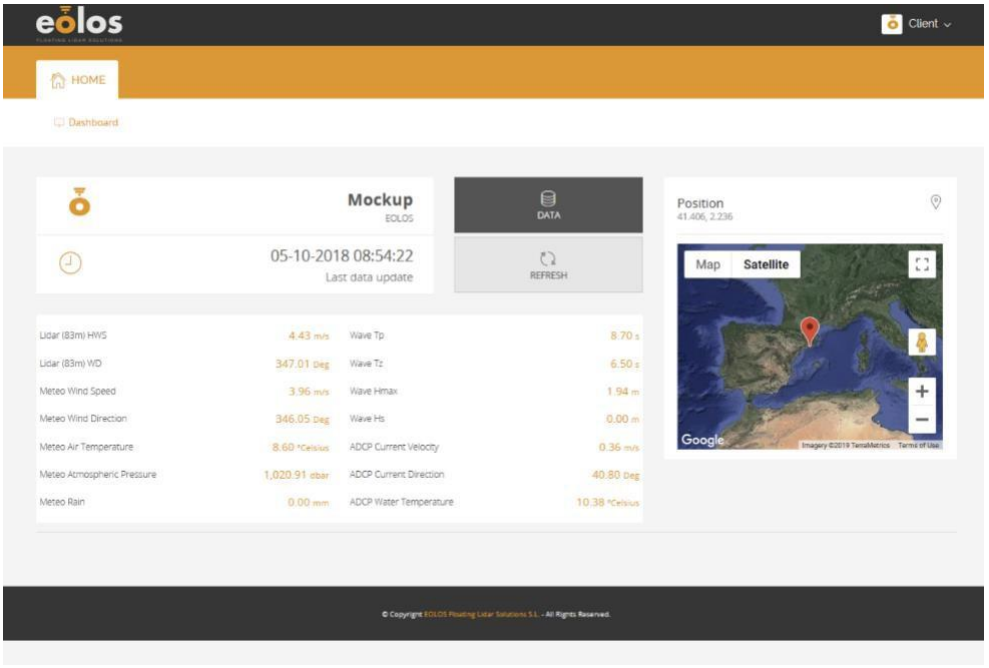

Figure 19: EOLOS Connect portal overview.

EOLOS Connect is a visualization portal only and no data can be downloaded.

The data files will be uploaded to the BOX (EOLOS cloud server) shared folder with LNEG:

01.PROJECT.DATA\EOL-LO2-PROJECT.DATA\E10\DAILY DATA

7.4.2. Monthly Reports

Monthly datasets will be uploaded to the BOX shared folder with LNEG:

01.PROJECT.DATA\EOL-LO2-PROJECT.DATA\E10\MONTHLY DATA

And monthly reports will be uploaded to the following BOX shared folder:

02.PROJECT.MANAGEMENT\E10-LO2\Monthly Report

7.4.3. End of campaign

Summary Report and datasets will be uploaded to BOX, following the same fashion as described in previous sections.

8. Project Document Control

Document control for the LO2 project will be the responsibility of the project manager, who will follow up across the entire project.

The documents are identified as IFI (Issued for information), IFA (Issued for Acceptance) or IFR (Issued for Review), and will be named with the following structure.

EOL [PROJECT NAME] [VERSION] OPS- [NAME OF THE DOCUMENT]

- Version 00 for internal use only, 01 and above for external communications.
- First page including Author and Revised by person.
- First page including version control.
- First page including date.
- First page including title and pages.

The Project Manager is the owner and responsible to create, archive, review and maintain the folder and its documents. Documents will be created by the core team and the support team depending on the technical/area of discipline and the PM will be communicated for the review and classification process.

8.1. Document deliverables

Documents are to be provided according to EOL-LO205-V01-OPS-Document Deliverables Plan [9].

9. Risk Management Environment, Safety & Health / Emergency Situations

The HSE plan needs to be placed to guarantee safety management on site during all operations. HSE detailed plan for the LO2 project is described in detail in:

1) EOL-LO206-V01-OPS-HSE Plan [12].

A detailed procedure to follow in case of potential emergency situations including all project emergency contacts and emergency considerations included in:

2) EOL-LO206-V01-OPS-Emergency Response Plan [13].

For all offshore operations, the following documents need to be fully read, understood, and agreed by main personnel on board of the operations vessel:

3) RAMS for FLS200 Operations.

9.1. INCIDENT AND EMERGENCY REPORTING

9.1.1. Buoy incidences

In case of technical malfunction incidents, LNEG will be informed by EOLOS at the Project Management level within the following due dates:

Action	Due Date	Deliverable
Verbal communication	Within 48 hours of alarm	Email
Indent notification report	Within 72 hours of alarm	Incident notification
Unscheduled visit after incident notification	Within 15 calendar days of notification (weather dependant).	RAMS ERP
Maintenance report after unscheduled visit	Within 15 calendar days of unscheduled visit.	Maintenance report

Table 8: Notification due dates for technical malfunctions

Technical incidents will be notified only:

1) If the incidence triggers maintenance.
2) If the incidence represents a danger to navigation.
3) If the incident affects communication/ dataflow.

9.1.2. Accidents

Emergency situations or accidents at or near the Lote 2 deployment location impacting people (LNEG, EOLOS, third party) or environment will be reported to LNEG at the Project Management level immediately.

The first and most important action after an incident will be securing safety of personnel. Immediately after LNEG and EOLOS will then initiate respective emergency response plans.

More details on the flow of information and procedures can be found at the Emergency Response Plan (ERP) and Health and Safety pan (HSE).

10. Project Quality

10.1. The FLS200 Buoy

Quality documentation related to the buoy and its hardware can be found in the following standalone documents:

- Factory Acceptance Test (FAT) Report
- Port Acceptance Test (PAT) Report
- Site Acceptance Test (SAT) Report

These are issued by EOLOS toward LNEG on a for Information basis (IFI).

EOLOS' priority is to deliver industry-credible data to the Client. To meet this objective, data management and delivery operates with two core documents:

- EOL-DOC114 Data Quality Control Procedures, which describes how EOLOS – independently, or based on instrument OEM know-how – assesses a data observation as valid or invalid (i.e., flagged).
- The Project-specific Measurement Plan, which details the specific measurement parameters customized to suit the relevant Client contract or Client needs.

10.2. Subcontracted Services

Marine operations are one of the most critical activities carried out by EOLOS in order to execute the measurement campaign. Therefore, in line with the EOLOS purchases procedure and the EOLOS standard Scope of Work for marine contractors, the minimum requirements for any work vessel contracted by EOLOS are:

a) CMID
b) Crane working diagram
c) Certificate of registry
d) Certificate of classification
e) Certificates of insurance
f) Evidence of insurance
g) Attestation of Cargo Gear Survey
h) Crew Certification (GWO, BOSIET, or STCW) – 4 modules (firefighting, sea survival, first aid, manual handling)
i) LOLER certification of lifting elements or crane through examination

11. Permits

11.1. Permit for deployment at site

LNEG is responsible for the process to acquire the permit (*Título de Utilizaçao Privativa do Espaço Marítimo* – TUPEM) to deploy the assets on site for the duration of the measurement campaign.

11.2. Navigational Aids Permit

EOLOS is responsible to acquire the AIS licence for the AtoN devices mounted on the buoy and will process it with the corresponding authorities.

12. Payment calculations

According to the Contract D26805 the following milestones should be paid:

Milestone	Description	Payment calculation
Project Execution Plan	EOLOS delivers to LNEG the Project Execution Plan within 20 days after the contract signature.	374,500.0 €
Deployment Report	After the successful deployment of the FLS200 E10 at the LO2 site, EOLOS provides LNEG with the Deployment Report.	74,900.0 €
Monthly Reports 1-12	Monthly invoices upon receiving the monthly datasets and associated report.	42,800.0 €/month
Recovery and final report	Upon completion of the data measurements campaign and issuing the final data report.	107,000.0 €

Figure 20: Contractual project invoiceable milestones.

Payment calculation for the monthly reports will be issued along with the monthly reports and the data sets after two weeks of the current month.

The following payment calculation will be used to determine the monthly rate to be paid upon reception of the monthly data sets and reports, based on the LiDAR wind speed and direction post-processed data availability at 140 meters (or another agreed reference height, which will be included in the Measurement Plan):

Wind Speed and Direction post-processed data availability at 140m	Payment (% of the monthly fee)
>85%	100% * Monthly fee

<85%	$$Penalties = Monthly\ fee * \left(\frac{Penalty * Unavailable\ time\ stamps}{Reference\ time\ stamps}\right)$$ Being • Penalty: 5% • Unavailable timestamps: In a period of 12 months, the number of time stamps not registered assuming as a reference one year of data recorded in a 10-min interval. • Reference time stamps: number of time stamps in a 30 day month, assuming in this case the value 4320.

References

[1] EOL-LO202-V01-OPS-FAT PAT SAT Examples.

[2] OWA Roadmap for the Commercial Acceptance of Floating LiDAR Technology (2018).

[3] IEC 50.4.

[4] 3rd party assessment of Stage-3 maturity achievements of the EOLOS FLS-200 Floating LiDAR Buoy according to the “Carbon Trust Offshore Wind Accelerator Roadmap for the Commercial Acceptance of Floating Lidar Technology”, MV-3005-PV1-065-TN-001-C.

[5] EOL-LO203-V01-OPS-As Installed.

[6] EOL-LO204-V01-OPS- Mooring Design Report_LO2 Site.

[7] EOL-DOC93-V04-PROD-Sensors measurement principles and specifications.

[8] EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan.

[9] EOL-LO205-V01-OPS-Document Deliverables Plan.

[10] EOL-LO206-V01-OPS-HSE Plan.

[11] EOL-LO206-V01-OPS-Emergency Response Plan.

EOL-LO301-V01-OPS

PROJECT EXECUTION PLAN
LOTE 3
FIGUEIRA DA FOZ

PREPARED		**REVISED**		**APPPROVED**	
By	**Ignasi Andreu**	By	**Oriol Costillas**	By	**Felix Urrea**
Date	16/12/2024	Date	16/12/2024	Date	16/12/2024

VERSIONS		
Version	**Modification causes**	**Date**
01	**Document Creation**	16/12/2024

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Figures

Tables

Acronyms/Abbreviations

PEP	*Project Execution Plan*
IPT	*Integrated Project Team*
FAT	*Factory Acceptance Test*
PAT	*Port Acceptance Test*
SAT	*Site Acceptance Test*
HAZID	*Hazard Identification*
HIRA	*Hazard Identification and Risk Assessment*
BOM	*Bill of Materials*
OWA	*Offshore Wind Accelerator*
RAMS	*Risk Assessment and Method Statement*
LNEG	*Laboratório Nacional de Energia e Geologia, I.P.*

1. Introduction

1.1. Overview

EOLOS Floating Lidar Solutions has been awarded Contract D26805 by the Laboratório Nacional de Energia e Geologia, I.P. (LNEG) to carry out a 1-year wind resource assessment campaign from Q1 2025 to Q1 2026. The wind resource assessment will be done primarily with the deployment of an EOLOS FLS200 metocean buoy (with serial number E15) off the coast of Figueira da Foz, Portugal.

Figure 1: Lote 3 (Figueira da Foz) site location on map.

1.2. Purpose

This Project Execution Plan (PEP) defines a proposal for the **Lote 3 (LO3)** project and describes planning, assumptions, constraints, roles, responsibilities, authorities, management interactions and interfaces necessary to successfully execute the project in a safe and efficient manner.

2. Mission & Objectives

2.1. Mission Specifications

The mission of EOLOS defined in this Project Execution Plan is to provide LNEG with 1 year of bankable meteorological, met ocean and environmental data through the deployment of the EOLOS FLS200 E15.

2.2. Project Objectives

- Provision of a validated metocean buoy for the whole duration of the campaign, delivering the highest practicable post-processed wind data availability.
- Maximise the quality data availability of all the relevant sensors included in the offer.
- Minimize environmental impact in the deployment area.
- Ensure that environmental, safety, health and security requirements are fully considered and appropriately implemented in project execution.

3. Organization & Responsibilities

3.1. EOLOS Representatives

NAME	POSITION	BACKUP
Felix Urrea	Director of Operations	Gastao Moura
Ignasi Andreu	Project Manager	Mike Serquina
Adrià Miquel	Chief Data Scientist	Giacomo Rapisardi
Lluís Raurich	Engineering Director	Raúl Rodríguez
Gastao Moura	O&M & HSE Manager	Jorge Garcia
Julian Harland	Contract Manager	Rajai Aghabi
Xisca Ferrer	Fleet Engineering	Lluís Raurich
Jose Miguel Garro	Data Scientist	Sandra Coll
Raimon Targa	Project Reporting	Marc Borrell
Daniel Sanchez	Reliability Manager	Mario Berral
Juan Delgado	CFO	Rajai Aghabi

Table 1: EOLOS Personnel for the Project

3.2. CLIENT Representatives

Name	Position	Email
Ana Estanqueiro	Senior Researcher	ana.estanqueiro@lneg.pt
Teresa Simoes	Wind Resource Assessment	teresa.simoes@lneg.pt

Table 2: LNEG Personnel for the Project

3.3. EOLOS Project Team

EOLOS will be organised as follows to fulfil all aspects of the **LO3** project:

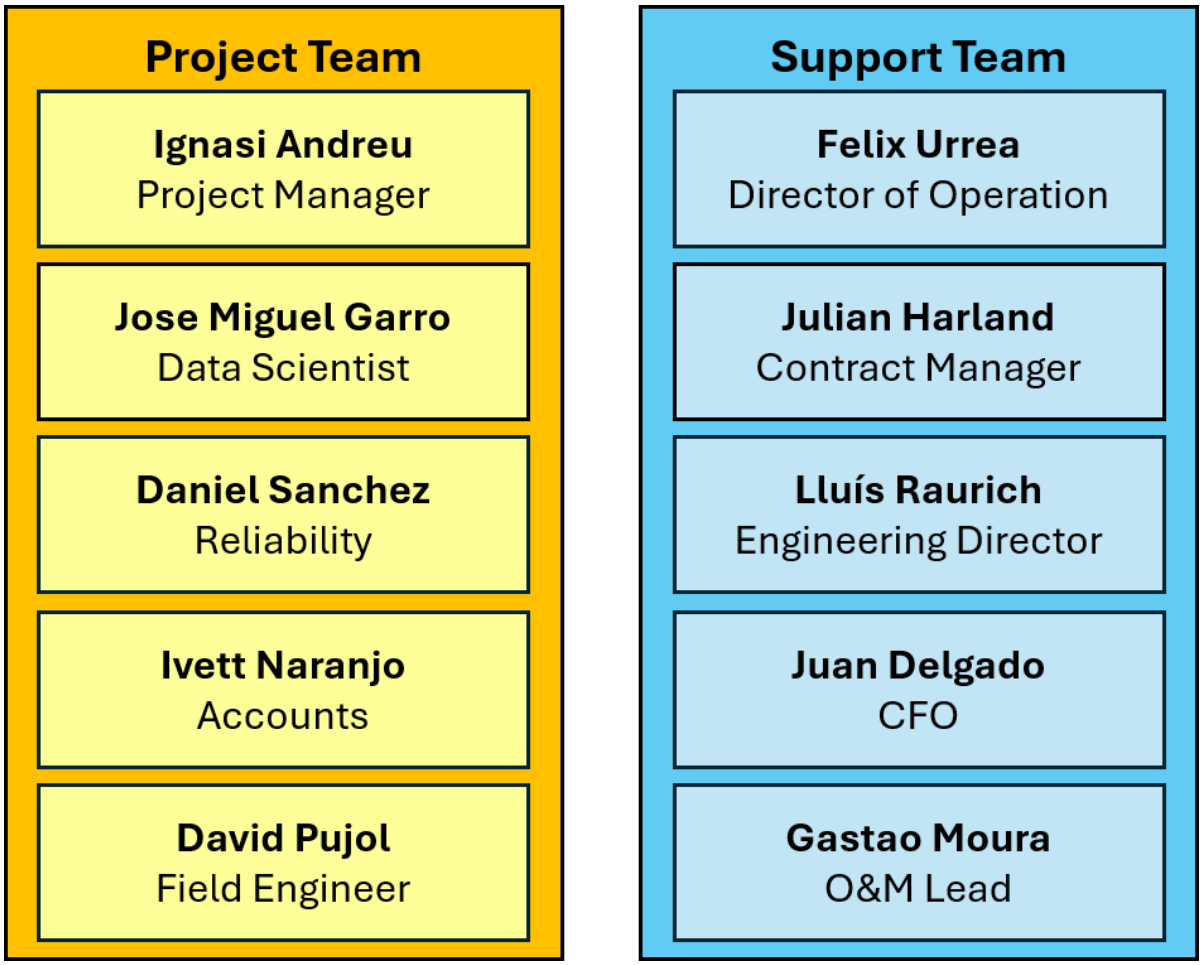

Figure 2: EOLOS Company Organisational Scheme

3.4. Project Interfaces

During the duration of the project, EOLOS must contact different stakeholder in order to successfully perform the object of the contract. The involved parties will be:

Stakeholder	Role	Managed by
Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM)	To grant the permits to deploy the FLS200 E15 at the Lote 3 site.	LNEG
Autoridade Marítima Nacional (AMN) - Coastguards	Supervise and coordinate the activities related to maritime safety, marine environmental protection and maritime rescue	LNEG and EOLOS, as applicable.

Aveiro port	Provide the facilities and lifting equipment required to assemble the FLS200, as well as the quayside where the vessel used for the marine operation will berth.	EOLOS
London Marine Consultants (LMC)	Provide an independent assessment and validation on the mooring design designed by EOLOS.	EOLOS
Dutch Marine Contractors (DMC)	Search and hire suitable vessels for the marine operations.	EOLOS
Wilhelmsen Port Services	Provide all the logistics for vessel entry at port, and contact point between Aveiro port authority and EOLOS.	EOLOS

Table 3: Project stakeholders

4. Project Description

4.1. Overall Project Description

The project goal is to perform a 1-year measurement campaign for the designated project coordinates with no declared extension. The unit FLS200 E15 will be tasked with acquiring accurate wind, metocean and environmental data for a period spanning 12 months.

EOLOS will conduct an internal testing and system verification, constituting a Factory Acceptance Test (FAT) for the unit assigned to the project, after its refurbishment at EOLOS premises located in Barcelona, Spain. The FAT comprises a comprehensive series of tests encompassing all sensors and configuration systems integral to its suitability and performance.

These tests include assessment of sensors, power units, control units, communications, navigational, and security systems. Rigorous mechanical inspections and verifications, coupled with thorough electrical and electronic assessments, form integral components of these tests.

A sample of this Factory Acceptance Test (FAT) can be found in the document: EOL-LO3O2-V01-OPS-FAT PAT SAT Examples [1], which also encompasses the Factory Acceptance Test (FAT), Port Acceptance Test (PAT) and Site Acceptance Test (SAT).

The technical phases of the project as seen from EOLOS' side:

- The EOLOS FLS200 E15 buoy has been allocated as the measurement system. Refurbishment and ex-works schedule are described in section 4.2.1 of the current PEP document.
- After the allocate unit is successfully tested in the EOLOS workshop, including the met ocean and environmental sensors in the buoy, the unit will be partially disassembled and packed for transportation to the assembly port in Aveiro.
- The buoy will then be completely assembled, and a Port Acceptance Test will be conducted at Aveiro port.
- If requested by LNEG, a quayside test in line with applicable guidelines like OWA/CT FLS Roadmap [2] and IEA RP18 [3] recommendations could be performed together with the other allocated FLS200 for the Lote 1, 3 and 4 projects, and a shore based LiDAR unit. The approximate duration of this sanity check is 1 week.
- Once the weather conditions and vessels are confirmed, buoys and materials are loaded onto the vessel in preparation for the deployment.
- The final deployment at the Lote 3 (Figueira da Foz) site is done by EOLOS with the buoy and mooring system on board the vessel. This marks commencement of the validation campaign.
- All above procedures are subject to the operations RAMS procedure.

4.2. Project Scheduling

4.2.1. Project Schedule and Contingencies Considered

Main activities and dates have been considered while taking into account, suppliers' deadlines, assembly, EOLOS experience and marine operation dates discussed and analysed with the O&M team.

As the validation campaign has already taken place, the scope is focused on the final measurement campaign at the Lote 3 site.

EOLOS submits the following Gantt chart highlighting those relevant milestones and identifying the critical paths impacting the planned schedule.

	Task Name	Duration	Start	Finish
1	**LOTE 3 (LO3)**	**93 days**	**Mon 18/11/24**	**Tue 18/02/25**
2	**FLS200 E15**	**87 days**	**Sun 24/11/24**	**Tue 18/02/25**
3	FLS200 E15 Refurbishment works	40 days	Sun 24/11/24	Thu 02/01/25
4	FLS200 E15 Factory Acceptance Test (FAT)	7 days	Fri 03/01/25	Thu 09/01/25
5	FLS200 E15 ExWorks	0 days	Thu 09/01/25	Thu 09/01/25
6	Contract Suspension	50 days	Tue 03/12/24	Tue 21/01/25
7	FLS200 E15 Road Transport to Aveiro	3 days	Mon 03/02/25	Wed 05/02/25
8	FLS200 E15 Assembly at Aveiro port	5 days	Thu 06/02/25	Mon 10/02/25
9	FLS200 E15 Port Acceptance Test	1 day	Tue 11/02/25	Tue 11/02/25
10	Quayside Test (if required)	7 days	Wed 12/02/25	Tue 18/02/25
11	**Mooring System**	**73 days**	**Mon 18/11/24**	**Wed 29/01/25**
12	Reception of site metocean conditions	0 days	Mon 18/11/24	Mon 18/11/24
13	Reception of site depth	0 days	Mon 02/12/24	Mon 02/12/24
14	Mooring design analysis (1st draft)	8 days	Mon 25/11/24	Mon 02/12/24
15	Bill of material	0 days	Mon 02/12/24	Mon 02/12/24
16	Launch of PO for Clump Weight (CW)	0 days	Mon 16/12/24	Mon 16/12/24
17	Delivery time for CW	40 days	Mon 16/12/24	Fri 24/01/25
18	Launch of PO for Midline Floater (MF)	0 days	Mon 16/12/24	Mon 16/12/24
19	Delivery time for MF	45 days	Mon 16/12/24	Wed 29/01/25
20	Launch of PO for chains	0 days	Tue 07/01/25	Tue 07/01/25
21	Delivery time for chains	14 days	Tue 07/01/25	Mon 20/01/25
22	Buoy Ready for deployment	0 days	Tue 18/02/25	Tue 18/02/25

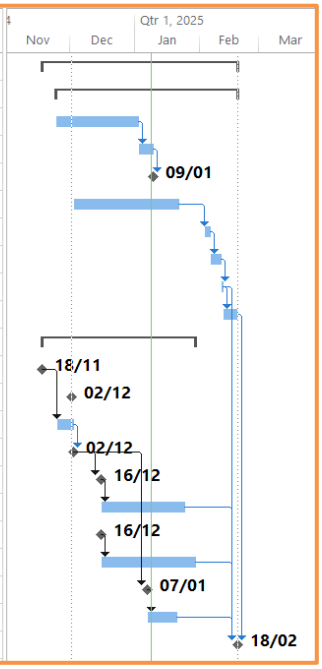

Figure 3: LO3 project schedule.

4.2.2. Risk Mitigation in the Scheduling

There are many risks that must be considered, ranging between low or high impact on the scheduling of the project. When it comes to offshore operations in harsh seas, remote areas and /or new regulations in countries and mapping areas, several factors can affect the above-mentioned timeline.

Risk can be categorized as follows:

1) Environmental risks: Those linked to adverse weather conditions, fisheries and other marine activities in the area.
2) Operational risks: Vessel's unavailability or unsuitability, accidents, deployment challenges.
3) Regulatory risks: Regulatory changes, delays on permitting.
4) Supply chain and logistics: Suppliers shortage, customs.

EOLOS aims to offer one FLS200 by making the equipment available at Aveiro port and ready for deployment by 18th of February 2025 and starting the campaign as soon as reasonably possible shortly after, depending on weather conditions and vessel availability.

The risk mitigation measures put in place to reduce the impact on scheduling are detailed on below table.

Category	Details	Mitigations/Proposals
Environmental Risks	Adverse weather conditions	Regular crosscheck between different forecast models: Windy, StormGeo and/or client specialized forecast.
Environmental Risks	Simultaneous OPS in the area	EOLOS liaise with LNEG to identify potential objections for the FLS200 deployment and engage with local stakeholders.
Operational Risks	Vessel's unavailability or unsuitability	Vessel's identifications is carried out before the contract signs off. If not, EOLOS work with specialized marine contractors with wide experience in floating LiDAR operations. Active and problem-solving mindset is encouraged between EOLOS and the vessel owners to clear any outstanding point that could impact the vessel unsuitability (such as on-site inspections).
Operational Risks	Accidents during deployment (or offshore operations)	EOLOS will send trained personnel in safety protocols and provide protective equipment. Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Operational challenges	Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Safety risks to personnel during offshore operations.	Risk assessment includes and establishes comprehensive safety protocols and risks management. The Emergency Response Plan details the procedure required in any incident.
Operational Risks	Environmental incidents.	EOLOS will ensure compliance with environmental regulations and monitor for potential spills.
Regulatory and Permitting Risks	Delays in obtaining necessary permits for offshore deployment.	EOLOS submit permit applications early and maintain communication with regulatory bodies. If permitting is not within Eolos scope, as is the case in this project, help will be offered to ease the process.
Regulatory and Permitting Risks	Changes in regulatory requirements affecting deployment	EOLOS and clients keep constant communication on the topic to identify actions that could help reduce the impact on regulations.
Logistics and Supply Chain Risks	Customs delays when importing equipment or spare parts for deployment.	Engage multiple suppliers to increase flexibility and expedite customs processes. EOLOS works with multimodal logistics partners with large experience in worldwide shipments.
Supply Chain and	Shortages of critical components or materials	Stock critical spare parts and maintain agreements with multiple vendors.

Procurement Risks	due to global supply chain disruptions.	

Table 4: Schedule risks mitigation measures.

4.2.3. Key Milestones to be considered

There are some key items and milestones to be noticed from the schedule above:

- EOLOS assumes February 3, 2025, as the earliest date on which the transport of the FLS200 E15 to Portugal can commence.
- EOLOS assumes February 11, 2025, as the earliest date on which the Port Acceptance Test could be performed.
- EOLOS assumes February 12, 2025, as the earliest date on which the quayside test on Aveiro port could be performed if requested.
- EOLOS assumes February 18, 2025, as the target date on which the FLS200 E15 could be ready for deployment on the Lote 3 site. The actual deployment date will depend on:
    - Suitable weather window to deploy the FLS200 at the Lote 3 site.
    - Vessel availability for any offshore operations

4.3. Base Port

EOLOS has select a workshop at Aveiro port to conduct pre-operational work, buoy final assembly, and testing. This port will serve as the departure point for offshore operations and as a potential maintenance location if the buoy needs to be brought onshore.

Figure 4: Aveiro location on the map.

It will be the centre of operations for the LO3 project, and all the activity needed to support O&M, including the storage of tools and spare parts.

The workshop location offers enough space to carry out the buoy assembly, disassembly and onshore maintenance. It also has sufficient lifting means to recalibrate sensors, transfer the buoy to/from vessels and trucks and perform various checks on the Port Acceptance Test methodology.

The covered space guarantees safe operations when electronic components must be accessed, modified or replaced.

The Aveiro port is suitable in terms of access to water and availability of tools, facilities and services. Specifications are the following:

- Location: Aveiro Port
- Storage/ assembly area: 200 m2
- Direct access to the water: Yes
- Lifting means available: Reachstaker, cranes and forklifts, capacity from 5 tons and above.

4.4. Project Coordinates

The measurement campaign for the Lote 3 (Figueira da Foz) project will take place at the following coordinates:

FLS200 Unit	LAT:	LONG:	Depth (m)
E15	40° 11' 10.056" N	09° 30' 03.051" W	154 m
	40° 11.16760' N	09° 30.05085' W	
	40.186126° N	09.500847° W	

Table 5: Lote 3 (Figueira da Foz) site coordinates.

Figure 5: Lote 3 (Figueira da Foz) site location on map.

5. Equipment

5.1. FLS200 Buoy

The EOLOS FLS200 unit is defined by two different parts:

1) the buoy itself with all measurement devices, as a generic product
2) the mooring line, which is design specific for each operational location.

The EOLOS FLS200 is described in two main document types, one for the buoy description and one for the mooring as follows:

3) *"As Installed"* [5] document including the technical description/specification of the buoys main equipment and sensors, with certificates of conformity or calibrations of the main measurement systems including Lidar, wave sensor, current profiler, IMU and Vaisala met station. The buoy main body is a generic device usable for different projects and locations.
4) *"Mooring Design Report_LO3 Site" [6]* document, with description of the specific mooring design for the deployment of the FLS200 units at the Lote 3 site.

EOLOS has its own mooring design department, responsible for ensuring survivability of the buoy in the most extreme conditions while keeping the buoy motions within reasonable limits to guarantee the quality of the measured data. Hydrodynamic simulations with the sea conditions are performed to guarantee an optimal design.

Alternatively, EOLOS also works with large, experienced companies such as *London Marine Consultants* (LMC) for mooring designs and BOMs definitions.

The EOLOS FLS200 LiDAR buoy is a fully equipped and autonomous wind, wave and ocean current measuring system based on LIDAR technology with additional meteo-oceanographic instrumentation.

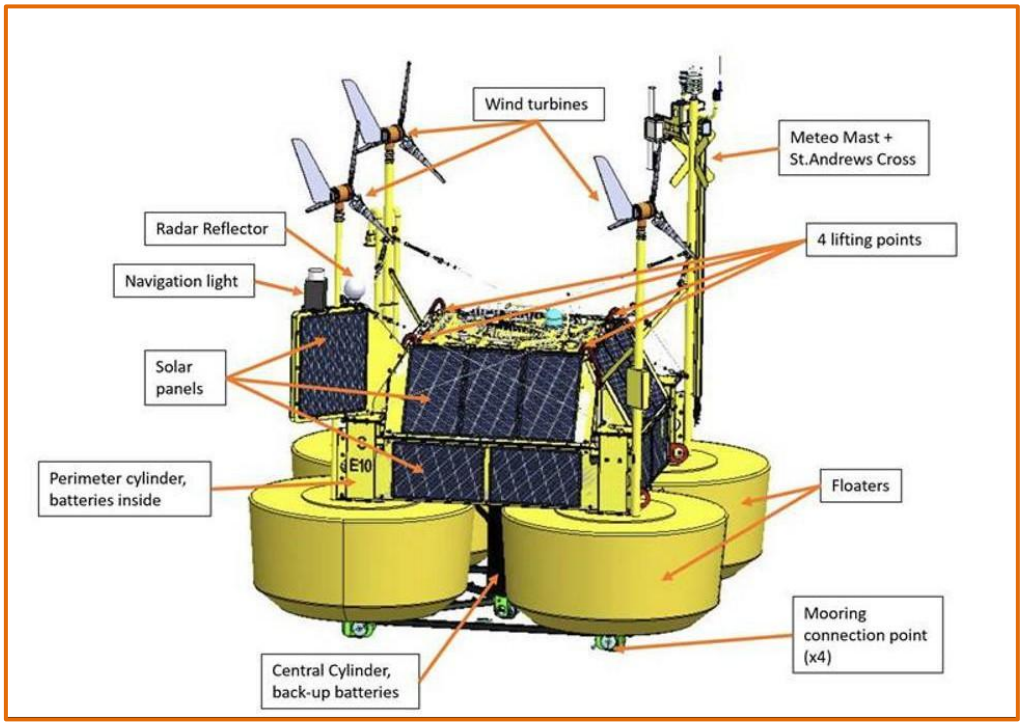

Figure 6: The EOLOS FLS200 LiDAR Buoy

The EOLOS FLS200 power system is fully redundant and autonomous, using three independent sources of charging power, minimizing the risk of a power shortage in any weather circumstance or unforeseen event (such as failure of one of the power systems).

The EOLOS FLS200 buoy has a custom power distribution system with the following components:

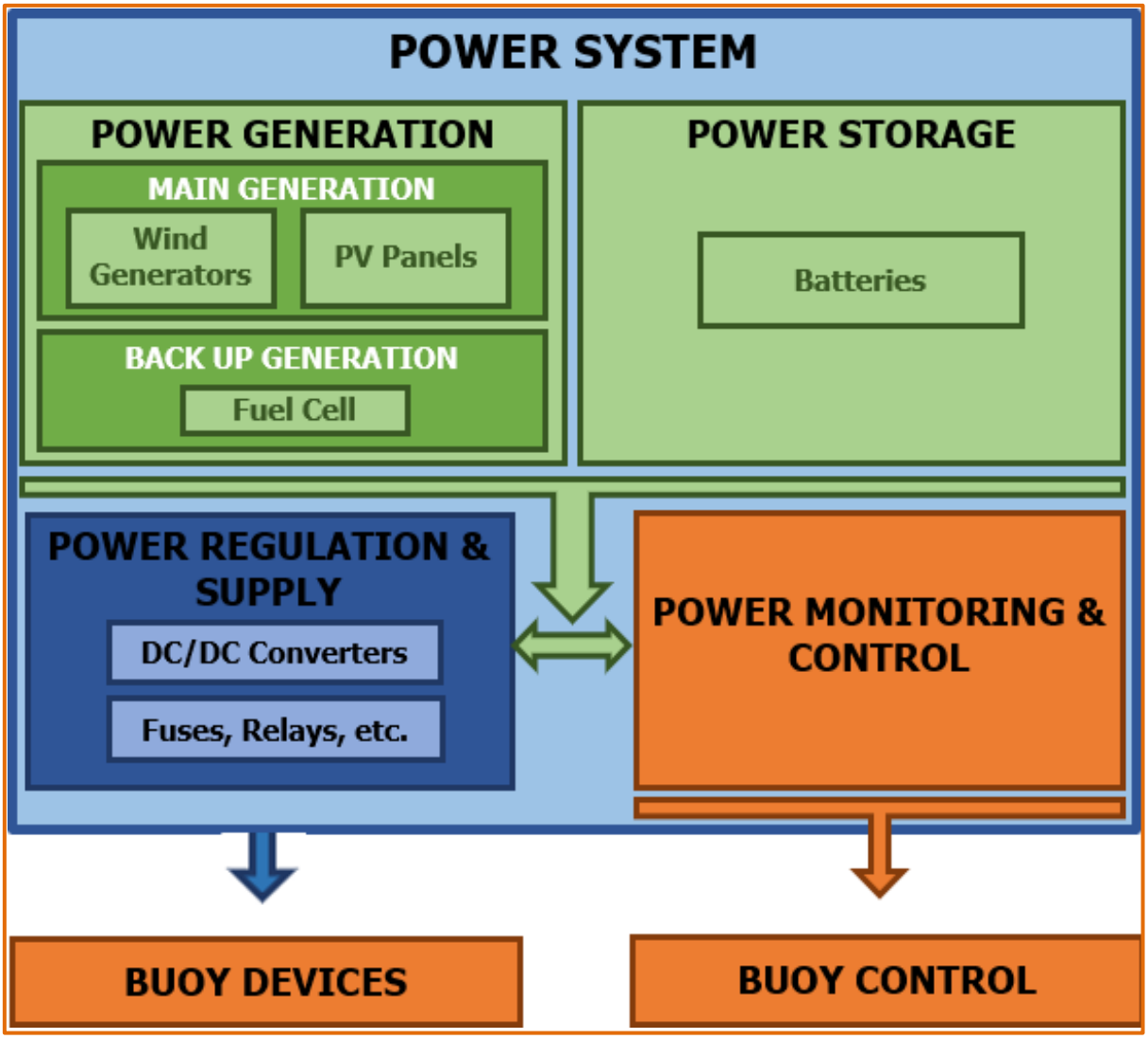

Figure 7: FLS200 energy supply schematic.

The FLS200 buoy is powered by: (i) wind turbine generators on the east, west, and south masts; (ii) 2 solar panel rings around the buoy cabin, with 2 additional panels on the south mast; (iii) batteries that are charged by the generation of (i) and (ii); and (iv) a methanol fuel cell for low-generation scenarios.

The FLS200 has been fitted with: (i) ZX LiDAR ZX300M, (ii) Vaisala meteorological station, (iii) Nortek current profiler Signature 250, (iii) A+D wave sensor, (iv) KVH Compasses, (v) Garmin GPS, and (vi) Li-Cor pyranometer.

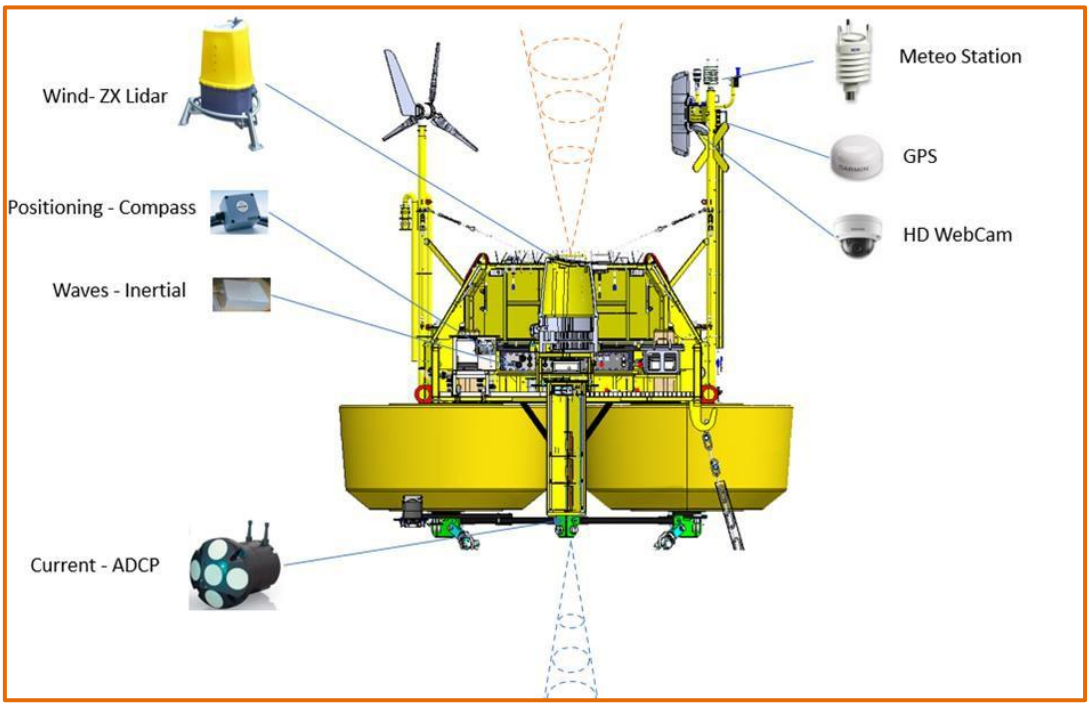

Figure 8: FLS200 E15 main sensors layout.

The measurement configurations of the Lidar device and the ADCP device are to be documented and approved by the Client in the Measurement Plan.

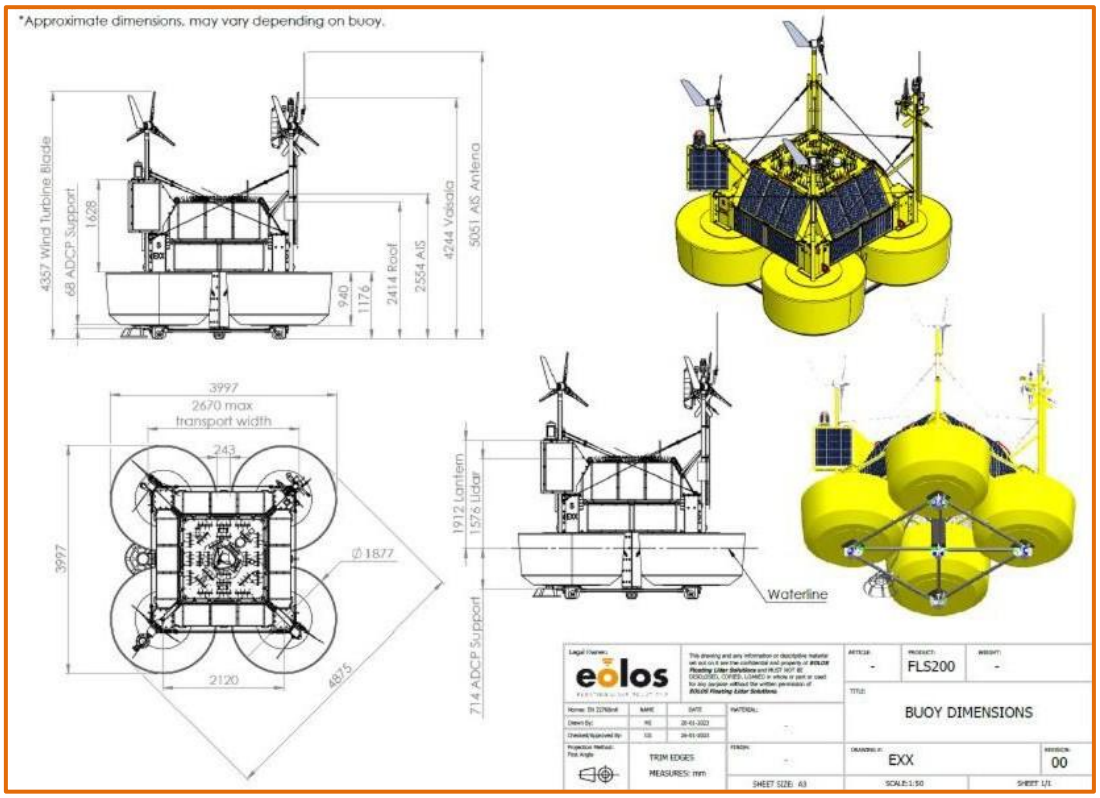

Figure 9: FLS200 technical drawings.

5.1.1. FLS200 buoy mooring

5.1.1.1. Upper mooring (standard)

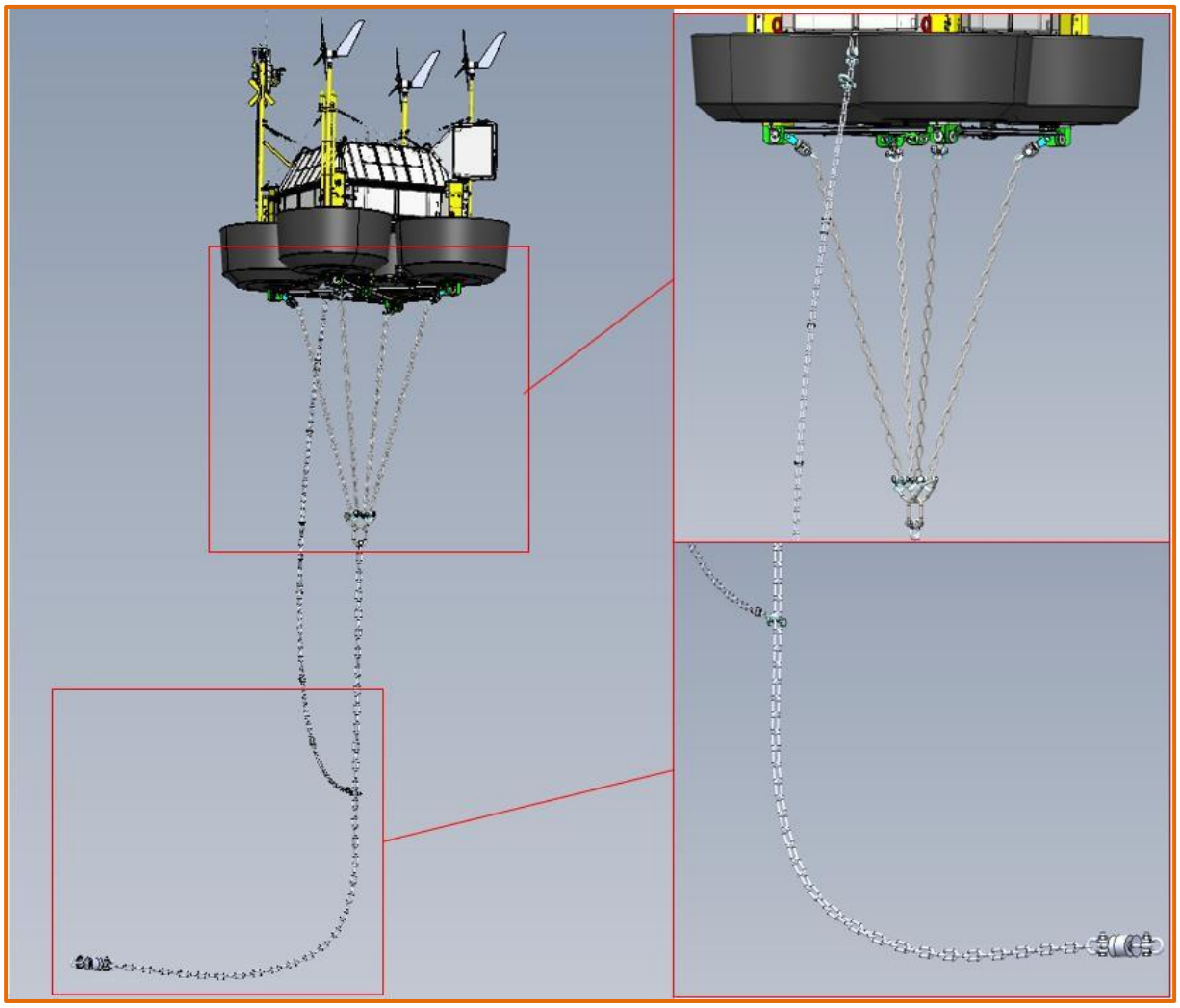

Figure 10: FLS200 upper mooring arrangement.

5.1.1.2. Lower mooring (site specific)

The site-specific mooring system is currently being designed by the EOLOS mooring department and it will be included in this Project Execution Plan once it has been completed. London Marine Contractors (LMC) has been designated as a third-party consultant to review and validate the EOLOS design.

6. Marine operations

Marine operations are critical for the success and development of the project. Proper planning and execution are essential to achieve an early and efficient deployment, minimizing delays, and maximizing data availability throughout the LNEG desired period. These operations include all activities related to transportation, deployment, maintenance, and recovery of the buoy, ensuring that the equipment is correctly positioned, functioning, and maintained to gather reliable data for the project duration.

6.1. Weather window identification

Detailed weather forecasts must be in place prior to all vessel operations. This includes deployment, recovery and offshore maintenances. This forecast report shall have a minimum forecast look ahead of 5 days, and can come from different sources:

- Windy: A weather forecasting tool that provides detailed meteorological information by aggregating data from multiple weather models. For this LO3 project the ECMWF Integrated Forecast System (IFS) will be used. It is a global numerical weather prediction model employing spectral methods for atmospheric dynamics and a semi-Lagrangian scheme for advection. It operates on a hybrid vertical coordinate system and utilizes 4D-Var data assimilation for optimal integration of observational data. The model's resolution typically reaches ~9 km (T1279) for deterministic runs and ~18 km (T639) for ensemble forecasts, with up to 137 vertical levels extending to the mesosphere.
- Storm Geo: Offers site-specific forecasts with reliability indexes that help improve the offshore operations planning. When crosschecked with Windy, it gives Eolos more certainty in harsh seas or during winter months.
- Other site-specific forecasts.

When the project requires and offshore operation, the project manager will inform the O&M lead of the imminent need for a vessel and team. The weather is then monitored by both, PM and O&M, until favourable conditions appear. As a general guide the following limits apply depending on the nature of the operation.

Transit or tow / Offshore lifts

- Max wave height [m]: 1.5 / 1
- Significant wave height[m]: 1.0 / 0.8
- Max wind speed[kn]: 15 / 13
- Max wind gusts [kn]: 19 / 17

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Table 6: Weather Threshold for EOLOS Operations

Surface current speeds are desired to be below 0.8 m/s. Special consideration must be made with respect the RAMS and actions to follow when the buoy is recovered/dropped as current might influence the positioning with respect the vessel.

The Beaufort scale is used to categorize the weather conditions reported in every operation at site which takes as input the wave height, wind speeds and environmental parameters to assign a value from 1 to 10. Any value above 4 is considered beyond the threshold set to safely conduct any operation.

The length of the weather window must match the estimated duration of the marine operation, including the time needed to halt it if necessary. Offshore servicing is critical, as the buoy is typically on deck with the mooring already deployed, making it more time-consuming to redeploy the buoy in the event of an unforeseen incident.

If a favourable weather forecast is available, and the length is appropriate for the task, the following steps apply prior to mobilisation to site:

a) 72 hours RAMS is prepared and sent to the client and the vessel.
b) 48 hours notify port authority of intended operations.
c) 24 hours all materials shall be loaded, inspected and prepared for transit to site.
d) 12 hours decision made to transit to site
e) 0 hours final weather forecast reviewed and go no go decision made.

6.2. Mitigation

EOLOS understands the dynamics and complex nature of offshore weather conditions, and this is expected to play a key role in the development of the project and the operations of deployment, maintenances and recoveries. Thus, EOLOS has an entire department (O&M) that closely monitors the weather through the above-mentioned sources and work side by side with the Project Managers to identify the needs of the project.

The potential drawbacks of sailing and operating under extreme weather conditions far exceed the benefits from taking the risks, and EOLOS operate under a policy of nil incidents and accidents throughout the entire campaign.

If offshore operations are scheduled, such as deployment of the system or preventive maintenances, Dutch Marine Contractors (DMC) is contacted to trigger the search of the vessel. This is done far in advance to locate vessels finishing other contracts to guarantee vessel availability by the time of operations. If weather conditions are not acceptable, but they are forecasted to end soon, EOLOS remains in standby until is safe to sail out.

Conversely, especially when corrective actions on the buoys must be done, EOLOS will is to lower the impact on the project. This is done by a negotiation with the Marine contractor and the vessel owners to ensure the following:

- Availability of slightly bigger vessels with DP and better behaviour to waves.
- Book high skilled and experienced vessels working with floating Lidars.

EOLOS maintenance schedules as seen in the section 6.4 Maintenance and Operational Methodology aim to foresee well in advance the upcoming operation, allowing the operational team to organise the logistics to have all material ready to service the buoys at any time. The goal is to service the buoys when weather is expected to be mild and reduce the offshore operations during winter months.

The Vessel Master will have the right and responsibility to make the final decision on whether the operation can be safely conducted based on his/her knowledge of the vessel capabilities and, his/her marine experience.

Figure 11: EOLOS FLS200 onboard a multicat.

6.3. Offshore operations strategy

The measurement campaign will last 12 months, and it typically includes the deployment, recovery and scheduled services at 6 months intervals. For this campaign, the tentative schedule would be:

- Deployment
- 6 months scheduled service
- Recovery

Marine operations will described in detail in the documents:

- RAMS for campaign deployment.
- RAMS for campaign recovery
- RAMS for maintenance

Each of these documents includes the different considerations, technical aspects, resources, and tools to execute the different operations and including risks already identified, its avoidance and mitigation.

When marine operations take place, EOLOS will report its outcome in the following documents:

- Deployment report
- Recovery report
- Maintenance report
- Daily Progress Report

6.4. Maintenance and Operational Methodology

Every works on the buoys is described in the operational plan developed by O&M department and specifically designed following the flow diagram presented in this section.

EOLOS reserves the right to move back and forth maintenance activities to optimize its operations, always under the premise to comply with HSE requirements and keep data availability to a maximum value.

The buoys are daily monitored by the data team and reference engineers, who notify everyone related to the project when there is anomalous behaviour or warnings raised by the system itself. EOLOS diligently plans unscheduled operations to fix whichever alarm must be mitigated. More details on monitoring can be found in the following sections.

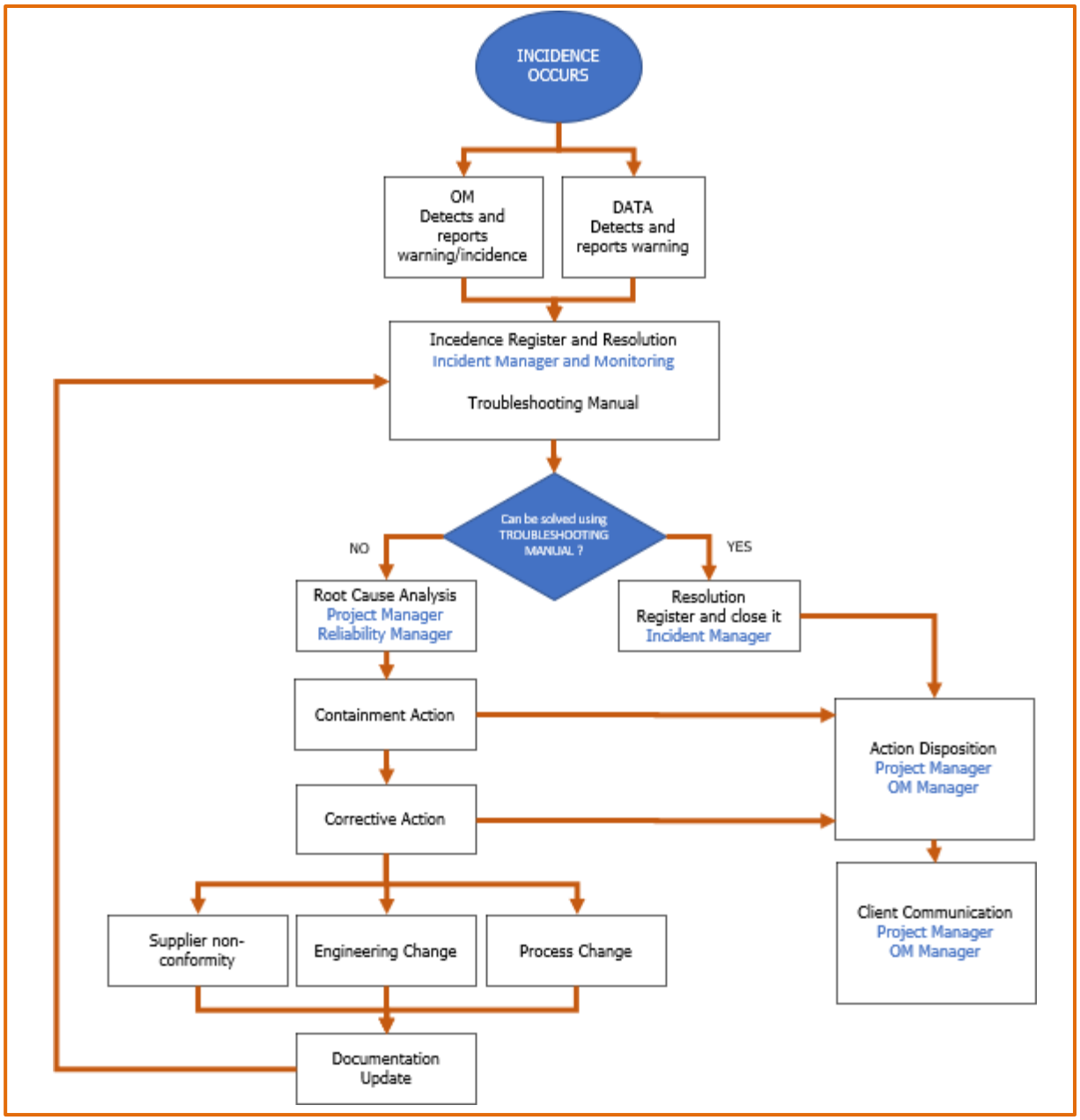

Figure 12: O&M flowchart.

6.5. EOLOS Operational Centre

EOLOS will work from its base port located at Aveiro to optimize the operations during the campaign.

Figure 13: EOLOS FLS200 buoy at port

6.6. Vessel for Marine Operations

EOLOS will ensure to hire local vessels (if available) through its marine contractor, Dutch Marine Contractors (DMC). A reduced number of multipurpose vessels can be used by EOLOS as part of the regular operation of deployment, recovery, and maintenance, with these being mainly Multicat vessel and Tugs fitted with offshore cranes, however, also crane barges and some offshore supply vessels could be used.

In order to provide evidence that the vessel status and capabilities fall within acceptable parameters of conformity, EOLOS stablishes a set of minimum requirements with respect vessel documentation listed below:

- CMID OVID, or equivalent inspection such as EOLOS suitability assessment.
- Hull and Machinery insurance.
- Protection and indemnity insurance.
- Crane specifications thorough examination - SWL testing.
- Safety management system (according to ISM or local flag).
- Safe manning document.

- Crew certification and list crane operator included:
  - SCTW.
  - Bosiet.
  - OWC.
- Ship registry certificate.
- Class certificate.
- Crew rest of hours.
- Vessel workboat certificate.
- Vessels contact details: mail, phone, SAT phone.

The minimum vessel capabilities are defined by EOLOS and transmitted to DMC to seek vessels for every operation. Considering the buoy characteristics, the vessel must have, as a minimum:

- Open deck (stern /bow)
- Crane capable of lifting >7 mT over the open deck
- Winch capable with a pull force >10 t
- Deck area > 50 m^2

Figure 14: Portuguese based tug vessel Castelo de Óbidos (Rebonave).

Figure 15: Spanish based multicat vessel Fenix Vigo (Northcom Diving).

7. Measurement campaign, data management, monitoring and data provision chain

The main goal of the project is to provide LNEG with a 1-year long metocean bankable data. Data measurements, management, processing and delivery are the most important aspect of the Lote 3 project.

7.1. Data acquisition

The measurements campaign will last 12 months, and data will be measured by deploying an FLS200.

The Measurement Plan is the standard EOLOS document that describes data conventions, sensors configurations, data files formats and data deliverables across the entire campaign.

The sensors that will be installed in the LO3 buoy are:

Sensor	Brand	Location
Lidar	ZX	FLS200
ADCP	Nortek	FLS200
Wave sensor	A+D	FLS200
Meteorological station	Vaisala	FLS200
Pyranometer	LiCor	FLS200

Table 7: Measurement sensors installed on the FLS200.

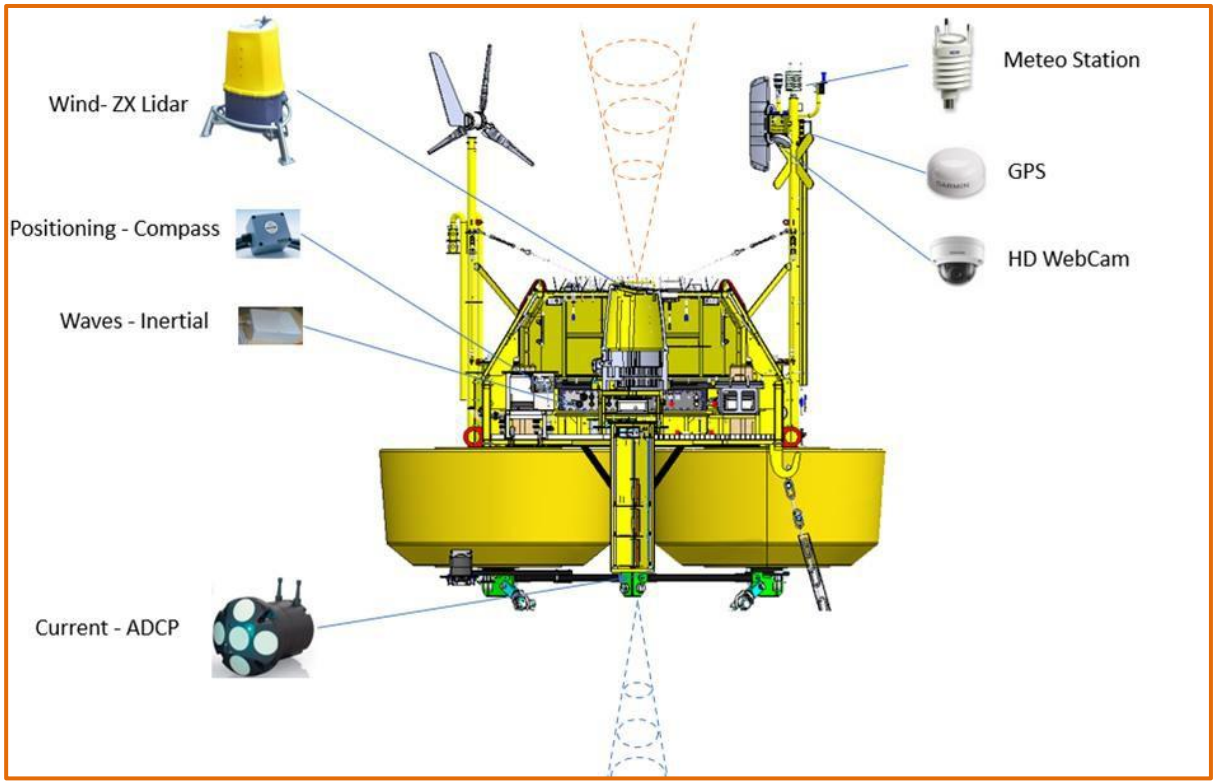

Figure 16: FLS200 main sensors layout.

Each sensor measures at regular intervals and frequency as described in the Measurement Plan, and can be subdivided into two sections:

- Data accessible remotely: These data are the average 10-min or 30-min files which are sent to EOLOS servers and are used for monitoring and updating data portals. Data sets are updated daily (every 48 h).
- Data stored within the system/sensors: These data include average and high frequency data. Datasets will usually be downloaded at regular intervals (scheduled maintenances) or at the end of the campaign, after the buoy recovery.

Data stored within the sensors (Lidar, wave and ADCP) also works as a backup copy that is recovered after accessing physically to the buoy.

The measurement principles of all the sensors mounted on the buoy EOLOS FLS200 are explained in more detail in the complementary document EOL-DOC93-V04-PROD-Sensors measurement principles and specifications [7].

7.2. Monitoring

The FLS200 system is composed of different subsystems, each with its own function and monitoring capability. Some subsystems may be designed to be monitored remotely onshore, with status messages or similar being sent via the internet.

These same subsystems may or may not be for measurement, i.e., producing quantitative observations to meet the project objectives. Malfunctions or outages detected in measurement subsystems will always cause an incident notification toward LNEG because they affect the data. Malfunctions or outages detected in non-measurement subsystems will not generate an incident notification toward LNEG if: (a) there is no effect on the data; and (b) there is a design redundancy still available.

Below table displays the subsystems and how monitoring works:

	Monitored remotely	**Not monitored remotely**
Measurement systems	Lidar ADCP Wave Meteorological station GPS Pyranometer	
Non-measurement systems	Communications: Neptulink (4G) Communications: Iridium Energy: Wind generators Energy: Solar panels Energy: Battery racks Energy: Fuel cell Dataloggers	AIS Lantern Corrosion protection Mooring TRBM structure

All those subsystems that are not monitored remotely are going to be accessed physically at the interval given in the O&M operations schedule. If data can be retrieved, it will be shared with LNEG.

There are various scenarios which may cause the buoy to travel outside of its drift radius (buoy adrift), most commonly due to mooring failure.

Any instance of buoy adrift sends an alarm to EOLOS Project Manager, Operations & Maintenance Manager, and Operations Director via the Smartone system. The alarm is repeated every hour while the buoy remains outside its programmed drift radius.

The section below shows how the FLS200 communicates with EOLOS HQ

7.3. Data management

The data flow at EOLOS follows the pattern as shown below:

Figure 17:

Data is measured by sensors deployed offshore by different devices. The sensors gather data in a raw format that is delivered to the FLS200 control units, the dataloggers. Data is then merged, packed and sent to EOLOS on-land servers by different telemetry system. If the buoy is closer to shore, 3G/4G communication is used, otherwise, the Iridium satellite antennas are used. Eolos has redundancy communications systems to avoid interruptions in data transmission. The following image shows which data can be recovered using several communications channels.

		Master	Slave	Lidar	Wave	ADCP
Telemetry	3G					
	Iridium					
In situ data recovery	Wi-Fi / cable					
	Internal memory					

Figure 18: FLS200 communication channels.

Once on land, the post processing is applied, which includes filtering to ensure data quality. Some of the filters are included in the sensors themselves, while others are implemented by EOLOS. Additionally, the Lidar measurements are corrected for tidal variation and the magnetic declination corrected to reference all measurements to true north.

More details on filtering and post processing can be found at EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan [8].

7.4. Data reporting and deliverables

Data will be delivered for the LO3 project at different intervals and in standard text format .dat, with the following names:

- *EOLOS_START-DATE_START-HOUR_END-DATE_END-HOUR_hour.dat*

If preferred by LNEG the data files can also be provided in .csv format.

7.4.1. Daily data reporting

Data will be automatically uploaded to Eolos connect portal.

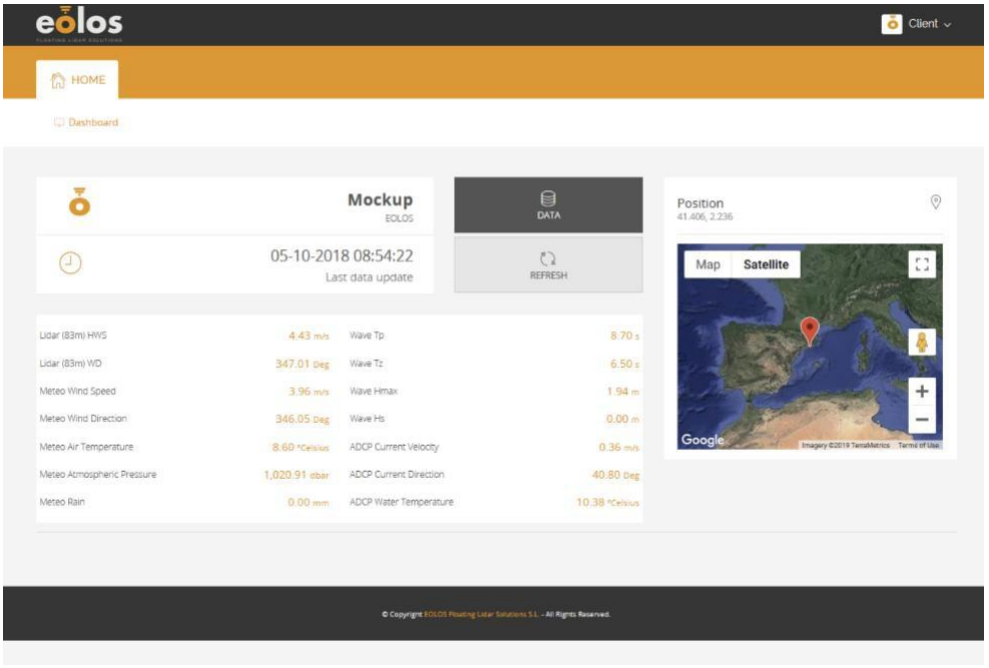

Figure 19: EOLOS Connect portal overview.

EOLOS Connect is a visualization portal only and no data can be downloaded.

The data files will be uploaded to the BOX (EOLOS cloud server) shared folder with LNEG:

01.PROJECT.DATA\EOL-LO3-PROJECT.DATA\E15\DAILY DATA

7.4.2. Monthly Reports

Monthly datasets will be uploaded to the BOX shared folder with LNEG:

01.PROJECT.DATA\EOL-LO3-PROJECT.DATA\E15\MONTHLY DATA

And monthly reports will be uploaded to the following BOX shared folder:

02.PROJECT.MANAGEMENT\E15-LO3\Monthly Report

7.4.3. End of campaign

Summary Report and datasets will be uploaded to BOX, following the same fashion as described in previous sections.

8. Project Document Control

Document control for the LO3 project will be the responsibility of the project manager, who will follow up across the entire project.

The documents are identified as IFI (Issued for information), IFA (Issued for Acceptance) or IFR (Issued for Review), and will be named with the following structure.

EOL [PROJECT NAME] [VERSION] OPS- [NAME OF THE DOCUMENT]

- Version 00 for internal use only, 01 and above for external communications.
- First page including Author and Revised by person.
- First page including version control.
- First page including date.
- First page including title and pages.

The Project Manager is the owner and responsible to create, archive, review and maintain the folder and its documents. Documents will be created by the core team and the support team depending on the technical/area of discipline and the PM will be communicated for the review and classification process.

8.1. Document deliverables

Documents are to be provided according to EOL-LO305-V01-OPS-Document Deliverables Plan [9].

9. Risk Management Environment, Safety & Health / Emergency Situations

The HSE plan needs to be placed to guarantee safety management on site during all operations. HSE detailed plan for the LO3 project is described in detail in:

1) EOL-LO306-V01-OPS-HSE Plan [12].

A detailed procedure to follow in case of potential emergency situations including all project emergency contacts and emergency considerations included in:

2) EOL-LO306-V01-OPS-Emergency Response Plan [13].

For all offshore operations, the following documents need to be fully read, understood, and agreed by main personnel on board of the operations vessel:

3) RAMS for FLS200 Operations.

9.1. INCIDENT AND EMERGENCY REPORTING

9.1.1. Buoy incidences

In case of technical malfunction incidents, LNEG will be informed by EOLOS at the Project Management level within the following due dates:

Action	Due Date	Deliverable
Verbal communication	Within 48 hours of alarm	Email
Indent notification report	Within 72 hours of alarm	Incident notification
Unscheduled visit after incident notification	Within 15 calendar days of notification (weather dependant).	RAMS ERP
Maintenance report after unscheduled visit	Within 15 calendar days of unscheduled visit.	Maintenance report

Table 8: Notification due dates for technical malfunctions

Technical incidents will be notified only:

1) If the incidence triggers maintenance.
2) If the incidence represents a danger to navigation.
3) If the incident affects communication/ dataflow.

9.1.2. Accidents

Emergency situations or accidents at or near the Lote 3 deployment location impacting people (LNEG, EOLOS, third party) or environment will be reported to LNEG at the Project Management level immediately.

The first and most important action after an incident will be securing safety of personnel. Immediately after LNEG and EOLOS will then initiate respective emergency response plans.

More details on the flow of information and procedures can be found at the Emergency Response Plan (ERP) and Health and Safety pan (HSE).

10. Project Quality

10.1. The FLS200 Buoy

Quality documentation related to the buoy and its hardware can be found in the following standalone documents:

- Factory Acceptance Test (FAT) Report
- Port Acceptance Test (PAT) Report
- Site Acceptance Test (SAT) Report

These are issued by EOLOS toward LNEG on a for Information basis (IFI).

EOLOS' priority is to deliver industry-credible data to the Client. To meet this objective, data management and delivery operates with two core documents:

- EOL-DOC114 Data Quality Control Procedures, which describes how EOLOS – independently, or based on instrument OEM know-how – assesses a data observation as valid or invalid (i.e., flagged).
- The Project-specific Measurement Plan, which details the specific measurement parameters customized to suit the relevant Client contract or Client needs.

10.2. Subcontracted Services

Marine operations are one of the most critical activities carried out by EOLOS in order to execute the measurement campaign. Therefore, in line with the EOLOS purchases procedure and the EOLOS standard Scope of Work for marine contractors, the minimum requirements for any work vessel contracted by EOLOS are:

a) CMID
b) Crane working diagram
c) Certificate of registry
d) Certificate of classification
e) Certificates of insurance
f) Evidence of insurance
g) Attestation of Cargo Gear Survey
h) Crew Certification (GWO, BOSIET, or STCW) – 4 modules (firefighting, sea survival, first aid, manual handling)
i) LOLER certification of lifting elements or crane through examination

11. Permits

11.1. Permit for deployment at site

LNEG is responsible for the process to acquire the permit (*Título de Utilizaçao Privativa do Espaço Marítimo* – TUPEM) to deploy the assets on site for the duration of the measurement campaign.

11.2. Navigational Aids Permit

EOLOS is responsible to acquire the AIS licence for the AtoN devices mounted on the buoy and will process it with the corresponding authorities.

12. Payment calculations

According to the Contract D26805 the following milestones should be paid:

Milestone	Description	Payment calculation
Project Execution Plan	EOLOS delivers to LNEG the Project Execution Plan within 20 days after the contract signature.	374,500.0 €
Deployment Report	After the successful deployment of the FLS200 E15 at the LO3 site, EOLOS provides LNEG with the Deployment Report.	74,900.0 €
Monthly Reports 1-12	Monthly invoices upon receiving the monthly datasets and associated report.	42,800.0 €/month
Recovery and final report	Upon completion of the data measurements campaign and issuing the final data report.	107,000.0 €

Figure 20: Contractual project invoiceable milestones.

Payment calculation for the monthly reports will be issued along with the monthly reports and the data sets after two weeks of the current month.

The following payment calculation will be used to determine the monthly rate to be paid upon reception of the monthly data sets and reports, based on the LiDAR wind speed and direction post-processed data availability at 140 meters (or another agreed reference height, which will be included in the Measurement Plan):

Wind Speed and Direction post-processed data availability at 140m	Payment (% of the monthly fee)
>85%	100% * Monthly fee

<85%	$$Penalties = Monthly\ fee * \left(\frac{Penalty * Unavailable\ time\ stamps}{Reference\ time\ stamps}\right)$$ Being • Penalty: 5% • Unavailable timestamps: In a period of 12 months, the number of time stamps not registered assuming as a reference one year of data recorded in a 10-min interval. • Reference time stamps: number of time stamps in a 30 day month, assuming in this case the value 4320.

References

[1] EOL-LO302-V01-OPS-FAT PAT SAT Examples.

[2] OWA Roadmap for the Commercial Acceptance of Floating LiDAR Technology (2018).

[3] IEC 50.4.

[4] 3rd party assessment of Stage-3 maturity achievements of the EOLOS FLS-200 Floating LiDAR Buoy according to the “Carbon Trust Offshore Wind Accelerator Roadmap for the Commercial Acceptance of Floating Lidar Technology”, MV-3005-PV1-065-TN-001-C.

[5] EOL-LO303-V01-OPS-As Installed.

[6] EOL-LO304-V01-OPS- Mooring Design Report_LO3 Site.

[7] EOL-DOC93-V04-PROD-Sensors measurement principles and specifications.

[8] EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan.

[9] EOL-LO305-V01-OPS-Document Deliverables Plan.

[10] EOL-LO306-V01-OPS-HSE Plan.

[11] EOL-LO306-V01-OPS-Emergency Response Plan.

EOL-LO401-V01-OPS

PROJECT EXECUTION PLAN
LOTE 4
ERICEIRA

PREPARED		**REVISED**		**APPPROVED**	
By	**Ignasi Andreu**	By	**Oriol Costillas**	By	**Felix Urrea**
Date	16/12/2024	Date	16/12/2024	Date	16/12/2024

VERSIONS		
Version	**Modification causes**	**Date**
01	**Document Creation**	16/12/2024

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Figures

Tables

Acronyms/Abbreviations

PEP	*Project Execution Plan*
IPT	*Integrated Project Team*
FAT	*Factory Acceptance Test*
PAT	*Port Acceptance Test*
SAT	*Site Acceptance Test*
HAZID	*Hazard Identification*
HIRA	*Hazard Identification and Risk Assessment*
BOM	*Bill of Materials*
OWA	*Offshore Wind Accelerator*
RAMS	*Risk Assessment and Method Statement*
LNEG	*Laboratório Nacional de Energia e Geologia, I.P.*

1. Introduction

1.1. Overview

EOLOS Floating Lidar Solutions has been awarded Contract D26805 by the Laboratório Nacional de Energia e Geologia, I.P. (LNEG) to carry out a 1-year wind resource assessment campaign from Q1 2025 to Q1 2026. The wind resource assessment will be done primarily with the deployment of an EOLOS FLS200 metocean buoy (with serial number E42) off the coast of Ericeira, Portugal.

Figure 1: Lote 4 (Ericeira) site location on map.

1.2. Purpose

This Project Execution Plan (PEP) defines a proposal for the **Lote 4 (LO4)** project and describes planning, assumptions, constraints, roles, responsibilities, authorities, management interactions and interfaces necessary to successfully execute the project in a safe and efficient manner.

2. Mission & Objectives

2.1. Mission Specifications

The mission of EOLOS defined in this Project Execution Plan is to provide LNEG with 1 year of bankable meteorological, met ocean and environmental data through the deployment of the EOLOS FLS200 E42.

2.2. Project Objectives

- Provision of a validated metocean buoy for the whole duration of the campaign, delivering the highest practicable post-processed wind data availability.
- Maximise the quality data availability of all the relevant sensors included in the offer.
- Minimize environmental impact in the deployment area.
- Ensure that environmental, safety, health and security requirements are fully considered and appropriately implemented in project execution.

3. Organization & Responsibilities

3.1. EOLOS Representatives

NAME	POSITION	BACKUP
Felix Urrea	Director of Operations	Gastao Moura
Ignasi Andreu	Project Manager	Mike Serquina
Adrià Miquel	Chief Data Scientist	Giacomo Rapisardi
Lluís Raurich	Engineering Director	Raúl Rodríguez
Gastao Moura	O&M & HSE Manager	Jorge Garcia
Julian Harland	Contract Manager	Rajai Aghabi
Raúl Rodríguez	Fleet Engineering	Lluís Raurich
Jose Miguel Garro	Data Scientist	Sandra Coll
Raimon Targa	Project Reporting	Marc Borrell
Daniel Sanchez	Reliability Manager	Mario Berral
Juan Delgado	CFO	Rajai Aghabi

Table 1: EOLOS Personnel for the Project

3.2. CLIENT Representatives

Name	Position	Email
Ana Estanqueiro	Senior Researcher	ana.estanqueiro@lneg.pt
Teresa Simoes	Wind Resource Assessment	teresa.simoes@lneg.pt

Table 2: LNEG Personnel for the Project

3.3. EOLOS Project Team

EOLOS will be organised as follows to fulfil all aspects of the **LO4** project:

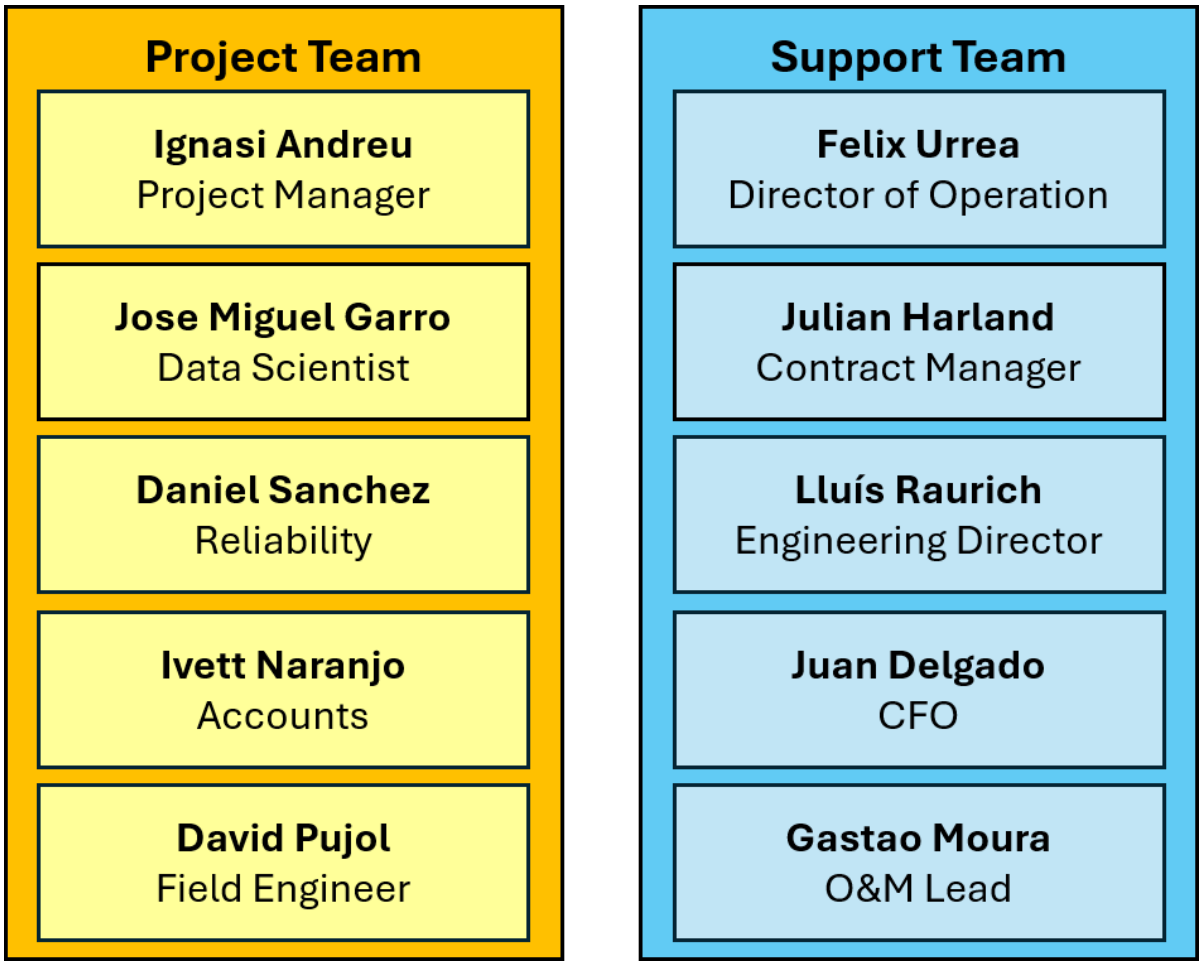

Figure 2: EOLOS Company Organisational Scheme

3.4. Project Interfaces

During the duration of the project, EOLOS must contact different stakeholder in order to successfully perform the object of the contract. The involved parties will be:

Stakeholder	Role	Managed by
Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM)	To grant the permits to deploy the FLS200 E42 at the Lote 4 site.	LNEG
Autoridade Marítima Nacional (AMN) - Coastguards	Supervise and coordinate the activities related to maritime safety, marine environmental protection and maritime rescue	LNEG and EOLOS, as applicable.

Aveiro port	Provide the facilities and lifting equipment required to assemble the FLS200, as well as the quayside where the vessel used for the marine operation will berth.	EOLOS
London Marine Consultants (LMC)	Provide an independent assessment and validation on the mooring design designed by EOLOS.	EOLOS
Dutch Marine Contractors (DMC)	Search and hire suitable vessels for the marine operations.	EOLOS
Wilhelmsen Port Services	Provide all the logistics for vessel entry at port, and contact point between Aveiro port authority and EOLOS.	EOLOS

Table 3: Project stakeholders

4. Project Description

4.1. Overall Project Description

The project goal is to perform a 1-year measurement campaign for the designated project coordinates with no declared extension. The unit FLS200 E42 will be tasked with acquiring accurate wind, metocean and environmental data for a period spanning 12 months.

EOLOS will conduct an internal testing and system verification, constituting a Factory Acceptance Test (FAT) for the unit assigned to the project, after its refurbishment at EOLOS premises located in Barcelona, Spain. The FAT comprises a comprehensive series of tests encompassing all sensors and configuration systems integral to its suitability and performance.

These tests include assessment of sensors, power units, control units, communications, navigational, and security systems. Rigorous mechanical inspections and verifications, coupled with thorough electrical and electronic assessments, form integral components of these tests.

A sample of this Factory Acceptance Test (FAT) can be found in the document: EOL-LO4O2-V01-OPS-FAT PAT SAT Examples [1], which also encompasses the Factory Acceptance Test (FAT), Port Acceptance Test (PAT) and Site Acceptance Test (SAT).

The technical phases of the project as seen from EOLOS' side:

- The EOLOS FLS200 E42 buoy has been allocated as the measurement system. Refurbishment and ex-works schedule are described in section 4.2.1 of the current PEP document.
- After the allocate unit is successfully tested in the EOLOS workshop, including the met ocean and environmental sensors in the buoy, the unit will be partially disassembled and packed for transportation to the assembly port in Aveiro.
- The buoy will then be completely assembled, and a Port Acceptance Test will be conducted at Aveiro port.
- If requested by LNEG, a quayside test in line with applicable guidelines like OWA/CT FLS Roadmap [2] and IEA RP18 [3] recommendations could be performed together with the other allocated FLS200 for the Lote 1, 3 and 4 projects, and a shore based LiDAR unit. The approximate duration of this sanity check is 1 week.
- Once the weather conditions and vessels are confirmed, buoys and materials are loaded onto the vessel in preparation for the deployment.
- The final deployment at the Lote 4 (Ericeira) site is done by EOLOS with the buoy and mooring system on board the vessel. This marks commencement of the validation campaign.
- All above procedures are subject to the operations RAMS procedure.

4.2. Project Scheduling

4.2.1. Project Schedule and Contingencies Considered

Main activities and dates have been considered while taking into account, suppliers' deadlines, assembly, EOLOS experience and marine operation dates discussed and analysed with the O&M team.

As the validation campaign has already taken place, the scope is focused on the final measurement campaign at the Lote 4 site.

EOLOS submits the following Gantt chart highlighting those relevant milestones and identifying the critical paths impacting the planned schedule.

	Task Name	Duration	Start	Finish
1	**LOTE 4 (LO4)**	**93 days**	**Mon 18/11/24**	**Tue 18/02/25**
2	**FLS200 E42**	**78 days**	**Tue 03/12/24**	**Tue 18/02/25**
3	Contract Suspension	50 days	Tue 03/12/24	Tue 21/01/25
4	FLS200 E42 Refurbishment works	19 days	Wed 08/01/25	Sun 26/01/25
5	FLS200 E42 Factory Acceptance Test (FAT)	7 days	Mon 27/01/25	Sun 02/02/25
6	FLS200 E42 ExWorks	0 days	Sun 02/02/25	Sun 02/02/25
7	FLS200 E42 Road Transport to Aveiro	3 days	Mon 03/02/25	Wed 05/02/25
8	FLS200 E42 Assembly at Aveiro port	5 days	Thu 06/02/25	Mon 10/02/25
9	FLS200 E42 Port Acceptance Test	1 day	Tue 11/02/25	Tue 11/02/25
10	Quayside Test (if required)	7 days	Wed 12/02/25	Tue 18/02/25
11	**Mooring System**	**73 days**	**Mon 18/11/24**	**Wed 29/01/25**
12	Reception of site metocean conditions	0 days	Mon 18/11/24	Mon 18/11/24
13	Reception of site depth	0 days	Mon 02/12/24	Mon 02/12/24
14	Mooring design analysis (1st draft)	8 days	Mon 25/11/24	Mon 02/12/24
15	Bill of material	0 days	Mon 02/12/24	Mon 02/12/24
16	Launch of PO for Clump Weight (CW)	0 days	Mon 16/12/24	Mon 16/12/24
17	Delivery time for CW	40 days	Mon 16/12/24	Fri 24/01/25
18	Launch of PO for Midline Floater (MF)	0 days	Mon 16/12/24	Mon 16/12/24
19	Delivery time for MF	45 days	Mon 16/12/24	Wed 29/01/25
20	Launch of PO for chains	0 days	Tue 07/01/25	Tue 07/01/25
21	Delivery time for chains	14 days	Tue 07/01/25	Mon 20/01/25
22	Buoy Ready for deployment	0 days	Tue 18/02/25	Tue 18/02/25

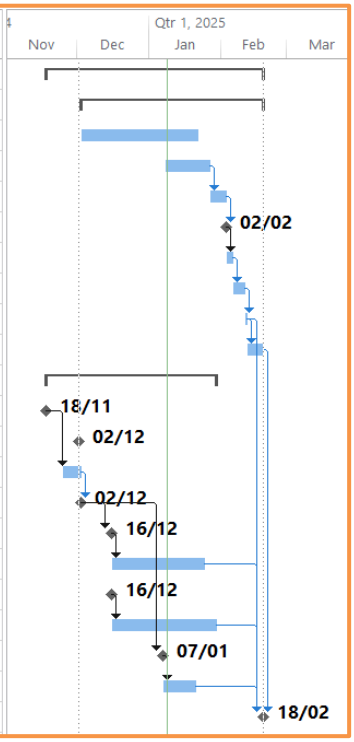

Figure 3: LO4 project schedule.

4.2.2. Risk Mitigation in the Scheduling

There are many risks that must be considered, ranging between low or high impact on the scheduling of the project. When it comes to offshore operations in harsh seas, remote areas and /or new regulations in countries and mapping areas, several factors can affect the above-mentioned timeline.

Risk can be categorized as follows:

1) Environmental risks: Those linked to adverse weather conditions, fisheries and other marine activities in the area.
2) Operational risks: Vessel's unavailability or unsuitability, accidents, deployment challenges.
3) Regulatory risks: Regulatory changes, delays on permitting.
4) Supply chain and logistics: Suppliers shortage, customs.

EOLOS aims to offer one FLS200 by making the equipment available at Aveiro port and ready for deployment by 5th of March 2025 and starting the campaign as soon as reasonably possible shortly after, depending on weather conditions and vessel availability.

The risk mitigation measures put in place to reduce the impact on scheduling are detailed on below table.

Category	Details	Mitigations/Proposals
Environmental Risks	Adverse weather conditions	Regular crosscheck between different forecast models: Windy, StormGeo and/or client specialized forecast.
Environmental Risks	Simultaneous OPS in the area	EOLOS liaise with LNEG to identify potential objections for the FLS200 deployment and engage with local stakeholders.
Operational Risks	Vessel's unavailability or unsuitability	Vessel's identifications is carried out before the contract signs off. If not, EOLOS work with specialized marine contractors with wide experience in floating LiDAR operations. Active and problem-solving mindset is encouraged between EOLOS and the vessel owners to clear any outstanding point that could impact the vessel unsuitability (such as on-site inspections).
Operational Risks	Accidents during deployment (or offshore operations)	EOLOS will send trained personnel in safety protocols and provide protective equipment. Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Operational challenges	Risk assessment and method statements are vessel specific and reviewed by the crew
Operational Risks	Safety risks to personnel during offshore operations.	Risk assessment includes and establishes comprehensive safety protocols and risks management. The Emergency Response Plan details the procedure required in any incident.
Operational Risks	Environmental incidents.	EOLOS will ensure compliance with environmental regulations and monitor for potential spills.
Regulatory and Permitting Risks	Delays in obtaining necessary permits for offshore deployment.	EOLOS submit permit applications early and maintain communication with regulatory bodies. If permitting is not within Eolos scope, as is the case in this project, help will be offered to ease the process.
Regulatory and Permitting Risks	Changes in regulatory requirements affecting deployment	EOLOS and clients keep constant communication on the topic to identify actions that could help reduce the impact on regulations.
Logistics and Supply Chain Risks	Customs delays when importing equipment or	Engage multiple suppliers to increase flexibility and expedite customs processes.

	spare parts for deployment.	EOLOS works with multimodal logistics partners with large experience in worldwide shipments.
Supply Chain and Procurement Risks	Shortages of critical components or materials due to global supply chain disruptions.	Stock critical spare parts and maintain agreements with multiple vendors.

Table 4: Schedule risks mitigation measures.

4.2.3. Key Milestones to be considered

There are some key items and milestones to be noticed from the schedule above:

- EOLOS assumes February 15, 2025, as the earliest date on which the transport of the FLS200 E42 to Portugal can commence.
- EOLOS assumes February 23, 2025, as the earliest date on which the Port Acceptance Test could be performed.
- EOLOS assumes February 24, 2025, as the earliest date on which the quayside test on Aveiro port could be performed if requested.
- EOLOS assumes March 5, 2025, as the target date on which the FLS200 E42 could be ready for deployment on the Lote 4 site. The actual deployment date will depend on:
  - Suitable weather window to deploy the FLS200 at the Lote 4 site.
  - Vessel availability for any offshore operations

4.3. Base Port

EOLOS has select a workshop at Aveiro port to conduct pre-operational work, buoy final assembly, and testing. This port will serve as the departure point for offshore operations and as a potential maintenance location if the buoy needs to be brought onshore.

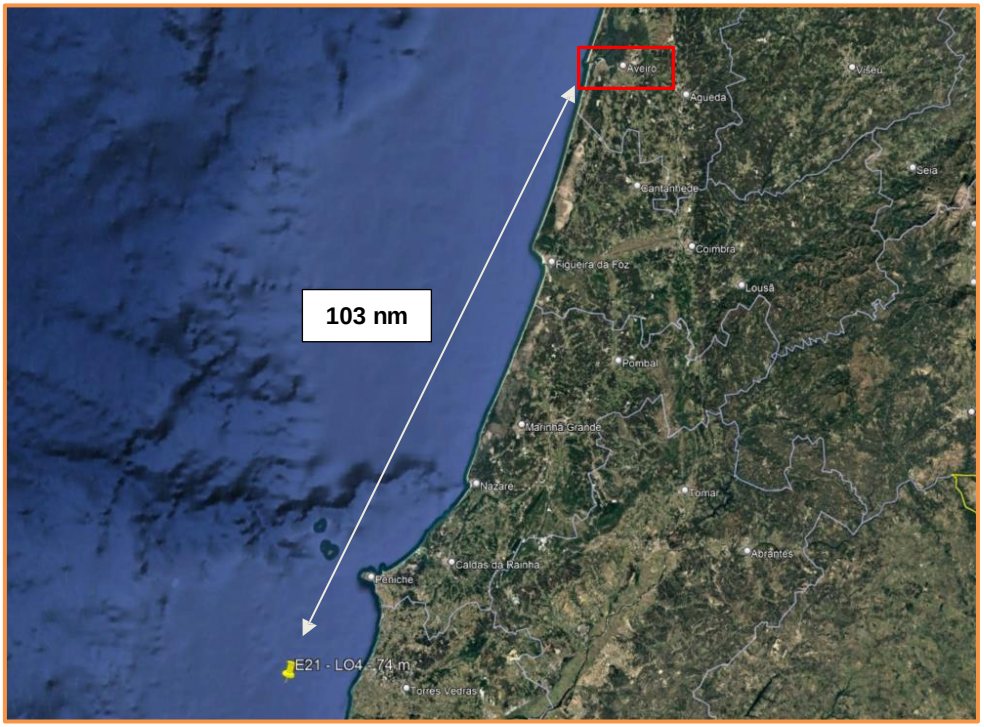

Figure 4: Aveiro location on the map.

It will be the centre of operations for the LO4 project, and all the activity needed to support O&M, including the storage of tools and spare parts.

The workshop location offers enough space to carry out the buoy assembly, disassembly and onshore maintenance. It also has sufficient lifting means to recalibrate sensors, transfer the buoy to/from vessels and trucks and perform various checks on the Port Acceptance Test methodology.

The covered space guarantees safe operations when electronic components must be accessed, modified or replaced.

The Aveiro port is suitable in terms of access to water and availability of tools, facilities and services. Specifications are the following:

- Location: Aveiro Port
- Storage/ assembly area: 200 m2
- Direct access to the water: Yes
- Lifting means available: Reachstaker, cranes and forklifts, capacity from 5 tons and above.

4.4. Project Coordinates

The measurement campaign for the Lote 4 (Ericeira) project will take place at the following coordinates:

FLS200 Unit	LAT:	LONG:	Depth (m)
E42	39° 05' 12.161" N	09° 37' 56.108" W	75 m
	39° 05.20268' N	09° 37.93513' W	
	39.086711° N	09.632252° W	

Table 5: Lote 4 (Ericeira) site coordinates.

Figure 5: Lote 4 (Ericeira) site location on map.

5. Equipment

5.1. FLS200 Buoy

The EOLOS FLS200 unit is defined by two different parts:

1) the buoy itself with all measurement devices, as a generic product
2) the mooring line, which is design specific for each operational location.

The EOLOS FLS200 is described in two main document types, one for the buoy description and one for the mooring as follows:

3) *"As Installed"* [5] document including the technical description/specification of the buoys main equipment and sensors, with certificates of conformity or calibrations of the main measurement systems including Lidar, wave sensor, current profiler, IMU and Vaisala met station. The buoy main body is a generic device usable for different projects and locations.
4) *"Mooring Design Report_LO4 Site" [6]* document, with description of the specific mooring design for the deployment of the FLS200 units at the Lote 4 site.

EOLOS has its own mooring design department, responsible for ensuring survivability of the buoy in the most extreme conditions while keeping the buoy motions within reasonable limits to guarantee the quality of the measured data. Hydrodynamic simulations with the sea conditions are performed to guarantee an optimal design.

Alternatively, EOLOS also works with large, experienced companies such as *London Marine Consultants* (LMC) for mooring designs and BOMs definitions.

The EOLOS FLS200 LiDAR buoy is a fully equipped and autonomous wind, wave and ocean current measuring system based on LIDAR technology with additional meteo-oceanographic instrumentation.

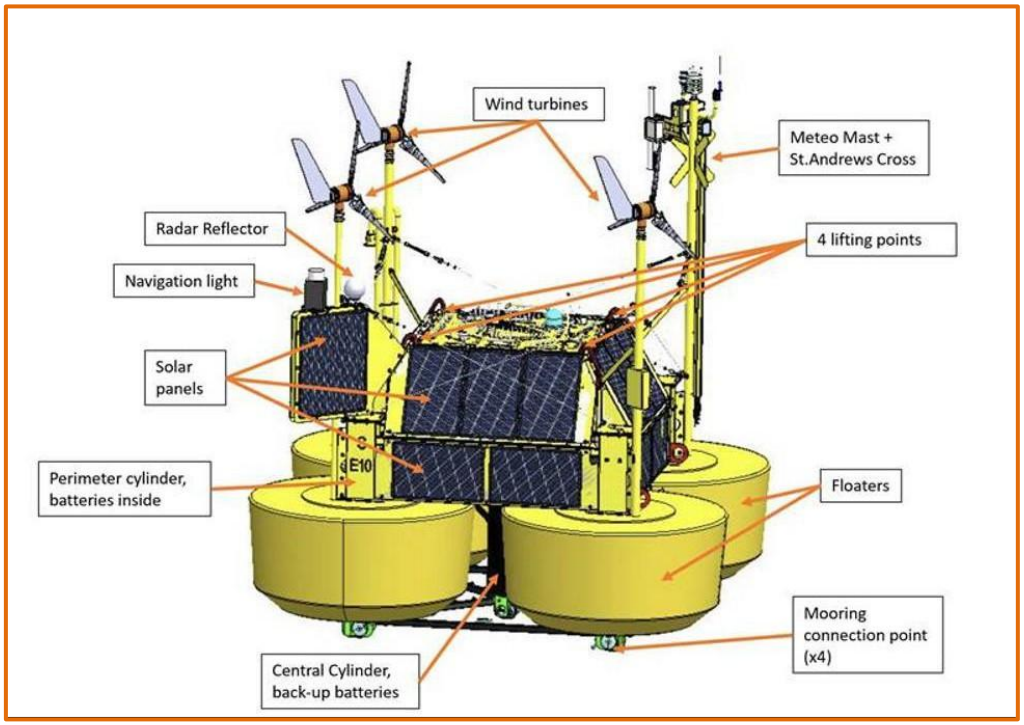

Figure 6: The EOLOS FLS200 LiDAR Buoy

The EOLOS FLS200 power system is fully redundant and autonomous, using three independent sources of charging power, minimizing the risk of a power shortage in any weather circumstance or unforeseen event (such as failure of one of the power systems).

The EOLOS FLS200 buoy has a custom power distribution system with the following components:

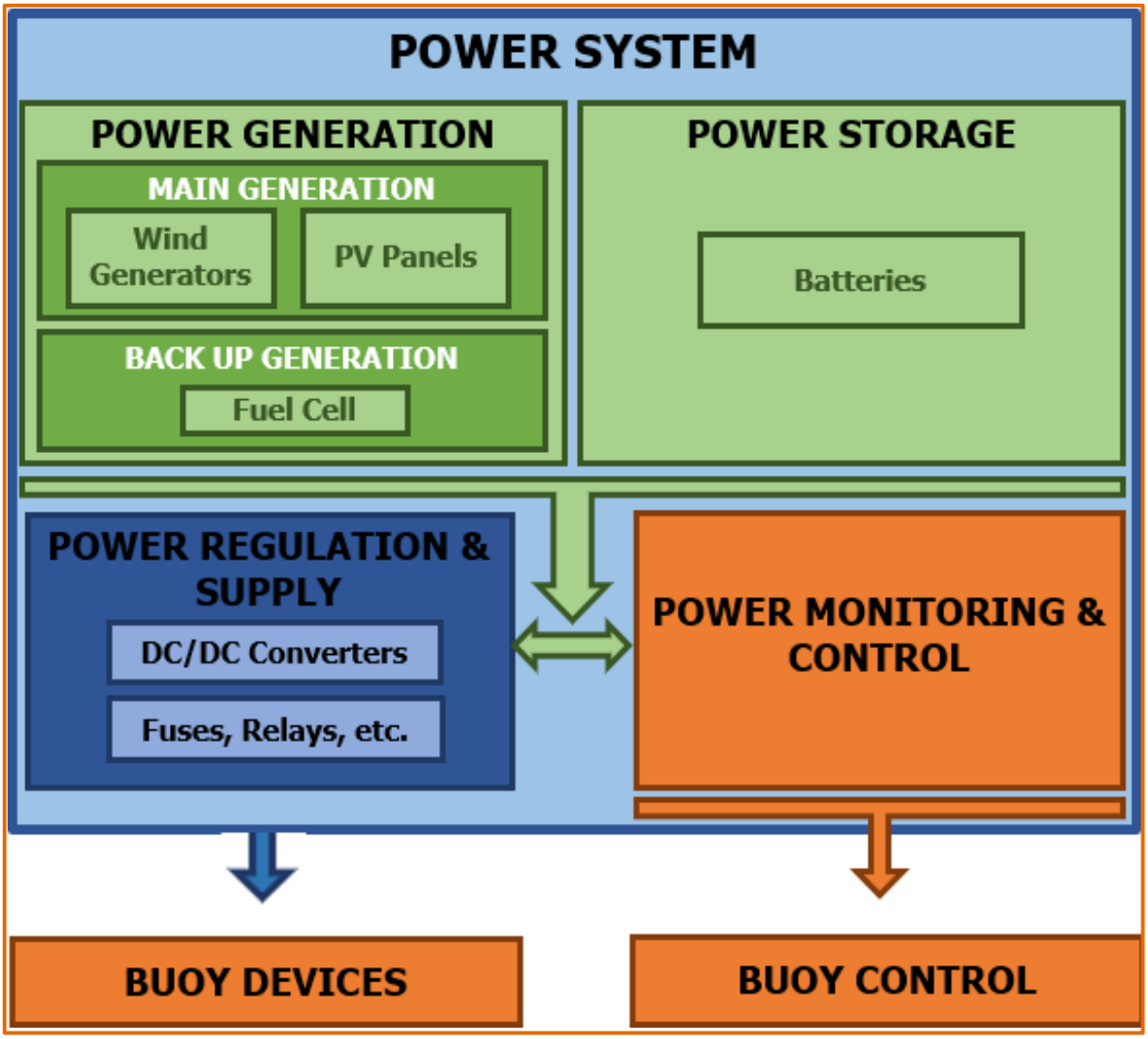

Figure 7: FLS200 energy supply schematic.

The FLS200 buoy is powered by: (i) wind turbine generators on the east, west, and south masts; (ii) 2 solar panel rings around the buoy cabin, with 2 additional panels on the south mast; (iii) batteries that are charged by the generation of (i) and (ii); and (iv) a methanol fuel cell for low-generation scenarios.

The FLS200 has been fitted with: (i) ZX LiDAR ZX300M, (ii) Vaisala meteorological station, (iii) Nortek current profiler Signature 250, (iii) A+D wave sensor, (iv) KVH Compasses, (v) Garmin GPS, and (vi) Li-Cor pyranometer.

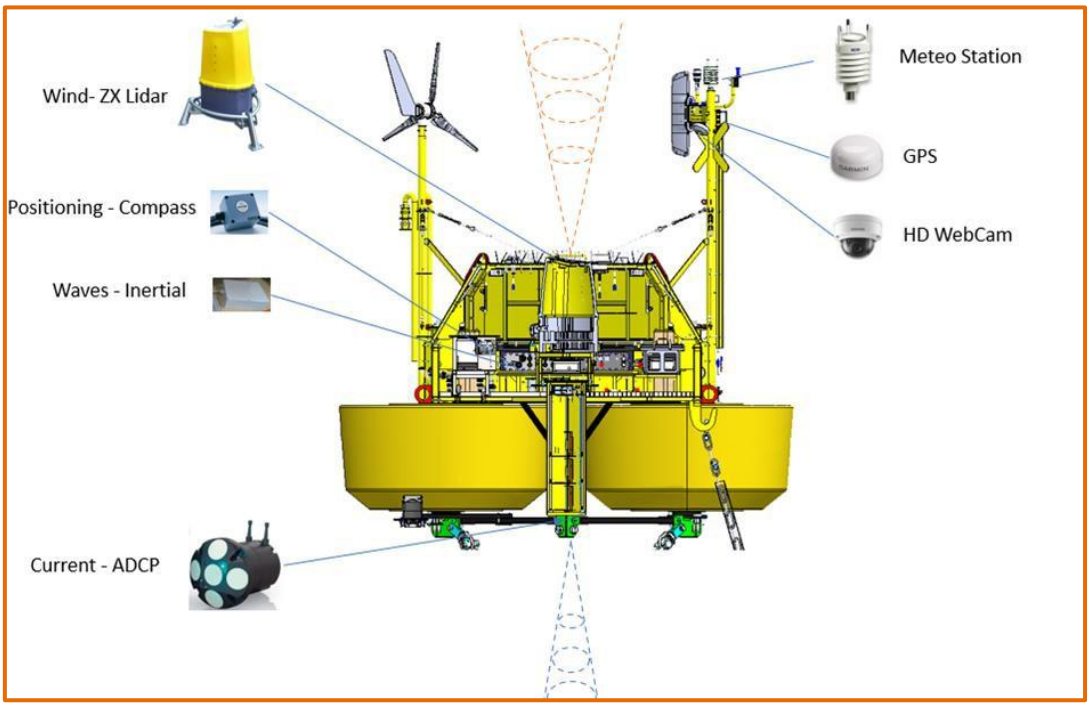

Figure 8: FLS200 E42 main sensors layout.

The measurement configurations of the Lidar device and the ADCP device are to be documented and approved by the Client in the Measurement Plan.

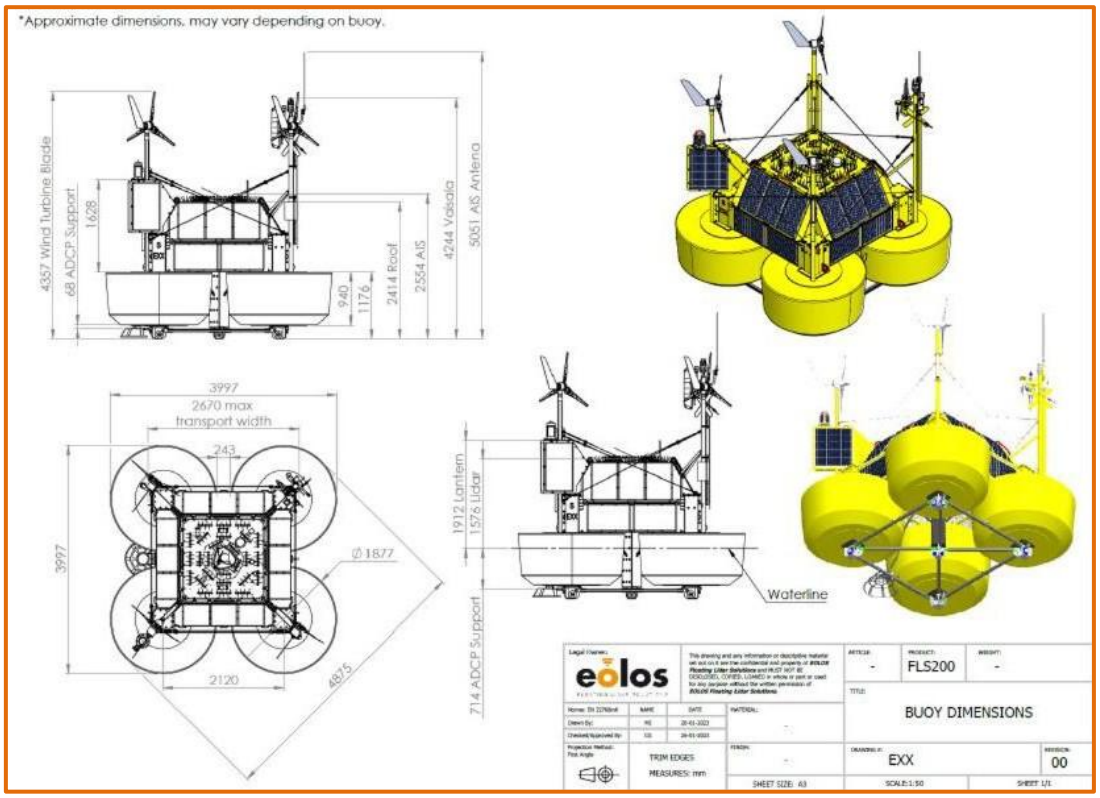

Figure 9: FLS200 technical drawings.

5.1.1. FLS200 buoy mooring

5.1.1.1. Upper mooring (standard)

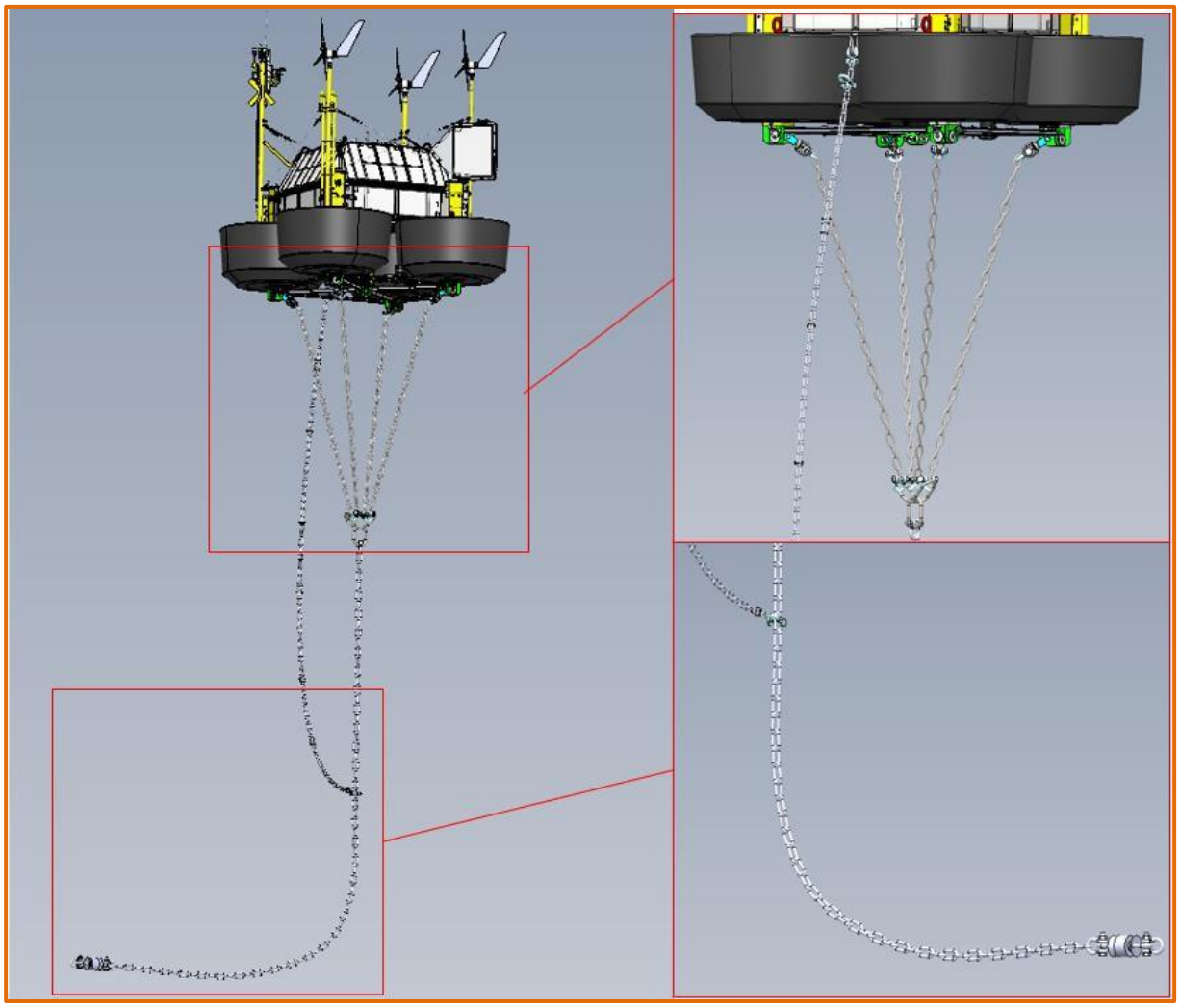

Figure 10: FLS200 upper mooring arrangement.

5.1.1.2. Lower mooring (site specific)

The site-specific mooring system is currently being designed by the EOLOS mooring department and it will be included in this Project Execution Plan once it has been completed. London Marine Contractors (LMC) has been designated as a third-party consultant to review and validate the EOLOS design.

6. Marine operations

Marine operations are critical for the success and development of the project. Proper planning and execution are essential to achieve an early and efficient deployment, minimizing delays, and maximizing data availability throughout the LNEG desired period. These operations include all activities related to transportation, deployment, maintenance, and recovery of the buoy, ensuring that the equipment is correctly positioned, functioning, and maintained to gather reliable data for the project duration.

6.1. Weather window identification

Detailed weather forecasts must be in place prior to all vessel operations. This includes deployment, recovery and offshore maintenances. This forecast report shall have a minimum forecast look ahead of 5 days, and can come from different sources:

- Windy: A weather forecasting tool that provides detailed meteorological information by aggregating data from multiple weather models. For this LO4 project the ECMWF Integrated Forecast System (IFS) will be used. It is a global numerical weather prediction model employing spectral methods for atmospheric dynamics and a semi-Lagrangian scheme for advection. It operates on a hybrid vertical coordinate system and utilizes 4D-Var data assimilation for optimal integration of observational data. The model's resolution typically reaches ~9 km (T1279) for deterministic runs and ~18 km (T639) for ensemble forecasts, with up to 137 vertical levels extending to the mesosphere.
- Storm Geo: Offers site-specific forecasts with reliability indexes that help improve the offshore operations planning. When crosschecked with Windy, it gives Eolos more certainty in harsh seas or during winter months.
- Other site-specific forecasts.

When the project requires and offshore operation, the project manager will inform the O&M lead of the imminent need for a vessel and team. The weather is then monitored by both, PM and O&M, until favourable conditions appear. As a general guide the following limits apply depending on the nature of the operation.

Transit or tow / Offshore lifts

- Max wave height [m]: 1.5 / 1
- Significant wave height[m]: 1.0 / 0.8
- Max wind speed[kn]: 15 / 13
- Max wind gusts [kn]: 19 / 17

Beaufort wind scale	Mean Wind Speed		Limits of wind speed		Significant wave height (Hs)	Maximum wave height (Hmax)	Seastate
	Knots	m/s	Knots	m/s	meters	meters	
0	0	0	<1	<1	-	-	0
1	2	1	1-3	1-2	0.1	0.1	1
2	5	3	4-6	2-3	0.2	0.3	2
3	9	5	7-10	4-5	0.6	1.0	3
4	13	7	11-16	6-8	1.0	1.5	3-4
5	19	10	17-21	9-11	2.0	2.5	4
6	24	12	22-27	11-14	3.0	4.0	5
7	30	15	28-33	14-17	4.0	5.5	5-6

Table 6: Weather Threshold for EOLOS Operations

Surface current speeds are desired to be below 0.8 m/s. Special consideration must be made with respect the RAMS and actions to follow when the buoy is recovered/dropped as current might influence the positioning with respect the vessel.

The Beaufort scale is used to categorize the weather conditions reported in every operation at site which takes as input the wave height, wind speeds and environmental parameters to assign a value from 1 to 10. Any value above 4 is considered beyond the threshold set to safely conduct any operation.

The length of the weather window must match the estimated duration of the marine operation, including the time needed to halt it if necessary. Offshore servicing is critical, as the buoy is typically on deck with the mooring already deployed, making it more time-consuming to redeploy the buoy in the event of an unforeseen incident.

If a favourable weather forecast is available, and the length is appropriate for the task, the following steps apply prior to mobilisation to site:

a) 72 hours RAMS is prepared and sent to the client and the vessel.
b) 48 hours notify port authority of intended operations.
c) 24 hours all materials shall be loaded, inspected and prepared for transit to site.
d) 12 hours decision made to transit to site
e) 0 hours final weather forecast reviewed and go no go decision made.

6.2. Mitigation

EOLOS understands the dynamics and complex nature of offshore weather conditions, and this is expected to play a key role in the development of the project and the operations of deployment, maintenances and recoveries. Thus, EOLOS has an entire department (O&M) that closely monitors the weather through the above-mentioned sources and work side by side with the Project Managers to identify the needs of the project.

The potential drawbacks of sailing and operating under extreme weather conditions far exceed the benefits from taking the risks, and EOLOS operate under a policy of nil incidents and accidents throughout the entire campaign.

If offshore operations are scheduled, such as deployment of the system or preventive maintenances, Dutch Marine Contractors (DMC) is contacted to trigger the search of the vessel. This is done far in advance to locate vessels finishing other contracts to guarantee vessel availability by the time of operations. If weather conditions are not acceptable, but they are forecasted to end soon, EOLOS remains in standby until is safe to sail out.

Conversely, especially when corrective actions on the buoys must be done, EOLOS will is to lower the impact on the project. This is done by a negotiation with the Marine contractor and the vessel owners to ensure the following:

- Availability of slightly bigger vessels with DP and better behaviour to waves.
- Book high skilled and experienced vessels working with floating Lidars.

EOLOS maintenance schedules as seen in the section 6.4 Maintenance and Operational Methodology aim to foresee well in advance the upcoming operation, allowing the operational team to organise the logistics to have all material ready to service the buoys at any time. The goal is to service the buoys when weather is expected to be mild and reduce the offshore operations during winter months.

The Vessel Master will have the right and responsibility to make the final decision on whether the operation can be safely conducted based on his/her knowledge of the vessel capabilities and, his/her marine experience.

Figure 11: EOLOS FLS200 onboard a multicat.

6.3. Offshore operations strategy

The measurement campaign will last 12 months, and it typically includes the deployment, recovery and scheduled services at 6 months intervals. For this campaign, the tentative schedule would be:

- Deployment
- 6 months scheduled service
- Recovery

Marine operations will described in detail in the documents:

- RAMS for campaign deployment.
- RAMS for campaign recovery
- RAMS for maintenance

Each of these documents includes the different considerations, technical aspects, resources, and tools to execute the different operations and including risks already identified, its avoidance and mitigation.

When marine operations take place, EOLOS will report its outcome in the following documents:

- Deployment report
- Recovery report
- Maintenance report
- Daily Progress Report

6.4. Maintenance and Operational Methodology

Every works on the buoys is described in the operational plan developed by O&M department and specifically designed following the flow diagram presented in this section.

EOLOS reserves the right to move back and forth maintenance activities to optimize its operations, always under the premise to comply with HSE requirements and keep data availability to a maximum value.

The buoys are daily monitored by the data team and reference engineers, who notify everyone related to the project when there is anomalous behaviour or warnings raised by the system itself. EOLOS diligently plans unscheduled operations to fix whichever alarm must be mitigated. More details on monitoring can be found in the following sections.

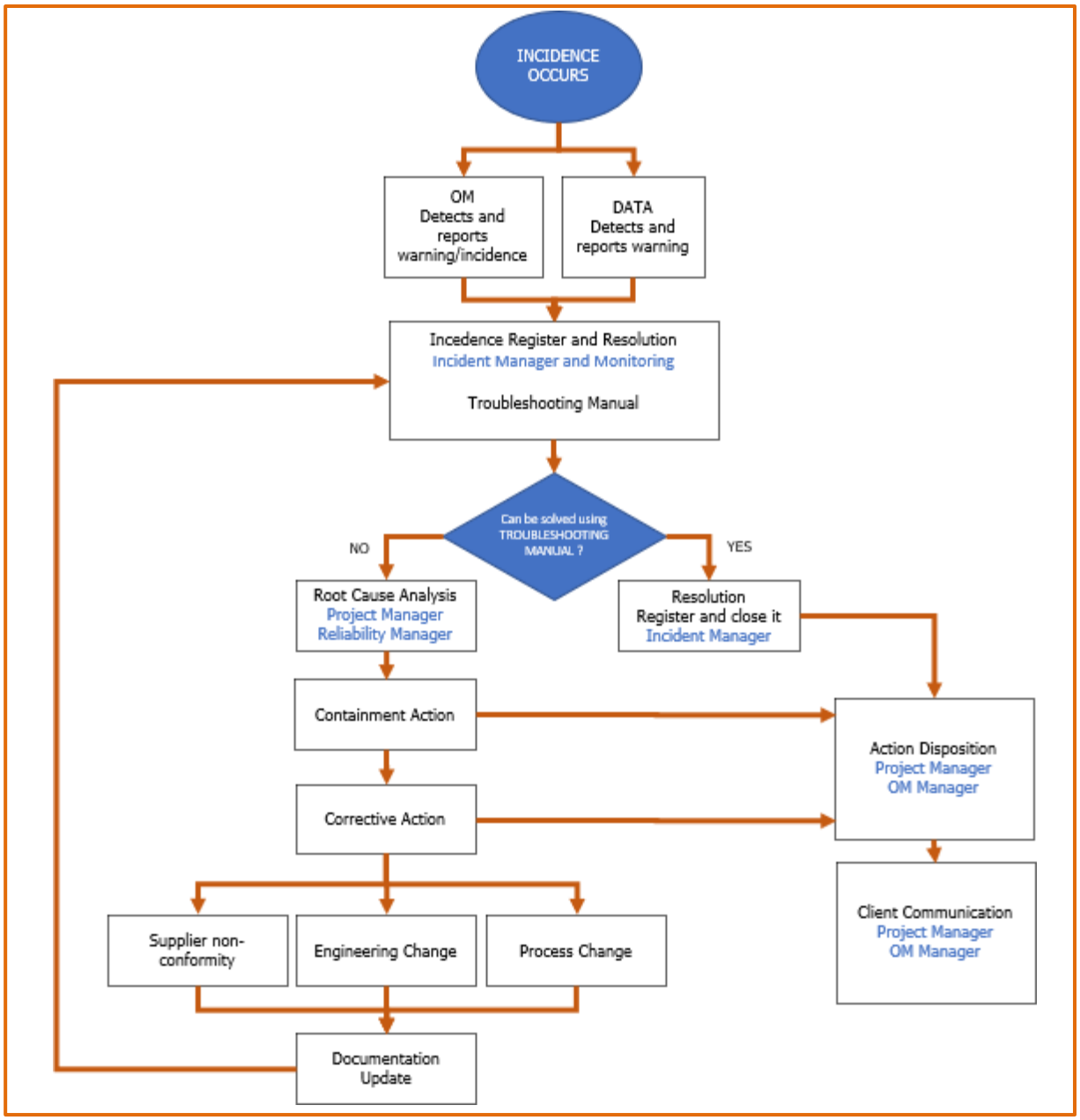

Figure 12: O&M flowchart.

6.5. EOLOS Operational Centre

EOLOS will work from its base port located at Aveiro to optimize the operations during the campaign.

Figure 13: EOLOS FLS200 buoy at port

6.6. Vessel for Marine Operations

EOLOS will ensure to hire local vessels (if available) through its marine contractor, Dutch Marine Contractors (DMC). A reduced number of multipurpose vessels can be used by EOLOS as part of the regular operation of deployment, recovery, and maintenance, with these being mainly Multicat vessel and Tugs fitted with offshore cranes, however, also crane barges and some offshore supply vessels could be used.

In order to provide evidence that the vessel status and capabilities fall within acceptable parameters of conformity, EOLOS stablishes a set of minimum requirements with respect vessel documentation listed below:

- CMID OVID, or equivalent inspection such as EOLOS suitability assessment.
- Hull and Machinery insurance.
- Protection and indemnity insurance.
- Crane specifications thorough examination - SWL testing.
- Safety management system (according to ISM or local flag).
- Safe manning document.

- Crew certification and list crane operator included:
  - SCTW.
  - Bosiet.
  - OWC.
- Ship registry certificate.
- Class certificate.
- Crew rest of hours.
- Vessel workboat certificate.
- Vessels contact details: mail, phone, SAT phone.

The minimum vessel capabilities are defined by EOLOS and transmitted to DMC to seek vessels for every operation. Considering the buoy characteristics, the vessel must have, as a minimum:

- Open deck (stern /bow)
- Crane capable of lifting >7 mT over the open deck
- Winch capable with a pull force >10 t
- Deck area > 50 m^2

Figure 14: Portuguese based tug vessel Castelo de Óbidos (Rebonave).

Figure 15: Spanish based multicat vessel Fenix Vigo (Northcom Diving).

7. Measurement campaign, data management, monitoring and data provision chain

The main goal of the project is to provide LNEG with a 1-year long metocean bankable data. Data measurements, management, processing and delivery are the most important aspect of the Lote 4 project.

7.1. Data acquisition

The measurements campaign will last 12 months, and data will be measured by deploying an FLS200.

The Measurement Plan is the standard EOLOS document that describes data conventions, sensors configurations, data files formats and data deliverables across the entire campaign.

The sensors that will be installed in the LO4 buoy are:

Sensor	Brand	Location
Lidar	ZX	FLS200
ADCP	Nortek	FLS200
Wave sensor	A+D	FLS200
Meteorological station	Vaisala	FLS200
Pyranometer	LiCor	FLS200

Table 7: Measurement sensors installed on the FLS200.

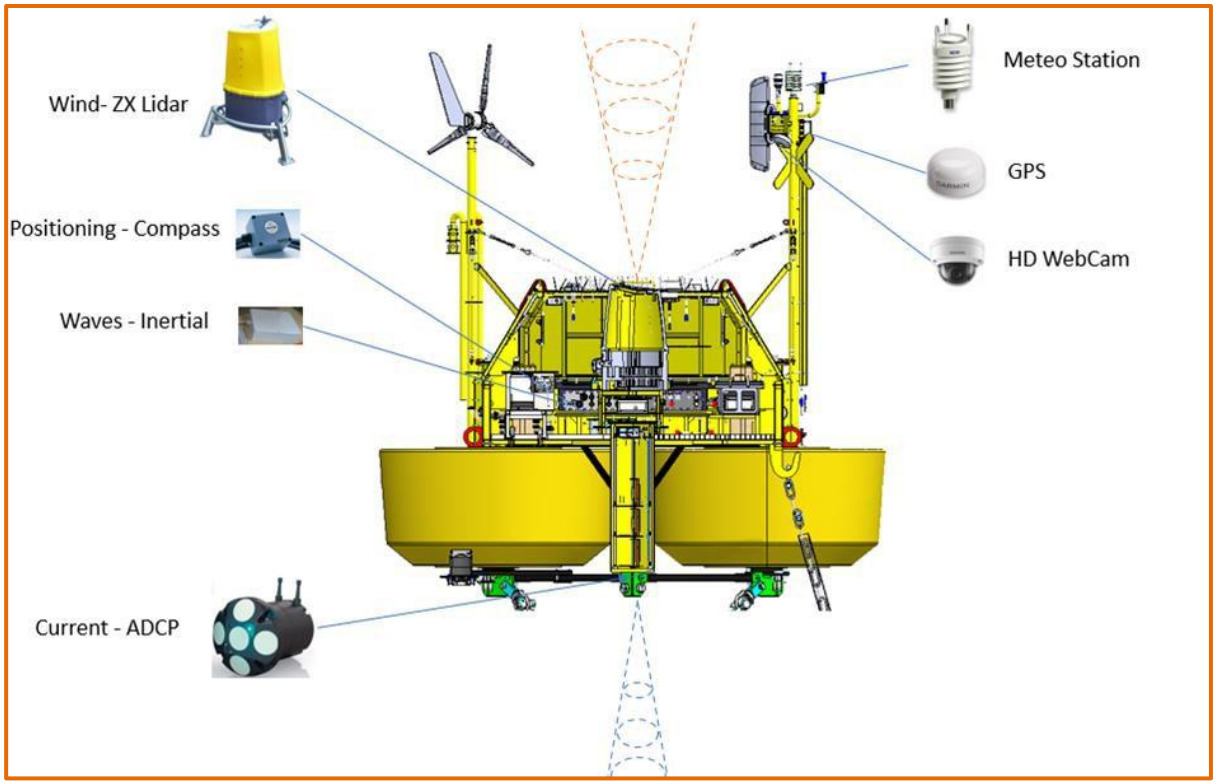

Figure 16: FLS200 main sensors layout.

Each sensor measures at regular intervals and frequency as described in the Measurement Plan, and can be subdivided into two sections:

- Data accessible remotely: These data are the average 10-min or 30-min files which are sent to EOLOS servers and are used for monitoring and updating data portals. Data sets are updated daily (every 48 h).
- Data stored within the system/sensors: These data include average and high frequency data. Datasets will usually be downloaded at regular intervals (scheduled maintenances) or at the end of the campaign, after the buoy recovery.

Data stored within the sensors (Lidar, wave and ADCP) also works as a backup copy that is recovered after accessing physically to the buoy.

The measurement principles of all the sensors mounted on the buoy EOLOS FLS200 are explained in more detail in the complementary document EOL-DOC93-V04-PROD-Sensors measurement principles and specifications [7].

7.2. Monitoring

The FLS200 system is composed of different subsystems, each with its own function and monitoring capability. Some subsystems may be designed to be monitored remotely onshore, with status messages or similar being sent via the internet.

These same subsystems may or may not be for measurement, i.e., producing quantitative observations to meet the project objectives. Malfunctions or outages detected in measurement subsystems will always cause an incident notification toward LNEG because they affect the data. Malfunctions or outages detected in non-measurement subsystems will not generate an incident notification toward LNEG if: (a) there is no effect on the data; and (b) there is a design redundancy still available.

Below table displays the subsystems and how monitoring works:

	Monitored remotely	**Not monitored remotely**
Measurement systems	Lidar ADCP Wave Meteorological station GPS Pyranometer	
Non-measurement systems	Communications: Neptulink (4G) Communications: Iridium Energy: Wind generators Energy: Solar panels Energy: Battery racks Energy: Fuel cell Dataloggers	AIS Lantern Corrosion protection Mooring TRBM structure

All those subsystems that are not monitored remotely are going to be accessed physically at the interval given in the O&M operations schedule. If data can be retrieved, it will be shared with LNEG.

There are various scenarios which may cause the buoy to travel outside of its drift radius (buoy adrift), most commonly due to mooring failure.

Any instance of buoy adrift sends an alarm to EOLOS Project Manager, Operations & Maintenance Manager, and Operations Director via the Smartone system. The alarm is repeated every hour while the buoy remains outside its programmed drift radius.

The section below shows how the FLS200 communicates with EOLOS HQ

7.3. Data management

The data flow at EOLOS follows the pattern as shown below:

Figure 17:

Data is measured by sensors deployed offshore by different devices. The sensors gather data in a raw format that is delivered to the FLS200 control units, the dataloggers. Data is then merged, packed and sent to EOLOS on-land servers by different telemetry system. If the buoy is closer to shore, 3G/4G communication is used, otherwise, the Iridium satellite antennas are used. Eolos has redundancy communications systems to avoid interruptions in data transmission. The following image shows which data can be recovered using several communications channels.

		Master	Slave	Lidar	Wave	ADCP
Telemetry	3G					
	Iridium					
In situ data recovery	Wi-Fi / cable					
	Internal memory					

Figure 18: FLS200 communication channels.

Once on land, the post processing is applied, which includes filtering to ensure data quality. Some of the filters are included in the sensors themselves, while others are implemented by EOLOS. Additionally, the Lidar measurements are corrected for tidal variation and the magnetic declination corrected to reference all measurements to true north.

More details on filtering and post processing can be found at EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan [8].

7.4. Data reporting and deliverables

Data will be delivered for the LO4 project at different intervals and in standard text format .dat, with the following names:

- *EOLOS_START-DATE_START-HOUR_END-DATE_END-HOUR_hour.dat*

If preferred by LNEG the data files can also be provided in .csv format.

7.4.1. Daily data reporting

Data will be automatically uploaded to Eolos connect portal.

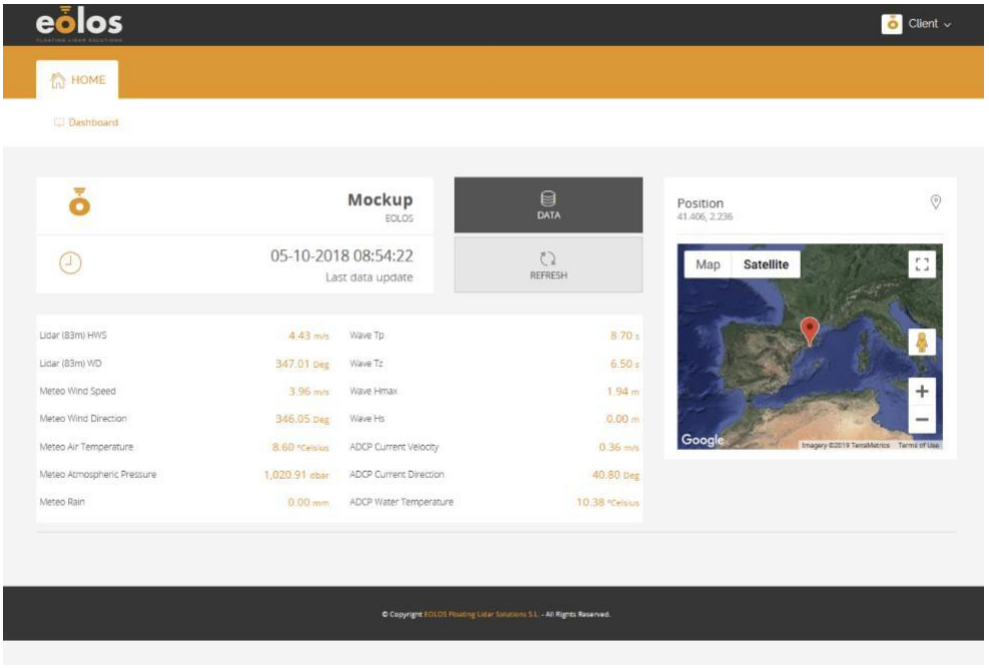

Figure 19: EOLOS Connect portal overview.

EOLOS Connect is a visualization portal only and no data can be downloaded.

The data files will be uploaded to the BOX (EOLOS cloud server) shared folder with LNEG:

01.PROJECT.DATA\EOL-LO4-PROJECT.DATA\E42\DAILY DATA

7.4.2. Monthly Reports

Monthly datasets will be uploaded to the BOX shared folder with LNEG:

01.PROJECT.DATA\EOL-LO4-PROJECT.DATA\E42\MONTHLY DATA

And monthly reports will be uploaded to the following BOX shared folder:

02.PROJECT.MANAGEMENT\E42-LO4\Monthly Report

7.4.3. End of campaign

Summary Report and datasets will be uploaded to BOX, following the same fashion as described in previous sections.

8. Project Document Control

Document control for the LO4 project will be the responsibility of the project manager, who will follow up across the entire project.

The documents are identified as IFI (Issued for information), IFA (Issued for Acceptance) or IFR (Issued for Review), and will be named with the following structure.

EOL [PROJECT NAME] [VERSION] OPS- [NAME OF THE DOCUMENT]

- Version 00 for internal use only, 01 and above for external communications.
- First page including Author and Revised by person.
- First page including version control.
- First page including date.
- First page including title and pages.

The Project Manager is the owner and responsible to create, archive, review and maintain the folder and its documents. Documents will be created by the core team and the support team depending on the technical/area of discipline and the PM will be communicated for the review and classification process.

8.1. Document deliverables

Documents are to be provided according to EOL-LO405-V01-OPS-Document Deliverables Plan [9].

9. Risk Management Environment, Safety & Health / Emergency Situations

The HSE plan needs to be placed to guarantee safety management on site during all operations. HSE detailed plan for the LO4 project is described in detail in:

1) EOL-LO406-V01-OPS-HSE Plan [12].

A detailed procedure to follow in case of potential emergency situations including all project emergency contacts and emergency considerations included in:

2) EOL-LO406-V01-OPS-Emergency Response Plan [13].

For all offshore operations, the following documents need to be fully read, understood, and agreed by main personnel on board of the operations vessel:

3) RAMS for FLS200 Operations.

9.1. INCIDENT AND EMERGENCY REPORTING

9.1.1. Buoy incidences

In case of technical malfunction incidents, LNEG will be informed by EOLOS at the Project Management level within the following due dates:

Action	Due Date	Deliverable
Verbal communication	Within 48 hours of alarm	Email
Indent notification report	Within 72 hours of alarm	Incident notification
Unscheduled visit after incident notification	Within 15 calendar days of notification (weather dependant).	RAMS ERP
Maintenance report after unscheduled visit	Within 15 calendar days of unscheduled visit.	Maintenance report

Table 8: Notification due dates for technical malfunctions

Technical incidents will be notified only:

1) If the incidence triggers maintenance.
2) If the incidence represents a danger to navigation.
3) If the incident affects communication/ dataflow.

9.1.2. Accidents

Emergency situations or accidents at or near the Lote 4 deployment location impacting people (LNEG, EOLOS, third party) or environment will be reported to LNEG at the Project Management level immediately.

The first and most important action after an incident will be securing safety of personnel. Immediately after LNEG and EOLOS will then initiate respective emergency response plans.

More details on the flow of information and procedures can be found at the Emergency Response Plan (ERP) and Health and Safety pan (HSE).

10. Project Quality

10.1. The FLS200 Buoy

Quality documentation related to the buoy and its hardware can be found in the following standalone documents:

- Factory Acceptance Test (FAT) Report
- Port Acceptance Test (PAT) Report
- Site Acceptance Test (SAT) Report

These are issued by EOLOS toward LNEG on a for Information basis (IFI).

EOLOS' priority is to deliver industry-credible data to the Client. To meet this objective, data management and delivery operates with two core documents:

- EOL-DOC114 Data Quality Control Procedures, which describes how EOLOS – independently, or based on instrument OEM know-how – assesses a data observation as valid or invalid (i.e., flagged).
- The Project-specific Measurement Plan, which details the specific measurement parameters customized to suit the relevant Client contract or Client needs.

10.2. Subcontracted Services

Marine operations are one of the most critical activities carried out by EOLOS in order to execute the measurement campaign. Therefore, in line with the EOLOS purchases procedure and the EOLOS standard Scope of Work for marine contractors, the minimum requirements for any work vessel contracted by EOLOS are:

a) CMID
b) Crane working diagram
c) Certificate of registry
d) Certificate of classification
e) Certificates of insurance
f) Evidence of insurance
g) Attestation of Cargo Gear Survey
h) Crew Certification (GWO, BOSIET, or STCW) – 4 modules (firefighting, sea survival, first aid, manual handling)
i) LOLER certification of lifting elements or crane through examination

11. Permits

11.1. Permit for deployment at site

LNEG is responsible for the process to acquire the permit (*Título de Utilizaçao Privativa do Espaço Marítimo* – TUPEM) to deploy the assets on site for the duration of the measurement campaign.

11.2. Navigational Aids Permit

EOLOS is responsible to acquire the AIS licence for the AtoN devices mounted on the buoy and will process it with the corresponding authorities.

12. Payment calculations

According to the Contract D26805 the following milestones should be paid:

Milestone	Description	Payment calculation
Project Execution Plan	EOLOS delivers to LNEG the Project Execution Plan within 20 days after the contract signature.	374,500.0 €
Deployment Report	After the successful deployment of the FLS200 E42 at the LO4 site, EOLOS provides LNEG with the Deployment Report.	74,900.0 €
Monthly Reports 1-12	Monthly invoices upon receiving the monthly datasets and associated report.	42,800.0 €/month
Recovery and final report	Upon completion of the data measurements campaign and issuing the final data report.	107,000.0 €

Figure 20: Contractual project invoiceable milestones.

Payment calculation for the monthly reports will be issued along with the monthly reports and the data sets after two weeks of the current month.

The following payment calculation will be used to determine the monthly rate to be paid upon reception of the monthly data sets and reports, based on the LiDAR wind speed and direction post-processed data availability at 140 meters (or another agreed reference height, which will be included in the Measurement Plan):

Wind Speed and Direction post-processed data availability at 140m	Payment (% of the monthly fee)
>85%	100% * Monthly fee

<85%	$$Penalties = Monthly\ fee * \left(\frac{Penalty * Unavailable\ time\ stamps}{Reference\ time\ stamps}\right)$$ Being • Penalty: 5% • Unavailable timestamps: In a period of 12 months, the number of time stamps not registered assuming as a reference one year of data recorded in a 10-min interval. • Reference time stamps: number of time stamps in a 30 day month, assuming in this case the value 4320.

References

[1] EOL-LO402-V01-OPS-FAT PAT SAT Examples.

[2] OWA Roadmap for the Commercial Acceptance of Floating LiDAR Technology (2018).

[3] IEC 50.4.

[4] 3rd party assessment of Stage-3 maturity achievements of the EOLOS FLS-200 Floating LiDAR Buoy according to the “Carbon Trust Offshore Wind Accelerator Roadmap for the Commercial Acceptance of Floating Lidar Technology”, MV-3005-PV1-065-TN-001-C.

[5] EOL-LO403-V01-OPS-As Installed.

[6] EOL-LO404-V01-OPS- Mooring Design Report_LO4 Site.

[7] EOL-DOC93-V04-PROD-Sensors measurement principles and specifications.

[8] EOL-DOC114-V05-PROD-Data Quality Control Procedures and the Measurement Plan.

[9] EOL-LO405-V01-OPS-Document Deliverables Plan.

[10] EOL-LO406-V01-OPS-HSE Plan.

[11] EOL-LO406-V01-OPS-Emergency Response Plan.