



PLANET
LIGHTING



FOCUS INTEGRAL: FI1 & FI2

MANUAL

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1 INTRODUCTION

This manual describes how to install, operate and maintain the Focus Integral sea cage light from Planet Lighting (referred to throughout this document as the 'Product'). Prior to installation please carefully read through all the instructions in this manual.

1.1 PURPOSE OF THE LUMINAIRE

The Focus Integral luminaire is engineered to enhance aquaculture by delivering controlled photoperiod and optimized illumination in sea-cage environments.

- Lifecycle management: Uniform lighting helps reduce sexual maturation and supports efficient growth.
- Improved fish welfare: Underwater illumination encourages fish to swim at greater depths, reducing parasite exposure.
- Enhanced feeding behaviour: Research demonstrates that tailored light regimes—optimised for intensity, light distribution, spectrum and duration—can improve feeding patterns, growth rates, and feed conversion across aquaculture species.
- Operational support: The luminaire provides reliable lighting for underwater cameras used in remote feeding management and cage inspection.

Delivering up to 70,000 lumens with soft-start capability, the Focus Integral integrates all components into a compact, sealed unit that requires no external gear. It offers high reliability, minimal maintenance, and robust performance from standard to deep-water sites.

1.2 SCOPE OF THE MANUAL

This manual provides guidance for the correct installation, operation, and maintenance of the product. It is intended for end users and farm operators responsible for deploying and managing Focus Integral units in active farming environments.

This edition includes a dedicated installation section aligned with the requirements of NS9415, UL676 and other applicable international standards. It also expands on product deployment on deep farming sites, addressing handling, installation, and performance considerations in high-pressure and low-light conditions.

This manual covers routine operation, safety measures, inspection procedures, and basic troubleshooting. It does not include advanced servicing or non-approved system modifications.

Always follow site-specific protocols and regional regulations when installing or operating Focus Integral (FI2) equipment.

1.3 APPLICABLE STANDARDS & CERTIFICATIONS

The Focus Integral luminaire has been developed and tested in alignment with key standards covering electrical safety, electromagnetic compatibility, ingress protection, and aquaculture-specific requirements.

Compliance has been certified with the following standards:

- EN 61547 – Electromagnetic immunity requirements for general lighting. Confirms reliable operation in the presence of voltage dips, surges, and RF interference.
- EN 55015 – Limits and methods of measurement for electromagnetic emissions from lighting equipment, ensuring low interference with other systems.
- IEC 60598-2-4 – Particular requirements for luminaires for use in aquariums and similar environments, including construction, safety, and performance under immersion conditions.
- IP68 – Ingress Protection rating verifying full protection against dust and long-term immersion in water under pressure.

Compliance with the following standards is self-certified by the manufacturer:

- Where relevant, the product complies with Norwegian Standard NS9415 for floating aquaculture farms.

The product carries the following compliance marks:

- CE mark indicating compliance with standards for sale in the European Economic Area.
- RCM mark for products marketed in Australia and New Zealand, confirming electrical safety and EMC compliance.

The Focus Integral is designed to operate safely and reliably in demanding marine environments and will be updated to reflect further completed certifications as they are confirmed.

2 SAFETY INFORMATION

 **Important:** Read all safety instructions before installing or operating the Focus Integral luminaire. Failure to follow these warnings may result in injury, equipment damage, or loss of compliance with applicable standards.

2.1 OPERATOR QUALIFICATION

The following qualification requirements are based on the definitions given under the 'Glossary of Terms' (section 12.4 on page 40). The qualification requirements for various tasks relating to the Product are as follows :

Installation: SERVICE PERSONNEL

Use: OPERATOR

Cleaning: OPERATOR

Routine maintenance: SERVICE PERSONNEL

Special maintenance: SERVICE PERSONNEL

Disposal: RESPONSIBLE ORGANISATION and SERVICE PERSONNEL

2.2 SAFETY SYMBOLS AND CONVENTIONS

The following safety symbols are used throughout this manual. They highlight important warnings and instructions for the safe installation and operation of the Focus Integral luminaire. Always follow the guidance associated with each symbol.

Symbol	Meaning	Description
	Electrical Safety	Warns of electrical hazards. Always disconnect power before installation or service.
	Underwater Use Only	Indicates that the luminaire must be operated underwater and within limits.
	Thermal / Overheating Protection	Highlights risks related to overheating. Do not operate outside water; thermal protection will engage if overheated.
	Handling & Installation	Identifies requirements for safe handling, mounting, and installation.
	Photobiological Safety	Warns of bright and blue light hazards. Do not stare directly at the light source.
	Diver Safety	Used to mark guidance specifically for divers working around luminaires in sea-cage environments.
	Marking & Labels	Indicates that product labels and compliance markings must remain visible and legible.
	Cleaning	Follow cleaning guidance carefully to prevent damage during cleaning.
	General Warning	Indicates important safety information. Pay special attention to the accompanying text.

2.2.1 Electrical Safety

- The Focus Integral contains hazardous voltages within a sealed metal enclosure.
- Always disconnect the power supply before handling, installing, or servicing the luminaire.
- POWER OFF equipment immediately if damaged. If equipment is suspected damaged by machinery or force,



operators should take steps to ensure the system is completely powered off before commencing salvage.

- Beware of loose and damaged connectors. Always ensure that the AC connector is installed correctly, the connector is secure and the internal seals are in good condition.
- Fill connectors with encapsulant where possible for additional water ingress protection.

2.2.2 Underwater Use Only

- DO NOT run lights out-of-water under any circumstances. Ensure the Focus light is fully submerged before operation. The Focus Integral sea cage light is designed to run UNDERWATER ONLY.
- Operating the unit outside water may cause overheating or equipment failure and void warranty. Operation out-of-water may lead to BURNS or PERMANENT INJURY.
- Open water under 20°C is required to maintain a compliant running temperature.
- The Focus Integral Generation 2 (FI2) is rated to 60m max depth. The Focus Integral Generation 1 (FI1) is rated to 20m max depth.

2.2.3 Thermal / Overheating Protection

- The Focus Integral is equipped with internal thermal throttle circuits which will dim light output to protect the product during an over temperature event.
- Operators of the equipment are advised not to rely on the thermal throttle feature for protection. Always operate the product under water.
- Each thermal throttle is autonomous and does not require resetting.
- During normal operation immersed in water within specified operating temperature (up to 20°C), the thermal throttle circuit will not trigger. A thermal throttle event in these conditions may be a fault, and the unit may require service.
- The thermal throttle protects your equipment. Attempts to bypass or disable overheating protection features will void warranty.

2.2.4 Handling and Installation

- Do not attempt to open or modify the luminaire. There are no user-serviceable parts, all service and maintenance tasks are to be completed by authorised SERVICE PERSONNEL.
- Use only approved mounting methods and accessories as specified in this manual.
- Ensure flexible wiring connections are securely fixed and protected against mechanical strain.
- Never suspend the light via its power cable only. The Product cable strain relief is not designed as a substitute for appropriate suspension of the light.

2.2.5 Photobiological Safety

- Risk of Permanent Eye Damage. DO NOT look into the light fitting when powered. The LED emits extremely bright light which can cause damage to the retina.
- The luminaire has been assessed under IEC/TR 62778 and is classified as Risk Group 2 for retinal blue-light hazard.
- Do not look directly into the light source at any range.

2.2.6 Diver Safety

 **Important: Divers working in sea-cage environments where Focus Integral luminaires are installed must follow strict safety procedures to prevent injury.**

- Divers must avoid looking directly into the light source. The luminaire produces high-intensity illumination that can cause temporary or long-term eye damage.
- Always switch off and isolate power to all luminaires before divers enter the water. Confirm isolation at the control point before commencing work.
- Divers should operate their own personal light source in such a way as to reduce glare and improve vision whilst servicing the luminaire.

2.2.7 Marking and Labels

- Always retain product labels and safety symbols.
- If labels become damaged or unreadable, contact the supplier for replacements.
- The product label will indicate the maximum depth rating of 60m for the Focus Integral 2, and 20m for the Focus Integral 1. If the label is damaged or unreadable, the FI2 or FI1 product code that is stamped into the product can also indicate this difference.

2.2.8 Cleaning

- Turn OFF the light before commencing any cleaning, service or maintenance.
- Do not use abrasive products, petrol, paint thinners, alkaline detergent, acidic cleaning agents or aldehydes. Make sure the proportions of the detergents/cleaning agents are accurate based on manufacturer's instructions.
- The disinfectants/cleaning agents may contain substances harmful to health: use disinfectants only recommended by your health authorities and follow the manufacturer's user instruction carefully.
- After use of any cleaning fluids including water, visually confirm that no fluid ingress has occurred into the LED chamber or any electrical connections. Then use an adequately protected circuit to carefully confirm that the product powers up safely and without fault.

2.2.9 General Warnings

2.2.9.1 Service Personnel

ONLY authorised SERVICE PERSONNEL are permitted to carry out maintenance on Planet Lighting products. Planet Lighting disclaims all liability for any injury to persons or damage to things caused by the Product having been installed or maintained by persons who are not authorised SERVICE PERSONNEL.

2.2.9.2 User safety

The Product information and warnings described in this document are likely to assist in the protection of the SERVICE PERSONNEL and the Operator from injury, however these must not be relied on as the only reference or processes for user and personnel safety. Operators and Service Personal should also follow their local and workplace safety processes and Organisations strive to improve upon safety processes with their staff.

Where there is conflicting or confusing advice or an absence of relevant information, we recommend seeking out further advice or instruction from a supervisor, supplier or another suitable expert.

2.2.9.3 Warranty and liabilities

Planet Lighting disclaims all liability with regard to unreliable Product operation in any of the following cases:

- Installation, modifications, and repairs have not been performed by SERVICE PERSONNEL.
- The Product has not been used for its intended purpose and in conformity with these operating instructions.
- The Product is run whilst out of water.
- The electrical system supplying the lights does not deliver an input voltage within the range specified.
- The electrical system supplying the lights does not comply with local laws and regulations.
- The electrical system does not adequately manage the electrical earth, risking corrosion via electrolysis.
- The electrical system has been wired incorrectly.
- Where modifications or adjustments have been made to the Product without permission from us.

2.2.9.4 No Modification

No arbitrary structural changes, modifications or variations to the Product are permitted without prior written authorisation from the manufacturer. In the case that the Product has been tampered with, the warranty shall be invalidated and the manufacturer disclaims all liability for any injuries or damage caused.

2.3 ENVIRONMENTAL & OPERATIONAL LIMITS

2.3.1 Packaging

The product is supplied in a collapsible, stackable crate designed for use throughout the product's lifetime. This crate should be retained for off-season storage and for safe transport to and from marine farming sites.

Any cardboard packaging associated with the shipment should be disposed of in accordance with applicable national waste-disposal regulations.

2.3.2 Transport

For ease of handling during transport and off-season storage, the product is shipped in a crate designed to stack in rows of four on a standard Euro pallet (1200 × 800 mm). Pallets may be built to various heights depending on the transport method and handling equipment available.

The product is suitable for high-altitude, low-pressure air transport and contains no hazardous fluids, meaning it requires no special handling when transported by air, road, or sea.

2.3.3 Storage

The Product must be packed, transported and stored (warehoused) in a dry premises within the following range:

Temperature (°C): -15 / +60

2.3.4 Place of installation

The environment where the Product is started up must have the following characteristics:

Air Temperature (°C): -40 / +40

Water Temperature (lighting fitting only) (°C): -15 / +20

Maximum Water Depth:

- Focus Integral 2 (FI2) up to 60m. FI2 manufactured since 2024.
- Focus Integral 1 (FI1) up to 20m. FI1 manufactured 2022 & 2023.

Minimum water depth: ensure all metal parts of the light body are immersed fully in water.

3 PRODUCT OVERVIEW

3.1 PRODUCT DEFINITION

The Product is the Focus Integral sea-cage light and its associated components—a highly efficient, all-in-one underwater luminaire engineered specifically for marine aquaculture systems. It is designed to deliver exceptional performance in a compact, lightweight form, while maintaining the strength and durability required for demanding sea-cage environments.

The Product's robust, low-mass, and energy-efficient construction provides a lighting solution that is easy to deploy, minimises maintenance, and delivers class-leading operational efficiency.

3.2 PRODUCT FEATURES

- High performance, ultra efficient LED technology designed for the sea cage.
- Modular and sustainable product design: delivered with design for disassembly, and recyclable material choices.
- Compact and lightweight for safe & easy handling.
- Slim hydrodynamic dynamic design, steady position in strong currents.
- Ultimate efficiency of up to 171 lumens per watt.
- Focused, downwelling light (~120° beam angle) creates a more natural environment for fish and improves efficiency.
- Ultra durable, low maintenance design with robust, anti-corrosion features and materials.
- Long life LED - LED Projected Lifetime > 109,000hrs.
- Automatic thermal protection.
- Adaptable to traditional metal halide or other integral gear LED + DALI installations, and existing RCD protection circuits.
- Deep water capable: Focus Integral 2 up to 60m, Focus Integral 1 up to 20m.
- Service by authorised Service Personnel only. Please contact your supplier.

3.3 KEY FEATURES

3.3.1 Efficiency

The Focus Integral has been developed with a clear efficiency objective "More light, and more useful light." This principle is realised through:

- **High-performance electronics:** Best-in-class components deliver exceptional lumen output per input watt, maximising energy efficiency.
- **Focussed design:** A performance-oriented product architecture minimises light loss, ensuring that generated light is directed where it is most effective.

3.3.2 Automatic Thermal Protection

The Focus Integral incorporates a custom electronic emitter design that provides **automatic thermal protection** to safeguard the LEDs and extend product life. When the emitter board approaches temperatures that could cause damage, the thermal-throttle circuit automatically reduces output power to **10%**.

The thermal-throttle function is intended to protect the product when operated outside of normal conditions, such as:

- when used **in air**,
- when submerged in **water warmer than the rated maximum of 20 °C**,
- when used in **restricted or stagnant water** with insufficient cooling, or
- **immediately after heating** caused by any of the above situations.

This mechanism reduces the risk of thermal damage when the product is exposed to **sub-optimal cooling**. The system has intentionally low sensitivity and **will not activate during normal operation**.

3.3.3 Soft Start

Soft start is provided as standard to benefit fish health. When powered on, the Product runs a dimming program starting at 10% of maximum output. Brightness is slowly increased at a linear rate to 100% over 30 minutes.

Note that the soft start feature will not operate if the product is connected to a DALI controller.



Note that the product has an additional 1 minute delay when powered on. In this window, the product is awaiting a signal from a DALI controller. If no signal is received, then the soft start program will commence.

3.3.4 Sustainability & Repairability

The Focus Integral has been engineered with sustainability at its core. Sustainability principles are embedded throughout the product's design and construction, including:

- Responsible material selection: In support of the circular-economy, the product is predominantly manufactured from highly recyclable materials such as aluminium, copper, and steel.
- Resource-efficient design: A compact, efficient form factor minimises overall material consumption during manufacture.
- Long-life durability: Robust, rugged components and assemblies are specified to maximise operational lifespan and reduce the frequency of replacement.
- Enhanced repairability: Components are designed for straightforward replacement, enabling cost-effective repairs, reducing waste, and extending the product's service life.

3.3.5 Low Maintenance

The marine environment is tough, and equipment needs to be properly maintained to last. Maintenance costs are a factor in the total cost of ownership for equipment used in marine farming. The Focus Integral is designed to minimise this cost.

3.3.5.1 Photonic Density & Cleaning

Biofilm growth on the optic of an underwater luminaire reduces light output and efficiency over time. Maintenance effort is required to keep this surface clean.

With the highest photonic density on the market at this time, the Focus Integral minimises biofilm growth on the optical surface (thus reducing maintenance effort).

3.3.5.2 Materials & Finish

Exposed surfaces of the product are made from materials carefully selected for use in rugged marine environments. They are selected for extreme durability, with no paint or other finishes applied. This makes the product corrosion resistant, abrasion resistant and easily cleaned.

3.3.5.3 Long Life LEDs

Planet Lighting stays abreast of the latest in LED technology from all reputable LED brands. As a result you can rest assured that our luminaires use the latest technology the industry has to offer. This in conjunction with design for optimised thermal management, delivers a long service life for our luminaires.

3.4 MANUFACTURER

The Focus Integral is designed and manufactured in Australia by Planet Lighting, an award-winning design & manufacture company established in 1911. Planet Lighting is a globally recognised supplier of advanced solid-state lighting solutions for aquaculture, architectural, and medical applications.

With a proven track record in delivering LED sea-cage lighting systems since 2012, we maintain a strong commitment to continuous product improvement and innovation.

We welcome enquiries, feedback, or requests for specialised lighting solutions. Planet Lighting is proud to support its products with exceptional service and a comprehensive long-term warranty.

3.5 PRIMARY COMPONENTS OF THE LUMINAIRE

Material Construction and Durability

The luminaire's construction avoids cosmetic finishes in favour of raw durability.

- **Marine Grade Aluminium:** The body is crafted from marine-grade aluminium alloy selected for its corrosion resistance and thermal conductivity. Notably, the exterior surfaces are left with a coarse, unpolished extrusion finish; this lack of paint or surface treatment preserves the metal's cellular alignment for optimal corrosion protection and abrasion resistance, making it easy to clean.
- **Component Materials:** High-tensile fixings utilise 316 stainless steel for corrosion resistance, while flexible components (such as strain relief) are turned from engineering-grade acetal to prevent seizing or fusing to metal parts.
- **Optics:** The lens material varies by generation to match depth requirements. The Focus Integral 1 (FI1) uses 6mm borosilicate glass, whereas the deep-water Focus Integral 2 (FI2) employs 10mm tempered glass to withstand pressures at depths up to 60 metres.

Thermal and Hydrodynamic Design

- The **physical shape** of the unit is directly tied to its performance capabilities.
- **Integrated Heat Sink:** The body acts as a thick-walled structural square tube capped by a heat sink. This design maximizes the surface area for "best in class" heat dissipation, which is critical for maintaining the lifespan of the LED board and electronics.
- **Hydrodynamics:** The unit features a slim, aerodynamic design intended to maintain a steady position even in strong currents. A low cross-sectional area (10,201 mm²) helps minimise drag, reducing strain on the suspension equipment

Mechanical Evolution: FI1 vs. FI2

The mechanical design distinguishes significantly between the two product generations based on depth rating and reparability:

- **Focus Integral 1 (FI1 - 20m):** Features a single back plate with a panel mount that supports a pluggable cable design, allowing for easy cable replacement.
- **Focus Integral 2 (FI2 - 60m):** Utilises two back plates to enclose a less repairable but more robust cable entry. This design change improves protection against water ingress for deep-water deployment (up to 60m).

Cable Management and Strain Relief

The design includes specific mechanical features to protect the electrical cabling, which is the component most vulnerable to damage.

- **Dual Strain Relief:** The system employs a stainless steel carabiner at the surface (supply end) and a turned acetal assembly at the underwater end.
- **Suspension Protocol:** The luminaire is mechanically designed to be suspended via a rope passed through the soft shackle, never by the power cable itself.
- **Cable Visibility:** The unit is typically supplied with a yellow marine-grade rubber cable to ensure high visibility on-site, reducing the risk of accidental damage from machinery or vessels.

Sustainability and Repairability

Planet Lighting emphasizes a "Design for Disassembly" philosophy.

- **Recyclability:** The fixture is over 95% recyclable, primarily using infinitely recyclable aluminium for all housing materials.
- **Serviceability:** Unlike disposable units, the Focus Integral is designed to be opened and repaired (by authorised personnel), extending its service life beyond the standard warranty period. Components are replaceable, supporting a lower total cost of ownership.

3.5.1 Drivers (Internal)

There are two LED drivers inside the product, each powering half of the LEDs on the board. The primary/supply circuit of the drivers is common. But the SELV secondary/output circuits of each driver are electrically isolated from earth, the primary and each other.

There are additional components inside the driver chamber which house the drivers securely inside the product while also providing electrical insulation and electrical connections.

3.5.2 Electrical Cable

The electrical cable has been customised for the aquaculture industry by the manufacturer. The primary customisation has been sheath and core colours to meet high visibility requests from the market and the meet CE or UL/CSA colour designations for electrical cable.

Depending on your region one of following two cable specifications will be recommended and supplied with the product when requested:

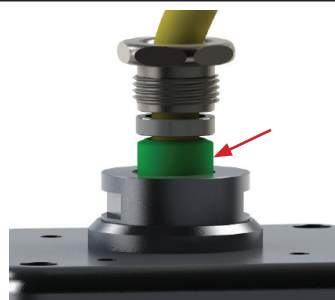
- Platinum Cables: H075G1-AM
- Tfkabel: S00W 18-5

Cable details are as per the following table:

Parameter	Platinum Cables: H075G1-AM	Tfkabel: S00W 18-5
Configuration	4 Core×1mm2+Earth×1mm2	4 Core×18 awg+Earth×18 awg
Sheathing Type	EPR/CPE	EPR/PE
Physical Construction		
Conductor Type	Tinned copper to AS/NZS 1125 (class 5)	Flexible stranded bare copper
Conductor Size	1 mm2	18 awg
Insulation Type	R-EP-90 Ethylene-propylene rubber (EPR)	EPR compound Class 3 comply with Table 8 of UL 62
Inner Sheath Type	EPDM Rubber	EPR compound Class 3
Outer Sheath Type	CPE rubber compound	PE compound Class 1.4
Core Colours	Red, White, Blue, Black, Green/Yellow	black, white, red, green, orange
Outer Sheath Colour	Yellow	black
Complete Cable		
Overall Diameter (nom.)	11mm±0.5	11.7mm
Weight	190 kg/km	183kg/km
Min. Bending Radius (during installation)	58mm	tba
Min. Bending Radius (after installation)	46mm	tba
Temperature Range (fixed)	-40°C to +90°C	-40°C to +90°C
Submersible Depth	200m	-
Electrical Specifications		
Voltage Rating (U0/U)	0.6/1 kV , 1.6/1 kV	600v
Current Carrying Capacity @ 40°C (in air)	16 A at 40°C in air	5.6A at 30°C in air
Applicable Standards		
Standards	AS/NZS 1125, IEC 60332-1-2:2004, EN60332-1-2-2004, RoHS Compliant & CE Certified	UL 62, CAN/CSA-C22.2 No 49, MSHA: UL: E123366 (CPE), CSA: 1534535 (LL 103932)(CPE), MSHA: P-7K-254013 (CPE), FT2

3.3.2.1 Cable Glands

When replacing cables use the following guide to ensure you have the correct cable gland for your preferred cable. Note the maximum allowable outer diameter of the cable is Ø13.5mm:

cable gland colour	recommended cable diameter range	
green	Ø9.5-11.5mm	
blue	Ø11.5 - 13.5mm	

3.5.3 Main External Components

Item Name:	Carabiner strain relief
Item Code:	FLS-SR
Material:	316 Stainless Steel
Description:	Carabiner, linkage, and cable clamp assembly

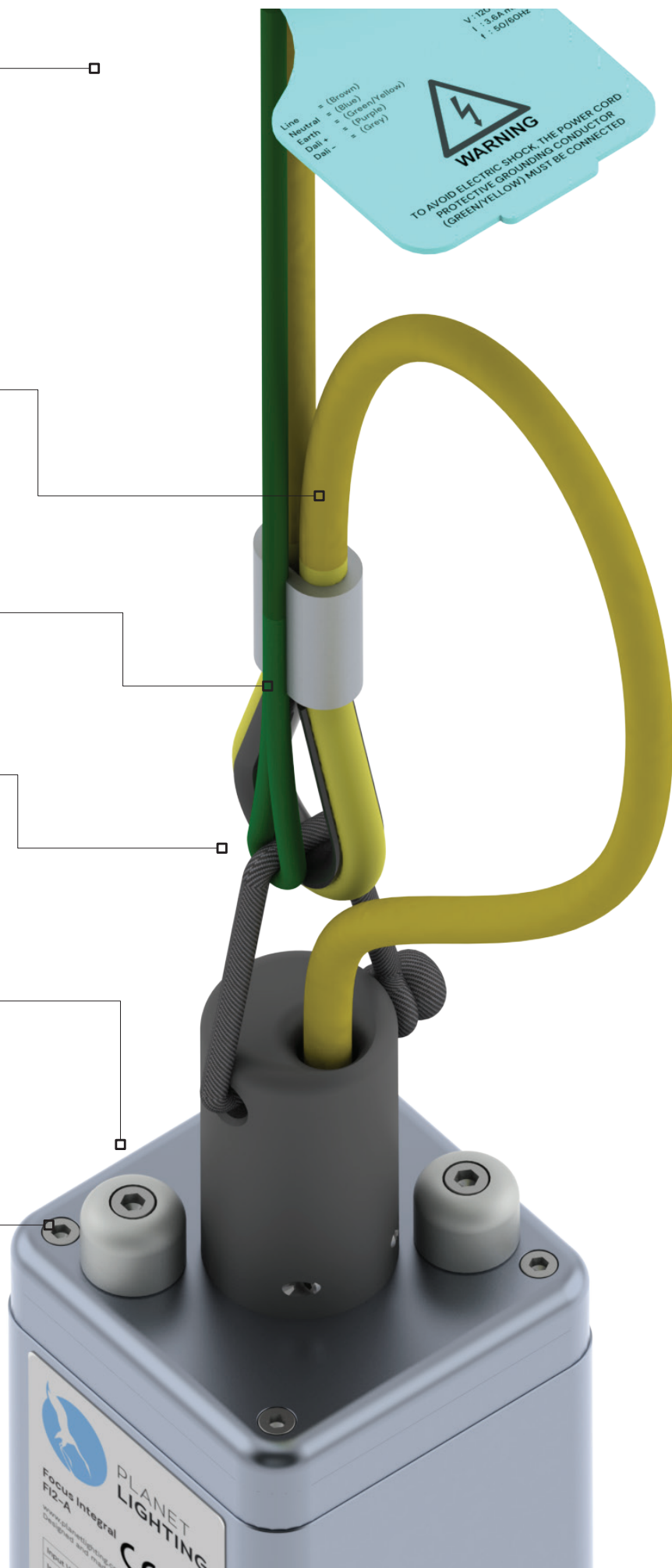
Item Name:	FI2 cable assembly
Item Code:	FICA1, or FICA2
Material:	EPR/CPE
Description:	H075G1-AM 4 Core + E x 1mmsq Tinned Copper, EPR/CPE, 0.6/1kV Flexible Submersible 200m Cable

Item Name:	Soft Shackle
Item Code:	FLS-SS
Material:	UHMWPE
Description:	4mm x Ø100 UHMWPE button knot soft shackle

Item Name:	Suspension Rod
Item Code:	FI2-SR
Material:	Acetal
Description:	CNC Machined suspension rod and cable clamp.

Item Name:	Zinc Anode
Item Code:	FLS-A6
Material:	Zinc
Description:	Zinc anode barrel with soft edges and counterbored screw hole detail

Item Name:	Outer Backplate
Item Code:	FIOBP, or FIOBP2
Material:	Marine Grade 6061 Aluminium
Description:	CNC machined plate as the rear outer backplate and final sealing cap to the body assembly.



Item Name:	FI2 Label
Item Code:	FIMS2
Material:	Polymeric PVC with acrylic adhesive
Description:	Hexis V200WG1 Printable film composed of a 70-µm, calendered, polymeric PVC, which is coated with a grey, pressure-sensitive, acrylic adhesive. Glossy surface finish.

Item Name:	Body Tube
Item Code:	FIHS2
Material:	Marine Grade 6061 Aluminium
Description:	Raw heavy wall aluminium extrusion

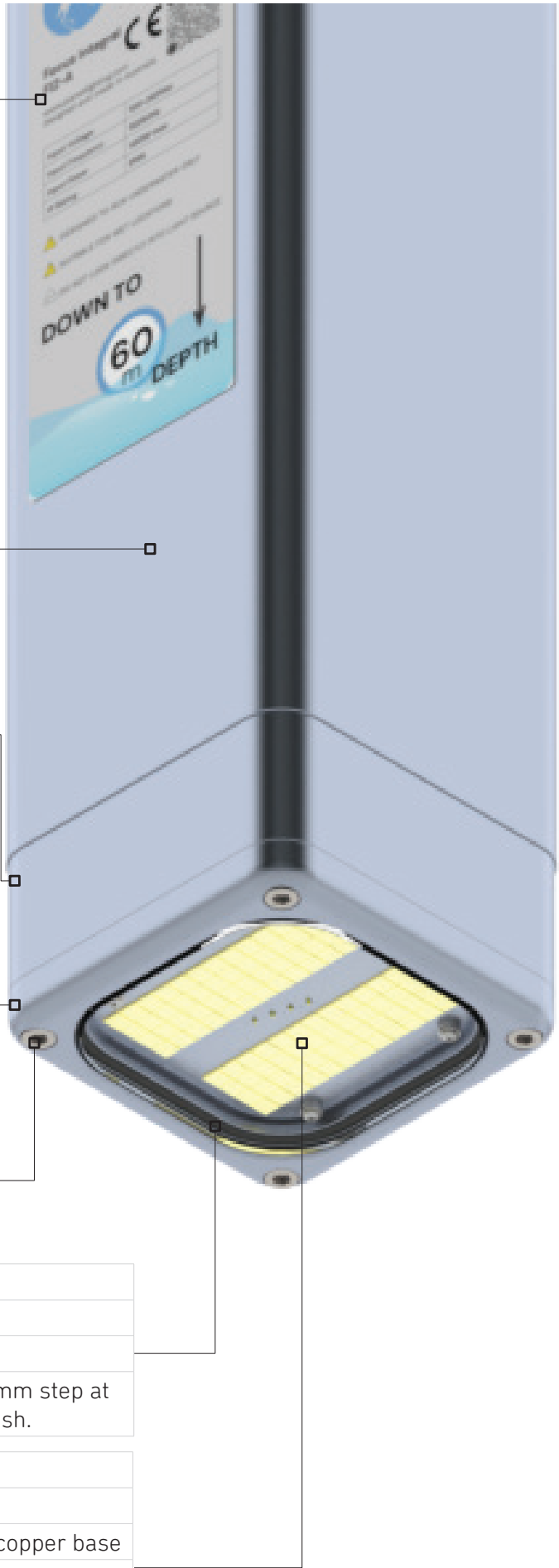
Item Name:	FI2 heatsink/Front Assembly
Item Code:	FIHS
Material:	Marine Grade 6061 Aluminium
Description:	CNC 6061 plate oring sealed cap for the body, and based for the oring sealed mounting surface for the PCB

Item Name:	Front Plate
Item Code:	FIFP2
Material:	Marine Grade 6061 Aluminium
Description:	CNC 6061 plate cap for the heatsink, lens, and PCB mount with oring seal

Item Name:	All Fixings
Item Code:	varies
Material:	316 Stainless Steel (marine grade)
Description:	Various marine grade socket head cap screws

Item Name:	Optic
Item Code:	FIOP2
Material:	Tempered Glass
Description:	10mm water clear tempered glass, with 4mm step at the perimeter providing a flush external finish.

Item Name:	board
Item Code:	FIB-A
Material:	Various electronic components on 1.6mm copper base
Description:	Custom high power electronic LED emitter, with two independantly powered LED banks, built in thermal protection, and BTB header pin connection on the rear.



3.6 CONSUMABLE COMPONENTS

3.6.1 Zinc Anodes

The product supports up to two zinc anodes secured to the back plate for corrosion protection.

Deep farming units on long cable come standard with two anodes, for additional corrosion protection over an extended operational duration.

Anodes are a consumable which should be checked regularly and replaced whenever significant loss of anode material has occurred.

A sudden change in rate of anode depletion may indicate a change in electrical conditions on the site. Always report this observation to relevant authorised personnel.

Any zinc anode designed for the protection of material in the marine environment may be used on the product. However, the use of original anodes from the manufacturer is recommended, as these are uniquely designed with a rounded top in order to minimise the risk of net tearing.

3.7 SERVICE LIFE CONSIDERATIONS

3.7.1 Product Service Life

The manufacturer provides a three-year warranty covering defects in materials and workmanship (refer to the warranty statement for details).

With correct operation, regular maintenance, and occasional repair or component replacement, the typical service life of the Focus Integral is expected to exceed five years.

It should be noted that lumen maintenance projections extend significantly beyond this period. In practice, if a luminaire installed in saltwater production requires LED board replacement due to lumen depreciation, this would indicate an exceptionally well-maintained unit and a highly successful equipment investment.

3.7.2 Lumen Maintenance

The projected lifetime of the LEDs is based on extrapolated LM-80 test data, indicating an L90 lumen maintenance beyond 109,000 hours.

In practical terms, this means a typical LED is expected to retain at least 90% of its initial light output after more than 109,000 hours of operation at a temperature and current consistent with test conditions.

3.7.3 Cable Service Life

 The warranty period for cables is one year.

Although manufacturing defects in cables are extremely rare, cables are the component most vulnerable to damage during everyday operations. Handling during cleaning, installation, removal, or storage presents the highest risk, as does contact with other equipment in use on site, such as net cleaners, winches, or remotely operated vehicles (ROVs).

In the event of damage, cables can be repaired. The manufacturer recommends that cable repair is conducted by authorised SERVICE PERSONNEL to protect warranty, ensure the product is correctly sealed, and to uphold standards for electrical safety and compliance.

Replacement cable, complete cable assemblies and cable replacement kits (for use with your own cable) are available from your supplier.

When sourcing alternative cable for use in repair or replacement, bright colours are advised so that the cable remains visible on site. Alternative cable materials such as PUR are viable, so long as the cable is rated for marine use.

  Any cable fitted to the product must meet minimum specifications stated here, as well as required local standards for marine use.

  All cables will have a minimum bend radius specification. When installing the product, care must be taken to manage cables with respect to the minimum bend radius.

3.8 Sustainability & Repair

The Focus Integral is designed with disassembly and repair in mind. All components are replaceable provided they remain available from the manufacturer. This approach allows the service life of the luminaire to be extended through repair, replacement, or upgrade of parts as required.

This approach not only reduces waste and supports environmental sustainability, but also contributes to long-term operational savings through lower lifetime ownership costs.

Product servicing can be carried out by the manufacturer, the supplier, or an authorised repairer. Authorised repairers are supported directly by the manufacturer with access to original spare parts, specialised tools, ongoing technical support, and in-depth product knowledge. This ensures that all repairs meet the required standards for safety and performance.

It is important to note that any repair not performed in accordance with the manufacturer's instructions, or using non-original parts, may be considered a modification. Such modifications will void the product warranty.



4 TECHNICAL SPECIFICATIONS

4.1 ELECTRICAL SPECIFICATIONS

Electrical Specifications

Max Power	450 W
Typical Voltage	230 V/110 V
Typical Current	1.9-2.0 A (at 230 VAC) ; 4.0-4.23 A (at 110 VAC)

AC Input Specifications

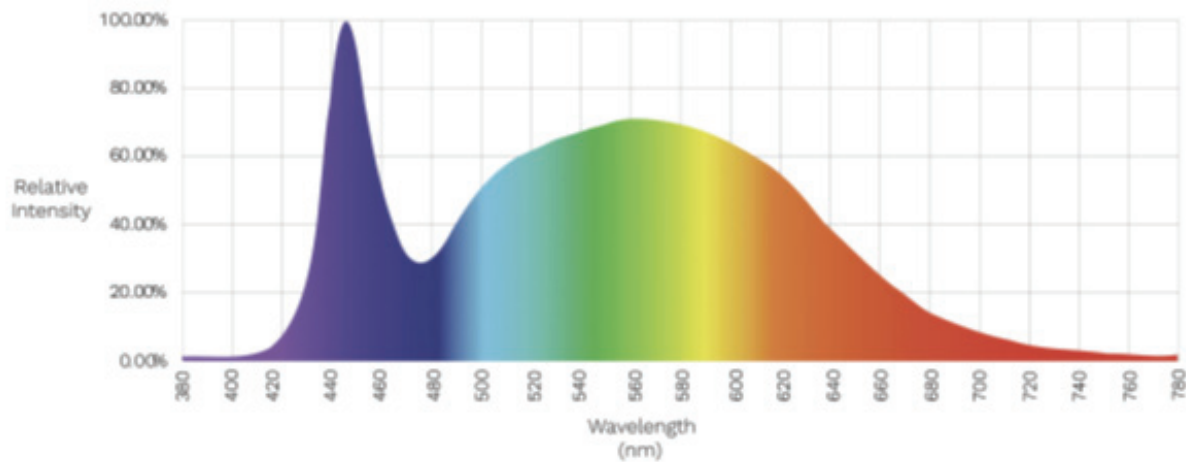
PARAMETER	VALUE	NOTES
Input Voltage	90 VAC - 305 VAC	
Input Frequency	47 Hz min/63 Hz max	
Leakage Current	1.4 mA	IEC60598-1; 240 VAC/ 60 Hz
Input AC Current	4.15 A	Measured at 100% load and 120 VAC input
	2.2 A	Measured at 100% load and 220 VAC input
Inrush Current (A ² s)	8.78 A ² s	
Power Factor	0.9	

4.2 PHOTOMETRIC & PERFORMANCE CHARACTERISTICS

4.2.1 Optical Specifications

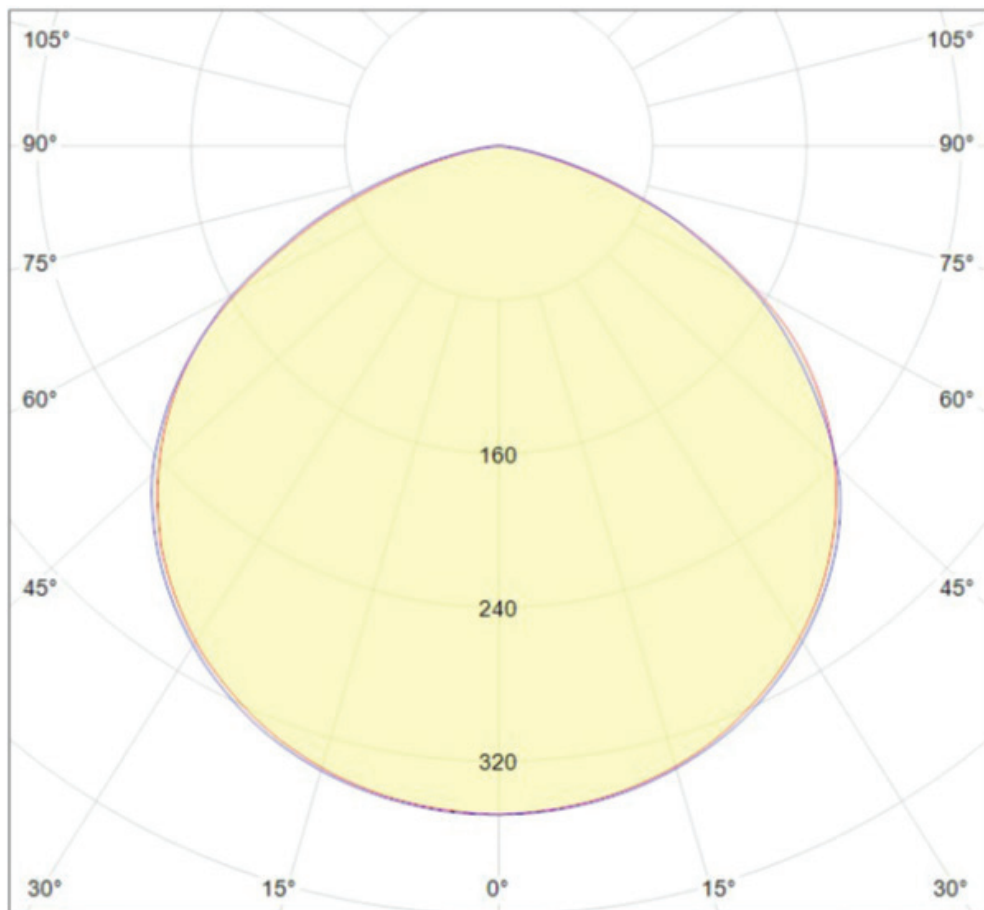
Parameter	Value	Notes
Efficacy	156 lm/W	Power (W) refers to input power, not radiant flux.
Typical Output	66,000 lm	
Max. Output	72,000 lm	
Min. Output	3,300 lm	Dimmable via DALI to 5%.
Soft Start	6,600 lm	Unless DALI controlled ramps to peak output over 30 minutes after power on.
Optical Area	6351 mm ²	Defined as the external area of the light emitting surface of the product.
Typical Photonic Density	10.4 lm/mm ²	Typical output (lm) divided by optical area (mm ²).
Correlated Colour Temperature	~6500K	Daylight White LED approximately equivalent to a 6500K CCT LED.
Colour Rendering Index	70	
Beam Distribution	Circular ~ 120°	
Performance tolerance	+/-8%	

4.2.2 Relative Intensity Diagram



4.2.3 Polar Diagram

The polar diagram shows light distribution in air as a circular beam with a ~120° beam angle. Accurate measurement of light distribution in water is not feasible, but the water penetration diagram attempts to illustrate the range with respect to significant additional variables present in the open water marine environment.



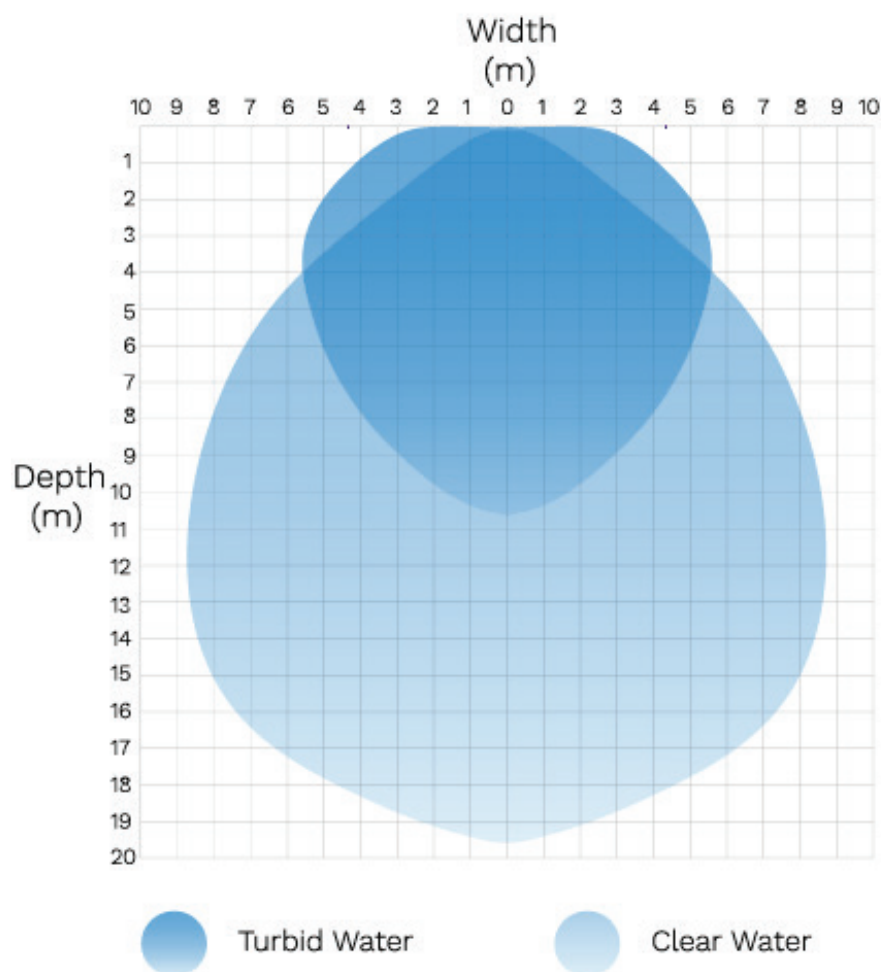
4.2.4 Water Penetration Diagram

This plot of water penetration is based on handheld observations using an underwater light meter, measuring the distance from the luminaire at which “biologically significant illumination” is measurable.

For this purpose, “biologically significant illumination” was defined by radiometric measure of 0.016 W/m². This is nominally equivalent to 10 lux at 555nm.

The data illustrates a range of water penetration results that vary due to differences in water conditions at the time of testing.

On available data it is not possible to express a theoretical maximum or minimum range of water penetration. This diagram can only provide a visual guideline as to what is possible. But it also shows how significant a factor water quality is when evaluating the performance of a production aquaculture lighting installation.



4.3 ENVIRONMENTAL PARAMETERS

Parameter	Value	Notes
Max Operating Depth	FI2: 60m FI1: 20m	
Water Operating Temperature	20°C max to -15°C min	Volume and movement approximating marine open water conditions also required to properly cool the product during extended operation.
Protection Class	IP68	Independent lab tested at 60m for 1h. Long-term tested by the manufacturer at 8 bar (80m) for [max cycling test duration ?].
Max. Cross-sectional Area	10201 mm ²	Area of largest surface. Low values imply more stable in moving water.
Wet Weight - luminaire	2.6 kg	Approximate weight under water.
Wet Weight - cable	0.11 kg/m	Approximate weight under water.

4.4 MECHANICAL DETAILS

Parameter	Value	Notes
Dry Weight – light (excluding cable)	6.4kg	
Weight outside water.		
Dry Weight - cable	0.19kg/m	Weight outside water.
Luminaire Dimensions	102 mm (W) x 102 mm (D) x 448 mm (H)	

5 INSTALLATION INSTRUCTIONS

 Review product safety information in section 2 of this manual before installation. Always follow site-specific protocols and regional regulations when installing or operating Focus Integral (FI2) equipment.

5.1 PRE-INSTALLATION

The Focus Integral is most often used seasonally, for photoperiod manipulation to extend hours of light over the winter months. But some aquaculture production systems use light for growth and other effects, operating lights at any time of the year.

In either case, lighting equipment will be installed and removed from pens on marine farming sites routinely over the course of the product lifetime.

The following plans and checks are recommended before each installation.

5.1.1 Site Lighting Plan

A lighting plan for your site should describe:

1. The number of lights per sea cage.
2. Plus the number of spare/backup units to be stored on site for rapid replacement in the event of equipment damage or fault.
3. Start and end dates for the planned lighting season. The number of hours per day lights will be operated. Lights on & off times if lights are not run 24 hours each day.
4. An electrical installation plan to safely distribute power required for the lighting on the site.
5. Contingency plans for electrical outages and/or plans for the management of brief power outages due to generator cutover.
6. Intended layout of the lights detailing which cages will have lights, plus position and depth for each light in these cages.

5.1.2 Cage Lighting Plan

Having developed a site lighting plan, a plan for each cage will be of use during installation and operation.

A lighting plan for each cage should describe:

1. Electrical connection detail per light, describing how and where lights will be plugged in at the cage, and where & how they can be powered on/off.
2. Lighting suspension detail describing suspension method and equipment. Manage cables to keep clear from other equipment, minimise trip hazards and to limit cable flexing, especially where that might exceed the minimum bend radius.
3. Any further practical installation measures where applicable for your site such as:
 - Use of electrical tape, cable ties or cable clamps to manage the risk of exceeding minimum bend radius of electrical cables. See 3.8.3 Cable Service Life on page 17.
 - The use of floats to manage cable, for example to keep it clear of netting on the top of a deep farming / submerged pen design.

5.1.3 Inspection of unit & accessories

Before installing the product for a season on your site, ensure that all monthly, quarterly and annual service checks described in section 7 Maintenance & Inspection on page 31 have been completed.

These checks help ensure that your luminaire is ready for the underwater lighting season.

Many of these checks are recommended through the lighting season as well. But a complete inspection prior to installation is advised. This is not just a good start to the lighting season, but practical as the checks can be conducted more thoroughly in the salt water depot, before the lighting equipment is installed in the cage. Inspection checks ask that you:

1. Confirm electrical safety details checking for water ingress while verifying cable, connector and contact condition.
2. Check that the body of your product is clean of biofilm and minerals. Buildup of either may reduce the thermal performance of the product.
3. Ensure the optic is clean and clear for optimal light output.
4. Make sure the product is ready for a season underwater: seals intact and sufficient sacrificial anode material present to protect from galvanic corrosion.



5.2 MOUNTING PROCEDURES

The following procedures are in addition to details on pre-installation site and cage lighting plans discussed above.

5.2.1 Suspend from Soft Shackle

| ⚡ ⚠ Do not suspend the product from its cable. Always suspend using a rope through the soft shackle.

During suspension, ropes and cables should be managed so that there's enough slack to allow for movement in the highest energy conditions anticipated at the site. However cables should not be afforded too much slack so that loose cables may create loops underwater that could exceed minimum bend radius specifications and/or snag other equipment.



5.2.2 One/Two Person Lift Limits

Without cable, a Focus Integral falls comfortably within typical one person lift weight limits. But when packed in its crate with a full length of cable, the total weight may exceed one person lift limits applicable on site. This will depend on factors which may vary such as applicable one person lift limits for your operation, cable length and cable specification.

Installation of many luminaires on site at the start of a lighting season may involve repetitive handling of loads that approach or exceed safe one person handling limits.

Always consider health and safety risks, and make installation plans that manage and mitigate these risks.

5.2.3 Compatibility with aquaculture cages, nets, or barges

The Focus Integral is compact, durable, powerful and designed to be compatible with most marine farming infrastructure.

Beyond an electrical connection and cable strain relief, correct installation of the product does not require special equipment like brackets that may need to be customised for any specific sea cage design.

Some cage designs may require additional plans to ensure the product is interoperable with the cage and other equipment on site. For example, operators of submerged cages often employ floats to keep cables clear of the top nets used in these cage designs.

5.3 ELECTRICAL CONNECTION

The Focus Integral is an electrical appliance designed for use on commercial aquaculture production sites.

Electrical installations on marine farms may be subject to specific local maritime regulations, in addition to national and international electrical safety standards. There is also a range of electrical equipment in use on marine farms, and a range of power distribution systems which the Focus Integral will be connected to for power.

For this reason, the product is typically supplied without a connector. This allows marine electrical installers to specify and fit electrical connections suitable for the power distribution system available on site.

| ⚡ ⚠ Electrical installation of the equipment supplying power to the product must be completed by appropriately qualified marine electrical SERVICE PERSONNEL and in compliance with applicable regulations. If your lighting equipment was supplied without a connector, then the specification and wiring of the connector is a part of the electrical installation and not a part of the product.

5.3.1 Strain relief requirements

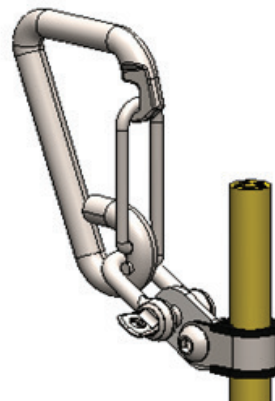
  Always secure the strain relief carabiner to an appropriate fixture near the power distribution board.

  Do not move the strain relief carabiner more than 1.52m (5 feet) from the connector to limit movement, chafing or stressing of the cable.

Above Water Strain Relief

The Focus Integral features a stainless steel 316 spring clip/carabiner fitted at the above water/supply end of the cable on a cable clamp. Correctly secured, this provides strain relief at the above water end of the cable.

The cable clamp can be loosened and moved along the cable during installation as required, using a 4mm hex/ allen key (i.e. suitable for an button head M6 socket screw). This should be used to create a little slack between the connector and the carabiner, making a "drip loop" that allows water to run along cable down and away from electrical connections.



Additional Strain Relief (by farm operator)

There are many additional methods that can be used to protect the cable from movement and tension during operation:

1. **cable thimbles** can be installed to where cable is fixed to structures as these allow the cable freedom of movement, and allows the strain relief force to be maintained
2. **Elastic rope** can be attached to cables (as shown), which can soften cable movements and protect the cable at fixed structures.
3. **Braided cable sleeving** can be used to grip the cable over a longer length, thus reducing damage due to gripping.



  Caution: Hard clamping to the cable can result in damage to the cable sheath, and can interrupt electrical supply and/or cause electrical shorts, thereby tripping any RCD protection.



5.3.2 Cable routing & securement

Applicable North American standards require that flexible cord must be secured to suitably rigid structural members, the luminaire or other objects installed for the purpose of limiting movement, chafing or stressing of the cable. Flexible cord lengths which are not secured should not exceed 1.52m (5 feet).

On a marine farm, this standard provides practical guidelines which the manufacturer also recommends for installations beyond North America.

A marine farm is a temporary and floating structure designed with flexibility to accommodate movement that is natural to the marine farming environment. But all cage systems have structural members and ropes installed which can be used appropriately to limit movement, chafing and stressing of cable.

When installing the Focus Integral:

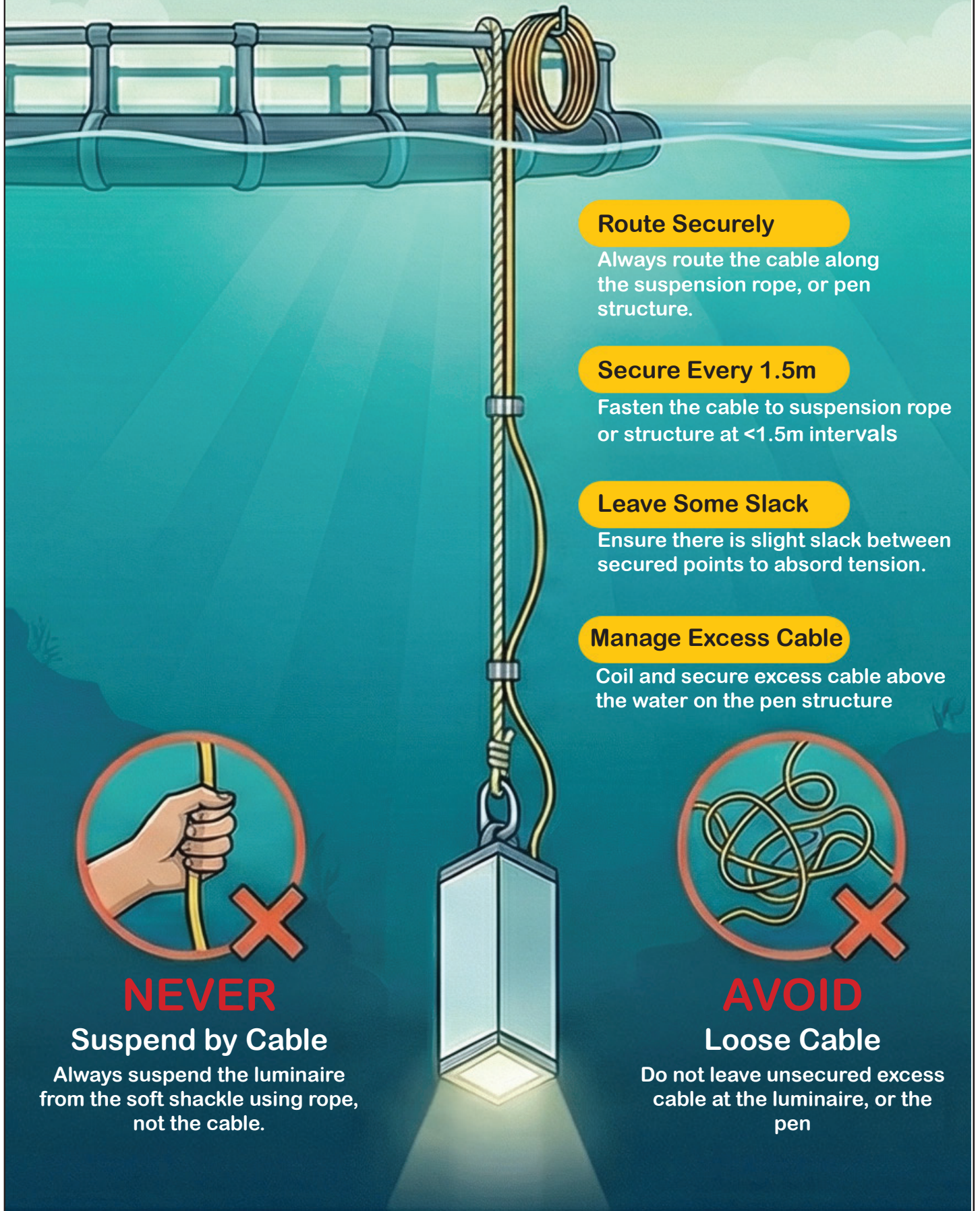
- **Always** route cable from the luminaire along the suspension ropes, securing cable to rope at least every 1.5m (5 feet).
- **Always** leave a little slack in the cable between secured points. A little slack will allow the cable length to absorb tension as the structure moves, while the 1.5m tie spans with limit overall movement and chafing.
- **Do not** leave excess cable hanging slack inside the cage (or at the luminaire), instead secure it in a coil above water on the side of the cage.
- Where possible, route along & secure cable to structure, structural ropes, or suspension ropes both on the surface, along the vertical descent, and at the installed depth.

Cable Securement

Do not leave excess cable hanging slack inside the cage (or at the luminaire), instead secure it in a coil above water on the side of the cage.



Cable routing & securement



Route Securely

Always route the cable along the suspension rope, or pen structure.

Secure Every 1.5m

Fasten the cable to suspension rope or structure at <1.5m intervals

Leave Some Slack

Ensure there is slight slack between secured points to absorb tension.

Manage Excess Cable

Coil and secure excess cable above the water on the pen structure



NEVER

Suspend by Cable

Always suspend the luminaire from the soft shackle using rope, not the cable.



AVOID

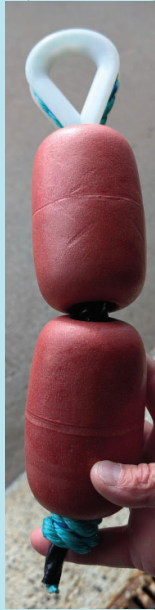
Loose Cable

Do not leave unsecured excess cable at the luminaire, or the pen



Best Practice for Cable Management at Deep Water Sites

Counter Floats with a soft grip

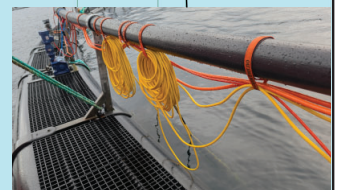


Rough calculations for buoyancy requirements can be done using the following wet weights:

- FI2 luminaire = 2.6kg
- FI2 cable = 0.11kg/m

Spread the load of cable fixture, and do not exceeding the cables minimum bend radius of 46mm.

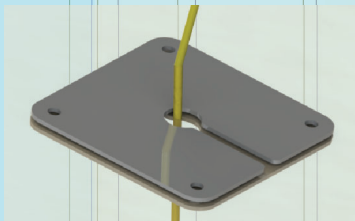
Cable thimbles protect the cable by allowing the connection point to re-orient to the pull direction.



Neat cable management above water will reduce cable damage, and keep access clear.

Options for net entry

Sandwich plates



5.3.2.1 Deep Water Installations

In deep water sea cages use the wet weights of the luminaire and cable given to optimise your cable floats and luminaire float installations to ensure:

- The luminaire is suspended from the soft shackle, and fixed to the cage structure or structural ropes.
- Has enough floatation buoyancy added to deliver neutral (or positive buoyancy): as is your site preference.
- The cable length is set for the deep position, and has floats installed periodically to deliver the desired buoyancy. This should be optimised by site personnel to ensure the cable is managed safely during hoisting of the cage up and down in the water, and during static positions.

Monitor the float installation during operation to ensure the power cables are adequately controlled during the dynamic process of winching the sea cage into its various positions. Adjust the float installation to suit your site conditions and operational methods.

Some common cable and float management options are shown below:

Foam Floats

Closed cell EVA foam floats are commonly available in a variety of sizes, usually with a net buoyancy ranging from 3.5kg to 14kg.



Float Clusters

Tying EVA foam floats together with cable thimbles is a durable assembly which can be used to anchor the floats to cable and luminaires. The number of foam floats in the cluster can be adjusted to establish the ideal float amount for the anchor point.

Rough calculations for buoyancy requirements can be done using the following wet weights:

- FI2 luminaire = 2.6kg
- FI2 cable = 0.11kg/m

e.g. 1 luminaire + 5m of submerged cable requires:
 $2.6 + 5 \times 0.11 = 3.15\text{kg}$ of buoyancy to be neutrally buoyant.

Monitoring buoys, cables, and rope during dynamic movements of the structure is required to optimise float locations and buoyancy settings.



Boat Cleats

Boat cleats or rope tensioners can be used to anchor rope and/or cable to structure. Especially useful at suspension points



5.3.3 Grounding and Isolation

The product is powered via a single phase electrical supply circuit using three conductors:

- Line/Active
- Neutral
- Earth/Ground

LED drivers inside are class I electrical devices which require a mandatory earth connection for safety.

 **Do not install, connect or power the product without a functional electrical earth connection which is compliant with applicable electrical safety standards, installed & maintained by appropriately qualified SERVICE PERSONNEL.**

Circuits powering the product must use a ground fault protection device such as an RCD, GCSI or integrated breaker. This is likely mandatory in general electrical installations or at least in marine electrical installations in most jurisdictions. But even if not mandatory in your location, the product has been designed under the assumption that ground fault protection devices will always be in place during normal operation.

 **Always ensure that the electrical supply circuit that powers the product is protected by a ground fault protection device. The selected device must comply with relevant local certifications, standards and directives.**

5.4 FINAL VERIFICATION

After installation and before operation, perform a final check to verify the following:

- ☑ All lights are installed according to the pre-installation plans.
- ☑ The lights will not be operated at temperatures, depths or supply voltages which exceed product specifications.
- ☑ Appropriately qualified SERVICE PERSONNEL have verified that the electrical installation is complete and compliant. Mandatory electrical earth is connected and functional. Ground fault protection devices are present and operational. Appropriate marine grade connectors are fitted.
- ☑ Suspension, strain relief, cable routing and securement requirements detailed in this manual have been correctly applied during installation.
- ☑ Operators on site know where to power lights on/off. Ensure that clear start up and shut down procedures are in place:
- ☑ For the deployment of backup units in the event of a fault.
- ☑ For diver safety with respect to section 2.2.6 ☐ Diver Safety on page 5.
- ☑ For planned and unplanned power outages on site.
- ☑ Lights can all be powered up without a ground fault. Lights correctly begin soft start after the pre-programmed 1 minute delay.

6 OPERATION & USE

6.1 SWITCHING ON/OFF PROCEDURES

Sudden changes in lighting levels can cause stress, negatively impacting fish health. The soft start feature pre-programmed into the Focus Integral provides a gradual increase in lighting levels when lights are powered on. DALI lighting controls can be integrated and used to provide “soft stop” to ramp illumination down gradually when powering off.

Salt water production lighting is typically turned on at the start of the lighting season, remaining powered until the end of the lighting season. On/off procedures are generally related to unplanned outages, or scheduled for diver safety.

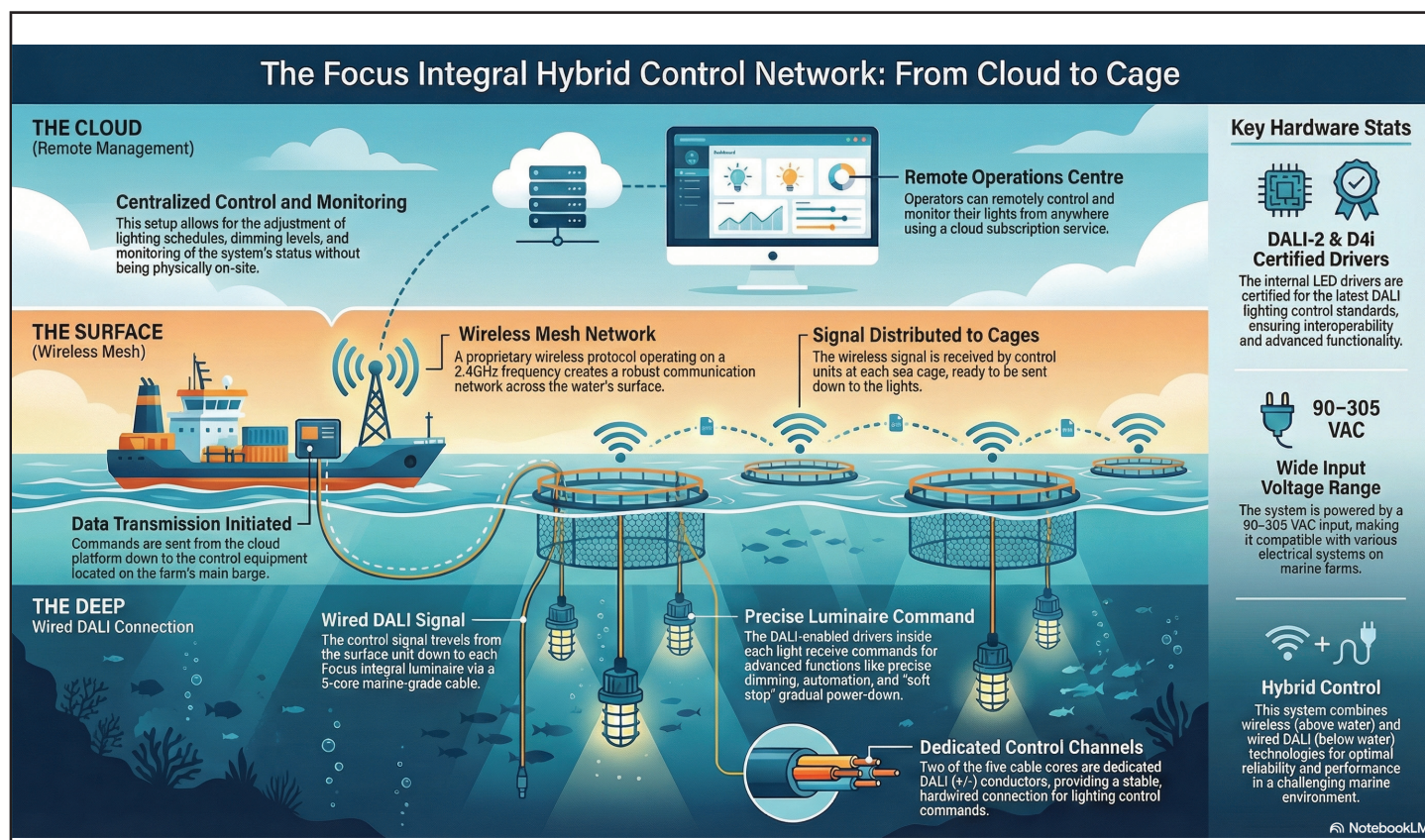
Some operators may only use lighting through the night, depending on local conditions. Operators on these sites should power lights on and off during the day time, as ambient daylight will reduce the apparent change in illumination in the pen providing some mitigation of risks associated with a sudden change in lighting levels.

6.2 CONTROL SYSTEM INTEGRATION (MONITORING, TIMERS, DIMMING & AUTOMATION)

As a standard feature, LED drivers inside the Focus Integral are DALI-2 and D4i certified. This means that the Focus Integral is supplied ready to wire to a DALI bus.

DALI is a lighting control protocol that is long established in the lighting industry. There are many different DALI controllers available. There are also different versions of DALI (DALI & DALI-2) and associated technologies (D4i). Not all commercially available DALI controllers support all versions or associated technologies. A range of options will be available in most territories that can provide monitoring, control, dimming or automation features.

Planet Lighting are developing a wireless control system which uses a wireless protocol operating over a WIFI mesh network above the water, and DALI on the cable below the water. This system can provide control and monitoring from a device on site or from the barge. It can also be connected to a cloud service which allows operators to control and monitor their lights remotely from remote operations centres. Ask your supplier about the Wireless integration for the Focus Integral.



6.3 RECOMMENDED USAGE CYCLES FOR FISH HEALTH AND ENERGY EFFICIENCY

Salt water production lighting regimes in finfish aquaculture can vary considerably.

Lighting seasons may be limited to winter only for photoperiod manipulation, as in classic Norwegian Salmon production. Or extended through the entire salt water grow out stage.

At lower latitudes, ambient daylight may be used to save energy during winter days. But in locations with high natural levels of insolation, fish may acclimatize to bright conditions and require more light to achieve a biological objective than a fish that is acclimated to less bright conditions.

There is no “one size fits all” recommendation for the use of salt water production lighting in marine aquaculture.

What is best for any given aquaculture production system will depend on a wide range of variables broadly covering:

- Species and/or lifecycle specific behaviours such as positive or negative phototaxis.
- Biological objectives for the lighting system such as maturation suppression, increased growth or attraction of fish to a particular depth to limit exposure to parasites.
- Economic factors such as the price of power, other production costs and market price fluctuations.
- Water quality and seasonal variability of natural light or other environmental factors.
- Cage sizes, lighting layouts, biomass & density.
- Appetite for risk of maturation losses relative to higher operating costs.
- Operational considerations for the lease: in some production systems shorter salt water production schedules have high value and more light may be used to this effect.
- Latitude of your site, and seasonal variations in day/night hours and conditions.

The biological objectives of a lighting system are among the most important factors. Research supports the principle that more light and more uniform light can deliver faster growth rates in typical farmed fish species. But maturation suppression or attraction to depth may require relatively less light, especially at higher latitudes where winters are dark, or in locations where prevailing weather conditions reduce natural illumination.

6.4 LIMITATIONS OF OPERATION (DEPTH, ENVIRONMENT, DURATION)

The Focus Integral is subject to limits of operation as detailed in section 4.3 Environmental Parameters on page 21.

The equipment is designed for use in the marine environment. All routine inspection & maintenance procedures documented in section 7 Maintenance & Inspection on page 31 must be followed to maintain performance of the equipment through the product service life.

The product is designed to allow extended durations of use at sea including typical winter-only lighting seasons as well as extended lighting seasons for the entire duration of a 12-18 month salt water production stage. Where inspection & maintenance procedures require assessment in a workshop, these procedures should be followed at any possible time.

7 MAINTENANCE & INSPECTION

7.1 MAINTENANCE WARNING



Review all safety warnings in section 2 Safety Information on page 2 of this manual before engaging in maintenance, inspection or service of the Product.

7.2 REGULAR INSPECTION SCHEDULE

7.2.1 LED End-of-Season Maintenance

To maintain consistent light output and optimal LED performance, each luminaire must be inspected for visible signs of VOC contamination. If contamination is identified, the affected luminaire should undergo the VOC burn-off procedure.

This process helps remove potential VOC (Volatile Organic Compound) contamination from the LEDs, which can accumulate over time and cause a reduction in light output.

Performing the VOC burn-off procedure as part of routine seasonal maintenance helps restore and maintain the luminaire's intended light output and performance.



Safety Note: Ensure the luminaire is securely supported and appropriately monitored throughout the procedure. Do not look directly at the LEDs while the luminaire is operating.

Additional Information: VOC Removal Treatment

The VOC removal process does not damage the PCB or LEDs. The luminaire's built-in thermal throttling provides effective protection against excessive operating temperatures. Every unit undergoes this treatment during factory production; however, variations in thermal throttling behaviour and LED chemistry mean that some units may require additional treatment later in their service life.

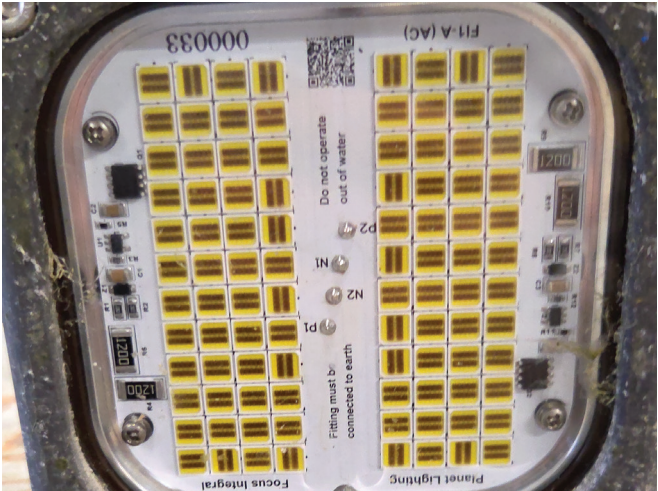
- LED lifetime is not materially affected. As an example of a 72-hour treatment at 100% output represents only 72 hours of an LED rated life exceeding 109,000 hours.
- VOC contamination cannot be removed by surface cleaning. The compounds are absorbed into the silicone material of the LED package rather than simply deposited on its surface. Exposure to light drives the compounds out of the LED, while the open lens and resulting airflow allow them to dissipate, helping prevent reabsorption.
- The treatment is safe for unaffected luminaires. Luminaires without VOC contamination will not be adversely affected by the procedure, provided the thermal throttling system is functioning correctly. Thermal throttle failure is extremely rare. Therefore, where it is unclear whether discolouration or reduced output is caused by VOC contamination or another form of degradation, performing the VOC removal procedure is an appropriate first diagnostic step.
- Thermal throttling during treatment is normal. The PCB incorporates two independent thermal throttles, so each half of the board may throttle at different times. During the procedure, the LEDs may cycle between higher and lower output as the thermal protection responds to temperature changes. This behaviour is expected, and the system will reach a thermal equilibrium over time.

This procedure has been successfully performed thousands of times and is an established method for safely removing VOC contamination and recovering LED performance.

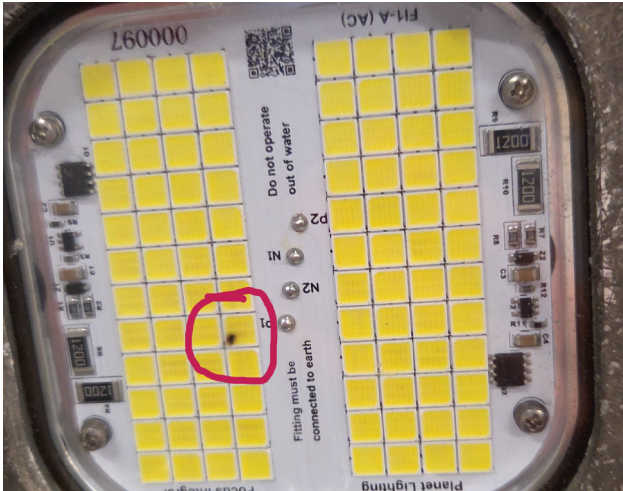


TASK	DESCRIPTION	ACTION
Check for visible signs of VOC contamination and Performing the VOC burn-off procedure if needed	VOC Removal Procedure 1. Visual Inspection: Inspect the luminaire for visible signs of VOC contamination. Only luminaires showing evidence of VOC contamination should undergo the VOC burn-off procedure. 2. Create ventilation: Loosen the front plate screws and carefully lower the glass lens to create an air gap, allowing accumulated VOCs to escape. 3. 3Position the luminaire: Suspend the luminaire securely out of the water, then connect it to power. 4. Begin the burn-off process: Operate the luminaire at 100% output, with the glass lens lowered and the unit remaining out of the water. Allow the PCB to enter thermal throttling mode. 5. Monitor burn-off daily: Inspect the LEDs every 24 hours for visible brown VOC deposits and continue the treatment until the contamination has been removed. Once no visible VOC deposits remain, the burn-off process may be stopped. Burn-off for no more than 3 days. Any marks remaining after 72 hours were probably not VOC contamination. 6. Final Visual Inspection: Inspect the luminaire to confirm that all visible signs of VOC contamination have been removed. If the contamination has cleared and the luminaire is operating as expected, the VOC removal procedure is complete.	check / apply

EXAMPLE OF VOC & NOT VOC CONTAMINATION



LED board affected by VOC contamination.



A pinprick solder splatter burn.

7.2.2 Monthly Maintenance

CABLES, POWER AND CONNECTOR

TASK	DESCRIPTION	ACTION
Check connector and seals	Always ensure that AC connector is installed correctly. The connector is tightened, secure and the seals are in good condition	check / replace
Check for cable damage	Check the full length of cable for kinks, nicks, or cuts. Replace if damaged.	check / replace
Check cable strain relief	Ensure strain relief carabiner is correctly secured to protect all lighting cables. Check strain relief on supply cables where applicable.	check / replace
Check cable management	Check that cables are secured to suspension ropes at correct intervals.	check / replace
Check cable floats	In Deep sea cage installations check floats to ensure correct buoyancy is occurring during both static and dynamic (winching) operation of the cage.	check / replace

LIGHT FITTINGS

TASK	DESCRIPTION	ACTION
Check mineral build up	Mineral build up (e.g. salt) around the cable gland, front plate or lens should be cleaned away to prevent minerals working into seals. Take care not to damage parts when cleaning.	check / replace
Check for biofouling	Check for build up of biofouling on the aluminium light body and the lens. Heavy biofouling may reduce cooling and lifetime of the LED.	check / replace
Check for water ingress	Visually inspect the lens, looking for signs of water ingress.	check / replace
Check sacrificial anode(s)	Check the outer surface of the anode(s) for evidence of corrosion. Replace anode(s) if there is significant loss of material.	check / replace

7.2.3 Quarterly Maintenance (Every 3 Months)

CABLES, POWER AND CONNECTOR

TASK	DESCRIPTION	ACTION
Check cable install	Check that the cable is installed as per the original plan. Check that cables are secure, out of the way and that cable strain relief is installed and protecting electrical lines. Where Applicable ensure that the cables are secured to the suspension ropes at the recommended interval of 1.5m.	Improve cable management on site

LIGHT FITTINGS

TASK	DESCRIPTION	ACTION
Check mineral build up	Mineral build up (e.g. salt) around the cable gland, front plate or lens should be cleaned away to prevent minerals working into seals. Take care not to damage parts when cleaning.	check / replace
Check corrosion on body	If anode(s) are lost, corrosion may impact the body of the luminaire. Replace anode(s) immediately to prevent further damage. Excess pitting due to corrosion around the seals can cause water ingress. Away from seals, moderate corrosion will not reduce the performance of the product.	check / replace

7.3 CLEANING PROCEDURES

7.3.1 Biofouling Prevention

Any part of the product submerged in water for some time is likely to develop biofouling.

Biofouling on the optic will reduce light output of the product. The Focus Integral is designed to minimise these losses. Checking the optic and cleaning where necessary are recommended to ensure performance of the product.

Biofouling on submerged metal parts may reduce heat dissipation, ultimately affecting product performance with possible reduction in lifetime of LEDs or drivers. Routine cleaning is recommended for optimal product lifetime.

7.3.2 Safe Detergents

Do not use abrasive products, petrol, paint thinners, alkaline detergent, acidic cleaning agents or aldehydes. Make sure the proportions of the detergents/cleaning agents are accurate based on manufacturer's instructions.

7.4 O-RING SEAL REPLACEMENT INTERVALS

The manufacturer does not recommend opening the product unless it is necessary in order to effect a repair.

Applicable o-ring seals and gaskets should always be replaced whenever possible.

Care must be taken to ensure that correctly sized and specified o-ring seals are greased, properly fitted into the correct groove and carefully checked for foreign bodies that might degrade water ingress protection. Parts that compress o-ring seals must be fitted correctly and with the specified torque applied to relevant fixings.

7.5 CORROSION & AUXILIARY EQUIPMENT CHECKS

7.5.1 Check Anodes Monthly

Sacrificial anodes supplied with the product need to be monitored while the product is in use in the marine environment.

In normal operation and conditions, there is sufficient anode material to protect the product for a winter lighting season. Note that anodes may not last through a longer 12-18 month growing season.

Rapid depletion of anode material, or an acceleration in the rate of depletion of anode material, could indicate the presence of an galvanic anomaly at the site such as different metals, water chemistry, stray currents or degraded electrical earthing.

The manufacturer recommends fitting a new anode before the start of every lighting season. Anodes should immediately be replaced if significantly depleted.

7.6 RECORD-KEEPING REQUIREMENTS

7.6.1 Record Installation Date & Serial Number

The manufacturer recommends that customers keep a record of serial numbers and installation dates for initial installations of all Focus Integral units. We recommend that the site and cage of initial installation also be recorded with this information.

Without such a record, it will not be possible to establish an installation date for warranty purposes. The start date for the warranty period will fall back to the manufacturing date stamped on the product. The manufacturing date may be some time before initial installation.

7.6.2 Record Service Activity

For the purpose of maintaining warranty, the manufacturer recommends that customers keep records of any product service activity which might lead to repairs or modifications which could void warranty. This does not include cleaning, inspection or anode replacement. Only activity which might require opening, repair or modification of the product in any way should be recorded.

7.6.3 Record Repairer or Service Agent Activity

If units are sent to a repairer, it is advised that the customer keeps records of serial numbers sent along with some kind of assessment detail that describes why that unit was sent for repair. This is good practice simply to manage the repair event, and help inform any possible warranty service work which may be completed as a part of a repair or service activity.

7.6.4 Log of Routine Maintenance

A log of all routine maintenance checks should be kept at each site to ensure that all recommended checks have been done throughout the lifecycle of the luminaire.

8 TROUBLESHOOTING

 Review section 2 Safety Information on page 2 before attempting any troubleshooting of the product.

 In the event of a suspected electrical fault in a luminaire, always disconnect power as a priority before commencing troubleshooting.

8.1 COMMON ISSUES

8.1.1 Ground Fault

 The manufacturer recommends protecting circuits powering Focus Integral lights with a ground fault protection device such as an RCD or GCFI.

A ground fault or “breaker trip” on a circuit powering one or more Focus Integral lights may indicate an electrical fault in the equipment. If a ground fault is detected:

1. Firstly power off and inspect all units for physical damage or water ingress. Separate visibly damaged units for further action.
2. With the assistance of SERVICE PERSONNEL, safely conduct isolation testing on any remaining equipment to confirm which units are causing ground faults.
3. Send faulty units to your authorised repairer or supplier for assessment and repair.

8.1.2 Cable Damage

The marine cable that supplies power to the product is the most exposed and least easy to protect component in the electrical design. Cables can be easily damaged by machinery, cleaning or handling.

 Cables with visible damage of any kind to the outer sheath of the cable should be immediately replaced.

8.1.3 Connector Damage

Connectors, like cables, are exposed components within the product’s power-supply system and require careful handling. To minimise the risk of electrical faults:

- Make all electrical connections above water,
- Keep connectors completely dry, and positioned in mechanically protected areas where they cannot be strained, impacted, or otherwise damaged.
- Ensure all cable strain-relief features are correctly fitted and securely installed to prevent undue stress on the connectors and cables.

8.1.4 Thermal Throttle Events

If trigger temperature is reached, the automatic thermal protection feature dims either half or all of the LEDs to 10% output. If the product has ramped up towards maximum output, this will appear as a visible change in light output.

 Thermal throttle sensitivity is designed to ensure that thermal throttle events do not occur during normal operation in water within the specified temperature range.

If a thermal throttle event is observed, first confirm that the product is completely cooled and fully submerged in a significant volume of cool open water with some natural water movement. If throttle events persist despite correct operating conditions, contact your supplier or service agent as the unit may have a fault.

8.2 DIAGNOSTIC STEPS

8.2.1 On Site Diagnostic Procedure

 Diagnostic options on site will always be limited due to electrical safety. Do not attempt on site diagnostics if external electrical components (cables, strain relief or connectors) are damaged in any way.



1. Disconnect power to any unit with a suspected fault.
2. Inspect the unit for damage to external electrical components. If there is any visible damage to cables, conductors, strain relief or connector components, immediately abort on site diagnostics. Remove the damaged unit to the workshop and replace with a spare.
3. Disconnect the faulty unit. Connect a known good spare to the same outlet and power on.
4. If a known-good spare used in replacement also immediately fails, the fault is most likely in the electrical installation. This requires assessment by SERVICE PERSONNEL. If the replacement is operational, then it should be installed in place of the faulty unit which will need to go for diagnostics in the workshop.

8.2.2 Workshop Diagnostic Procedure



Damage to or modification of a Focus Integral during a workshop inspection or attempted repair is likely to void warranty. Personnel conducting workshop diagnostics are advised to consult with your supplier, authorised repairer or with Planet Lighting to ensure you have access to product maintenance documentation plus complete, current and correct instructions for any diagnostic or repair work.

8.2.2.1 Before Commencing Workshop Diagnostics

1. Note the product serial number and manufacture date wwww code stamped on the product.
2. Alongside the serial number, make a note of the fault that led to the product coming into the workshop for diagnosis.
3. If possible, take photos of the product to record condition before initiating diagnostics.

8.2.2.2 Non-Invasive Workshop Diagnostics

1. Begin with a non-invasive external inspection of the product. Start at the power supply/plug end of the cable and work towards the Glass/LED end of the product.
 - a. Visually inspect each component, making note of and photographing any water ingress or damage observed.
 - b. Shake the product and listen/feel for water inside the driver chamber.
 - c. Visually inspect the LEDs for water damage, dark marks or burns.
2. If a component is damaged such that it may be electrically unsafe, abort workshop diagnostics and proceed with repair per manufacturer's instructions of the electrically unsafe component.

Always treat a product with water visible in the LED chamber, or water ingress which can be heard/felt inside the driver chamber as electrically unsafe. These issues must always be correctly repaired before attempting to power the product.

Minor burns or brown contamination of the LEDs are most likely not electrically unsafe, unless there is black soot or visible damage to electrical components on the board.

3. Carefully attempt to power the unit, as follows:
 - a. Ensuring the circuit is switched off, connect the unit to power.
 - b. Ensure the power supply circuit is protected with a functional electrical earth and a properly specified RCD/ground fault device.
 - c. Ensure no personnel are touching or holding the faulty unit, and that it is grounded and isolated from any unsafe contact.
 - d. Avoid risks to eyesight by ensuring that the LEDs on the unit are directed away from all present personnel. Where possible use a cover or glass, such as a welder's mask, to protect the eyes of all present personnel.
 - e. Warn personnel in the area of a possible bright light hazard.
 - f. Turn power to the unit on.
 - g. Wait 1 minute for product to start up.
 - h. Note either successful soft start, failure to illuminate or ground fault.
 - i. Power off and disconnect the unit.

8.3 ACTIONS TO TAKE / WHOM TO CONTACT

Evaluate likelihood of warranty coverage for the fault. If your product is within the warranty period and if the fault is clearly the result of a manufacturing defect, the product should be delivered to your nearest authorised repairer for warranty repair.



When making repairs to the Focus Integral in your own workshop, always consult the Focus Integral Maintenance Manual or other available content for correct repair procedure. Ask your supplier, authorised repairer or Planet Lighting for repair guidance and documentation. Always follow manufacturer's instructions when making a repair.

If a warranty repair is not applicable, assess repair risks and procedure. You may wish to consult with an authorised repairer or to review the Focus Integral Maintenance Manual. The Focus Integral is designed for easy repair, with many parts easily replaced using commonly available tools.

Note that some repairs may require specialised tools, processes or skills. If your units require a repair of this nature, the manufacturer recommends taking the repair to an authorised repairer who will have the tools, materials, skills and support required.

9 STORAGE & TRANSPORTATION

9.1 PACKAGING REQUIREMENTS

The Focus Integral is typically shipped packed into a collapsible crate, that is intended to serve as lifetime packaging.

The crates pack neatly on standard 1200 x 800 euro pallets. They can be collapsed for storage out of the way during the lighting season. Then used to transport lights between the salt water operations depot and the site during seasonal installation and removal activities.

The crates will also help in the event that your lights need to be packed and transported to a service agent.

At the end of product life, the crates can also be used to pack and ship lights for recycling.

9.2 HANDLING PRECAUTIONS

9.2.1 Assess Two Person Lift Risk

Depending on cable length and workplace health and safety policies in place, a fully packed crate holding an FI2 may approach or exceed a two person lift limit.

This will be informed by a number of variables which are independent of product design & manufacture. The manufacturer recommends that customers undertake a risk assessment considering:

- specific packed weight for your cable/length (nominally 0.19kg/m, but this may vary if the cable has been in water or replaced).
- Nature of install & remove task: awkward postures, number of lights vs size of team (work per person), individual worker capacity & environment (slippery surfaces, weather hazards, tight spaces, gaps from vessels to floating walkways etc).

9.2.2 Protect Components

The Focus Integral is very robust, but some components are more easily damaged than others. Cable, connectors, strain relief components and glass optics are sometimes damaged in handling.

Always pack cable carefully, ensuring that cables are packed without squeezing cable into tight bends that might exceed minimum bend radius constraints.

Dropping lights, or dropping lights into crates on top of other lights, can cause collisions which may damage components.

Operating the product at depths that exceed depth ratings is at your own risk, and may result in water ingress, mechanical failure or broken glass.

Entanglement with other machinery on site such as net cleaners or winches may damage cables.

Cleaning of the product, can cause damage to various components. Take particular care to reduce the risk of cable cuts from tools used to scrape off biofouling.

9.3 STORAGE CONDITIONS

Please see section 2.3.2 Transport and Storage on page 7.

10 END-OF-LIFE & DISPOSAL

10.1 SAFE DISPOSAL OF ELECTRICAL COMPONENTS

All components comply with European Union restriction of hazardous substances (RoHS) directives.

10.2 RECYCLING GUIDANCE

The product has been designed with careful consideration of material selection to ensure that, at end-of-life, the disposal method chosen minimises environmental impact and risk to human health.

Where practical, end-of-life units should be processed by local recycling services to avoid unnecessary resource use associated with long-distance transport. However, customers located close to the manufacturer may find it most efficient to return units directly to Planet Lighting for recycling.

10.2.1 Materials

The Focus Integral is constructed primarily from highly recyclable materials, including aluminium, copper, and steel. These materials can be efficiently recovered and reintroduced into circular material streams.

10.2.2 Emitters

Unlike the sources of traditional light, LED's do not contain mercury, toxic gases, filaments or fragile parts. Due to the fixture being over 95% recyclable and there being no Bulbs/Globe changing during the Focus LED projected lifetime of >109,000 hours, your environmental footprint will be significantly reduced.

10.2.3 End of Life Recycling

When the product reaches the end of its operational life, contact Planet Lighting or your local authorised agent for advice on suitable recycling options. Disposal must always comply with local laws and environmental regulations.

The most resource-efficient recycling approach is to disassemble the product, separating aluminium & steel components from electronic/copper based parts before supplying them to local recyclers.

It may be possible to save viable spare parts during this process, for use to repair other units which remain in service.

11 DOCUMENTATION & CERTIFICATION

11.1 MARKINGS

The Focus Integral has met requirements for CE and RCM compliance markings, with testing conducted by an independent NATA laboratory.

Further compliance work to certify compliance with North American standards is in progress.

11.2 COMPLIANCE DOCUMENTATION REFERENCES

All compliance documentation such as statements of conformity or test reports are available on request from your supplier. Planet Lighting is also able to supply relevant compliance documentation on request.

11.3 WARRANTY INFORMATION

The product warranty statement is available from your supplier. If the warranty statement was not supplied with your purchase, please get in touch with your supplier or with Planet Lighting directly to get your copy.

12 ABOUT THIS DOCUMENT

12.1 PRODUCT MANUAL REVISIONS

This section provides version history and change tracking for the Focus Integral product manual. All revisions are logged with a summary of changes, date of issue, and responsible editor or approving authority, in accordance with documentation control practices recommended under NS 9415.

Version	Date Issued	Description	
1.0	dd/m/2022	Initial content from product release	00001 : xx22 to 0000x : xx24
1.1	30/09/2024		00001 : xx22 to TBD
2.0	05/06/2025	Updated for the release of the Focus Integral Gen 2 (FI2)	00001 : xx22 to TBD
2.1	(now in draft)	Complete re-draft of the manual with respect to NS9514 requirements.	00001 : xx22 t

12.2 LANGUAGE OF PUBLICATION

The original language of this document is English. Translations to other languages may become available. In the event of any discrepancies, please refer to the original English language version.

12.3 GRAPHIC SIGNS & SYMBOLS USED IN THIS MANUAL

The following safety measures and warnings should be observed during Product installation, use and servicing.

To emphasize their importance, a number of safety precautions are repeated throughout the manual. Follow the safety precautions before using or repairing the Product. Carefully abiding by the safety precautions improves the ability to use the Product safely and correctly and helps prevent incorrect maintenance which could be hazardous and cause damage. The safety measures are approximate and not exhaustive; the Operator, the Responsible Organization and the SERVICE PERSONNEL must develop their capacities to upgrade and integrate them.

Indications such as DANGER, WARNING and CAUTION, preceded by the symbol , indicate the level of risk to which the SERVICE PERSONNEL, the RESPONSIBLE ORGANISATION and the PRODUCT could be exposed.

DANGER: indicates an immediately hazardous situation which could result in death or serious injuries.

WARNING: indicates a potentially hazardous situation that could result in death or serious injuries.

CAUTION: indicates a potentially hazardous situation which could result in moderate or light injuries and Product damage.

This triangular symbol together with the explanation alongside (shown above) indicates the type of hazard to be dealt with.

2.4 GLOSSARY OF TERMS

Version	Date Issued
PRODUCT	The equipment to which this manual refers is the Focus Integral sea cage light and its components. For ease of description, this manual may refer to this equipment as the “Product”.
WE / US	The manufacturer and company Planet Lighting.
OPERATOR	Person handling the equipment (e.g. professional aquaculture personnel, non-expert person assisting the aquaculture processes).
RESPONSIBLE ORGANIZATION	Entity accountable for the use and maintenance of the equipment (e.g. an aquaculture farming operation). Preparation and training are included in use.
SERVICE PERSONNEL	Authorised and qualified individuals or entities accountable to the responsible organisation that install, assemble, maintain or repair the equipment. In certain circumstances, the safety of such persons depends on their knowledge and training and ability to take appropriate precautions when gaining access to hazardous parts of the Product assembly. As an example only, the following professional figures may be considered SERVICE PERSONNEL: • Mechanical or Structural Engineer (for the suspension works) • Electrical Engineer, or other Electro-technical expert qualified to work as an electrician (for the electrical works) • Technician (employee of manufacturer or distributor) trained by Planet Lighting to conduct in-field refurbishments.

13 RECORD KEEPING

13.1 TRACEABILITY

Traceability of equipment and documentation is a key requirement under NS 9415 which stipulates that components used in marine aquaculture installations can be tracked from manufacture to deployment and service.

This manual is a controlled document and forms part of the required technical documentation for the Focus Integral luminaire. The following traceability measures apply:

13.1.1 Product Identification

Each Focus Integral unit is marked with a unique serial number, a product code, a manufacture date and a unique serial number for the emitter PCB.

The unique serial number must be recorded during installation. It is recommended to also record the unique serial number for the emitter PCB, and to link these serial numbers to:

- Site location and cage number
- Installation date
- Configuration details (e.g. mounting, cabling, depth)
- Version of this manual and related technical documents

Important: Serial numbers are required to remain legible and accessible on installed equipment.

- The product serial number is stamped into marine grade aluminium on the product. In the event that anodes are not adequately maintained, corrosion of this material during a long service life in the marine environment may reduce the legibility of the serial number.
- The unique serial number for the board is printed on the MCPCB that is protected inside the product. This identifier is not exposed to the marine environment. But it may change if the board is replaced through repair or upgrade of the unit.

Product identification records are required per installation in Norway by NS 9415. But customers in other territories may nonetheless benefit from keeping such records at least for initial installation for warranty purposes.

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Important: Product identification records are required per installation in Norway by NS 9415. But customers in other territories may nonetheless benefit from keeping such records at least for initial installation for warranty purposes.

13.1.2 Deployment Records

Operators are responsible for maintaining deployment logs, including:

- Manual version in use at time of installation
- Batch number or shipment ID (if available)
- Installer name or contractor
- Any deviations from standard installation procedure
- Visual records or photos, if required by site procedures

These records must be retained and made available for inspection upon request by authorities or certification bodies.

13.1.3 Document Linkage

This manual should always be used in conjunction with:

- The system's installation report or deployment log
- The Declaration of Conformity
- Applicable certificates (e.g. IP rating, EMC, RCM)
- Any site-specific risk assessments or engineering documents

Where manual versions are updated, the document control section (Section 12) must be consulted to determine if the changes impact safety, installation, or compliance procedures.

END OF THE DOCUMENT

