

【International Standard Specification】 Work-Vessel Proximity, Pre-Installed Anchor, Wooden Floating Island Seaweed Cultivation & Blue Carbon Full Cycle Protocol

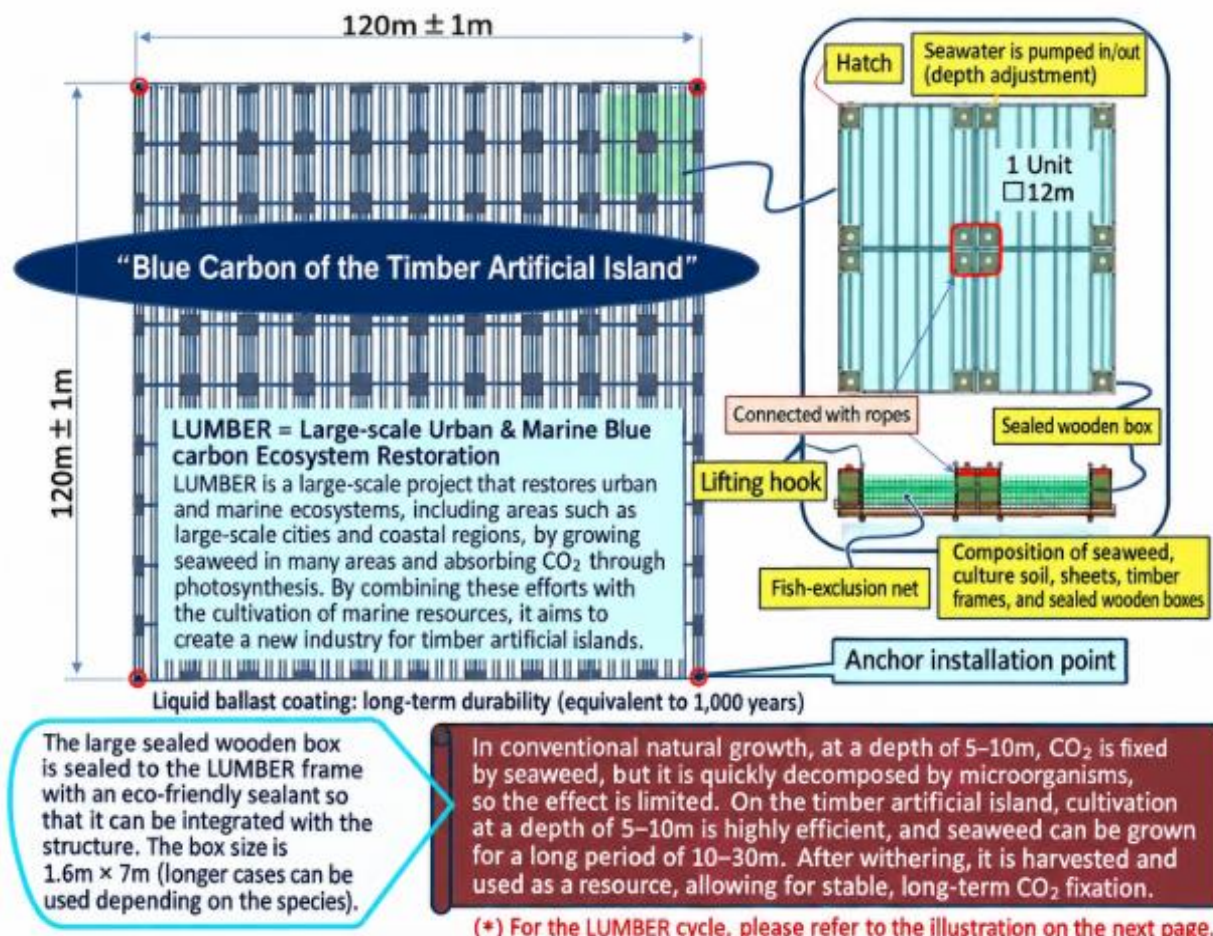
Effective Date: September 12, 2026

Formulated & Issued by: Garden Field Co., Ltd.

Compliance Standard: UN Ocean Environmental Protection Guidelines / International Native Species Preservation Protocol (Strict Prohibition of Non-Native Species)

Chapter 1: Purpose and Core Concepts

This standard operating procedure (SOP) is an international standard specification compiled in accordance with UN ocean environmental protection and Blue Carbon promotion policies to enable immediate global deployment across coastal cities and sheltered bay areas. Prioritizing the "Strict Prohibition of Non-Native Species" to safeguard biodiversity and eliminate ecosystem risks, this document establishes the full cycle from installation and cultivation in shallow bays (depth: 10m to 30m) to permanent deep-sea sequestration (depth: 100m+) and 100% material reuse.



1.1 Primary Concepts

- **Work-Vessel Proximity Approach:** Operates work vessels in waters deeper than 10m to approach the immediate vicinity of the installation point for safe and accurate setup.
- **Pre-Installed Anchor System:** Heavy anchors are deployed in advance at the four corners of a 120m × 120m section (100 connected units) with marker buoys, enabling precise positioning and connection starting from the first unit.
- **International Native Species Protocol:** To prevent ecosystem disruption, only native seaweeds indigenous to the area within a 50km radius of the installation site are selected and cultivated.
- **Closed-Loop Blue Carbon Cycle:** Following biomass maturation, modules are towed to deep-sea areas (depth: 100m+), where seaweed biomass and nutrient soil are deposited into aphotic, hypoxic seafloors for permanent carbon sequestration, while durable sheets are high-pressure washed and 100% reused.

Chapter 2: Location Guidelines and Site Selection Criteria

2.1 Installation & Cultivation Area (Sheltered Bays / Coastal Waters, Depth: 10m to 30m)

- **Water Depth Requirement:** Minimum 10m depth (Recommended: 10m to 30m). This guarantees safe draft clearance and grounding prevention for work vessels, while maintaining a minimum 5m clearance between the bottom sheet of the unit and the seabed even during spring low tides.
- **Marine Environment:** Calm sheltered bays ("うち湾") or protected coastal zones where wave energy is controlled, permitting safe diver operations, vessel positioning, and manual towing.
- **Cultivation Layer:** Ballast valves and internal seawater weight maintain the modules at optimal surface layer depths (3m to 5m) for seaweed photosynthetic efficiency.

2.2 Soil & Biomass Sequestration Zone (Deep Sea, Depth: 100m+)

- **Transfer & Sequestration Condition:** Upon completing the cultivation cycle, modules are unmoored and towed by vessels to offshore deep-sea regions with depths exceeding 100m.
- **Sequestration Objective:** Deposition into aphotic (lightless) and hypoxic deep-sea floors prevents carbon re-emission into the atmosphere or surface water, achieving permanent Blue Carbon sequestration.

Chapter 3: Native Seaweed Selection & Cultivation Guidelines (Strict Prohibition of Non-Native Species)

【CRITICAL DIRECTIVE: STRICT PROHIBITION OF NON-NATIVE SPECIES】

Introducing non-native (alien) seaweed species from other regions carries catastrophic risks, including native species displacement and the spread of pathogens or parasites. Regardless of growth efficiency, non-native species are strictly forbidden. All operations must exclusively utilize native species indigenous to the local coastal area (within a 50km radius).

Climate Zone & Region	Target Cities & Coasts	Marine Environment & Water Temp	Recommended Native Seaweed Species	Primary Uses & Expected Effects
Europe & North Atlantic (Pioneer Model)	Stockholm, Oslo, Galway	Cold to Subpolar (0°C–15°C) Low temperature, high nutrient level	• Sugar Kelp (<i>Saccharina latissima</i>) • Durvillaea / Kelp species	Large-scale offshore cultivation suitability, establishment of deep-sea permanent carbon sequestration model
East Asia & North Pacific	Tokyo, Yokohama, Kawasaki, Busan, Qingdao	Temperate to Cold-Temperate (5°C–25°C) High seasonal variance, nutrient-rich	• <i>Saccharina japonica</i> , Mitsuishi Kelp • Wakame, Susabi-nori	High carbon fixation, biomass production, coastal ecosystem restoration
North American West Coast (East Pacific)	Seattle, San Francisco, Vancouver	Cold current / Cold water (8°C–18°C) Highly fertile due to upwelling	• Giant Kelp (<i>Macrocystis</i>) • Bull Kelp (<i>Nereocystis</i>)	World's fastest growth rate (up to 30 cm/day), formation of massive underwater kelp

Climate Zone & Region	Target Cities & Coasts	Marine Environment & Water Temp	Recommended Native Seaweed Species	Primary Uses & Expected Effects
				forests
Southeast Asia & Tropical	Bali, Cebu, Singapore	Tropical (25°C+) Year-round warm water & stable sunlight	• <i>Kappaphycus</i> • <i>Eucheuma</i>	Ultra-fast growth (~40-day cycle), raw material for bioplastics and carrageenan
Southern Hemisphere & Mid-Latitude	Sydney, Cape Town, Santiago	Temperate to Subpolar (10°C–22°C) Strong winds, high wave energy	• Bull Kelp (<i>Durvillaea</i>) • Sargassum species	High wave resistance, creation of fish nursery grounds (Marine Protected Areas)
Middle East, Red Sea & Persian Gulf	Dubai, Jeddah, Abu Dhabi	Subtropical to Extreme Heat (30°C+) High salinity environment	• Chaetomorpha species • Gracilaria species (Heat-tolerant strains)	Environmental adaptation in extreme conditions, coastal wastewater purification, nutrient recovery

Chapter 4: Material & Equipment Specifications

- **12m × 12m Wooden Floating Island Unit:** Liquid-glass coated sealed wooden frame with high durability.
 - **Sealed Wooden Box System:** Waterproof sealed wooden box structure equipped with a

hatch, internal ballast compartment, and water pump integration.

- **Corner Lifting Hooks & Hardware:** Equipped with 4 lifting hooks at the unit corners for crane hoisting and lowering using heavy-duty synthetic ropes, plus quick-release inter-unit connection hardware.
- **Reusable Box-Shaped Sheet:** High-durability polyester/polymer composite sheet holding nutrient soil (100% reusable after high-pressure washing).
- **Specialized Nutrient Soil:** Artificial cultivation soil uniformly blended with slow-release fertilizer and fulvic acid iron.
- **Pre-Installed Anchor & Marker Buoy Sets (4 sets):** Heavy seabed anchors, abrasion-resistant chains, and LED marker buoys installed at the four corners of the 120m × 120m grid.
- **Work Vessel (Mother Ship):** Work vessel operable in water depths of 10m+. Equipped with heavy cranes and high-pressure seawater pumps.
- **Diving Team Equipment:** 10 certified divers, acoustic whistles for surface-to-underwater signaling, and underwater manipulation tools.

Chapter 5: Step-by-Step Operational Procedures

【Phase 1】 Pre-Installation of Four-Corner Anchors

1. **GPS Survey & Grid Setting:** Utilize GPS/RTK positioning systems to establish the four corner coordinates of a 120m × 120m section in target coastal/sheltered bay waters (depth: 10m to 30m).
2. **Heavy Anchor Deployment:** Lower heavy anchors from the vessel crane to the seabed and ensure solid engagement with the seafloor sediment.
3. **Marker Buoy Mooring:** Connect tether ropes to high-visibility LED marker buoys and keep them floating at the surface awaiting module arrival.

【Phase 2】 On-Deck Initial Assembly & Crane Hoisting

1. **Wooden Frame & Sheet Assembly:** Mount the 12m × 12m wooden frame on the vessel deck. Stretch reusable box sheets seamlessly inside the frame and install anti-grazing nets to prevent fish feeding and soil loss.
2. **Nutrient Soil Filling & Native Seedling Fixing:** Fill specialized nutrient soil into the box sheet and securely plant native seaweed seedlings under continuous seawater showers.
3. **Dry-Box Condition at Setup:** During initial assembly and placement, **no seawater is contained within the sealed wooden box** (maintaining maximum positive buoyancy).
4. **Lifting Hook Attachment & Crane Lowering:** Workers securely fasten heavy-duty lifting ropes to the **4 corner hook points** (ユニットのフック部分 4 か所) of the unit. The vessel crane attaches to the rigging ropes to lift the unit from the deck and gently lower it onto the

sea surface.

【Phase 3】 First Unit Deployment, Buoyancy/Depth Adjustment & Anchor Connection

1. **Proximity Lowering & Position Guidance:** Lower the unit onto the sea surface adjacent to the target corner anchor buoy. Diver team guides the unit into exact position.
2. **Hatch Opening & Seawater Injection (Depth Adjustment):** Before connecting to adjacent units or corner anchors, workers open the hatch of the sealed wooden box and install a seawater pump. Seawater is pumped into the sealed wooden box, ballast level is controlled, and the unit draft is precisely adjusted to the depth most suitable for seedling growth.
3. **Inter-Unit & Anchor Connection:** Once optimal depth alignment is established, divers connect the anchor tether to the unit's corner hardware, and prepare adjacent hardware for module expansion.

【Phase 4】 Sequential Expansion, Depth Calibration & Connection (100-Unit Array Construction)

1. **Crane Lowering & Water Injection of Subsequent Units:** Subsequent units are hoisted via 4-point corner hooks, lowered into the sea without seawater inside, and then pumped with seawater via hatch installation to achieve exact depth matching with existing units.
2. **Inter-Unit Locking & Rope Fastening:** After depth calibration, workers/divers connect adjacent units using heavy-duty ropes and quick-release snap locks.
3. **120m × 120m Array Completion:** Expand in a 10×10 grid, connect anchor lines at all four corners, and calibrate overall line tension.

【Phase 5】 Surface Cultivation & Operational Management

1. **Target Depth Maintenance (3m to 5m):** Maintain the module array at optimal photosynthetic depths (3m to 5m) via the sealed box water level controls and ballast valves.
2. **Seabed Clearance Verification:** Ensure a minimum clearance of 5m between the unit bottom and the seabed during spring low tides.
3. **Periodic Diving Inspection:** Conduct routine dive inspections to clean nets, check seaweed growth, and verify anchor line tension.

【Phase 6】 Deep-Sea Towing, Carbon Sequestration & Sheet Reuse

1. **Quick-Release Detachment:** Upon seaweed maturity, divers trigger quick-release mechanisms to detach corner anchor lines and inter-unit locking hardware.
2. **Offshore Deep-Sea Towing (Depth: 100m+):** Tow the module array to designated deep-sea zones with depths exceeding 100m.
3. **Deep-Sea Sequestration:** Hoist units onto vessel decks using heavy cranes attached to the 4 corner hooks, and drop mature seaweed biomass and nutrient soil directly into the deep

sea for permanent Blue Carbon isolation.

4. **High-Pressure Washing & 100% Reuse:** Wash recovered box sheets and anti-grazing nets with high-pressure seawater, inspect for integrity, and return them directly to Phase 2 for the next operational cycle.

Chapter 6: Safety Management & Environmental Protection Standards

- ---

Strict Quarantine Protocols: Thoroughly inspect all seedlings and materials before and during setup to prevent contamination by non-native organisms.
- **Vessel Grounding Prevention:** Continuously monitor vessel draft and seabed bathymetry using echo sounders to maintain safe operation in waters deeper than 10m.
- **Crane Rigging & Hoisting Safety:** Ensure all 4 corner hooks and lifting ropes are inspected for rated load limits prior to crane operation.
- **Diver Underwater Safety:** Adhere strictly to standardized acoustic whistle signaling patterns to maintain synchronized towing and prevent accidents caused by currents or swells.