INSTALLATION MANUAL FOR
WEKA BOXCOOLERS

WEKA BOXCOOLERS B.V.
INDUSTRIEWEG 8
NL-2921 LB
KRIMPEN A/D IJSSEL
NETHERLANDS

Phone       +31 180 516 588
Fax          +31 180 516 064
E-mail address info@wekaboxcoolers.com
Website      WekaBoxcoolers.com
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INTRODUCTION

- Read this instruction manual before proceeding with installation of WEKA Boxcooler
- Important documents besides this instruction manual are the order confirmation, the specification sheet and drawings.

1.1 Guarantee and liability

The “General conditions of sale of WEKA Boxcoolers BV” are applicable. Also refer to the order confirmation for possible additions.

1.2 Receipt of goods

- Upon receipt of goods, please report any damage or discrepancy to WEKA Boxcoolers BV
- Compare the data on the identification plate, order confirmation and on the drawing
- Always store the Boxcoolers in a dry room with stable temperature conditions
- When the Boxcooler is not put into operation immediately after receipt, then follow the “Instruction for conservation”
2. PREPARATIONS BEFORE INSTALLATION

2.1 Shape of sea-chest
The water content of the sea-chest has no significant influence on the thermal behavior of the Boxcooler. The shape of the sea-chest is not critical, as long as there is a free space around the Boxcoolers bundle of not less than 150mm. The shape of the top-plate is of great influence for the cooling. No flow restrictions may be used on the underside of the top-plate, to guarantee a smooth flow to the outlet grids. Preferably the top plate near the outlet grids should be inclined (e.g. 10 degrees) to improve the water circulation to the outlet as well as the de-aeration of the sea-chest.
Preferably the sea-chest should allow withdrawal of the tube stack without dry-docking the ship. This can be realized by several means such as:
- Observing the waterline
- Trimming the ship
- Implementing a 'cofferdam'

In case more than one Boxcooler is needed for the thermal duty, Boxcoolers can either be connected in series or in parallel.

2.2 Clearance for dismantling and cleaning
Provide sufficient clearance above the Boxcooler to permit withdrawal and replacement of the tube bundle. It may be desirable to provide extra flange connections in the piping near the Boxcooler to make an easy dismounting possible.

2.3 Sea-chest construction
The top-plate of the sea-chest must be constructed for bearing the complete Boxcooler. A weak construction may lead to leakage between bundle and mounting frame. The top of the mounting frame, which is welded to the top-plate of the sea-chest, must be fitted below or at the light-ship waterline. Install a permanent vent pipe DN50 (2") or larger at the highest point on the top-plate of the sea-chest. The minimum distance between tube bundle and the sea-chest walls shall be 150 mm (6") or larger to secure a proper water flow around the tubes. Near frames or reinforcement bars a minimum distance of 100 mm (4") is required.

The sea-chest shall be designed so as to avoid stray currents. Open frames or other openings between sea-chest are not recommended. Should openings be required, WEKA should be consulted. Protective devices against ship corrosion, such as anodes, should not be placed in sea-chests. See also section 2.6.1

2.4 Orientation & Leveling
The Boxcooler can be positioned both athwart-ships or longitudinally, see Attachment II. The Boxcooler must be set level and square so that pipe connections can be made without force. An inclined installation is only allowed after consulting WEKA Boxcoolers BV. If the low temperature system consist of more than one Boxcooler in series or parallel then each Boxcooler must be installed in a separate sea-chest. The frames between the various sea-chests should be either closed or completely open. Partly opened frames can cause local high velocities of sea-water which can cause serious damage to the Boxcooler.
2.5 Inlet- and Outlets grids in the ship's hull

2.5.1 Inlet grids (bottom)
The actual required opening is stated on the Specification sheet of the Boxcooler. The grids must be oriented transversely on the sailing direction. This prevents too much turbulence and too high water velocities near the lower end of the bundle. The width of the grids must be not larger than 50 mm, length 500-600 mm. A pattern of holes is also acceptable. See attachment XI.
The inlet grids need to be located in the lowest possible position just below the Boxcooler. The distance between the inlet-grids and the bundle must not be less than 150 mm (6’). This is to minimize the risk for unacceptable vibrations. Also in shallow, muddy waters, this configuration can be beneficial.

2.5.2 Outlet grids (side)
The actual required opening is stated on the Specification sheet of the Boxcooler. The grids must be oriented longitudinally to the sailing direction and must be positioned as high as possible in the sea-chest directly under the top-plate but still below the empty waterline. Maximum distance from underside of the top-plate to the uppermost outlet slot is 25 mm. The width of the grids must not be larger than 50 mm, length 500-600 mm. A pattern of holes is also acceptable. See Attachment XI.
The distance between the outlet grids and the bundle of the Boxcooler must be not less than 150 mm (6’).

Please contact WEKA Boxcoolers BV for having the total number and size of the grids estimated for the application. A drawing of the sea-chest with all relevant dimensions must be sent together with your request.

2.6 Protection of the ship's hull

2.6.1 Sacrificial anodes in the sea-chest
The ship needs to be protected from corrosion. Corrosion protection for the hull should not be placed in the sea-chest. Protective devices against ship corrosion, such as sacrificial anodes, may induce stray currents, which may damage the Boxcooler. Should anodes be required in a sea-chest, care must be applied as to their number, weight and position, in order to avoid the generation of potentially excessive stray currents. The size and placement of the anodes must relate to the design of the sea-chest and the placement of the Boxcooler. Please consult WEKA Boxcoolers BV for advice regarding the amount and placement of the sacrificial anodes.
Large sacrificial anodes may cause stray currents which may damage the Boxcooler. Reference is also made to sections 2.3 and 2.7.2.
The following advice is given for general consideration.

Boxcoolers - as electrically (galvanically) isolated from the ship’s hull – are subject to damage by stray current. While WEKA Boxcoolers have WEKA Guard and WEKA Protector devices to protect from stray currents, excessive stray currents may damage even WEKA Boxcoolers. More information about stray currents may be found on WEKA’s web page.

If sacrificial anodes are prescribed for corrosion protection of the sea-chest, such anodes shall be placed at the bottom of the sea-chest, below the Boxcooler. The anodes should be equally spread at all sides on the bottom.

If sacrificial anodes are prescribed, the weight should be kept as low as possible. Unnecessarily large anodes may try to protect the ship’s hull also outside the sea-chest; the resulting stray current flows resulting may damage the Boxcooler. The weight per anode should in any case not exceed 2 kg.

A schematic overview is shown in enclosure (Attachment IX).

2.6.2 ICCP Systems

Where an ICCP (Impressed Current Cathodic Protection) system will be used on board, WEKA should be advised of the electrical output of the system (i.e. the current rating per anode) in order to advise the minimum distance between anode and Boxcooler sea-chest. In all cases the Dielectric Shield of the ICCP anode must never cover the Boxcoolers sea-chest grating.

2.7 Protection of the Boxcooler

2.7.1 Temporary protection unit - WEKA Guard

In the shipment a device is included which protects the Boxcooler from damage by regular welding currents. This device (WEKA-Guard) must be connected to the Boxcooler and to the ship’s hull during the newbuilding process of the ship, when the ship-based electrical supply is not yet available. If not installed, the Boxcooler may suffer from severe corrosion due to welding currents. With Boxcoolers in place, welds must be made using the most modern and best available professional welding methods. Once the ship is completed and due for delivery, the WEKA Guard will be replaced by the WEKA Protector, which from this point takes over the protection of the Boxcooler. An instruction on how to connect the WEKA Guard is included in the shipment of the Boxcooler and can be downloaded from www.Boxcoolers.com.

2.7.2 Permanent protection unit - WEKA Protector

WEKA strongly recommends the yard to install one WEKA Protector per Boxcooler. This protects the Boxcooler from damage by well designed and properly working regular ICCP-systems or by regular currents originating from small sacrificial anodes. The WEKA Protector is a small device, which is placed in the vicinity of the Boxcooler to be protected. An instruction on how to install and operate the WEKA Protector will be included in the shipment of the Boxcooler and can be downloaded from www.Boxcoolers.com.
2.8 Fittings & Piping

2.8.1 Construction and nozzle load
The piping must be constructed in a way that the Boxcooler can be mounted without any problems. The Boxcooler is not intended to serve as an anchor point for piping; this can result in over-stressing or damaging of the bonnet. Therefore the piping must be designed and installed in such a way that the piping loads on the Boxcooler are negligible.

2.8.2 Vents
It is advisable to install vent valves in the piping for de-aeration of the system.

2.8.3 Drains
The piping must be provided with drains near the Boxcooler. Installing valves on the drains is recommended.

2.8.4 Valves
It may be desirable to provide valves in the piping systems to permit inspection and repairs without draining the complete system.

2.9 Instructions for conservation
The Boxcooler is supplied without any conservation. In case the Boxcooler will not be installed immediately, we advise to treat the Boxcooler with a rust preventive liquid of a type suited for long term conservation. When necessary, contact a specialized company. Take the material of the Boxcooler (see Specification sheet) into consideration. Be aware that in uncontrolled storage conditions large amounts of water can accumulate in the heat exchanger as a result of condensation.

2.10 Leakage due to damaged tubes
Leakage due to damaged tubes is normal, and in line with industrial experience. Each Boxcooler from WEKA is designed with a sufficient over-capacity. The Boxcooler is a cooling system, not only a number of tubes.

When a leakage is found (procedure described in Section 6.3), the leaking tube shall be plugged off at both ends. Plugs for this purpose are supplied with each order, can be ordered from WEKA, or can be easily produced by any mechanical workshop or on board ship in a lathe in copper or brass material. The form and dimensions can be found on the enclosed drawing. (Attachment X)
3. UNPACKING

Warning:
The bundle of tubes can easily be damaged. Prevent this by removing the cover and sidewalls carefully!

Boxcoolers are generally packed in wooden cases. It is advised to unpack near the jobsite, to prevent damage.

3.1 Steps to be followed during the unpacking of the Boxcooler

a. Remove the cover of the case.
b. Take the mounting frame out of the case and weld it on top of the sea-chest.
c. Close the case until the tube bundle is needed for installation.
d. Remove the cover and sidewalls of the case.
e. Remove the bonnet from the tube-sheet by removing the bolts.
f. Rotate the tube bundle as described in section 3.2.2.
g. Attach the hoisting beams or eye-bolts to make the tube bundle suitable for hoisting. Perform the hoisting as described in section 3.2.

3.2 Hoisting instruction

Hoisting of the Boxcoolers, and parts of it, may only be done by trained and skilled personnel. Use hoisting materials and tools, which are suited for the load. The weight of the tube bundles can be found on the Specification sheet of the Boxcooler.

3.2.1 Hoisting Tools

For hoisting of the tube bundles there are three ways of hoisting:

1. Using four eye-bolts M12 (DIN580; C15). Four threaded holes are available in the tube-sheet for this purpose. Eye-bolts are not supplied with the Boxcooler. Make sure the load is uniformly spread over all the eye-bolts. See Attachment III for details.
2. Using the hoisting bar and beam according to Attachment IV. These may be used for hoisting the tube bundle out of the packaging and to the jobsite. These tools are not supplied with the Boxcooler. In Attachment IV details can be found to fabricate these parts.
3. Only applicable when hoisting beams according to Attachment V are supplied. Use the hoisting beams that are supplied with the Boxcooler. These beams must be fitted to the tube-sheet using M12 bolts with a minimum tensile strength of 500N/mm² (72500 psi). Four threaded holes are available in the tube-sheet for this purpose. See Attachment V for details.

Warning:
Do not hoist the Boxcooler by using cables or chains that are put through the lane in the middle of the bundle or connected to a support plate. This may cause severe damage to the tube bundle.

3.2.2 Rotating the tube bundle

Each tube bundle must be rotated using a hoisting procedure to get it into the mounting position (see figure below). The rotating must be performed on a flat sub-soil. Always use a protective material such as rubber between the sub-soil and the tube bundle to prevent damage. Rotating a tube bundle - which is standing on the tube sheet - by pushing it over and let it fall to the floor is not allowed.
PROTECT BUNDLE WITH ELASTOMERE SHEET OR CARDBOARD

PROTECTION
4. INSTALLATION

4.1 Cut-out in, Mounting frame and final painting
Cut a hole to the correct size in the top-plate of the sea-chest. Size of the cut-out is obtained using the dimensions A and C from the Specification sheet of the Boxcooler together with Attachment VI. Radius in each corner of the cut-out to be <50 mm. Place the mounting frame into position and weld it to the top-plate according to the right detail of figure below.

An extra protection with Hempel coating (or equal) is required for the top-plate and mounting frame. Please refer to www.Boxcoolers.com: Downloads – Information Material- Corrosion protection, for details.

Take precautions to prevent bending due to heat input. Large mounting frames have an extra reinforcement strip between the long sides. Do not remove this until the mounting frame is welded to the top-plate. Round all edges after welding – before the touch-up paint is applied. See also Attachment VI.

4.2 Installation of the Boxcooler
Perform the following steps during installation of the Boxcooler.

Step 1: Place the mounting frame gasket (the gasket without web-pattern) into position on the mounting frame. Place the tube bundle into position on the mounting frame. For hoisting instructions see section 3.2. Install the hexagon socket head screws and washers in the stepped holes in the tube-sheet. First the plastic washer, then the metal washer and finally the hexagon head screw. Make sure there is a plastic bushing fitted in the hole of the tube-sheet. The metal washer must be mounted with the sloped side facing up. Tighten them with a wrench moment of 10-12 Nm. See Attachment VII for more details.

Conductive grease, such as copper slip, must not be applied.
Step 2: Place the bonnet gasket (the gasket with web-pattern) on the tube-sheet and check if the gaskets web matches the lanes between the tubes and to the partition plates in the bonnet. Make sure there is an insulation bushing in each hole of the tube-sheet. Next, position the bonnet and install all hexagon bolts according to Attachment VIII. It is important that these bolts are tightened 3 times and use with a limitation of 20 Nm (14 lb ft) the first time. The maximum wrench moment is 50-60 Nm (35-45 lb ft).

Note: Excessive tightening may endanger the electric insulation! (See section 4.3)

Step 3: Verify by measuring that the tube bundle is insulated from its surrounding parts. See section 4.3 for the applicable method.

Step 4: Connect the piping.

4.3 Electric insulation from the ship’s hull

To prevent corrosion of the sea-chest, and to safeguard the anti-marine growth characteristics of the Boxcooler, the tube bundle must be fully electrically insulated from the top-plate of the sea-chest. For this reason, the bolt holes are provided with insulation bushings. Verify during installation of the tube bundle that these bushings are present in each hole and that they are not broken. There shall be bushings for the hexagon socket head screw as well as for the hexagon bolts. See Attachment I.

After installing the complete Boxcooler including the bonnet, verify it is insulated from the rest of the ship.

That should be done as follows:

Tube bundle not in water

Measure the resistance between the tube-sheet and a bare piece of the top-plate of the sea-chest. The resistance must be more than 500 Ω. Values under 50 Ω are not acceptable. Values between 50 Ω and 500 Ω need further investigation to determine the cause for these values.

Tube bundle in water

Measure the potential (DC) between the tube-sheet and a bare piece of the top-plate of the sea-chest. The voltage should be approximately 350 mV. In case a very low voltage is measured (=0V) this indicates a short-circuit and a non-isolated Boxcooler.
5. START-UP OPERATION
The equipment is designed for use with the conditions specified on the identification plate, specification sheet and/or drawing. It must not be operated at conditions which exceed those specified.

5.1 Connection of protectors
All nozzle openings must be inspected for foreign material. Protective plugs and covers may not be removed until just prior to connecting the piping.

5.2 Dirt removal
The entire system shall be clean before starting operation. If foreign material can be expected, the use of strainers in the piping towards the heat exchangers is required.

5.3 Operating procedures

5.3.1 Start-up
During start-up all vent valves should be opened and left open until all passages have been purged from air and are completely filled with fluid.

5.3.2 Shut-down operation
When shutting down the system, the Boxcooler should be drained completely or filled with suitable antifreeze liquid when there is the possibility of freezing or corrosion damage. A complete draining of the tube bundle is only possible after disassembly of the bundle and pouring the water out the bundle.

5.3.3 Inhibitors
There can be reasons to add an inhibitor to the circuit of the Boxcooler. Contact a specialized company, which can also check for harmfulness of the inhibitor to the materials of the Boxcooler (see Specification sheet for material of the tube bundle). Follow the instructions of the supplier for use of the inhibitor.

5.3.4 Bolted joints
Due to normal relaxing of the gasket joints all external bolted joints require re-tightening after the Boxcooler has once reached its operating temperature. Re-tightening may only be done when the unit is cold and depressurized. The same wrench moments as mentioned in section 4.2, steps 1 and 2 are applicable.
6. MAINTENANCE

6.1 Inspection
At regular intervals, i.e. the docking periods of the ship, an examination shall be made of the exterior condition of the Boxcooler. The condition of the sea-chest is to be inspected with regard to dirt and anti-fouling paint. It is not necessary to examine the interior of the Boxcooler (the inside of the Boxcooler).

6.2 Cleaning
Provided the Boxcooler is properly installed and electrical insulated from the ship’s hull, marine growth will not occur on the Boxcooler. Still, when dry-docking there is a possibility that the Boxcooler is or becomes dirty from mud or sand. Cleaning of the Boxcooler can easily be done from outside by using a high-pressure water jet. The tube-stack of the Boxcooler will probably have a greenish or brownish appearance. Don’t remove this layer since this consists of copper-oxide. The copper-oxide is a stable chemical fraction and is the very reason for why the Boxcooler shows anti-fouling growth characteristics.

6.3 Locating leaking tubes when loosing coolant
Extreme weather conditions, collision and objects entering the sea-chest can damage the tube bundles of the Boxcooler and cause leakages of the pipes. If this happens there are ways to overcome the problems and to repair the leaking pipes:

The ship is afloat
Depressurize and drain the freshwater cooling system by closing off the valves on the inlet- and outlet piping of the Boxcooler.

The ship must be trimmed to make sure the top of the tube-sheet is below the waterline. Loosen the hexagon bolts but do not remove them. Wait until the coolant has leaked out under the bonnet. If water leaks between the tube-sheet and mounting frame, tighten the hexagon socket head bolts until leaking stops.

Never loosen the hexagon socket head bolts when the ship is afloat!!!

After that, the hexagon bolts and the bonnet can be removed. Due to the pressure acting on the outside of the tube bundle, the water will make it visible which tube is leaking.

Leaking tubes can be plugged off with conical plugs (copper or brass). Do not apply too much force when installing a plug. This will cause deformation of the tube-sheet that will result in leakage of the surrounding tubes. Conical plugs of the correct size are obtainable from WEKA Boxcoolers BV.

The ship is in dry-dock
Depressurize and drain the freshwater cooling system by closing off the valves on the inlet- and outlet piping of the Boxcooler.

Dismount the Boxcooler from the sea-chest. Fit the bonnet and the bonnet gasket to the tube-sheet and blind all nozzle openings. Test the Boxcooler with hydraulic pressure or compressed air (submerge Boxcooler in water) applying the pressure stated on the identification plate. At the point where water or air appears, the tube bundle is leaking. Again, plug off the leaking pipes as described above.
7. PERFORMANCE FAILURES
The failure of the Boxcooler to perform satisfactorily may be caused by one or more factors, such as:
- Excessive fouling at the outside of the tubes.
- The Boxcooler is not installed correctly.
- Electrical insulation between tube-sheet and hull fails.

**Solution:**
- Clean tube bundle according to section 6.2
- Re-install the Boxcooler to obtain electrical acc. to section 4.3.

b. Presence of air or gas resulting from improper piping installation or lack of suitable vents.

**Solution:** Ventilate complete system

c. Restricted outboard water flow.

**Solution:**
- Check the inlet and outlet for an unrestricted entrance.
- Check for air-traps in the upper region of the sea-chest.
- Check the size of the openings and/or consult WEKA Boxcoolers BV

d. Operating conditions differ from design conditions.
Mounting Principle

ATTACHMENT II

LONGITUDINAL MOUNTING

ATHWARTSHIP MOUNTING

HOISTING WITH EYE-BOLTS
ATTACHMENT III

WEIGHT BUNDLE <600KG (13001b)
HOISTING WITH HOISTING BAR

ATTACHMENT IV

INSERT HOISTING LUGS IN 11mm GAPS BETWEEN

MAXIMUM LOAD: 1100 kg (2400lbs)

MEASUREMENTS IN mm

DIMENSION IN mm: 1" = 25.4 mm
MATERIAL: A106B/St. 37

HOISTING LUG, 2" REQUIRED
HOISTING WITH HOISTING BEAMS

ATTACHMENT V

WEIGHT BUNDLE >400 KG (880lbs)
FITTING MOUNTING FRAME TO TOPPLATE

ATTACHMENT VI

-Typical Cross - Section

-TOP VIEW

-Size of the hole to be cut in the top-plate of the sea-chest:

LENGTH (minimum) = A - 100mm (A - 4")
WIDTH (minimum) = C - 100mm (C - 4")

-Bring the mounting frame into position and weld it to the top plate of the sea-chest.
INSTALLING THE TUBE BUNDLE TO THE MOUNTING FRAME
- PUT THE MOUNTING FRAME GASKET ON THE MOUNTING FRAME
- SECURE THE HOISTING TOOL TO THE THREADED HOLES IN THE TUBE-SHEET (SEE ATTACHMENT III AND V), AND PLACE THE BUNDLE INTO POSITION
- INSTALL THE HEXAGON BOLTS INCLUDING THE WASHERS, METAL- AND PLASTIC RINGS.
INSTALLING THE BONNET TO THE TUBE-SHEET / MOUNTING FRAME

- POSITION THE BONNET GASKET ON THE TUBE-SHEET
- SECURE THE BONNET TO THE TUBE-SHEET / MOUNTING FRAME BY MEANS OF THE M12 HEXAGON BOLTS.

BOLT TIGHTENING PROCEDURE

- FOLLOW A DIAMETRICALLY STAGGERED PATTERN (AS ILLUSTRATED)
- APPLY A WRENCH MOMENT OF 10-12 Nm
- REPEAT THIS PATTERN 2 TO 3 TIMES.
- THE MAXIMUM WRENCH MOMENT IS 50-60 Nm.
PLACEMENT OF THE SACRIFICIAL ANODES IN SEA-CHEST

ATTACHMENT IX

CORRECT

ONLY AT THE BOTTOM

CORRECT

SPREAD AT ALL SIDES
WEIGHT PER ANODE NOT TO EXCEED 2 KG

WRONG

NEVER LIKE THIS
PLUG FOR LEAKING TUBES

ATTACHMENT X

MEASUREMENTS IN mm

MATERIAL: COPPER OR BRASS
INSTRUCTIONS FOR INLET AND OUTLET SLOTS

ATTACHMENT XI

NOTE:
TOTAL REQUIRED OPENING AREA FOR INLET AND OUTLET RESPECTIVELY IS GIVEN FROM SPECIFICATION SHEET OF THE BOXCOOLER INSTALLED