Inspection report

Inspection damage 300 TPD six stage flash evaporator on the Ms Love boat 2

Client: Love boat company
……
Technical Superintendent Sr.
……
……..
USA …….

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Report nr. 1-2416
Date: 03/04 june 2025
Page: 1
Pages:17 incl. Attachment

Introduction:

Mister ..... Technical Superintendent Sr. Love boat company has requested Cobra Consultancy to investigate a damaged 300 TPD six stages flash evaporator on the Ms. Love boat 1.

Damage on one of the evaporators occurred and the chief engineer of the Love boat Mr. .....send me some photos that showed me a typical example of erosion corrosion.
During the 3th and 4th of June we investigated the total damage of the evaporator on board of the MS. Love boat.
Unfortunately there were no technical drawings and material data of the evaporator at hand.
The Chief engineer informed me that the material that was used constructing the evaporator, is a metal substance called Cupro nickel: also known as Cunifer.

After analyses in a laboratory of two little pieces of material, removed from the tube and the baffle box it came clear that the tubes as well as the baffle boxes are not made out of Cunifer or Cupro Nickel?

History:

The 300 TPD six stages evaporator was installed around twenty years ago on the Love boat 1 (around 89) which is now called Love boat 1. In 2003 the tubes were cleaned and the gasket was probably not replaced for a new one.

Inspection

The first impression of the evaporator was the enormous damage of the tube sheets especially the tube sheets SB2 and BB2 in the middle of the evaporator.

Tube sheet SB2 (a part of the measuring holes)

Left	Middle	Right
9mm	4,7mm	9mm
11,2mm	2,9mm	9,1mm
13,1mm	14,1mm	10mm
9,1mm	11,6mm	11mm
8,9mm	7,1mm	
6,1mm	3,9mm	13,1mm
5,9mm		
2,1mm		

Tube sheet BB2 (a part of the measuring holes)

Left	Middle	Right
6,5mm		1,5mm
8mm		3mm
11,5mm		2,1mm
9mm		3,0mm
		3,0mm

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Tube sheet SB1

Left	Middle	Right
4,1mm		
3,1mm		
3mm		
4,1mm		

Tube sheet BB1

Left	Middle	Right
6,0mm		6.0mm
5mm		5,5mm
5,0mm		

Tube sheet SB3 and BB3 are not damaged by erosion

Conclusion and progress

The First impression of the evaporator was the enormous damage of the tube sheets especially the tube sheets SB2 and BB2.The deepest measured hole in the middle of the tube sheet SB2 is 14,1 mm. The deepest hole on the left side of the tube sheet BB2 measured 11,5mm

The damage of the tube sheets and the tubes has started as a result of short circuits between the gaskets and the tube sheet.
After cleaning the tubes the gasket was probably not renewed, probably the surface under the gasket was not cleaned as a result of leakage between the gasket and the material.

But the biggest problem with this installation is the fact that the evaporator is not manufactured as stated from the material Cunifer. See material analyses in the appendix page. 16 &17. This made the evaporator much more sensitive to erosion of the material present here!

Options

1. Repair through applying a paste substance of Copper epoxy called Devcon.

   This will be a temporary solution because the extremely erosion of the baffle boxes. It is also nearly impossible to create a total smooth surface of the tube sheet to seal the spacing entirely.
   Inserts need to be placed because some tubes are worn out for over 50 % on the pipe plate by erosion

2. Repair to bore out/ level off the tubes.

   The 6 baffle boxes and the tube sheets will be leveled on a boring machine.

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But the tube sheets especially the middle tube sheet after reducing more than 10 mm.
After recalculation the strengthens will probably too low and not justify anymore.
See the attachment 1 Option 2: No option

According to the texture of material (analysis: C687 ALBs 76 % Cu and 21 % Zn) it's well known that during time, it's become rigid and therefore cracks will appear whilst rolling the tubes.
This kind of material is also absolutely not suitable for welding.

3. *The best and most reliable solution is to renew the pipe plates and tubes in order to realize the original capacity of the evaporator. Within the pipe plates slotted grooves will need to be made which will put the gasket in place during these extreme circumstances.*

Note

It's recommendable to perform checkups on a regular basis with these kind of evaporators. Endoscopy is a perfect way to investigate the condition of the baffle boxes, marine box and tube plates through a small interface made in the evaporator. Problems can be detected in a early stage and therefore you will be able to perform future damage control.

Attachment:

1: 1 -4 offer company .....

5: Drawing Company .....example grooves in tube sheet

6: Material analyze baffle box

7: Material analyze tube

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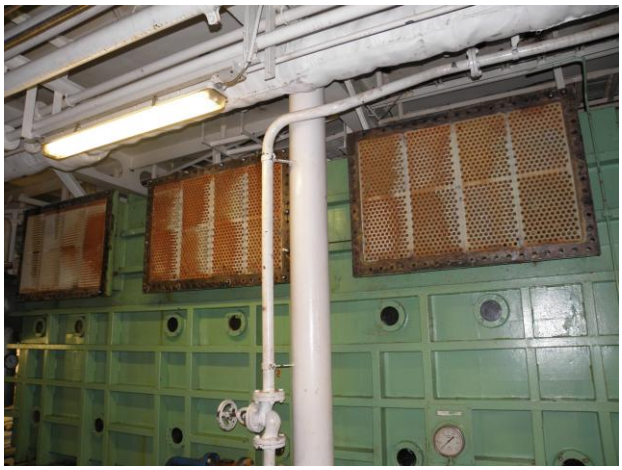
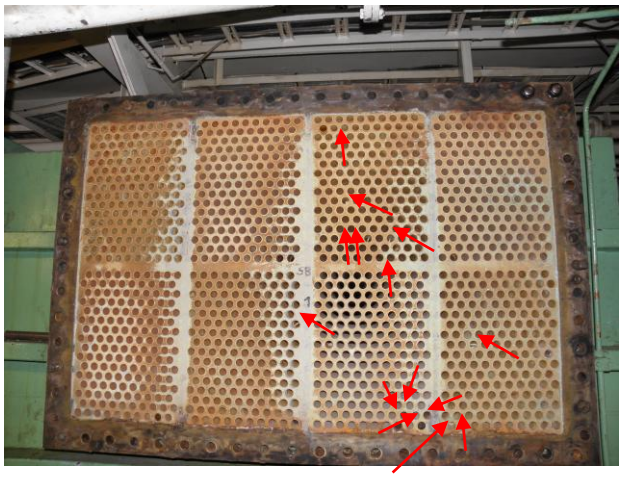


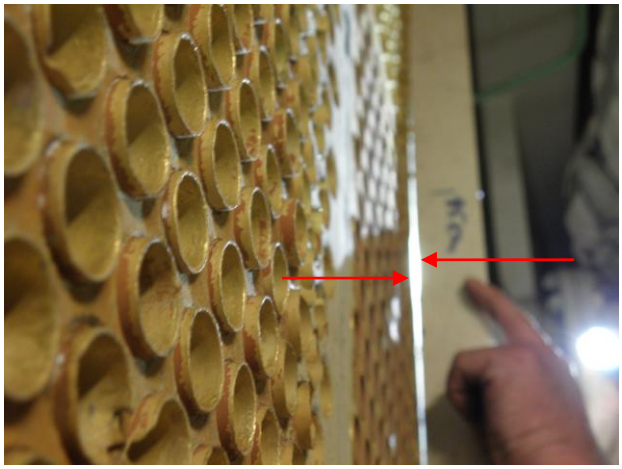
Evaporator Tube sheets

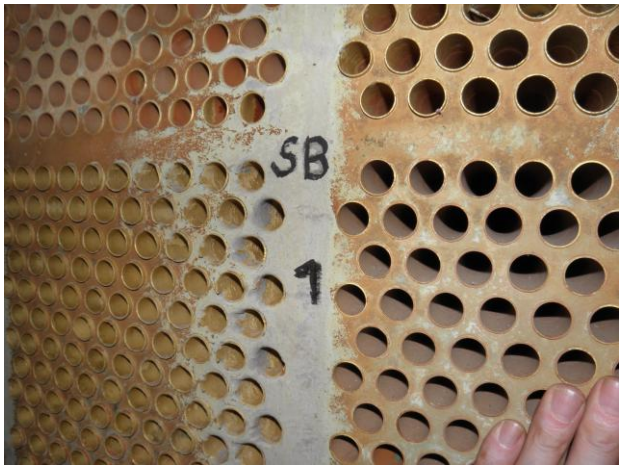


SB1 tube sheet 1 dirt in tubes

A lot of dirt in some tubes (close up)

Tubes damaged (close up)





Space between ruler and tube sheet 5 a 6 mm

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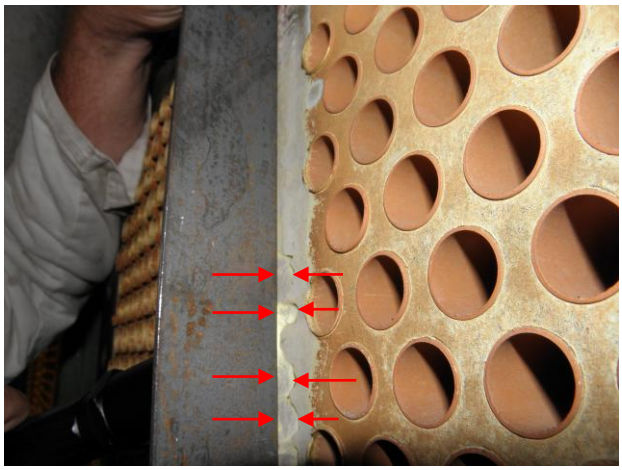
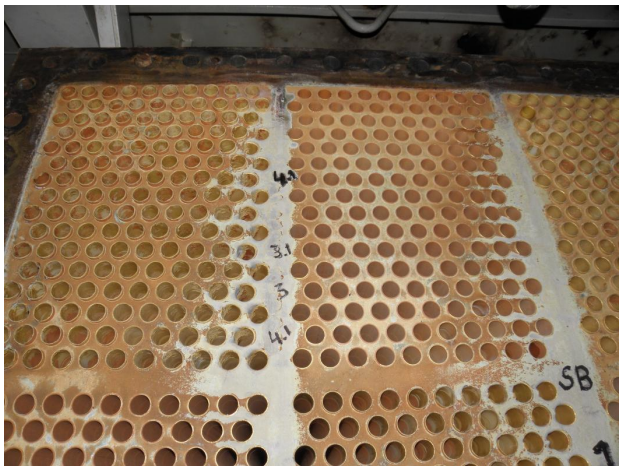
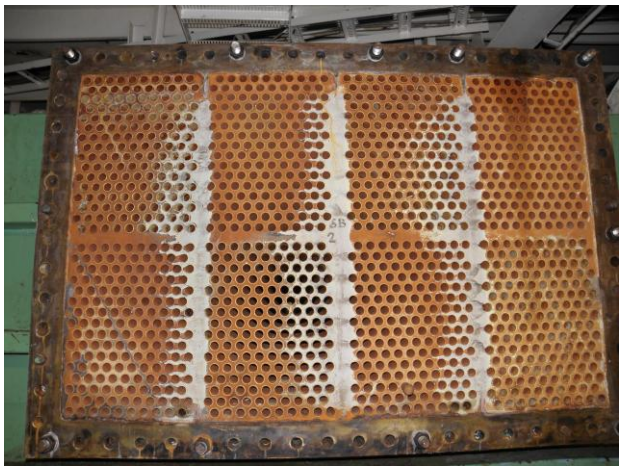


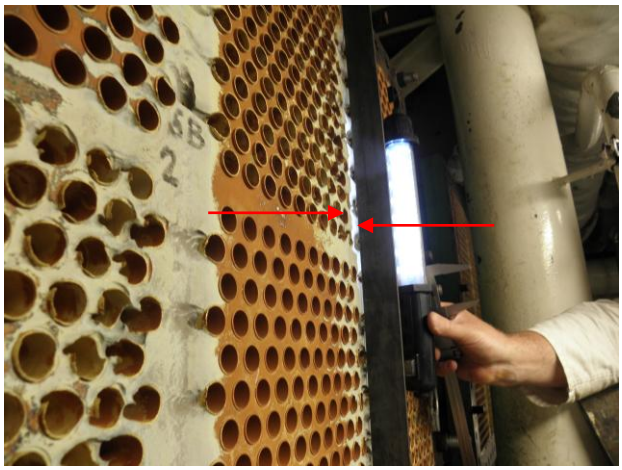
Spaces between ruler and tube sheet



Maximum 4.1 mm tube sheet SB 1



Tube sheet SB 2



Space between tube sheet and ruler

Space 3 to 6 mm

13.1 mm deepest hole

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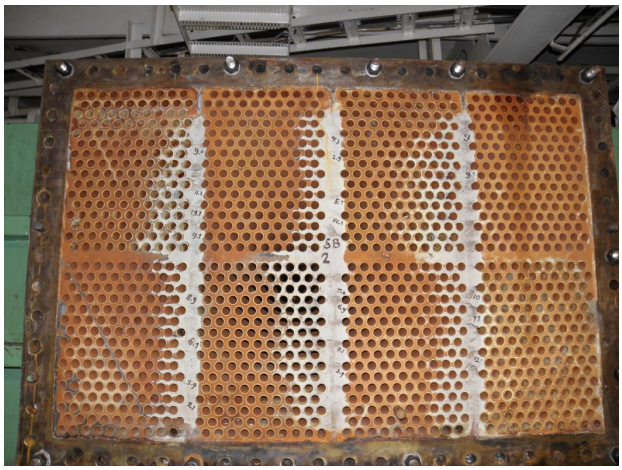
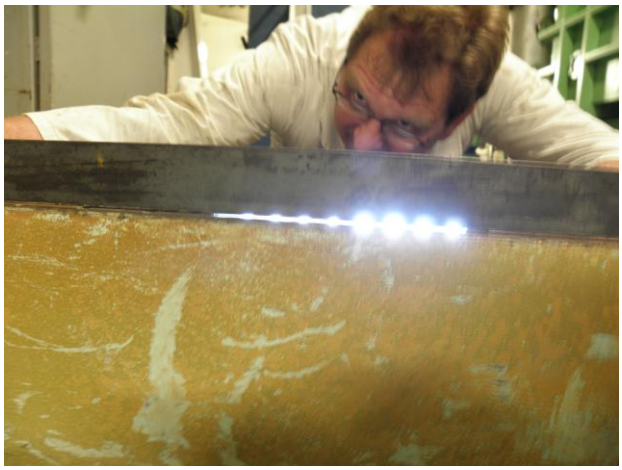
Tubes sheet thickness reduce till 13 mm

Close up

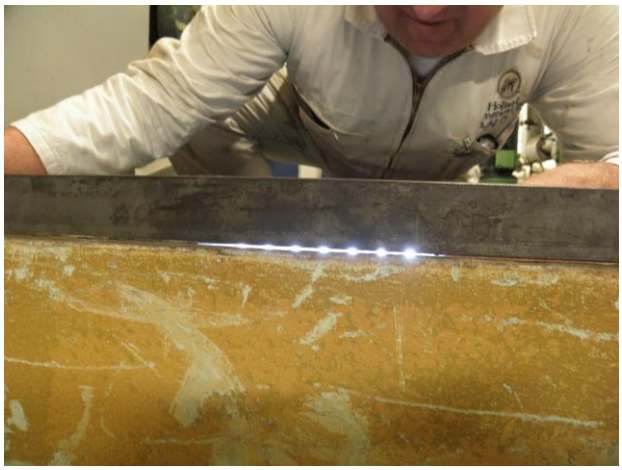


Max. 14 mm material delivery

Baffle box SB 2



Erosion baffle box SB 2



Holes Δ 3 mm

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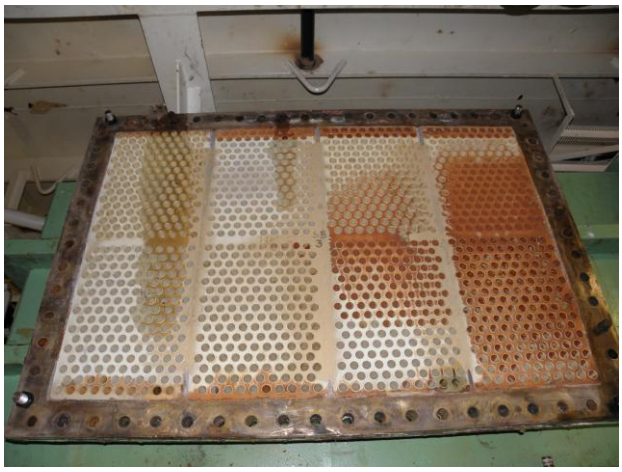
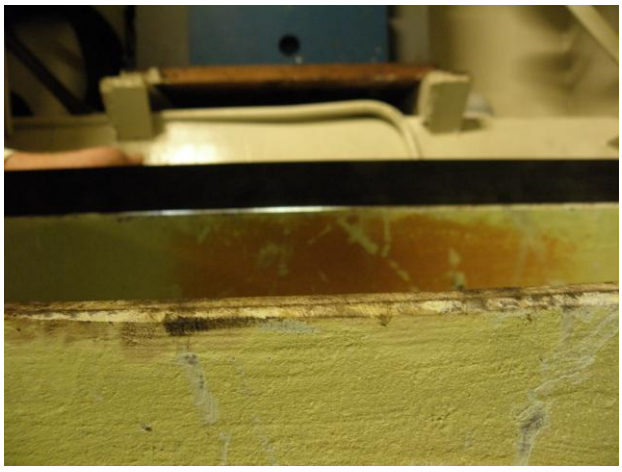


Tube sheet SB 3 no material delivery

Baffle box SB3 little material delivery



In the middle reducing material (FWD) about 2 a 3 mm

FDW reducing material space 2 a 3 mm

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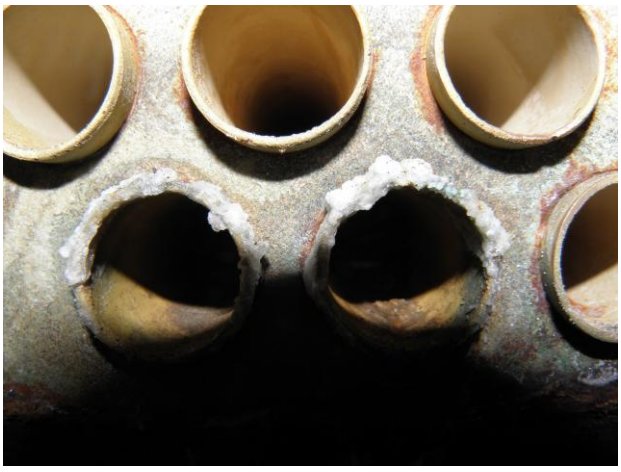
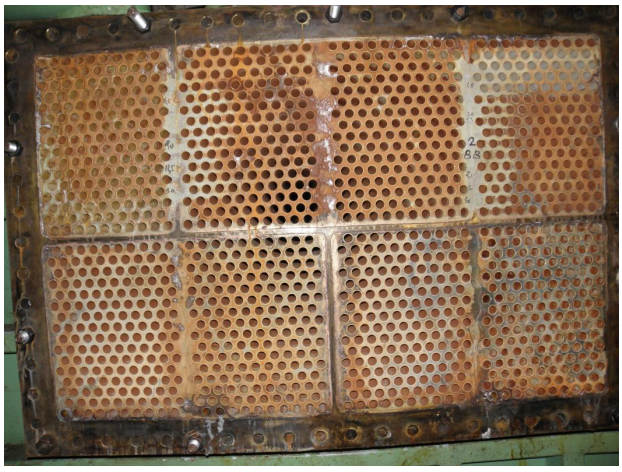
BB3 no material delivery

Dirt in some of the tubes

Destruction two tubes



Leakage tubes



Deepest hole 11.5 mm BB 2

Leakage

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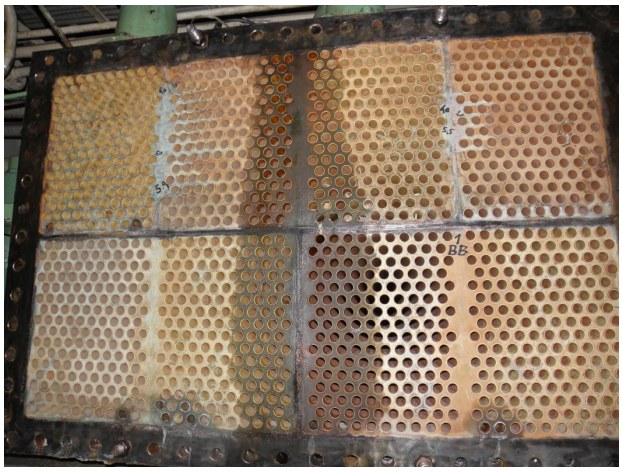

BB 1 deepest hole 6 mm

Dirt in tubes

Dirt in tubes

Leakage

FDW

Space between ruler and marine box 1.5 till 3 mm

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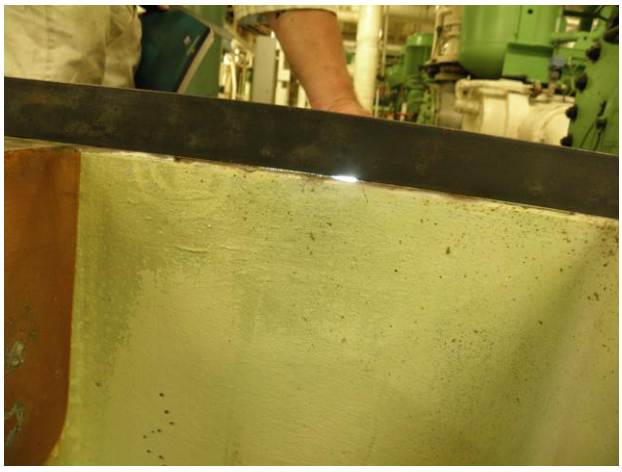
Space between ruler and marine box FDW Δ 2mm

AFT marine box



Space between ruler and marine box AFT 3mm

Close up erosion

Space between Δ 2 mm

SB side evaporator

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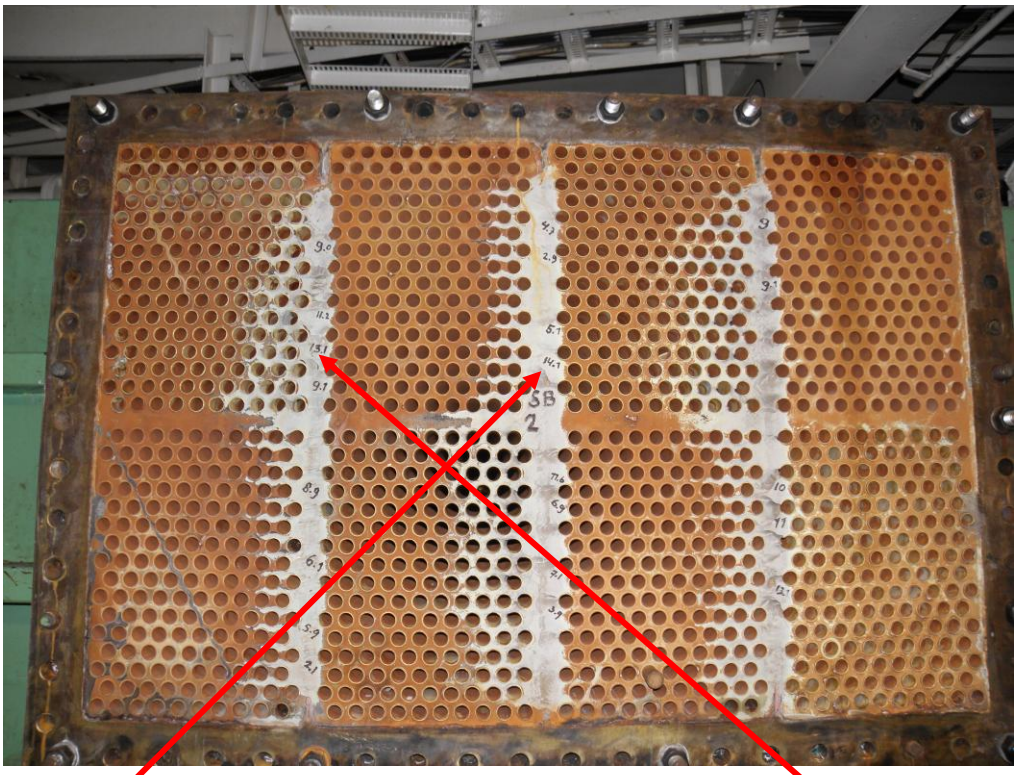
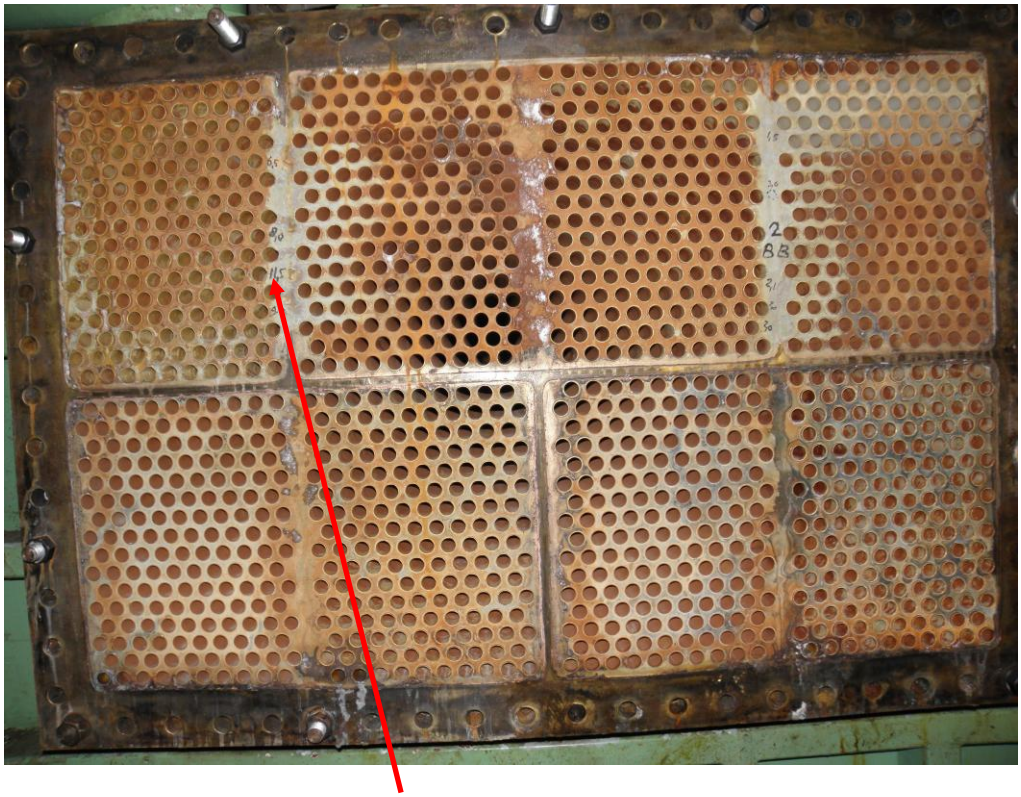


14,1 mm in the Middle SB2 The deepest holes left 13,1 mm



BB2 deepest hole 11,5mm

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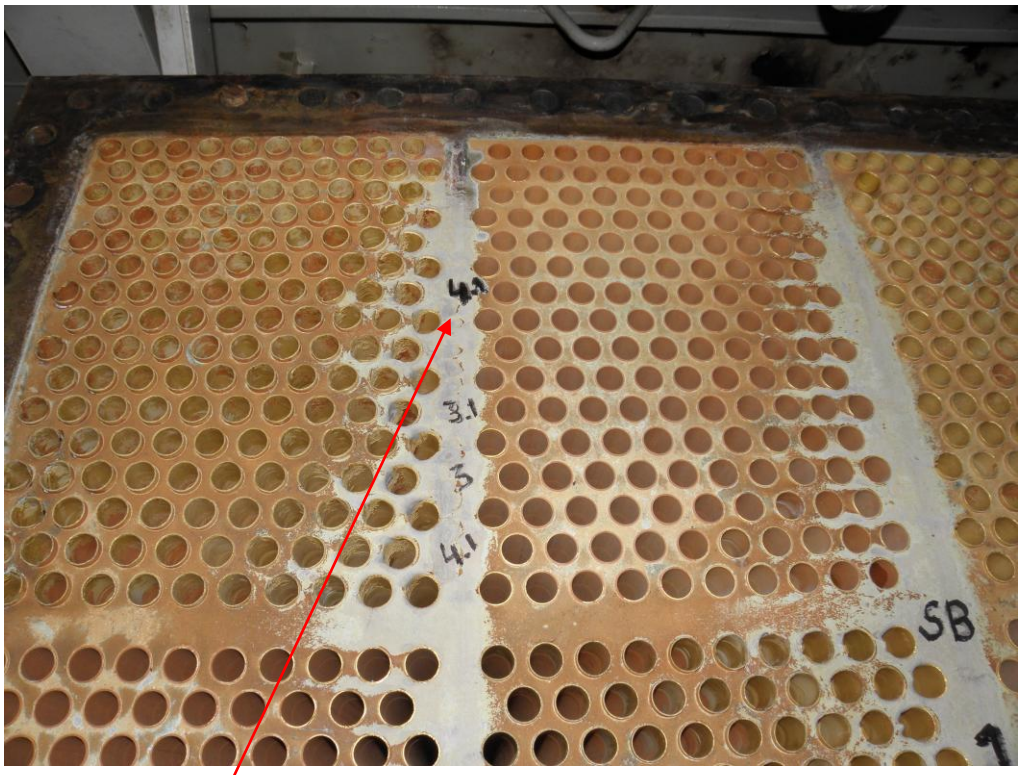
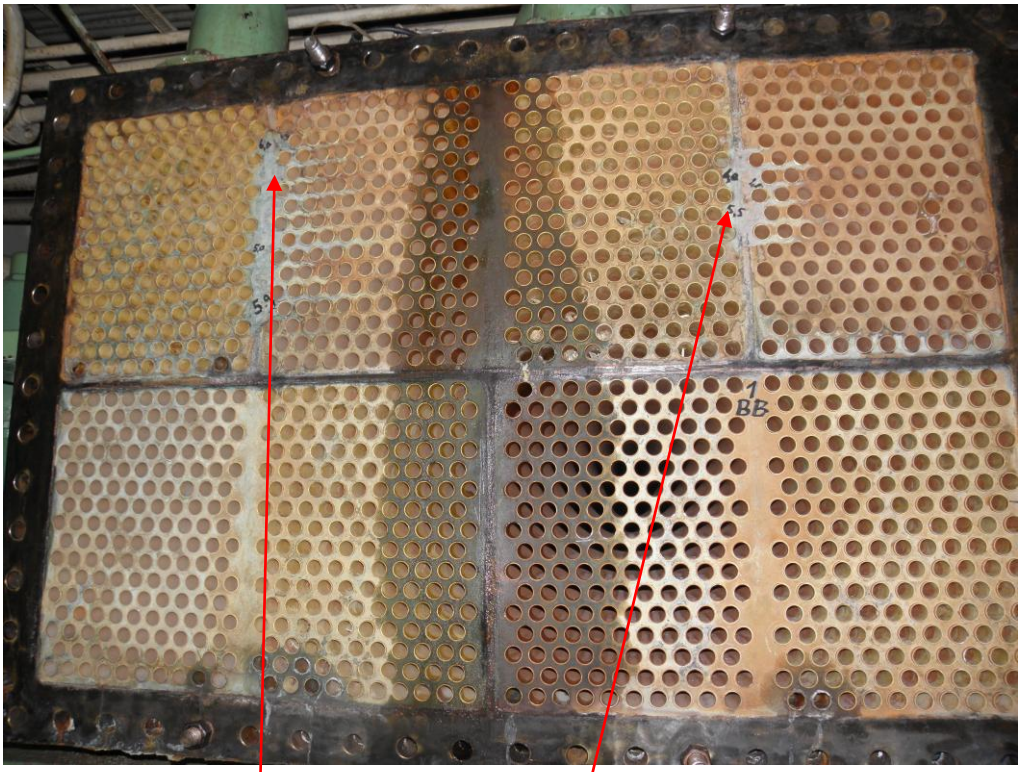


4,1 mm Tube sheet SB1 deepest hole left side



BB1 Tube sheet deepest hole 6mm 5,5 mm right side

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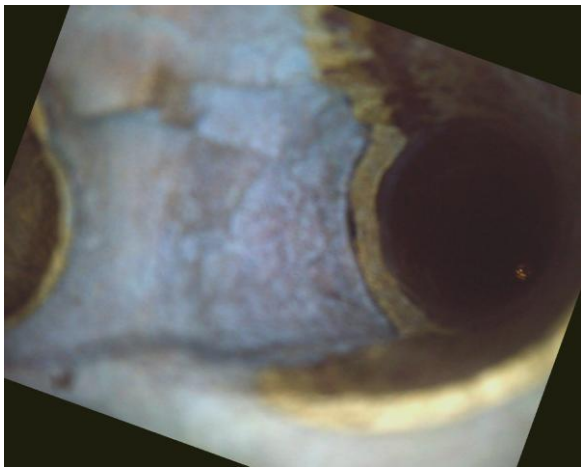
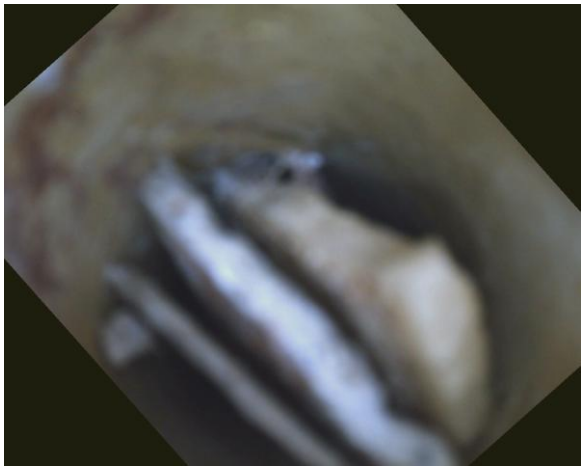
Endoscopic photos



Part of tube removed by erosion



Dirt in tubes SB1

Tube sheet SB1

Tubes inside evaporator

View under tubes SB

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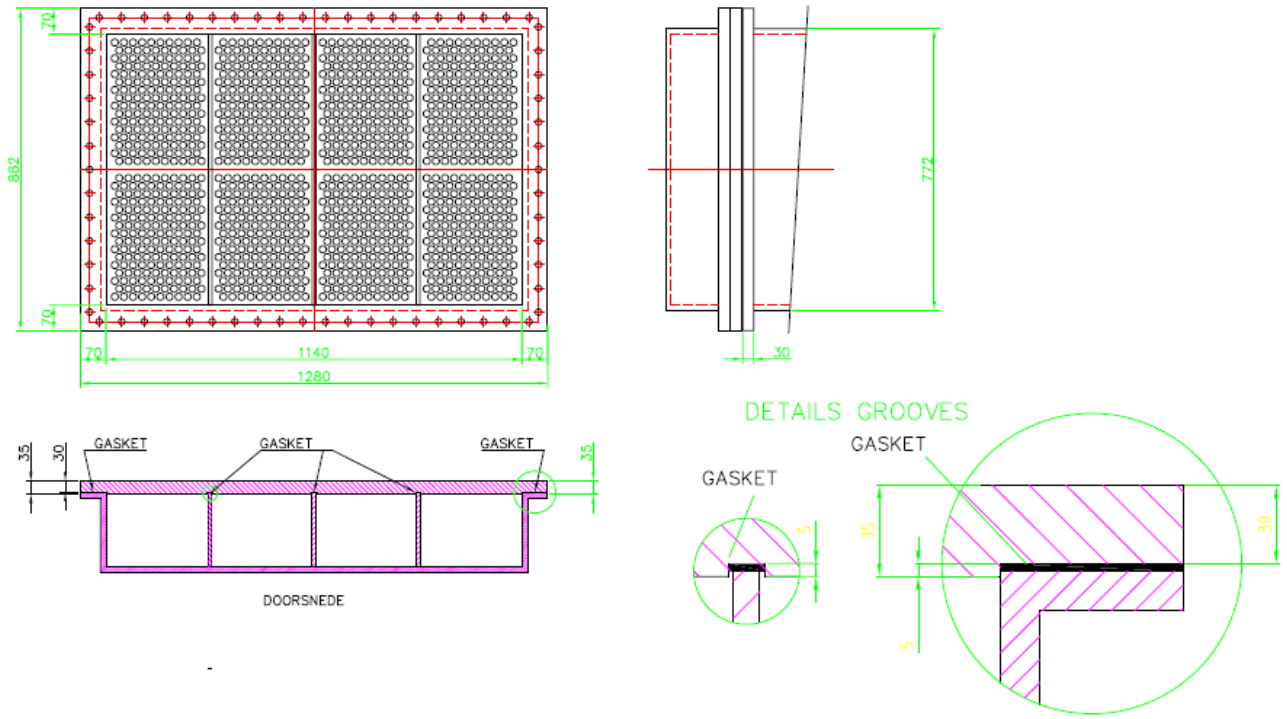
Repair:



C:\Program Files\Autodesk\Inventor 2009\Templates\Kapp\Kapp A3 offerte .dw

Example:

Slotted grooves will need to be made which will put the gasket in place during these extreme circumstances!

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Attachment

Certificate of Verification
XL3t-35084
Reading No 314
Mode ALLOY
Time 2009-06-05 12:13
Duration 147.62
Sequence Final
Alloy1 No Match : *4.15
Alloy2 No Match : *4.79
Baffle box MS Prinsendam

Alloy	% ± Error
Sb	0.086 ± 0.015
Sn	7.444 ± 0.055
Pd	0.000 ± 0.003
Baffle box	
Piece for analyze	
Ag	0.224 ± 0.161
Ru	0.000 ± 0.002
Mo	0.002 ± 0.001
Nb	0.004 ± 0.002
Zr	0.000 ± 0.003
Bi	0.006 ± 0.008
Pb	3.359 ± 0.035
Se	0.000 ± 0.003
W	0.000 ± 0.019
Zn	2.070 ± 0.026
Cu	85.932 ± 0.309
Ni	0.693 ± 0.015
Co	0.001 ± 0.004
Fe	0.036 ± 0.007
Mn	0.000 ± 0.006
Cr	0.000 ± 0.005
V	0.035 ± 0.005
Ti	0.081 ± 0.004
Al	0.000 ± 0.361
P	0.000 ± 0.026
Si	0.025 ± 0.052
Mg	0.000 ± 0.001

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Attachment

Certificate of Verification
XL3t-35084
Reading No 316
Mode ALLOY
Time 2009-06-05 12:20

Duration 61.38
Sequence Final
Alloy1 C687AlBs : 0.32
Alloy2 No Match : *2.19
Flags
SAMPLE:
Tubes evaporator MS Prinsendam
Piece for analyze

Alloy	% ± Error
Sb	0.007 ± 0.013
Sn	0.023 ± 0.009
Pd	0.001 ± 0.004
Ag	0.135 ± 0.096
Ru	0.000 ± 0.002
Mo	0.008 ± 0.001
Nb	0.062 ± 0.003
Zr	0.000 ± 0.002
Bi	0.002 ± 0.002
Pb	0.020 ± 0.004
Se	0.000 ± 0.002
W	0.000 ± 0.054
Zn	21.105 ± 0.186
Cu	76.398 ± 0.618
Ni	0.067 ± 0.007
Co	0.000 ± 0.004
Fe	0.198 ± 0.008
Mn	0.012 ± 0.005
Cr	0.004 ± 0.007
V	0.000 ± 0.010
Ti	0.047 ± 0.016
Al	1.686 ± 0.787
P	0.000 ± 0.051
Si	0.223 ± 0.100Mg 0.001 ± 0.001

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