





ارامكو السعودية
Saudi Aramco

Saudi Aramco's experience in Repairing Industrial Equipment

تجربة شركة أرامكو السعودية في إصلاح المعدات الصناعية

November 19, 2018

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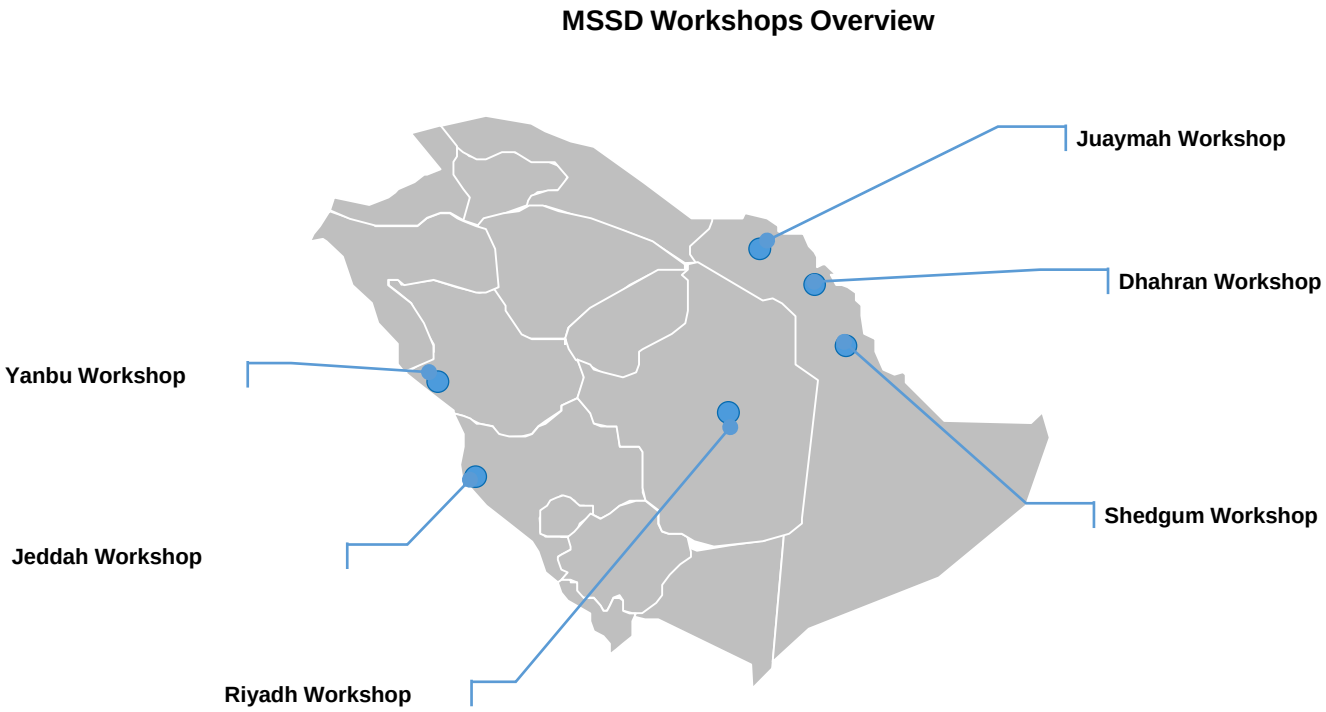
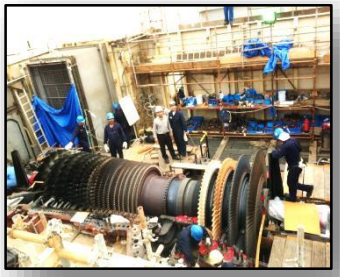
Purpose

- Sharing Saudi Aramco Maintenance Practices
- Open Channel for Benchmarking to identify improvement opportunities
- Address areas to concerned organizations (Researchers/Designers) of mutual interests to conduct/deploy new studies/technology at Plants & Services Providers Facilities

Mechanical Services Shops Department (MSSD) operates six workshops providing repair and overhaul services to Saudi Aramco in a centralized manner



MSSD Workflow Process



Field Services

Technical Assistance

Support Depts.
(Inspection, R&DC, CSD)

- Innovative Solutions
- Technical Knowledge
- Experience

Plant

MSSD

In-house

MSSD

Ship back to Plant

Plant

Contractors

Ship repaired parts/equipment back to MSSD

- Safety and Reliability
- Quality
- TAT
- Cost Effectiveness

Capabilities

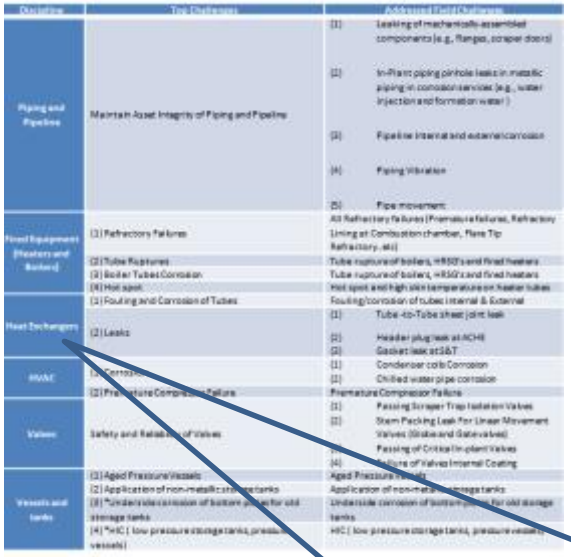
- Steam Turbines
- Gas Compressors

MSSD In-House Specialty

- Gearboxes
- Pumps
- Motors
- Coatin
-
-

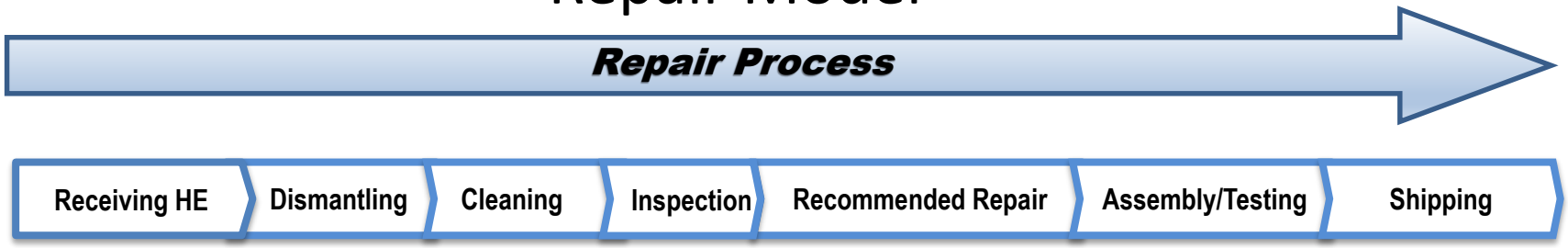
HE Types

Stationary Equipment Top Challenges



Heat Exchangers	(1) Fouling and Corrosion of Tubes	Fouling/corrosion of tubes internal & External
	(2) Leaks	(1) Tube -to-Tube sheet joint leak (2) Header plug leak at ACHE (3) Gasket leak at S&T

Repair Model



Repair Process

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping

- Repair Documents
- Equipment Offload

MAINTENANCE WORK ORDER

M&SD-SHOPS WORK

FIELD SUPERIOR ORDER NO. 1 0 9 2 5 4 9 4 - -

DATE	FIELD OPC	COST CENTER	SAP EQUIPMENT No.	SUB ORDER No.
05 26 09	495	3 8 2 8 0 3	2 4 3 6 8 1 0 -	1 0 5 8 0 9 2 3 - -

WBS ELEMENT (IF REQUIRED)	DDA	ENG. PLANT No.	ENG. ITEM No.
	R H 7	0 7 0 - -	CWGM 1

SUPPORT INFORMATION

	YES	NO
DRAWING AVAILABLE	☐	☑
PARTS AVAILABLE IN FIELD	☐	☑
MANUALS AVAILABLE	☐	☑
EXPLOSION PROOF MOTOR	☐	☑

SERVICE ENVIRONMENT

RPM

Pressure PS

Temp °F

Fluid

REPLACEMENT COST

EQUIPMENT DESCRIPTION: (Manufacturer, Model, Type)

70:Chilled Water Pump Motor up Normal Noise
CWGM1 CHILLED WATER PUMP MOTOR

WORKSCOPE- (Include cause of failure (symptoms); special modification information)

LABORATORY BUILDING , RT REFINERY
70:Chilled Water Pump Motor up Normal Noise need to be rewinding and check .

FIELD CONTACTS

	PRIMARY	ALTERNATE	SUPERINTENDENT E-MAIL
NAME			
PHONE	873-1552	873-1220	OFF-DUTY CONTACT
FAX			
MOBILE			
E-MAIL			
PAGER			

FIELD REQUIRED DATE
MONTH/DAY/YEAR

DATE RECEIVED AT M&SD

NOTE. SHOULD THERE BE A NEED TO HOT LIST THIS WORK (OVERTIME REQUIREMENT) PLEASE PROVIDE JUSTIFICATION WITH DEPARTMENT HEAD APPROVAL.

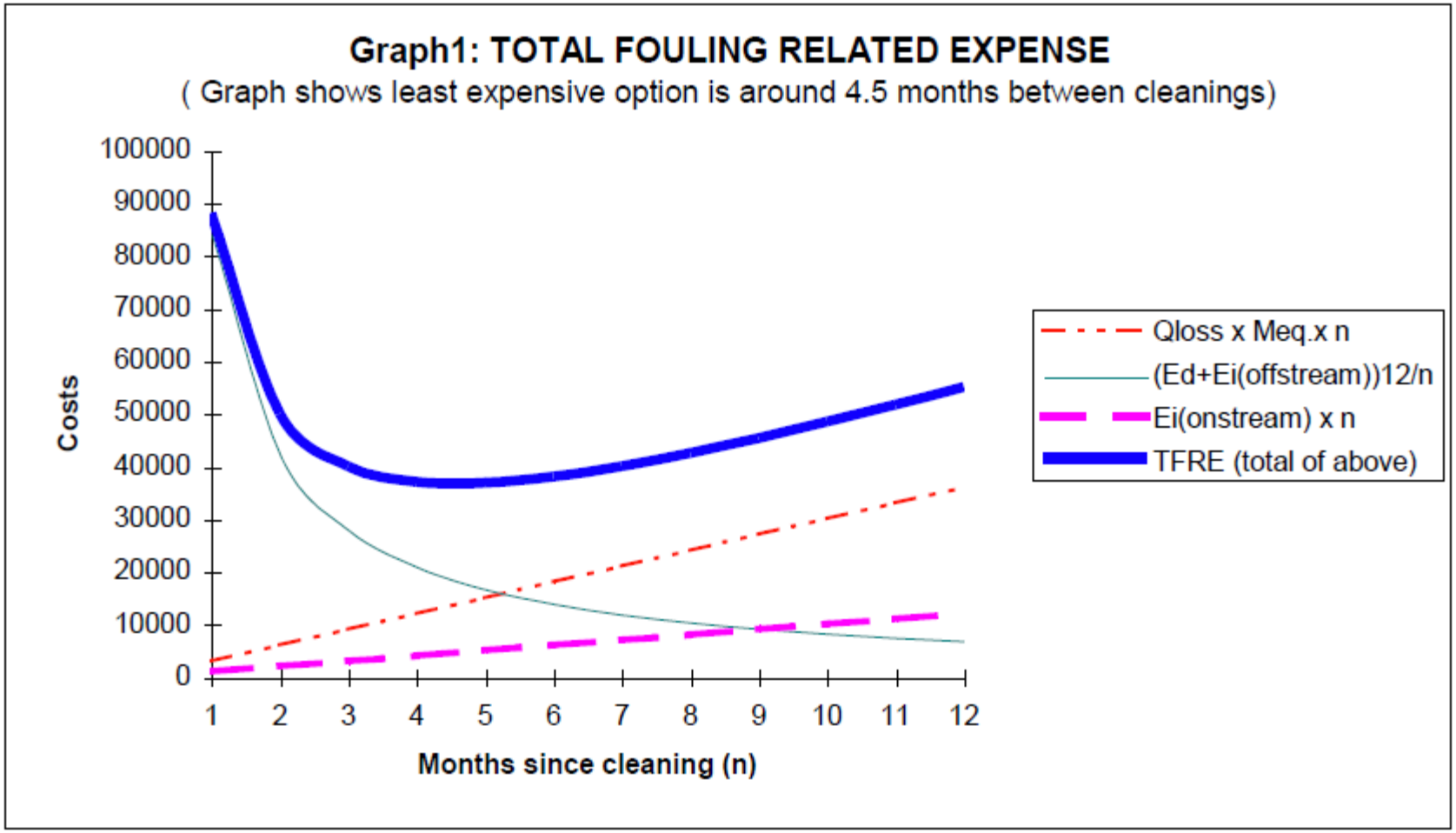
Repair Process

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping

- Marking
- Dismantling the components
- Removing the bundle

Cleaning Criteria

1. Inspection
2. Clean whenever the actual heat transfer coefficient (U_{actual}) drops to 60 % of the U_{design} at heat exchanger design operating conditions
3. Clean when the total fouling related expenditure (TFRE) is at the minimum
4. Clean whenever the drop in heat duty is unacceptable to Plant Operations
5. Clean during unplanned shutdown to take advantage of down time
6. Using scale monitoring or based on recorded rate of scale or corrosion products build up



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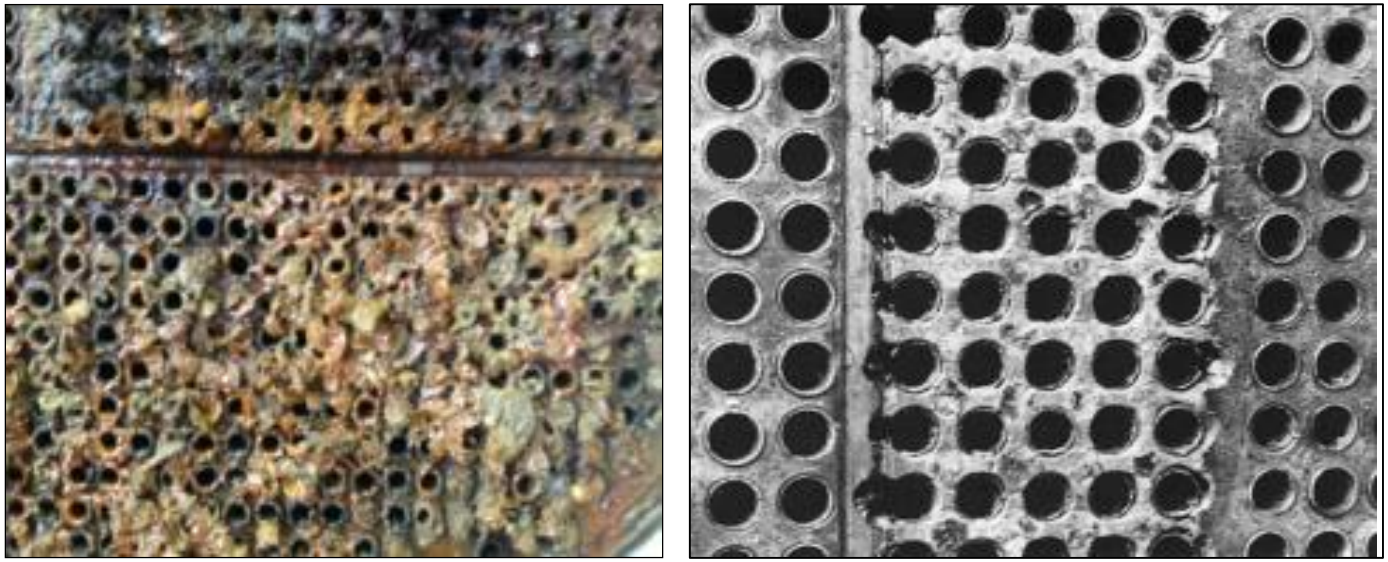
Typical Fouling



Tube Sheet Corroded Beneath Marine Growth

Typical Fouling

Clogged Tubesheet by Sever fouling

Coke fouling accumulation

Typical Fouling




Cooler Complete blockage with Salt and Dirt


Sludge from Heat Exchanger

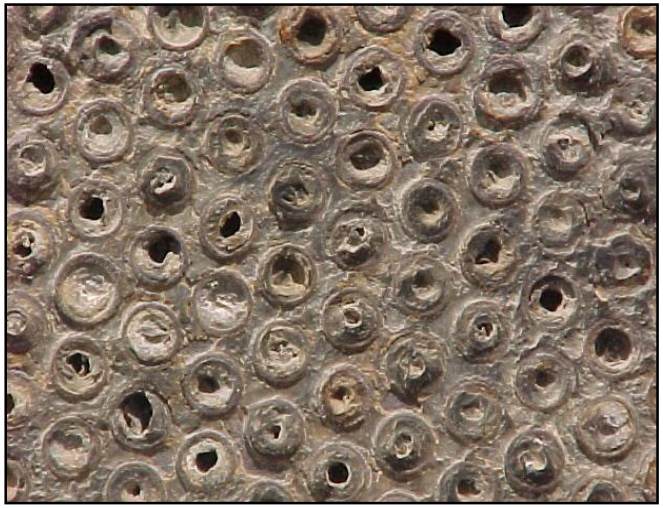
Cleaning Techniques

- Mechanical Cleaning
- High Pressure Water Jetting (HPJ)
- Hot alkaline treatment
- Acid Cleaning and Neutralization
- Passivation

- Grit blasting the components
- Hydro jetting the bundle
- If required additional Cleaning:
  - Chemical cleaning
  - Jet drilling

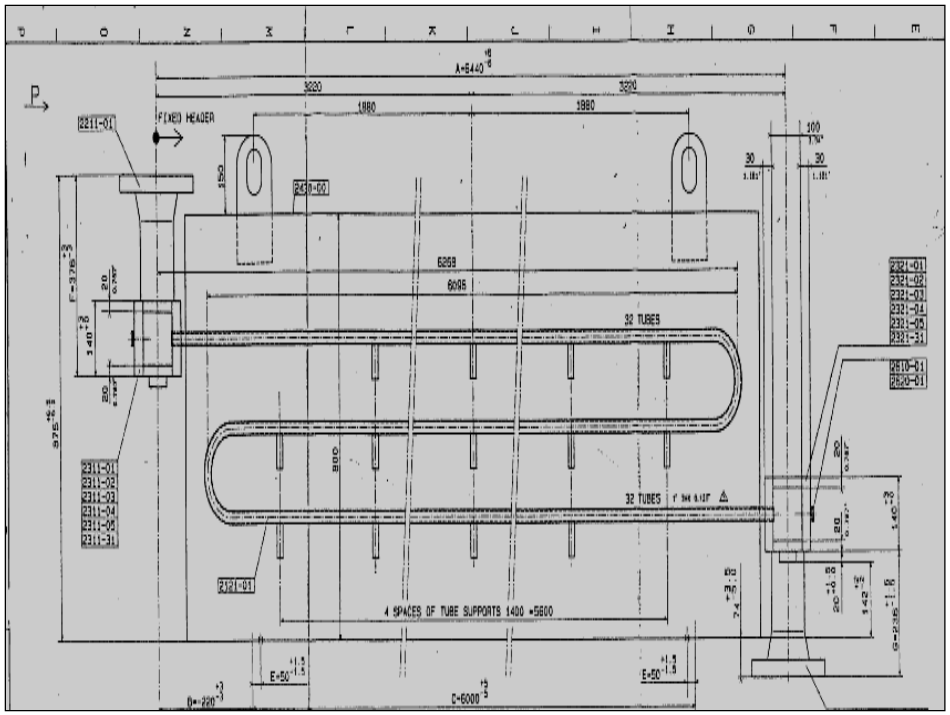
Case-2

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping



Case-3

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping



Hydrogen with tube material of SA213-T11

Case-4

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping

Acid & Max. Conc.	Max. Corr. Rate (7) at Max. Temp.
HCl, 6 % v/v	300 mpy at 82°C
H_2SO_4, 8% v/v	200 mpy at 82°C
Citric, 5% v/v	200 mpy at 93°C
Sulfamic 10% v/v	200 mpy at 65°C
Na-EDTA 10% w/w	50 mpy at 95°C

Repair Process

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping

Develop Inspection Report

Some Techniq

- Visual Insp
- Dye Penetr
- Advanced
- DT (I

- Partial Re-tube
- Complete Re-tube
- Component Repair
- Component Fabrication

	Major Process-R74E105/B	From	To
8	DISMANTLING BOTH SIDE CHANNELS	10/9/2007	10/20/2007
9	ORDERING 7250 TUBES FOR E-105 A/B	11/3/2007	3/13/2008
10	REMOVING PLUGS OUT OF TUBES	11/1/2007	11/20/2007
12	CUT BETWEEN FIX TUBESHEET AND SHELL	11/21/2007	11/30/2007
14	PULLING AND CUTTING TUBES FROM FLOATING SIDE	11/9/2007	2/9/2008
16	REMOVE REAMAIN PLUGS FROM BOTH SIDE OF T- SHEETS	2/9/2008	3/1/2008
18	BURN OUT NEW BAFFLES AT WELDING SHOP	1/25/2008	2/5/2008
20	FABRICATING NEW BAFFLES SKELETON AT MSU	2/3/2008	2/13/2008
22	CUT FLOATING TUBE SHEET BY BAND SAW	3/1/2008	3/7/2008
23	PULLING TUBE BUNDLE OUT OF THE SHELL	3/7/2008	3/9/2008
25	CUTTING TUBE BUNDLE FROM FIXED T- SHEET	3/9/2008	3/15/2008
27	DETUBBING BAFFLES TUBES	3/15/2008	3/20/2008
28	PREPARING SHELL & T-BUNDLE FOR INSPECTION	3/20/2008	3/25/2008
29	INSPECTION WITH COMPONENTS & SHELL	3/25/2008	3/28/2008
30	CUT SPACERS AND TIE ROD	3/22/2008	3/23/2008
31	INSTALLING SPACER AND TIE ROD	3/22/2008	3/24/2008
32	INSTALLING TUBES IN BAFLE SKELETON	03/24/208	3/31/2008
33	GRIND BOTH SIDE OF SHELL AS CSD RECOMMENDED	4/9/2008	4/11/2008
34	MACHIN & WELD REPAIR WITH FIXED T-SHEET	3/11/2008	5/1/2008
35	MACHIN & WELD REPAIR WITH FLOATING T-SHEET	3/15/2008	4/26/2008
36	WELD FLOATING TUBE SHEET TO SHELL AS CSD RECOM	4/27/2008	5/2/2008
37	INSTALL FIXED TUBE SHEET BAFFLES SKELETON	5/1/2008	5/2/2008
38	DRAFTING TUBES TO FIXED TUBE SHEET	5/2/2008	5/4/2008
39	INSTALL TUBE BUNDLE INSID THE SHELL	5/4/2008	5/5/2008
40	DRAFTING TUBES TO FLOATING TUBE SHETT	5/6/2008	5/11/2008
41	WELD FIXED TUBE SHEET JOINT TO SHELL	5/12/2008	5/18/2008
42	NDT & REQUIRED INSPECTION	5/19/2008	5/20/2008
43	ROLLING TUBES FOR BOTH TUBE SHEETS	5/20/2008	6/10/2008
44	SCHEDULE FOR ROAD HEAVY EQUIPMENT	6/10/2008	6/15/2008

Repair Process

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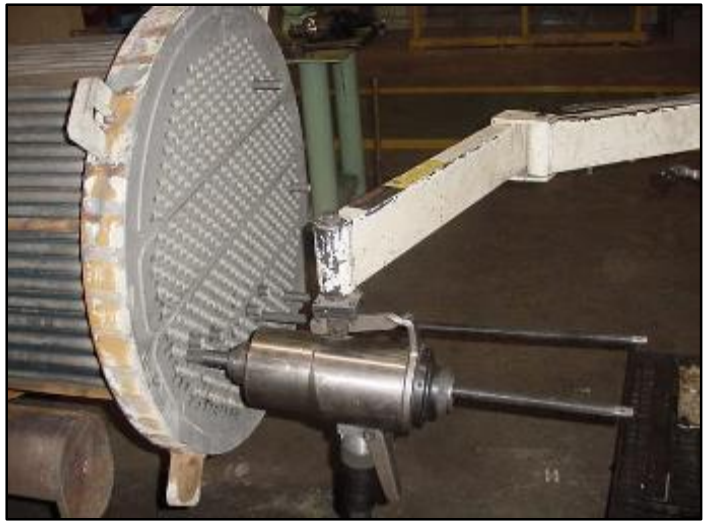
Partial Re-Tubing

- Marked damaged tubes are pulled out and replaced.
- Rolling /Seal Welding application



Complete Re-Tube

- Bundle is cut by the band saw
- Remove Tubes Remaining (Destubing)
- Pulling the tubes from the skeleton

Complete Re-tubing

- Mounting Fixed Tube Sheet
- New tubes inserted
- Tubes Expansion

Repair Process

Receiving HE | Dismantling | Cleaning | Inspection | **Recommended Repair** | Assembly/Testing | Shipping

Component Repair (Welding and Machining)

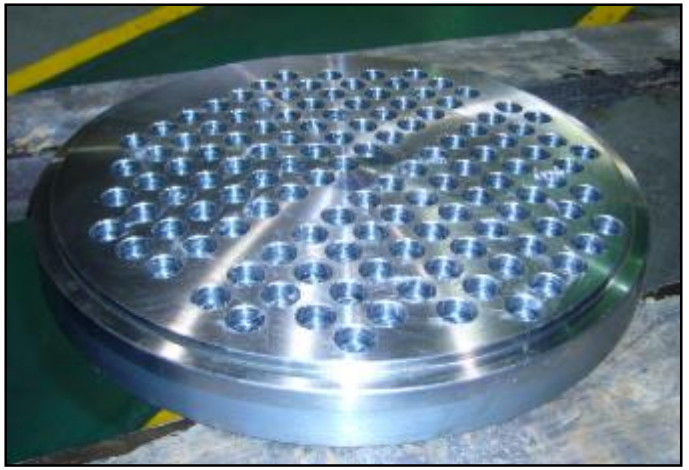
- Tubesheets
- Water Box /Channel
- Floating head

Repair Process

Receiving HE | Dismantling | Cleaning | Inspection | Recommended Repair | Assembly/Testing | Shipping

Components Fabrication

- Baffles Plates
- Tube Sheets
- Complete Bundle



- Assembly Steps:
  - Install Bundle in Shell
  - Install Channel
  - Install Test Ring
- Types of hydro tests
  - Ring Test
  - Tube Test
  - Shell Test

Repair Process

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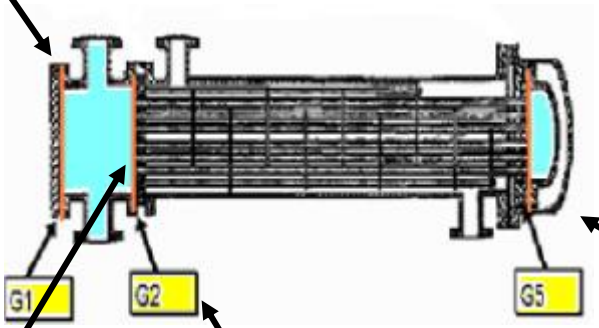


- Shipping Shell & Tube Bundle.
- Shipping Bundle with Carrier
- Shipping Air Cooled Fin Fan

Recommendations

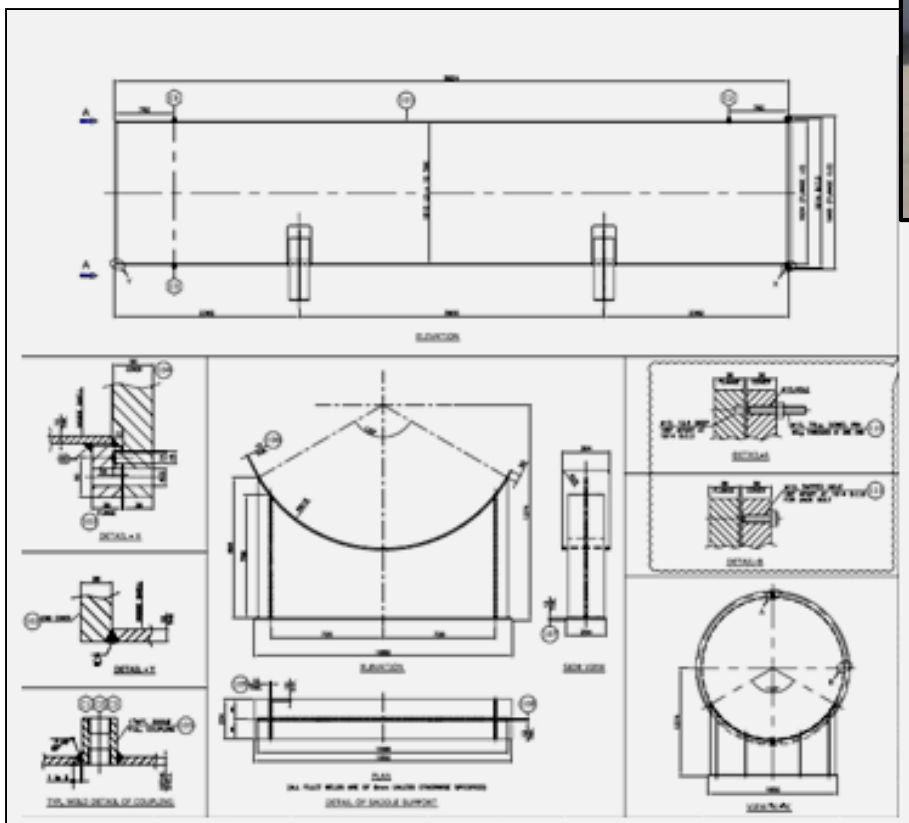
$$t = \frac{PR}{SE + 0.6P} \rightarrow (1)$$

$$P = \frac{SEt}{R + 0.6t} \rightarrow (2)$$

- Use industrial recommended practices
  (Ex API 510, API 579, API 580…)
- Select applicable cleaning methods
  (Effectiveness, Cost, Downtime)
- Apply best practices during design stage
  (Storage Spare Bundle, parallel heat exchanger, proper HEX selection)
- Maintain important documents
  (Ex. maintenance manual including material of construction, corrosion rate, tolerances, thermal design specifications ,fabrication drawings &test Ring)
- Conduct studies or technology deployment to enhance maintenance methods

Storage Spare Bundle

- N_2 Storage Procedure
- Canister fabrication



BILL OF MATERIALS (FOR ONE UNIT ONLY)

DESCRIPTION	MATERIAL	QTY.	SIZE	LENGTH	WEIGHT(Kg.)
SHELL	SA 285 Gr.C	1	5718 CIR.	8586	
END COVER	SA 285 Gr.C	1	ø1830 x 25 THK	–	
FLANGE	SA 36	1	1834 I.D x 1965 O.D x 38 THK		
FLANGE COVER	SA 36	1	1965 O.D x 50 THK	–	
COUPLING	SA 105	3	1"NPT,3000#, FULL COUPLING		
WEAR PLATE	SA 285 Gr.C	2	304 W x 10 THK	2028	
BASE PLATE	SA 36	2	254 W x 12 THK	1650	
WEB PLATE	SA 36	2	896 W x 12 THK	1600	
GUSSET PLATE	SA 36	4	111 W x 12 THK	786	
DOWEL PIN	SA 193 Gr.B7	2	ø10 x 76Lg. (45 Lg. THREADED AT ONE END)		
JACK BOLT	SA 193 Gr.B7	2	(AS SHOWN)		

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Thank You