

經濟部所屬各機關因公出國人員出國報告  
(出國類別:其他)

M10101大林廠第三重油加氫脫硫  
工場反應器監造

服務機關:台灣中油股份有限公司興建工程處

出國人職稱:機械工程監、機械工程師

出國人姓名:蘇進生、蘇炫銘

派赴國家:日本

出國期間: 102 年 10 月 3 日至 102 年 10 月 9 日

報告日期: 102 年 12 月 10 日

## 摘要

在政府積極推動油品自由化政策下，本公司國內油品市場已經面臨台塑及進口油商等市場競爭，而不在享有獨占之局面，再加上日益嚴格之環保規範，公司面臨之經營環境也更加嚴峻，為了在此競爭之環境下保持領先之地位，本公司勢必提高重點工場設備利用率，改善煉製流程提高產品產值及品質，以強化市場競爭力，達成公司永續經營之目標。

目前重油加輕脫硫工場，為本公司煉製結構瓶頸，所產出之低硫燃料油除供應下游需求外，亦作為重油裂解工廠(RFCC)進料，使低硫燃料油需求更形短缺，為彌補 RFCC 進料不足及增加石化丙烯及輕質汽柴油之產率，故提出第三重油加輕脫硫工場擴產投資計畫，實有其必要性及妥適性。

## 目次

壹、目的.....	4
貳、過程.....	5
參、心得與建議.....	20
肆、附件.....	22

## 壹、目的

第三重油加氫脫硫工場提升投資計畫(M10101)，除產能去瓶頸之工程外，最主要係增加向上流動反應器(UFR, Up Flow Reactor)之煉能，並有效去除重油進料之金屬含量及降低殘碳量，且可避免煉量提升後降低觸媒操作週期，是故本設備未來將由 30,000BPSD 之煉量及觸媒操作週期 14 個月之產能提升至 40,000 BPSD 之煉量及觸媒操作週期可維持 14.03 個月，為達此一目標，本次計劃擬採用美國 CLG(Chevron Lummus Global)公司之專利製程，取代舊有之製程，這對於未來煉製結構之改善將有很大之助益即可提升經濟效益。

本次出國最主要任務及目的，係針對上述之向上流動反應器(UFR)，就有關設計、製造、檢查、測試、運送等相關議題與先行與較具有資格能力之製造廠商(Japan steel works LTD 及 Kobe steel LTD 等二家)進行討論(全球有能力製造廠家有 10 家，因受限於時程，本次只挑選較鄰近之國家日本地區)，並實地參觀製造工場生產線之設備，了解相關設備製造能力，以作為日後決標審查之參考依據。

## 貳、過程

### (一)行程安排

表 1-1

102/10/3	啟程(台北-北海道)
102/10/4~5	參訪 JSWL 公司了解 UFR 反應器製程品質檢驗流程。
102/10/6	北海道往大阪市
102/10/7~8	參訪 KOBE 公司了解 UFR 反應器製程及品質檢驗流程。
102/10/9	返程(關西-台北)

### (二)參訪日本製鋼(JSW L.T.D.)

#### (1).公司簡介

本次拜訪廠家日本製鋼公司位於日本北海道室蘭市，由製造部部長-TSUYOSHI NAKAMURA /壓力設備鍛造部門經理- YUJI SHIMAKI /工程師-NAOKI YAMAGUCHI/業務部門-KENSUKE IUCHI 接待，介紹該公司、討論高壓反應器製作檢驗並參訪各工廠區。

北海道室蘭日本製鋼公司成立於 1907 年，在日本鋼鐵生產中心，作為一個合資企業開始於英國爵士 WG 阿姆斯特朗惠氏有限公司和維氏父子和 Maxim 公司在日本國內武器生產的目標。

二戰結束後，本公司將其先進的技術和相當豐富的經驗滿足平時需求的任務。從鋼鐵製造及機械的發展，新的業務領域，如汽車，電氣設備，信息設備，以及電力，鋼鐵，造船，石化等重工業，公司擴大其業務領域，並開始賺取全世界作為一家領先的綜合鋼鐵和機械製造商的聲譽。

目前作為一個材料機電企業它滿足 IT 相關的行業，如信息和通信的需求，日本鋼鐵的全球性活動舒展超越其現有領域，以涵蓋的發展等前沿技術作為新的能源、自然能源、新材料、光學及電子和生物技術。該公司還積極在市區重建和環境相關的業務領域，總是走在社會和行業的發展趨勢，動態的多方面的日本鋼鐵正準備持續蓬勃增長，在為數眾多的新興領域提升其企業價值，以滿足其客戶股東和員工的需求。

(2).行程安排

## **PROPOSED AGENDA**

1. DATE AND PLACE

October 04, 2013 at No.12 Reception Room of JSW Muroran Plant

2. GUESTS

Mr. Sue Jing-Shung	Manager of Construction Division
Mr. Su Shiuan-Ming	Engineer

3. ATTENDANTS FROM JSW

Tsuyoshi Nakamura	Deputy Plant Manager / General Manager, Forgings, Casting & Pressure Vessel Dept.
Yuji Shimaki	Group Manager, Pressure Vessel Group
Hidekazu Isogai	Deputy General Manager, Pressure Vessel Group
Naoki Yamaguchi	Senior Engineer, Pressure Vessel Group
Kensuke Iuchi	Deputy Sales Manager, Tokyo Head Office

4. PROPOSED SCHEDULE

October 04, 2013 (Friday) ·· Reception Room No.12

9 : 15 - 9 : 25	Greeting
9 : 25 - 10 : 00	Explanation of JSW Muroran Plant -The Video Program of Pressure Vessel
10 : 00 - 12 : 00	Shop Tour for the JSW's facility (Forging Shop - No.4 Machining Shop – No.4 Fabrication Shop - Japanese Sword Shop)
12 : 00 - 13 : 00	Lunch at JSW Guest House
13 : 00 - 16 : 30	Discussion - Introduction of Current Activity for Pressure Vessels - Q&A
16 : 30	Closing

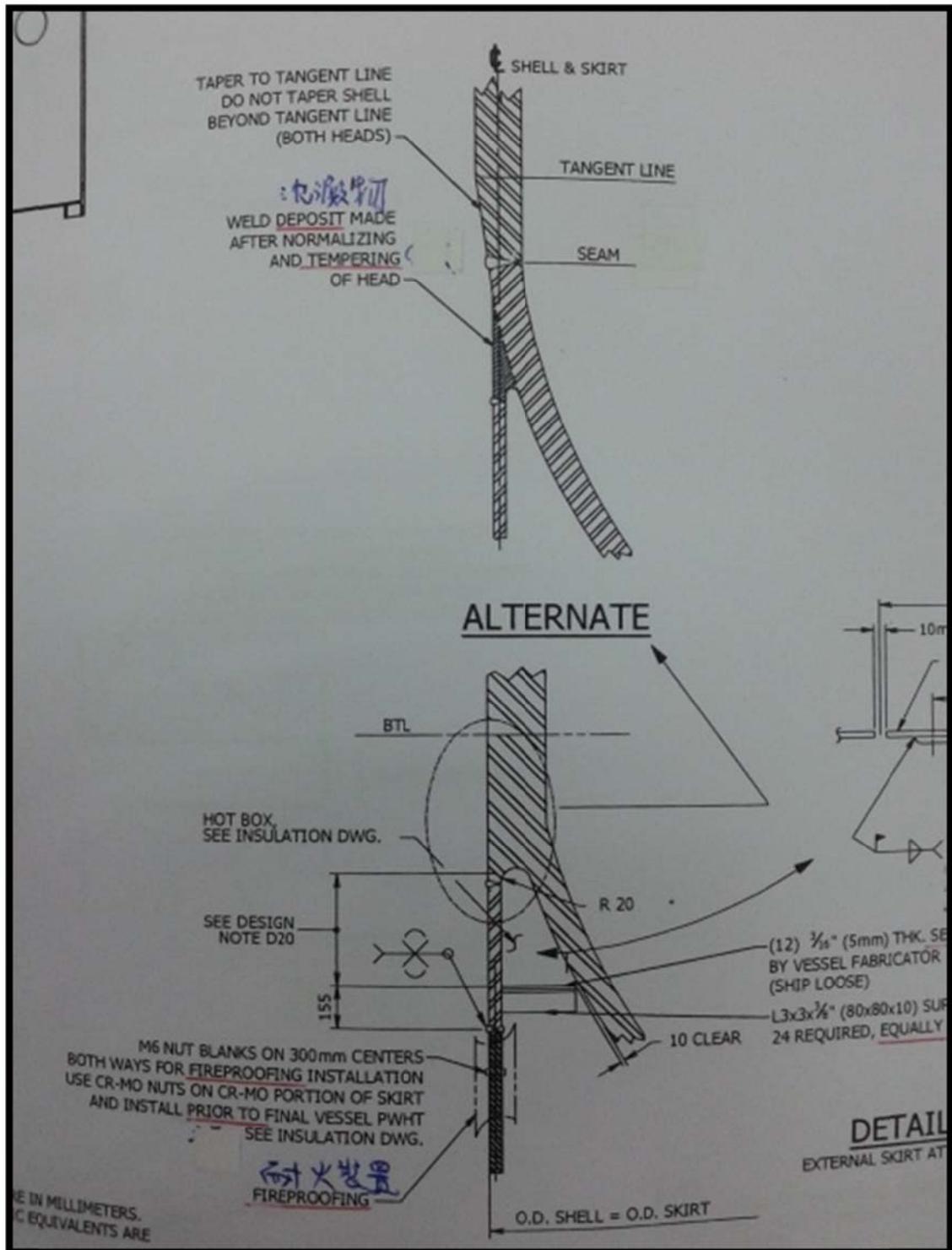
(3).反應器製程技術及問題探討

關於此座反應器我們提出三項有關製作及檢驗相關問題如下:

Q1.The weld joint type selection between btm-head to skirt of this Reactor.

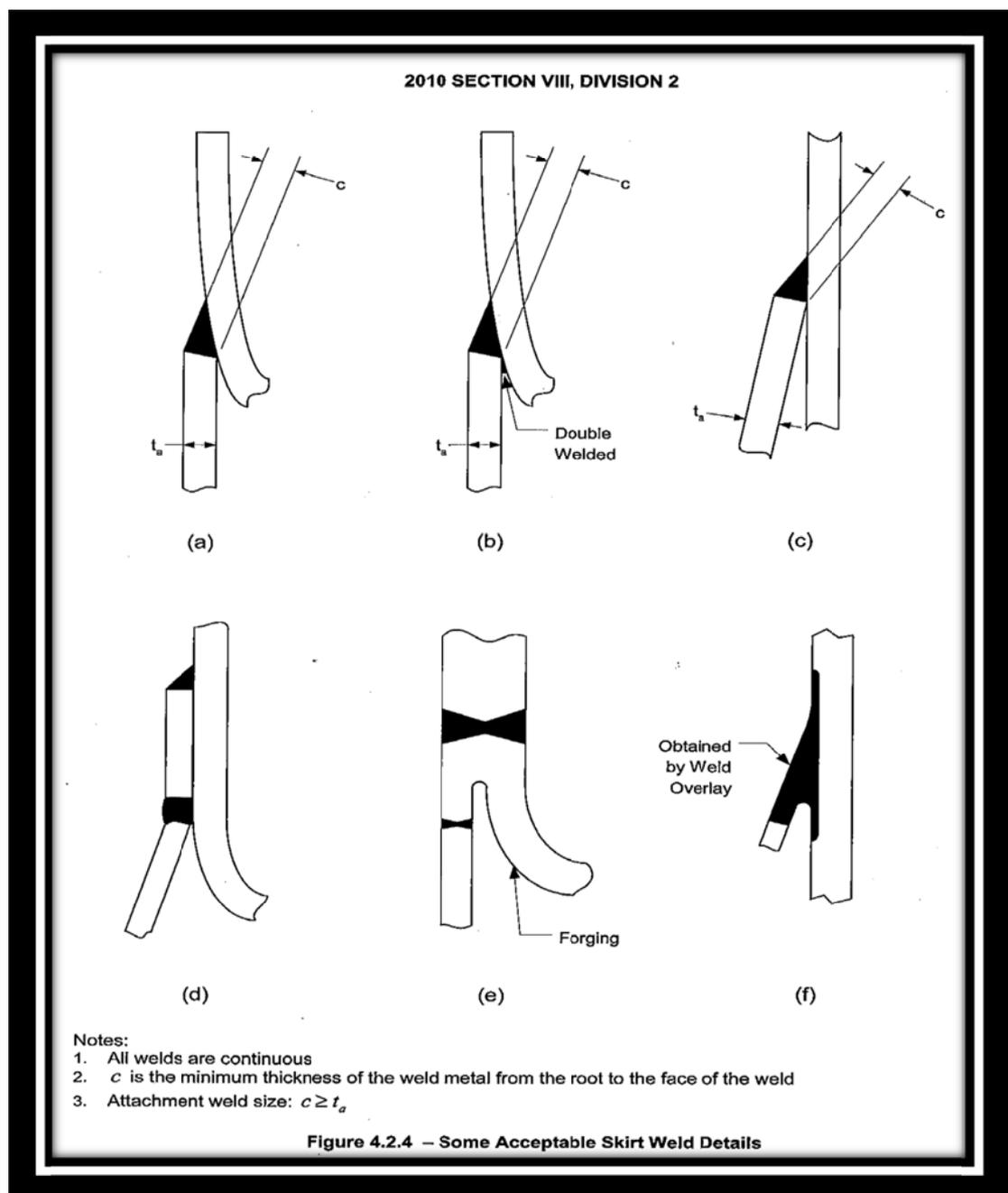
What NDT(non-destructive testing)treatment is applied for this weld joint.

(如圖 1-1)。



(圖 1-1)

A1：此反應器設計溫度為 454 度 C；設計壓力為 182 kg/cm<sup>2</sup>，日本鋼鐵公司對於如此高溫高壓之壓力容器決議使用一體成型鍛造方式進行製造(如圖 1-2 中 figure 4.2.4(e))，再予以進行內外同時焊接更能增加焊道強度，避免使用傳統方式接著恐造成接著焊道強度不足問題產生；對於對焊焊道表面會進行磁粉檢測(MT)方式進行缺陷檢查，更進一步利用超音波檢測(UT)進行內部缺陷之檢驗以確保焊道品質。



(圖 1-2)



(照片 1)

Q2.The low alloy steel 2.25CR-1MO-0.25V application display.

A2：反應器壁承載材料的 2 1/4Cr-1Mo 鋼(一般達 210mm thickness),將因應力與氫腐蝕的聯合作用而破壞。為了防止反應器 2 1/4Cr-1Mo 鋼的腐蝕，因此在反應器內壁上，加以堆焊(overlay)厚度約 3-4mm 厚的不銹鋼(SS309L/SS347L)，因應抗氫腐蝕材料。在加氫反應器運轉中，如果內層不銹鋼堆焊層有裂紋，在母材(2 1/4Cr-1Mo 鋼)大量氫破壞後，每次停爐時吸收的氫將會助長裂紋的臨界擴散，因而向母材(2 1/4Cr-1Mo 鋼)延伸。當母材中含有裂紋，如果裂紋尖端的應力強度因子到達裂紋擴展的斷裂韌性，裂紋將擴散，當裂紋長度擴展到臨界長度時，將引起反應器破裂，造成嚴重的事故。

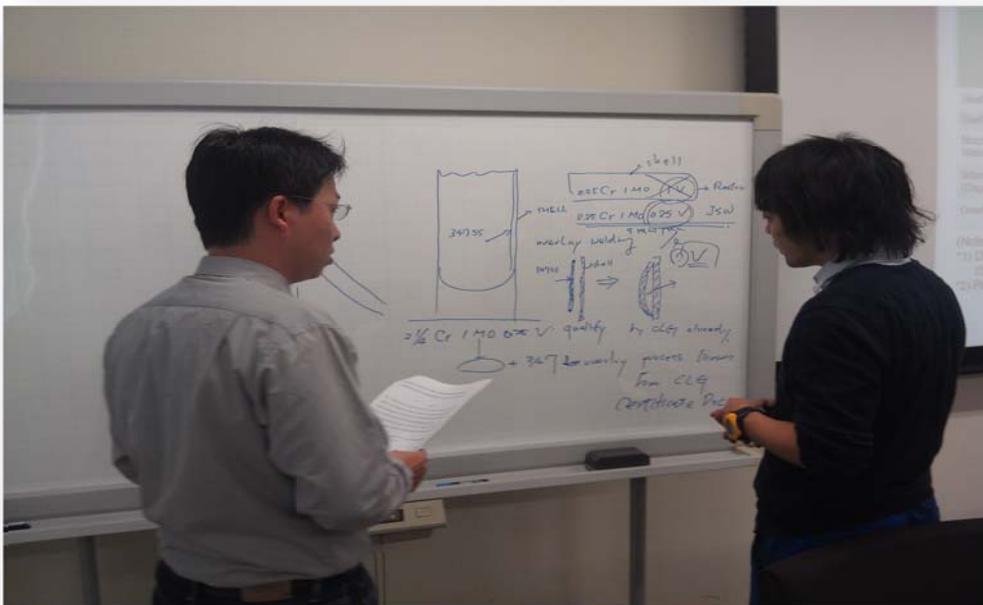
2 1/4Cr-1Mo 鋼具有强度高、抗氫性能良好的特點。在國內外已被應用於製造壓力容器及其它設備。例如重點用於石油加氫裂化及重油脫硫等製作的反應器。高溫、高壓加氫反應器是加氫裂化和加氫脫硫裝置的核心設備，現今大多採用 Cr-Mo 鋼材料，最常使用 2 1/4Cr-1Mo 鋼。但是隨著加氫技術進步、加氫反應器的尺寸越來越大，厚度越來越厚，設計條件越來越嚴苛，一般的 2 1/4Cr-1Mo 鋼已很難滿足要求，而 2 1/4Cr-1Mo-V 鋼，由於具有較高的強度等級，具有較高的抗回火淬化能力、更好的抗氫侵蝕、氫脆和氫裂紋的能力、非常高的抗不銹鋼堆焊層(overlay)剝離(disbonding)性能，因此被廣泛應用在高壓容器製作上。



(照片 2)

Q3.The NDT(non-destructive testing)application for shell thickness=253mm with 347SS overlay process.

A3：關於此設備之 shell plate with overlay，日本鋼鐵公司建議針對不銹鋼堆焊層完成後施以超音波檢測檢驗堆焊層與母材層是否有剝離現象(disbonding)，並參考原製程廠商(C.L.G.)指定規範 PVM-SU-5004-H 進行檢驗。



(照片 3)

#### (4).設備及實績



圖 1-3: 14000t 反應器鍛造壓延機

表 1-2 主要設備

設備名稱	設備容量(噸)	數量(台)
Melting Furnace	120t electric arc furnace	1
Vacuum-degassing equipment	Up to 600t ingot	7
Ladle degassing equipment	Up to 100t per ladle	4
Hydraulic forging press	14000t	2
Closed die forging press	8000t	1
Open die forging press	3000t	1
Rolling mill	4 high , 5.3m , reversing	1

表 1-3 特殊鍛造壓力容器實績

壓力容器名稱	內徑 (mm)	長(高度) (mm)	厚度 (mm)	重量 (tons)	材料
Hydrotreating Reactor (圖 1-4)	5,207	10,084	351	847	ASME SA336-F22V W/S.S. Welding Overlay
Hydroprocessing Reactor (圖 1-5)	5,800	16,916	277	1,024	ASME SA336-F22V W/S.S. Welding Overlay
Hydrocracking Reactor (圖 1-6)	4,500	32,850	273	1,450	12CrMoVTi1210 W/S.S. Welding Overlay
H-OIL Reactor (圖 1-7)	3,400	26,213	229	755	ASME SA336-F3V W/S.S. Welding Overlay
Hydrotreater Re- actor(圖 1-8)	4,268	29,938	154	692	ASME SA387-22 CL.2 W/S.S. Welding Overlay
H <sub>2</sub> S Absorber (圖 1-9)	2,100	15,500	114	126	ASME SA516-70



圖 1-4



圖 1-5



圖 1-6



圖 1-7



圖 1-8

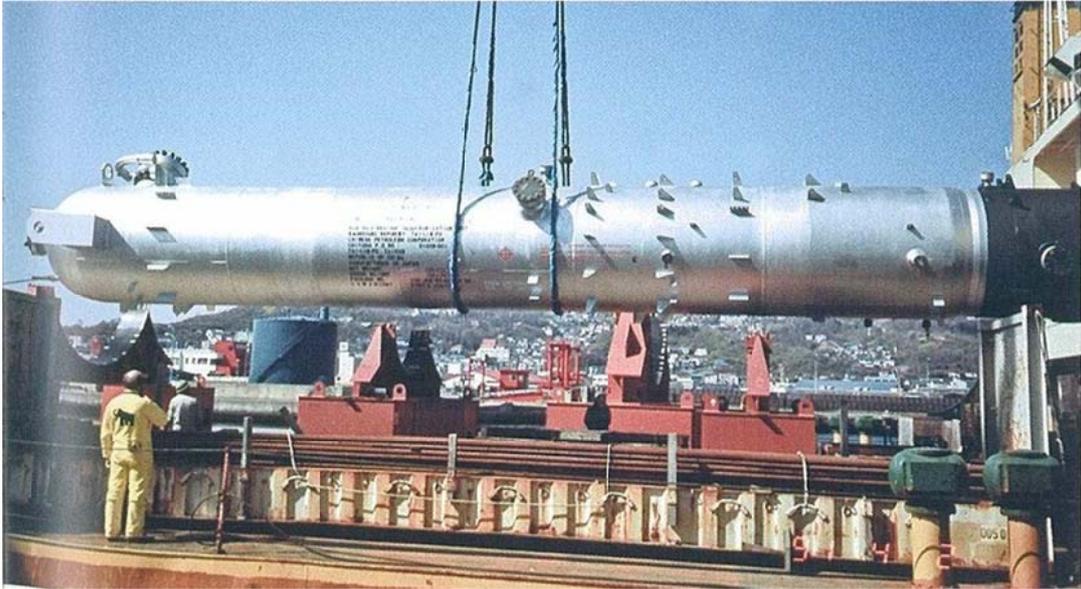


圖 1-9

### (三)參訪神戶製鋼(KOBE L.T.D.)

#### (1).公司簡介

神戶鋼鐵公司是日本第三大鋼鐵聯合企業，該公司創建於 1905 年，以鋼鐵製造業、鍛造業起家，其前身為 1905 年 9 月建立的當時日本國內最大的貿易廠家的神戶鋼鐵廠。1960 年公司開啟了全球化發展的新紀元，迄今以成為涵蓋鋼鐵、機械、工程、房地產等多個領域；公司在電子和信息系統方面都具有高科技業務。以鋼鐵業為核心的綜合性跨國公司，在日本本土及世界各地控股多家子公司，並設立了多家海外辦事機構，公司在日本，美國，亞洲和歐洲都有很多穩定的有一定影響力的公司。現在公司已成為世界 500 強之一的企業集團，擁有先進的工程機械製造技術、先進的管理經驗以及雄厚的資金實力。100 年全球開發的先進經驗、100 年工程機械研發技術的積澱，累積了日本“神鋼”獨特的競爭優勢和品牌優勢。

本次拜訪廠家神戶製鋼公司位於日本神戶，由工程部部长-Masato Yamada /工程部門經理- Tomoaki Nakanish /業務部門-Jun Minekawa 接待，介紹公司、討論高壓反應器製作檢驗並參訪工廠區。

神戶製鋼公司是世界唯一在壓力容器材料包括鍛造筒身、厚鋼板、甚至銲接材料的供應上完全自給自足，神戶製鋼所自 1967 年就開始提供脫硫及加氫裂解反應器給世界各地煉油廠，Takasago 工廠製造 1050 噸以下壓力容器，於 1995 年在日本 HARIMA(Takasago 工廠東邊 10 公里)製造 2200 噸壓力容器的組裝工廠，2009 年製造四座 1900 噸目前全世界最大反應器。

神戶製鋼公司在 1998 年成功開發改良 2 1/4Cr-1Mo-0.25V 反應器鋼材，比反應器傳統材料有較高強度、抗氫性質及防止夾層產生，因較高強度，可使重量減少，目前 10% 神戶製鋼公司的壓力容器廠取得 ASME U/ASME U2/ISO 9001/ISO 14001 認證。

(2).行程安排

**< Minutes of Meeting with CPC Corporation dated October 7, 2013 >**

Date : October 7, 2013

Place : Takasago Equipment Plant, Hyogo, Japan

CPC Visitors : 1) Mr. Jing-Shung Su, Chief of Project & Construction Division  
2) Mr. Shiuan-Ming Su, Project & Construction Divisio

KSL Attendees : 1) Mr. Masato Yamada, General Manager, Engineering Section  
2) Mr. Tomoaki Nakanishi, Manager, Engineering Section  
3) Mr. Jun Minekawa, Sales & Marketing Department

**<Description of Meeting Agenda>**

**1. Introduction of Takasago Equipment Plant and Pressure Vessels**

KSL showed presentation videos to CPC for better understanding to KSL's Takasago Equipment Plant and Pressure Vessels.

**2. Exchange of the upcoming project information**

CPC and KSL exchanged the information of the Talin Refinery No.3 RDS expansion project.

**3. KSL response to CPC's inquiry**

KSL informed CPC the response to following inquiries:

- 1) The join type selection between btm head & skirt of the Reactor.
- 2) The low alloy steel 2.25CR-1MO & 2.25CR-1MO-0.25V application display.
- 3) The NDT(non-destructive testing) application for t=253mm min. shell & 347SS overlay.

**4. Takasago Shop Tour**

CPC visitors visited Takasago Equipment Plant and Takasago Forging Shop.

### (3).反應器製程技術探討

關於此座反應器我們提出三項有關製作及檢驗相關問題如下:

Q1.The weld joint type selection between btm-head to skirt of this Reactor.

What NDT(non-destructive testing)treatment is applied for this weld join.

Ans:針對反應器一體成型下端板與裙板相接之焊道將採取超音波檢測方式(UT)進行焊道品質檢測。

Q2.The low alloy steel 2.25CR-1MO-0.25V application display.

Ans:神鋼公司針對 2.25CR-1MO 材料增加釩(V)元素來做多項交叉比較分析，如加釩(V)分析其化學性質變化、氫攻擊、overlay disbonding、同溫下其容許應力及厚度重量比較，由這些分析比較結果得知 2.25CR-1MO-0.25V 材料確實很適用於壓力容器製造，對於未來極具競爭力。

Q3.The NDT(non-destructive testing)application for shell thickness=253mm with 347SS overlay process.

A3：關於此反應器之厚度達 253mm(with 3 mm overlay)，製造商針對母材表面施以液滲檢測(PT)檢驗母材表面是否有缺陷；針對不銹鋼堆焊層完成後施以超音波檢測(UT)檢驗堆焊層與母材層是否有剝離現象(disbonding)。



(照片 4)

(4).設備及實績



圖 4-8: 13000t 壓延機

表 1-4:實績特色

CAPACITY OF FORGED SHEEL RING MANUFACTURING

Max. O.D.(max. capacity)	6,800 mm
Max. Thickness	450 mm
Max. Weight of Shell Ring	120 ton

REACTOR FABRICATION CAPACITY

Max. Annual Capacity	15,000 ton/year
Max. Shipping Capacity	2,200 ton
Max. Thickness	450 mm
Max. Outside Diameter	9,000 mm(Plate)/6,800mm(Forged)
Max. Length	90 m

FABRICATION EXPERIENCE (至 2013.10)

Max. Weight	1,886 ton
Max. O.D.	5,894 mm
Max. shell thickness	351 mm
Number of Delivery	Total 351 vessels

## 參、心得與建議

1. Cr-Mo-V steel 為 KOBE L.T.D.先行研發之壓力容器使用材料，目前被許多製造商廣泛利用在壓力容器製造使用，該材料具備主要三個優勢：
  - (1)減少反應器重量約 25%以上，進而減少鋼板厚度成本。
  - (2)避免氫對於鋼板之影響。(ex:Hydrogen Attack, Hydrogen Embrittlement)
  - (3)避免不鏽鋼板 overlay 層產生剝離現象(disbonding)。
2. JSW L.T.D.針對壓力容器展現卓越技術改良是當前台灣國內廠商需求新求變的一環：
  - (1)ONE PIECE HEAD:一體成型的鍛造製程增強了壓力容器設備 TOP HEAD 強度。(如圖 4-9 左)
  - (2)SEAMLESS FORGED SHELL & INTERNAL SUPPORT: 無縫鍛造胴板技術推廣後進而達到省材料成本工時及減少非破壞檢驗程序並且增強內構件支撐強度。(如圖 4-9 中)
  - (3)FORGED-IN SHELL RING:下端板與裙板接觸點通常為最弱之焊接點，如果能以鍛造手法延伸至裙板區域，不僅使焊接方式改由對焊處理增加強度且對於非破壞檢測進行能更順利準確。(如圖 4-9 右)

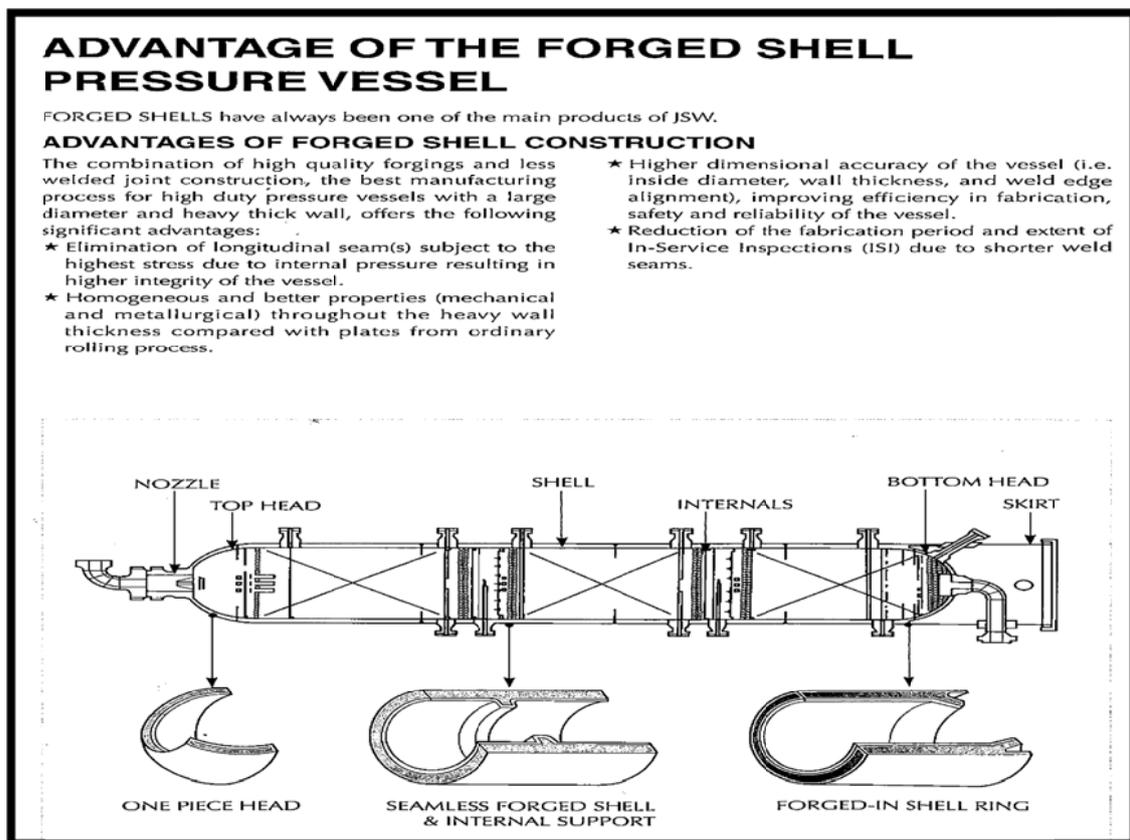


圖 4-9

3. JSW L.T.D.除了擁有數間工場外最具有競爭力的就是自有港口及貨輪，讓設備可以順利運送出貨，附圖 4-10 為該公司運送 1,175 tons x 9 sets(ID:3,658mm ; TL: 33,528mm)之情形，其載運量之大足以省下其大部分之吊運成本，目前台灣國內應朝向此方向邁進，提升國際競爭力。



**SHIPPING OF HYDRO-DESULFURIZATION REACTORS**

ID : 3,658mm  
TL/TL : 33,528mm  
T-HK : 282mm  
Weight : 1,175 tonsx9 sets  
Material: ASME SA336-F22  
W/S.S. Weld Overlay

圖 4-10

肆、附件(神戸鋼鐵利用在煉油業之壓力容器製造實績表)

**KOBELCO**

**DELIVERY LIST OF PRESSURE VESSELS  
FOR  
HYDROGENATING SERVICE USED IN OIL REFINERY PLANT**

Oct 2013

**◆ KOBE STEEL, LTD.**  
TAKASAGO, JAPAN

**REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT**

**KOBELCO**

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK (MM)	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
1	66-15066	ISOMAX REACTOR	Sep-67	237	96	1	13.9	140	3,700 A387GR.B	S.S. OVERLAY
2	66-15066	ISOMAX REACTOR	Sep-67	237	96	1	13.9	140	3,700 A387GR.B	S.S. OVERLAY
3	68-15015	REACTOR	Nov-68	51	77	1	6.8	399	2,745 A204GR.A	S.S. LINING
4	68-15015	REACTOR	Nov-68	39	75	1	6.3	427	2,440 A204GR.A	S.S. LINING
5	70-18050	REACTOR	Feb-71	39	51	1	5.0	441	2,100 A204GR.C	
6	70-18050	DESULFURIZER	Feb-73	42	41	1	4.9	430	1,820 A302GR.B	
7	73-18071	REACTOR	Oct-74	137	92	1	6.8	440	3,810 A387GR.D	S.S. OVERLAY★
8	73-18071	REACTOR	Oct-74	83	64	1	6.1	125	3,250 JIS SB 46	
9	73-18071	REACTOR	Oct-74	172	99	1	6.9	440	4,110 A387GR.D	S.S. OVERLAY★
10	73-18071	SEPARATOR	Oct-74	69	64	1	6.1	150	3,050 JIS SB 46	
11	73-18074	SEPARATOR	Nov-74	153	162	1	16.5	95	3,200 JIS SB 46	
12	73-18074	SCRUBBER	Nov-74	90	103	1	16.5	95	1,830 JIS SB 46	S.S. LINING
13	73-18074	SEPARATOR	Nov-74	50	89	1	14.5	95	1,980 JIS SB 46	
14	73-18123	HOT SEPARATOR	Mar-75	20	23	1	1.5	405	2,600 JIS SB 49M	
15	73-18123	HOT SEPARATOR	Mar-75	20	23	1	1.5	405	2,600 JIS SB 49M	
16	73-18123	GAS SUCTION DRUM	Mar-75	33	33	1	13.4	70	2,000 A516-70	
17	73-18123	GAS SUCTION DRUM	Mar-75	33	33	1	13.4	70	2,000 A516-70	
18	73-18123	B.P.H2S SCRUBBER	Mar-75	113	104	1	13.4	90	2,200 A516-70	
19	73-18123	B.P.H2S SCRUBBER	Mar-75	113	104	1	13.4	90	2,200 A516-70	
20	73-18123	H.P. WARM SEPARATOR	Mar-75	48	161	1	12.5	334	2,200 JIS SB 46M	
21	73-18123	H.P. WARM SEPARATOR	Mar-75	48	161	1	12.5	334	2,200 JIS SB 46M	
22	73-18123	H.P. COLD SEPARATOR	Mar-75	130	55	1	13.4	65	1,800 A516-60	S.S. OVERLAY★
23	73-18123	H.P. COLD SEPARATOR	Mar-75	130	55	1	13.4	65	1,800 A516-60	S.S. OVERLAY★
24	73-18134	H.P. SEPARATOR	Apr-75	90	112	1	13.1	265	2,500 JIS SB 46	
25	73-18134	H.P. ABSORBER	Apr-75	110	103	1	13.1	105	2,200 JIS SB 46	
26	76-18706	COAL LIQ. REACTOR	Jun-77	140	151	1	24.8	468	1,848 SA-336-F22	S.S. OVERLAY
27	76-18706	COAL LIQ. SEPARATOR	Jun-77	52	143	1	24.8	468	1,392 SA-336-F22	S.S. OVERLAY
28	79-18832	HDS REACTOR	Jul-81	260	160	1	10.0	435	3,543 SA-336-F12	S.S. OVERLAY★
29	80-17012(U2)	GUARD REACTOR	Oct-81	230	219	1	15.7	427	3,886 SA-336-F22	S.S. OVERLAY
30	80-17012(U2)	GUARD REACTOR	Oct-81	230	219	1	15.7	427	3,886 SA-336-F22	S.S. OVERLAY
31	80-17012(U2)	SECT I REACTOR	Oct-81	366	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
32	80-17012(U2)	SECT I REACTOR	Oct-81	366	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
33	80-17012(U2)	SECT II REACTOR	Oct-81	506	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
34	80-17012(U2)	SECT II REACTOR	Oct-81	506	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
35	80-17012(U2)	SECT III REACTOR	Oct-81	506	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
36	80-17012(U2)	SECT III REACTOR	Oct-81	506	219	1	16.5	427	3,886 SA-336-F22	S.S. OVERLAY
37	80-17039(U2)	FIRST HDS. REACTOR	Jun-82	312	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY
38	80-17039(U2)	FIRST HDS. REACTOR	Jun-82	312	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY
39	80-17039(U2)	SECOND HDS. REACTOR	Jun-82	489	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY
40	80-17039(U2)	SECOND HDS. REACTOR	Jun-82	489	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY
41	80-17039(U2)	THIRD HDS. REACTOR	Jun-82	663	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY
42	80-17039(U2)	THIRD HDS. REACTOR	Jun-82	663	262	1	17.1	427	4,436 SA-336-F22	S.S. OVERLAY

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
43	80-17039(U2)	FOURTH HDS. REACTOR	Jun-82	663	262	1	17.1	427	4,436	SA-336-F22	S.S. OVERLAY
44	80-17039(U2)	FOURTH HDS. REACTOR	Jun-82	663	262	1	17.1	427	4,436	SA-336-F22	S.S. OVERLAY
45	81-11017	REACTOR	May-82	32	13	1	6.6	399	2,745	SCMV3	
46	81-11017	REACTOR	May-82	38	70	1	6.2	427	2,440	SCMV3	
47	81-11059	COAL LIQ. REACTOR	Mar-83	31	130	1	30.4	490	650	SA-336-F21	S.S. OVERLAY
48	81-11060	COAL LIQ. REACTOR	Mar-83	73	232	1	30.4	490	1,020	SA-336-F22	S.S. OVERLAY
49	82-11202(U2)	HDS. REACTOR	Aug-83	217	146	1	13.5	454	3,048	SA-336-F22	S.S. OVERLAY*
50	82-11202(U2)	HDS. REACTOR	Aug-83	211	141	1	13.1	454	3,048	SA-336-F22	S.S. OVERLAY*
51	82-11202(U2)	HOT SEPARATOR	Aug-83	53	77	1	12.0	454	1,829	SA-387-22-2	S.S. OVERLAY*
52	83-11005(U2)	GUARD REACTOR	Mar-85	219	281	1	18.0	395	4,267	SA-336-F22	S.S. OVERLAY
53	83-11005(U2)	REACTOR No.1	Mar-85	712	294	1	18.0	436	4,267	SA-336-F22	S.S. OVERLAY
54	83-11005(U2)	REACTOR No.2	Mar-85	690	283	1	17.4	439	4,267	SA-336-F22	S.S. OVERLAY
55	83-11005(U2)	REACTOR No.3	Mar-85	677	279	1	17.0	441	4,267	SA-336-F22	S.S. OVERLAY
56	83-11005(U2)	H.P. HOT SEPARATOR	Mar-85	90	128	1	16.7	441	2,000	SA-336-F22	S.S. OVERLAY
57	83-11261(U2)	FIRST STAGE ISOCRACKER REACTOR	Mar-85	832	245	1	18.5	400	3,861	SA-336-F22	W/BOTTLE LINER
58	83-11261(U2)	SECOND STAGE ISOCRACKER REACTOR	Mar-85	780	245	1	18.5	400	3,861	SA-336-F22	W/BOTTLE LINER
59	83-11061	COAL LIQ. REACTOR	Mar-85	17	85	1	22.6	460	700	SA-336-F21	S.S. OVERLAY
60	83-11061	COAL LIQ. REACTOR	Mar-85	18	85	1	22.6	460	700	SA-336-F21	S.S. OVERLAY
61	83-11061	COAL LIQ. REACTOR	Mar-85	18	85	1	22.6	460	700	SA-336-F21	S.S. OVERLAY
62	83-11061	COAL LIQ. SEPARATOR	Mar-85	7	62	1	22.6	430	750	SA-336-F21	S.S. OVERLAY
63	84-11261(U2)	REACTOR	Jun-85	262	132	1	13.6	454	2,743	SA-336-F22	S.S. OVERLAY*
64	84-11261(U2)	REACTOR	Jun-85	230	126	1	13.0	454	2,743	SA-336-F22	S.S. OVERLAY*
65	85-11004	NIH REACTOR	Apr-86	10	24	1	3.0	375	1,600	SA-387-11-2	TP405 CLAD
66	85-11004	NIH REACTOR	Apr-86	10	27	1	4.7	375	1,200	SA-387-11-2	TP321 CLAD
67	85-11004	RF No.1 REACTOR	Apr-86	12	30	1	1.4	552	1,400	SA-387-11-1	
68	85-11004	RF No.2 REACTOR	Apr-86	21	38	1	1.4	552	1,990	SA-387-11-1	
69	85-11004	RF No.3 REACTOR	Apr-86	34	50	1	1.3	552	2,600	SA-387-11-1	
70	85-11281	REACTOR	May-86	25	41	1	8.6	430	1,000	SA-387-11-2	S.S. OVERLAY*
71	85-11281	REACTOR	May-86	25	41	1	8.6	430	1,000	SA-387-11-2	S.S. OVERLAY*
72	85-11283(U2)	GUARD REACTOR	Mar-87	357	265	1	14.2	454	4,115	SA-336-F22	S.S. OVERLAY
73	85-11283(U2)	GUARD REACTOR	Mar-87	357	265	1	14.2	454	4,115	SA-336-F22	S.S. OVERLAY
74	85-11283(U2)	MAIN REACTOR	Mar-87	727	265	1	14.2	454	4,115	SA-336-F22	S.S. OVERLAY
75	85-11283(U2)	MAIN REACTOR	Mar-87	727	265	1	14.2	454	4,115	SA-336-F22	S.S. OVERLAY
76	86-11282(U2)	DHC REACTOR	Jun-87	375	294	1	21.5	454	3,800	SA-336-F22	S.S. OVERLAY
77	86-11282(U2)	DHC REACTOR	Jun-87	578	251	1	21.3	454	3,800	SA-336-F22	S.S. OVERLAY
78	86-11282(U2)	HC REACTOR	Jun-87	70	105	1	20.6	454	1,400	SA-387-22-2	S.S. OVERLAY
79	86-11282(U2)	RECYCLE GAS SCRUBBER	Jun-87	139	135	1	19.9	120	1,900	SA-516-70	S.S. OVERLAY
80	86-11282(U2)	DHC HIGH PRESS. SEPARATOR	Jun-87	251	280	1	19.9	195	3,650	SA-105	
81	86-11282(U2)	HC HIGH PRESS. SEPARATOR	Jun-87	43	125	1	20.0	173	1,700	SA-516-70	
82	86-11282(U2)	MEDIUM PRESS. FLASH DRUM	Jun-87	89	83	1	6.1	120	3,800	SA-516-70	
83	86-11282(U2)	RECYCLE GAS SUCTION DRUM	Jun-87	31	66	1	19.9	120	1,800	SA-516-70	
84	86-11508(U2)	GUARD REACTOR	Mar-88	118	205	1	18.7	439	2,895	SA-336-F22	S.S. OVERLAY

FILE:80-02-01-03 Date:2013/08

Page 2 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
85	86-11508(U2)	REACTORS	Mar-88	252	205	1	18.7	439	2,895	SA-336-F22	S.S. OVERLAY
86	86-11508(U2)	REACTORS	Mar-88	252	205	1	18.7	439	2,895	SA-336-F22	S.S. OVERLAY
87	86-11508(U2)	REACTORS	Mar-88	252	205	1	18.7	439	2,895	SA-336-F22	S.S. OVERLAY
88	86-11508(U2)	H.P. HOT SEPARATOR	Mar-88	68	126	1	15.1	424	1,830	SA-336-F22	S.S. OVERLAY
89	86-11508(U2)	RECYCLE GAS ADIP ABSORBER	Mar-88	113	94	1	16.5	89	1,270	SA-516-55	
90	86-11536	No.1 REACTOR	Apr-88	106	122	1	18.6	450	2,286	SA-336-F22	S.S. OVERLAY*
91	86-11536	No.2 REACTOR	Apr-88	321	197	1	18.2	450	3,050	SA-336-F22	S.S. OVERLAY*
92	88-04269(U2)	HDW REACTOR	Jan-90	150	127	1	24.0	399	1,524	SA-336-F22	S.S. OVERLAY
93	89-00041	HOT HP SEPARATOR	Jul-90	31	115	1	22.4	301	1,110	SA-336-F22	S.S. OVERLAY*
94	89-00041	WATER WASH TOWER	Jul-90	29	79	1	22.1	94	700	SA-516-70	S.S. OVERLAY
95	90-00099	HDS. REACTOR	Feb-91	52	60	1	4.0	405	3,600	SA-204-C	TP321 CLAD
96	89-00039(U2)	HDS. REACTOR	Feb-91	346	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
97	89-00039(U2)	HDS. REACTOR	Feb-91	397	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
98	89-00039(U2)	HDS. REACTOR	Mar-91	768	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
99	89-00039(U2)	HDS. REACTOR	Mar-91	725	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
100	89-00039(U2)	H.P. HOT SEPARATOR	Apr-91	139	166	1	15.6	454	3,000	SA-336-F22	S.S. OVERLAY
101	89-00039(U2)	HDS. REACTOR	Apr-91	346	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
102	89-00039(U2)	HDS. REACTOR	Apr-91	397	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
103	89-00039(U2)	HDS. REACTOR	May-91	768	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
104	89-00039(U2)	HDS. REACTOR	May-91	725	236	1	17.7	454	4,400	SA-336-F22	S.S. OVERLAY
105	91-00099(U2)	HT REACTOR	Aug-92	528	235	1	19.7	449	3,372	SA-336-F22	S.S. OVERLAY
106	91-00099(U2)	HC REACTOR	Aug-92	423	235	1	19.7	449	3,372	SA-336-F22	S.S. OVERLAY
107	91-00013	VOG-HDS REACTOR	Oct-92	142	101	1	10.3	454	2,060	SA-336-F22	S.S. OVERLAY
108	91-00019(U2)	REACTOR	Jan-93	170	192	1	14.9	441	3,708	SA-336-F22	S.S. OVERLAY
109	91-00019(U2)	REACTOR	Jan-93	253	186	1	14.5	441	3,708	SA-336-F22	S.S. OVERLAY
110	91-00019(U2)	REACTOR	Jan-93	498	197	1	14.5	441	4,089	SA-336-F22	S.S. OVERLAY
111	91-00019(U2)	HOT H.P. SEPARATOR	Jan-93	131	149	1	12.9	441	3,353	SA-336-F22	S.S. OVERLAY
112	91-00021	REACTOR	Jul-93	1,004	303	1	19.2	454	4,420	SA-336-F22	S.S. OVERLAY
113	91-00021	REACTOR	Jul-93	1,004	303	1	19.2	454	4,420	SA-336-F22	S.S. OVERLAY
114	91-00021	REACTOR	Jul-93	1,004	303	1	19.2	454	4,420	SA-336-F22	S.S. OVERLAY
115	91-00021	REACTOR	Jul-93	1,004	303	1	19.2	454	4,420	SA-336-F22	S.S. OVERLAY
116	92-00006	No.1 REACTOR	Nov-93	64	71	1	8.5	440	1,960	SA-387-11-2	S.S. CLAD
117	92-00006	No.2 REACTOR	Nov-93	32	61	1	8.1	260	1,750	SA-387-11-2	
118	92-00008(BS)	SWING REACTORS	Mar-94	610	296	1	20.1	445	5,230	B5500/73	S.S. OVERLAY*
119	92-00008(BS)	SWING REACTORS	Mar-94	610	296	1	20.1	445	5,230	B5500/73	S.S. OVERLAY*
120	92-00008(BS)	SEPARATOR DRUM	Mar-94	126	120	1	18.0	380	2,500	B5500/73	S.S. OVERLAY*
121	92-00008(BS)	2ND/3RD REACTORS	May-94	762	288	1	19.6	445	5,230	B5500/73	S.S. OVERLAY*
122	92-00008(BS)	2ND/3RD REACTORS	May-94	762	288	1	19.6	445	5,230	B5500/73	S.S. OVERLAY*
123	92-00008(BS)	4TH/5TH REACTORS	May-94	822	273	1	18.9	435	5,230	B5500/73	S.S. OVERLAY*
124	92-00008(BS)	4TH/5TH REACTORS	May-94	822	273	1	18.9	435	5,230	B5500/73	S.S. OVERLAY*
125	93-66521	REACTOR	Nov-94	912	283	1	16.5	454	4,800	SA-336-F22	S.S. OVERLAY
126	93-66521	REACTOR	Nov-94	912	283	1	16.5	454	4,800	SA-336-F22	S.S. OVERLAY

FILE:80-02-01-03 Date:2013/08

Page 3 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
127	93-6513(U2)	HYDROTREATER REACTOR	Mar-95	139	109	1	15.8	454	2,134	SA-336-F3VCb	S.S. OVERLAY
128	93-6513(U2)	HYDROCRACKER REACTOR	Mar-95	122	105	1	15.2	454	2,134	SA-336-F3VCb	S.S. OVERLAY
129	93-6513(U2)	HYDROCRACKER REACTOR	Mar-95	133	105	1	15.2	454	2,134	SA-336-F3VCb	S.S. OVERLAY
130	93-6515	HDS. REACTOR	Jan-95	52	60	1	4.5	405	3,600	SA-204-C	TP321 CLAD
131	94-66603	HP ADIP ABSORBER	Jan-95	161	176	1	18.3	110	2,100	SA-266-2	S.S. OVERLAY
132	94-66603	HOT HIGH PRESSURE SEPARATOR	Oct-95	232	214	1	18.3	435	3,660	SA-336-F22	S.S. OVERLAY
133	94-66603	WARM HIGH PRESSURE SEPARATOR	Oct-95	122	215	1	18.3	400	2,500	SA-336-F22	S.S. OVERLAY
134	94-66603	COLD HIGH PRESSURE SEPARATOR	Sep-95	84	155	1	18.3	160	1,800	SA-266-2	S.S. OVERLAY
135	94-66603	RECYCLE GAS COMPRESSOR KO DRUM	Sep-95	34	94	1	18.3	110	1,100	SA-266-2	S.S. OVERLAY
136	94-65602(U2)	COLD HP SEPARATOR	Jul-95	113	181	1	16.9	232	2,740	SA-350-LF2	S.S. OVERLAY
137	94-65602(U2)	RECYCLE GAS COMPRESSOR KO DRUM	Jul-95	133	195	1	16.9	232	2,910	SA-350-LF2	HIC resistance
138	94-6613	REACTOR	Oct-95	1,360	328	1	22.1	454	4,110	SA-336-F22	S.S. OVERLAY
139	94-6613	REACTOR	Oct-95	1,360	328	1	22.1	454	4,110	SA-336-F22	S.S. OVERLAY
140	94-6613	REACTOR	Oct-95	1,360	328	1	22.1	454	4,110	SA-336-F22	S.S. OVERLAY
141	94-6613	REACTOR	Oct-95	1,360	328	1	22.1	454	4,110	SA-336-F22	S.S. OVERLAY
142	94-6613	HOT HIGH PRESSURE SEPARATOR	Oct-95	270	292	1	22.1	454	3,660	SA-336-F22	S.S. OVERLAY
143	94-6613	COLD HIGH PRESSURE SEPARATOR	Oct-95	92	209	1	19.8	70	2,250	SA-266-2	S.S. OVERLAY
144	94-6613	RECYCLE GAS KO DRUM	Oct-95	57	116	1	19.8	90	2,000	SA-266-2	S.S. OVERLAY
145	94-6613	RECYCLE GAS H2S ABSORBER	Oct-95	280	241	1	19.8	90	2,600	SA-266-2	S.S. OVERLAY
146	94-65603(U2)	HDS. REACTOR	Sep-95	514	134	1	8.9	443	4,400	SA-387-22-2	S.S. OVERLAY*
147	94-65606(U2)	ARDS REACTOR	Oct-96	751	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
148	94-65606(U2)	ARDS REACTOR	Oct-96	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
149	94-65606(U2)	ARDS REACTOR	Jan-96	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
150	94-65606(U2)	ARDS REACTOR	Oct-96	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
151	94-65606(U2)	ARDS REACTOR	Apr-97	751	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
152	94-65606(U2)	ARDS REACTOR	Apr-97	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
153	94-65606(U2)	ARDS REACTOR	Apr-97	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
154	94-65606(U2)	ARDS REACTOR	Apr-97	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
155	94-65607(U2)	HDS. REACTOR	Apr-96	532	134	1	7.8	400	5,182	SA-387-22-2	S.S. OVERLAY
156	95-64807	REACTOR	Apr-96	451	147	1	9.6	427	3,700	SA-336-F11CL3	S.S. OVERLAY*
157	95-65002	1ST STAGE REACTOR	Jun-96	929	245	1	19.7	454	3,810	SA-336-F3VCb	S.S. OVERLAY
158	95-65002	2ND STAGE REACTOR	Jun-96	424	187	1	19.7	454	2,900	SA-336-F3VCb	S.S. OVERLAY
159	95-65606(U2)	ARDS REACTOR	Feb-98	751	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
160	95-65606(U2)	ARDS REACTOR	Feb-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
161	95-65606(U2)	ARDS REACTOR	Feb-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
162	95-65606(U2)	ARDS REACTOR	Feb-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
163	95-65606(U2)	ARDS REACTOR	Aug-98	751	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
164	95-65606(U2)	ARDS REACTOR	Aug-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
165	95-65606(U2)	ARDS REACTOR	Aug-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
166	95-65606(U2)	ARDS REACTOR	Aug-98	1,081	351	1	20.0	454	4,900	SA-336-F22	S.S. OVERLAY*
167	96-65006(U2)	REACTOR	Feb-97	382	102	1	7.4	430	4,115	SA387-22-2	S.S. OVERLAY
168	96-65006(U2)	REACTOR	Jan-98	220	126	1	21.5	454	1,829	SA-336-F22-3	S.S. OVERLAY*

111x-94-02-03 Date:2013/05

Page 4 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
169	96-6509(U2)	HDS REACTOR	Oct-97	290	115	1	7.4	426	4,570	SA-387-22-2	S.S. OVERLAY*
170	96-6511(U2)	COLD HIGH PRESSURE SEPARATOR	Apr-98	140	208	1	17.9	343	2,540	SA-266-4	S.S. OVERLAY*
171	96-6511(U2)	H2S ABSORBER	Apr-98	429	272	1	17.9	343	3,300	SA-266-4	HIC resistance
172	96-6511(U2)	RECYCLE GAS COMP. KO DRUM	Apr-98	154	221	1	17.9	343	2,670	SA-266-4	HIC resistance
173	96-6511(U2)	HOT HIGH PRESSURE SEPARATOR	Apr-98	298	273	1	18.6	454	4,110	SA-336-F22-3	S.S. OVERLAY*
174	96-6511(U2)	HDS REACTOR	Apr-98	252	97	1	5.9	405	4,000	SA-387-22-2	S.S. OVERLAY*
175	96-6511(U2)	HDS REACTOR	Apr-98	252	97	1	5.9	405	4,000	SA-387-22-2	S.S. OVERLAY*
176	96-6511(U2)	VGO HDS REACTOR	Apr-98	648	113	1	8.2	435	4,800	SA-387-22-2	S.S. OVERLAY*
177	96-6511(U2)	COLD HIGH PRESSURE SEPARATOR	Aug-98	140	208	1	17.9	343	2,540	SA-266-4	S.S. OVERLAY*
178	96-6511(U2)	H2S ABSORBER	Aug-98	429	272	1	17.9	343	3,300	SA-266-4	HIC resistance
179	96-6511(U2)	RECYCLE GAS COMP. KO DRUM	Aug-98	154	221	1	17.9	343	2,670	SA-266-4	HIC resistance
180	96-6511(U2)	HOT HIGH PRESSURE SEPARATOR	Aug-98	298	273	1	18.6	454	4,110	SA-336-F22-3	S.S. OVERLAY*
181	98-67006(U2)	REACTOR	Jun-99	1,352	213	1	19.0	454	4,572	SA-336-F22-3	S.S. OVERLAY*
182	98-67006(U2)	REACTOR	Jun-99	352	186	1	19.0	454	2,743	SA-336-F22-3	S.S. OVERLAY*
183	98-67006(U2)	HOT HIGH PRESSURE SEPARATOR	Jun-99	195	266	1	17.2	343	3,658	SA-336-F22-3	S.S. OVERLAY*
184	98-6701(U2)	HOT HIGH PRESSURE SEPARATOR	Jun-99	185	156	1	14.8	371	3,210	SA-336-F22-3	S.S. OVERLAY*
185	98-6701(U2)	HOT LOW PRESSURE SEPARATOR	Jun-99	63	47	1	3.6	371	3,210	SA-387-11-2	S.S. OVERLAY*
186	98-67013(U2)	DEDENISATION REACTOR	Apr-00	93	68	1	8.4	260	2,500	SA-387-11-2	S.S. OVERLAY*
187	98-67013(U2)	HDS REACTOR	Apr-00	805	132	1	7.0	415	5,500	SA-387-11-2	S.S. OVERLAY*
188	98-67013(U2)	NAPHTHA REACTOR	Apr-00	153	70	1	6.6	365	3,200	SA-387-11-2	S.S. OVERLAY*
189	98-67013(U2)	FIRST HC REACTOR	Apr-00	512	171	1	12.3	450	4,000	SA-336-F22-3	S.S. OVERLAY*
190	98-67013(U2)	FIRST HC REACTOR	Apr-00	512	171	1	12.3	450	4,000	SA-336-F22-3	S.S. OVERLAY*
191	98-67013(U2)	SECOND HC REACTOR	Apr-00	418	161	1	11.6	450	4,000	SA-336-F22-3	S.S. OVERLAY*
192	98-67013(U2)	SECOND HC REACTOR	Apr-00	418	161	1	11.6	450	4,000	SA-336-F22-3	S.S. OVERLAY*
193	98-67016(U2)	REACTOR	Feb-00	303	100	1	6.4	447	4,118	SA-387-11-2	S.S. OVERLAY*
194	99-66804(U2)	HYDROTREATER REACTOR	Sep-00	760	206	1	15.8	482	4,000	SA-336-F22V	316L OVERLAY
195	99-66804(U2)	HYDROTREATER REACTOR	Sep-00	760	206	1	15.8	482	4,000	SA-336-F22V	316L OVERLAY
196	99-66804(U2)	GUARD REACTOR	Sep-00	351	194	1	15.8	435	3,960	SA-336-F22V	316L OVERLAY
197	99-66804(U2)	GUARD REACTOR	Sep-00	351	194	1	15.8	435	3,960	SA-336-F22V	316L OVERLAY
198	99-66804(U2)	LCF. INTERSTAGE SEPARATOR	Sep-00	111	133	1	16.1	482	2,500	SA-336-F22V	316L OVERLAY
199	99-66804(U2)	LCF. INTERSTAGE SEPARATOR	Sep-00	111	133	1	16.1	482	2,500	SA-336-F22V	316L OVERLAY
200	99-66804(U2)	LCF. REACTOR EFFLUENT HPS	Sep-00	183	175	1	16.1	482	3,300	SA-336-F22V	316L OVERLAY
201	99-66804(U2)	LCF. REACTOR EFFLUENT HPS	Sep-00	183	175	1	16.1	482	3,300	SA-336-F22V	316L OVERLAY
202	99-66804(U2)	LCF. REACTOR EFFLUENT WASH TOWER	Sep-00	134	138	1	16.1	482	2,600	SA-336-F22V	316L OVERLAY
203	99-66804(U2)	LCF. REACTOR EFFLUENT WASH TOWER	Sep-00	134	138	1	16.1	482	2,600	SA-336-F22V	316L OVERLAY
204	99-66804(U2)	HYDROTREATER HOT HPS	Sep-00	83	118	1	14.8	482	2,440	SA-336-F22V	316L OVERLAY
205	99-66804(U2)	HYDROTREATER HOT HPS	Sep-00	83	118	1	14.8	482	2,440	SA-336-F22V	316L OVERLAY
206	99-66804(U2)	CATALYST TRANSFER VESSELS	Sep-00	31	126	1	20.0	427	1,700	SA-387-22-2	S.S. OVERLAY*
207	99-66804(U2)	CATALYST TRANSFER VESSELS	Sep-00	31	126	1	20.0	427	1,700	SA-387-22-2	S.S. OVERLAY*
208	99-66804(U2)	CATALYST TRANSFER VESSELS	Sep-00	31	126	1	20.0	427	1,700	SA-387-22-2	S.S. OVERLAY*
209	99-66804(U2)	CATALYST TRANSFER VESSELS	Sep-00	31	126	1	20.0	427	1,700	SA-387-22-2	S.S. OVERLAY*
210	00-66822(U2)	HYDROCRACKING REACTOR	Apr-01	418	256	1	17.8	430	4,000	SA-336-F22-3	S.S. OVERLAY*

111x-94-02-03 Date:2013/05

Page 5 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
* 211	00-6822(U2)	HYDROCRACKING REACTOR	Apr-01	505	249	1	17.4	450	4,000	SA-336-F22-3	S.S. OVERLAY★
* 212	00-6822(U2)	HYDROCRACKING REACTOR	Apr-01	633	244	1	17.1	450	4,000	SA-336-F22-3	S.S. OVERLAY★
* 213	00-6833(BS)	SWING REACTORS	Feb-02	610	256	1	20.1	445	5,230	BSS500/73	S.S. OVERLAY★
* 214	00-6833(BS)	SWING REACTORS	Feb-02	610	256	1	20.1	445	5,230	BSS500/73	S.S. OVERLAY★
* 215	00-6833(BS)	2ND/3RD REACTORS	Feb-02	762	288	1	19.6	445	5,230	BSS500/73	S.S. OVERLAY★
* 216	00-6833(BS)	2ND/3RD REACTORS	Feb-02	762	288	1	19.6	445	5,230	BSS500/73	S.S. OVERLAY★
* 217	00-6833(BS)	4TH/5TH REACTORS	Feb-02	822	273	1	18.9	435	5,230	BSS500/73	S.S. OVERLAY★
* 218	00-6833(BS)	4TH/5TH REACTORS	Feb-02	822	273	1	18.9	435	5,230	BSS500/73	S.S. OVERLAY★
* 219	00-6833(BS)	SEPARATOR DRUM	Feb-02	126	120	1	18.0	380	2,500	BSS500/73	S.S. OVERLAY★
220	01-67004(U2)	HP VGO HT LEAD REACTORS	Aug-02	370	157	1	12.4	454	3,962	SA-336-F22V	S.S. OVERLAY★
221	01-67004(U2)	HP VGO HT LEAD REACTORS	Aug-02	370	157	1	12.4	454	3,962	SA-336-F22V	S.S. OVERLAY★
222	01-67008(U2)	HYDROCRACKING REACTOR	Mar-03	458	201	1	18.3	454	3,500	SA-336-F22V	S.S. OVERLAY★
223	01-67008(U2)	HYDROCRACKING REACTOR	Mar-03	440	201	1	18.3	454	3,500	SA-336-F22V	S.S. OVERLAY★
224	01-67008(U2)	HYDROCRACKING REACTOR	Mar-03	451	184	1	18.3	454	3,200	SA-336-F22V	S.S. OVERLAY★
225	02-67212(U2)	GURAD REACTOR	Jun-04	206	177	1	15.5	454	3,658	SA-336-F22V	S.S. OVERLAY★
226	02-67212(U2)	HYDROCRACKING REACTOR	Jun-04	280	167	1	14.7	454	3,658	SA-336-F22V	S.S. OVERLAY★
227	02-67214(U2)	HYDROCRACKING REACTOR	Oct-03	578	261	1	18.6	454	4,450	SA-336-F22V	S.S. OVERLAY★
228	02-67214(U2)	HYDROCRACKING REACTOR	Oct-03	582	256	1	18.2	454	4,450	SA-336-F22V	S.S. OVERLAY★
229	02-67214(U2)	SEPARATOR	Oct-03	282	204	1	16.6	400	4,100	SA-336-F22V	S.S. OVERLAY★
* 230	02-67216(U2)	IDW REACTOR	Nov-03	194	146	1	19.1	454	2,134	SA-336-F22-3	S.S. OVERLAY★
231	02-67216(U2)	HDF REACTOR	Nov-03	153	134	1	18.4	343	2,134	SA-336-F22-3	S.S. OVERLAY★
* 232	02-67216(U2)	HOT HIGH PRESSURE SEPARATOR	Nov-03	28	86	1	17.9	343	1,400	SA-387-22-2	S.S. OVERLAY★
233	02-67219(U2)	DHDT REACTOR	Jan-04	520	160	1	13.2	430	4,000	SA-336-F22V	S.S. OVERLAY
234	02-67219(U2)	DHDT REACTOR	Jan-04	500	160	1	13.2	430	4,000	SA-336-F22V	S.S. OVERLAY
* 235	03-65201(U2)	HIT REACTOR	Apr-04	479	127	1	8.2	454	4,600	SA-387-22-2	S.S. OVERLAY (TP317L)
* 236	03-65203(U2)	HYDROTREATING REACTOR	Jan-05	734	224	1	14.6	454	4,572	SA-336-F22V	S.S. OVERLAY
237	03-65206(U2)	HYDROTREATING REACTOR	Apr-04	613	163	1	11.6	441	3,400	SA-387-22-2	S.S. OVERLAY★
238	03-65222(U2)	HYDROTREATING REACTOR	Nov-04	550	200	1	13.9	454	4,089	SA-336-F22-3	S.S. OVERLAY★
* 239	03-65218(CE)	ICR FIRST REACTOR	Jan-05	565	213	1	15.1	454	4,500	SA-336-F22V	S.S. OVERLAY
* 240	03-65218(CE)	ICR SECOND REACTOR	Jan-05	559	213	1	15.1	454	4,500	SA-336-F22V	S.S. OVERLAY
* 241	03-65234(U2)	HDS REACTOR	Aug-05	422	188	1	14.2	454	4,267	SA-336-F22V	S.S. OVERLAY
* 242	03-65235(U2)	ICR 1st REACTOR	Jul-05	653	219	1	19.0	454	3,650	SA-336-F22V	S.S. OVERLAY (TP317L)
243	03-65235(U2)	ICR 2nd REACTOR	Jul-05	495	219	1	19.0	454	3,650	SA-336-F22V	S.S. OVERLAY
* 244	04-65204(U2)	HDS REACTOR	Jun-05	533	92	1	5.1	405	5,700	SA-387-22-2	S.S. OVERLAY★
* 245	04-65205(U2)	HDS REACTOR	Jun-05	458	140	1	8.1	425	5,400	SA-387-22-2	S.S. OVERLAY★
* 246	04-65205(U2)	HDS REACTOR	Jun-05	126	101	1	8.1	390	4,600	SA-387-22-2	S.S. OVERLAY★
* 247	04-65205(U2)	HDS REACTOR	Feb-06	364	132	1	7.6	425	5,400	SA-387-22-2	S.S. OVERLAY★
* 248	04-65205(U2)	HDS REACTOR	Feb-06	114	95	1	8.1	390	4,000	SA-387-22-2	S.S. OVERLAY★
* 249	04-65210(U2)	HDS REACTOR	Sep-06	715	155	1	11.2	410	4,600	SA-336-F22V	S.S. OVERLAY★
* 250	04-65213(U2)	HDS REACTOR	Aug-05	345	171	1	12.4	454	3,962	SA-336-F22-3	S.S. OVERLAY★
* 251	04-65115(U2)	LCO REACTOR	Feb-06	695	154	1	12.8	454	3,353	SA-387-22-2	S.S. OVERLAY★
* 252	04-65401(U2)	RDS REACTOR	Apr-06	1,020	347	1	21.1	454	5,200	SA-336-F22V	S.S. OVERLAY

FILE:04-08-01-053 QMS02131005

Page 6 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN QTY	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS
* 253	04-65401(U2)	RDS REACTOR	Apr-06	1,020	347	1	21.1	454	5,200	SA-336-F22V	S.S. OVERLAY
* 254	04-65410(U2)	HIPS SEPARATOR	Aug-06	370	263	1	19.9	405	4,900	SA-336-F22-3	S.S. OVERLAY
* 255	04-65405	HDS REACTOR	Aug-06	577	186	1	15.5	455	2,800	SA-336-F22-3	S.S. OVERLAY★
* 256	04-65411(U2)	HC REACTOR	Jan-07	1,097	272	1	18.8	454	4,600	SA-336-F22V	S.S. OVERLAY (TP317L)
* 257	04-65411(U2)	HC REACTOR	Jan-07	974	262	1	18.1	454	4,600	SA-336-F22V	S.S. OVERLAY
* 258	04-65411(U2)	HC REACTOR	Jan-07	392	184	1	17.7	427	3,600	SA-336-F22V	S.S. OVERLAY★
* 259	04-65411(U2)	LOF REACTOR	Jan-07	364	173	1	18.6	427	3,050	SA-336-F22V	S.S. OVERLAY★
* 260	04-65411(U2)	LOF REACTOR	Jan-07	328	166	1	17.8	343	3,050	SA-336-F22V	S.S. OVERLAY★
* 261	04-65411(U2)	HIPS SEPARATOR	Jan-07	89	135	1	17.5	300	2,800	SA-336-F22V	S.S. OVERLAY★
* 262	04-65411(U2)	HIPS SEPARATOR	Jan-07	57	102	1	17.5	300	1,800	SA-387-22-2	S.S. OVERLAY★
* 263	05-65502(U2)	RDS REACTOR	Jul-07	644	308	1	19.9	454	4,900	SA-336-F22V	S.S. OVERLAY★
* 264	05-65502(U2)	RDS REACTOR	Jul-07	1,223	308	1	19.9	454	4,900	SA-336-F22V	S.S. OVERLAY★
* 265	05-65502(U2)	RDS REACTOR	Aug-07	644	304	1	19.7	454	4,900	SA-336-F22V	S.S. OVERLAY★
* 266	05-65502(U2)	RDS REACTOR	Aug-07	1,223	304	1	19.7	454	4,900	SA-336-F22V	S.S. OVERLAY★
* 267	05-65507	HDT REACTOR	Mar-07	506	202	1	16.8	465	3,050	SA-336-F22-3	S.S. OVERLAY★
* 268	05-65507	MSDW REACTOR	Mar-07	341	154	1	15.7	427	2,800	SA-387-22-2	S.S. OVERLAY★
* 269	05-65507	HDF REACTOR	Mar-07	200	139	1	14.9	350	2,800	SA-387-22-2	S.S. OVERLAY★
* 270	05-62157(U2)	DHT REACTOR	Sep-08	518	173	1	14.7	449	3,810	SA-336-F22V	S.S. OVERLAY★
* 271	05-62157(U2)	DHT REACTOR	Sep-08	518	173	1	14.7	449	3,810	SA-336-F22V	S.S. OVERLAY★
** 272	05-62173(U2)	LC-FINING REACTOR	Jun-08	955	242	1	19.5	460	3,886	SA-336-F22V	S.S. OVERLAY (TP316L)
** 273	05-62173(U2)	LC-FINING REACTOR	Jun-08	955	242	1	19.5	460	3,886	SA-336-F22V	S.S. OVERLAY (TP316L)
** 274	05-62173(U2)	CRACKING REACTOR	Jul-08	1,238	196	1	15.9	454	3,800	SA-336-F22V	S.S. OVERLAY
** 275	05-62173(U2)	TREATING REACTOR	Sep-08	224	166	1	14.5	426	3,800	SA-336-F22V	S.S. OVERLAY
* 276	05-62173(U2)	HP/HIT REACTOR	Feb-09	102	148	1	18.3	460	2,500	SA-336-F22V	S.S. OVERLAY (TP316L)
* 277	05-62173(U2)	INTERREACTOR SEPARATOR	Feb-09	95	145	1	19.5	460	2,300	SA-336-F22V	S.S. OVERLAY (TP316L)
* 278	05-62112(U2)	ICR 1st REACTOR	Mar-10	653	219	1	19.0	454	3,650	SA-336-F22V	S.S. OVERLAY (TP317L)
* 279	05-62112(U2)	ICR 2nd REACTOR	Mar-10	495	219	1	19.0	454	3,650	SA-336-F22V	S.S. OVERLAY★
* 280	06-62011(U2)	2ND STAGE REACTOR	Apr-09	1,145	271	1	18.3	454	4,724	SA-336-F22V	S.S. OVERLAY★
* 281	06-62011(U2)	DHT REACTOR	Apr-09	851	271	1	18.3	454	4,724	SA-336-F22V	S.S. OVERLAY★
* 282	06-62011(U2)	CFH REACTOR	Apr-09	886	206	1	13.8	454	4,877	SA-336-F22V	S.S. OVERLAY★
* 283	06-62029(CE)	CRACKING REACTOR	Mar-09	755	312	1	19.9	453	4,950	SA-336-F22V	S.S. OVERLAY★
* 284	06-62029(CE)	CRACKING REACTOR	Mar-09	1,145	303	1	19.4	453	4,950	SA-336-F22V	S.S. OVERLAY★
* 285	06-62029(CE)	CRACKING REACTOR	Mar-09	1,305	283	1	18.6	453	4,950	SA-336-F22V	S.S. OVERLAY★
* 286	06-62218(U2)	HDS REACTOR	Jun-08	458	140	1	8.1	425	5,400	SA-387-22-2	S.S. OVERLAY★
* 287	06-62218(U2)	HDS REACTOR	Jun-08	126	101	1	8.1	390	4,000	SA-387-22-2	S.S. OVERLAY★
* 288	06-62218(U2)	HDS REACTOR	Jun-08	532	134	1	7.8	400	5,182	SA-387-22-2	S.S. OVERLAY
* 289	06-62274(U2)	HYDROTREATING REACTOR	Mar-08	507	130	1	11.3	410	3,810	SA-542-D-4a	S.S. OVERLAY★
* 290	06-62274(U2)	RDS REACTOR	Oct-09	1,886	263	1	20.1	460	4,100	SA-336-F22V	# S.S. OVERLAY (TP316L)
* 291	06-62274(U2)	RDS REACTOR	Nov-09	1,886	263	1	20.1	460	4,100	SA-336-F22V	# S.S. OVERLAY (TP316L)
* 292	06-62274(U2)	RDS REACTOR	Nov-09	1,820	253	1	19.6	460	4,100	SA-336-F22V	# S.S. OVERLAY★
* 293	06-62274(U2)	RDS REACTOR	Oct-09	1,820	253	1	19.6	460	4,100	SA-336-F22V	# S.S. OVERLAY★
* 294	07-62461(U2)	CRACKING REACTOR	Mar-10	1,290	268	1	18.5	454	4,572	SA-336-F22V	# S.S. OVERLAY★

FILE:04-08-01-053 QMS02131005

Page 7 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS	
♦	295	07-62461(U2)	CRACKING REACTOR	Mar-10	1,290	268	1	18.5	454	SA-336-F22V ⊕	# S.S. OVERLAY★
♦	296	07-62461(U2)	DIESEL HYDROTREATER	Mar-10	991	154	1	10.5	435	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	297	07-62424(U2)	INTERSTAGE SEPARATOR	Dec-09	95	152	1	19.6	460	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	298	07-62424(U2)	INTERSTAGE SEPARATOR	Dec-09	95	152	1	19.6	460	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	299	07-62624(U2)	HP/HT SEPARATOR	Dec-09	86	145	1	18.7	460	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	300	07-62624(U2)	HP/HT SEPARATOR	Dec-09	86	145	1	18.7	460	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	301	07-62624(U2)	CATALYST TRANSFER VESSELS	Dec-09	56	150	1	22.9	412	SA-387-22-2	
♦	302	07-62624(U2)	CATALYST TRANSFER VESSELS	Dec-09	56	150	1	22.9	412	SA-387-22-2	
♦	303	07-62694(U2)	DEWAXING REACTOR	Jan-10	252	131	1	7.9	425	SA-387-22-2	S.S. OVERLAY★
♦	304	07-62710(U2)	HYDROCRACKING REACTOR	Feb-11	1,629	306	1	20.9	442	SA-336-F22V ⊕	S.S. OVERLAY★
♦	305	07-62710(U2)	HYDROCRACKING REACTOR	Feb-11	1,629	306	1	20.9	442	SA-336-F22V ⊕	S.S. OVERLAY★
♦	306	08-62798(U2)	1st STAGE HYDROCRACKING REACTOR	Jun-10	864	202	1	17.6	454	SA-336-F22V ⊕	S.S. OVERLAY (TP317L)
♦	307	08-62798(U2)	2nd STAGE HYDROCRACKING REACTOR	Jun-10	526	201	1	17.2	454	SA-336-F22V ⊕	
♦	308	08-62815(U2)	HYDROPROCESSING REACTOR	Oct-10	1,095	299	1	20.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	309	08-62815(U2)	HYDROPROCESSING REACTOR	Oct-10	1,095	299	1	20.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	310	08-62815(U2)	HYDROPROCESSING REACTOR	Oct-10	1,095	299	1	20.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	311	08-62815(U2)	HYDROPROCESSING REACTOR	Oct-10	1,095	299	1	20.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	312	08-62815(U2)	HYDROPROCESSING REACTOR	Oct-10	994	286	1	20.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	313	08-62842(U2)	DHDS REACTOR	Aug-10	654	137	1	9.4	425	SA-387-22-2	S.S. OVERLAY★
♦	314	08-62842(U2)	DHDS REACTOR	Aug-10	654	137	1	9.4	425	SA-387-22-2	S.S. OVERLAY★
♦	315	09-63174(U2)	CRACKING REACTOR	Dec-11	646	207	1	18.3	454	SA-336-F22V ⊕	S.S. OVERLAY
♦	316	09-63174(U2)	CRACKING REACTOR	Dec-11	646	207	1	18.3	454	SA-336-F22V ⊕	S.S. OVERLAY
♦	317	10-63408(U2)	HOT HIGH PRESSURE SEPARATOR	Apr-11	349	275	1	18.6	454	SA-336-F22-3	S.S. OVERLAY
♦	318	10-63408(U2)	COLD HIGH PRESSURE SEPARATOR	Apr-11	166	227	1	18.0	343	SA-266-4	S.S. OVERLAY★
♦	319	11-63483(U2)	HOT HP SEPARATOR DRUM	Apr-13	454	217	1	19.7	417	SA-336-F22V ⊕	S.S. OVERLAY★
♦	320	11-63483(U2)	HOT HP SEPARATOR DRUM	Apr-13	454	217	1	19.7	417	SA-336-F22V ⊕	S.S. OVERLAY★
♦	321	11-63483(U2)	COLD HP SEPARATOR DRUM	Apr-13	660	311	1	19.3	172	SA-266-2	
♦	322	11-63483(U2)	COLD HP SEPARATOR DRUM	Apr-13	660	311	1	19.3	172	SA-266-2	
♦	323	11-63483(U2)	RECYCLE COMPRESSOR KO DRUM	Apr-13	68	173	1	19.3	172	SA-266-2	
♦	324	11-63483(U2)	RECYCLE COMPRESSOR KO DRUM	Apr-13	68	173	1	19.3	172	SA-266-2	
♦	325	11-63792	1ST STAGE REACTOR	Apr-13	338	127	1	19.0	454	SA-542-D-4a ⊕	S.S. OVERLAY★
♦	326	11-63792	DHT STAGE REACTOR	Apr-13	561	191	1	19.0	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	327	11-63792	DHT REACTOR	Apr-13	380	172	1	17.2	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	328	11-63792	VOG REACTOR	Apr-13	1,249	210	1	18.1	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	329	10-63000	FIRST STAGE REACTOR	Feb-14	768	187	1	19.6	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	330	10-63000	SECOND STAGE REACTOR	Feb-14	768	187	1	19.6	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	331	10-63000	FIRST STAGE REACTOR	Feb-14	768	187	1	19.6	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	332	10-63000	SECOND STAGE REACTOR	Feb-14	768	187	1	19.6	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	333	12-64138	HCR REACTOR	Apr-14	440	163	1	18.6	454	SA-336-F22V ⊕	S.S. OVERLAY
♦	334	12-64138	DEWAXING REACTOR	Apr-14	151	101	1	17.8	428	SA-542-D-4a ⊕	S.S. OVERLAY
♦	335	12-64138	HYDROFINISHING REACTOR	Apr-14	126	96	1	17.1	343	SA-542-D-4a ⊕	
♦	336	13-64240	1ST STAGE REACTOR1	Oct-14	711	241	1	17.5	457	SA-336-F22V ⊕	S.S. OVERLAY★

FILE:KOC-08-01-011 Date:2013/05

Page 8 of 9

REACTORS & PRESSURE VESSELS FOR HYDROPROCESSING UNIT IN OIL REFINERY PLANT

KOBELCO

NO.	WORK NO.	DESCRIPTION	DELIVERY DATE	UNIT WEIGHT (TON)	WALL THICK. (MM)	DESIGN PRESS. (MPa)	DESIGN TEMP. (°C)	ID (MM)	MATERIAL	REMARKS	
♦	337	13-64240	1ST STAGE REACTOR1	Oct-14	711	241	1	17.5	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	338	13-64240	1ST STAGE REACTOR2	Oct-14	774	241	1	17.5	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	339	13-64240	1ST STAGE REACTOR2	Oct-14	774	241	1	17.5	457	SA-336-F22V ⊕	S.S. OVERLAY★
♦	340	13-64298	FIRST RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	341	13-64298	FIRST RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	342	13-64298	FIRST RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	343	13-64298	FIRST RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	344	13-64298	SECOND RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	345	13-64298	SECOND RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	346	13-64298	SECOND RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	347	13-64298	SECOND RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	348	13-64298	THIRD RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	349	13-64298	THIRD RHDS REACTOR	Dec-14	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	350	13-64298	THIRD RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
♦	351	13-64298	THIRD RHDS REACTOR	Feb-15	649	230	1	19.7	454	SA-336-F22V ⊕	S.S. OVERLAY★
				Total		351					

Notes:

- (1) \* : DHT (Dehydrogenation Heat Treatment) was performed on these items. (Total 243 vessels)
- (2) \*\*: These items were assembled on the job site.
- (3) \* : Single layer stainless steel weld overlay process was applied. (Total 164 vessels)
- (4) U2: (U2) in Work No. means the items with ASME U2 code stamp.
- (5) \* : UT in list of RT, was applied to girth seam welded joints. (Total 122 vessels)
- (6) ⊕: Reactors made of Vanadium modified Cr-Mo steels. (Total 118 vessels)

FILE:KOC-08-01-011 Date:2013/05

Page 9 of 9