經濟部所屬各機關因公出國人員出國報告

（出國類別：其他）

桃廠第三重油加氫脫硫工場高壓反應器製造控制點查驗監辦及聯繫

服務機關：台灣中油股份有限公司興建工程處

出國人職稱：一般工程監

出國人姓名：陳嘉昌、林瑞基

派赴國家：義大利、日本

出國期間：100 年 9 月 20 日至 100 年 9 月 29 日

報告日期：100 年 11 月 28 日

壹、摘要

M9504 煉製事業部桃園煉油廠第三重油加氫脫硫工場投資計畫主要目的是爲配合政府法規要求全國燃料油硫含量降至 0.5wt%以下，且面對日趨嚴格之低硫燃料油政策，本公司重油脫硫能力嚴重不足將會更加明顯，目前過度依賴增購高價格且數量稀少之低硫原油因應，但低硫原油日益短缺，價格不斷攀升，購買不易。另爲改善本公司之煉製結構，利用重油加氫脫硫工場生產低硫燃料油，作爲桃廠重油轉化工場之進料，生產汽、柴油、丙烯石化品，提升油品品質，增加本公司油品在國內外市場之競爭力。

桃園煉油廠第三重油加氫脫硫工場投資計畫原爲 95 年度新興投資計畫，因計畫實施階段適逢國際原油價格高漲，各類建場成本遽增，本公司爲考量財務問題，報奉行政院核定緩建 2 年，經煉製事業部檢討後，認爲本計畫有復辦必要性。爲符合日趨嚴格燃料油硫份品質規範及桃廠煉製結構改善，且建場工程市場已經回檔，遂變更計畫經報奉董事會通過，其中預算總金額由約 265 億 6800 萬元調整爲約 384 億 6200 萬元整，工期展延至 104 年 6 月底完工。

本投資計畫爲興建產能爲日煉 7 萬桶之重油加氫脫硫工場一座（含每日 7 萬桶重油加氫脫硫單元、每日 77 百萬立方英呎氫氣單元及每日 500 噸硫磺回收單元）及區外其他相關設施。重油加氫脫硫工場高壓反應器爲本投資計畫重要設備之一，費用約佔整體預算總金額之 15%。

100 年 5 月 12 日行政院函經濟部本計畫同意復辦，其中關鍵設備反應器採購案已獲第 600 次董事會通過待經濟部土地開發許可核發後，繼續辦理招標作業；反應器爲合金鋼焊造，其焊造控制點之停止點對整體製造品質管控十分重要，事先前往先進國家學習此等技術有其必要。

貳、目的

一個新建煉製工場的成功與否，除取決於前期的規劃、製程選擇及後期的設計請購裝建外，最重要的還是要視其核心設備的品質與交貨期。前者可影響工場操作的性能，後者可影響工場操作的壽命與整個建場工程的時程。而這些核心設備大部都是在國外生產製造。派員赴國外廠家了解設備製作能力及品質管控有其必要性。

以重油加氫脫硫工場爲例，其核心設備像反應器、高壓熱交換器、壓縮機及泵浦等，將來幾乎都是購自歐、美、日等國家。派員赴國外廠家察看討論製造流程與品管或會驗測試，對設備品質的管制提昇及交貨期的掌握都是非常有助益的，同時由觀摩及研討中，增長見聞，來提升參訪人員專業能力。

這次參訪高壓反應器製造廠 ATB RIVA CALZONI(義大利米蘭)、BELLELI(義大利米蘭)、KOBE STEEL(日本神戶)等，是要瞭解製造過程、製造控制點、檢查規範、及預估製造排程，藉由參訪觀摩製造商瞭解製造過程、製造控制點、檢查規範、及預估製造排程等應注意事項，使本計畫重油加氫脫硫工場高壓反應器日後採購、製造及交貨能順利如期完成且確保交貨品質。

參、過程

一、 行程安排

日期	詳細內容
100.09.20	啓程前往義大利
100.09.21～100.09.25	參訪 ATB 及 BELLELI
100.09.26	義大利至日本神戶
100.09.27～100.09.28	參訪日本製鋼公司
100.09.29	返程回台北

二、 參訪 ATB RIVA CALZONI 公司：

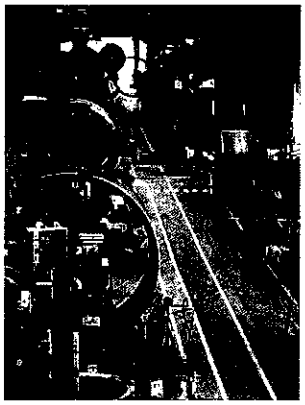
(一)公司簡介：

本次拜訪廠家 ATB RIVA CALZONI Spa 位於義大利米蘭近郊 RONCADELLE 總公司及主工廠、位於威尼斯海港第二工廠(最後組裝工廠)，由業務經理 Davide Taglietti 及壓力容器部門經理 Salvatore Poddighe 接待，介紹公司、討論高壓反應器檢驗、參訪 2 座工廠區。

義大利 ATB Riva Calzoni 公司於 2003 年 由 Acciaieria e Tubificio di Brescia (ATB) 和 Riva Calzoni Impianti S.r.l. (Riva Calzoni).合併。這兩家公司有超過 100 年的設計、製造及安裝機械設備使用於不同工業。ATB 成立於 1934 年，由 1903 年成立之 'Società Italiana Tubi Togni' and 'Società Siderurgica Togni' 合併，主要從事於水力發電廠、煉油及石化工業、熱電發電廠等，Riva Calzoni 從 1834 年歷經不同公司名稱主要從事於水力設施及水力發電廠設備之設計、製造、安裝。

ATB Riva Calzoni公司所屬TROMBINI集團，其總公司及主廠區位於ARTOGNE Brescia 。另Marghera 組裝工廠靠近威尼斯國際港區內，如設備重量超過200公噸以上，則在Marghera 組裝，無設備運輸，重量和尺寸限制，使ATB能力生產和調度提升。

爲追求傳統合作的政策和戰略利益的領域，市場更容易滲透，ATB Riva Calzoni 這些年與新的工業化國家當地製造廠商簽訂專有技術轉讓、提供基本和詳細設計等合作約定，2000 年與馬來西亞國家石油公司在馬來西亞成立 MMHE ATB 合資企業。



在 RONCADELLE總部

在 Porto Marghera最後組裝工場

(二)ATB 專業：

提供製造能力和設計、製造檢查和產品、設備的安裝服務，可分爲 1.煉油廠、石化及熱應用等壓力容器；2.水力電廠、水力設施等設備；3.核能電廠設備；4.製造服務；5.實驗室試驗及非破壞檢驗服務；6.特殊工作；7.售後服務。並取得 ASME(The American Society of Machanical Engineers)之 S (Power Boiler)、U(Pressure Vessel Section VIII Div.1)、U2(Pressure Vessel Section VIII Div.2)、N、NPT 等認證。

1.煉油廠、石化等壓力容器：

1.1 ATB 在 40 多年的經驗，已使其在煉油廠、石化廠等新精煉製程的壓力、溫度和氫腐蝕等超嚴苛條件通過考驗，使該公司在壓力容器設備之設計、製作與檢驗等技術屬領先廠家之一。

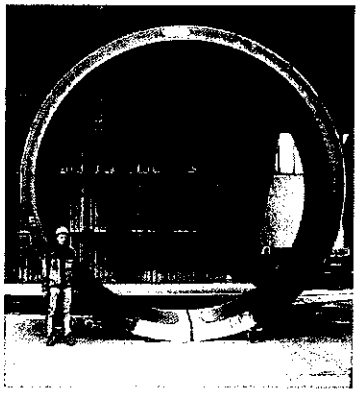
1.2 ATB 爲本案基本設計廠家 CLG(Chevron Lummus Global)於基本設計書中 2.25Cr-1Mo-0.25V 反應器之 5 家認可製造廠之一，亦爲少數曾經製造過 2.25Cr-1Mo-0.25V 反應器之廠家。

1.3 在 70 年代初，ATB 在義大利第一家取得 ASME 製造 U、U2 壓力容器認可廠家。同時 70 年代，ATB 提供在美國路易斯安那州，埃克森美孚煉油廠 12 座鉻鉬(Cr-Mo)鋼氫裂解反應器，每座重量 400 多公噸。1960 年至今，在煉油、石化、石油焦氣化、煤氣化、尿素業、氨液轉化及核能等工業之重大製程設備設計製造，ATB 已生產 1000 多座壓力容器。由於煉油廠和石油化工廠在製程不斷增加其生產能力，使最近幾年壓力容器設備在厚度、直徑和重量等增大，常考驗製造廠製造技術極限。ATB 目標朝最具挑戰性的工作，增設強大的製造設施和訓練熟練員工，

使 ATB 能承接製造特殊性較高之壓力容器。

1.4 ATB完成壓力容器設備中最大重量爲1350公噸、最大厚度爲358毫米、最大長度爲90公尺、最高設計溫度爲650℃、最低設計溫度爲 －196℃、最高設計壓力爲490 kg/cm2 。ATB曾製造過壓力容器，所使用鋼材含可適用 ASTM、 DIN、 英國標準及歐洲其他標準之碳鋼、碳鋼 HIC (Hydrogen Induced Cracking-氫誘導龜裂)性能、低溫碳鋼、低合金鋼（0.5Mo、1Cr -0.5Mo 、2.25Cr-1Mo及近年開發增強的性能和含釩）和低溫9%鎳不銹鋼等，

1.5 ATB 是少數全球領先的重量和高厚度反應器加氫處理設備製造廠之一，使用鍛造鋼材爲現在於加氫裂化反應器標準製造技術。而 ATB 最大冷軋板滾製厚度爲 260 毫米。



圖：冷軋板滾製

1.6 近年來 3Cr 1Mo 1/4V and 2 1/4Cr 1Mo 1/4V 等低合金高壓高溫壓力容器，ATB 是在合格的少數製造廠之一。

1.7 壓力容器設備在厚度、直徑和重量等增大，常受限運輸至工地現場困難，在 90 年代在埃克森美孚泰國煉油廠幾個反應器有現場組裝銲接經驗，2002在墨西哥石油公司Yula煉油廠加氫Cr-Mo-V反應器亦有現場組裝銲接經驗，陸續在義大利、美國加州亦有現場組裝銲接工程。

1.8 擁有自己工廠銲接訓練及研究中心，與工程公司、製程專利公司、主要材料供應商等維持密切關係，持續改進母材與銲條，在加氫處理設備使用高壓高溫反應器Cr-Mo-V母材與銲條材料製造，成爲新的設計規範，因其材料在高溫狀況下，仍有較高機械性質，故母材厚度可比原傳統Cr-Mo低合金鋼厚度減少10%以上，而ASME 2007年版Boiler and Pressure Vessel Code(鍋爐與壓力容器規範)Sec.VIII Div.2壓力容器製造規則，將2.25Cr-1Mo-0.25V鋼材在設計溫度450℃時，材料容許應力調升約15%，故母材厚度可比原傳統Cr-Mo低合金鋼厚度減少25%以上。近年來高壓高溫反應器以Cr-Mo-V爲新材料。低溫9%鎳不銹鋼。在

Overlay(堆銲)技術亦有30多年經驗。

2. 水力電廠、水力設施等設備：

Riva Calzoni 主要從事於水力設施及水力發電廠設備之設計、製造、安裝。水道、各類水閘門（含控制系統等）、未合併前 ATB 及 Riva Calzoni 在義大利水力設施及水力發電廠設備之站 90%以上，在義大利曾完成水頭 1418 公尺，直徑 2.15 公尺之高壓水道及其水閘門，在瑞士曾完成直徑爲 3 公尺，管厚爲 8 公分水道及相關設施。

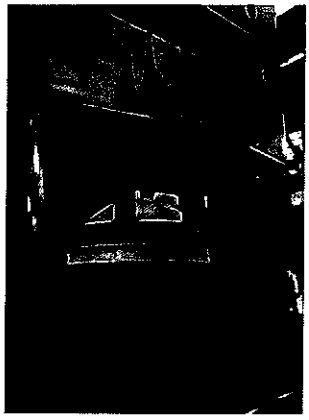
3.核能電廠設備：

取得 ASME Sec.III 之 N、NPT 認可，可生產核電主要設備，如蒸汽發電機、反應爐、壓力容器、壓力槽等。

4.製造服務：

4.1 端板成型(Head Forming)可提供球型或橢圓端板，成立獨立部門銷售國際市場。

4.1.1 一片（無銲縫）2:1：近似橢圓端板成型，最大內徑爲 3.9 公尺、最大厚度爲 140 公釐、最大重量爲 20 公噸。



圖：端板成型

4.1.2 多片鋼板端板成型，最大內徑爲 20 公尺、最大厚度爲 200 公釐。

4.1.3 主要油壓設備爲 3000 公噸。

4.2 機械加工可提供壓力容器和水力機械零部件的製造，成立銷售義大利國內與國際市場之 2 個部門，近年巨額投資車床，銑床和鑽床等設備，使爲高度自動化數控加工和車削加工中心。

5.實驗室試驗及非破壞檢驗均有對外服務。實驗室主要設施有拉伸破壞性試驗、 衝擊試驗、和硬度測試作出最嚴厲的測試條件（室溫、 低溫條件、 熱拉伸測試等）。

6. ATB 在煉油石化業的重鋼構、水泥、鋼鐵等提供製造超大尺寸和重鋼元件，最近並參與海洋平臺工程。

7.壓力容器及水力機械提供售後服務。

(三)主要生產設備：

Roncadelle 廠有 5 棟廠房寬度 23～25 公尺、長度 127～233 公尺、高度 12 公尺。PORTO MARGHER 有 2 棟廠房寬度 24～27 公尺、長度 120～210 公尺、高度 12 公尺。

1.冷軋板滾壓設備有三部：

1.1 有效寬度 4 公尺、6400 公噸油壓、滾壓最大厚度 330 公釐。

1.2 有效寬度 3.5 公尺、2000 公噸油壓、滾壓最大厚度 200 公釐。

1.3 有效寬度 4 公尺、800 公噸油壓、滾壓最大厚度 40 公釐。

2.端板成型設備：

2.1 近似 2:1：近似橢圓端板，其內徑爲 200 公釐～3900 公釐、最大厚度爲 200 公釐、最大重量爲 20 公噸。

2.2 半球端板型，其內徑爲 400 公釐～2600 公釐、最大厚度爲 190 公釐。

2.3 平面及半平面端板型，其內徑爲 400 公釐～4000 公釐、最大厚度爲 10 公釐～170 公釐。

3.工作母機：立式車床 4 部、水平車床 1 部、鑽床 7 部。

4.燃氣退火爐3座 其中1座爲9米x9米x32.5米（可加長至39米長）。

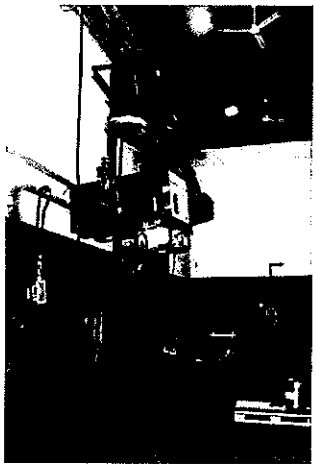
5.重型運輸工具最重可運輸1500公噸。

(四)品管設施：

1. 實驗室有拉伸破壞性試驗、 衝擊試驗、和硬度測試作等。

2. 放射性檢查2座 X-ray 房，其中分別配備 6 MeV、9MeV 加速器。

3.超音波（含 TOFD）、磁粉探傷、染色探傷等檢查。



圖：放射性檢查房

(五) 製造過程、製造控制點、檢查規範：

1.ATB RIVA CALZONI 品管計劃書(詳附件 1)，在歐洲及中東之煉油或石化業於反應器採購後除 ASME 檢查員(Authorized Inspection)在製造過程之檢查、文件審查、見證、控制點等工作外，均另委託技術顧問公司在製造過程中做隨機檢查 (Random Inspect)、文件審查(Review Documentatuon)、見證 (Witness Point)、控制點(Hold Point)等工作，比 ASME (或其他國際規範)檢查員做更多。附件 1 中採購者爲 NIS(NAFTAN INDUSTRIJA SRBIJE)，該公司另請顧問公司 CB&I LUMMUS 監督反應器製造過程，規範採 PED(Pressure Equipment Directive)97/23/EC 該規範由歐洲之 the European Parliament and the European Council 訂定。

2.品管計劃書中製造每個步驟均爲 ATB 製造控制點。

3.該案 PED 檢查員(Notified Body)其製造控制點爲 1.水壓試驗前目視檢查、2.水壓試驗、3.名牌核對及戳記、4.核對差異及缺失改善結案資料、5.核對 PED 認證及 CE 標記證券。

4. CB&I LUMMUS 監督中製造控制點爲 1.基礎螺絲樣板之目視及尺寸檢查、2.水壓試驗、3.內部、外部及法蘭面做最後目視檢查、4.核對差異及缺失改善結案資料。且比 PED 檢查員增加很多檢查、文件審查、見證等項目。

(六) 預估製造排程：

針對桃廠第三重油加氫脫硫工場 10 座高壓反應器及 2 座高壓分離器，預估主要胴身鍛造材料預估 14 個月交至製造廠，分 3 批分別於 18 個月、20 個月及 23 個月完成。

三、參訪 BELLELI ENERGY CPE 公司：

(一)公司簡介：

本次拜訪廠家 BELLELI ENERGY CPE 位於義大利米蘭近郊 MANTOVA，由銷售顧問- Gino Mori，業務經理- Fausto Fusari，總工程師-Etore Turano ，品管銲接-Nicola Maestri， 工廠主任-Aldo Patrini， 銷售工程師- Giulio Depetri，由業務經理 Fausto Fusari 介紹公司、與品管銲接部門經理 Nicola Maestri 討論高壓反應器檢驗、參訪工廠區及由鋼鐵公司 銷售董事-Damir Pitesa 介紹該公司鋼材研發及鍛造技術。

1947由Rodolfo Belleli先生於義大利Mantova創辦Belleli公司，1995 因財務困難重整爲Belleli Group 公司，1997成立Belleli Energy，2002 Belleli Energy 杜拜工廠及 Hamriyah 區，2003 Belleli Energy擁有Hanover壓縮機，2005/6 年 Belleli Energy S.p.A. 分成2個主要部門爲在義大利之C.P.E.（Critical Process Equipment,重大製程設備）及在杜拜之統包工程公司。2007 Merger between Hanover Compressor Co. and Universal to form Exterran Energy Solutions.

(二) Belleli Energy C.P.E.自 1947 年成立至今，60 多年主要從事於煉油、石化、石油焦氣化、煤氣化、及核能等工業之重大製程設備設計製造，並取得 ASME 之 S、U2、N、NPT 等認證及 AD-Merkblaetter,BS,Stoomwezen,Codap,Ispesl。

(三) Belleli Energy C.P.E.可依 ASME、AD-Merkblaetter, BS, Stoomwezen, Codap, Ispesl 等國際規範設計製造，承交各重型設備。

1.主要設計工具爲 3D 模擬、有限元素應力分析法、破壞力學分析，穩定與不穩定靜態分析、疲勞分析、潛變疲勞損傷評估、熱傳導之熱力設計。

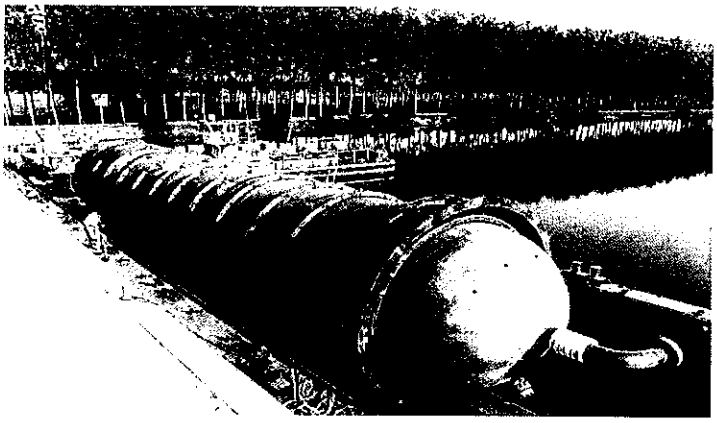
2.工廠佔地280,000 平方公尺，60,000平方公尺廠房，位於Mincio 河及高速公路間，交通運輸都很方便，工廠空間大、生產設備製造能力強及國際航運有利的運輸條件下，可完成任何設備尺寸和重量的要求。

3.主要完成設備：

3.1 氫裂解及氫處理反應器：

自1988起完成80座以上，重量從200噸～1350噸，最大長度（本體直緣）38 公尺，最大直徑 5.7 公尺，最大壁厚 328 公釐，材

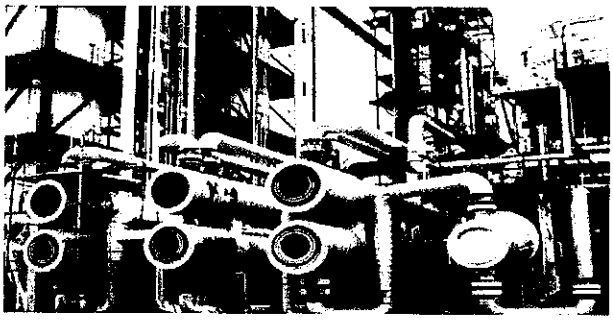
質爲2.25Cr-1Mo、2.25Cr-1Mo-0.25V（超過40座)及12CR-Mo9等，設計規範有ASME、AD-Merkblaetter、 BS5500、Finnish Code及EN1455等，製程專利有Chevron、UOP、 Lummus-ABB、 Exxon、Lurgi、IFP/Axens、Kellogg-Brown & Root、 Shell及Axens等



圖：Mincio 河

3.2 高壓熱交換器：

自1980起完成高壓熱交換器200座以上，重量從20噸～200噸，最大管子長度10 公尺，最大直徑 1.6 公尺，材質爲1.25CR-0.5 Mo、2.25Cr-1Mo、2.25Cr-1Mo-0.25V及12CR-Mo9等，設計型式有Breech Lock、Bolted In、Breech Lock及Bolted In混合式，製程專利有Chevron、UOP、 Lummus-ABB、 Exxon、IFP、Kellogg-Brown & Root、Shell等。



圖：高壓熱交換器

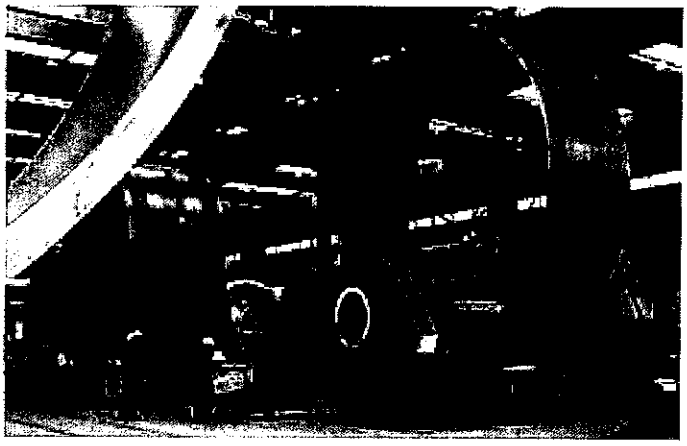
4.主要生產設備：

4.1 深孔鑽孔機(5部)： 鑽孔行程 1米。

圖：深孔鑽孔機

4.2 1部真圓度校正機: 胴身直徑12米, 重量250噸。

4.3 2部捲管機:板厚 400 mm, 寬4500 mm。



圖：捲管機

4.4 1部 3.000 噸壓床。

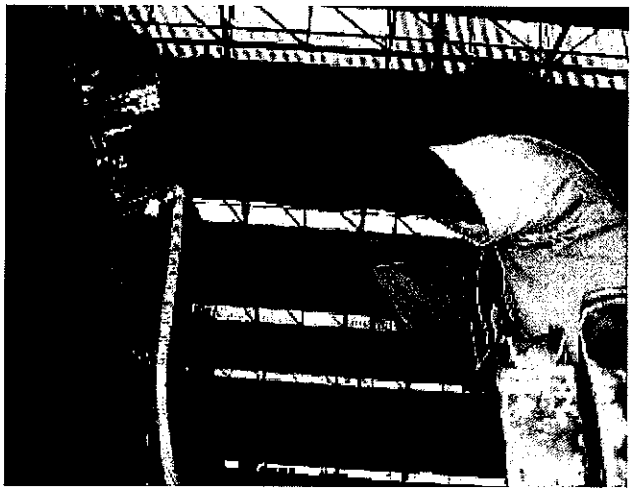
4.5 5座燃氣退火爐，其中兩座爲直徑5.5米x5.5米x27.5米長及8米x8米x33米長

4.6 2座 X-ray房, 其中一座配備 6 MeV線性加速器

4.7 技術材料測試實驗室

圖：實驗室

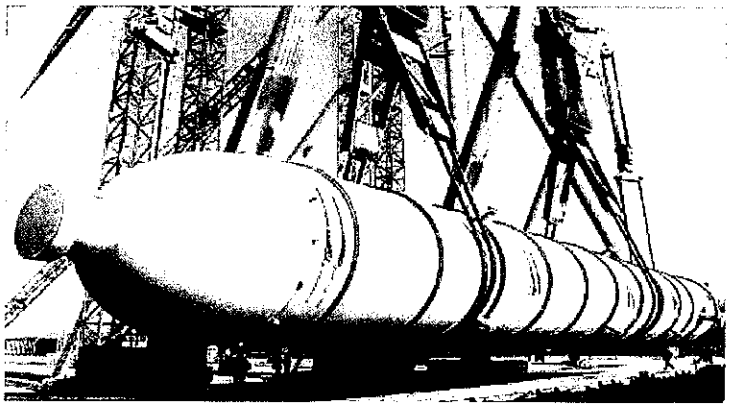
4.8 工廠超音波檢驗 (TOFD 檢查)



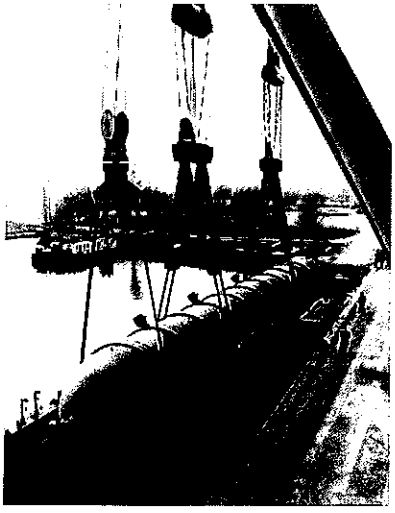
圖：TOFD 檢查

5.運輸：

自己擁有內河碼頭，1,500 噸起重設備，自行設計運輸工具，擁有鐵路與歐鐵連接，離義大利高速公路僅 1 公里，材料、設備運輸很方便。



Derrick Cranes(1.300 tons capacity) at Mantova Factory Harbour



at Mantova Factory Harbor (loading quay 78 m long; roll-on quay 11 m wide)

Factory Transportation Activity by means of self-propelled jack-up trailer

(四) 擁有自己工廠銲接訓練及研究中心

(五) 售後服務：

備品支援、備品更換、修護、技術服務、監督服務等

(六) 退火裂痕缺陷：

品管銲接部門經理 Nicola Maestri 特別強調在歐洲 2.25Cr-1Mo-0.25V 反應器**惟一製造過程從未發退火裂痕缺陷的製造廠**。因爲該公司特別注意所有過程。

1. 銲接參數、銲道開槽研討，在厚鋼板以窄間隙方式，減少銲接熔接量，也減少大量銲接殘餘應力，殘餘應力爲裂痕缺陷主要因素。

   25Cr-1Mo-0.25V 反應器爲避免任何裂痕缺陷，須控制下列五種嚴苛溫度：

1.1 預熱溫度：

預熱溫度須較高，可避免冷後氫裂痕，但因受限於層間溫度(Interpass Temperature)也不可以太高。

1.2 層間溫度 (Inter-pass temperatures)：

層間溫度將決定銲接冷卻及鋼材結構，預熱溫度及層間溫度須控制合適。

1.3 去氫熱處理(DHT Dehydrogenation Heat Treatment)：

去氫熱處理溫度及時間須控制，期使銲接殘餘氫氣低於 1 ppm(百萬分之一)，亦須控制其溫度升降速率，可避免鋼材溫度不均勻及因溫度變化太快產生熱膨脹(熱應力)。

1.4 中間應力釋除(Intermediate Stress Relieving)：

中間應力釋除時，須控制其退火溫度及時間，亦須控制其溫度升降速率。

1.5 銲後熱處理(Post Weld Heat Treatment)：

銲後熱處理與中間應力釋除相同，須控制其退火溫度及時間，亦須控制其溫度升降速率，以達到所需韌性及硬度。

2. 嚴格管制銲條銲药等材料品質、工廠管控(含儲存)。

3. Belleli 公司常須模擬熱處理循環，於製造過程(含熱處理)後獲得合適鋼料母材及銲條等材料機械性質，故須與鋼料母材及銲條等材料供應商維持密切合作關係，共同研究改善材料銲接性及性質。本次參訪時，該公司特地請他們 2.25Cr-1Mo-0.25V 鋼材供應鋼鐵公司

-Forgiatura A. Vienna 銷售董事-Damir Pitesa 介紹該公司鋼材研發及鍛造技術，Forgiatura A. Vienna 成立於 1962 年。

4. 發展高敏感度超音波檢查 TOFD(Time of Flight Diffraction)爲應用機械化、電腦化結合及有經驗合格超音波檢查員，使更有效檢查厚度較厚銲道檢查。

5.在現場或訓練中心對工作人員持續教授訓練以達到對 2.25Cr-1Mo-0.25V 反應器製造能無缺陷。

(七) **製造過程、製造控制點、檢查規範：**

1. Belleli 製造及檢查計劃書(詳附件 2)含製造過程、製造控制點及檢查規範等，與 ATB RIVA CALZONI 品管計劃書(詳附件 1)略同，在歐洲及中東之煉油或石化業於反應器採購後除 ASME 檢查員(Authorized Inspection)在製造過程之檢查、文件審查、見證、控制點等工作外，均另委託技術顧問公司在製造過程之做檢查(Inspect)、文件審查(Review)、證實(Verify)、見證(Witness)、控制點(Hold Point)等工作，比 ASME (或其他國際規範)檢查員做更多。附件 2 中採購者爲科威特國家石油公司(Kuwait National Petroeum Company)，該公司另請技術顧問公司監督反應器製造過程。

2. 製造及檢查計劃書中製造每個步驟均爲 Belleli 製造控制點。

3. 該案 AMSE 檢查員(A.I.A.)其製造控制點爲 1. 水壓試驗目視及尺寸檢查、2.最後目視及尺寸檢查、3.名牌核對及戳記，含 ASME A-1（表格）、4.審查最終文件資料。

4.技術顧問監督中製造控制點除上述 A.I.A. 製造控制點 1、2、4 項外增加 1.目視及尺寸檢查、2.各段及組合之銲後熱處理(PWHT)，且多項爲 AMSE 檢查員文件審查(Review)，技術顧問爲見證(Witness)項目。

(八) 預估製造排程：

針對桃廠第三重油加氫脫硫工場 10 座高壓反應器及 2 座高壓分離器，預估主要材料 17 個月全部交至製造廠，銲接程序 6 個月送核，2 座高壓分離器 12 個月完成，10 反應器分別於 20 個月及 24 個月各可完成 5 座。預估排程詳附件 3。而胴身鍛造材料預估 10 個月交至工廠。

四、參訪 Kobe Steel 公司：

(一)公司簡介：

本次拜訪廠家神戶製鋼公司位於日本神戶，由部長-Masato Yamada，工程部門經理- Tomoaki Nakanish，顧問(原神戶製鋼經理)-Fukuno Harada，銷售部門經理 Manager-Tomoaki Nakanish，銷售部門 - Jun Minekawa 接待，介紹公司、討論高壓反應器檢驗、參訪工廠區。

1905 年由 Suzuki Shoten 在日本神戶近郊高砂創辦 Kobe Steel Works 主要以鑄造及鍛造生產滑輪及鐵錨，1914 年已有 1,200 噸使用於鑄造及鍛造工廠，1915 年在日本生產第一部高壓往復壓縮機，1933 年生產 7,600 馬力柴油引擎(當時爲世界最大馬力)，1942 生產高品質電銲條，1953 年高砂廠生產輪機的曲軸、空氣分離機、水泥廠及化學工業用厚胴身壓力容器，高砂廠成爲神戶製鋼主要生產中心，1957 年完成橫濱廠，1960 年成立該公司中央研究實驗室，1962 年在東巴基斯坦完成肥料廠，1964 年研發耐腐蝕鋁合金使用於東京羽田機場單軌火車車箱，1979 年以 KOBELCO 爲國際商標，1982 年 P&H Kobelco 5650 移動式吊車(世界最大)，1995 年神戶大地震總公司及高爐都受損，地震後 2.5 個月，恢復生產，2006 以 KOBELCO 爲神戶集團標記。

(二)神戶製鋼公司是世界唯一在壓力容器材料包括鍛造胴身、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)建造能製造 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。

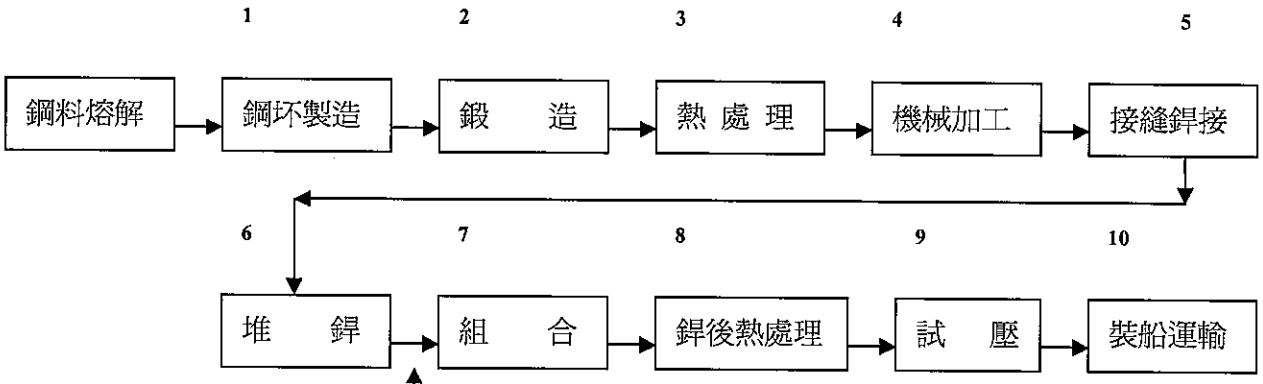
(三)神戶製鋼公司成功開發改良 2 1/4Cr-1Mo-0.25V 鋼材，比反應器傳統材料 2 1/4Cr-1Mo，有較高強度、抗氫性質及防止堆銲脫離，在 1998 年造以改良 2 1/4Cr-1Mo-0.25V 爲反應器材料，因較高強度，可使重量減少 10%，神戶製鋼公司的壓力容器廠取得 ASME U, U2, U3，ISO 9001, ISO 14001，中華人民共和國特種設備製造許可証(壓力容器)認證。

(四)神戶製鋼公司壓力容器廠製造能力，最大重量 2200 噸，最大長度 90 公

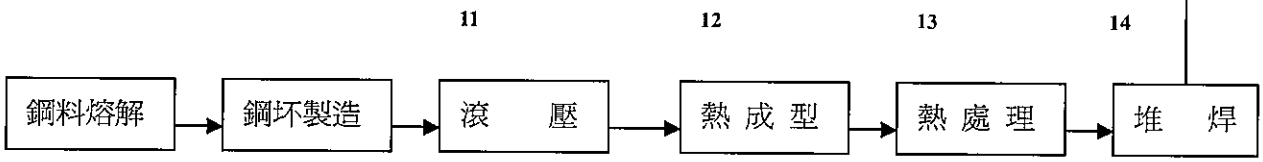
尺，最大胴身外徑 6.8 公尺(鍛造)，9 公尺(鋼板捲製) ，最大胴身厚 450 公釐(鍛造)，150 公釐(鋼板捲製) 。

(五)神戶製鋼公司反應器胴身及端板製造程序

銲造筒身環程序



端板成型

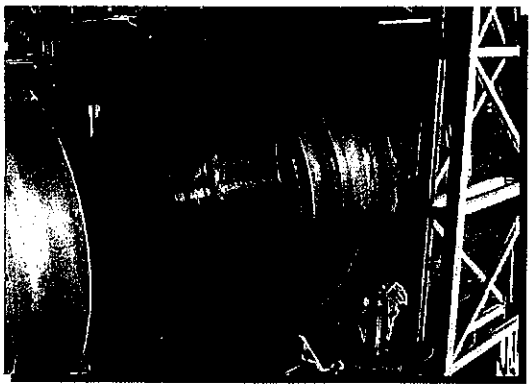


Ingot making ❶

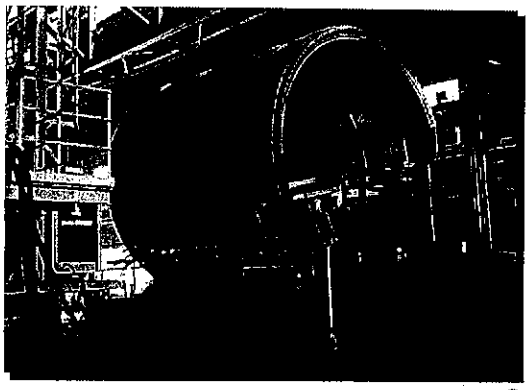
Ring forging ❷

Quenching heat treatment ❸

Machining ❹

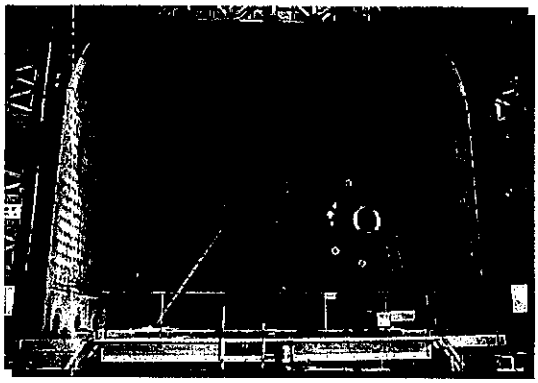


Girth seam welding ❺

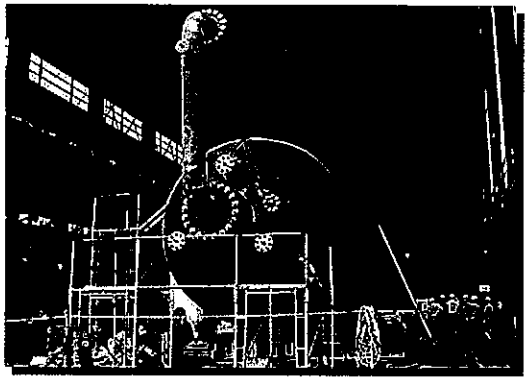


Weld overlay on shell ❻

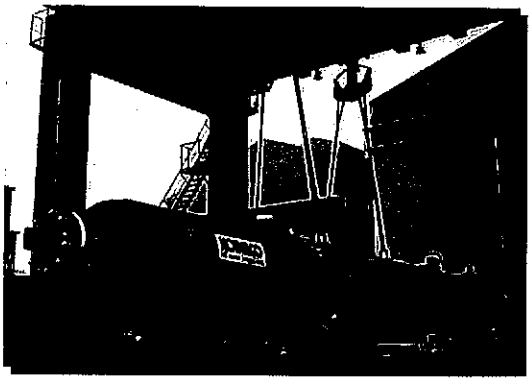
Radiographic examination ❼



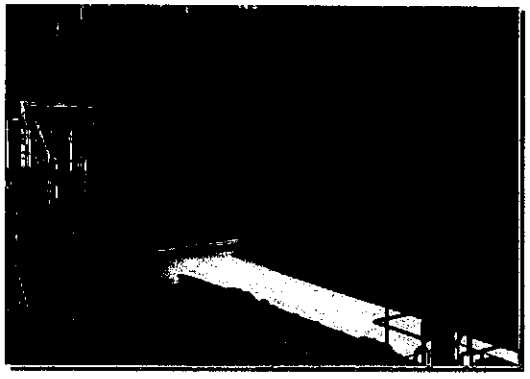
PWHT in furnace ❽



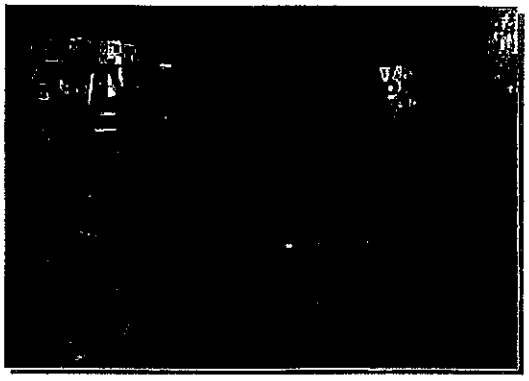
Hydrostatic test ❾



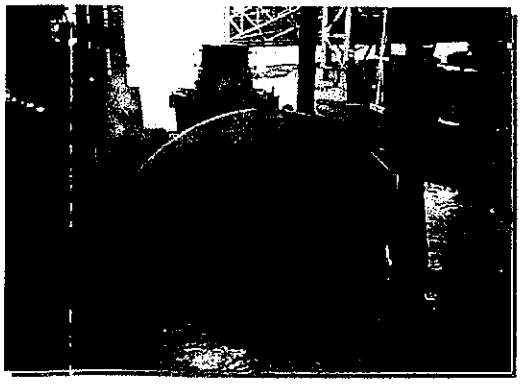
Shipping ❿



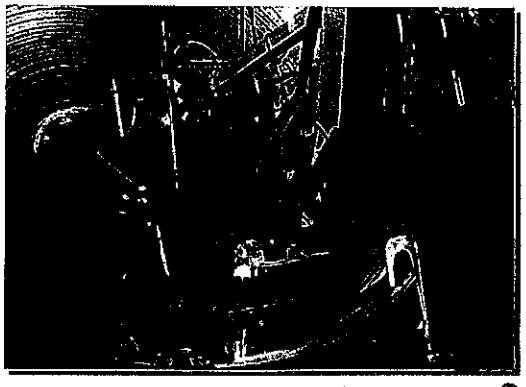
Rolling ⓫



Hot forming ⓬



Quenching heat treatment ⓭



Weld overlay on head ⓮

肆、 心得與建議

一、這次參訪兩家義大利製造廠家及一家日本製造廠家，其共同點爲：

(一)很重視客戶的參訪，從簡報到參觀工場區對公司設備能力及製造過程，解說詳細而有說服力，禮儀周到。工廠從業人員辛勤工作，敬業樂群。

(二)相當重視工安及環境的整潔，工地的 housekeeping 及 5S 做得很徹底，作業人員嚴格遵照一切安環規定。訪客參訪廠區要穿戴防護設備外，也不忘提醒危害告知。神戶製鋼公司特地在廠區地面劃上一條寬約一公尺的行進路線供訪客循線前進而不能越踰。

(三)對各種材料銲接程序非常重視，經常對銲工進行檢定，並用自己實驗室對試片作各種試驗，來管控施工品質。

(四)各種壓力容器製造過程檢驗停留點都已經標準化，規定非常完整，委託工程技術顧問公司及認證公司階段進場會驗時機也都有註明。

二、神戶製鋼公司無論在設備製造技術及鋼材、銲材研究開發上永遠處於領先地位，這種專注於本業不斷創新的精神，值得本國企業借鏡。

三、參訪三家廠商製造工廠區，只有ATB生產線滿檔，其餘兩家就顯得冷清，表示世界煉油及石化業景氣尚未復甦，應爲採購發包好時機。

四、厚壁壓力容器銲縫檢查ASME規範案例2235准許用自動UT取代傳統RT採用TOFD(Time of Fligt Diffraction)方法檢查，設檢單位應儘早收集相關資料進行了解。

五、銲接產生的氫殘留在鋼中會引起材料脆化現象,因此在堆銲過程中如何防止氫滲入，避免將來操作後產生堆銲層剝離現象，各家製造廠商都有自己處理程序，建議有人出國洽公考察，設法了解對日後維修有幫助。

六、ASME 2004 年版 Sec.VIII Div.2 2004 年版壓力容器製造規則

2.25Cr-1Mo-0.25V 鋼材厚度可比原傳統 2.25Cr-1Mo 低合金鋼厚度減少 10%以上，而 ASME 2007 年版 Sec.VIII Div.2，將 2.25Cr-1Mo-0.25V 鋼材在設計溫度 450℃時，材料容許應力調升約 15%，故母材厚度可比原傳統 Cr-Mo 低合金鋼厚度減少 25%以上。但因 2.25Cr-1Mo-0.25V 鋼材施工過程如銲接時、在熱時、預熱及層間溫度控制、中間應力釋除退火溫度、銲後熱處理退火溫度等容易產生裂痕，且 2.25Cr-1Mo-0.25V 銲料供應商較少，製造技術較高，全球有 2.25Cr-1Mo-0.25V 反應器製造經驗廠家較少。

伍、 附件目錄

附件 1：ATB Quality Control Plan(部分內容)。

附件 2：ATB 2.25Cr-1Mo-0.25V Reactor Fabrication Sequence。

附件 3：Belleli Fabrication & Inspection Plan(部分內容)。

附件 4：Belleli Preliminary Bar Chart Schedule。

附件 5：Kobe Reactor Fabrication Sequence。

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558QCP001

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

NUMBER	REV.	COMPONENT
200000558/55/00	0	DOCUMENTS REVIEW
200000558/55/01	0	MATERIALS
200000558/55/02	1	HEADS CONSTRUCTION
200000558/55/03	2	SHELL SECTIONS CONSTRUCTION
200000558/55/04	0	CIRCUMFERENTIAL WELDS (WITH LOCAL PWHT)
200000558/55/05	1	NOZZLES - SPOOLS
200000558/55/06	0	INTERNAL - EXTERNAL
200000558/55/07	1	FINAL INSPECTONS AND TEST PLATE

NIS AD	CB&I	No. Bo.

REV	DATE	ISSUED	VERIFIED	APPROVED	DESCRIPTION
3	22-02-11	Zuin	Possenti	Possenti	Modified sections 07 for inspection points
2	01-02-11	Zuin	Possenti	Possenti	Modified sections 200000558/02-03-05 for small changes
1	05-11-10	Zuin	Possenti	Possenti	Modified section 03 for sequence of construction
0	04-05-10	Zuin	Possenti	Possenti	First Issue

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558QCP001

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

All ATB Inspection Point are Hold Point

Reference Documents

M-001 / M-003	PLATE MATERIAL SPECIFICATIONS
M-002	FORGING MATERIAL SPECIFICATION
DWG	DRAWINGS
WPS	WELDING PROCEDURE SPECIFICATION
PC04	DIMENSIONAL PROCEDURE
PC50	RADIOGRAPHIC EXAMINATION PROCEDURE
PC65	MAGNETIC PARTICLE EXAMINATION PROCEDURE
PC55	ULTRASONIC EXAMINATION PROCEDURE
PC60	ULTRASONIC EXAMINATION OF BONDING PROCEDURE
PC70	DYE PENETRANT EXAMINATION PROCEDURE
PC62	TOFD EXAMINATION PROCEDURE
PC59	PHASED ARRAY EXAMINATION PROCEDURE
PC77	PRODUCTION TEST PLATE PROCEDURE
PC79	HARDNESS CHECK PROCEDURE
PC80	P.M.I. CHECK PROCEDURE
PC85	CHEMICAL ANALYSIS CHECK PROCEDURE
PC90	FERRITE CHECK PROCEDURE
PC96	REPAIR PROCEDURE
PF05	HOT FORMING OF HEADS PROCEDURE
PF10	POST WELD HEAT TREATMENT PROCEDURE
PF20	HYDROTEST PROCEDURE
PF25	NITROGEN PRESSURIZATION PROCEDURE
PF40	PAINTING PROCEDURE

Certificate

CMTR	CERTIFICATE MATERIAL TEST REPORT
IR	INTERNAL REPORT
PQR	PROCEDURE QUALIFICATION RECORD
VT	VISUAL EXAMINATION REPORT
DIM	DIMENSIONAL REPORT
MT	MAGNETIC TEST REPORT
UT	ULTRASONIC TEST REPORT
PT	DYE PENETRANT EXAMINATION REPORT
RT	RADIOGRAPHIC EXAMINATION REPORT
TOFD	TOFD EXAMINATION REPORT
PA	PHASED ARRAY EXAMINATION REPORT
HT	HEAT TREATMENT REPORT
PM	MECHANICAL TEST REPORT
CA	CHEMICAL ANALYSIS REPORT
FER	FERRITE CHECK REPORT
PMI	PMI CHECK REPORT
HB	HARDNESS CHECK REPORT
PI	HYDROTEST REPORT
AB	AS BUILT REPORT
SP	PAINTING CHECK REPORT
MDB	MANUFACTURING DATA BOOK

Inspection Point

RI	RANDOM INSPECTION
HP	HOLD POINT
WP	WITNESS POINT
RD	REVIEW DOCUMENTATION

Inspection Authorities

NIS	NAFTAN INDUSTRIJA SRBIJE (NIS) (end user)
CB&I	CB&I LUMMUS (Tech. con su/tant)
No.Bo.	PED NOTIFIED BODY

ATB RIVA CALZONI SpA	**QUALITY CONTROL PLAN**	SHEET	1
		DOCUMENT	200000558/55/00 (REV.0) GENERAL ACTIVIES

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
	MEETINGS								
1	KICK-OFF MEETING	AGENDA			WP	WP			
2	PRE INSPECTION MEETING	AGENDA			WP	WP			
	DOCUMENTS REVIEW								
1	QUALITY CONTROL PLAN	20558 QCP			RD		R		
2	DRAWINGS	20558 D XXX			RD		R		
3	CALCULATIONS	20558 N XXX			RD		R		
4	WPS, PQR AND WELD MAP	20558 WDB 001			RD		R		
5	MANUFACTURING PROCEDURES	20558 PF XXX			RD		R		
6	NON DESTRUCTIVE EXAMINATION PROCEDURES	20558 PC XXX			RD		R		
7	HAZARD ANALYSIS (PED)	20558 HA 97/23/EC			RD		R		
	QUALIFICATIONS								
1	WELDERS QUALIFICATION	LIST			RD		R		
2	NDT OPERATORS QUALIFICATION	LIST			RD		R		
	SUBORDERS								
1	MATERIAL SPECIFICATIONS	20558 M XXX			RD				
2	SUBORDERS CHECK	SO			RD				
	VARIOUS								
1	CHECK OF INSTRUMENT CALIBRATIONS	LIST			RD				
2	CHECK OF MATERIAL TRACEABILITY	LIST			RD				

Tech consult end user (same as UPC (+ Eur.))

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558/55/02 (REV.1) HEADS

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

TOP HEAD SECTORS FORMING

(001-01A) TOP HEAD (SECTOR)

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
1	HEAT TREATMENT OF HEAD	PF05		H	RD			HT	
2	VISUAL AND DIMENSIONAL EXAMINATION	D001		H	RD			IR	
3	SPECIMEN IDENTIFICATION	PF05		H	RD			IR	
4	SPECIMEN MECHANICAL TESTS	PF05 M001		H	RI		R	PM	

(001-01B) TOP HEAD (SECTOR)

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
1	HEAT TREATMENT OF HEAD	PF05		H	RD			HT	
2	VISUAL AND DIMENSIONAL EXAMINATION	D001		H	RD			IR	
3	SPECIMEN IDENTIFICATION	PF05		H	RD			IR	
4	SPECIMEN MECHANICAL TESTS	PF05 M001		H	RI		R	PM	

(001-01C) TOP HEAD (SECTOR)

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
1	HEAT TREATMENT OF HEAD	PF05		H	RD			HT	
2	VISUAL AND DIMENSIONAL EXAMINATION	D001		H	RD			IR	
3	SPECIMEN IDENTIFICATION	PF05		H	RD			IR	
4	SPECIMEN MECHANICAL TESTS	PF05 M001		H	RI		R	PM	

(001-01D) TOP HEAD (SECTOR)

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
1	HEAT TREATMENT OF HEAD	PF05		H	RD			HT	
2	VISUAL AND DIMENSIONAL EXAMINATION	D001		H	RD			IR	
3	SPECIMEN IDENTIFICATION	PF05		H	RD			IR	
4	SPECIMEN MECHANICAL TESTS	PF05 M001		H	RI		R	PM	

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET	1
		DOCUMENT	200000558/55/03 (REV.2) SHELL SECTIONS

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE

SECTION TOP HEAD (001-01) / SHELL COURSE (001-02)
(RONCADELLE SHOP)

WELD OVERLAY (001-02) SHELL COURSE									
1	MT EXAMINATION OF SURFACE TO BE OVERLAYED	PC65		H	RD			MT	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	DYE PENETRANT EXAMINATION ON WELD OVERLAY	PC70		H	RD			PT	
4	UT EXAMINATION OF WELD OVERLAY (SPOT CHECK)	PC60		H	RD			UT	
5	OVERLAY THICKNESS CHECK BY CALIPER ON THE EXPOSED SURFACE	D001		H	RD			IR	
6	PMI CHECK	PC80		H	RD			PMI	
7	FERRITE CHECK	PC90		H	RD			FE	
8	CHEMICAL ANALYSIS CHECK OF RESTORING	PC90A		H	RD			CA	

CLAD RESTORING BUILD UP ELEVATION +25976									
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON RESTORING	PC70		H	RD			PT	
3	PMI CHECK	PC80		H	RD			PMI	
4	FERRITE CHECK	PC90		H	RD			FE	
5	CHEMICAL ANALYSIS CHECK OF RESTORING	PC90A		H	RD			CA	

CIRCUMFERENTIAL WELD W2 (001-01 A÷D) TOP HEAD - (001-02) SHELL COURSE									
1	MT EXAMINATION OF CIRC. EDGES	PC65		H	RD			MT	
2	VISUAL AND DIMENSIONAL EXAMINATION AFTER FIT-UP	D001		H	W			IR	
3	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
4	MT EXAMINATION BEFORE BACK WELDING	PC65		H	RD			MT	
5	VISUAL AND DIMENSIONAL EXAMINATION AFTER WELDING	D001		H	RD			IR	
6	MT EXAM. OF WELD (BOTH SIDES INCL. TEMPORARY ATTACH. AREA)	PC65		H	RD			MT	
7	UT EXAMINATION OF WELD	PC55		H	RD			IR	
8	UT EXAMINATION OF WELD REPAIR (IF ANY)	PC55		H	W			IR	
9	UT RECORDABLE IN ACCORDANCE WITH ASME VIII DIV.2 SECT. 7.5.5	PC62		H	RD			TOFD	
10	UT RECORDABLE OF WELD REPAIR (IF ANY)	PC62		H	W			TOFD	
11	PMI CHECK	PC80		H	RD			PMI	

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558/55/04 (REV.1) CIRCUMFERENTIAL WELDS

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
	CIRCUMFERENTIAL WELD W3 (001-02) SHELL COURSE - (001-03) SHELL COURSE								**(MARGHERA SHOP)**
1	MT EXAMINATION OF CIRC. EDGES	PC65		H	RD			MT	
2	VISUAL AND DIMENSIONAL EXAMINATION AFTER FIT-UP	D001		H	W			IR	
3	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
4	MT EXAMINATION BEFORE BACK WELDING	PC65		H	RD			MT	
5	VISUAL AND DIMENSIONAL EXAMINATION AFTER WELDING	D001		H	RD			IR	
6	MT EXAM. OF WELD (BOTH SIDES INCL. TEMPORARY ATTACH. AREA)	PC65		H	RD			MT	
7	UT EXAMINATION OF WELD	PC55		H	RD			IR	
8	UT EXAMINATION OF WELD REPAIR (IF ANY)	PC55		H	W			IR	
9	UT RECORDABLE IN ACCORDANCE WITH ASME VIII DIV.2 SECT. 7.5.5	PC62		H	RD			TOFD	
10	UT RECORDABLE OF WELD REPAIR (IF ANY)	PC62		H	W			TOFD	
11	PMI CHECK	PC80		H	RD			PMI	
	CLAD RESTORING (001-02) SHELL COURSE - (001-03) SHELL COURSE								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON RESTORING	PC70		H	RD			PT	
3	UT EXAMINATION OF RESTORING	PC60		H	RD			UT	
4	PMI CHECK	PC80		H	RD			PMI	
5	FERRITE CHECK	PC90		H	RD			FE	
6	CHEMICAL ANALYSIS CHECK OF RESTORING	PC85		H	RD			CA	
	EXAMINATION BEFORE LOCAL PWHT								
1	VISUAL AND DIMENSIONAL EXAMINATION BEFORE PWHT	D001		H	W			VT/DIM	
	EXAMINATIONS AFTER LOCAL PWHT								
1	POST WELD HEAT TREATMENT	PF 10		H	RD			HT	
2	HARDNESS CHECK	PC79		H	RD			HB	
3	UT EXAMINATION	PC55		H	RD			UT	
4	UT RECORDABLE IN ACCORDANCE WITH ASME VIII DIV.2 SECT. 7.5.5	PC62		H	RD			TOFD	
5	PT EXAMINATION OF CLAD RESTORING	PC70		H	RD			PT	

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558/55/05 (REV.1) NOZZLES / SPOOLS

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
	OVERLAY NOZZLES								
	OVERLAY (003-01) NOZZLE M20								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON WELD OVERLAY	PC70		H	RD			PT	
3	UT EXAMINATION OF WELD OVERLAY	PC60		H	RD			UT	
4	PMI CHECK	PC80		H	RD			PMI	
5	FERRITE CHECK	PC90		H	RD			FE	
6	CHEMICAL ANALYSIS CHECK	PC85		H	RD			CA	
	OVERLAY (003-17) NOZZLE N7								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON WELD OVERLAY	PC70		H	RD			PT	
3	UT EXAMINATION OF WELD OVERLAY	PC60		H	RD			UT	
4	PMI CHECK	PC80		H	RD			PMI	
5	FERRITE CHECK	PC90		H	RD			FE	
6	CHEMICAL ANALYSIS CHECK	PC85		H	RD			CA	
	OVERLAY (003-17) NOZZLE N12								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON WELD OVERLAY	PC70		H	RD			PT	
3	UT EXAMINATION OF WELD OVERLAY	PC60		H	RD			UT	
4	PMI CHECK	PC80		H	RD			PMI	
5	FERRITE CHECK	PC90		H	RD			FE	
6	CHEMICAL ANALYSIS CHECK	PC85		H	RD			CA	
	OVERLAY (003-17) NOZZLE N17								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	DYE PENETRANT EXAMINATION ON WELD OVERLAY	PC70		H	RD			PT	
3	UT EXAMINATION OF WELD OVERLAY	PC60		H	RD			UT	
4	PMI CHECK	PC80		H	RD			PMI	
5	FERRITE CHECK	PC90		H	RD			FE	
6	CHEMICAL ANALYSIS CHECK	PC85		H	RD			CA	

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558/55/06 (REV.0) EXTERNAL / INTERNAL

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
	EXTERNAL								
	SKIN THERMOCOUPLE ST 1 ON NOZZLE M20 (003-01)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 2÷6 ON SHELL COURSE (001-04)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 7÷11 ON SHELL COURSE (001-05)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 12÷16 ON SHELL COURSE (001-07)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 17÷21 ON SHELL COURSE (001-08)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 22÷26 ON SHELL COURSE (001-10)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	SKIN THERMOCOUPLES ST 27÷31 ON SHELL COURSE (001-11)								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	

PJ141. 9/10

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 4
		DOCUMENT 200000558/55/06 (REV.0) EXTERNAL / INTERNAL

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

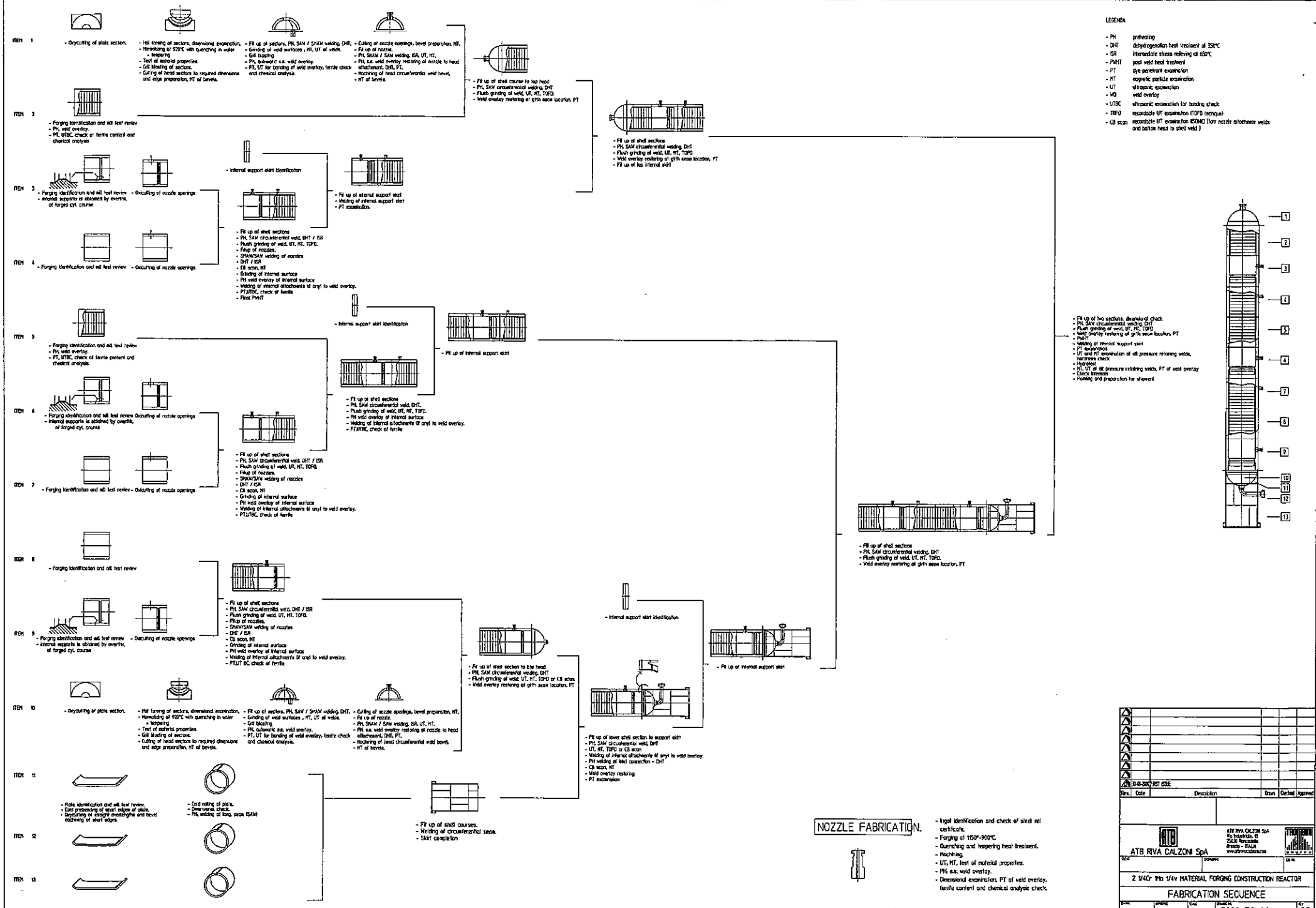
	DESCRIPTION	REFERENCE		INSPECTION POINTS				CERTIFICATE	
		DOC	REV	ATB	CB&I	NIS	No.Bo.	N°	DATE
	INTERNAL SKIRT WELD ON SHELL COURSE (001-02)								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	PT EXAMINATION OF WELD	PC70		H	RD			PT	
3	FERRITE CHECK OF WELD	PC90		H	RD			FE	
	INTERNAL SKIRT WELD ON SHELL COURSE (001-04)								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	PT EXAMINATION OF WELD	PC70		H	RD			PT	
3	FERRITE CHECK OF WELD	PC90		H	RD			FE	
	INTERNAL SKIRT WELD ON SHELL COURSE (001-07)								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	PT EXAMINATION OF WELD	PC70		H	RD			PT	
3	FERRITE CHECK OF WELD	PC90		H	RD			FE	
	INTERNAL SKIRT WELD ON SHELL COURSE (001-10)								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	PT EXAMINATION OF WELD	PC70		H	RD			PT	
3	FERRITE CHECK OF WELD	PC90		H	RD			FE	
	INTERNAL ATTACHMENTS								
1	UT EXAMINATION BEFORE WELDING	PC55		H	RD			IR	
2	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
3	PT EXAMINATION	PC70		H	RD			PT	
	LIFTING COVER								
1	CHECK OF WPS AND WELDING ACTIVITY	WPS		H	RD			PQR	
2	MT EXAMINATION	PC70		H	RD			MT	
3	UT EXAMINATION	PC55		H	RD			UT	
4	POST WELD HEAT TEATMENT	PF10		H	RD			HT	
5	MT EXAMINATION	PC70		H	RD			MT	
6	UT EXAMINATION	PC55		H	RD			UT	
	ANCHOR BOLTS TEMPLATE								
1	VISUAL AND DIMENSIONAL EXAMINATION	D004		H	H			AS BUILT	

ATB RIVA CALZONI SpA	QUALITY CONTROL PLAN	SHEET 1
		DOCUMENT 200000558/55/07 (REV.1) FINAL INSPECTIONS / TESTS

CLIENT	NAFTAN INDUSTRIJA SRBIJE (NIS)	ENGINEERING	CB&I LUMMUS
PROJECT	PANCEVO OIL REFINERY MODERNIZATION	CLIENT PROJECT No.	POR 02111-0330
EQUIPMENT	HYDROCRACKER REACTOR	TAG No.	DC-4301
ATB JOB	200000558	S.N.	19355

FINAL EXAMINATION AND TESTS

	DESCRIPTION	REFERENCE DOC	REV	INSPECTION POINTS ATB	CB&I	NIS	No.Bo.	CERTIFICATE N°	DATE
HYDROTEST AND EXAMINATIONS AFTER HYDROTEST									
1	VISUAL EXAMINATION BEFORE HYDROTEST (INTERNAL/EXTERNAL)	D001		H	W		H	VT	
2	CHECK OF WATER FOR HYDROTEST	PF20		H	R			AC	
3	HYDROTEST	PF20		H	H		H	PI	
4	MT EXAMINATION OF ALL SHELL / HEADS / NOZZLES / SPOOLS WELDS (PRESSURE WELDS)	PC65		H	RD		W	MT	
5	MT EXAMINATION OF SKIRT TO SHELL WELD	PC65		H	RD			MT	
6	MT EXAMINATION OF EXTERNAL ATTACHMENTS WELDS	PC65		H	RD		W	MT	
7	MT EXAMINATION OF ALL TEMPORARY ATTACHMENTS AREAS	PC65		H	RD		W	MT	
8	CHECK OF INTERNAL INSTALLATION	D001		H	W			IR	
9	FINAL VISUAL EXAMINATION (INTERNAL AND EXTERNAL AND FLANGE SURFACES)	D001		H	H			AB	
10	CHECK AND STAMPING OF NAMEPLATE	D007		H	RI		H		
11	CHECK OF SURFACE PREPARATION	PF40		H	RI			PAINT	
12	CHECK OF EXTERNAL SURFACE PAINTING	PF40		H	W			PAINT	
13	CHECK OF PREPARATION FOR SHIPMENT (INCLUDING NITROGEN PRESSURIZATION AND MARKING)	D009		H	RI			IR	
14	CHECK OF PARTS TO BE SHIPPED LOOSE	D009		H	RI			IR	
15	CHECK OF CLOSING NCR AND DEVIATIONS	D001		H	H		H		
16	CHECK OF PED CERTIFICATION + CE MARKING	D001		H	RI		H	CE	
17	ISSUE OF INSPECTION RELEASE NOTE			H	H				


ITEM 1
- Oxycutting of plate section.
- Hot forming of sectors, dimensional examination.
- Normalizing at 920°C with quenching in water + tempering
- Test of material properties.
- Grit blasting of sections.
- Cutting of head sectors to required dimensions and edge preparation, MT of bevels.
- Fit up of sectors, PH, SAW / SMAW welding, DHT.
- Grinding of weld surfaces , MT, UT of welds.
- Grit blasting
- PH, automatic s.s. weld overlay.
- PT, UT for bonding of weld overlay, ferrite check and chemical analysis.
- Cutting of nozzle openings, bevel preparation, MT.
- Fit up of nozzle.
- PH, SMAW / SAW welding, ISR, UT, MT.
- PH, s.s. weld overlay restoring of nozzle to head attachment, DHT, PT.
- Machining of head circumferential weld bevel.
- MT of bevels.
ITEM 2
- Forging identification and mill test review
- PH, weld overlay.
- PT, UTSC, check of ferrite content and chemical analysis
- Fit up of shell course to top head
- PH, SAW circumferential welding, DHT
- Flush grinding of weld, UT, MT, TOFD.
- Weld overlay restoring of girth seam location, PT
ITEM 3
- Forging identification and mill test review
- Internal supports is obtained by overthk. of forged cyl. course
- Oxycutting of nozzle openings
- Internal support skirt identification
- Fit up of internal support skirt
- Welding of internal support skirt
- PT examination.
ITEM 4
- Forging identification and mill test review
- Oxycutting of nozzle openings
- Fit up of shell sections
- PH, SAW circumferential weld, DHT / ISR
- Flush grinding of weld, UT, MT, TOFD.
- Fitup of nozzles.
- SMAW/SAW welding of nozzles
- DHT / ISR
- CB scan, MT
- Grinding of internal surface
- PH weld overlay of internal surface
- Welding of internal attachments of anyl to weld overlay.
- PT/UTSC, check of ferrite
- Final PWHT
- Fit up of shell sections
- PH, SAW circumferential welding, DHT
- Flush grinding of weld, UT, MT, TOFD
- Weld overlay restoring of girth seam location, PT
- Fit up of top internal skirt
ITEM 5
- Forging identification and mill test review
- PH, weld overlay.
- PT, UTSC, check of ferrite content and chemical analysis
- Internal support skirt identification
- Fit up of internal support skirt
- Fit up of shell sections
- PH, SAW circumferential weld, DHT.
- Flush grinding of weld, UT, MT, TOFD.
- PH weld overlay of internal surface
- Welding of internal attachments of anyl to weld overlay.
- PT/UTSC, check of ferrite
- Fit up of two sections, dimensional check.
- PH, SAW circumferential welding, DHT
- Flush grinding of weld, UT, MT, TOFD
- Weld overlay restoring of girth seam location, PT
- PWHT
- Welding of internal support skirt
- PT examination
- UT and MT examination of all pressure retaining welds, hardness check
- Hydrotest
- MT, UT of all pressure retaining welds, PT of weld overlay
- Check internals
- Painting and preparation for shipment
ITEM 6
- Forging identification and mill test review
- Internal supports is obtained by overthk. of forged cyl. course
- Oxycutting of nozzle openings
- Fit up of shell sections
- PH, SAW circumferential weld, DHT / ISR
- Flush grinding of weld, UT, MT, TOFD.
- Fitup of nozzles.
- SMAW/SAW welding of nozzles
- DHT / ISR
- CB scan, MT
- Grinding of internal surface
- PH weld overlay of internal surface
- Welding of internal attachments of anyl to weld overlay.
- PT/UTSC, check of ferrite
ITEM 7
- Forging identification and mill test review
- Oxycutting of nozzle openings
ITEM 8
- Forging identification and mill test review
ITEM 9
- Forging identification and mill test review
- Internal supports is obtained by overthk. of forged cyl. course
- Oxycutting of nozzle openings
- Fit up of shell sections
- PH, SAW circumferential weld, DHT / ISR
- Flush grinding of weld, UT, MT, TOFD.
- Fitup of nozzles.
- SMAW/SAW welding of nozzles
- DHT / ISR
- CB scan, MT
- Grinding of internal surface
- PH weld overlay of internal surface
- Welding of internal attachments of anyl to weld overlay.
- PT/UT DC check of ferrite
- Fit up of steel section to btw head
- PH, SAW circumferential welding, DHT
- Flush grinding of weld, UT, MT, TOFD or CB scan
- Weld overlay restoring of girth seam location, PT
- Internal support skirt identification
- Fit up of internal support skirt
ITEM 10
- Oxycutting of plate section.
- Hot forming of sectors, dimensional examination.
- Normalizing at 920°C with quenching in water + tempering
- Test of material properties.
- Grit blasting of sections.
- Cutting of head sectors to required dimensions and edge preparation, MT of bevels.
- Fit up of sectors, PH, SAW / SMAW welding, DHT.
- Grinding of weld surfaces , MT, UT of welds.
- Grit blasting
- PH, automatic s.s. weld overlay.
- PT, UT for bonding of weld overlay, ferrite check and chemical analysis.
- Cutting of nozzle openings, bevel preparation, MT.
- Fit up of nozzle.
- PH, SMAW / SAW welding, ISR, UT, MT.
- PH, s.s. weld overlay restoring of nozzle to head attachment, DHT, PT.
- Machining of head circumferential weld bevel.
- MT of bevels.
- Fit up of lower shell section to support skirt
- PH, SAW circumferential weld, DHT
- UT, MT, TOFD or CB scan
- Welding of internal attachments of anyl to weld overlay.
- PH welding of weld connection - DHT
- CB scan, MT
- Weld overlay restoring
- PT examination
ITEM 11
- Plate identification and mill test review.
- Cold preforming of short edges of plate.
- Oxycutting of straight overlengths and bevel machining of short edges.
- Cold rolling of plate.
- Dimensional check.
- PH, welding of long. seam (SAW)
ITEM 12
ITEM 13
- Fit up of shell courses.
- Welding of circumferential seam.
- Skirt completion
NOZZLE FABRICATION
- Ingot identification and check of steel mill certificate.
- Forging at 1150°-900°C.
- Quenching and tempering heat treatment.
- Machining.
- UT, MT, test of material properties.
- PH s.s. weld overlay.
- Dimensional examination, PT of weld overlay, ferrite content and chemical analysis check.
LEGENDA
- PH preheating
- DHT dehydrogenation heat treatment at 350°C
- ISR intermediate stress relieving at 650°C
- PWHT post weld heat treatment
- PT dye penetrant examination
- MT magnetic particle examination
- UT ultrasonic examination
- WO weld overlay
- UTSC ultrasonic examination for bonding check
- TOFD recordable UT examination (TOFD technique)
- CB scan recordable UT examination (ECHO) (for nozzle attachment welds and bottom head to shell weld)
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Rev. Date Description Drawn Checked Approved
31-05-2017 FIRST ISSUE
ATB RVA CALZONI SpA
ATB RVA CALZONI SpA
Via Volturno, 13
25010 Rezzato
Brescia - ITALIA
www.atbrvacalzoni.com
2 1/4Cr 1Mo 1/4v MATERIAL FORGING CONSTRUCTION REACTOR
FABRICATION SEQUENCE
DRAWING NO.
2000-FS-001
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SHEET
DRAWN
APPROVED
DATE
15/02/2016
SCALE
SHEET 2
R 1 1

EXTERRAN

Belleli Energy CPE S.p.A.
Critical Process Equipment

Doc. Title	**FABRICATION & INSPECTION PLAN**
Doc. No.	**PC-1190-01-001**

FLUOR ENTERPRISES, Inc.

KUWAIT NATIONAL PETROLEUM Co., MAB (KNPC)
CLEAN FUELS PROJECT 2020 - KUWAIT
P.O. No.: 69394 (MAB REFINERY)

FIXED REACTOR #1

No. 6 Reactors - Items: **212-R-0102 / 212-R-0105 / 112-R-0102**
112-R-0105 / 112-R-0202 / 112-R-0205

BELLELI Serial No.: **13760 to 13765**

MASTER DOCUMENT
(to be duplicated for each Reactor Item after review of this Master doc.)

FLUOR

TO BE COMPLETED BY SELLER:

CONTRACT NO.:	A2WD
P.O. NUMBER:	#69394
First Issue:	NO
EDR CODE:	
ITEM/TAG NUMBERS	212-R-0102 / 212-R-0105 / 112-R-0102 112-R-0105 / 112-R-0202 / 112-R-0205
Fluor Control Number (First Issue by Fluor):	69394-00073

FLUOR
TO COMPLETE:

Date Received: Rev.
Authorized by:

- ☐ A – Proceed
- ☐ B – Proceed, change as noted and resubmit
- ☐ C – DO NOT PROCEED, change as noted and resubmit
- ☐ D – Reviewed for Information Only
- ☐ Q – Quality is below standards. Correct and resubmit

Authorization to proceed does not relieve Seller of its responsibility or liability under the Contract

Rev.	Description Descrizione	Prepared Preparato		Reviewed for Approval Controllato per Approvazione	
05	**Revised Sections D5, K7, K8, N**	July 23rd, 2009	~~R. Simonetto~~	July 23rd, 2009	~~N. Maestri~~
04	Revised Sections B4, M2	June 3rd, 2009	R. Simonetto	June 3rd, 2009	N. Maestri
03	Revised as commented by KNPC	December 2nd, 2008	R. Simonetto	December 2nd, 2008	N. Maestri
02	Revised as per PIM's item No. 7 and where indicated 02	October 20th 2008	R. Simonetto	October 20th 2008	N. Maestri
01	Revised Bottom Head Fabrication Sequence (Sections G2 to G5)	July 23rd 2008	R. Simonetto	July 23th 2008	N. Maestri
00	First Issue	April 8th 2008	R. Simonetto	April 9th 2008	N. Maestri

PART 1 FABRICATION NOTES

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PART 1 FABRICATION NOTES

1.0 MAIN TECHNICAL DATA

Position	Material	I.D.(mm)	Thk.(mm)	Remarks
Heads	SA 542M Tp. D Cl. 4A	2322.1 I.R.	144+4.5	W.O. S.S. Tp. 347
Shell Barrels	SA 336M Gr. F22 V	4500	287+4.5	W.O. S.S. Tp. 347
Nozzle Flanges & Blind Flg's	SA 336M Gr. F22 V	see dwg	see dwg	W.O. S.S. Tp. 347
Skirt Top Barrel	SA 387M Gr. 22 Cl. 2	5003	40	
Skirt Bottom Barrels	SA 516M Gr. 485	5003	40	
Spool N20 & Quench Line Flg's	S.S. – see dwg	see dwg	see dwg	
Internals	SS Tp. 347	see dwg	see dwg	

2.0 REFERENCE DOCUMENTS

CODES: - ASME Sect. VIII Div. 2 2004 Ed. + 2006 Addenda & Code Case 2235 (UT in lieu of RT)
- ASME B31.3 for the spools
- API Recommended Practice 934 2000 Edition

User's Design Specification
Project Spec. P6000CFP.000.10.23.001, including documents in it referred

main **BELLELI** spec's:		
	Radiographic examination	SI 1190-01-001
	Ultrasonic examination (welds & weldoverlay)	SI 1190-01-002
	Magnetic Particle examination	SI 1190-01-003
	Liquid Penetrant examination	SI 1190-01-004
	Positive Material Identification	SI 1190-01-005
	Ultrasonic examination (mechanized)	SI 1190-01-006
	Ultrasonic examination of S.S. welds	SI 1190-01-007
	Postweld Heat Treatment (incl. ISR/DHT data)	SF 1190-01-001
	Hydrotest	SP 1190-01-001
	Welding Book & Welders' list	SS 1190-01-001

3.0 METHOD OF MARKING

It shall be performed by:
a) low-stress stamps, for **low alloy steel** materials;
b) paint or ink, free of chlorides, for **stainless steel** remaining components.

4.0 NONDESTRUCTIVE EXAMINATIONS

4.1 Extent
All NDE listed in the following sheets shall be on 100% basis, except as indicated here below;
- **Mechanized UT**: the examination shall be performed in lieu of RT, as allowed by ASME Code Case 2235, and the extent shall be as follows:
  - 100% shell circumferential welds;
  - 100% heads meridian welds;
  - 100% nozzle to shell buttwelds;
  - skirt to Reactor weld.

  The NDE shall be performed at least 24 hours after any intermediate or final heat treatment.
- **UT** of weld overlay: spot check before & after PWHT, on four strips approximately 75mm wide along the full length of Reactor, plus one strip across each head.

PART 1 FABRICATION NOTES

-2- Corrosion Test Blocks
Criteria to be followed shall be in accordance with P6000CFP.000.10.23.001 para. 9.1(J) requirements.

-3- UT Calibration Test Blocks
To be in accordance with specification P6000CFP.000.10.23.001 para. 10.3.B.7.
This is applicable either for conventional and mechanized methods.

9.0 HARDNESS TEST

Hardness test to be performed on 100% of pressure retaining ferritic welds and skirt to Reactor weld, including adjacent base metal, by a portable equipment type EQUOTIP (or equivalent).
Extent:
Weld metal: 1 set (average of three measurements) for each 3 meters of finished weld (1 test min.).
H.A.Z.: 1 set on each side of the weld;
Base Metal: 1 set on each side of the weld;
Acceptance: the max. value allowed is 235 HB (247 HV).

10.0 DIMENSIONAL TOLERANCES

To be in accordance with the following:
- **BELLELI** Drawings
- ASME Code
- Purchaser spec. P6000CFP.000.10.23.001 Attachment 02.

11.0 INSPECTION POINTS & INSPECTION AUTHORITIES LEGENDA (see Part 2)

Inspection Points

I	INSPECT
R	REVIEW (physical examination of documents)
V	VERIFY (verify that procedure has been authorized for use and verify the implementation)
W	WITNESS (activity to be notified – proceed if not available)
H	HOLD POINT (activity is not to proceed until inspected)

Action Type

b	FIRST ARTICLE ONLY – RANDOM THEREAFTER (criteria applied to each complete Reactor)
c1	RANDOM INSPECTION (ENGINEERED EQUIPMENT)
c2	RANDOM INSPECTION (NON ENGINEERED EQUIPMENT)
f	100% EXAMINATION

Inspection Authorities

- BELL	**BELLELI**
- KNPC/PMC	Purchaser (Kuwait National Petroleum Company)
- FLUOR/EPC	Contractor
- A.I.A.	**ASME** AUTHORIZED INSPECTION

EXTERRAN Belleli Energy CPE S.p.A. Critical Process Equipment	INSPECTION PLAN	**BELLELI** Doc. No. **PC 1190-01-001**
		SHEET **13** of **29** | Rev. **05**

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
D3	10	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
D3	11	FIT-UP & WELDING OF INTERNAL PIPES TO FLANGE [W32]	SS-1190-01-001	H			I (c1)	No
D3	12	MT OF MACHINED WELD	SI-1190-01-003	H	I (c1)		R	Yes
D3	13	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
D3	14	COMPLETION OF FLANGE / INTERNAL PIPE WELD OVERLAY	SS-1190-01-001	H			I (c1)	No
D3	15	VISUAL & PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)		R	Yes
D3	16	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY	Note 6.2	H	W (f)		R	Yes
D3	17	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
D3	18	PWHT OF ASSEMBLED FLANGE	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
D3	19	VISUAL & PT OF WELD OVERLAY (**BELLELI** OWN INSPECTION)	SI-1190-01-004	H	= ===== = =====	= ===== = =====	= ===== = =====	No
D3	20	VISUAL / DIMENSIONAL OF FINISHED FLANGE, INCLUDING INSPECTION OF SEALING SURFACE	DA-1190-01-011	H	H /I/(f)		R	Yes

SECTION D4: FABRICATION: TOP SPOOL N20

D4	1	BEVELING OF LOOSE PIECES	/	H			I (c1)	No
D4	2	VISUAL & PT OF BEVELS	SI-1190-01-004	H	I (c1)		R	Yes
D4	3	FIT-UP OF N20 SPOOL PIECES [W35-36]	SS-1190-01-001	H			I (c1)	No
D4	4	FIT-UP OF SPOOL TO FLANGE M9 [W34]	SS-1190-01-001	H			I (c1)	No
D4	5	CIRCUMFERENTIAL WELDINGS	SS-1190-01-001	H	V (c1)		I (c1)	No
D4	6	VISUAL & PT OF WELDS	SI-1190-01-004	H	I (c1)		R	Yes
D4	7	RT OF SPOOL WELDS	SI-1190-01-001	H	R (f)		R	Yes
D4	8	PMI OF SPOOL WELDS	Note 6.1	H	W (f)		R	Yes
D4	9	WELDING OF LUG TO SPOOL	SS-1190-01-001	H			I (c1)	No
D4	10	VISUAL & PT OF LUG TO TOP SPOOL	SI-1190-01-004	H	I (c1)		R	Yes
D4	11	VISUAL / DIMENSIONAL OF FINISHED SPOOL	DRAWING	H	H /I/R(f)		R	Yes

SECTION D5: FABRICATION: BOTTOM SPOOL N1

D5	1	WELD OVERLAY OF ELBOW & FLANGE	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	2	VISUAL & PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)		R	Yes
D5	3	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY	Note 6.2	H	W (f)		R	Yes
D5	4	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
D5	5	BEVELING OF LOOSE PIECES	/	H			I (c1)	No
D5	6	VISUAL & MT OF BEVELS	SI-1190-01-003	H	I (c1)		R	Yes

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
D5	7	FIT-UP OF ELBOW TO HORIZONTAL PIPE [W43]	SS-1190-01-001	H			I (c1)	No
D5	8	CIRCUMFERENTIAL WELDING	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	9	VISUAL & MT OF WELD	SI-1190-01-003	H	I (c1)		R	Yes
D5	10	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
D5	11	WELD OVERLAY OF PIPE	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	12	VISUAL & PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)		R	Yes
D5	13	FIT-UP OF FLANGE TO PIPE [W44]	SS-1190-01-001	H			I (c1)	No
D5	14	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	15	VISUAL & MT OF WELD	SI-1190-01-003	H	I (c1)		R	Yes
D5	16	WELD OVERLAY RESTORING	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	17	VISUAL & PT OF W.O RESTORING	SI-1190-01-004	H	W (b)		R	Yes
D5	18	CHEMICAL ANALYSIS (PMI) OF W.O RESTORING	Note 6.2	H	W (f)		R	Yes
D5	19	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
D5	20	FIT-UP OF ELBOW TO VERTICAL PIPE [W42]	SS-1190-01-001	H			I (c1)	No
D5	21	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	22	VISUAL & MT OF WELD	SI-1190-01-003	H	I (c1)		R	Yes
D5	23	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
D5	24	WELD OVERLAY OF PIPE	SS-1190-01-001	H	V (c1)		I (c1)	No
D5	25	VISUAL & PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)		R	Yes
D5	26	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY	Note 6.2	H	W (f)		R	Yes
D5	27	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
D5	28	RT OF BUTTWELDS	SI-1190-01-001	H	R (f)		R	Yes
D5	29	WELDING OF ATTACHMENTS TO SPOOL	SS-1190-01-001	H			I (c1)	No
D5	30	VISUAL & MT (or PT) OF ATTACHMENTS TO SPOOL	SI-1190-01-003 / 004	H	I (c1)		R	Yes
D5	31	PWHT OF SPOOL N1	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
D5	32	MANUAL UT OF WELDS	SI-1190-01-002	H	W /R(b)		R	Yes
D5	33	HARDNESS TEST OF WELDS	Note 9.0	H	W /R(b)		R	Yes
D5	34	VISUAL & PT OF WELD OVERLAYS (**BELLELI** OWN INSPECTION)	SI-1190-01-004	H	= ===== = ===== = =====			No

SECTION D6: FABRICATION: N2 NOZZLE PIPE

D6	1	WELD OVERLAY OF FLANGE	SS-1190-01-001	H	V (c1)		I (c1)	No
D6	2	VISUAL & PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)		R	Yes
D6	3	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY	Note 6.2	H	W (f)		R	Yes

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
J3	5	MECHANIZED UT (TOFD) OF CIRCUMFERENTIAL WELD	SI-1190-01-006	H	W (b)		R	Yes
J3	6	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
J3	7	WELD OVERLAY RESTORING	SS-1190-01-001	H	V (c1)		I (c1)	No
J3	8	PT OF WELD OVERLAY RESTORING	SI-1190-01-004	H	W (b)		R	Yes
J3	9	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY RESTORING	Note 6.2	H	W (f)		R	Yes
J3	10	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
J3	11	SPOT UT OF WELD OVERLAID SECTION	SI-1190-01-002 + Note 4.1	H	W /R(b)		R	Yes
J3	12	FIT-UP & WELDING OF EXTERNAL ATTACHMENTS	SS-1190-01-001	H			I (c1)	No
J3	13	VISUAL AND MT (PT for S.S.) OF ATTACHMENTS WELDS, including AREAS FOR TEMPORARY ATTACHMENTS	SI-1190-01-003 / 004	H	I (c1)		R	Yes
J3	14	FINAL PWHT OF MIDDLE SHELL SECTION	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
J3	15	MT 100% PRESSURE AND ATTACHMENT WELDS (**BELLELI** OWN INSPECTION)	SI-1190-01-003	H	= ===== = =====	= ===== = =====	= ===== = =====	No
J3	16	MECHANIZED UT (ISONIC & TOFD) OF PRESSURE BUTTWELDS	SI-1190-01-006	H	W /R(b)		R	Yes
J3	17	HARDNESS TEST OF PRESSURE WELDS	Note 9.0	H	W /R(b)		R	Yes
J3	18	PT OF WELD OVERLAY & RESTORINGS NOT EXAMINABLE AFTER HYDROTEST	SI-1190-01-004 + Note 4.1	H	W /R(b)		R	Yes
J3	19	PT OF REMAINING WELD OVERLAY & RESTORINGS (**BELLELI** OWN INSPECTION)	SI-1190-01-004 + Note 4.1	H	= ===== = =====	= ===== = =====	= ===== = =====	No
J3	20	SPOT UT OF WELD OVERLAY	SI-1190-01-002 + Note 4.1	H	W /R(b)		R	Yes
J3	21	FIT-UP & WELDING OF INTERNAL SKIRT AND INTERNAL ATTACHMENTS	SS-1190-01-001	H			I (c1)	No
J3	22	VISUAL AND PT OF WELDS	SI-1190-01-004	H	I (c1)		R	Yes
J3	23	THERMOWELLS BOSSES TO RELEVANT BUTTERING FIT-UP AND WELDING	SS-1190-01-001	H	V (c1)		I (c1)	No
J3	24	VISUAL AND PT OF WELDS, EACH PASS	SI-1190-01-004	H	I (c1)		R	Yes
J3	25	WELD OVERLAY COMPLETION AFTER PWHT (RING JOINT & N6 NOZZLE)	SS-1190-01-001	H	V (c1)		I (c1)	No
J3	26	PT OF WELD OVERLAYS	SI-1190-01-004	H	W /R(b)		R	Yes

SECTION K1: BOTTOM SECTION ASSEMBLING: W15 (barrel I to barrel II)

K1	1	BARREL I TO BARREL II CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
K1	2	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	I (c1)		R	Yes
K1	3	VISUAL & MT OF BACK-GOUGED SURFACE	SI-1190-01-003	H	I (c1)		R	Yes
K1	4	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
K1	5	MECHANIZED UT (TOFD) OF CIRCUMFERENTIAL WELD	SI-1190-01-006	H	W (b)		R	Yes
K1	6	PMI OF WELD	Note 6.1	H	W (f)		R	Yes

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
SECTION K5: BOTTOM SECTION ASSEMBLING: W17 (skirt barrel IV to shell barrel I)								
K5	1	SKIRT BARREL IV TO SHELL BARREL I CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
K5	2	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes
K5	3	VISUAL & MT OF BACK-GOUGED SURFACE	SI-1190-01-003	H	I (c1)		R	Yes
K5	4	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
K5	5	RT OF BUTTWELD (as alternate to following step K5-6)	SI-1190-01-001	H	R (f)		R	Yes
K5	6	MECHANIZED UT (TOFD) OF BUTTWELD (as alternate to above step K5-5)	SI-1190-01-006	H	W (b)		R	Yes
K5	7	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
K5	8	FIT-UP & WELDING OF EXTERNAL / INTERNAL ATTACHMENTS	SS-1190-01-001	H	V (c1)		I (c1)	No
K5	9	VISUAL AND MT (PT for S.S.) OF ATTACHMENTS WELDS, including AREAS FOR TEMPORARY ATTACHMENTS	SI-1190-01-003 / 004	H	I (c1)		R	Yes
SECTION K6: BOTTOM SECTION ASSEMBLING: W18 (skirt barrel III to skirt barrel IV)								
K6	1	SKIRT BARREL III TO SKIRT BARREL IV CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
K6	2	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes
K6	3	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
△05 SECTION K7: BOTTOM SECTION ASSEMBLING: W41 (spool N1 to block forging)								
K7	1	SPOT UT OF WELD OVERLAID SECTION	SI-1190-01-002 + Note 4.1	H	W /R(b)		R	Yes
K7	2	FIT-UP & WELDING OF EXTERNAL ATTACHMENTS TO SHELL	SS-1190-01-001	H			I (c1)	No
K7	3	VISUAL AND MT (PT for S.S.) OF ATTACHMENTS WELDS, including AREAS FOR TEMPORARY ATTACHMENTS	SI-1190-01-003 / 004	H	I (c1)		R	Yes
K7	4	FINAL PWHT OF BOTTOM SHELL SECTION	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
K7	5	MT 100% PRESSURE AND ATTACHMENT WELDS (**BELLELI** OWN INSPECTION)	SI-1190-01-003	H	= ===== = ===== = ===== = ===== = ===== = =====			No
K7	6	MANUAL UT OF PIPE BUTTWELDS & SKIRT TO REACTOR WELD	SI-1190-01-002	H	W /R(b)		R	Yes
K7	7	MECHANIZED UT (ISONIC & TOFD) OF REMAINING PRESSURE BUTTWELDS	SI-1190-01-006	H	W /R(b)		R	Yes
K7	8	HARDNESS TEST OF PRESSURE WELDS	Note 9.0	H	W /R(b)		R	Yes
K7	9	FIT-UP AND WELDING OF INTERNAL ATTACHMENTS	SS-1190-01-001	H	V (c1)		I (c1)	No
K7	10	PT OF WELD OVERLAY & RESTORINGS NOT EXAMINABLE AFTER HYDROTEST	SI-1190-01-004 + Note 4.1	H	W /R(b)		R	Yes
K7	11	PT OF REMAINING WELD OVERLAY & RESTORINGS (**BELLELI** OWN INSPECTION)	SI-1190-01-004 + Note 4.1	H	= ===== = ===== = ===== = ===== = ===== = =====			No
K7	12	SPOT UT OF WELD OVERLAY	SI-1190-01-002 + Note 4.1	H	W /R(b)		R	Yes
K7	13	SPOOL N1 TO BLOCK FORGING CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
K7	14	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
K7	15	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
K7	16	RT OF CIRCUMFERENTIAL WELD	SI-1190-01-001	H	W (b)		R	Yes
K7	17	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
K7	18	WELD OVERLAY RESTORING	SS-1190-01-001	H	V (c1)		I (c1)	No
K7	19	PT OF WELD OVERLAY RESTORING	SI-1190-01-004	H	W (b)		R	Yes
K7	20	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY RESTORING	Note 6.2	H	W (f)		R	Yes
K7	21	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
K7	22	LOCALIZED PWHT OF SPOOL N1 TO BLOCK FORGING [W41]	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
K7	23	MANUAL UT OF WELD	SI-1190-01-002	H	W /R(b)		R	Yes
K7	24	HARDNESS TEST OF WELD	Note 9.0	H	W /R(b)		R	Yes
K7	25	PT OF W.O. RESTORING (**BELLELI** OWN INSPECTION)	SI-1190-01-004	H	= ===== = =====	= ===== = =====	= ===== = =====	No

05 SECTION K8: BOTTOM SECTION ASSEMBLING: W19 (skirt barrel II to III) [moved into Section N]

~~K8~~	~~1~~	~~SKIRT BARREL II TO SKIRT BARREL III CIRCUMFERENTIAL FIT-UP~~	~~SS-1190-01-001~~	~~H~~	~~V (c1)~~		~~I (c1)~~	~~No~~
~~K8~~	~~2~~	~~CIRCUMFERENTIAL WELDING / DHT~~	~~SS-1190-01-001~~	~~H~~	~~V (c1)~~		~~R~~	~~Yes~~
~~K8~~	~~3~~	~~VISUAL & MT OF CIRCUMFERENTIAL WELD~~	~~SI-1190-01-003~~	~~H~~	~~I (c1)~~		~~R~~	~~Yes~~
~~K8~~	~~4~~	~~LOCALIZED PWHT OF FINAL SKIRT WELD W19~~	~~SF-1190-01-001~~	~~H~~	~~H /I/R(f)~~		~~R~~	~~Yes (chart)~~
~~K8~~	~~5~~	~~VISUAL & MT OF CIRCUMFERENTIAL WELD~~	~~SI-1190-01-003~~	~~H~~	~~I (c1)~~		~~R~~	~~Yes~~

SECTION K9: BOTTOM SECTION COMPLETION

K9	1	WELD OVERLAY COMPLETION AFTER PWHT (RING JOINT)	SS-1190-01-001	H	V (c1)		I (c1)	No
K9	2	PT OF WELD OVERLAYS	SI-1190-01-004	H	W /R(b)		R	Yes
K9	3	**THERMOWELLS BOSSES** TO RELEVANT BUTTERING FIT-UP AND WELDING	SS-1190-01-001	H	V (c1)		I (c1)	No
K9	4	VISUAL AND PT OF WELDS, EACH PASS	SI-1190-01-004	H	I (c1)		R	Yes

SECTION L1: SHELL ASSEMBLING: W12 (barrel IV to barrel V)

L1	1	BARREL **IV** TO BARREL V CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
L1	2	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	I (c1)		R	Yes
L1	3	VISUAL & MT OF BACK-GOUGED SURFACE	SI-1190-01-003	H	I (c1)		R	Yes
L1	4	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
L1	5	MECHANIZED UT (TOFD) OF CIRCUMFERENTIAL WELD	SI-1190-01-006	H	W (b)		R	Yes
L1	6	PMI OF WELD	Note 6.1	H	W (f)		R	Yes

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
L1	7	WELD OVERLAY RESTORING	SS-1190-01-001	H	V (c1)		I (c1)	No
L1	8	PT OF WELD OVERLAY RESTORING	SI-1190-01-004	H	W (b)		R	Yes
L1	9	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY RESTORING	Note 6.2	H	W (f)		R	Yes
L1	10	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
L1	11	LOCALIZED PWHT OF SHELL CIRCUMFERENTIAL WELD W12	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
L1	12	MT OF WELD (**BELLELI** OWN INSPECTION)	SI-1190-01-003	H	= =	= =	= =	No
L1	13	MECHANIZED UT (TOFD) OF WELD	SI-1190-01-006	H	W /R(b)		R	Yes
L1	14	HARDNESS TEST OF WELD	Note 9.0	H	W /R(b)		R	Yes
L1	15	PT OF WELD OVERLAY RESTORING (**BELLELI** OWN INSPECTION)	SI-1190-01-004	H	= =	= =	= =	No

SECTION L2: SHELL ASSEMBLING: W8 (barrel VIII to barrel IX)

L2	1	BARREL VIII TO BARREL IX CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
L2	2	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	I (c1)		R	Yes
L2	3	VISUAL & MT OF BACK-GOUGED SURFACE	SI-1190-01-003	H	I (c1)		R	Yes
L2	4	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
L2	5	MECHANIZED UT (TOFD) OF CIRCUMFERENTIAL WELD	SI-1190-01-006	H	W (b)		R	Yes
L2	6	PMI OF WELD	Note 6.1	H	W (f)		R	Yes
L2	7	WELD OVERLAY RESTORING	SS-1190-01-001	H	V (c1)		I (c1)	No
L2	8	PT OF WELD OVERLAY RESTORING	SI-1190-01-004	H	W (b)		R	Yes
L2	9	CHEMICAL ANALYSIS (PMI) OF WELD OVERLAY RESTORING	Note 6.2	H	W (f)		R	Yes
L2	10	FERRITE CONTENT DETERMINATION	Note 7.0	H	W (b)		R	Yes
L2	11	FINAL VISUAL AND DIMENSIONAL CHECK OF COMPLETE REACTOR	Note 10.0	H	H /I(f)		H (f)	Yes
L2	12	LOCALIZED PWHT OF SHELL CIRCUMFERENTIAL WELD W8	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
L2	13	MT OF WELD (**BELLELI** OWN INSPECTION)	SI-1190-01-003	H	= =	= =	= =	No
L2	14	MECHANIZED UT (TOFD) OF WELD	SI-1190-01-006	H	W /R(b)		R	Yes
L2	15	HARDNESS TEST OF WELD	Note 9.0	H	W /R(b)		R	Yes
L2	16	PT OF WELD OVERLAY RESTORING (**BELLELI** OWN INSPECTION)	SI-1190-01-004	H	= =	= =	= =	No

SECTION M1: PRODUCTION TEST COUPON(S)

M1	1	FIT-UP & WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes
M1	2	UT or RT OF WELD(S)	SI-1190-01-002 / 001	H	R		R	Yes
M1	3	SIMULATED MINIMUM & MAXIMUM PWHT	SF-1190-01-001	H	V (c1)		R	Yes

EXTERRAN
Belleli Energy CPE S.p.A.
Critical Process Equipment

INSPECTION PLAN

BELLELI Doc. No. **PC 1190-01-001**

SHEET **29** of **29** | Rev. **05**

PART 2 FABRICATION STEPS

STEP		OPERATION	REFERENCE	INSPECTIONS Points, Signature & Date BELL	KNPC PMC	FLUOR EPC	A.I.A.	REPORT
M1	4	TRACING AND MARKING OF SPECIMENS		H	W (b)		I (c1)	No
M1	5	TECHNOLOGICAL TESTS (Charpy-Vee) AFTER BOTH PWHT TYPES	Note 8.0	H	W (c1)		W (f)	Yes
SECTION M2: TEST BLOCKS								
M2	1	FIT-UP & WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes
M2	2	UT or RT OF WELD(S)	SI-1190-01-002 / 001	H	R		R	Yes
M2	3	WELD OVERLAY OF PIECES	SS-1190-01-001 + Note 8.0	H	V (c1)			No
M2	4	PT OF WELD OVERLAY	SI-1190-01-004	H	W (b)			Yes
M2	5	UT OF WELD OVERLAY	SI-1190-01-002	H	W (b)			Yes
M2	6	SIMULATED MINIMUM PWHT OF BLOCKS	SF-1190-01-001	H	V (c1)		R	Yes
M2	7	INSERTION INTO REACTOR		H				No
SECTION N: FINAL OPERATIONS AND TESTS								
N	1	ASSEMBLING TOP SPOOL N20 TO REACTOR	DO-1190-01-001	H	I (f)			Yes
N	2	HYDROTEST OF REACTOR	SP-1190-01-001	H	H /R(f)		H (f)	Yes
N	3	MT (PT for S.S.) 100% PRESSURE AND ATTACHMENT WELDS, including AREAS FOR TEMPORARY ATTACHMENTS	SI-1190-01-003 / 004	H	H /R(f)		R	Yes
N	4	PT OF WELD OVERLAY & RESTORING	SI-1190-01-004 + Note 4.1	H	W /R(b)		R	Yes
05 N	5	SKIRT BARREL II TO SKIRT BARREL III CIRCUMFERENTIAL FIT-UP	SS-1190-01-001	H	V (c1)		I (c1)	No
N	6	CIRCUMFERENTIAL WELDING / DHT	SS-1190-01-001	H	V (c1)		R	Yes
N	7	VISUAL & MT OF CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
N	8	LOCALIZED PWHT OF FINAL SKIRT WELD W19	SF-1190-01-001	H	H /I/R(f)		R	Yes (chart)
05 N	9	VISUAL & MT OF SKIRT CIRCUMFERENTIAL WELD	SI-1190-01-003	H	I (c1)		R	Yes
N	10	FINAL VISUAL AND DIMENSIONAL CHECK OF COMPLETE REACTOR, including TRIAL ASSEMBLY OF TAILING FRAME (except last Reactor of the project, where the same will be left assembled)	Note 10.0	H	H /I(f)		H (f)	Yes
N	11	TRIAL ASSEMBLY OF (ONLY) INLET DEFLECTION BASKET	e-mails dated 09-12-2008	H				No
N	12	SANDBLASTING AND PAINTING	DO-1190-01-001 & separate ITP	H	I (c1)			Yes
N	13	NAME PLATE STAMPING & VERIFICATION, INCLUDING REVIEW & ENDORSMENT OF ASME A-1 Form		H	I (f)		H (f)	Yes
N	14	NITROGEN CONDITIONING VERIFICATION	DO-1190-01-001	H	I (f)			Yes
N	15	PACKING / PREPARATION FOR SHIPMENT	DO-1190-01-001	H	I (f)			Yes
N	16	FINAL DOCUMENTATION REVIEW / MDR		H	H /R(f)		H (f)	Yes

PRELIMINARY BAR CHART SCHEDULE

BELLELI ENERGY CPE SRL

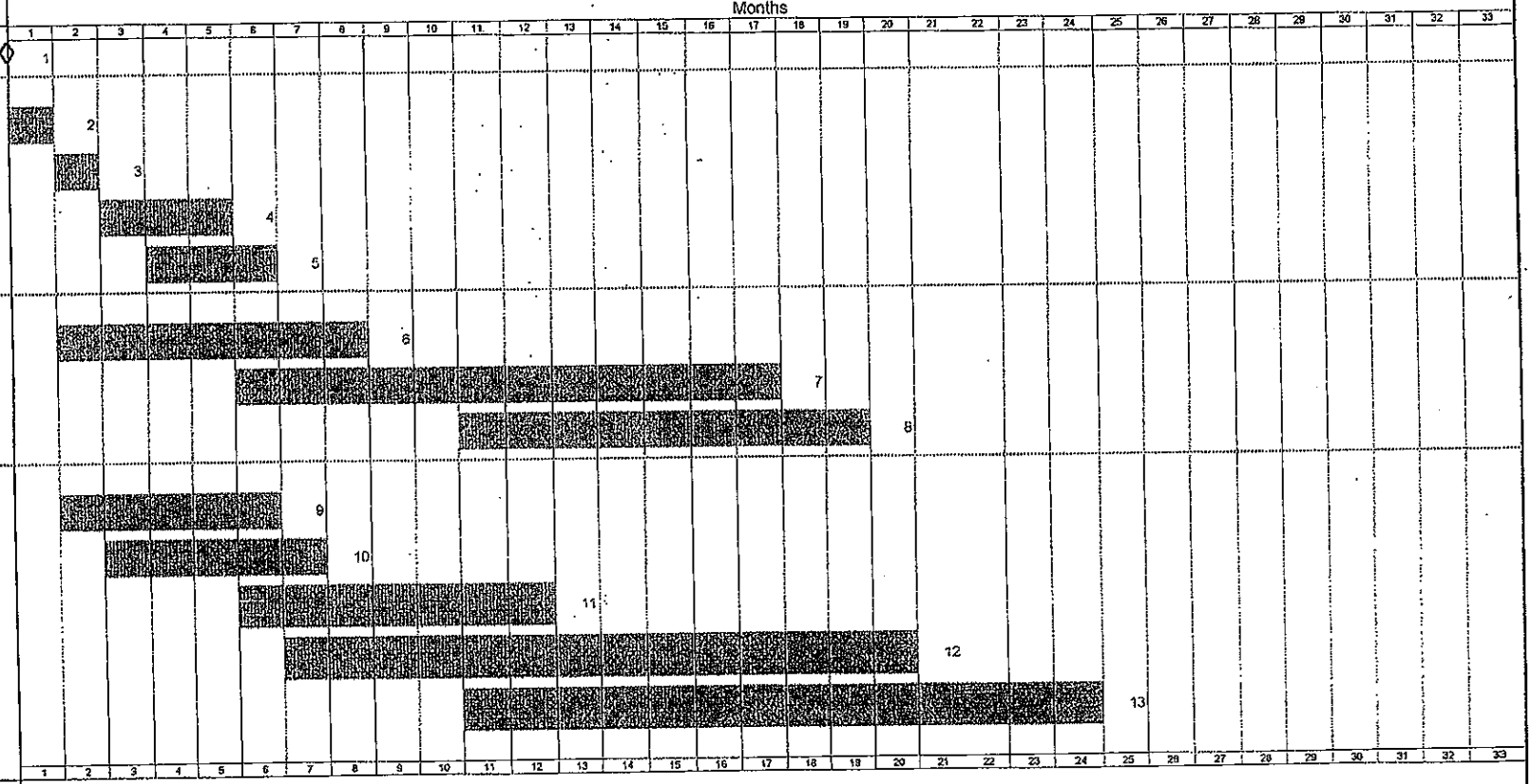
CLIENT: CPC

SUBJECT: No 10 REACTORS and No. 2 SEPARATORS

BELLELI ENERGY S.r.l. Ref.no.: 09205

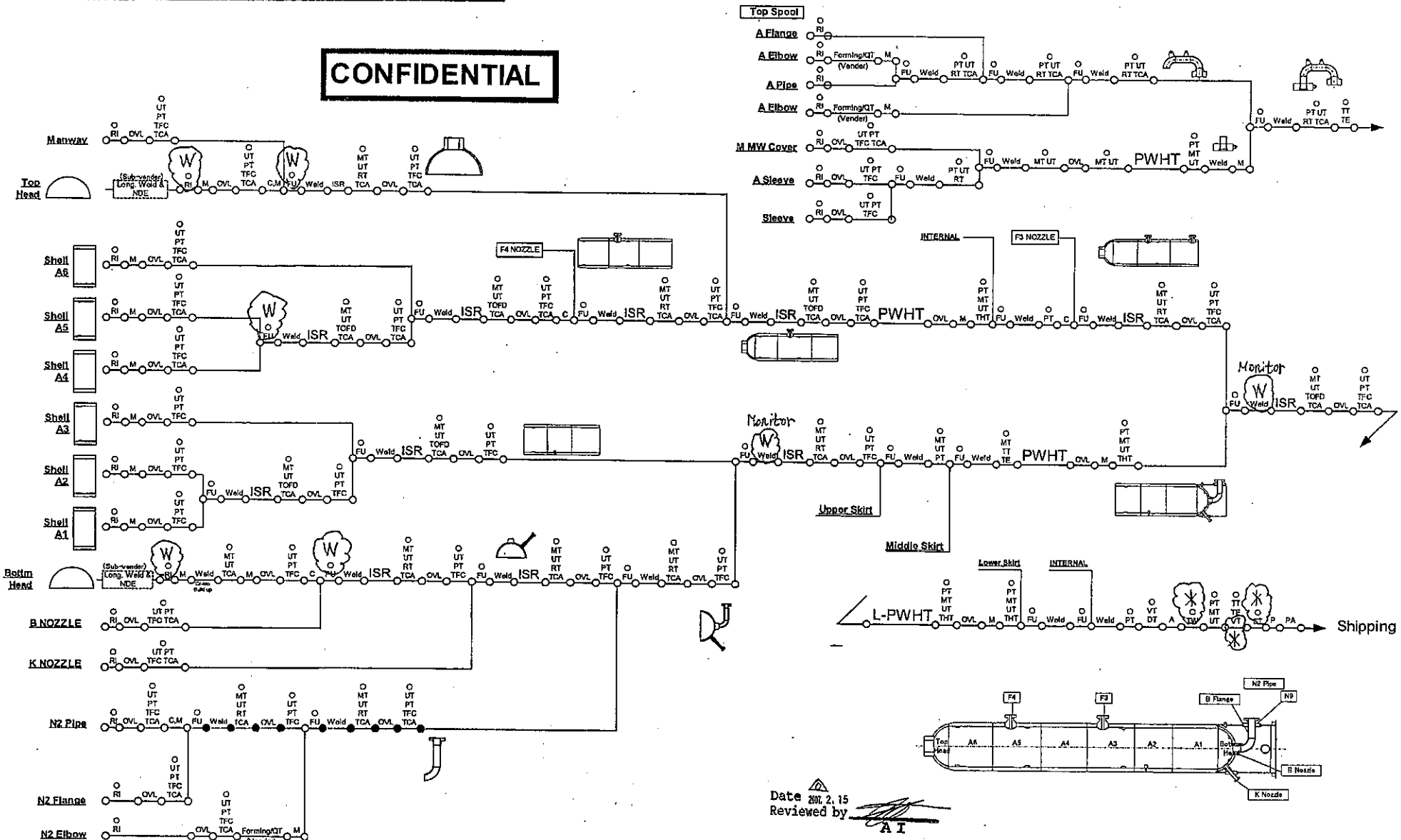
LOCATION: TAOYOUAN REFINERY TAIWAN

Ser.No.	Description
1	Contract Award
	ENGINEERING
2	Design Calculations
3	Assembly Drawings
4	Detail Drawings
5	Customer Approval for above
	PROCUREMENT OF MATERIALS
6	Issue of Material Sub-Orders
7	Main Materials Delivery
8	Balance Materials Delivery
	SHOP FABRICATION
9	Issue of W.P.S.
10	Customer Approval for above
11	Reactor fabrication & preparat. for shipment FCA Mantova (Italy) works nr. 2 separators
12	Reactor fabrication & preparat. for shipment FCA Mantova (Italy) works nr. 5 reactors
13	Reactor fabrication & preparat. for shipment FCA Mantova (Italy) works nr. 5 reactors



Fabrication Sequence of 3102-R-001 Reactor

CONFIDENTIAL



A:	Assembly	P:	Painting	TE	Appearance Check
C:	Cutting	PA:	Packing	TFC:	Ferrite Check
D:	Layout Marking	PT:	Liquid Penetrant Exam.	THT:	Hardness Test
FU:	Futting Up (Inspection)	PWHT:	Post Weld Heat Treatment	TOFD:	Ultrasonic Exam. (TOFD technique)
ISR:	Intermediate Heat Treatment	RI:	Receiving Inspection	TT:	Dimensional Inspection
M:	Machining	RT:	Radiographic Exam.	TW:	Hydrostatic Test
MT:	Magnetic Particle Exam.	TA:	Pneumatic Test	UT:	Ultrasonic Exam.
		ST:	Stamping	O:	Inspection point