行政院及所屬各機關出國報告審核表

出國報告名稱：第 3 期煤輪建造計畫主機性能測試		
出國人姓名	職稱	服務單位
陳承明	船舶建造計畫主管(企劃)	台灣電力公司

出國計畫 主辦機關 審核意見	☑1.依限繳交出國報告 ☑2.格式完整 ☑3.內容充實完備 ☐4.建議具參考價值 ☐5.送本機關參考或研辦 ☐6.送上級機關參考 ☐7.退回補正，原因： ☐不符原核定出國計畫 ☐以外文撰寫或僅以所蒐集外文資料為內容 ☐內容空洞簡略 ☐未依行政院所屬各機關出國報告規格辦理 ☐位於資訊網登錄提要資料及傳送出國報告電子檔 ☐8.其他處理意見：
層轉機關 審核意見	☐同意主辦機關審核意見 ☐全部 ☐部份 (填寫審核意見編號) ☐退回補正，原因： (填寫審核意見編號) ☐其他處理意見：

說明：

一、出國計畫主辦機關即層轉機關時，不需填寫「層轉機關審核意見」。

二、各機關可依需要自行增列審核項目內容，出國報告審核完畢本表請自行保存。

三、審核作業應於出國報告提交後兩個月內完成。

報告人 ：　　單位主管　　總經理　　副總經理

行政院及所屬各機關出國報告提要		
出國報告名稱：第 3 期煤輪建造計畫**主機性能測試**		
		頁數 82 含附件■是□否
出國計劃主辦機關/聯絡人/電話 台灣電力公司		
出國人員姓名/服務機關/單位/職稱/電話 陳承明/台灣電力公司/燃料處船舶建造計畫主管(企劃)/23668545		
出國類別：□1 考察□2 進修□3 研究□4 實習■5 其他		
出國期間： 100.03.28--100.04.01	出國地區： 韓國蔚山、釜山	
報告日期： 100.5.24		
分類號/目		
關鍵詞：現代重工，性能測試，廠試報告		

內容摘要：(二百至三百字)

一、本公司為了提升燃煤自運率，第 2/3 期煤輪建造計畫共計建造 4 艘 9.3 萬噸級煤輪，已於 98 年 7 月 17 日與台船公司簽訂建造契約，第 4 艘定名為電昌八號(台船編號：CSBC986)，其主機型號為 WARTSILA 6RT-flex 58T-D NoTier II，係最新型之電子式點火系統，其優點為重量較輕、省油、省啟動空氣量，最大連續出力(Maximum Continuous Rating, MCR)為 11290 千瓦，98.8 轉，正常運轉出力(Normal Operation Rating, NOR)則為 9597 千瓦，93.6 轉。

二、主機 6RT-flex 58T -D 為煤輪最重要的裝備之一，其為煤輪推進動力源，故品質及性能對煤輪未來營運至為重要，有必要於性能測試期間派員瞭解並見證，電昌八號(台船編號：CSBC986)之主機係由韓國蔚山 HHI(現代重工)公司生產製造，於 100 年 3 月 30~31 日兩天參與該主機出廠前性能測試。

三、電昌七號(CSBC985)主機更新活塞壓縮桿墊片規格後，已正式作廠試並確認符合 Tier II 氮氧化物排放，可發給引擎國際空污防治證書，因此，認定電昌七號主機為原型母機（Parent engine ），其餘主機認定為系列子機（family engines），本電昌八號主機規格與測試符合標準之電昌七號(CSBC985)主機相同，使用更新為 36mm 厚度之活塞壓縮桿墊片規格。

四、本電昌八號主機使用新壓縮桿墊片規格，已正式作廠試並確認符合標準，可發給引擎國際空污防治證書(Engine International Air Polution Prevention Certificate, EIAPP)。

五、本次參與現代重工主機廠出廠前測試，有中國驗船中心（CR）、法國驗船協會（BV）、聯合船舶設計中心(USDDC)、台船公司(CSBC)等單位人員，測試項目及結果（如附件 1&6）摘要如下：

(1)主機之各種負載（25%、50%、75%、85%（NOR）、100%及 110%）運轉性能正常及耗油率符合規範之要求。

(2)拆檢吊缸開放檢查良好。

(3)尺寸及間隙檢查正常。

(4)各種負載測試時無不正常、漏油、異音及高溫等現象。本次在韓國蔚山 HHI 廠測試時，共開出 10 項要求改善事項（如附件 2） 將由 HHI 廠負責改正答覆（如附件 3）。

六、發電機為煤輪最重要的裝備之一，電昌五號及電昌六號之發電機係由韓國蔚山 HHI(現代重工)公司生產製造，發電機型號為 HIMSEN 6H17/28 D/G，每船 3 部，兩船共 6 部發電機，因現代重工公司對外資料及人員嚴密管制，難以參觀其生產過程，惟發電機零配件之供應至為重要，有必要順道擇一日赴韓國發電機零配件廠商瞭解其品管過程等是否符合需求，參訪時，現代重工公司授權之零配件廠商之一 DAEHWA 公司提出其實績證明文件(含維修國輪陽明海運公司之實績)及現代重工公司授權書證明其符合要求。

行政院所屬各機關出國報告
（出國類別：洽公）

第 3 期煤輪建造計畫主機性能測試

服務機關：台灣電力公司
出國人 職 稱：燃料處船舶建造計畫主管企劃
姓 名：陳承明

出國地區：韓國釜山、蔚山

出國期間：100.03.28--100.04.01

報告日期：100.05.24

目錄

一、前言

1. 本公司第 2/3 期煤輪建造計畫辦理恢復及修正預算作業 ，於 98.6.17 陳報經濟部轉陳行政院。行政院 98.7.9 院授主孝二字第 0980004304 號函原則同意恢復辦理及一次發包事宜。本公司於 98.7.14 與台船公司完成採購 4 艘 9.3 萬載重噸煤輪議價作業，並於 98.7.17 完成簽約。

本公司新建 4 艘煤輪，依合約第一艘電昌五號交船日期為今(100)年 4 月 30 日，第二艘電昌六號交船日期為今年 7 月 31 日，第三艘電昌七號交船日期為今年 10 月 15 日，第四艘電昌八號交船日期為今年 12 月 15 日。第一艘電昌五號已於今年 3 月 29 日交船，第二艘電昌六號已於今年 5 月 19 日交船後加入營運，第三艘電昌七號預定於今年 8 月 5 日交船，第四艘電昌八號預定於今年 10 月 14 日交船，均較契約之交船日期提早約 1 至 2 個月。新建之 4 艘煤輪交船，投入營運後，加上第 1 期兩艘超巴拿馬型煤輪載運量約 260 萬公噸（年載量係澳洲與印尼各載半年運量計算），合計每年共可載運約 833 萬公噸，自運率約為 28%，尚有大部分進口燃料煤仍需租船載運。

為 4 艘新建煤輪營運需要，第一艘電昌五號及第三艘電昌七號委託裕民公司代營操作 ，第二艘電昌六號及第四艘電昌八號係委託台航公司代營操作，現有第 1 期兩艘 8.8 萬載重噸煤輪超巴拿馬型煤輪 電昌一號及電昌二號係委託陽明公司代營操作。

2. 本公司第 3 期煤輪建造計畫，新建 3 艘 9.3 萬載重噸級煤輪，其中 定名為電昌八號 （台船編號 ：CSBC986），其主機型號為 WARTSILA 6RT-flex 58T-D Nox Tier II，係最新型之電子式點火系統，其優點為重量較輕、省油、省啟動空氣量，最大連續出力(Maximum Continuous Rating, MCR)為 11290 千瓦，98.8 轉，正常運轉出力(Normal Operation Rating, NOR)為 9597 千瓦，93.6 轉。

3. 主機 6RT-flex 58T-D 為煤輪最重要的裝備之一，其為煤輪推進動力源，故品質及性能對煤輪未來營運至為重要 ，有必要於性

能測試期間派員瞭解並見證，電昌八號(台船編號：CSBC986)之主機係由韓國蔚山 HHI(現代重工)公司生產製造，於 100 年 3 月 30~31 日兩天參與主機出廠前性能測試。

4. 電昌五號及電昌六號(台船編號：CSBC983&CSBC984)於現代重工公司廠試後，Wartsila expert檢閱主機性能資料表發現汽缸壓縮壓力值較正常值低，Wartsila 提出為減少活塞環衝擊波及扭轉振動導致承受額外之機械應力　，應符合 ① Pmax-Pcomp≦45bars ，② 0.90≦(Pmax/Pcomp)≦1.25，因此，提出於氮氧化物及燃油消耗率不變下，增加壓縮壓力之建議，其方式為①增加壓縮桿墊片厚度 5mm，壓縮桿墊片由 31mm 改為 36mm，②排氣閥阻尼墊片增加 1mm。預估在 100%負荷下兩種方式各可分別增加壓縮壓力 5~6bar 及 2bar，電昌七號(CSBC985)主機於變更壓縮桿墊片規格後，已正式作廠試並確認符合 Tier II 氮氧化物排放，可發給引擎國際空污防治證書(Engine International Air Polution Prevention Certificate, EIAPP)，因而認定為電昌七號主機為原型母機（Parent engine），其餘主機認為系列子機（family engines），本電昌八號主機規格與測試符合標準之電昌七號(CSBC985)主機相同，使用更新為 36mm 厚度之活塞壓縮桿墊片規格。

二、出國行程

本次參加廠試會驗及往返行程共計 5 天（03 月 28 日至 04 月 01 日），如下所列：

1. 03 月 28 日　台北 → 釜山　（中華航空 CI 0160 班機
   轉韓航 KE 1115 班機）
2. 03 月 29 日　釜山　參訪 DAEHWA 公司
3. 03 月 30 日　釜山 → 蔚山　電昌八號 主機 SHOP TEST
4. 03 月 31 日　電昌八號　主機開放檢查
5. 04 月 01 日　蔚山 → 台北　（韓航 KE 1610 班機
   轉中華航空 CI 0163 班機）

三、電昌八號主機廠試

台電公司在台船公建造之 4 艘 93,300 載重噸運煤輪之主機均向韓國現代現代重工業公司(HHI，HYUNDAI HEAVY INDUSTRIES CO., LTD)購進，因此船舶建造裝機前需至該集團蔚山市之主機廠辦理廠試事宜。

(一)名稱與數量

1.名稱：主機（Main Diesel Engine）

2.數量：1（Set/Ship）

3.廠牌：Wartsila, Hyundai

4.型號：Wartsila 6RT-flex58T-D

5.規格：

Max. continuous output 11,290 KW * 98.8 rpm

Normal output rating(85%) 9,597 KW * 93.6 rpm

缸徑 580 mm *衝程 2,416 mm * 6 汽缸

6.機號： AA4163

(二)規範要求

1.適用法規：

Specification for 93,300 DWT Bulk Carrier HNo.983~986, Page G1-2

2.1 Rules and Regulations

China Register of Shipping （CR）with the symbols of 100+E, Bulk Carrier, CMS(CAU)+ and

LR： +100A1, Bulk Carrier, BC-B CSR, Shipright(SCM, CM), LI, ESP, GRAB[20], +LMC, UMS.

2.規格與要求：

Specification for 93,300 DWT Bulk Carrier HNo.983~986, Page M1-5

1.3.1 Main Diesel Engine

Type Wartsila 6RT-flex58T-D type Marine Diesel Engine

No. of set	One (1)
Max. continuous output	11,290 KW and shaft speed 98.8 rpm
Normal output(85%)	9,597 KW and shaft speed 93.6 rpm
No. of cylinder	6
Cylinder bore	580 mm
Stroke	2,416 mm
Fuel rate	164.1 g/KW.h plus 5% (172.3) allowance at normal output with lower calorific value of 10,200 kcal/kg at ISO condition.
Direction of rotation	Clockwise looking from aft

Attachment

Governor	Electric	1
Turbo-charger	High efficiency	1 set
Air cooler		1 set
Turning gear	Motor driven type	1 set
Auxiliary blower	Motor driven Centrifugal	2 sets

3.其他要求：

The exhaust gas shall be comply with Nox tier II. Delta tuning to be applied in M/E.

Second order balancer should be provided, if necessary.

(三)供應廠商

1.廠牌：Wartsila

2.供應商：Hyundai

(四)測試時程

1. 30th/Mar./2011 – official shop trial

2. 31th/Mar./2011 - Overhaul Inspection and Final meeting

(五)參與測試單位及人員

(1)HHI

Gyung Won Lee 李慶源 / Quality Management Dep't / Engine and Machinery Division

(2)CSBC Ship Yard

陳添飛 /台船公司 品保處工程師

(3)Taipower

陳承明 / 台電燃料處 船舶建造計畫主管企劃

(4)USDDC

Chao-Jen Hu 胡朝仁 / 聯設中心工程處輪機組組長

(5)Class Society

CR Surveyor Chang, Ming-Hsiung 張明雄 / 中國驗船中心技術處輪機組組長

LR Surveyor 文碩泰 / Senior Surveyor

(六)測試方法與程序

出國前需先研讀相關的採購規範、重要機材廠試查核表、船廠和船東審圖意見，並於測試前先瞭解測試計畫，包括測試項目、方法與程序等（附件 1），相關廠試程序與時程表如下：

1. 測試項目：

(1)安全保護裝置測試（Safety Device Test）

(2)啟動及反轉測試（Starting and reversing test）

(3)轉動機鎖住測試（Turning gear interlock test）

(4)主機控制操作及 WECS-9520 功能測試（Engine control & WECS-9520 function test）

(5) 最低轉速測試（Minimum revolution test）

(6) 負載測試（Load Test）

a. 轉速量測（rpm）

b. 負荷量測（KW）

c. 燃油消耗量測（Fuel oil consumption measurement）

(7) 調速器測試（Governor Test）

(8) 過速停機 (Over speed trip)

2.測試程序：

(1)09:00~11:25 安全保護裝置測試 (Safety Device Test)

(2)11:30~16:00 負載運轉測試 (Load Running Test)

11:30~12:00　25%Load (30 min)

12:00~12:30　50%Load (30 min)

13:20~13:50　75% Load (30 min)

13:50~14:50　85% Load (60 min)

14:50~15:50　100% Load (60 min)

15:50~16:20　110% Load (30 min)

3.測試方法：

(1)安全保護裝置測試(safety device test)：主機安全保護裝置測試依序執行測試項目如下列所示：

a.O.M.D. function test (Governor MK6)採模擬機訊號測試,確認是否停機O.M.D.。

b.主滑油進口低壓停機

主滑油壓力設定min 2.9 bar，確認10sec 內是否停機。

c.排氣閥低壓停機

排氣閥壓力設定min 4.5 bar，確認是否停機。

d.增壓機進口低壓停機

增壓機進口壓力設定min 0.6 bar，確認是否停機。

e.缸套冷卻水進口低壓停機

缸套冷卻水進口壓力設定min 2.5 bar，確認60sec內是否停機。

f.活塞冷卻油失效停機

活塞無冷卻油，確認15sec內是否停機。

g.活塞冷卻油壓差停機

活塞冷卻油壓差超過max 0.4 bar，確認15sec內是否停

機。

h.推力軸承高溫停機

推力軸承高溫 max85℃，確認 60sec 內是否停機。

i.緊急停機

操作緊急停機手把，確認是否停機。

(2)啟動及反轉測試(Starting and reversing test)：在機側確認主機是否啟動（正轉）和反轉。

(3)轉動機鎖住測試（Turning gear interlock test)：在機側確認轉動機操作桿位置在「engaged」主機是否能啟動，在「disengaged」主機是否無法啟動。

(4)無負荷狀態下最低轉速運轉測試（Minimum revolution test)：在無負荷狀態下，逐漸降低主機轉速至最低轉速（約 25rpm）進行 5 分鐘的最低轉速運轉測試，確認最低轉速並觀察主機運轉情形，觀查是否有異常現象。

(5) 負載運轉測試（Load Running Test)：主機啟動進行負載運轉測試，測試運轉階段與時間參閱前項廠試時程之內容，各負載測試情況，各負載測試結果。負載運轉的同時廠方亦配合進行主機燃油消耗量計測及符合主機燃油消耗量計測結果。

(6) 調速器測試（Governor Test)：調速器測試目的在於確定負荷變化情況下主機的反應，測試時，主機以 100% 負荷運轉，將負荷逐漸下降觀測轉速與負荷值的變化。

(7) 過速停機（Over speed trip)：確認主機轉速超過設定值時是否自動停機，設定值 110% at MCR（109 rpm)。

(七)測試結果

1.設備規格： 符合核定之廠家送審圖要求。

由於配合主機原廠對於本系列機型性能提升建議，本次廠試用活塞桿墊片厚度為 36mm。

2.測試記錄：

馬力結果符合規模要求,燃油消耗量測結果值 169.68g/KWh

（規範值：164.1 g/KWh plus 5%， max. 172.3 g/KWh）

3.拆缸檢驗（2011-03-31）：

拆缸檢驗決定第 4 缸，檢驗結果正常，拆檢項目如下；曲軸（Crank shaft）、汽缸套（Cylinder liner）、汽缸蓋（Cylinder cover）、活塞(Piston)、十字頭(Cross head)、過濾器（Strainer）等。

4.廠試檢討及報告

在出發前，須已先準備並研讀相關的採購規範、重要機材廠試查核表、船廠和船東審圖意見。

經過兩天測試與檢驗後，由船廠（台船公司）、本案監造廠商（聯設中心）和本公司共同提出檢驗意見（附件 2），要求主機廠家 HYUNDAI HEAVY INDUSTRY 進行缺失改善，HYUNDAI HEAVY INDUSTRY 針對上述意見提出答覆(附件 3)。其中，於測試當日 12:37 p.m. 50%負載 No.4 及 No.5 兩缸發生 P.C.O. nonflow shutdown 停機情況，HHI 提出答覆確認已處理正常，將待海試時再確認。

廠試測試期間各類負載檢錄資料如附件 4。

HYUNDAI HEAVY INDUSTRY 並提供測試各類油料、各項檢測儀器提供原始資料或校正資料如附件 5。

電昌八號主機廠試報告如附件 6。

四、參訪現代重工公司主機及發電機售後顧客服務部門及發電機零配件供應廠商之一 DAEHWA 公司

發電機為煤輪最重要的裝備之一，電昌五號及電昌六號之發電機係由韓國蔚山 HHI(現代重工)公司生產製造 ，發電機型號為 HIMSEN 6H17/28 D/G，發電量為 560kW，每船 3 部，故每船發電量 1680kW，兩船共 6 部使用 HIMSEN 發電機。，電昌七號及電昌八號之發電機係由日本 YANMAR 公司生產製造，發電機型號為 6EY18ALW D/G，每船 3 部，兩船共 6 部使用 YANMAR 發電機。

電昌五號及電昌六號發電機之機頭為 HIMSEN 6H17/28，屬直列

式 4 衝程燃油直接噴射渦輪進氣增壓柴油引擎，其缸數為 6 汽缸，活塞直徑 170mm，衝程為 280mm，額定輸出 600kw，轉數 900rpm。

電昌七號及電昌八號發電機之機頭為 YANMAR 6EY18ALW，屬直列式 4 衝程燃油直接噴射渦輪進氣增壓柴油引擎，其缸數為 6 汽缸，活塞直徑 180mm，衝程為 280mm，額定輸出 615kw，轉數 900rpm，點火順序為 1-4-2-6-3-5-1。

4 艘船之柴油發電機均為可燃燒雙燃料之柴油引擎，其可燃燒輕柴油(diesel oil)及重油(heavy fuel oil)，於大洋中航行時可燃燒重油以降低營運成本，為有效降低燃油系統如噴油嘴、噴射泵等阻塞，於港口需停機前，可換燃燒輕柴油以保持柴油引擎燃油系統流暢。

發電機之電頭為　日本 TAIYO 公司 製造 ，其額定輸出 為 700kVA(560kw)，電壓 450VAC，電流 898A，3 相，頻率 60Hz， 8 極，轉數 900rpm。

電昌五號及電昌六號發電機 製造廠家現代重工公司對外資料及人員嚴密管制，參加主機之廠試時，廠內僅少數電腦可以使用隨身碟，並要求使用船廠專用相機及專人拍攝，婉拒船東所使用之相機，且限制參與測試人員參與區域，故一般難以了解其生產過程，惟發電機零配件之供應至為重要，本次趁赴韓國辦理「第 3 期煤輪建造計畫主機性能測試」之便，順道安排 1 天參訪現代重工公司 柴油機售後顧客服務部門及其授權之　發電機零配件 公司，瞭解其主機及發電機售後顧客服務組織及相關專責人員並交換名片 ，與本公司 船舶業務有關之部門為　HIMSEN Service Team、Wartsila Service Team 、Parts & Technical Service 以及 Custom Service Planning Team 等，各 Team 之負責人職稱為部長(General Manager)，參訪現代重工公司 柴油機售後顧客服務部門後，續赴韓國現代重工公司授權之發電機零配件廠商瞭解其零配件供應品管過程等是否符合需求。

當日參訪現代重工公司授權之零配件廠商之一 DAEHWA 公司，

除參訪該公司時了解其零配件供應及維護實績外，本國國輪公司陽明海運公司船舶至韓國釜山港亦長期委由 DAEHWA 公司供應零配件及航修，此外，在參訪過程與該公司技術人員切磋及交換意見，包括 DAEHWA 公司提出實績證明文件、在台灣之聯絡人員、建議改善事項…等等。DAEHWA 公司亦提出現代重工公司授權書證明其符合要求。

現代重工公司主機及發電機售後顧客服務部門組織及 DAEHWA 公司授權書如附件 7。

附件 1：測試與檢驗之適用格式以及測試計畫

HYUNDAI HEAVY INDUSTRIES CO., LTD.

	Doc. No.: K630-IR10A-3535	Page No: 1 / 4
SHOP TRIAL PLAN FOR MAIN ENGINE	Engine No.	AA4160/61/62/63
	Engine type	6RT-flex58T-D
	Hull No.	CSBC983/4/5/6
	Owner	TPC CORPORATION
	Class	BV+CR:CSBC983/5 LR+CR:CSBC984/6
	Ship yard	CSBC(Taiwan)

CONTENTS

* This procedure is prepared on the basis of the engine specification and technical data.
(Dwg. No. A24-218427-8.1)

QUALITY MANAGEMENT DEPARTMENT
HHI-EMD

Rev.	Prepared	Checked	Approved	Description
2				
1				
0	Y.S.KIM 2010-08-09		Y. M. KIM 2010-08-09	First issue

1. ENGINE PARTICULARS

Type of Engine		HYUNDAI-Wartsila , electronically controlled two-stroke, single acting, direct reversible, crosshead type diesel engine with constant pressure turbocharging.	
Model		6RT-flex58T-D	
Number of cyl.		6	
Cyl. bore		mm	580
Stroke		mm	2,416
Maximum Continuous Rating (M.C.R)	Output	bhp	-
		kW	11,290
	Rev.	rpm	98.8
	M.E.P	bar	17.9
	Pmax	bar	160
	Speed	m/s	8.00
Continuous Service Rating (C.S.R)	Output	bhp	-
		kW	9,597
	Rev.	rpm	93.6
	M.E.P	bar	16.1
Firing order		Ahead: 1-5-3-4-2-6-1	
Direction of rotation		Ahead: Clockwise, looking from aft	
Turbocharger type		HHI-ABB TPL77B (1 Set)	
Air cooler type		Fin & Tube type (1 Set)	
Governor type		Electronic Digital Governor(WECS-9520)	

* Specification Fuel oil consumption

1) 164.1 g/kWh at 85% CMCR (i.e. 9,597 kW ×93.6 rpm) with tolerance margin of +5%

2) To be converted to ISO condition.

2. DESCRIPTION OF TRIAL

All tests are to be carried out according to the usual practice of maker.

1) Safety device test

Each set value of safety device is to be confirmed by automatic shut down of engine.

2) Starting and reversing test

This test to be carried out at the emergency console.

3) Turning gear interlock test

Move turning device to the position where the interlock system activated, and confirm the engine start failure.

4) Minimum revolution test (abt.5min)

The lowest working speed is confirmed by decreasing engine revolution gradually under water brake coupled condition.

5) Load test

This test is to be performed in order to determine the performance characteristics.

The calculation formula for output is as follow.

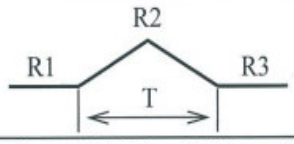
BHP = K * N * W

Where K : Dynamometer (water brake) coefficient, N : Revolution per minute, W : kg on water brake

6) Governor test
When engine is running at 100% full load, the load of the water brake is to be decreased by operating valve of water brake.
7) Over speed trip
The set value of RPM to trip is to be confirmed by automatic stopping of engine.
8) Fuel oil consumption measurement at each load
9) One(1) turbocharger cut-off test(1st engine only in series)
10) IMO NOx compliance test. (for one engine only in series engines)
11) WECS-9520 test acc. To flex system instruction(I.D 4_107.346.451a)

3. SHOP TRIAL SCHEDULE

No	Kind of test	Guidance of test		Result	Remarks	T.S
1)	Safety test	O.M.D function test (Graviner MK6)				(1)
		Main lub.oil inlet low pressure (stop: min 2.9 bar / 10sec)		bar sec		(2)
		Exh. Valve spring air low pressure (stop: min 4.5 bar)		bar		(3)
		Turbocharger inlet low pressure (stop: min 0.4 bar / 5 sec)	#1	bar sec		(4)
			#2	bar sec		
		Jacket cooling water inlet low pressure (stop: min 2.5 bar / 60 sec)		bar sec		(5)
		Piston cooling oil flow (stop: no flow / 15 sec)		℃ sec		(7)
		Piston cooling oil diff. pressure (stop: max 0.4 bar / 15 sec)		bar sec		(8)
		Thrust bearing high temperature (stop: max. 85℃ / 60 sec)		℃ sec		(9)
		Emergency stop		☐Yes ☐No		(12)
2)	Starting & reversing test	Starting ahead		☐Yes ☐No	At local	(6)
		Starting astern		☐Yes ☐No		
3)	Turning gear interlock test	Turning gear engaged start		☐Yes ☐No		(10)
		Turning gear disengaged start		☐Yes ☐No		
4)	Astern test	Astern running test at no load (abt.5min)		☐Yes ☐No		(11)
5)	Minimum revolution test (abt.5min)	Engine speed		rpm	24.7 rpm	(14)
		Engine output		kW		
		Turbocharger speed	#1	rpm		
			#2	rpm		
		Fuel pump mark				
		Handle notch mark				
		Scavenge air pressure		bar		

<table>
<tr><td rowspan="6">4)</td><td rowspan="6">WECS test
(refer to instruction for WECS-9520 function check)</td><td colspan="4">Software verification
Engine type:</td><td rowspan="6"></td><td rowspan="6">(13)</td></tr>
<tr><td colspan="4">HULL NO</td></tr>
<tr><td>SOFTWARE VERSION</td><td>BUILD</td><td></td><td>BLV</td></tr>
<tr><td>APP CRC VALUE</td><td colspan="2">IMO SW-NO</td></tr>
<tr><td>IMO CRC VALUE</td><td colspan="2">IMO DATA LENGTH</td></tr>
<tr><td colspan="4">Power supply failure FCM-20 and loss of one Cylinder
Fuel shut down pilot valve (emergency stop test)
Crank angle bus/sensor failure Crank angle bus wiring
Engine failure and communication test WECS9520 safety system</td><td>☐Yes ☐No
☐Yes ☐No
☐Yes ☐No
☐Yes ☐No</td></tr>
<tr><td>6)</td><td>Load test(E2)</td><td colspan="4"><table><tr><th>Load</th><th>rpm</th><th>Output(kW)</th><th>Duration(min)</th></tr><tr><td>25%</td><td>62.2</td><td>2,823</td><td>30</td></tr><tr><td>50%</td><td>78.4</td><td>5,645</td><td>30</td></tr><tr><td>75%</td><td>89.8</td><td>8,468</td><td>30</td></tr><tr><td>85%</td><td>93.6</td><td>9,597</td><td>60</td></tr><tr><td>100%</td><td>98.8</td><td>11,290</td><td>60</td></tr><tr><td>110%</td><td>102.0</td><td>12,419</td><td>30</td></tr></table></td><td>See the test record</td><td>SFOC at 85%</td><td>(15)</td></tr>
<tr><td>7)</td><td>Governor test</td><td colspan="4"> 
</td><td>R1:
R2:
R3:
T :</td><td>R: rpm
T: second</td><td>(16)</td></tr>
<tr><td>8)</td><td>Over speed trip</td><td colspan="4">Over speed stop (110% at MCR rpm)</td><td>rpm</td><td>109 rpm</td><td>(17)</td></tr>
</table>

4. Overhaul

After shop test, overhaul inspection to be carried out in the presence of owner's representative and surveyor to classification society for chosen cylinder.

* Overhaul item

No.	Item	Q'ty	Kind of insp.	No.
1)	Crankshaft journal Main bearing	1 brg.	Appearance inspection	Brg. No.
2)	Cylinder liner Cylinder cover Piston complete X-head pin & brg. Guide shoe	1 cyl.	Appearance inspection	Cyl. No.
	Crank pin & brg.	1 cyl.	Appearance inspection	Cyl. No.
3)	Gear wheel	1 eng.	Appearance inspection	All
4)	Servo oil automatic filter	1 ea	Appearance inspection	1(one) filter
5)	Fuel valve	1 ea	injection pressure test	Cyl. No.

附件 2：廠試檢討提出改善事項

HYUNDAI HEAVY INDUSTRIES CO., LTD.

APPLICATION FOR INSPECTION & TEST

(ENGINE AND MACHINERY DIVISION)

Insp. Date : 2011-03-30 Messrs: T.P.C / CSBC / LR / CR Page: 1 / 1

No.	Ship No Type Project No	Nomenclature Kind of insp	Charge No Item No	Q'ty	Time Location	PIC Extension Mobile	Remarks
1	CSBC986	MAIN ENGINE	1.SAFETY DEVICE TEST & ETC.	1	09:00	G.W.Lee	
			2.LOAD TEST 25% LOAD : 30 (~~13:30~~ 12:00)				
	6RT-flex58T-D	OFFICIAL SHOP TRIAL	50% LOAD : 30 (12:00~12:30)		Assembly Shop(For M/E) 1-3	202-9037	
	AA4163		75% LOAD : 30 (13:30~13:50)			010-2769-1933	
			85% LOAD : 60 (13:50~14:50)				
			100% LOAD : 60 (14:50~15:50)				
			110% LOAD : 30 (15:50~16:20)				
			3.GOVERNOR TEST & OVER SPEED TRIP				

Chen, Cheng-Ming 30/March-2011

Chaofen Hu
OWNER

T.Z. Chen (CSBC)
YARD

Lloyd's Register Asia
Ulsan
Lloyd's Register
CLASS 30/MAR/2011

1. 12:37 cyl. 4/5 p.c.o. nonflow shutdown at 50% load. should be clarified.
2. Flex pipe for c.f.w outlet should be provided for 4 ships engine because of HNo.983 bad seatral ~~experience~~ condition.
3. ~~One control pipe~~ a/r M.P. pump unit oil leakage should be modifyed
4. Heavy vibration of servo oil filter should be modified.
5. Some of ~~screws~~ bolts & nuts and blind flange are missing.
6. please provided studs cup for cylinder cover.
7. D.P. alarm from Autofilter of Servo. oil. please check.
8. Oil leakage 3 place from crankdoor side. Should be modify
9. All not finished work such as painting, insulation and No. marking should be well down.
10. All comments of pre-FAT should be followed

GENERAL MANAGER
QM, HHI-EMD
S. C. JIN

附件 3：HHI 於 2011/4/25 答覆船東意見表

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

ISO 9001 REGISTERED

ENGINE & MACHINERY DIVISION

HEAD OFFICE
1, CHEONHA-DONG, DONG-GU, ULSAN, KOREA
TEL: +82 (0)52-202-9037
FAX: +82 (0)52-250-9563 / 202-7691
E-mail: average@hhi.co.kr

To:	CSBC Corporation QA Department	From:	Quality Management Department
Attn.:	Mr. Tien-Fei Chen	P.I.C.:	G. W. Lee (Tel: 052-202-9037)
E-mail :	091372@csbcnet.com.tw	Ref. No.:	K630-FAX11-0073
C.C.:	TPC / Mr. Chen Cheng-Ming USDDC / Mr. Chao-Jen Hu	Date:	2011. 04. 25
E-mail :	u685331@taipower.com.tw hu@mail.usddc.org.tw	Page:	Total 6 Sheet(s)

※ If you fail to receive all of this transmission. Please inform us at above tel. no.

SUBJECT: Reply to Owner Comment for CSBC986 Main Engine (6RT-flex58T-D)

Dear sirs :

Thank you for your kind co-operation with us.

With reference to your shop test and overhaul comments dated on 30th, Mrch and 1st, April 2011, we would like to inform you that your comments have been completed except below 2 items.

2. **Flexible pipe for C.F.W outlet should be provided for 4 ships engine because of CSBC983 showed bad sea trial condition.**
-> Please discuss with shipyard for this matter. It is out of our scope of supply.

4. Heavy vibration of servo oil filter should be modifed.
-> Please keep it as it is, and we would like to discuss internally and inform you the modification method after checking during sea trial of CSBC984.

And regarding two(2) of your comments in below, we would like to explain as follows.

1. At 12:37 p.m., cyl.no.4 and 5 P.C.O nonflow shutdown at 50% load should be clarified.
-> As we explained after the shop test at that time, we assume that the shutdown was happened by lub. oil facility of assembly shop. We carried out flushing for the other M/E at the same time with the shop test, and because of that, pressure difference could be made. (Some of L.O pumps in our assmebly shop facility were started and stopped during the shop test.) We are sure that the problem will not happen again anymore and we already have carry out double-check for the all system of P.C.O non-flow.
Please kindly understand this happening, and we will also confirm again at sea trial.

7. D.P. alarm from auto filter of servo oil to be checked.

-> The purpose of DP alarm is just to indicate that "Back-Flushing" was activated within two(2) hours, in other words, it is a kind of notice. It is to be considered as normal situation, and it is also stated in the auto filter manual. (Back-Flushing will be activated every two(2) hour or whenever limited pressure drop is happened through the filter.)

For other comments, please refer to the enclosure for the details and if you have any question or concern, feel free to contact us.

Sincerely yours,

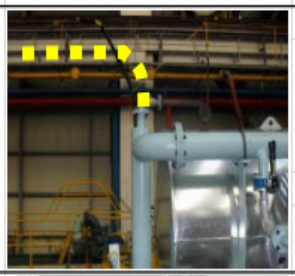
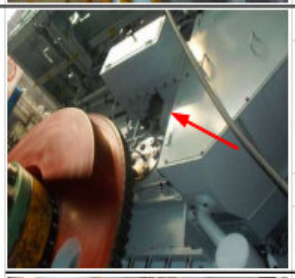
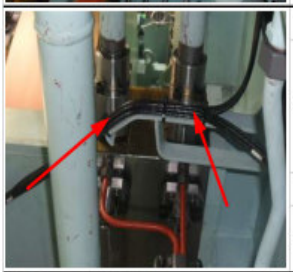
For

S. C. Jin / General Manager
Quality Management Department

Enclosure : 0. CSBC986 Main Engine Shop Test and Overhaul Comments – 1 copy

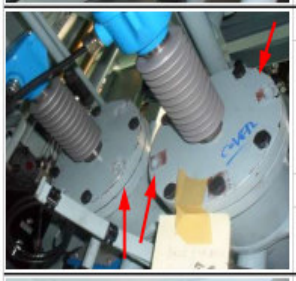
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ship No	CSBC986	Eng.Type	6RTX58T-D	Owner's Comment	QM PIC	G.W.Lee	Drawn	Check	Appd
Eng. No	AA4163	Test Date	2011.03.30		Issued	10			
Owner	T.P.C	Delivery	-		Completed	8			

No	Picture	Description	Charge/Date		After Management
1	BLANK	Description 12:37 cyl.no.4 and 5 P.C.O nonflow shutdown at 50% load should be clarified. Action Please refer to the explanation in previous page.	St 1 2 3	Shop Test	BLANK Confirm
2		Description Flexible pipe for C.F.W outlet should be provided for 4 ships engine because of CSBC983 showed bad sea trial condition. Action Please discuss with shipyard for this matter. It is out of our scope of supply.	St 1 2 3	Shop Test	BLANK Confirm
3		Description High pressure pump unit oil leakage should be modified. Action Rectified.	St 1 2 3	Shop Test	BLANK Confirm
		Description Same as above. Action Rectified.	St 1 2 3	Shop Test	BLANK Confirm
		Description Same as above. Action Rectified.	St 1 2 3	Shop Test	BLANK Confirm
4		Description Heavy vibration of servo oil filter should be modifed. Action Please refer to the right column.	St 1 2 3	Shop Test	Please keep it as it is, and we would like to discuss internally and inform you the modification method after checking during sea trial of CSBC984. Confirm

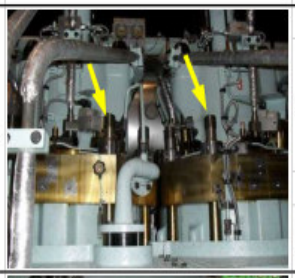
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ship No	CSBC986	Eng.Type	6RTX58T-D	Owner's Comment	QM PIC	G.W.Lee	Drawn	Check	Appd
Eng. No	AA4163	Test Date	2011.03.30		Issued	10			
Owner	T.P.C	Delivery	-		Completed	8			

No	Picture	Description	Charge/Date		After Management
4		Description Same as above. Action Same as above.	St 1 2 3	Shop Test	Same as above. Confirm
		Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm
		Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm
		Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm
5		Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm
	BLANK	Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm

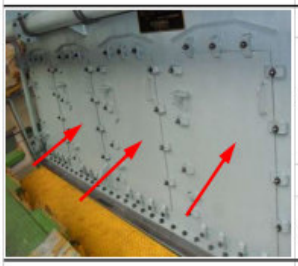
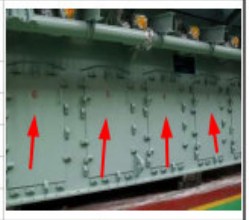
HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ship No	CSBC986	Eng.Type	6RTX58T-D	Owner's Comment	QM PIC	G.W.Lee	Drawn	Check	Appd
Eng. No	AA4163	Test Date	2011.03.30		Issued	10			
Owner	T.P.C	Delivery	-		Completed	8			

No	Picture	Description	Charge/Date		After Management
	BLANK	Description Some of bolts, nuts and blind flange are missing. Action Completed.	St 1 2 3	Shop Test	 Confirm
6		Description Please provide studs cap for cylinder cover. Action Caps were provided in separate boxes.	St 1 2 3	Shop Test	BLANK Confirm
7		Description D.P. alarm from auto filter of servo oil to be checked. Action Please refer to the explanation in previous page.	St 1 2 3	Shop Test	BLANK Confirm
		Description Oil leakage (3 places) from crank door side should be modified. Action Completed.	St 1 2 3	Shop Test	BLANK Confirm
8		Description Same as above. Action Completed.	St 1 2 3	Shop Test	BLANK Confirm
		Description Same as above. Action Completed.	St 1 2 3	Shop Test	BLANK Confirm

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Ship No	CSBC986	Eng.Type	6RTX58T-D	Owner's Comment	QM PIC	G.W.Lee	Drawn	Check	Appd
Eng. No	AA4163	Test Date	2011.03.30		Issued	10			
Owner	T.P.C	Delivery	-		Completed	8			

No	Picture	Description	Charge/Date		After Management
	BLANK	Description All not finished works such as painting, insulation and cyl. no. marking should be done. Action Completed.	St 1 2 3	Shop Test	 Confirm
9		Description Same as above. Action Completed.	St 1 2 3	Shop Test	 Confirm
	BLANK	Description Same as above. Action Completed.	St 1 2 3	Shop Test	 Confirm
10	BLANK	Description All comments of pre-FAT should be followed. Action Comments of previous engine were applied except some leakage matters.	St 1 2 3	Shop Test	BLANK Confirm

附件 4：廠試各項紀錄資料表

HYUNDAI HEAVY INDUSTRIES CO.,LTD. **Official Shop Test Result For Main Engine**

HYUNDAI - WARTSILA | **Load Data Sheet 1**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30.'17
Output(MCR)	11290 kW	Engineer	Y.H. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

PRELIMINARY

General Data	Loading power(%) / Check time			%	Time	25%	11:40	50%	12:20	75%	13:30								
	Engine power / speed (theoretical)			kW	rpm	2823	62.2	5645	78.4	8468	89.8								
	Mean eff. pressure design / actual			bar		7.1	-	11.3	-	14.8	-								
	Brake force (indicated)			tonf·m		61.5		98.0		128.5									
	Engine power / speed (measured)			kW	rpm	2823	62.2	5645	78.4	8468	89.8								
	VIT + FQS(IT_G) / inj. begin standard value			∠°		2.8	0.0	-1.6	0.0	-2.9	0.0								
	Fuel oil:	Actuator Output	Fcmd	%		30.0	27.0	41.0	40.9	50.0	51.5								
		Consumption absol.		kg/h	g/kWh	-	-	-	-	-	-								
		Consumption ISO		g/kWh		-		-		-									
	Cyl. Lub. oil:	Injection Number		10min/1cyl		173		289		417									
		Total Feed Rate		kg/h		5.2		8.6		12.4									
		Feed Rate		g/bhph	g/kWh	1.34	1.83	1.12	1.53	1.08	1.47								
Scavenge Air	Aux. Blower / Nozzles in operation			on/off	EA	ON	ALL	OFF	ALL	OFF	ALL								
	Barometric pressure / Humidity			hPa	%	1020.0		1020.0		1019.0									
	Ambient temp.			℃		17.0		18.4		19.1									
	Press drop across air cooler			mmAq		35		67		95									
	T/C filter suction pressure			mmAq		4		20		50									
	Pressure after blower			mmHg		180		790		1460									
	Scavenge air pressure			mmHg	bar	240	0.330	770	1.050	1440	1.950								
	Temp. before blower			℃		16.0	18.0			22.0	19.0			22.0	21.0				
	Temp. before air cooler			℃		40		98		150									
	Temp. after air cooler			℃		23		27		33									
Exhaust Gas	Turboblower speed			rpm		6150		10579		13470									
	Pressure before turbine			mmHg		170		600		1210									
	Pressure after turbine			mmAq		15		65		135									
	Temp. before turbine			℃		283		331		340									
	Temp. after turbine			℃		241		254		224									
	Temp. after cylinder	Mean		℃		245.0		296.2		308.2									
		1	2 3 4	℃		245	245	243	250	286	293	300	313	301	303	310	325		
		5	6	℃		243	244			292	293			305	305				
Cylinder Pressures	Maximum / Compression press.	Mean		bar	bar	84.3	57.2	114.7	75.0	145.2	104.5								
		No,	1	bar	bar	85	57	115	75	145	105								
		No,	2	bar	bar	84	57	115	75	146	104								
		No,	3	bar	bar	84	57	114	75	145	105								
		No,	4	bar	bar	83	57	114	75	145	105								
		No,	5	bar	bar	85	57	115	75	145	104								
		No,	6	bar	bar	85	58	115	75	145	104								
Systems	Air press.:	Control air / Valve air spring		bar		6.60	6.70	6.60	6.70	6.60	6.70								
	Lub. oil press. :	Bearing / Cross head bearing		bar		4.60	11.40	4.30	11.10	4.60	11.50								
		Servo oil		bar		121		141		159									
		Servo oil pump inlet		bar		4.40		4.05		4.20									
		T/C lub oil inlet		bar		1.90		1.20		1.70									
		Axial detuner driving / free end		Mpa		0.39	0.38	0.38	0.38	0.38	0.38								
	Water press.:	Cylinder		bar		3.8		3.8		3.95									
	Lub. oil temp.:	Bearing / Turbocharger		℃		42.0		42.0		43.0									
		Crosshead inlet		℃		42.0		42.0		43.0									
		T/C outlet		℃		45		55		69									
	Water temp.:	cylinder inlet		℃		55.0		58.0		63.0									
		cylinder outlet	Mean	℃		58.0		63.5		69.0									
			1 2 3 4	℃		58	58	58	58	63	63	63	64	69	69	69	69		
			5 6	℃		58	58			64	64			69	69				
		Air cooler inlet		℃		19		22		26									
		Air cooler outlet		℃		23		54		62									
	Fuel:	Press. bef / aft retaining valve		bar		9	3.5	8.7	3.4	8.6	3.3								
		Press. Engine inlet / Rail		bar	bar	8.6	596	8.4	600	8.3	600								
		Temp. before engine		℃		45.0		46		46									
	Thrust bearing temp.			℃		44		44		45									

HYUNDAI HEAVY INDUSTRIES CO.,LTD. **Official Shop Test Result For Main Engine**

HYUNDAI - WARTSILA **Load Data Sheet 2**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30 2[illegible]1
Output(MCR)	11290 kW	Engineer	[illegible]. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

PRELIMINARY

General Data	Loading power(%) / Check time		%	Time	85%		14:10		100%		15:[illegible]0		100%		15:20	
	Engine power / speed (theoretical)		kW	rpm	9597		93.6		11290		98.8		11290		98.8	
	Mean eff. pressure design / actual		bar		16.1		-		17.9		-		17.9		-	
	Brake force (indicated)		tonf·m		139.5				155.5				155.5			
	Engine power / speed (measured)		kW	rpm	9597		93.6		11290		98.8		11290		98.8	
	VIT + FQS(IT_G) / inj. begin standard value		∠°		-2.4		0.0		0.2		0.0		0.2		0.0	
	Fuel oil: Actuator Output	Fcmd	%		55.0		55.4		63.0		63.3		63.1		63.3	
	Consumption absol.		kg/h	g/kWh	1654.00		172.35		-		-		-		-	
	Consumption ISO		g/kWh		169.68				-				-			
	Cyl. Lub. oil: Injection Number		10min/1cyl		459				535				536			
	Total Feed Rate		kg/h		13.7				15.9				16.0			
	Feed Rate		g/bhph	g/kWh	1.05		1.43		1.04		1.41		1.04		1.42	
Scavenge Air	Aux. Blower / Nozzles in operation		on/off	EA	OFF		ALL		OFF		ALL		OFF		ALL	
	Barometric pressure / Humidity		hPa	%	1018.0				1018.0				1018.0			
	Ambient temp.		℃		19.8				20.0				19.9			
	Press drop across air cooler		mmAq		104				116				117			
	T/C filter suction pressure		mmAq		63				82				82			
	Pressure after blower		mmHg		1790				2260				2260			
	Scavenge air pressure		mmHg	bar	1760		2.340		2230		2.990		2230		3.000	
	Temp. before blower		℃		25.0	21.0			28.0	21.0			28.0	21.0		
	Temp. before air cooler		℃		169				196				197			
	Temp. after air cooler		℃		35				36				37			
Exhaust Gas	Turboblower speed		rpm		14330				15638				15642			
	Pressure before turbine		mmHg		1450				1880				1880			
	Pressure after turbine		mmAq		180				230				232			
	Temp. before turbine		℃		356				389				390			
	Temp. after turbine		℃		224				234				235			
	Temp. after cylinder	Mean	℃		322.2				356.7				357.0			
		1 2 3 4	℃		315	322	322	328	348	355	359	370	347	356	360	371
		5 6	℃		320	326			349	359			350	358		
Cylinder Pressures	Maximum / Compression press.	Mean	bar	bar	151.0		114.2		150.0		137.5		149.8		137.2	
		No, 1	bar	bar	152		115		150		136		150		136	
		No, 2	bar	bar	150		114		150		137		150		136	
		No, 3	bar	bar	151		114		150		138		150		137	
		No, 4	bar	bar	152		114		150		138		149		138	
		No, 5	bar	bar	151		114		150		138		150		138	
		No, 6	bar	bar	150		114		150		138		150		138	
Systems	Air press.: Control air / Valve air spring		bar		6.60		6.60		6.60		6.60		6.60		6.60	
	Lub. oil press.: Bearing / Cross head bearing		bar		4.20		11.30		4.17		11.30		4.16		11.30	
	Servo oil		bar		172				200				200			
	Servo oil pump inlet		bar		4.10				4.00				4.00			
	T/C lub oil inlet		bar		1.80				1.85				1.85			
	Axial detuner driving / free end		Mpa		0.37		0.37		0.37		0.37		0.37		0.37	
	Water press.: Cylinder		bar		4				4				4			
	Lub. oil temp.: Bearing / Turbocharger		℃		43.0				43.0				43.0			
	Crosshead inlet		℃		43.0				43.0				43.0			
	T/C outlet		℃		75				81				81			
	Water temp.: cylinder inlet		℃		69.0				68.0				68.0			
	cylinder outlet	Mean	℃		75.0				75.5				75.7			
		1 2 3 4	℃		75	75	75	75	75	76	76	75	76	76	76	75
		5 6	℃		75	75			75	76			75	76		
	Air cooler inlet		℃		28				23				23			
	Air cooler outlet		℃		58				67				68			
	Fuel: Press. bef / aft retaining valve		bar		8.3		3.2		8.3		3.1		8.3		3.1	
	Press. Engine inlet / Rail		bar	bar	8.2		745		8.0		748		8.0		747	
	Temp. before engine		℃		46.0				46				46			
	Thrust bearing temp.		℃		45				45				45			

HYUNDAI HEAVY INDUSTRIES CO.,LTD.	Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
		Engine No.	AA4163	Class	LR + CR
		Engine Type	6RT-flex58T-D	Test Date	Mar.30.2[illegible]
HYUNDAI - WARTSILA	Load Data Sheet 3	Output(MCR)	11290 kW	Engineer	[illegible] KIM
		Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

PRELIMINARY

Group	Parameter		Unit		Value			
General Data	Loading power(%) / Check time		%	Time	110%	16:00		
	Engine power / speed (theoretical)		kW	rpm	12419	102.0		
	Mean eff. pressure design / actual		bar		19.1	-		
	Brake force (indicated)		tonf·m		165.5			
	Engine power / speed (measured)		kW	rpm	12419	102.0		
	VIT + FQS(IT_G) / inj. begin standard value		∠°		0.5	0.0		
	Fuel oil: Actuator Output	Fcmd	%		67.0	67.9		
	Consumption absol.		kg/h	g/kWh	-	-		
	Consumption ISO		g/kWh		-			
	Cyl. Lub. oil: Injection Number		10min/1cyl		593			
	Total Feed Rate		kg/h		17.7			
	Feed Rate		g/bhph	g/kWh	1.05	1.42		
Scavenge Air	Aux. Blower / Nozzles in operation		on/off	EA	OFF	ALL		
	Barometric pressure / Humidity		hPa	%	1018.0			
	Ambient temp.		℃		19.2			
	Press drop across air cooler		mmAq		117			
	T/C filter suction pressure		mmAq		97			
	Pressure after blower		mmHg		2450			
	Scavenge air pressure		mmHg	bar	2430	3.260		
	Temp. before blower		℃		28.0	21.0		
	Temp. before air cooler		℃		207			
	Temp. after air cooler		℃		36			
Exhaust Gas	Turboblower speed		rpm		16330			
	Pressure before turbine		mmHg		2080			
	Pressure after turbine		mmAq		290			
	Temp. before turbine		℃		425			
	Temp. after turbine		℃		252			
	Temp. after cylinder	Mean	℃		386.7			
		1 2 3 4	℃		375	390	385	400
		5 6	℃		380	390		
Cylinder Pressures	Maximum / Compression press.	Mean	bar	bar	155.7	145.8		
		No, 1	bar	bar	156	146		
		No, 2	bar	bar	156	146		
		No, 3	bar	bar	156	145		
		No, 4	bar	bar	156	146		
		No, 5	bar	bar	155	146		
		No, 6	bar	bar	155	146		
Systems	Air press.: Control air / Valve air spring		bar		6.60	6.60		
	Lub. oil press.: Bearing / Cross head bearing		bar		4.15	11.30		
	Servo oil		bar		200			
	Servo oil pump inlet		bar		4.10			
	T/C lub oil inlet		bar		1.80			
	Axial detuner driving / free end		Mpa		0.37	0.37		
	Water press.: Cylinder		bar		4			
	Lub. oil temp.: Bearing / Turbocharger		℃		43.0			
	Crosshead inlet		℃		43.0			
	T/C outlet		℃		84			
	Water temp.: cylinder inlet		℃		68.0			
	cylinder outlet	Mean	℃		76.0			
		1 2 3 4	℃		76	76	76	76
		5 6	℃		76	76		
	Air cooler inlet		℃		23			
	Air cooler outlet		℃		65			
	Fuel: Press. bef / aft retaining valve		bar		8.3	2.1		
	Press. Engine inlet / Rail		bar	bar	8	790		
	Temp. before engine		℃		46			
	Thrust bearing temp.		℃		45			

附件 5：廠試之油料、儀器校正資料

CERTIFICATE OF QUALITY

HYUNDAI OIL REFINERY CO.LTD.QC SECTION

Ulsan Terminal
TEL : 052)208-6828
FAX : 052)266-2866

Seoul Office
TEL : 02)2004-3000(Exchange)
FAX : 02)2004-3410

Product Name : Bunker-A (0.3%)
Tank No. :
Customer : H H I

Ticket No : 3146749
Testing Date : 2011.03.12
Equip No : 82-1737

Test Items	Test Method	Specification	Results
API Gravity 60°F	ASTM D-1298	Report	24.5
Specific Gravity 15/4℃	ASTM D-1298	Report	0.9065
Density 15℃ kg/㎥	ASTM D-1298	Report	906.5
Flash Point ,PMCC ℃	ASTM D-93	Min 60	72.0
Kinematics Viscosity 50℃ ㎟/sec	ASTM D-445	Max 20	5
Sulfur wt %	ASTM D-4294	Max 0.3	0.190
Pour Point ℃	ASTM D-97	Max 0	0.0
Water & Sediment vol %	ASTM D-1796	Max 0.3	0.1
Ash wt %	ASTM D-482	Max 0.05	0
Conradson Carbon Residue wt%	ASTM D-4530	Max 8	1.0
Calorific Value(Net) Kcal/kg	KS M 2057		10025
Calorific Value(Gross) Kcal/kg	KS M 2057		10650

I certify the above statement of quality to be true and correct.

2011 3 25

kim y . S

ULSAN TERMINAL MANAGER

附件 6：電昌七號主機廠試報告

HYUNDAI HEAVY INDUSTRIES CO., LTD.

		Doc. No.: K630-IR11A-2237
SHOP TEST RESULT FOR MAIN ENGINE	Engine No.	AA4163
	Engine type	6RT-flex58T-D
	Hull No.	CSBC986
	Owner	TPC
	Class	LR + CR
	Ship yard	CHINA SHIPBUILDING CORPORATION

HYUNDAI - WARTSILA

CONTENTS **PAGE No.**

QUALITY MANAGEMENT DEPARTMENT
HHI-EMD

Rev.	Prepared	Checked	Approved	Description
2				
1				
0	G. W. LEE 2011.04.18	Y. M. KIM 2011.04.18	M. H. KIM 2011.04.18	First issue

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Trial Report

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

Engine Specification

* Cylinder Bore	580 mm	* Piston Stroke	2416 mm	* Installation	CSBC986	* Direction of Rotaion : Clockwise
* Engine Builder	HHI - EMD	* No. of Cylinder	6	* M.E.P	17.9 bar	
* Brake Type & Coefficient		CFSR-24 & 1 / 1.35962 (kW base)				

Turbocharger Specification

* Type		1 X TPL77B12
* Specification		CT75CA15 TF20TA22
* Maximum RPM/TEMP	nBmax/tBmax	16200 rev/m 520 ℃
	nMmax/tMmax	17040 rev/m 550 ℃
* Serial No.		XH002993
* Manufacturer		HYUNDAI - ABB

Power Take Off (P.T.O) Generator Specification

* Type	
* Serial No.	
* Nominal Power	
* Nominal Speed	
* Nominal Voltage	

Governor Specification Electric(O) Hydraulic( )

Speed Governor

* Type	AC C20 DGS	* Manufacturer	KONGSBERG MARITIME KOREA

Electric Actuator

* Type	Proact Digital Plus	* Serial No.P/E	17260022 / 17259999 - 1012		
* Manufacturer	WOODWARD LOVELAND,CO.,USA			* Part No.P/E	8404-045

Cylinder Lubricators Specification

* Piston Diameter	- mm	* Gear Ratio	-	* Type	Pulse Feed Cyl.lubricator
* Manufacturer	WILLY VOGELE AG				

Air Cooler Specification

* Part No	A29-179492-5	* MFG No	20003389/40
* Manufacturer	GEA INDUSTRIAL HEAT EXCHANGER SYSTEMS (CHINA) CO.,LTD		

Auxiliary Blower Specification

* Fan	* Type	TBCR-050G-4526	* Serial No.1,2	10B0037-01- 07/08	* Pressure	673 mmAq	
	* Manufacturer	TEA-IL BLOWER					
* Elect. Motor	* Type	HM	* Power,Amp.	45 kW, 72.1 A	* Voltage	440 V	60 Hz
	* Serial No.1,2	0F720F03-001/002	* Manufacturer	HYUNDAI HEAVY INDUSTRIES CO. LTD			

Specification of Oil used at Shop Trial

	Fuel Oil	Bearing Oil	Cylinder Oil	T/C Oil
* Grade of Oil	BUNKER-A	MELINA S30	ALEXIA LS	MELINA S30
* Density at 15℃ (g/ml)	0.9065	0.8834	0.9128	0.8834
* Viscosity (㎟/s)	5.0 50℃	104.2 40℃	204.0 40℃	104.2 40℃
* Lower calorific value(kcal/kg)	10025			

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
	Engine No.	AA4163	Class	LR + CR
	Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Setting Table A1	Output(MCR)	11290 kW	Engineer	C.B. KIM
	Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

*** Injection control units** Draw. No. : *2-107.347.582*

Quantity piston stroke : *80* [mm] Quantity piston diam. : *36* [mm]

*** Fuel rail pressure** : *Fuel quantity and speed dependent (WECS-9520 parameter)*

Safety valve opening pressure : *1250* [bar]

Emergency fuel pressure control valve : *1050* [bar]

*** Control oil pressure** : - [bar]

*** Injection valves and fuel pressure pipes**

* Nozzle Draw. No. : A20-218678-6 (EXEC. 208)

* Needle lift : 1.20 [mm]

* Opening pressure : 375±5bar [bar]

No. of holes	1	2	3	4	5	BLANK
Hole diam. [mm]	0.600	0.900	0.850	0.825	0.750	
vertical ∠ α°	17	14	11	13	13	
horizontal ∠ β°	-12	9	19	28	38	

* High pressure pipe diameter : to the fuel rail inside 12.0 [mm] outside 30.0 [mm]

to the injection valve inside 6.0 [mm] outside 18.0 [mm]

*** Injection timing** : *Charge air pressure, fuel pressure and speed dependent (WECS-9520 parameter)*

*** Exhaust valve timing** : *Charge air pressure and speed dependent (WECS-9520 parameter)*

*** Exhaust valve control unit** Draw. No. : *0-107.351.163*

Piston stroke : 57 [mm] Piston diameter : 71 [mm]

*** Servo oil pressure** : *100 - 200 bar (charge air pressure dependent WECS-9520 parameters)*

*** SW-INFO WECS 9520**

ENGINE TYPE	6RT-flex58T-D	Hull NO.		CSBC986	
SOFTWARE VERSION	32	Build	82	BLV	3.11
APP CRC VALUE	0x561E	IMO SW-NO		LN-BE9801	
IMO CRC VALUE	0x34D3	IMO DATA LENGTH		524	

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 fV Data IMO

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

IMO: IMO Parameter — Card-CRC: 0x1FDF

Plant SW-INFO (Check)

Engine Type	06RT-flex58T-D
Manufacturing No	AA4163
Hull No	CSBC986
SW-Version	32
SW-Build	082
IMO No.of SW	LN-BE9801
BootLdVers.	3.11

All Mod.	App.	IMO	FPGA
Data length	491468	524	180252
CRC Value	0x561E	0x34D3	0x2019
CRC State	CRC OK	CRC OK	CRC OK

IMO-CrcState: 0

VIT: IT_A

Point	ScavAirPr	Angle
1	0.00	0.5 <?
2	0.35	0.5 <?
3	0.55	-3.5 <?
4	0.80	-3.0 <?
5	0.85	-3.0 <?
6	1.00	0.0 <?
7	1.05	1.0 <?
8	1.15	0.0 <?
9	1.20	0.0 <?
10	2.00	0.0 <?

IT_B

Point	Speed	Angle
1	0 %	3.0 <?
2	20 %	3.0 <?
3	55 %	3.0 <?
4	70 %	3.0 <?
5	80 %	2.0 <?
6	90 %	1.0 <?
7	100 %	0.0 <?
8	110 %	-1.0 <?
9	120 %	-1.0 <?
10	200 %	-1.0 <?

IT_C

Point	FuelPr	Angle
1	0 bar	-3.0 <?
2	150 bar	-3.0 <?
3	450 bar	-1.5 <?
4	750 bar	0.0 <?
5	1350 bar	3.0 <?
6	2000 bar	3.0 <?

Note: plant specific parameters can be set on fV-Card COMMIS

Fuel press.setpoint curve

Point	Load	FuelPr
1	0 %	600 bar
2	15 %	600 bar
3	25 %	600 bar
4	50 %	600 bar
5	76 %	600 bar
6	83 %	750 bar
7	95 %	750 bar
8	200 %	750 bar

Reference val.at CMCR

Nominal Speed	99 RPM
Fuel cmd. scal.to nom.load	63.0 %
Scav.air pess.at CMCR	2.95 barG
Exh.valve close at CMCR	271.0 <?
ExvOpenAtCmcr	128.7 <? (COMMIS, not IMO)

Injection timing parameters

FQS Limit	-5.0 <?	
IT_DEL Inj.timing delay	0.0 <?	
Inj. begin standard value	0.0 <?	
FQS	0.0 <?	USER
VeoCompensationByVec	20 %	not IMO

°<? = deg CA

Exh.valve, VEO = f(n)

Point	Speed	Angle
1	0 %	15.0 <?
2	45 %	15.0 <?
3	70 %	4.0 <?
4	100 %	0.0 <?
5	105 %	-1.0 <?
6	150 %	-1.0 <?

not IMO

Exh.valveVEC=f(ch.pr.)

Point	ScavAirP	Angle
1	0.00	0 <?
2	0.60	0 <?
3	0.75	0 <?
4	0.80	0 <?
5	0.85	0 <?
6	0.87	0 <?
7	1.06	0 <?
8	2.00	0 <?

Exh.valve VEC=f(speed)

Point	Speed	Angle
1	0 %	-33 <?
2	25 %	-33 <?
3	35 %	0 <?
4	55 %	0 <?
5	65 %	-33 <?
6	79 %	-10 <?
7	100 %	0 <?
8	150 %	0 <?

Journl

SW-Info: Software check and simulation — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x9D3B

Plant SW-INFO of All Mod.

Engine Type	06RT-flex58T-D
Manufacturing No	AA4163
Hull No	CSBC986 (BASIC)
SW-Version/Build	32 SW-Build 082
IMO No.of SW	LN-BE9801 BootLdVers. 3.11
Developer No	0210

PARA - CRC Values

		Len	
BASIC Paras CRC	0x436D	324	ok
USER Paras CRC	0x5F7F	76	ok
ADJUST Paras CRC	0x4D08	268	ok
IMO CRC Value	0x34D3	524	ok
GLOBAL Paras CRC	0x2A26	956	ok
COMMIS Paras CRC	0xB072	596	ok
LUB Paras CRC	0xE8F8	496	ok

Check CRC Monitoring: Disabled

HW Rev.	Ser. No	Pow.Board	CPU-Board.
06			
FCM0	703685	704058	703921
FCM1	728507	704100	703917
FCM2	703600	703989	703787
FCM3	728504	704104	703879
FCM4	703603	703963	703806
FCM5	728503	704101	676706
FCM6	703686	704062	703924

Time cnt [h]

Spare	21.716
Cyl. 1	21.7
Cyl. 2	21.7
Cyl. 3	21.7
Cyl. 4	21.7
Cyl. 5	21.7
Cyl. 6	21.7

WECS-9520 Software check

	App.	IMO	FPGA	ALM
Data length	491468	524	180252	38308
CRC Value	0x561E	0x34D3	0x2019	0x882E
CRC State	CRC OK	CRC OK	CRC OK	CRC OK

Autodownload is active

SW State: OK

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 **fV Data 25%**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	27 %	30020
Time Count of Spare	16.78 h	

Engine speed (n)

Engine Speed	62 RPM
Percentage	62.9 %

Fuel command (LI)

Used for Injection	26.7 %	30001
FuelCommandPCS	26.8 %	30009
Percent of CMCR	42.8 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	0.34 bar	30003
Sensor 1	0.34 bar	30033
Sensor 2	0.33 bar	30034
Scaled to CMCR	0.34	

Fuel Rail Pressure

Setpoint	600 bar		30018
Actuator outp./Lim./near Lim.	29 %	No / No	30019
Mean value	600 bar		30017
Sensor 1	599 bar		30015
Sensor 2	601 bar		30016

Servo Oil Pressure

Setpoint reference	121 bar		30014
Mean value	121 bar		30013
Sensor 1	121 bar		30011
Sensor 2	122 bar		30012
Setpoint correction	113 bar		
Deviation	0 bar		

Injection timing

IT_D (MIT)	2.8 <?	30023
VIT + FQS (IT_G)	2.8 <?	30024
Injection begin	2.8 <?	30025
Inj. time, Average val.	26.3 ms	30026
IT_A f(ch/pr)	0.5 <?	
IT_B f(speed)	3.0 <?	
IT_C f(fuel pr.)	-0.8 <?	
VIT on/off	on	

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	130.6 <?	30021
Closing angle	244.8 <?	30022
Opening deadtime	19.2 ms	
Closing deadtime	97.3 ms	

Crank Angle

Crank angle 1	0.0 <?	
Crank angle 2	0.0 <?	
TDC	Gap	
F ZeroOrderFrmW/ECS	NO	

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State: OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082-3 02.06.2010

Cyl.	Open Pos. Sensor 1/2 Sensor1	Open Pos. Sensor 1/2 Sensor2	Closed Pos. Sensor 1/2 Sensor 1	Closed Pos. Sensor 1/2 Sensor 2	Exv.A/M Cmd	Deadtime Open.Deadtim	Deadtime Clos.Deadtim	On Time Open / Close OnTime Open	On Time Open / Close OnTime Close
1	7.1 mA	7.8 mA	15.0 mA	15.4 mA	AUTO	19 ms	99 ms	0.8 ms	0.8 ms
2	7.2 mA	8.0 mA	14.4 mA	15.5 mA	AUTO	19 ms	97 ms	0.8 ms	0.9 ms
3	7.6 mA	7.7 mA	15.3 mA	15.1 mA	AUTO	19 ms	97 ms	0.8 ms	0.8 ms
4	7.5 mA	7.3 mA	15.4 mA	14.8 mA	AUTO	19 ms	97 ms	0.8 ms	0.8 ms
5	8.2 mA	8.2 mA	16.2 mA	16.4 mA	AUTO	19 ms	97 ms	0.7 ms	0.8 ms
6	7.0 mA	8.0 mA	14.9 mA	15.7 mA	AUTO	19 ms	98 ms	0.8 ms	0.8 ms

Time count [h]: 16.78

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	8.7 mA	12.3 ms	3.0 <?	26.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
2	4.4 mA	8.7 mA	12.3 ms	2.9 <?	26.3 ms	0.9 ms	0.9 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
3	4.5 mA	8.8 mA	12.5 ms	3.0 <?	26.6 ms	1.0 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
4	4.4 mA	8.7 mA	12.4 ms	2.6 <?	25.8 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
5	4.4 mA	8.8 mA	12.5 ms	2.6 <?	26.4 ms	0.7 ms	0.8 ms	0.8 ms	0.7 ms	0.8 ms	0.7 ms
6	4.4 mA	8.7 mA	12.2 ms	2.4 <?	26.5 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms

Measured Speed: 62.2 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 27 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 **fV Data 75%**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	75 %	30020
Time Count of Spare	18.49 h	

Engine speed (n)

Engine Speed	90 RPM	
Percentage	90.8 %	

Fuel command (LI)

Used for Injection	51.9 %	30001
FuelCommandPCS	51.9 %	30009
Percent of CMCR	82.8 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	1.96 bar	30003
Sensor 1	1.96 bar	30033
Sensor 2	1.95 bar	30034
Scaled to CMCR	0.75	

Fuel Rail Pressure

Setpoint	600 bar		30018
Actuator outp./Lim./near Lim.	53 %	No	No 30019
Mean value	599 bar		30017
Sensor 1	599 bar		30015
Sensor 2	601 bar		30016

Servo Oil Pressure

Setpoint reference	159 bar		30014
Mean value	159 bar		30013
Sensor 1	159 bar		30011
Sensor 2	160 bar		30012
Setpoint correction	149 bar		
Deviation	0 bar		

Injection timing

IT_D (MT)	-2.9 <?	30023
VIT + FQS (IT_G)	-2.9 <?	30024
Injection begin	-2.9 <?	30025
Inj. time, Average val.	39.7 ms	30026
IT_A f(ch/pr)	-3.1 <?	
IT_B f(speed)	0.9 <?	
IT_C f(fuel pr.)	-0.8 <?	
VIT on/off	on	

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	129.0 <?	30021
Closing angle	266.7 <?	30022
Opening deadtime	18.0 ms	
Closing deadtime	92.7 ms	

Crank Angle

Crank angle 1	0.0 <?	
Crank angle 2	0.0 <?	
TDC	Gap	
F ZeroOrderFrmWECS	NO	

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State: OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082-3 02.06.2010

Cyl.	Open Pos. Sensor 1	Open Pos. Sensor 2	Closed Pos. Sensor 1	Closed Pos. Sensor 2	Exv.A/M Cmd	Deadtime Open.Deadtim	Deadtime Clos.Deadtim	On Time Open / Close OnTime Open	OnTime Close
1	7.1 mA	7.7 mA	15.0 mA	15.4 mA	AUTO	18 ms	94 ms	0.8 ms	0.7 ms
2	7.0 mA	7.9 mA	14.2 mA	15.6 mA	AUTO	18 ms	92 ms	0.8 ms	0.8 ms
3	7.3 mA	7.7 mA	15.2 mA	15.2 mA	AUTO	18 ms	93 ms	0.8 ms	0.8 ms
4	7.4 mA	7.4 mA	15.3 mA	14.9 mA	AUTO	18 ms	91 ms	0.7 ms	0.8 ms
5	7.9 mA	8.3 mA	16.1 mA	16.4 mA	AUTO	18 ms	93 ms	0.7 ms	0.8 ms
6	6.7 mA	8.1 mA	14.8 mA	15.8 mA	AUTO	18 ms	93 ms	0.8 ms	0.7 ms

Time count [h]: 18.49

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	12.8 mA	12.0 ms	-2.7 <?	38.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
2	4.4 mA	12.8 mA	12.1 ms	-2.8 <?	40.0 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
3	4.4 mA	12.7 mA	12.1 ms	-2.7 <?	39.4 ms	0.9 ms	0.7 ms	0.8 ms	0.7 ms	0.7 ms	0.7 ms
4	4.4 mA	12.8 mA	12.2 ms	-3.1 <?	39.2 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
5	4.4 mA	12.8 mA	11.9 ms	-3.1 <?	39.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
6	4.4 mA	12.8 mA	11.8 ms	-3.3 <?	39.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms

Measured Speed: 89.8 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 75 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 **fV Data 50%**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	52 %	30020
Time Count of Spare	17.29 h	

Engine speed (n)

Engine Speed	78 RPM	
Percentage	79.4 %	

Fuel command (LI)

Used for Injection	40.9 %	30001
FuelCommandPCS	41.0 %	30009
Percent of CMCR	64.7 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	1.01 bar	30003
Sensor 1	1.01 bar	30033
Sensor 2	1.00 bar	30034
Scaled to CMCR	0.51	

Fuel Rail Pressure

Setpoint	600 bar		30018
Actuator outp./Lim./near Lim.	41 %	No / No	30019
Mean value	601 bar		30017
Sensor 1	601 bar		30015
Sensor 2	602 bar		30016

Servo Oil Pressure

Setpoint reference	141 bar		30014
Mean value	141 bar		30013
Sensor 1	141 bar		30011
Sensor 2	142 bar		30012
Setpoint correction	131 bar		
Deviation	0 bar		

Injection timing

IT_D (VIT)	-1.4 <?	30023
VIT + FQS (IT_G)	-1.3 <?	30024
Injection begin	-1.3 <?	30025
Inj. time, Average val.	33.7 ms	30026
IT_A f(ch/pr)	-2.7 <?	
IT_B f(speed)	2.1 <?	
IT_C f(fuel pr.)	-0.8 <?	
VIT on/off	on	

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	129.5 <?	30021
Closing angle	261.2 <?	30022
Opening deadtime	18.7 ms	
Closing deadtime	94.2 ms	

Crank Angle

Crank angle 1	0.0 <?	
Crank angle 2	0.0 <?	
TDC	Gap	
F.ZeroOrderFrmWECS	NO	

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State — OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082-3 02.06.2010

Cyl.	Open Pos. Sensor 1/2 Sensor 1	Open Pos. Sensor 1/2 Sensor 2	Closed Pos. Sensor 1/2 Sensor 1	Closed Pos. Sensor 1/2 Sensor 2	Exv.A/M Cmd	Deadtime Open.Deadtim	Deadtime Clos.Deadtim	On Time Open / Close OnTime Open	On Time Open / Close OnTime Close
1	7.1 mA	7.8 mA	15.0 mA	15.4 mA	AUTO	19 ms	96 ms	0.8 ms	0.8 ms
2	7.0 mA	8.1 mA	14.3 mA	15.5 mA	AUTO	19 ms	94 ms	0.8 ms	0.9 ms
3	7.4 mA	8.0 mA	15.1 mA	15.2 mA	AUTO	19 ms	94 ms	0.8 ms	0.8 ms
4	7.6 mA	7.4 mA	15.4 mA	14.8 mA	AUTO	18 ms	93 ms	0.8 ms	0.8 ms
5	8.3 mA	8.1 mA	16.3 mA	16.2 mA	AUTO	19 ms	94 ms	0.7 ms	0.8 ms
6	7.0 mA	8.1 mA	14.9 mA	15.6 mA	AUTO	19 ms	94 ms	0.8 ms	0.8 ms

Time count [h]: 17.28

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	11.1 mA	12.1 ms	-1.1 <?	33.0 ms	0.8 ms	0.7 ms	0.8 ms	0.7 ms	0.7 ms	0.8 ms
2	4.4 mA	11.1 mA	12.0 ms	-1.2 <?	34.3 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
3	4.5 mA	11.0 mA	12.2 ms	-1.1 <?	34.3 ms	0.9 ms	0.7 ms	0.8 ms	0.8 ms	0.7 ms	0.7 ms
4	4.4 mA	11.0 mA	12.1 ms	-1.5 <?	33.5 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.7 ms	0.8 ms
5	4.4 mA	11.1 mA	12.3 ms	-1.5 <?	33.9 ms	0.7 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.7 ms
6	4.4 mA	11.0 mA	11.9 ms	-1.7 <?	33.7 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms

Measured Speed: 78.4 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 52 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 **fV Data 85%**

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	83 %	30020
Time Count of Spare	19.33 h	

Engine speed (n)

Engine Speed	93 RPM
Percentage	94.6 %

Fuel command (LI)

Used for Injection	55.6 %	30001
FuelCommandPCS	55.1 %	30009
Percent of CMCR	88.2 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	2.36 bar	30003
Sensor 1	2.36 bar	30033
Sensor 2	2.34 bar	30034
Scaled to CMCR	0.85	

Fuel Rail Pressure

Setpoint	745 bar		30018
Actuator outp./Lim./near Lim.	56 %	No / No	30019
Mean value	745 bar		30017
Sensor 1	744 bar		30015
Sensor 2	745 bar		30016

Servo Oil Pressure

Setpoint reference	172 bar		30014
Mean value	173 bar		30013
Sensor 1	173 bar		30011
Sensor 2	174 bar		30012
Setpoint correction	159 bar		
Deviation	1 bar		

Injection timing

IT_D (MIT)	-2.5 <?	30023
VIT + FQS (IT_G)	-2.5 <?	30024
Injection begin	-2.5 <?	30025
Inj. time, Average val.	38.1 ms	30026
IT_A f(ch/pr)	-3.0 <?	
IT_B f(speed)	0.5 <?	
IT_C f(fuel pr.)	0.0 <?	
VIT on/off	on	

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	128.9 <?	30021
Closing angle	268.5 <?	30022
Opening deadtime	17.1 ms	
Closing deadtime	91.7 ms	

Crank Angle

Crank angle 1	0.0 <?	
Crank angle 2	0.0 <?	
TDC	Gap	
F.ZeroOrderFrmWECS	NO	

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State: OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082-3 02.06.2010

Cyl.	Open Pos. Sensor 1/2 Sensor 1	Open Pos. Sensor 1/2 Sensor 2	Closed Pos. Sensor 1/2 Sensor 1	Closed Pos. Sensor 1/2 Sensor 2	Exv.A/M Cmd	Deadtime Open.Deadtim	Deadtime Clos.Deadtim	On Time Open / Close OnTime Open	On Time Open / Close OnTime Close
1	7.4 mA	7.4 mA	15.0 mA	15.1 mA	AUTO	17 ms	93 ms	0.8 ms	0.7 ms
2	7.0 mA	7.9 mA	14.1 mA	15.4 mA	AUTO	17 ms	92 ms	0.8 ms	0.8 ms
3	7.1 mA	8.1 mA	14.9 mA	15.2 mA	AUTO	17 ms	91 ms	0.8 ms	0.7 ms
4	7.8 mA	7.0 mA	15.5 mA	14.4 mA	AUTO	17 ms	91 ms	0.8 ms	0.8 ms
5	8.3 mA	8.2 mA	16.3 mA	16.2 mA	AUTO	17 ms	92 ms	0.8 ms	0.7 ms
6	7.1 mA	8.1 mA	14.8 mA	15.6 mA	AUTO	18 ms	92 ms	0.8 ms	0.7 ms

Time count [h]: 19.33

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	13.4 mA	11.5 ms	-2.3 <?	37.9 ms	0.8 ms	0.7 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
2	4.4 mA	13.3 mA	11.6 ms	-2.4 <?	38.4 ms	0.8 ms	0.8 ms	0.7 ms	0.7 ms	0.8 ms	0.8 ms
3	4.4 mA	13.3 mA	11.6 ms	-2.3 <?	38.2 ms	0.8 ms	0.7 ms	0.8 ms	0.7 ms	0.7 ms	0.7 ms
4	4.4 mA	13.3 mA	11.6 ms	-2.7 <?	38.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
5	4.4 mA	13.3 mA	11.3 ms	-2.7 <?	37.9 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
6	4.4 mA	13.3 mA	11.2 ms	-2.9 <?	37.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms

Measured Speed: 93.6 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 83 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 | fV Data 100%

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082.3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	100 %	30020
Time Count of Spare	20.31 h	

Engine speed (n)

Engine Speed	99 RPM	
Percentage	100.0 %	

Fuel command (LI)

Used for Injection	63.3 %	30001
FuelCommandPCS	63.4 %	30009
Percent of CMCR	100.0 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	2.97 bar	30003
Sensor 1	2.97 bar	30033
Sensor 2	2.95 bar	30034
Scaled to CMCR	1.01	

Fuel Rail Pressure

Setpoint	750 bar		30018
Actuator outp./Lim./near Lim.	64 %	No / No	30019
Mean value	748 bar		30017
Sensor 1	747 bar		30015
Sensor 2	749 bar		30016

Servo Oil Pressure

Setpoint reference	200 bar		30014
Mean value	200 bar		30013
Sensor 1	200 bar		30011
Sensor 2	201 bar		30012
Setpoint correction	183 bar		
Deviation	-1 bar		

Injection timing

IT_D (VIT)	0.2 <?		30023
VIT + FQS (IT_G)	0.2 <?		30024
Injection begin	0.2 <?		30025
Inj. time, Average val.	40.9 ms		30026
IT_A f(ch/pr)	0.1 <?		
IT_B f(speed)	0.0 <?		
IT_C f(fuel pr.)	0.1 <?		
VIT on/off	on		

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	128.7 <?	30021
Closing angle	271.0 <?	30022
Opening deadtime	15.8 ms	
Closing deadtime	89.8 ms	

Crank Angle

Crank angle 1	0.0 <?	
Crank angle 2	0.0 <?	
TDC	Gap	
F.ZeroOrderFmWECS	NO	

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State: OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082.3 02.06.2010

Cyl.	Open Pos. Sensor 1	Open Pos. Sensor 2	Closed Pos. Sensor 1	Closed Pos. Sensor 2	Exv.A/M	Deadtime Open	Deadtime Close	On Time Open	On Time Close
1	7.4 mA	7.8 mA	14.9 mA	15.2 mA	AUTO	16 ms	91 ms	0.8 ms	0.7 ms
2	7.5 mA	7.9 mA	14.3 mA	15.1 mA	AUTO	16 ms	89 ms	0.7 ms	0.9 ms
3	7.5 mA	8.2 mA	15.1 mA	15.0 mA	AUTO	16 ms	89 ms	0.8 ms	0.7 ms
4	7.9 mA	7.3 mA	15.5 mA	14.4 mA	AUTO	16 ms	89 ms	0.8 ms	0.8 ms
5	8.4 mA	8.4 mA	16.1 mA	16.1 mA	AUTO	16 ms	91 ms	0.8 ms	0.7 ms
6	7.1 mA	8.1 mA	14.8 mA	15.5 mA	AUTO	16 ms	90 ms	0.8 ms	0.7 ms

Time count [h]: 20.15

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	14.6 mA	10.9 ms	0.1 <?	40.6 ms	0.8 ms	0.7 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
2	4.4 mA	14.5 mA	11.1 ms	0.0 <?	41.0 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
3	4.4 mA	14.5 mA	11.0 ms	0.1 <?	41.0 ms	0.9 ms	0.8 ms	0.8 ms	0.7 ms	0.8 ms	0.8 ms
4	4.4 mA	14.6 mA	11.0 ms	-0.3 <?	40.9 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
5	4.4 mA	14.5 mA	10.8 ms	-0.3 <?	41.1 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.7 ms
6	4.4 mA	14.4 mA	10.7 ms	-0.5 <?	41.0 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms

Measured Speed: 98.8 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 100 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine

Setting Table A2 | fV Data 110%

Hull No.	CSBC986	Owner	TPC
Engine No.	AA4163	Class	LR + CR
Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Output(MCR)	11290 kW	Engineer	C.B. KIM
Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

INDIC2: RT-flex Indications — fV-Config Vers.: 082-3 02.06.2010 — Card-CRC: 0x1004

Miscellaneous

Est.Power (FuelCmd x n)	111 %	30020
Time Count of Spare	21.02 h	

Engine speed (n)

Engine Speed	102 RPM
Percentage	103.2 %

Fuel command (LI)

Used for Injection	68.0 %	30001
FuelCommandPCS	68.2 %	30009
Percent of CMCR	107.3 %	
WECS Fuel Cmd Limiter	Normal	

Scavenge Air Pressure

Mean value	3.25 bar	30003
Sensor 1	3.25 bar	30033
Sensor 2	3.23 bar	30034
Scaled to CMCR	1.08	

Fuel Rail Pressure

Setpoint	750 bar		30018
Actuator outp./Lim./near Lim.	67 %	No / No	30019
Mean value	748 bar		30017
Sensor 1	748 bar		30015
Sensor 2	750 bar		30016

Servo Oil Pressure

Setpoint reference	200 bar		30014
Mean value	200 bar		30013
Sensor 1	200 bar		30011
Sensor 2	201 bar		30012
Setpoint correction	184 bar		
Deviation	-1 bar		

Injection timing

IT_D (MT)	0.5 <?		30023
VIT + FQS (IT_G)	0.5 <?		30024
Injection begin	0.5 <?		30025
Inj. time, Average val.	43.4 ms		30026
IT_A f(ch/pr)	0.8 <?		
IT_B f(speed)	-0.3 <?		
IT_C f(fuel pr.)	0.0 <?		
VIT on/off	on		

Number of inj. nozzles

Injection with	all nozzles	30008

Exhaust Valve

Opening angle	128.1 <?		30021
Closing angle	271.0 <?		30022
Opening deadtime	16.4 ms		
Closing deadtime	90.1 ms		

Crank Angle

Crank angle 1	0.0 <?		30023
Crank angle 2	0.0 <?		30024
TDC	Gap		30025
F ZeroOrderFmWECS	NO		30026

Interlocks

Turning Gear FCM 3	Disengaged
Turning Gear FCM 4	Disengaged
Any Blower running	No
Shutdown on Safety System	No

SW State

OK

Journal

EXHV: Exhaust valve indications — fV-Config Vers.: 082-3 02.06.2010

Cyl.	Open Pos. Sensor 1	Open Pos. Sensor 2	Closed Pos. Sensor 1	Closed Pos. Sensor 2	Exv.A/M Cmd	Deadtime Open.Deadtim	Deadtime Clos.Deadtim	On Time Open / Close OnTime Open	OnTime Close
1	7.5 mA	7.5 mA	15.1 mA	15.1 mA	AUTO	16 ms	92 ms	0.8 ms	0.7 ms
2	7.2 mA	8.2 mA	14.0 mA	15.4 mA	AUTO	16 ms	89 ms	0.8 ms	0.9 ms
3	7.8 mA	7.7 mA	15.3 mA	14.8 mA	AUTO	16 ms	90 ms	0.8 ms	0.7 ms
4	8.0 mA	7.1 mA	15.5 mA	14.4 mA	AUTO	17 ms	90 ms	0.8 ms	0.8 ms
5	8.5 mA	8.3 mA	16.3 mA	16.1 mA	AUTO	17 ms	90 ms	0.8 ms	0.7 ms
6	7.0 mA	8.2 mA	14.8 mA	15.5 mA	AUTO	17 ms	90 ms	0.8 ms	0.8 ms

Time count [h]: 21.02

Journal

INJECT: Inj.timing, value, inj.begin & deadtime

Cyl.	Quantity Piston Return	Quantity Piston Inject	Inj. begin Deadtime	Inj. begin Angle	Injection Time	OnTime Railvalve Inject Vlv.1	Vlv.2	Vlv.3	OnTime Railvalve Return Vlv.1	Vlv.2	Vlv.3
1	4.5 mA	15.4 mA	11.0 ms	0.7 <?	43.3 ms	0.8 ms	0.7 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
2	4.4 mA	15.4 mA	10.8 ms	0.6 <?	43.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms
3	4.4 mA	15.3 mA	11.2 ms	0.7 <?	43.3 ms	0.9 ms	0.7 ms	0.8 ms	0.7 ms	0.8 ms	0.7 ms
4	4.4 mA	15.4 mA	11.1 ms	0.3 <?	43.4 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
5	4.4 mA	15.4 mA	11.0 ms	0.3 <?	42.9 ms	0.8 ms	0.8 ms	0.9 ms	0.8 ms	0.8 ms	0.8 ms
6	4.4 mA	15.3 mA	10.4 ms	0.1 <?	43.6 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms	0.8 ms

Measured Speed: 102.0 RPM

Injection with: all nozzles

Est.Power(FuelCmd x n): 111 %

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
	Engine No.	AA4163	Class	LR + CR
	Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
Setting Table B	Output(MCR)	11290 kW	Engineer	C.B. KIM
	Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

Starting Air Pilot Valve

Cylinder No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Opens after T.D.C [°]	Ahead	0	0	0	0	0	0	BLANK							
	Astern	0	0	0	0	0	0								
Closes after T.D.C [°]	Ahead	90	90	90	90	90	90	BLANK							
	Astern	90	90	90	90	90	90								

Cylinder

Cylinder No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14
On Test	Distance b include Shims mm	24.1	24.4	24.2	24.5	24.1	24.1	BLANK							
↓ Bed	Compression Shim mm	36	36	36	36	36	36								
b	Comp'Pressure at 25%Output Scav. air pressure 0.330 bar	57.0	57.0	57.0	57.0	57.0	58.0	BLANK							
	Combustion Pressure at 100% Output (Fuel command 63.3 %)	150	150	150	150	150	150								
For Delivery	Distance b include Shims mm	24.1	24.4	24.2	24.5	24.1	24.1	BLANK							
	Compression Shim mm	36	36	36	36	36	36								

* Cylinder Liner Drawing No.	A20-220743-9	* Cylinder Cover Drawing No.	A20-217855-5
		* Piston Head Drawing No.	A20-146854-6

*Distance b is measured between Top surface of Piston and Upper edge of Cyl. Liner(Piston at T.D.C gasket removed)

* Piston ring	Type	No.1 : SCP1CC18	No.2~4 : SCP1RC18
	Manufacturer	GEOTZE	GEOTZE

Special Tests

* Engine speed increase	From 98.8 rpm to 100.5 rpm ΔN= 1.72%
* M/E Overspeed	Safety device stop the Engine at 107.3 rpm, 108.6% of Nominal speed

Set Points	Too low brg.oil & PCO	Exhaust v/v air spring	Piston.C.O non-flow	T/C L.O	Oil mist detector
* Pressure (kg/cm²)	2.82	4.50	ALL TESTED	0.6	ALL TESTED
* Slow down delayed (sec)	9.06	-	-	4.39	-
* Thrust pad temp.sh./down(℃)	84.9				
* Slow down delayed (sec)	58.00				

* Minimun speed	Fuel cmd %	Eng. speed	T/C speed	Power	Eng.Speed(%)	Brake
	14.1	24.7 rpm	2630	454 kW	25.00%	25.0 tonf

HYUNDAI HEAVY INDUSTRIES CO.,LTD. Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
	Engine No.	AA4163	Class	LR + CR
	Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
HYUNDAI - WARTSILA / Load Data Sheet 1	Output(MCR)	11290 kW	Engineer	C.B. KIM
	Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

Group	Item	Unit	25%		50%		75%	
General Data	Loading power(%) / Check time	% / Time	25%	11:40	50%	12:15	75%	13:30
	Engine power / speed (theoretical)	kW / rpm	2823	62.2	5645	78.4	8468	89.8
	Mean eff. pressure design / actual	bar	7.1	7.1	11.3	11.3	14.8	14.8
	Brake force (indicated)	tonf·m	61.5		98.0		128.5	
	Engine power / speed (measured)	kW / rpm	2823	62.2	5645	78.4	8468	89.8
	VIT + FQS(IT_G) / inj. begin standard value	∠°	2.8	0.0	-1.6	0.0	-2.9	0.0
	Fuel oil: Actuator Output / Fcmd	%	30.0	27.0	41.0	40.9	50.0	51.5
	Fuel oil: Consumption absol.	kg/h / g/kWh	515.00	182.46	985.00	174.49	1440.00	170.06
	Fuel oil: Consumption ISO	g/kWh	181.20		172.79		168.68	
	Cyl. Lub. oil: Injection Number	10min/1cyl	173		289		417	
	Cyl. Lub. oil: Total Feed Rate	kg/h	5.2		8.6		12.4	
	Cyl. Lub. oil: Feed Rate	g/bhph / g/kWh	1.34	1.83	1.12	1.53	1.08	1.47
Scavenge Air	Aux. Blower / Nozzles in operation	on/off / EA	ON	ALL	OFF	ALL	OFF	ALL
	Barometric pressure	hPa	1020.0		1020.0		1019.0	
	Ambient temp.	℃	17.0		18.4		19.1	
	Press drop across air cooler	mmAq	35		67		95	
	T/C filter suction pressure	mmAq	4		20		50	
	Pressure after blower	mmHg	180		790		1460	
	Scavenge air pressure	mmHg / bar	240	0.330	770	1.050	1440	1.950
	Temp. before blower	℃	16.0 18.0		22.0 19.0		22.0 21.0	
	Temp. before air cooler	℃	40		98		150	
	Temp. after air cooler	℃	23		27		33	
Exhaust Gas	Turboblower speed	rpm	6150		10579		13470	
	Pressure before turbine	mmHg	170		600		1210	
	Pressure after turbine	mmAq	15		65		135	
	Temp. before turbine	℃	283		331		340	
	Temp. after turbine	℃	241		254		224	
	Temp. after cylinder Mean	℃	245.0		296.2		308.2	
	Temp. after cylinder 1 2 3 4	℃	245 245	243 250	286 293	300 313	301 303	310 325
	Temp. after cylinder 5 6	℃	243 244		292 293		305 305	
Cylinder Pressures	Maximum / Compression press. Mean	bar / bar	84.3	57.2	114.7	75.0	145.2	104.5
	No, 1	bar / bar	85	57	115	75	145	105
	No, 2	bar / bar	84	57	115	75	146	104
	No, 3	bar / bar	84	57	114	75	145	105
	No, 4	bar / bar	83	57	114	75	145	105
	No, 5	bar / bar	85	57	115	75	145	104
	No, 6	bar / bar	85	58	115	75	145	104
Systems	Air press.: Control air / Valve air spring	bar	6.60	6.70	6.60	6.70	6.60	6.70
	Lub. oil press. : Bearing / Cross head bearing	bar	4.60	11.40	4.30	11.10	4.60	11.50
	Servo oil	bar	121		141		159	
	Servo oil pump inlet	bar	4.40		4.05		4.20	
	T/C lub oil inlet	bar	1.90		1.20		1.70	
	Axial detuner driving / free end	Mpa	0.39	0.38	0.38	0.38	0.38	0.38
	Water press.: Cylinder	bar	3.8		3.8		3.95	
	Lub. oil temp.: Bearing / Turbocharger	℃	42.0		42.0		43.0	
	Crosshead inlet	℃	42.0		42.0		43.0	
	T/C outlet	℃	45		55		69	
	Water temp.: cylinder inlet	℃	55.0		58.0		63.0	
	cylinder outlet Mean	℃	58.0		63.5		69.0	
	cylinder outlet 1 2 3 4	℃	58 58	58 58	63 63	63 64	69 69	69 69
	cylinder outlet 5 6	℃	58 58		64 64		69 69	
	Air cooler inlet	℃	19		22		26	
	Air cooler outlet	℃	23		54		62	
	Fuel: Press. bef / aft retaining valve	bar	9	3.5	8.7	3.4	8.6	3.3
	Press. Engine inlet / Rail	bar / bar	8.6	596	8.4	600	8.3	600
	Temp. before engine	℃	45		46		46	
	Thrust bearing temp.	℃	44		44		45	

HYUNDAI HEAVY INDUSTRIES CO., LTD. Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
	Engine No.	AA4163	Class	LR + CR
	Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
HYUNDAI - WARTSILA / Load Data Sheet 2	Output(MCR)	11290 kW	Engineer	C.B. KIM
	Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

Group	Item	Unit							
General Data	Loading power(%) / Check time	%	Time	85%	14:10	100%	15:10	100%	16:00
	Engine power / speed (theoretical)	kW	rpm	9597	93.6	11290	98.8	11290	98.8
	Mean eff. pressure design / actual	bar		16.1	16.1	17.9	17.9	17.9	17.9
	Brake force (indicated)	tonf·m		139.5		155.5		155.5	
	Engine power / speed (measured)	kW	rpm	9597	93.6	11290	98.8	11290	98.8
	VIT + FQS(IT_G) / inj. begin standard value	∠°		-2.4	0.0	0.2	0.0	0.2	0.0
	Fuel oil: Actuator Output / Fcmd	%		55.0	55.4	63.0	63.3	63.1	63.3
	Consumption absol.	kg/h	g/kWh	1654.00	172.35	1990.00	176.26	-	-
	Consumption ISO	g/kWh		169.68		173.83		-	
	Cyl. Lub. oil: Injection Number	10min/1cyl		459		535		536	
	Total Feed Rate	kg/h		13.7		15.9		16.0	
	Feed Rate	g/bhph	g/kWh	1.05	1.43	1.04	1.41	1.04	1.42
Scavenge Air	Aux. Blower / Nozzles in operation	on/off	EA	OFF	ALL	OFF	ALL	OFF	ALL
	Barometric pressure / Humidity	hPa	%	1018.0		1018.0		1018.0	
	Ambient temp.	℃		19.8		20.0		19.9	
	Press drop across air cooler	mmAq		104		116		117	
	T/C filter suction pressure	mmAq		63		82		82	
	Pressure after blower	mmHg		1790		2260		2260	
	Scavenge air pressure	mmHg	bar	1760	2.340	2230	2.990	2230	3.000
	Temp. before blower	℃		25.0 21.0		28.0 21.0		28.0 21.0	
	Temp. before air cooler	℃		169		196		197	
	Temp. after air cooler	℃		35		36		37	
Exhaust Gas	Turboblower speed	rpm		14330		15638		15642	
	Pressure before turbine	mmHg		1450		1880		1880	
	Pressure after turbine	mmAq		180		230		232	
	Temp. before turbine	℃		356		389		390	
	Temp. after turbine	℃		224		234		235	
	Temp. after cylinder Mean	℃		322.2		356.7		357.0	
	1 2 3 4	℃		315 322	322 328	348 355	359 370	347 356	360 371
	5 6	℃		320 326		349 359		350 358	
Cylinder Pressures	Maximum / Compression press. Mean	bar	bar	151.0	114.2	150.0	137.5	149.8	137.2
	No, 1	bar	bar	152	115	150	136	150	136
	No, 2	bar	bar	150	114	150	137	150	136
	No, 3	bar	bar	151	114	150	138	150	137
	No, 4	bar	bar	152	114	150	138	149	138
	No, 5	bar	bar	151	114	150	138	150	138
	No, 6	bar	bar	150	114	150	138	150	138
Systems	Air press.: Control air / Valve air spring	bar		6.60	6.60	6.60	6.60	6.60	6.60
	Lub. oil press.: Bearing / Cross head bearing	bar		4.20	11.30	4.17	11.30	4.16	11.30
	Servo oil	bar		172		200		200	
	Servo oil pump inlet	bar		4.10		4.00		4.00	
	T/C lub oil inlet	bar		1.80		1.85		1.85	
	Axial detuner driving / free end	Mpa		0.37	0.37	0.37	0.37	0.37	0.37
	Water press.: Cylinder	bar		4		4		4	
	Lub. oil temp.: Bearing / Turbocharger	℃		43.0		43.0		43.0	
	Crosshead inlet	℃		43.0		43.0		43.0	
	T/C outlet	℃		75		81		81	
	Water temp.: cylinder inlet	℃		69.0		68.0		68.0	
	cylinder outlet Mean	℃		75.0		75.5		75.7	
	1 2 3 4	℃		75 75	75 75	75 76	76 75	76 76	76 75
	5 6	℃		75 75		75 76		75 76	
	Air cooler inlet	℃		28		23		23	
	Air cooler outlet	℃		58		67		68	
	Fuel: Press. bef / aft retaining valve	bar		8.3	3.2	8.3	3.1	8.3	3.1
	Press. Engine inlet / Rail	bar	bar	8.2	745	8.0	748	8.0	747
	Temp. before engine	℃		46		46		46	
	Thrust bearing temp.	℃		45		45		45	

HYUNDAI HEAVY INDUSTRIES CO.,LTD.	Official Shop Test Result For Main Engine	Hull No.	CSBC986	Owner	TPC
		Engine No.	AA4163	Class	LR + CR
		Engine Type	6RT-flex58T-D	Test Date	Mar.30,2011
HYUNDAI - WARTSILA	Load Data Sheet 3	Output(MCR)	11290 kW	Engineer	C.B. KIM
		Speed(MCR)	98.8 rpm	Operator	Y.H. KIM

General Data	Loading power(%) / Check time				%	Time	110%	16:00						
	Engine power / speed (theoretical)				kW	rpm	12419	102.0						
	Mean eff. pressure design / actual				bar		19.1	19.1						
	Brake force (indicated)				tonf·m		165.5							
	Engine power / speed (measured)				kW	rpm	12416	102.00						
	VIT + FQS(IT_G) / inj. begin standard value				∠°		0.5	0.0						
	Fuel oil:	Actuator Output	Fcmd		%		67.0	67.9						
		Consumption absol.			kg/h	g/kWh	2225.00	179.16						
		Consumption ISO			g/kWh		177.02							
	Cyl. Lub. oil:	Injection Number			10min/1cyl		593							
		Total Feed Rate			kg/h		17.7							
		Feed Rate			g/bhph	g/kWh	1.05	1.42						
Scavenge Air	Aux. Blower / Nozzles in operation				on/off	EA	OFF	ALL						
	Barometric pressure / Humidity				hPa	%	1028.0	21.0						
	Ambient temp.				℃		19.2							
	Press drop across air cooler				mmAq		117							
	T/C filter suction pressure				mmAq		97							
	Pressure after blower				mmHg		2450							
	Scavenge air pressure				mmHg	bar	2430	3.260						
	Temp. before blower				℃		28.0	21.0						
	Temp. before air cooler				℃		207							
	Temp. after air cooler				℃		36							
Exhaust Gas	Turboblower speed				rpm		16330							
	Pressure before turbine				mmHg		2080							
	Pressure after turbine				mmAq		290							
	Temp. before turbine				℃		425							
	Temp. after turbine				℃		252							
	Temp. after cylinder		Mean		℃		386.7							
			1 2 3 4		℃		375	390	385	400				
			5 6		℃		380	390						
Cylinder Pressures	Maximum / Compression press.		Mean		bar	bar	155.8	145.8						
			No,	1	bar	bar	156	146						
			No,	2	bar	bar	156	146						
			No,	3	bar	bar	156	146						
			No,	4	bar	bar	156	145						
			No,	5	bar	bar	156	146						
			No,	6	bar	bar	155	146						
Systems	Air press.:	Control air / Valve air spring			bar		6.60	6.60						
	Lub. oil press. :	Bearing / Cross head bearing			bar		4.15	11.30						
		Servo oil			bar		200							
		Servo oil pump inlet			bar		4.10							
		T/C lub oil inlet			bar		1.80							
		Axial detuner driving / free end			Mpa		0.37	0.37						
	Water press.:	Cylinder			bar		4							
	Lub. oil temp.:	Bearing / Turbocharger			℃		43.0							
		Crosshead inlet			℃		43.0							
		T/C outlet			℃		84							
	Water temp.:	cylinder inlet			℃		68							
		cylinder outlet	Mean		℃		76.0							
			1 2 3 4		℃		76	76	76	76				
			5 6		℃		76	76						
		Air cooler inlet			℃		23							
		Air cooler outlet			℃		65							
	Fuel:	Press. bef / aft retaining valve			bar		8.3	3.1						
		Press. Engine inlet / Rail			bar	bar	8	790						
		Temp. before engine			℃		46							
	Thrust bearing temp.				℃		45.0							

附件 7：現代重工公司主機及發電機售後顧客服務部門組織及 DAEHWA 公司授權書

Jan 05, 2011

HYUNDAI
HEAVY INDUSTRIES CO.LTD

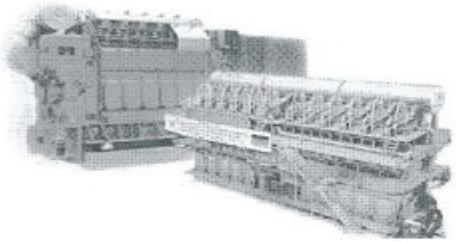
엔진기계
ENGINE & MACHINERY

Organization
of
Engine Customer Service Department

http://cs.hyundai-engine.com

E-mail : enginecs@hhi.co.kr

Organization of Engine Customer Service Department



Engine CS Department

Seon-Gun Cha / General Manager
Tel : +82 52 202 7411
Fax : +82 52 202 7581
E-mail: sgcha@hhi.co.kr

HiMSEN Service Team

Kyung-Dal Kim / Leader
Tel : +82 52 202 9457
E-mail: kimkd@hhi.co.kr

MAN Service Team

Ahn-Min Kim / Leader
Tel : +82 52 202 7418
E-mail: amkim@hhi.co.kr

Rotterdam Service Center

Jeong-Su Lee / GM
Tel : +31 10 212 1567
E-mail: jsyi@hhi.co.kr

Power Plant Service Team

Ho-Jeong Song / Leader
Tel : +82 52 202 7583
E-mail: hjdpp@hhi.co.kr

Wartsila Service Team

Kyong-Uk Song / Leader
Tel : +82 52 202 7412
E-mail: kusong@hhi.co.kr

Singapore Service Center

Jae-Hyung Ahn / DGM
Tel : +65 9732 4593
E-mail: engineas@hhisgp.com

Global Patrol Service

Sung-Lim Choi / Leader
Tel : +82 52 202 7313
E-mail: slchoi@hhi.co.kr

CS Planning Team

Jae-Ho Jung / Leader
Tel : +82 52 202 7586
E-mail: kevin@hhi.co.kr

Dubai Service Center

Kyun-Sik Jang / DGM
Tel : +971 4 425 7995
E-mail: j007@hhi.co.kr

Parts & Technical Service

Hyoung-Log Oh / Leader
Tel : +82 52 202 7312
E-mail: hloh@hhi.co.kr

Cuba TSC

In-Kyu Ryu / GM
Tel : +53 5 286 7712
E-mail: ikryu@hhi.co.kr

HiMSEN Service Team

Kyung-Dal Kim / Leader

Tel : +82 52 202 9457
E-mail: kimkd@hhi.co.kr

1. Guarantee Claim Management for HiMSEN & Medium Engines
2. Field service
3. Customer Management
4. Feedback
5. Major Common Defect Management
6. Issuing Service Letter
7. Customer Assist for Guarantee Expired Engine

O.R. Kim
(Ext.2-9459)
orkim@

B.I. Min
(Ext.2-9458)
minbl@

J.B. Youn
(Ext.2-9092)
jbyoun@

S.H. Lee
(Ext.2-9459)
sungholee@

J.H. Yoo
(Ext.2-9458)
jhyoo56@

K.S. Choi
(Ext.2-9092)
kisung2nd@

J.Y. Ahn
(Ext.2-9459)
jiyeon115@

Parts & Technical Service Team

Hyoung-Log Oh / Leader

Tel : +82 52 202 7312
E-mail: hloh@hhi.co.kr

1. Sales for Marine Engine Spare Parts
2. Technical Information
3. Field Service
4. Invoicing & payment receipt
5. Management for Authorized Sales Agents

H.J. Lee
(Ext.2-7414)
icepark@

C.S. Kang
(Ext.2-7317)
cskang@

S.Y. Kim
(Ext.2-7314)
skytop@

S.D. Seo
(Ext.2-7316)
sdseo@

K.H. Kim
(Ext.2-7580)
khkim2@

H.Y. Jung
(Ext.2-7315)
hyjung@

H.S. Lim
(Ext.2-7316)
hyangsoo klim@

J.M. Kim
(Ext.2-7580)
junman@

M.Y. Kim
(Ext.2-7315)
mykim@

H.J. Lee
(Ext.2-7317)
hj0423@

J.I. Kwon
(Ext.2-7584)
juniry@

J.Y. Kang
(Ext.2-7314)
jykang83@

S.J. Park
(Ext.2-7584)
sujin2011@

Wartsila Service Team

Kyong-Uk Song / Leader

Tel : +82 52 202 7412
E-mail: kusong@hhi.co.kr

1. Guarantee Claim Service for Wartsila Engines
2. Guarantee Claim Service for Pump, Turbine and Thruster
3. Feedback
4. Major Common Defect Management
5. Publication of Service Letter
6. Technical Support for the Engines after Guarantee periods

Y.J. Lee
(Ext.2-7420)
yongjoon@

J.S. Park
(Ext.2-7417)
jspark@

S.H. Cha
(Ext.2-7419)
shcha@

D.H. Son
(Ext.2-7419)
doohyun.son@

H.B. Lee
(Ext.2-7420)
leehb@

CS Planning Team

Jae-Ho Jung / Leader

Tel : +82 52 202 7586
E-mail: kevin@hhi.co.kr

1. Management of Global Service Network
2. Simple Guarantee Claim (C3) Management
3. Management of Stock for Spare Parts
4. Statistical Data of CS Business
5. Hi-Service Management
6. Outsourcing Arrangement
7. Invoicing and Payment Control
8. Administration

S.S. Choi
(Ext.2-9460)
sschoi@

C.K. Kang
(Ext.2-7588)
dream4u@

J.H. Yoon
(Ext.2-7587)
yoonjh@

I.D. Kim
(Ext. 3-1704)
idkim@

S.O. Lim
(Ext.2-7590)
soonok@

S.Y. Yun
(Ext.2-7588)
sy.yun@

H.S. Kim
(Ext.2-7588)
hyoosook@

J.H. Heo
(Ext.2-7590)
jhheo@

S.Y. Choi
(Ext.2-7587)
bunch22@