出國報告（出國類別：洽公)

50,000 噸級油品化學品輪(安運輪)建造採購案(A2910T002)主機出廠前性能測試

服務機關：台灣中油股份有限公司
姓名職稱：黃戊辰 組長 / 徐耀南 工程師
派赴國家：韓國釜山
出國期間：112 年 11 月 13 日至 16 日
報告日期：112 年 12 月 12 日

摘要

為配合本公司「A10901 四萬噸級成品油輪新建投資計畫」，於台灣國際造船股份有限公司建造 50,000 噸級油品化學品輪一艘(船號 H1193)，於建造期間確認主要裝備之性能滿足規範需求，並於出廠前進行廠內性能測試(FACTORY ACCEPTANCE TEST, FAT)。

本次測試裝備為該輪所用主推進引擎，於原廠位於韓國釜山昌原市之 HSD Engine 公司進行。測試內容包含安全保護裝置作動情形、緊急運轉測試、緊急停止測試、負載運轉性能測試、調速計測試、超速測試、最小運轉測試及油耗量測等測試，並於運轉後拆解部分主要構件進行檢查。

經兩天運轉測試及拆檢結果，初步測試及最後之討論結果確認主機性能符合原廠所提供之性能測試標準。廠試後，此主機將送往台船公司進行安裝，於新船下水後再進行船上試驗及最終調校等，並於海上公試時進行整合測試，以確保未來營運期間可正常運轉並符合作業需求。

本次測試自 112 年 11 月 13 至 112 年 11 月 16 日止，總計 4 天，含交通往返。

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一 、目的

為滿足本公司國內白油類油品環島調度運輸之需求，新建 50,000 噸級油品化學品輪一艘，船名為「安運輪」，於 111 年 7 月 20 日與台灣國際造船股份有限公司簽約建造，交船期限為 113 年 12 月 31 日。

為配合船廠建造期程，於建造期間確認主要裝備之性能滿足規範需求，於出廠前進行廠內性能測試(FACTORY ACCEPTANCE TEST, FAT)，以確保未來安裝於新船上符合契約要求及實際作業需求。

本次測試裝備為該輪所用主推進引擎，於原廠位於韓國釜山昌原市之 HSD Engine 公司進行。測試內容包含安全保護裝置作動情形、緊急運轉測試、緊急停止測試、負載運轉性能測試、調速計測試、超速測試、最小運轉測試及油耗量測等測試，並於運轉後拆解部分主要構件進行檢查。

二 、過程

本次測試自 112 年 11 月 13 至 112 年 11 月 16 日止，總計 4 天，含交通往返。

(一) 出國行程

預定起迄日期	到達地點	工作內容
112 年 11 月 13 日	台北-韓國釜山-昌原	去程
112 年 11 月 14-15 日	韓國昌原市 HSD 工廠	1. 廠試前溝通會議 2. 安全保護裝置測試 3. 無負載啟動、操控及反轉測試 4. 負載運轉測試 5. 調速器測試 6. 超速測試 7. 最低轉速測試 8. 其他項目測試 (氮氧化物排放、震動及連續啟動) 9. 運轉後拆缸檢驗 10. 結束會議
112 年 11 月 16 日	昌原-韓國釜山-台北	回程

(二) 參加人員

1. 廠商(HSD Engine公司)代表：
   品管部：Hoosun Lee、Cheulmin Cha、Keunwoo Lee

2. 船東：
   中油儲運處造船組 黃戊辰組長、徐耀南工程師

3. 中油委託技術服務案廠商：
   財團法人船舶暨海洋產業研發中心 船舶產業處輪機組 林昇翰副組長

4. 船廠代表：
   台灣國際造船股份有限公司 品保處 黃安逸工程師

5. 驗船協會：
   中國驗船中心：檢驗處 驗船師 徐伯諒專案經理
   勞氏驗船協會：昌原辦事處 驗船師 Tae-Hoon Kim

(三) 廠試標的

1. 名稱：主推進引擎

2. 廠牌：HSD Engine
   型號：5S50ME-C10.6-Tier Ⅱ
   編號：DML0106665

3. 額定出力：6,850 kW x 117.0 RPM

(四) 廠試過程

1. 廠試前溝通會議

於上午抵達 HSD ENGINE Co., LTD. 昌原工廠會議室，首先由該廠 Deputy General Manager MR. Lee 主持啟始會議，再由 Technical Senior Manager MR. Cha 介紹本次測試程序、測試內容及預計時程，之後穿戴個人安全防護具至測試工廠開始進行測試流程。

廠試前溝通會議

主機外觀

2. 安全保護裝置測試

為確保安全保護裝置功能正常，本次測試項目總計11項。舉例說明如下：

(1) 油霧偵測器功能測試(O.M.D. function test)：分為模擬測試及實測測試，模擬測試為訊號測試；實測測試為利用瓦斯直接噴至偵測器觸發其功能。

No.1 Cyl 實測測試

No.4 Cyl 模擬測試

(2) 推力塊高溫(Thrust pad high temp.)：使用模擬方式使推力塊溫度升高，進而作動安全保護機制，致使主機停機。

溫度校正器

主機銘牌

(3) 主潤滑油低壓(Main lub. oil low pressure)：模擬壓力低至1.3±0.1 bar時，作動安全保護機制使主機停機。

(4) 增壓機潤滑油低壓(T/C lub. oil low pressure)：模擬壓力低至0.6±0.1 bar時，作動安全保護機制使主機停機。

主潤滑油低壓測試

增壓機潤滑油低壓測試

其他測試項目包括轉車機互鎖功能，油壓動力系統(HPS)之油壓泵油壓建立時間功能

及洩漏警報與進口低壓等功能，測試結果皆正常運作，測試合格。(測試結果如下圖)

No.	Safety Device	Setting	Actually
1.	Thrust pad high temp.	90 ± 2 ℃	90.2 ℃
2.	Turning gear interlock test		OK
3.	O.M.D. function test – NO.1 & NO.4		OK
4.	Main lub. oil low pressure	1.3 ± 0.1 bar	1.33
5.	T/C lub. oil low pressure	0.6 ± 0.1 bar	0.66
6.	Test of cyl. lub. oil slow down sensor-level		OK
7.	Meas. of press. build-up time with start pump (1 pump)	3 mins	22.11 s
8.	Meas. of press. build-up time with start pump (2 pumps)	1.5 mins	16.98 s
9.	Test of HPS leakage alarm – large oil leakage		OK
10.	Test of HPS inlet pressure Low		OK
11.	Test of hydraulic main pumps – pump response test		OK

3. 無負載啟動、操控及反轉測試

於機側控制盤上操作主機，分別令主機於正轉及反轉進行測試，並進行緊急停止測試。測試功能皆正常運作，測試合格。

M/E Local Operation Panel

M/E Emergency Trip Test

4. 負載運轉測試

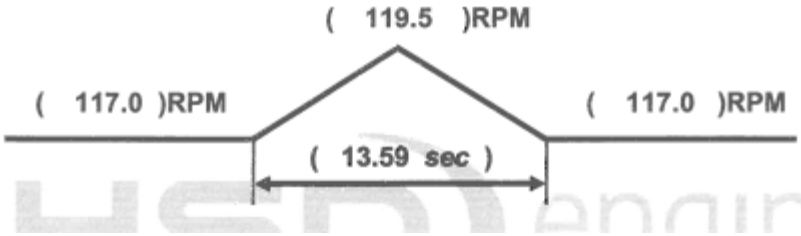
此測試分成10階段進行：25%、35.4%、46.2%、50%、58.8%、73.5%、75%、85%、100%及110%，以觀察不同負載時之運轉狀況，並於運轉過程中記錄各階段輸出功率、轉速、增壓機轉速、掃氣壓力及溫度、爆發壓力及排氣溫度等，做為未來營運及維護之參考資料。

此外，亦確認主機於 85% MCR 功率和轉速時之燃油消耗率，且經由ISO公式修正後為 156.5 (g/kW-h)，符合原廠標準 151.4+5% (g/kW-h)範圍內。(公式如下圖，並參考附件二 Summary of Load Test P3-1~3-3)

$$\text{ISO correction} = \text{Measured value} \times (LCV/LCVref) \times [1 + \{(Tsc,ref - Tsc)/10 \times (factor) + (To,ref - To)/10 \times (factor) + (Po,ref - 1000/750.0617 \times Po)/10 \times (factor) + (PEaT,ref - PEaT)/100 \times (factor)\} / 100]$$

5. 調速器測試

主要測試調速器於負載劇烈變動時之反應能力。將主機維持在滿負載且穩定運轉後，迅速移除負載，以觀測主機轉速變化率，其衡量標準為不得超過額定轉速(Revolution of MCR)之15%。測試最高轉速由每分鐘117轉上升至119.5轉，回復時間為13.59秒，(119.5-117)/117 × 100% = 2.14%，轉速變化率為2.14 %，調速器功能正常且滿足船級協會標準。(如下圖)



6. 超速測試

轉速超速安全保護裝置測試，確認超速保護裝置功能正常。測試結果於128.8 RPM時主機跳脫，此時轉速約超過MCR轉速(117 RPM)的10.09%。(如下圖)

SETTING VALUE	ACTUAL VALUE
127.5	*128.8*

7. 最低轉速測試

主機可維持正常運轉時之最低轉速，測試結果以 25.0 RPM 執行運轉測試5分鐘，確認主機運作正常無誤。(如下圖)

Check Point	Act'l Value	Unit	Check Point	Act'l Value	Unit
Engine Speed	*25.0*	RPM	#1 T/Charger	*4482*	RPM
Water Brake	*24.1*	TON			
Fuel Index	*38*	-			

調速器測試

最低轉速測試

8. 其他項目測試（氮氧化物排放、震動及連續啟動）

主機在測試過程中，量測氮氧化物排放及震動皆無異常現象。另以遠端操控主機進行連續啟動測試，確保啟停正常作動達12次；但因廠商測試之空氣櫃與該油輪實際大小有異，本次測試僅供參考，實際情形需待設備安裝上船後列入測試項目。

氮氧化物排放測試

振動量測

連續啟動測試

船級協會鋼印

9. 運轉後拆缸檢驗

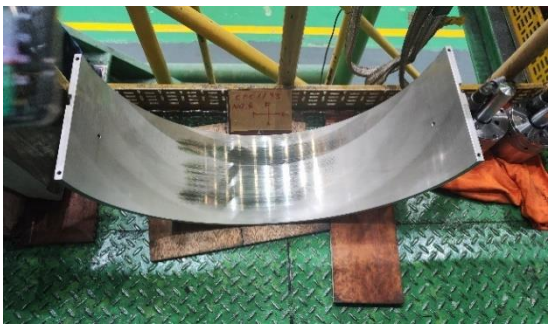
拆缸檢驗於廠試第二天引擎冷卻後執行。

(1) 挑選第1缸，檢驗其十字頭軸承、十字頭導軌、氣缸套、氣缸頭及活塞。

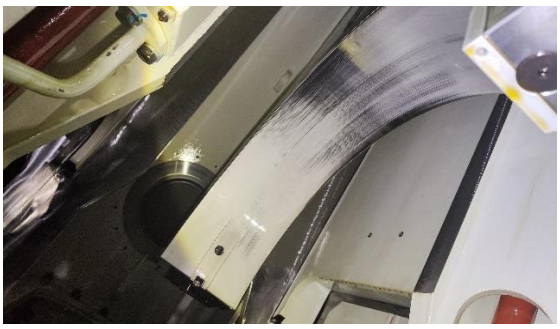
(2) 挑選第4缸，檢驗其主軸承。

(3) 挑選第5缸，檢驗其曲柄銷軸承，並至曲軸箱內檢視其曲拐軸。

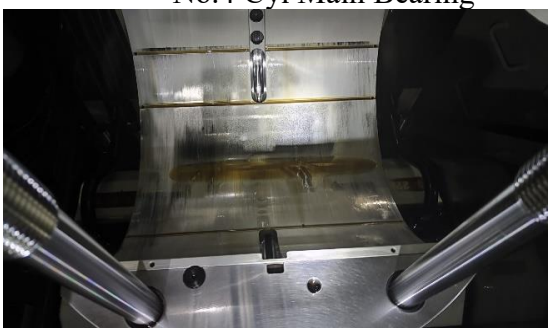
測試結果未見任何異常，確認各部位於運轉後仍保持良好狀態。另外，觀察到本次測試用潤滑油色澤較為暗沉，經廠商澄清為重複使用所致，故請廠商進行化驗並提供檢驗報告及Flushing report。



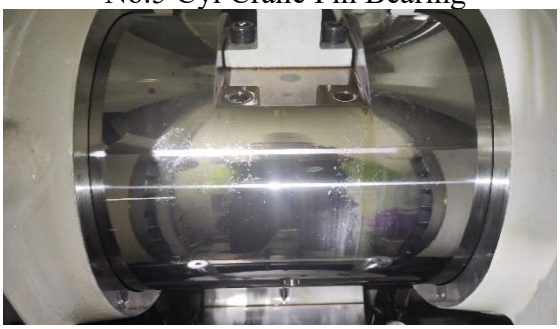
No.4 Cyl Main Bearing



No.5 Cyl Crane Pin Bearing

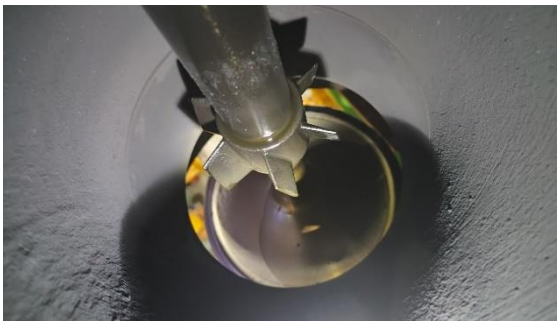


No.1 Cyl Crosshead Bearing

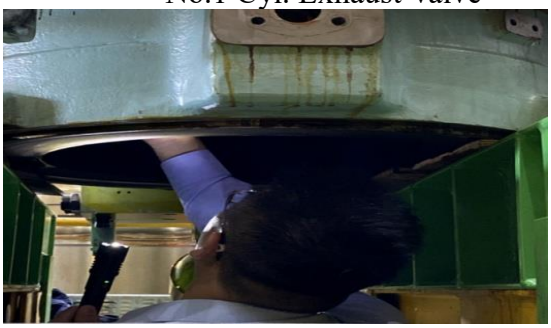


No.1 Crosshead Pin and Guide Rail

No.1 Cyl. Exhaust Valve



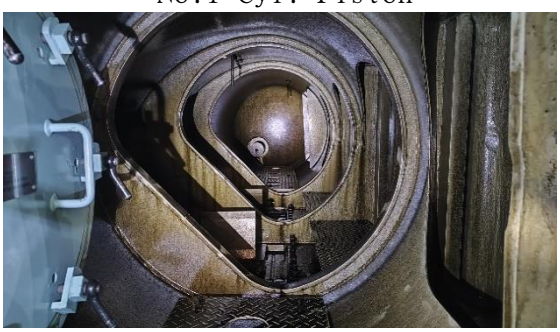
No.1 Cyl. Exhaust Valve



No.1 Cyl Cover

No.1 Cyl. Piston

No.1 Cyl Piston Rod Stuff Box



Scav. Space

10. 結束會議

各項測試完成後，召開討論會議及建議事項，並確認廠試結果符合設計條件及規範需求，結束本次廠試流程。(檢驗記錄如附件一及附件二)

廠試過程發現有部分需改善之項目，並開觀察事項，要求原廠提供改善及補充資料，其中需追蹤項目如下:

1. 由於本次廠試前，原廠發現第1缸排氣閥組發生異常噪音，而導致廠試延後，要求原廠提供排氣閥檢查及分析報告。

2. 部分管路明顯有振動發生，建議加強固定及防震。

3. 滑車之荷重為3噸，但支撐樑只有標示2噸，請釐清及正確標示。

4. 部分之警示牌建議提供中英文對照，並修正部分中文之翻譯用詞。

5. 所有EYE PIECE須標示SWL，SWL需要用PUNCH MARK而不是僅使用油漆標示。

6. 操作說明位置需移位，以方便船員操作時讀取資訊，包括啟動閥斯緊急操作及透平機之清洗步驟。

7. Scav. Air receiver(0.5 bar = 0.6 bar abs)的警示牌有誤，請修改。

三 、具體成效

本次廠試主要目的為針對製造完成之主機引擎，於現場驗證其設計條件、參數範圍值、引擎馬力、燃油消耗率及其他相關功能等項目是否符合船級協會、船東契約及規範及廠家所提供之標準。此外，收集相關量測數值也可做為該油輪未來營運操作之參考基準。

四 、心得及建議

1. 本次主機於 112 年 11 月 14 日早上 9 時試運轉時，第 1 缸排氣閥組發生異常噪音，經廠商查驗後仍無法查出原因及處理，故採取更換第 1 缸整組元件，於下午 4 時後才開始進行測試。後續測試過程中無發生任何相關噪音及警報等異常，廠試結束後亦請廠商提供相關事故診斷報告，分析原因為異物進入節流閥導致噪音產生而無法正常運作。(如附件三)

2. 為使本次量測數值具正確性及參考價值，請廠商提供各儀器校正報告，查詢其 Expire Date 皆未逾期。(如附件四)

3. 廠試完成後，於結束會議中提出請廠商改善項目及補充資料，並進行後續追蹤。(如附件五)

4. 本次為職第一次參加國外廠試之經驗，藉由圖說及測試程序並配合現場實作下，更能清楚明瞭主機之各種性能。尤其是運轉後拆解檢驗部分，更加熟悉各部位零件其功能及運作原理。因此，為使爾後本公司對於油輪管理及設備保養維修更有成效，裝備出廠前先進行廠內性能測試仍有其必要性。

5. 主機之燃料油消耗率量測結果為 156.6 (g/kW-h)，雖大於契約要求的 152.5 (g/kW-h)，但仍在所規定之 152.5±5% (g/kW-h)範圍內，因此尚符合契約規定之需求。

6. 主機為油輪之主要動力來源，若無相當之可靠及耐用性，易發生故障致無法正常運轉。失去動力時不但對船體造成威脅，也會危害到船員之生命安全，更間接影響到本公司之經營績效。因此，為確認主機各項功能是否符合法規標準，油耗是否符合契約需求，必須透過第一階段廠試來把關，以確保往後運轉之穩定性。

7. 本次廠試結果順利符合各項規定，然而後續還得待設備運送至船廠並正式安裝於新建油輪上，且與各種設備及諸多系統完成整合。首先經由船上試驗(On Board Test)來進行最終調校，再執行海上測試(Sea Trail)來驗證船廠設計能力及能源效率設計指數(EEDI)是否達標，最後驗收交船程序後才能算正式完成。

五 、附件

(一) INSPECTION RECORD

(二) Summary of Load Test

(三) RCA for abnormal sound of exhaust valve

(四) 儀器校正報告

(五) Comments for After FAT meeting

HSD engine **INSPECTION RECORD(A)** 검 사 기 록 서				Record No. 기록서 번호 : 1193 A-T012-01	
				Page No. 페이지 번호 : 2 of 5	
Pjt. Name 공 사 명 : CPC 1193		Hull No. 선박번호 : 1193		Dwg/Trv No. 도번/공정번호 : 7203	
Owner 주 문 주 : CPC Corporation, Taiwan		Class 선 급 : CR + LR		Engine Type 엔진형식 : 5S50ME-C10.6-TII	
Result 결 과 : ☑ Satisfactory ☐ Unsatisfactory		Inspected By 검사자		C. M. CHA	15th Nov 2023 Date
Kind of inspection 검사종류 : OFFICIAL SHOP TEST					
Witnessed By 입 회 자 :		Witnessed By 입 회 자 :		Witnessed By 입 회 자	

ENGINE TYPE : 5S50ME-C10.6-TII
OUT PUT AT MCR : 6,850 (kW) X 117.0 RPM
SHOP TEST DATE : 14th Nov 2023 15:00 ~
OVERHAUL DATE : 15th Nov 2023 14:00 ~
TEST PLACE : HSD Engine Plant No.1

952-23-1061
CHA2304914
15-Nov-2023

1. OFFICIAL SHOP TEST

THE FOLLOWING TESTS ARE TO BE CARRIED OUT AT ENGINE BUILDER'S TEST BENCH, USING ENGINE BUILDER'S FACILITIES, LUB.OIL AND DIESEL OIL IN THE PRESENCE OF THE REPRESENTATIVE OF SHIPYARD, SHIPOWNER, CLASSIFICATION SOCIETY.

1) SAFETY DEVICE CONFIRMATION TEST (Yes / No)

EACH SET VALUE OF THE FOLLOWING ENGINE SAFETY DEVICE IS CONFIRMED TO CAUSE ENGINE AUTOMATIC EMERGENCY STOP.

SAFETY TEST ITEM	SETTING VALUE	ACTL VALUE	UNIT
Thrust pad high temp.	90 ± 2	90.2	℃
Turning gear interlock test	-	OK	-
O.M.D function test[1]	No.1, 4	OK	-
Main lub. oil low pressure	1.3 ± 0.1	1.33	bar
T/C lub. oil low pressure	0.6 ± 0.1	0.66	bar
Control System FAT[2]	-		-

[1] OMD function test : 2Cylinders (1Cylinder: M/E running, 1Cylinder: Simulation)
[2] Control System FAT : Please refer to a separate Control System FAT report

2) EMERGENCY RUNNING TEST (Yes / No)

IT SHALL BE CONFIRMED THAT THE ENGINE CAN BE MANOEUVRED,I.E. STARTING, FUEL RUNNING AND REVERSING, BY USING MANOEUVRING HANDLE AND VALVES ON LOCAL MANOEUVRING STAND AT ENGINE SIDE UNDER THE ASSUMPTION OF CONTROL ROOM CONTROL FAILURE.

3) EMERGENCY TRIP TEST (Yes / No)

IT SHALL BE CONFIRMED THAT THE ENGINE IS TO BE STOPPED BY ACTIVATING THE EMERGENCY STOP SWITCH ON LOCAL MANOEUVRING STAND AT ENGINE SIDE.

4) STARTING AND MANEUVERING TEST AT NO LOAD & ASTERN TEST AT NO LOAD (Yes / No)

THIS TEST IS CARRIED OUT VIA THE GOVERNOR SYSTEM(ECR control) AND CONSISTS OF MANOEUVRES START AHEAD-STOP-START ASTERN (1 Time)

HSD engine	INSPECTION RECORD(B) 검 사 기 록 서	Record No. 기록서 번호 : 1193 A-T012-01
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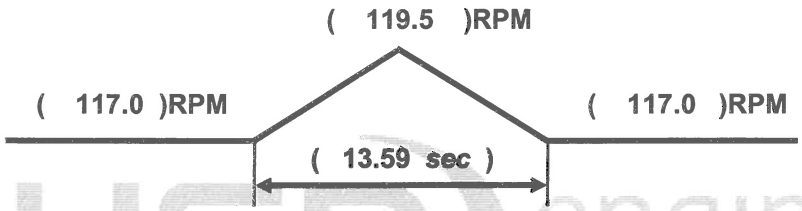
5) LOAD TEST (Yes / No)

LOAD (%)	Rpm	Output (KW)	Time (min)	Measuring	Comment
25	73.7	1713	30	1 time	
35.4	82.8	2425	30	1 time	
46.2	90.4	3165	30	1 time	
50	92.9	3425	30	1 time	
58.8	98.0	4028	30	1 time	
73.5	105.6	5035	30	1 time	
75	106.3	5138	30	1 time	
85	110.8	5823	60	1 time	SFOC
100	117.0	6850	60	2 time	
110	120.8	7535	30	1 time	

6) GOVERNOR TEST (Yes / No)

SET ENGINE AT SMCR LOAD AND DECREASE LOAD BY WATER BRAKE AS FAST AS POSSIBLE
CONTROL FUNCTION OF THE GOVERNOR WILL BE CONFIRMED.



7) OVER SPEED TEST (Yes / No)

THE SET VALUE OF RPM TO TRIP IS TO BE CONFIRMED BY WAY OF AUTOMATIC STOPPING OF ENGINE AT FOLLOWING RPM

SETTING VALUE	ACTUAL VALUE
127.5	*128.8*

8) MINIMUM REVOLUTION TEST (Yes / No)

IT IS ASCERTAINED THAT THE ENGINE IS TO BE ABLE TO RUN AT THE MINIMUM CONTINUOUS REVOLUTIONS OF **25.0 *RPM ± 1.0 RPM*** UNDER THE FIRING CONDITION OF ALL CYLINDERS.

Check Point	Act'l Value	Unit	Check Point	Act'l Value	Unit
Engine Speed	***25.0***	RPM	#1 T/Charger	***4482***	RPM
Water Brake	***24.1***	TON			
Fuel Index	***38***	-			

9) ADDITIONAL ITEMS

A-1) Nox mearsurement at 25, 50, 75% and 100% load for 1st engine only (Yes / No)

A-2) Vibration mearsurement at 50, 75, 85% and 100% load for 1st engine only (Yes / No)

A-2) Consecutive start test before load test for 1st engine only (Yes / No)

HSD engine INSPECTION RECORD(B) 검 사 기 록 서	Record No. 기록서 번호 : 1193 A-T012-01
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2. OVERHAUL INSPECTION (HULL NO. : 1193)

AFTER SHOP TEST, APPEARANCE INSPECTIONS ARE TO BE CARRIED OUT ON THE FOLLOWING PARTS IN THE PRESENCE OF THE REPRESENTATIVE OF SHIPYARD, SHIP OWNER AND CLASSIFICATION SOCIETY.

ITEM	CYL' NO.	RESULT
1. CRANKSHAFT WITHOUT LIFTING FROM BEDPLATE	Visual	OK
2. 1SET OF MAIN BEARING (DISMANTLED FROM ENGINE)	4	OK
3. 1SET OF CRANK PIN BEARING (WITHOUT DISMANTLING FROM ENGINE)	5	OK
4. 1SET OF CROSSHEAD BEARING (WITHOUT DISMANTLING FROM ENGINE)	1	OK
5. 1SET OF CROSSHEAD PIN AND GUIDE RAIL (WITHOUT DISMANTLING FROM ENGINE)		
6. 1SET OF CYLINDER LINER (INNER SURFACE, WITHOUT DISMANTLING FROM ENGINE)		
7. 1SET OF CYLINDER COVER (COMBUSTION SURFACE, DISMANTLED FROM ENGINE)		
8. 1SET OF PISTON COMPLETE (DISMANTLED FROM ENGINE)		
9. STEP-UP GEAR (WITHOUT DISMANTLING FROM ENGINE)	Visual	OK
* REMARK :		

RESULT OF OVERHAUL INSPECTION

SHIP OWNER	SHIP YARD	CLASS	HSD ENGINE
		CR B.C. Hsu	15th Nov. 23

LR
T.H. Kim
15-Nov-2023

HSD engine INSPECTION RECORD(B) 검 사 기 록 서	Record No. 기록서 번호 : 1193 A-T012-01
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3. PARTICULARS OF ENGINE

No.	ITEMS	DESCRIPTION
1	Type	HSD-MAN B&W type, Two stroke, Single acting, Direct reversible, Welded design, Crosshead type, Main Diesel Engine with Exhaust gas turbocharger(s).
2	Arrangement of Engine	Starboard
3	Rotation direction	Clockwise, viewed from Aft side (driving end)
4	Arrangement of cylinders	No.1 cyl. to be arranged at fore side (free end)
5	Model	5S50ME-C10.6
6	Number of Cylinders	5
7	Firing order	1 – 4 – 3 – 2 - 5
8	Cylinder bore	500 (mm)
9	Stroke	2,214 (mm)
10	Specific Max. Continuous Rating (SMCR) 10.1 Output 10.2 Pmax *1) 10.3 Compression pressure 10.4 M.E.P 10.5 M.I.P 10.6 Con. rod ratio (λ=l/r) 10.7 Compression ratio (ξ) 10.8 Charge air pressure	 6,850 kW x 117.0 RPM 220 (Bar) 185 (Bar) 16.2 (Bar) 17.2 (Bar) 0.5 16.4 2.72 (Bar.a)
11	Weight of flywheel (turning wheel)	12,716 (kg)
12	Outer diameter of flywheel (turning wheel)	2,808 (mm)
13	Diameter of crankshaft journal	618 (mm)
14	Diameter of thrust shaft journal	618 (mm)
15	Weight of reciprocating parts	2,985 (kg/cyl.)
16	Quantities of auxiliary blowers	2 (sets)
17	Specifications for turbocharger(s)	A165-L x 1 set
18	Area of Explosion of relief valve for crankcase	8,325 cm2
19	Total volume of crankcase	72.4 (m^3)
20	Combined free area of the safety valves per crankcase gross volume	**(cm^2 / m^3)** **∴ (cm^2 / m^3) ≥ 115 (cm^2 / m^3)** **∴ Satisfied with the class. requirement!**

Programme for Factory Acceptance Test

HSD-MAN B&W ME Engine Control System

Engine Type : 5S50ME-C10.6-TII

Project Name : CPC 1193

Shop Test Date : 14th Nov 2023

Participants

Owner : CPC Corporation, Taiwan

Shipyard : CSBC Corporation, Taiwan

Class : CR + LR

HSD ENGINE CO., LTD.

SHIP OWNER	SHIP YARD	CLASS	MAN-ES	HSD Engine
		CR / <LR> 5-Nov-2023		15th Nov, 23

Engine Control system FAT

1. Test of cylinder lube oil slow down sensor – lube oil level
2a. Measurement of pressure build-up time with start pump (1pump)
2b. Measurement of pressure build-up time with start pumps (2pumps)
3. Test of HPS leakage alarm sensor – large oil leakage
4. Test of HPS inlet pressure low
5. Test of hydraulic main pumps – pump response test

Each test case is described in the following tables:

1. Test of cylinder lube oil slow down sensor – lube oil level.					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine Stopped	Close the valve for lube oil supply on all cylinders		14th Nov. 2023	
		Activate lube test sequence for all cylinders	"No Cyl. lube Oil Supply (Slowdown)" alarm occurred from each cylinder		
2.	Recovery procedure	Open the valve for lube oil supply on all cylinders	"No Cyl. lube Oil Supply (Slowdown)" alarm disappeared		
			However, the alarm might happen after recovery. The de-aeration work will be occasionally necessary		

2a. Measurement of pressure build-up time with start pump (1pump)					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine stopped. HPS mode = Manual. Start up pumps stopped. Hydraulic pressure is about 0 bar.	Start pump 1 Measure the pressure build up time from about 0 bar to 220~225 bar	The build-up time is less than 3.0 minutes Actual time : 22.11 **Secs**	14th Nov. 2023	

2b. Measurement of pressure build-up time with start pumps (2pumps)					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine stopped. HPS mode = Auto. Start up pumps stopped. Hydraulic pressure is about 0 bar.	Change FWE to Standby command in order to start both pumps. Measure the pressure build up time from about 0 bar to 220~225 bar	The build-up time is less than 1.5 minutes Actual time : 16.98 **Secs**	14th Nov. 2023	

HSD ENGINE Co.,Ltd.

HSD engine

3. Test of HPS leakage alarm – large oil leakage.					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine running.	Add fluid into the drain from the HPS in order to simulate a large oil leakage	1. Alarm for hydraulic oil leakage high level - "Hydraulic leakage" on the MOP	14th Nov. 2023	

4. Test of HPS inlet pressure. Low					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine running. Service terminal connected to ECU(s). Service terminal access level = service.	Adjust the parameter for low inlet oil pressure shutdown via service terminal as follows: ECU A/B (only the controlling ECU needs adjustment) -> Auxiliary command -> HPS Command -> Pump inlet press shtdwn lev(bar) Set from 0.5 to 4.0	1. The engine is shut down 2. Alarm for low inlet oil pressure shut down	14th Nov. 2023	

5. Test of hydraulic main pumps – pump response test.					
Test step	Specific Preconditions and Initial States	Action	Expected Result	Checked by	C. M. CHA
	Description	Description	Description	Date	Sign
1.	Engine running 25% load ahead. Main pump 1 = pressure controlling unit	Disconnect the control signal to the proportional valve as follows: At ACU 1 remove 2X10	1. The Engine keeps running 2. Swash plate angle at main pump 1 changes to max. Position ahead and another pump is chosen automatically as pressure control pump 3. Alarm for pump failure activated	14th Nov. 2023	

SHOP TEST REPORT

ENGINE TYPE	5S50ME-C10.6
PROJECT NAME	CPC1193
CLIENT	CSBC Corporation, Taiwan
CLASS	CR
ENGINE No.	DML106665
HULL No.	1193
TEST DATE	2023.11.14

HSD engine

Production Division

Operation Team

PREPARED	J.L. Ko	
CHECKED	K.H. Kim	
APPROVED	J.H. Kim	

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Performance Observations(Measured Value) -1	4
Summary of load test -2	5
Performance Observations(Measured Value) -2	6

Particulars of engine

Engine specification	
Maker	HSD engine
Type	5S50ME-C10.6
No. of cylinders	5
Piston stroke (mm)	2,214
Layout Power (kW)	6,850
Layout Speed (rev/min)	117
Firing order	1-4-3-2-5
Rotational direction	CLOCKWISE Seen from AFT. In ahead

Water brake specification	
Maker	FUCHINO
Type	CFSR-26(E)
Coefficient	1
Maximum capacity	45,000 BHP × 250 RPM

Summary of Load Test (Measured Value)

Project	: CPC1193	Hull No.	: 1193
Date	: 2023.11.14	Fuel Mode	: Diesel
LCV of Fuel oil	: 10002 kcal/kg	Emission	: Tier II
Engine Mode	: Tier II		

Test No.		1	2	3	4	5	6	7	8
Load	(%)	25	35.4	46.2	50	58.8	73.5	75	85
Power	(kW)	1713	2425	3165	3425	4028	5035	5138	5823
Speed	(r/min)	73.7	82.8	90.4	92.9	98.0	105.6	106.3	110.8
MEP	(bar)	6.4	8.1	9.7	10.2	11.3	13.2	13.3	14.5
Fuel index	(%)	42.0	52.0	61.0	64.0	72.0	81.0	83.0	89.0
Exh.Valve Opening Timing	(CA)	123.9	125.1	124.3	123.9	123.9	123.9	123.9	123.9
Ambient pressure	(mmHg)	765.4	765.5	765.5	765.8	765.8	766.1	766.2	766.5
Blower Inlet Temp.	(℃)	16.5	16.4	16.8	17.1	17.5	18.1	18.6	19.1
Scav. Air Receiver Temp.	(℃)	26.0	24.0	26.0	28.0	29.0	32.0	34.0	36.0
A/C C.W Inlet temp.	(℃)	17.0	18.0	18.0	19.0	19.0	20.0	20.0	20.0
Pmax	(bar)	133.9	157.2	170.4	180.6	194.9	216.6	218.9	219.8
Pcomp	(bar)	83.9	106.9	120.8	131.1	145.3	166.7	169.4	179.8
Pscav	(bar)	0.40	0.74	0.94	1.08	1.40	1.94	2.01	2.36
Pcomp Ratio	(Pcomp/Pscav)	60.7	62.0	62.8	63.5	61.0	57.0	56.6	53.8
Pexh	(bar)	0.34	0.69	0.84	0.97	1.30	1.79	1.88	2.20
Exh. Temp. Cyl Outlet	(℃)	227.0	240.4	273.0	271.4	280.2	298.4	300.4	
Exh. Temp. Before T/C	(℃)	230.0	260.0	300.0	300.0	308.0	325.0	327.0	342.0
Exh. Temp. After T/C	(℃)	190.0	200.0	223.0	220.0	220.0	220.0	220.0	220.0
T/C Speed	(rpm)	7707	10428	11775	12510	13801	15533	15773	16674
Hydraulic System (bar)	Before Filter	2.1	2.1	2.0	2.1	2.0	2.0	2.0	2.1
	After Filter	2.1	2.1	2.0	2.1	2.0	2.0	2.0	2.1
	Main Pressure	225	226	228	229	233	239	240	251
SFOC (g/kW.h)	Measured	171.3	165.6	163.0	161.1	157.8	158.4	158.8	159.7
	ISO Condition	169.5	164.0	160.8	158.9	155.6	156.2	156.3	156.5

Remark

FUEL OIL CONSUMPTION (CPC1193 / 5S50ME-C10.6)

Description		Load / Unit	25	35.4	46.2	50	58.8	73.5	75	85	Remark
Measured value	Start value	kg	7602	8750	10384	10099	9733	9523	9971	9830	
	Stop value	kg	7553	8683	10298	10007	9627	9390	9835	9675	
	Time	min	10	10	10	10	10	10	10	10	
	Difference	kg	49	67	86	92	106	133	136	155	
	F.O leakage Drain	kg/10min	0.100	0.055	0.035	0.055	0.060	0.055	0.060	0.055	
	Hourly Consumption	kg	293.4	401.7	515.8	551.7	635.6	797.7	815.6	929.7	(A)
Loaded Condition	Engine revolution	r/min	73.7	82.8	90.4	92.9	98.0	105.6	106.3	110.8	
	Engine power	kW	1713	2425	3165	3425	4028	5035	5138	5822.5	(B)
Measured spec. fuel consumption		g/kW.h	171.3	165.6	163.0	161.1	157.8	158.4	158.8	159.7	(C) = (A)/(B)×1000

ISO correction = Measured value × (LCV/LCVref) × [1 + { (Tsc,ref - Tsc)/10 ×(factor) + (To,ref -To)/10×(factor) + (Po,ref-1000/750.0617×Po)/10×(factor) + (PEaT,ref-PEaT)/100 × (factor)} / 100]

				SFOC factor
-. Scav. air temp. (Tsc,ref)	rise	10	℃ -----	0.413 %
-. Blower inlet temp. (To,ref : 25℃)	rise	10	℃ -----	0.707 %
-. Barometer press. (Po,ref : 1000 mbar)	rise	10	mbar -----	-0.053 %
-. Back pressure. (PEaT,ref)	rise	100	mmWC -----	0.168 %
-. F.O lower calorific value (LCVref : 10200kcal/kg)	rise	1	% -----	-1 %

SFOC ISO Correction

Description		Load / Unit	25		35.4		46.2		50		58.8		73.5		75		85		Remark
			Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	
Measured	SFOC	g/kW.h	171.3		165.6		163.0		161.1		157.8		158.4		158.8		159.7		(C)
Ambient Condition	Scav. air temp. Tsc	℃	26.0	0.248	24.0	0.367	26.0	0.057	28.0	0.162	29.0	0.018	32.0	-0.010	34.0	-0.083	36.0	-0.096	(D) = (Tsc,ref - Tsc)/10×(0.413)
	Blower inlet temp. To	℃	16.5	0.601	16.4	0.608	16.8	0.580	17.1	0.559	17.5	0.530	18.1	0.488	18.6	0.452	19.1	0.417	(E) = (To,ref - To)/10×(0.707)
	Barometer press. Po	mmHg	765.4	0.108	765.5	0.109	765.5	0.109	765.8	0.111	765.8	0.111	766.1	0.114	766.2	0.114	766.5	0.116	(F) = (Po,ref-1000/750.0617×Po)/10×(-0.053)
	Back press. PEaT	mmWG	30	-0.009	90	-0.073	100	-0.042	120	-0.202	170	-0.092	210	-0.063	210	-0.053	270	-0.077	(G) = (PEaT,ref - PEaT)/100×(0.168)
	LCV	kcal/kg	10002	0.981	10002	0.981	10002	0.981	10002	0.981	10002	0.981	10002	0.981	10002	0.981	10002	0.981	(H) = LCV/LCVref
SFOC ISO Correction		g/kW.h	169.6		164.1		160.9		158.9		155.6		156.2		156.4		157.1		(I) = (C)×(H)×[1+({(D)+(E)+(F)+(G)}/100]
Pmax corr. Factor		%	0.3		0.1		0.3		0.2		0.1		0.0		0.1		1.7		(s) = Refer to the next page
SFOC ISO Correction with Reference Pmax		g/kW.h	169.5		164.0		160.8		158.9		155.6		156.2		156.3		156.5		SFOC ISO Correction × (1+(-0.231) × Pmax corr. Factor/100)

ISO correction = Measured value × [1 + { (Tsc,ref - Tsc)/10 ×(factor) + (To,ref -To)/10×(factor) + (Po,ref-1000/750.0617×Po)/10×(factor) + (PEaT,ref-PEaT)/100 × (factor)} / 100]

				Pmax factor	Pcomp factor
-. Scav. air temp. (Tsc,ref)	rise	10	℃	-----	0.810 %	1.530 %
-. Blower inlet temp. (To,ref : 25℃)	rise	10	℃	-----	-2.198 %	-2.954 %
-. Barometer press. (Po,ref : 1000 mbar)	rise	10	mbar	-----	0.165 %	0.226 %
-. Back pressure. (PEaT,ref)	rise	100	mmWC	-----	-0.528 %	-0.702 %

Pmax ISO Correction

Description		Load / Unit	25		35.4		46.2		50		58.8		73.5		75		85		Remark
			Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	
Measured	Maximum Pressure	bar.a	134.9		158.2		171.4		181.6		196.0		217.6		219.9		220.8		(a)
Ambient Condition	Scav. air temp. Tsc	℃	26.0	0.487	24.0	0.720	26.0	0.113	28.0	0.000	29.0	0.035	32.0	-0.019	34.0	-0.162	36.0	-0.188	(b) = (Tsc,ref - Tsc)/10×(0.81)
	Blower inlet temp. To	℃	16.5	-1.868	16.4	-1.890	16.8	-1.802	17.1	-1.736	17.5	-1.649	18.1	-1.517	18.6	-1.407	19.1	-1.297	(c) = (To,ref - To)/10×(-2.198)
	Barometer press. Po	mmHg	765.4	-0.337	765.5	-0.339	765.5	-0.339	765.8	-0.345	765.8	-0.345	766.1	-0.353	766.2	-0.355	766.5	-0.362	(d) = (Po,ref-1000/750.0617×Po)/10×(0.165)
	Back press. PEaT	mmWG	30	0.028	90	0.231	100	0.133	120	0.179	170	0.289	210	0.199	210	0.165	270	0.243	(e) = (PEaT,ref- PEaT)/100×(-0.528)
Pmax ISO Correction		bar.a	132.7		156.2		168.1		178.1		192.7		213.9		216.1		217.2		(g) = (a)×[1+({(b)+(c)+(d)+(e)}/100]

Pcomp ISO Correction

Description		Load / Unit	25		35.4		46.2		50		58.8		73.5		75		85		Remark
			Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	Actual value	Factor	
Measured	Compressure Pressure	bar.a	84.9		107.9		121.8		132.1		146.3		167.7		170.4		180.9		(h)
Ambient Condition	Scav. air temp. Tsc	℃	26.0	0.920	24.0	1.359	26.0	0.213	28.0	-0.001	29.0	0.066	32.0	-0.036	34.0	-0.306	36.0	-0.355	(i) = (Tsc,ref - Tsc)/10×(1.53)
	Blower inlet temp. To	℃	16.5	-2.511	16.4	-2.540	16.8	-2.422	17.1	-2.334	17.5	-2.216	18.1	-2.038	18.6	-1.891	19.1	-1.743	(j) = (To,ref - To)/10×(-2.954)
	Barometer press. Po	mmHg	765.4	-0.461	765.5	-0.464	765.5	-0.464	765.8	-0.473	765.8	-0.473	766.1	-0.484	766.2	-0.486	766.5	-0.495	(k) = (Po,ref-1000/750.0617×Po)/10×(0.226)
	Back press. PEaT	mmWG	30	0.037	90	0.307	100	0.177	120	0.238	170	0.384	210	0.264	210	0.219	270	0.324	(l) = (PEaT,ref - PEaT)/100×(-0.702)
Pcomp ISO Correction		bar.a	83.2		106.5		118.8		128.7		143.0		163.9		166.2		176.8		(n) = (h)×[1+({(i)+(j)+(k)+(l)}/100]

Pmax correction factor

Description	Load / Unit	25	35.4	46.2	50	58.8	73.5	75	85	Remark
Pressure Rise	bar	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	(o) Design value
Pmax Limit	bar.a	211.5	221.0	221.0	221.0	221.0	221.0	221.0	221.0	(p) Design
Pmax adjusted	bar.a	133.1	156.4	168.6	178.6	192.9	213.9	216.2	224.2	(q)=(g)+((o)-(g)+(n))/(1+((n)×0.459/(g))
Reference Pmax	bar.a	133.1	156.4	168.6	178.6	192.9	213.9	216.2	221.0	(r)= Lower value{(p), (q)}
Pmax correction factor	%	0.3	0.1	0.3	0.2	0.1	0.0	0.1	1.7	(s)=[{(r)-(g)}/(g)]×100

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		17:10	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
25	73.7	31.6	1713	Diesel	42	765.4	16.5	32.7	Tier2	171.3	169.5	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		6.3	6.3	6.2	6.2	6.2										6.2
Pmax (bar)		133.9	134	134.2	133.5	134										133.9
Pcomp (bar)		83.9	83.9	83.9	84.0	83.9										83.9
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		60.6	60.6	60.6	60.7	60.6										60.7
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		200	230	230	230	245										227.0
C.W.Out	Cover	60	60	60	61	60										60.2
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		45	45	46	45	45										45.2

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	41	1	1	0.34	1	1	1	1	0.40	1	1	1
Cooling Oil	40	44	Thrust	230	190		30	7707	5	20		16.5	47	18
2.2	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			50			(bar)					℃			
2.3	3	3		3	3	0.33	3	3	3	3	26	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											0.34			
Average	40	44		230	190		30	7707	5	20	Average	16.5	47	18

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.1		9.2	On
60		1	1	1	4.3	3.0	After Filter		After Filter	Axial
		17	20				2.1		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						225		(℃)	0.66
1	1	3	3	3			Swash Plate Position (%)		19	T/V Damper
							1	23		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		17	20				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		17:35	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
35.4	82.8	39.8	2425	Diesel	52	765.5	16.4	34.6	Tier2	165.6	164.0	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		8.0	8.0	8.0	8.0	8.0										8.0
Pmax (bar)		156.9	157.1	157.1	158.1	156.9										157.2
Pcomp (bar)		106.8	107.0	106.8	107.0	106.8										106.9
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		62.0	62.1	62.0	62.1	62.0										62.0
E/V Open Angle		125.1	125.1	125.1	125.1	125.1										125.1
Exh.Gas Temp(℃)		220	237	245	245	255										240.4
C.W.Out	Cover	62	62	61	62	60										61.4
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		47	47	47	47	46										46.8

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	41	1	1	0.69	1	1	1	1	0.74	1	1	1
Cooling Oil	40	48	Thrust	260	200		90	10428	10	30		16.4	73	19
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			52			(bar)					℃			
2.0	3	3		3	3	0.66	3	3	3	3	24	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											0.75			
Average	40	48		260	200		90	10428	10	30	Average	16.4	73	19

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.1		9.2	On
60		1	1	1	4.3	3.0	After Filter		After Filter	Axial
		18	22				2.1		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						226		(℃)	0.70
1	1	3	3	3			Swash Plate Position (%)		21	T/V Damper
							1	25		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		18	22				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		18:00	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
46.2	90.4	47.6	3165	Diesel	61	765.5	16.8	35.7	Tier2	163.0	160.8	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		9.6	9.6	9.6	9.6	9.6										9.6
Pmax (bar)		170.0	170.1	170.2	170.9	170.6										170.4
Pcomp (bar)		120.8	120.7	121.0	120.8	120.8										120.8
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		62.8	62.7	62.9	62.8	62.8										62.8
E/V Open Angle		124.3	124.3	124.3	124.3	124.3										124.3
Exh.Gas Temp(℃)		250	270	275	275	295										273.0
C.W.Out	Cover	62	62	62	62	62										62.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		47	47	46	47	46										46.6

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	41	1	1	0.84	1	1	1	1	0.94	1	1	1
Cooling Oil	40	50	Thrust	300	223		100	11775	15	35		16.8	90	20
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			52			(bar)					℃			
2.0	3	3		3	3	0.82	3	3	3	3	26	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											0.95			
Average	40	50		300	223		100	11775	15	35	Average	16.8	90	20

Cooling Water							Hydraulic Pressure	Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)	(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter	Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0	9.2	Off
60		1	1	1	4.3	3.0	After Filter	After Filter	Axial
		18	22				2.0	9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure	Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						228	(℃)	0.82
1	1	3	3	3			Swash Plate Position (%)	23	T/V Damper
							1 25		(bar)
2	2	4	4	4			2 50		-
							3		Exhuast Gas
Average		18	22				4		By-pass V/V
									Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		18:30	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
50	92.9	50.1	3425	Diesel	64	765.8	17.1	38.2	Tier2	161.1	158.9	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		10.2	10.1	10.1	10.1	10.2										10.1
Pmax (bar)		181.0	180.5	180.1	180.0	181.3										180.6
Pcomp (bar)		131.2	131.0	131.1	131.0	131.1										131.1
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		63.6	63.5	63.5	63.5	63.5										63.5
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		250	273	279	270	285										271.4
C.W.Out	Cover	62	62	62	62	62										62.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		47	47	46	47	46										46.6

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	41	1	1	0.97	1	1	1	1	1.08	1	1	1
Cooling Oil	40	53	Thrust	300	220		120	12510	20	35		17.1	100	21
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			53			(bar)					℃			
2.0	3	3		3	3	0.95	3	3	3	3	28	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											1.09			
Average	40	53		300	220		120	12510	20	35	Average	17.1	100	21

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.1		9.2	Off
61		1	1	1	4.3	3.0	After Filter		After Filter	Axial
		19	22				2.1		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						229		(℃)	0.92
1	1	3	3	3			Swash Plate Position (%)		28	T/V Damper
							1	27		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		19	22				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		19:05	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
58.8	98.0	55.9	4028	Diesel	72	765.8	17.5	38.0	Tier2	157.8	155.6	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		11.4	11.4	11.4	11.4	11.4										11.4
Pmax (bar)		195.0	194.6	194.4	196.0	194.7										194.9
Pcomp (bar)		145.2	145.3	145.3	145.2	145.4										145.3
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		60.9	61.0	61.0	60.9	61.0										61.0
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		261	280	270	285	305										280.2
C.W.Out	Cover	63	63	63	63	63										63.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		52	52	52	52	52										52.0

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	41	1	1	1.30	1	1	1	1	1.40	1	1	1
Cooling Oil	40	57	Thrust	308	220		170	13801	30	40		17.5	117	21
2.2	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			49			(bar)					℃			
2.1	3	3		3	3	1.26	3	3	3	3	29	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											1.41			
Average	40	57		308	220		170	13801	30	40	Average	17.5	117	21

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.2	Off
61		1	1	1	4.0	3.2	After Filter		After Filter	Axial
		19	23				2.0		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						233		(℃)	1.52
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	28		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		19	23				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		19:40	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
73.5	105.6	64.8	5035	Diesel	81	766.1	18.1	38.4	Tier2	158.4	156.2	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		13.2	13.3	13.3	13.3	13.3										13.3
Pmax (bar)		216.1	216.8	216.1	217.1	216.7										216.6
Pcomp (bar)		166.8	166.6	166.7	166.6	166.8										166.7
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		57.1	57.0	57.0	57.0	57.1										57.0
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		273	300	300	300	319										298.4
C.W.Out	Cover	64	64	64	64	64										64.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		51	51	50	50	50										50.4

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	1.79	1	1	1	1	1.94	1	1	1
Cooling Oil	40	62	Thrust	325	220		210	15533	40	40		18.1	141	22
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			47			(bar)					℃			
2.1	3	3		3	3	1.76	3	3	3	3	32	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											1.95			
Average	40	62		325	220		210	15533	40	40	Average	18.1	141	22

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.2	Off
61		1	1	1	4.3	3.2	After Filter		After Filter	Axial
		20	24				2.0		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						239		(℃)	1.08
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	30		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	24				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		20:10	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
75	106.3	65.7	5138	Diesel	83	766.2	18.6	38.9	Tier2	158.8	156.3	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		13.4	13.5	13.5	13.5	13.5										13.5
Pmax (bar)		218.4	219.6	219.4	218.3	218.9										218.9
Pcomp (bar)		169.3	169.4	169.7	169.2	169.4										169.4
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		56.6	56.6	56.7	56.5	56.6										56.6
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		277	300	300	300	325										300.4
C.W.Out	Cover	64	64	64	64	64										64.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		51	51	51	51	51										51.0

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	1.88	1	1	1	1	2.01	1	1	1
Cooling Oil	40	63	Thrust	327	220		210	15773	40	40		18.6	145	22
2.2	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			47			(bar)					℃			
2.2	3	3		3	3	1.85	3	3	3	3	34	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											2.02			
Average	40	63		327	220		210	15773	40	40	Average	18.6	145	22

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.2	Off
61		1	1	1	4.3	3.2	After Filter		After Filter	Axial
		20	25				2.0		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						240		(℃)	1.13
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	30		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	25				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		20:45	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
85	110.8	71.4	5823	Diesel	89	766.5	19.1	39.7	Tier2	159.7	156.5	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		14.8	14.8	14.9	14.9	14.8										14.8
Pmax (bar)		220.2	219.5	219.3	219.7	220.1										219.8
Pcomp (bar)		179.9	179.8	179.8	179.9	179.8										179.8
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		53.8	53.8	53.8	53.8	53.8										53.8
E/V Open Angle		123.9	123.9	123.9	123.9	123.9										123.9
Exh.Gas Temp(℃)		293	315	320	320	340										317.6
C.W.Out	Cover	64	64	64	64	64										64.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		53	53	52	52	52										52.4

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	2.20	1	1	1	1	2.36	1	1	1
Cooling Oil	40	66	Thrust	342	220		270	16674	50	45		19.1	160	22
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			48			(bar)					℃			
2.1	3	3		3	3	2.17	3	3	3	3	36		3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											2.37			
Average	40	66		342	220		270	16674	50	45	Average	19.1	160	22

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.1		9.2	On
61		1	1	1	4.3	3.0	After Filter		After Filter	Axial
		20	26				2.1		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						251		(℃)	0.63
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	64		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	26				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

0%

Summary of Load Test (Measured Value)

Project	:	CPC1193			Hull No.	:	1193		
Date	:	2023.11.14			Fuel Mode	:	Diesel		
LCV of Fuel oil	:	10002 kcal/kg			Emission	:	Tier II		
Engine Mode	:	Tier II							

Test No.		1	2	3					
Load	(%)	100	100(2)	110					
Power	(kW)	6850	6850	7535					
Speed	(r/min)	117.0	117.0	120.8					
MEP	(bar)	16.2	16.2	17.2					
Fuel index	(%)	100.0	100.0	106.0					
Exh.Valve Opening Timing	(CA)	125.0	125.0	125.0					
Ambient pressure	(mmHg)	766.7	767.3	769.1					
Blower Inlet Temp.	(℃)	19.8	19.9	20.5					
Scav. Air Receiver Temp.	(℃)	37.0	38.0	39.0					
A/C C.W Inlet temp.	(℃)	20.0	20.0	20.0					
Pmax	(bar)	219.4	220.5	219.7					
Pcomp	(bar)	186.3	187.4	177.5					
Pscav	(bar)	2.65	2.65	2.87					
Pcomp Ratio	(Pcomp/Pscav)	51.3	51.6	46.1					
Pexh	(bar)	2.43	2.44	2.67					
Exh. Temp. Cyl Outlet	(℃)	366.4	368.0	382.0					
Exh. Temp. Before T/C	(℃)	387.0	385.0	410.0					
Exh. Temp. After T/C	(℃)	230.0	230.0	240.0					
T/C Speed	(rpm)	17385	17390	17905					
Hydraulic System (bar)	Before Filter	2.0	2.0	2.0					
	After Filter	2.0	2.0	2.0					
	Main Pressure	263	263	263					
SFOC (g/kW.h)	Measured	169.9	169.9	175.9					
	ISO Condition	166.7	166.8	173.7					

Remark

FUEL OIL CONSUMPTION (CPC1193 / 5S50ME-C10.6)

Description		Load / Unit	100	100(2)	110						Remark
Measured value	Start value	kg	9484	9525	9532						
	Stop value	kg	9290	9331	9311						
	Time	min	10	10	10						
	Difference	kg	194	194	221						
	F.O leakage Drain	kg/10min	0.065	0.065	0.060						
	Hourly Consumption	kg	1163.6	1163.6	1325.6						(A)
Loaded Condition	Engine revolution	r/min	117.0	117.0	120.8						
	Engine power	kW	6850	6850	7535						(B)
Measured spec. fuel consumption		g/kW.h	169.9	169.9	175.9						(C) = (A)/(B)×1000

ISO correction = Measured value × (LCV/LCVref) × [1 + { (Tsc,ref - Tsc)/10 ×(factor) + (To,ref -To)/10×(factor) + (Po,ref-1000/750.0617×Po)/10×(factor) + (PEaT,ref-PEaT)/100 × (factor)} / 100]

				SFOC factor
-. Scav. air temp. (Tsc,ref)	rise	10 ℃	-----	0.413 %
-. Blower inlet temp. (To,ref : 25℃)	rise	10 ℃	-----	0.707 %
-. Barometer press. (Po,ref : 1000 mbar)	rise	10 mbar	-----	-0.053 %
-. Back pressure. (PEaT,ref)	rise	100 mmWC	-----	0.168 %
-. F.O lower calorific value (LCVref : 10200kcal/kg)	rise	1 %	-----	-1 %

SFOC ISO Correction

Description		Load / Unit	100		100(2)		110												Remark
			Actual value	Factor	Actual value	Factor	Actual value	Factor											
Measured	SFOC	g/kW.h	169.9		169.9		175.9												(C)
Ambient Condition	Scav. air temp. Tsc	℃	37.0	0.000	38.0	-0.041	39.0	0.041											(D) = (Tsc,ref - Tsc)/10×(0.413)
	Blower inlet temp. To	℃	19.8	0.368	19.9	0.361	20.5	0.318											(E) = (To,ref - To)/10×(0.707)
	Barometer press. Po	mmHg	766.7	0.117	767.3	0.121	769.1	0.135											(F) = (Po,ref-1000/750.0617×Po)/10×(-0.053)
	Back press. PEaT	mmWG	300	0.000	300	0.000	350	0.010											(G) = (PEaT,ref - PEaT)/100×(0.168)
	LCV	kcal/kg	10002	0.981	10002	0.981	10002	0.981											(H) = LCV/LCVref
SFOC ISO Correction		g/kW.h	167.4		167.3		173.4												(I) = (C)×(H)×[1+({(D)+(E)+(F)+(G)}/100]
Pmax corr. Factor		%	1.8		1.3		-0.8												(s) = Refer to the next page
SFOC ISO Correction with Reference Pmax		g/kW.h	166.7		166.8		173.7												SFOC ISO Correction × (1+(-0.231) × Pmax corr. Factor/100)

ISO correction = Measured value × [1 + { (Tsc,ref - Tsc)/10 ×(factor) + (To,ref -To)/10×(factor) + (Po,ref-1000/750.0617×Po)/10×(factor) + (PEaT,ref-PEaT)/100 × (factor)} / 100]

				Pmax factor	Pcomp factor
-. Scav. air temp. (Tsc,ref)	rise	10	℃	0.810 %	1.530 %
-. Blower inlet temp. (To,ref : 25℃)	rise	10	℃	-2.198 %	-2.954 %
-. Barometer press. (Po,ref : 1000 mbar)	rise	10	mbar	0.165 %	0.226 %
-. Back pressure. (PEaT,ref)	rise	100	mmWC	-0.528 %	-0.702 %

Pmax ISO Correction

Description		Load / Unit	100 Actual value	100 Factor	100(2) Actual value	100(2) Factor	110 Actual value	110 Factor											Remark
Measured	Maximum Pressure	bar.a	220.5		221.6		220.8												(a)
Ambient Condition	Scav. air temp. Tsc	℃	37.0	0.000	38.0	-0.081	39.0	0.081											(b) = (Tsc,ref - Tsc)/10×(0.81)
	Blower inlet temp. To	℃	19.8	-1.143	19.9	-1.121	20.5	-0.989											(c) = (To,ref - To)/10×(-2.198)
	Barometer press. Po	mmHg	766.7	-0.365	767.3	-0.378	769.1	-0.419											(d) = (Po,ref-1000/750.0617×Po)/10×(0.165)
	Back press. PEaT	mmWG	300	0.000	300	0.000	350	-0.032											(e) = (PEaT,ref- PEaT)/100×(-0.528)
Pmax ISO Correction		bar.a	217.1		218.1		217.8												(g) = (a)×[1+({(b)+(c)+(d)+(e)}/100]

Pcomp ISO Correction

Description		Load / Unit	100 Actual value	100 Factor	100(2) Actual value	100(2) Factor	110 Actual value	110 Factor											Remark
Measured	Compressure Pressure	bar.a	187.3		188.4		178.5												(h)
Ambient Condition	Scav. air temp. Tsc	℃	37.0	0.000	38.0	-0.153	39.0	0.153											(i) = (Tsc,ref - Tsc)/10×(1.53)
	Blower inlet temp. To	℃	19.8	-1.536	19.9	-1.507	20.5	-1.329											(j) = (To,ref - To)/10×(-2.954)
	Barometer press. Po	mmHg	766.7	-0.500	767.3	-0.518	769.1	-0.574											(k) = (Po,ref-1000/750.0617×Po)/10×(0.226)
	Back press. PEaT	mmWG	300	0.000	300	0.000	350	-0.043											(l) = (PEaT,ref - PEaT)/100×(-0.702)
Pcomp ISO Correction		bar.a	183.5		184.3		175.3												(n) = (h)×[1+({(i)+(j)+(k)+(l)}/100]

Pmax correction factor

Description	Load / Unit	100	100(2)	110						Remark
Pressure Rise	bar	40.0	40.0	40.0						(o) Design value
Pmax Limit	bar.a	221.0	221.0	221.0						(p) Design
Pmax adjusted	bar.a	221.7	222.6	216.0						(q)=(g)+((o)-(g)+(n))/(1+((n)×0.459/(g))
Reference Pmax	bar.a	221.0	221.0	216.0						(r)= Lower value{(p), (q)}
Pmax correction factor	%	1.8	1.3	-0.8						(s)=[{(r)-(g)}/(g)]×100

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		21:40	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
100	117.0	79.6	6850	Diesel	100	766.7	19.8	39.4	Tier2	169.9	166.7	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		16.6	16.5	16.5	16.6	16.6										16.6
Pmax (bar)		219.0	219.3	219.9	219.4	219.6										219.4
Pcomp (bar)		186.5	186.4	186.4	185.9	186.4										186.3
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		51.4	51.3	51.3	51.2	51.3										51.3
E/V Open Angle		125.0	125.0	125.0	125.0	125.0										125.0
Exh.Gas Temp(℃)		340	360	364	373	395										366.4
C.W.Out	Cover	65	65	65	65	65										65.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		54	55	55	55	55										54.8

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	2.43	1	1	1	1	2.65	1	1	1
Cooling Oil	40	67	Thrust	387	230		300	17385	60	48		19.8	169	23
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			50			(bar)					℃			
2.1	3	3		3	3	2.42	3	3	3	3	37	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											2.67			
Average	40	67		387	230		300	17385	60	48	Average	19.8	169	23

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.2	Off
62		1	1	1	4.3	3.2	After Filter		After Filter	Axial
		20	26				2.0		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						263		(℃)	1.06
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	85		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	26				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

100%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		22:00	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
100(2)	117.0	79.6	6850	Diesel	100	767.3	19.9	39.7	Tier2	169.9	166.8	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		16.6	16.7	16.5	16.5	16.6										16.6
Pmax (bar)		220.7	219.7	220.5	220.8	221.0										220.5
Pcomp (bar)		187.5	187.1	187.4	187.5	187.4										187.4
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		51.6	51.5	51.6	51.6	51.6										51.6
E/V Open Angle		125.0	125.0	125.0	125.0	125.0										125.0
Exh.Gas Temp(℃)		345	360	365	375	395										368.0
C.W.Out	Cover	65	65	65	65	65										65.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		58	58	58	58	58										58.0

Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	2.44	1	1	1	1	2.65	1	1	1
Cooling Oil	40	68	Thrust	385	230		300	17390	60	48		19.9	170	22
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			50			(bar)					℃			
2.1	3	3		3	3	2.42	3	3	3	3	38	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											2.66			
Average	40	68		385	230		300	17390	60	48	Average	19.9	170	22

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.2	Off
62		1	1	1	4.3	3.2	After Filter		After Filter	Axial
		20	26				2.0		9.2	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						263		(℃)	1.07
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	85		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	26				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

100%

HSD engine	Engine type		5S50ME-C10.6		Project	CPC1193	Engine No.	DML106665	Test Bed
Layout Power(kW)	6850	Speed	117.0	Client	CSBC Corporation, Taiwan			Hull No.	1193

Turbocharger				Cyl. constant(in kW)	0.7245	Brand & Type	
				Fuel Oil(BUNKER-A)		Cylinder oil	MOBILGARD 540 AC
Specification		Serial Number		Viscosity	6.045 cSt at 40°C	Circulation oil	SK SUPERMAR AS
Maker	ABB	1	29480	Density at 15°C	0.9120	Turbo oil	SK SUPERMAR AS
Type	A165-L	2		Sulphur %	0.23	Water brake	FUCHINO,CFSR-26(E)
Nmax	22020 r/min	3		Heat value	10002 kcal/kg	EGB Orifice(mm)	
Tmax	550 °C	4		Water ppm	1090	Ø49	
Date	2023.11.14			Meas. time		22:40	

Load	Engine	Weight on	Eff. Power	Fuel	Fuel Index(%)	Barometer	Shop	Humid.	Emission	SFOC(g/kW.h)		
(%)	Speed	Brake (ton)	(kW)	Mode	ECU	(mmHg)	Temp.	(%)	Mode	Meas.	ISO	Site
110	120.8	84.8	7535	Diesel	106	769.1	20.5	39.6	Tier2	175.9	173.7	

Cyl. No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Ave.
Pi (bar)		17.7	17.7	17.8	17.8	17.7										17.7
Pmax (bar)		219.6	219.7	219.2	220.0	220.2										219.7
Pcomp (bar)		177.4	177.5	176.9	177.7	177.8										177.5
F/I	High															
Offset	Low															
Pmax Adj.(bar)																
Pcomp. Ratio		46.1	46.1	46.0	46.2	46.2										46.1
E/V Open Angle		125.0	125.0	125.0	125.0	125.0										125.0
Exh.Gas Temp(℃)		360	370	380	390	410										382.0
C.W.Out	Cover	66	66	66	66	66										66.0
Temp.(℃)	Liner															
P.O.Lub. Temp(℃)		57	57	57	57	57										57.0

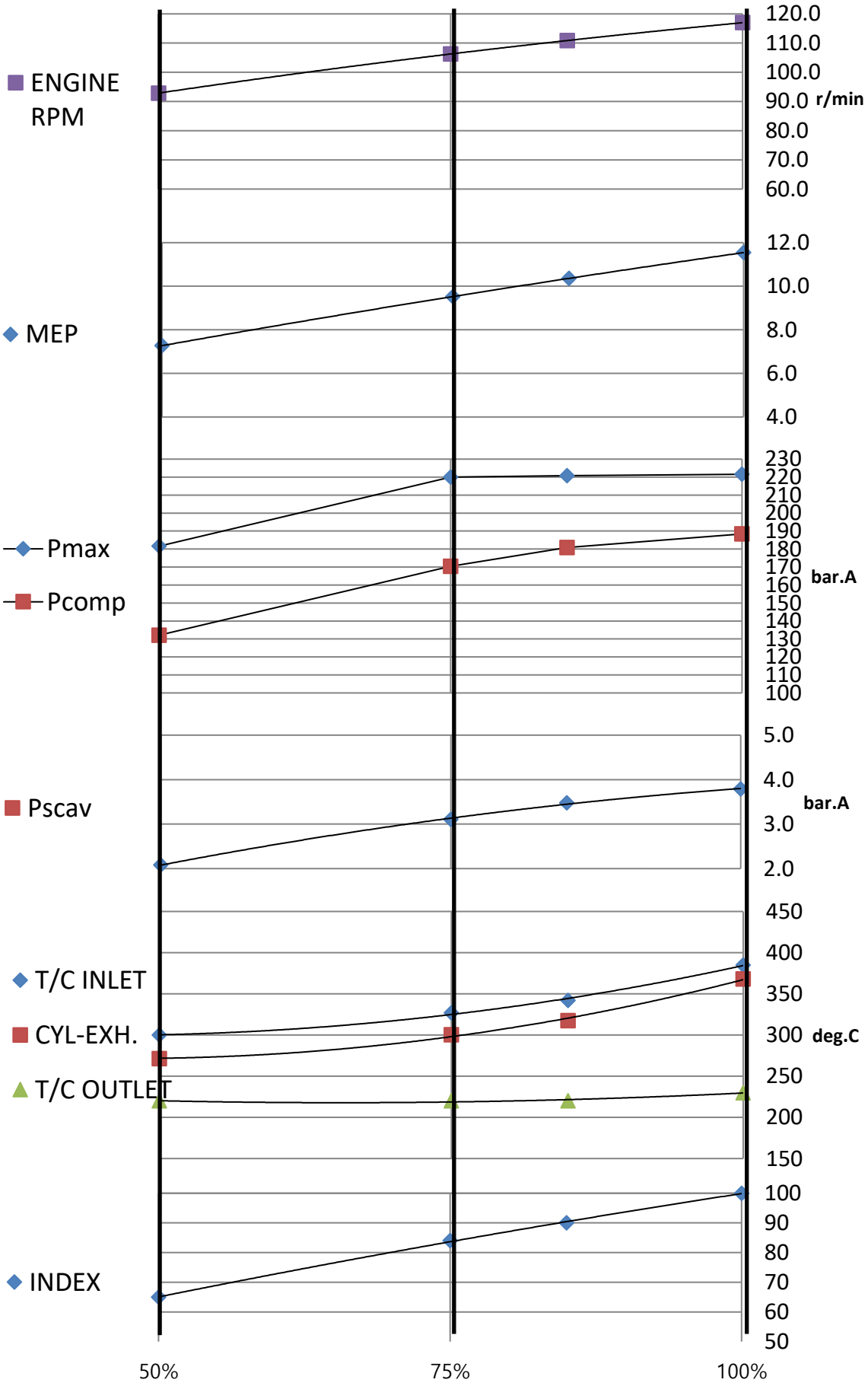
Lubricating Oil				Exhaust Gas				Turbo	Scavenge Air					
Pressure	Temperature (℃)			Temp.(℃)		Pressure		charger	dP		Receiver	Temperature(℃)		
(bar)	Turbine		Main Engine	Turbine		Receiver	T/C out	Speed	(mmWC)		Press.	T/C	Before	After
System Oil	Inlet	Outlet	Inlet	Inlet	Outlet	(bar)	(mmWC)	(r/min)	Filter	Cooler	(bar)	blower	A/C	A/C
2.1	1	1	42	1	1	2.67	1	1	1	1	2.87	1	1	1
Cooling Oil	42	70	Thrust	410	240		350	17905	70	50		20.5	178	23
2.1	2	2	Segment	2	2	T/C inlet	2	2	2	2		2	2	2
Turbine oil			50			(bar)					℃			
2.1	3	3		3	3	2.65	3	3	3	3	39	3	3	3
											Blower out			
	4	4		4	4		4	4	4	4	Press.(bar)	4	4	4
											2.88			
Average	42	70		410	240		350	17905	70	50	Average	20.5	178	23

Cooling Water							Hydraulic Pressure		Fuel Oil Pressure	Aux.
Temperature (℃)					Press.(bar)		(bar)		(bar)	Blower
HT C.W		Air cooler		T/C	Cyl.	Air	Before Filter		Before Filter	On/Off
Jaket Inlet	Cover Inlet	Inlet	Outlet	Outlet	Jacket	Cooler	2.0		9.3	Off
63		1	1	1	4.3	3.2	After Filter		After Filter	Axial
		20	27				2.0		9.3	Vibration
1st Air Cooler		2	2	2			Main Pressure		Fuel Oil Inlet Temp.	(mm)
Inlet	Outlet						263		(℃)	1.12
1	1	3	3	3			Swash Plate Position (%)		30	T/V Damper
							1	85		(bar)
2	2	4	4	4			2	50		-
							3			Exhuast Gas
Average		20	27				4			By-pass V/V
										Position

Note : The fuel oil consumption is corrected to LCV 10,200 kcal/kg & ISO reference condition

100%

MEASURED DATA



HSD engine

RCA for abnormal sound of exhaust valve (cyl. no.1) on CPC 1193

11th Dec. 2023

Quality Assurance Team
C. M. CHA

RCA for abnormal sound of exhaust valve

1. Engine Information

Engine Number : DML0106665

Engine Type : 5S50ME-C10.6-TII

Ship Owner : CPC Corporation, Taiwan

Ship Yard : CSBC Corporation, Taiwan

Ship Number : 1193

Shop Test Date : 14th Nov. 2023

2. Phenomenon

-. Abnormal sound was found in the no.1 cylinder cover area especially in the exhaust valve at start of official FAT.

-. The no.1 exhaust valve along with assembled cylinder cover was disassembled, and on-site inspection of the surrounding parts was carried out. (Piston, Cylinder cover, Cylinder liner, Exhaust valve etc..)

-. The on-site inspection revealed no unusual issues. However, the no.1 exhaust valve, considered the most likely source of abnormal sound, was replaced with a spare part.

-. Subsequently, official FAT was conducted, and it was completed without any problems.

RCA for abnormal sound of exhaust valve

3. Action and Investigation (1/2)

I. After completely overhauling the no.1 cylinder cover and exhaust valve, we promptly conducted on-site inspections to examine the dimensions and identify any abnormalities.

	Item	Result	Item	Result
Inspection Results	Cylinder cover (Internal & External parts)	Normal	Cylinder liner (Running surface)	Normal
	Piston crown (External parts)	Normal	Exhaust valve * (Spindle & External parts)	Normal

* Despite no abnormalities, exhaust valve is believed to have the highest likelihood of producing abnormal sound due to the coincidence of the timing of oil cylinder operation and the moment of noise generation.

➔ Therefore, It was taken out to manufacturer and a detailed inspection has been carried out in addition.

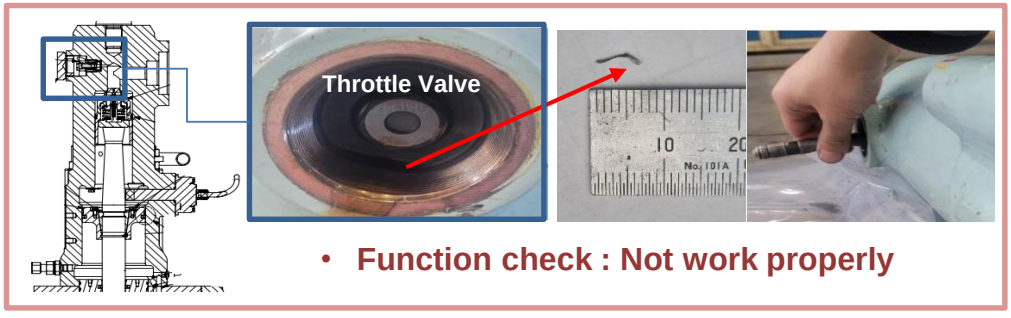
[Inspection of surrounding parts]

RCA for abnormal sound of exhaust valve

3. Action and Investigation (2/2)

II. The exhaust valve was totally overhauled and inspected whole components.

a) Visual check : Foreign matter found in near the throttle valve (Other parts are normal)



After Cleaning

- **It was confirm that <u>foreign matter entered the throttle valve, so it was not operating normally</u>.**
- **<u>After cleaning, it was finally operating normally</u>.**

b) Dimension check : All parts are normal

[Inspection of exhaust valve components]

RCA for abnormal sound of exhaust valve

4. Root cause

-. Foreign matter entered the throttle valve, causing the valve to not operate properly.

After cleaning, it was confirmed to be functioning normally.

-. In light of the information above, the determination is made that the air vent function in the oil cylinder, the main purpose of the throttle valve, was not carried out properly due to the entry of foreign matter.

This, in turn, resulted in the knocking noise(abnormal sound) during exhaust valve spindle operation.

5. Conclusion

-. The abnormal sound(knocking noise) from the exhaust valve is identified as being caused by foreign matter entering the throttle valve..

-. After cleaning the throttle valve, it has been confirmed that it is operating normally. Moreover, the final function test results with the complete assembly of the exhaust valve are clearly satisfactory.

-. The exhaust valve, which has been thoroughly validated for its operation and functionality by the manufacturer, is to be supplied as the spare part which already adopted no.1 cylinder.

Calibration Certificate

Q & Q Corporation
58, Hwajeonsandan 3-ro, Gangseo-gu, Busan, Korea
Tel : 051-292-0395, Fax : 051-292-0397

Certificate No : Q2308525-204-004

KOREA LABORATORY ACCREDITATION SCHEME KOLAS CALIBRATION NO. KC01-079

1. Client

Name : HSD Engine Co., Ltd

Address : 67, Gongdan-ro, Seongsan-gu, Changwon-si, Gyeongsangnam-do, Korea

2. Calibration Subject

Description : Barometer(Dial Type)

Manufacturer & Type : BARIGO, (960 ~ 1 060) hPa

Serial Number : DFG07600-D0811

3. Date of Calibration : 06. Oct. 2023

4. Environment

Temperature : (22.9 ± 0.1) ℃ Humidity : (48 ± 1) % R.H.

Location : ■ Permanent Calibration Lab □ Mobile Lab □ On Site Calibration

[Address : 58, Hwajeonsandan 3-ro, Gangseo-gu, Busan, Korea]

5. Traceability

Calibration method and/or brief description

The above instrument has been calibrated according to the calibration instruction of Barometers (QECI-PS406-1) using the below standard instrument which is established a traceability to National Metrology Institute.

List of used standards/specifications

Description	Manufacturer and Model	Serial Number	The due date of next calibration	Calibration laboratory
Pressure Calibrator/Controller	FLUKE DHI, PPC4-ui A7Mp	1331	14. Jun. 2024.	PDK
Digital Thermo-Hygrometer	OMEGA, Temp 2000	N19542	10. Nov. 2023.	Q & Q Corp.

6. Calibration result : Refer to the attached Calibration Result.

7. Measurement uncertainty : Refer to the attached Calibration Result.

Affirmation	Measurements performed by Name : Dong Seok Kang (signature)	Approved by Title : Technical Manager Name : He Sang Woo (signature)

The above certificate of calibration is the accredited calibration items by Korea Laboratory Accreditation Scheme, which signed the ILAC-MRA.

10. Oct. 2023.

Q & Q Corporation
Accredited by KOLAS , Republic of KOREA

(NOTE) If any significant instability or other adverse factor(overload, temperature, humidity etc.) manifests itself before, during or after calibration, and is likely to affect the validity of the calibration.

verify No.704453476405

Calibration Result

Q & Q Corporation
58, Hwajeonsandan 3-ro, Gangseo-gu, Busan, Korea
Tel : 051-292-0395, Fax : 051-292-0397

Certificate No : Q2308525-204-004

KOREA LABORATORY ACCREDITATION SCHEME KOLAS CALIBRATION NO. KC01-079

* Manufacturer : BARIGO
* Model Name : (960 ~ 1 060) hPa
* Serial number : DFG07600-D0811

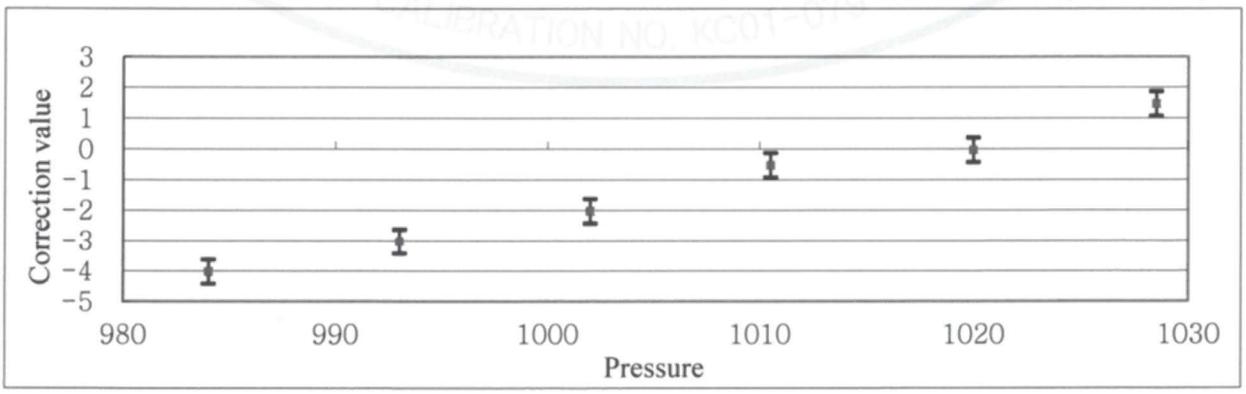
1. Barometer Calibration

Cal. Point No	Standard pressure value	Barometer		
		Mean value	Correction value	Measurement uncertainty (Coverage probability of approximately 95%, $k = 2$)
	hPa	hPa	hPa	hPa
1	979.98	984.0	-4.0	0.4
2	989.98	993.0	-3.0	0.4
3	999.97	1 002.0	-2.0	0.4
4	1 009.97	1 010.5	-0.5	0.4
5	1 019.97	1 020.0	0.0	0.4
6	1 029.97	1 028.5	1.5	0.4

2. Uncertainty graph

The following graph represents the range of the correction value at each measured pressure.
Here, the correction value is opposed to the sign of deviation value. The length of y direction represents the size of measurement uncertainty, the center dot is the correction value at each pressure.

(Unit : hPa)



The End.

HSD engine

교정 검사 성적서

DATE : 2023년11월14일 화
PAGE : 1

REPORT OF CALIBRATION

관리번호 Control No.	9A0803-03-00004D055	계측기명 Instru. Name	DIGITAL MANOMETER		
규격 Size	2023P(0-7BAR)	제조번호 Serial No.		제작회사 Manufacturer	DIGITRON
전교정일 Pre. Cal. Date	2023-06-26	교정주기 Cycle of Cal.	3 Months	유효기간 Expire Date	2024-01-11
교정일 Date of Cal.	2023-10-12	교정번호 Cal. No.	C20231109302	교정기관 Cal. Organ.	HSD엔진㈜
기준기명 Instrument of Cal.	PRESSURE CALIBRATOR		기준서 번호 Cal. Procedure No.	QP-PM-02	
기준기 고유번호 Serial No. of Instru.	DDB00020-D0701	온도 Temperature	20 ± 2 °C	습도 Humidity	55% RH이하

교정 검사 결과
(Calibration Result)

순번 No.	교정항목 Calibration Item.	허용치 Tolerance	전교정값 Pre.Cal.Value	교정값 Cal.Value
1	종합오차(Combined Error) 1.0 bar	±2.0 mbar	-1.0 mbar	-2.0 mbar
2	종합오차(Combined Error) 2.0 bar	±2.0 mbar	-2.0 mbar	-2.0 mbar
3	종합오차(Combined Error) 3.0 bar	±2.0 mbar	-2.0 mbar	-2.0 mbar
4	종합오차(Combined Error) 4.0 bar	±2.0 mbar	-2.0 mbar	-2.0 mbar
5	종합오차(Combined Error) 5.0 bar	±2.0 mbar	-2.0 mbar	-2.0 mbar
0				
0				
0				
0				
0				
0				
0				
0				

판 정 JUDGE.	합격 ACCEPTABLE

REMARK

상기 기기는 해당 기준서에 따라 국가 측정표준 기관으로부터 측정의 소급성이 확보 된 표준장비를 이용하여 비교 교정되었음.
This equipment has been calibrated according to Its Calibration procedure with The instrument of calibration having Traceability to National Measurement Institutes(KRISS).

결재	담 당	팀 장
	2023-10-12	2023-10-12

HSD engine

교정 검사 성적서

DATE : 2023년11월14일 화
PAGE : 1

REPORT OF CALIBRATION

관리번호 Control No.	9A0901-01-000095003 1JHA00010-5003	계측기명 Instru. Name	DIGITAL THERMOMETER		
규격 Size	(-50)-999 ' C	제조번호 Serial No.	N/A	제작회사 Manufacturer	YOKOGAWA
전교정일 Pre. Cal. Date	2023-06-07	교정주기 Cycle of Cal.	3 Months	유효기간 Expire Date	2024-01-11
교정일 Date of Cal.	2023-10-12	교정번호 Cal. No.	C20231109306	교정기관 Cal. Organ.	HSD엔진㈜
기준기명 Instrument of Cal.	MICROPROCESSOR CALIBRATOR		기준서 번호 Cal. Procedure No.	QP - PM - 007	
기준기 고유번호 Serial No. of Instru.	JHC00081-D9701	온도 Temperature	20 ± 2 °C	습도 Humidity	55% RH이하

교정 검사 결과
(Calibration Result)

순번 No.	교정항목 Calibration Item.	허용치 Tolerance	전교정값 Pre.Cal.Value	교정값 Cal.Value
1	종합오차(Combined Error) 0 °C	±1.0 °C	+0.20 °C	-0.40 °C
2	종합오차(Combined Error) 100 °C	±1.1 °C	-0.40 °C	-0.60 °C
3	종합오차(Combined Error) 200 °C	±1.2 °C	-1.00 °C	-1.00 °C
0				
0				
0				
0				
0				
0				
0				
0				
0				
0				

판 정 JUDGE.	합격 ACCEPTABLE

REMARK

상기 기기는 해당 기준서에 따라 국가 측정표준 기관으로부터 측정의 소급성이 확보 된 표준장비를 이용하여 비교 교정되었음.
This equipment has been calibrated according to Its Calibration procedure with The instrument of calibration having Traceability to National Measurement Institutes(KRISS).

결재	담 당	팀 장
	2023-10-12	2023-10-12

HSD engine

교정 검사 성적서

DATE : 2023년11월14일 화
PAGE : 1

REPORT OF CALIBRATION

관리번호 Control No.	9A0703-11-000105002 1DBD00100-5002	계측기명 Instru. Name	ELECTRONIC BALANCE (전자저울)		
규격 Size	10 Kg x 2g	제조번호 Serial No.	CEY1A0056	제작회사 Manufacturer	CAS
전교정일 Pre. Cal. Date	2023-03-20	교정주기 Cycle of Cal.	6 Months	유효기간 Expire Date	2024-04-11
교정일 Date of Cal.	2023-10-12	교정번호 Cal. No.	C20231109299	교정기관 Cal. Organ.	HSD엔진㈜
기준기명 Instrument of Cal.	COUNTER WEIGHT		기준서 번호 Cal. Procedure No.	QP-PM-08	
기준기 고유번호 Serial No. of Instru.	M1(10g.50g.100g. 1kg.10kg)	온도 Temperature	20 ± 2 °C	습도 Humidity	55% RH이하

교정 검사 결과
(Calibration Result)

순번 No.	교정항목 Calibration Item.	허용치 Tolerance	전교정값 Pre.Cal.Value	교정값 Cal.Value
1	종합오차 0 kg	±2 g	0.00 g	0.00 g
2	종합오차 2 kg	±2 g	0.00 g	0.00 g
3	종합오차 4 kg	±2 g	0.00 g	0.00 g
4	종합오차 6 kg	±2 g	0.00 g	0.00 g
5	종합오차 8 kg	±2 g	0.00 g	0.00 g
6	종합오차 10 kg	±2 g	0.00 g	0.00 g
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판 정 JUDGE.	합격 ACCEPTABLE

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결재	담 당	팀 장
	2023-10-12	2023-10-12

HSD engine

교정 검사 성적서

DATE : 2023년11월14일 화
PAGE : 1

REPORT OF CALIBRATION

관리번호 Control No.	9A0901-02-00008D014 1JPX06081-D200802	계측기명 Instru. Name	THERMO/HYGROMETER		
규격 Size	10~95% 0~+50C/(608-H1)	제조번호 Serial No.	N/A	제작회사 Manufacturer	TESTO
전교정일 Pre. Cal. Date	2023-09-13	교정주기 Cycle of Cal.	1 Months	유효기간 Expire Date	2023-11-19
교정일 Date of Cal.	2023-10-20	교정번호 Cal. No.	C20231109310	교정기관 Cal. Organ.	HSD엔진㈜
기준기명 Instrument of Cal.	디지탈 온습도계		기준서 번호 Cal. Procedure No.	QP-PM-04	
기준기 고유번호 Serial No. of Instru.	JHJ60100-D0001	온도 Temperature	20 ± 2 °C	습도 Humidity	55% RH이하

교정 검사 결과
(Calibration Result)

순번 No.	교정항목 Calibration Item.	허용치 Tolerance	전교정값 Pre.Cal.Value	교정값 Cal.Value
1	지시습도 35%	±1.05 %	+1.00 %	+0.80 %
2	지시습도 60%	±1.8 %	+1.50 %	+1.50 %
3	지시습도 85%	±2.40 %	+1.80 %	+2.00 %
4	지시온도 10°C	±0.3 °C	+0.20 °C	+0.20 °C
5	지시온도 20°C	±0.6 °C	+0.20 °C	+0.20 °C
6	지시온도 30°C	±0.9 °C	+0.20 °C	+0.20 °C
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판 정 JUDGE.	합격 ACCEPTABLE

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결재	담 당	팀 장
		
	2023-10-20	2023-10-20

HSD engine

교정 검사 성적서

DATE : 2023년11월09일 목
PAGE : 1

REPORT OF CALIBRATION

관리번호 Control No.	9A0901-13-000015006 1JJZ00300-5007	계측기명 Instru. Name	WATER THERMOMETER CHAMBER		
규격 Size	0.3L(200℃) WATER용	제조번호 Serial No.	000900100003	제작회사 Manufacturer	S-TECH(국산제작)
전교정일 Pre. Cal. Date	2021-07-06	교정주기 Cycle of Cal.	24 Months	유효기간 Expire Date	2025-07-05
교정일 Date of Cal.	2023-07-06	교정번호 Cal. No.	C20230726499	교정기관 Cal. Organ.	HSD엔진㈜
기준기명 Instrument of Cal.	열전식 디지탈 온도계		기준서 번호 Cal. Procedure No.	QP-PM-15	
기준기 고유번호 Serial No. of Instru.	JHA00031-D0001	온도 Temperature	20 ±2℃	습도 Humidity	55% RH이하

교정 검사 결과
(Calibration Result)

순번 No.	교정항목 Calibration Item.	허용치 Tolerance	전교정값 Pre.Cal.Value	교정값 Cal.Value
1	종헙오차 10℃	±0.1 ℃	-0.10 ℃	+0.20 ℃
2	종헙오차 50℃	±0.5 ℃	-0.50 ℃	-0.30 ℃
3	종헙오차 100℃	±1.00 ℃	-0.80 ℃	+0.30 ℃
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판 정 JUDGE.	합격 ACCEPTABLE

REMARK

상기 기기는 해당 기준서에 따라 국가 측정표준 기관으로부터 측정의 소급성이 확보 된 표준장비를 이용하여 비교 교정되었음.
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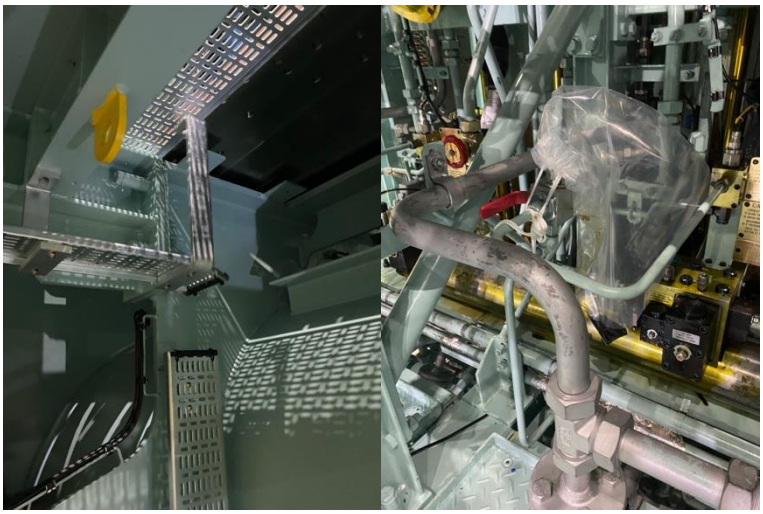
결재	담 당	팀 장
	2023-07-06	2023-07-06

Comments for After FAT meeting

1. The file as below should be provided by email
   - Time table revised version.
   - Calibration report for all measurement devices.
   - Fuel analysis report.
   - Hot & Cold deflection report
   - Bearing clearance report
   - The final FAT report(sign version)
   - The photo of punch mark for each CLASS(CR+LR)
2. Fuel injection valve test.
   - Does Fuel injection valve of this engine doing open pressure test, please clarify.
   - Please explain the actual time for test, and I didn't find any member add me in LINE app, please check.
3. Please provide an analysis report on the engine failure, and briefly explain the root cause of the malfunction as well as the replacement of equipment.
4. Please refer to the diagram below for reinforcement of pipeline fixation to reduce pipeline vibrations

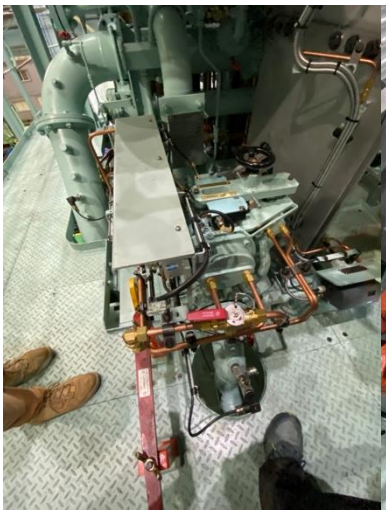
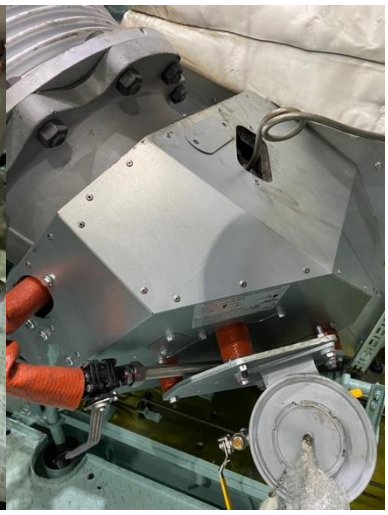


5. The load of trolley(3 tons) was not matched on the lift beam(2 tons), please modify.

6. Some caution plate(not only for pic as below) are only provided in English. Please add Chinese explanations.

7. Please use punch mark for the weight indication on the whole eye plate, and avoid using only paint.

8. Please relocate caution plate of ‘Emergency main starting valve’ and ‘Turbine dry cleaning’ according to the shipowner's recommend, and provide labels on the corresponding valves.

9. The cylinder NO. must be painted in relative cover.

10. Please provide the standard of vibration to check measurement.
11. Label orientation is incorrect, please adjust.

12. The green mark of P.C.P. inlet gauge needs to be increased, please adjust.

13. There has something wrong in the caution plate for Scav. Air receiver(0.5 bar = 0.6 bar abs), please modify.

14. Some caution plate have Chinese explanations that are not fluent. Please adjust them in accordance with the shipowner's instructions.

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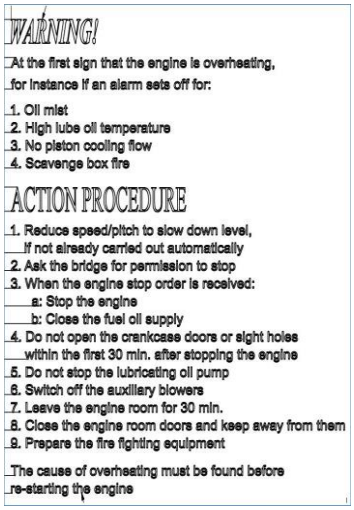
WARNING!
At the first sign that the engine is overheating,
for instance if an alarm sets off for:
1. Oil mist
2. High lube oil temperature
3. No piston cooling flow
4. Scavenge box fire
ACTION PROCEDURE
1. Reduce speed/pitch to slow down level,
If not already carried out automatically
2. Ask the bridge for permission to stop
3. When the engine stop order is received:
a: Stop the engine
b: Close the fuel oil supply
4. Do not open the crankcase doors or sight holes
within the first 30 min. after stopping the engine
5. Do not stop the lubricating oil pump
6. Switch off the auxiliary blowers
7. Leave the engine room for 30 min.
8. Close the engine room doors and keep away from them
9. Prepare the fire fighting equipment
The cause of overheating must be found before
re-starting the engine
</td>
<td>
警告！
一但有引擎過熱跡象時，
以下警報觸發：
1. 油霧
2. 滑油高溫
3. 活塞無冷卻
4. 掃氣箱著火
執行程序：
1. 如果減俥功能沒有自動執行，請將轉速/螺距降至慢俥
2. 向駕駛台請示停俥
3. 當收到停俥指示後：
a. 停俥
b. 關閉燃油供應
4. 在停止主機後的首 30 分鐘內，請勿開啟曲軸箱門或窺視孔
5. 請勿停止潤滑油泵
6. 關閉輔鼓風機
7. 離開機艙 30 分鐘
8. 關閉及遠離機艙的門
9. 準備滅火設備

重新啟動主機之前，請務必找出主機過熱的原因。
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<td>
僅需用手進行兩個步驟，即可拴緊
</td>
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</table>

15. The T/C lubricating oil is too thick and dirty. Please provide a lubricating oil analysis report.

16. The performance data or curves of FAT measurements must be provided as much as possible, let it be a annex in the FAT report and be a reference for user.