

出國報告（出國類別：洽公）

『卡達長期租用 LNG 船案』主機  
Main Turbine 廠試及查核新建 LNG  
船進度辦理情形

服務機關：台灣中油公司總工程師室

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派赴國家：日本

出國期間：97.11.17~97.11.21

報告日期：98 年 1 月日

## 摘要

為供應大潭電廠及台灣中、北部市場之天然氣，本公司與日本郵船株式會社(NYK)、日本三井物產株式會社(Mitsui)合資興建 4 艘 LNG 新船，並於交船後由本公司長期租用，俾以載運本公司向卡達購買之 300 萬噸/年之 LNG。配合此建造任務之執行，本公司依租船合約規定需派員參加 LNG 船所購置重要設備之性能檢驗，及赴船廠進行重點查核，以確保造船進度與品質。

本次出國係因應三菱重工 Hno.2242 LNG 船所購置之 Main Turbine，由租船人(本公司)會同、船東(Nimic)及驗船協會(NK)進行廠試，並順道赴川崎造船廠查核造船品質與進度，結果：

1. Main Turbine 測試部份：廠試結果合格，惟廠試後之開放檢查發現高壓 Turbine 外殼下半部異物夾處，將持續追蹤發生原因及改善結果。
2. 進度部份：符合預定進度。

日本船廠在品質管理上，確有我國現行品管值得學習之處，尤其是 5S 管理之落實、查核表製作之細膩，以及工作人員之敬業精神與工作態度，尤其高專業性船舶如 LNG 船之關鍵技術等值得我國借鏡、學習之處甚多。

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## 一、前言

本公司為供應大潭電廠及台灣中、北部市場天然氣之需求，經公開招標辦理「長期租用 LNG 船勞務採購案」，於 95 年 10 月 18 日與得標廠商共同團隊（日本郵船株式會社 Nippon Yusen Kabushiki Kaisha 及日本三井物產株式會社 Mitsui & Co. Ltd.），依該採購案規定新設立之 4 家 NiMiC 船東公司（NiMiC No. 1 S.A.、NiMiC No. 2 S.A.、NiMiC No. 3 S.A.及 NiMiC No. 4 S.A.，以下合稱「船東公司」）分別簽署租用 4 艘 145,000 立方公尺 LNG 船之計時租船契約（以下簡稱「計時租船契約」）。簽約後，船東公司於 95 年 10 月 18 日分別與日本川崎造船廠（Kawasaki Shipbuilding Corporation）及三菱重工（Mitsubishi Heavy Industries, Ltd.）（以下簡稱「造船廠」）各簽署新建 2 艘 145,000 立方公尺 LNG 船之造船契約（以下簡稱「造船契約」），並約定於 98 及 99 年各完成 2 艘 LNG 新船。

本公司復依長期租用 LNG 船勞務採購案契約及計時租船契約之規定，為完成該 LNG 船之新建，符合所需之作業需求，辦理「LNG 船計時租船契約技術服務」勞務採購案公開招標，由財團法人聯合船舶設計發展中心（以下簡稱船舶中心）得標，協助本公司應辦理之設計及計畫審查、建造品質查核及相關協助、諮詢等技術服務。

本公司赴船廠重點查核之重點工作包括：重要設備製造廠性能驗證、貨液艙焊接組合、主機軸系看中、下水前各項檢驗等，其目的即在於確保造船進度與品質，維護公司應有之利益。

## 二、目的

日本 NYK 之子公司 NYKE 電子傳輸通知本公司 97 年 11 月 18 日將在日本神戶舉行 MHI HNO. 2242 主透平機（Main Turbine）廠試檢驗，本公司遂派遣方振仁及劉晟熙會同參加，並順道至川崎造船坂出工場查核在該廠新建 2 艘 LNG 船之執行情況。

## 三、過程

（一）11 月 17 日：啓程赴日

（二）11 月 18 日：川崎重工神戶工場，Main Turbine 廠試

1. 參與人員：

NiMic 船東代表：井上敬介(Group 部長代理)

NYK：三橋孝司(Manager)

Mitsui：緒方輝久(Naval Architect)

MHI：宮崎美弘(Engineer)、下村勝一(Engineer)、松本應光(Acting Manager)

KHI 代表：木曾美樹(QA Department)、佐藤晃三(Assistant Manager)、今井善信(Manager)

NK 代表：Mr. Minoru KATO

台灣中油公司：劉晟熙、方振仁

船舶中心：李文宏

2. 廠試前會議(2008.11.18 上午 10 點)：

(1). 由川崎重工主持此次廠試會議之技術總監堀家弘先向造船廠(MHI)、租船人及船東代表等作廠試前簡報。說明：

- 測試儀器之校正證書、廠試設備及測試程序計劃書(如附件一)。測試儀器之校正證書曾於現場核對，校正日期未超過 6 個月
- 提出 MHI HNO.2421 Main Turbine 廠試時船東所提之要求回覆單供參考(如附件二)。

(2). 與會代表對於測試程序均無意見。

3. 廠試後會議(2008.11.18 下午 16 點)：

(1). 討論廠試性能測試報告(如附件三)，與會代表均對性能測試之結果接受，惟有下列待澄清或缺點待改善之處(如附件四)：

- (a) 由高壓蒸汽透平機之迷宮式迫緊洩漏之蒸汽於轉速降至 40RPM 時尚未停止之原因？
- (b) 控制油壓力錶(PI 134)對用於緊急停車 (Trip Test) 測試，壓力太低，請檢討。(測試用 305kpa，PI 295kpa)
- (c) 高壓與中壓，低壓與中壓之前後軸承之音度差較大，請檢討是否有問題。
- (d) 高壓透平機後之疏水活塞閥，請掛上銘牌。
- (e) 暖機之活塞閥之作動狀況，請於有負荷運轉時再確認(廠試為無負載運轉測試)。
- (f) 減速齒輪箱之角落有切屑殘留，請清除。
- (g) 高壓透平機第一級踏板與低壓透平機第一級踏板之梯子高度不夠，在海上公試前須確認其安全性。

4. 測試後開放檢查結果(2008.11.20)：

- (1). 透平機轉子之葉片無受傷情況。
- (2). 減速齒輪接觸面良好，無刮傷或受 particle 壓傷。

- (3). 軸承軸瓦無受傷及刮傷。
- (4). 推力軸承及推力塊表面情況均良好。
- (5). 滑油過濾器濾蕊清潔情況良好。
- (6). 上下外殼間有鐵線外物，要求廠方提出解決方法，詳附件五照片。

(三) 11月19日：川崎造船廠，工作進度查核

1. 過程摘述：

赴川崎造船廠會見 NYKE 駐廠監督室長及船廠相關人員並提出問題討論，聽取船廠簡報以及至現場並勘查 LNG TANK 製作施工情形。

2. 參與人員：

川崎造船：營業部：岡村健 東京營業本部課長代理、高田武明 課長代理、  
古川 賢治  
品質保證部：堀井久壽雄  
工作部部長：餅田義典  
副廠長：阿部元一

NYKE：鬼頭明生 監督室長

中油公司：劉晟熙（方振仁因家中臨時有要事，於 11/19 先行返國）

船舶中心：李文宏

3. 結果：

- (1). MHI.SNO.1625：本船鋼板切割預定 12 月開始，目前在工場僅施做鋁合金貨艙相關的鋁合金球體。其中全船貨艙頂板的小組合區塊已完成 61.9%；鋁合金球形貨艙的製作則區分為下半部、中部和上半部，下半部球體已完成 32%、中部球體是 26%、上半部球體是 5%；管群塔的小組合區塊已完成 92%，其銲接組合已達 39%。
- (2). MHI.SNO.1626：本船鋼板切割預定明年 6 月開始，現所進行的工作尚未達到正式檢查階段，其中鋁合金板切割於 10 月 9 日開始。
- (3). 建造預定進度表如附件六及相關照片。

## 四、心得及建議

此次赴川崎造船廠查核 LNG 船建造進度，並檢驗主要設備 Main Turbine，有以下之感想及建議：

1. 船東公司委託之監造單位 NYKE，以及日方造船廠或 Main Turbine 製造商，對於工作處理之積極態度與做事謹慎，留下深刻之印象，我國之台船公司與其

相比實有相當之差距，相信本案 LNG 船之建造能順利圓滿完成，如期進入 LNG 船的營運階段。

2. LNG 船載運著常壓低溫的貨物，造船之技藝首重貨艙結構，承造船廠均將貨艙施工視為機密，而貨艙構材有鋁合金、不銹鋼與鋼材，不同材質的銲接是一特殊的技術。每艘 LNG 船有 4 個球體貨艙，每個球艙可分上中下 3 部分，其中球艙中部之銲接就有技術性的考量，必須同步進行，以減少熱脹冷縮之效應。爲了保持貨物溫度，鋁合金球體承載液體貨物之絕緣體之施工也是一大考驗。總之，高附加價值之船舶，需要高技術的銲接、高科技的材料和領先的設計。台灣造船公司若欲進入 LNG 船建造之領域，首先即需突破此項技術及品管系統的嚴格執行，應仍有一段路要努力。
3. 日本工廠之查核表 (Check List)，遠較本公司廠商所用之自主檢查表爲詳細，他的檢查工項後面有查核人員簽字以及複核人簽字，對檢查之事物也多能具體指稱，甚至有些查核項目尚附註有查核重點。因爲自主檢查表是所謂品管七大手法之一，它是品質作業的基礎，是否落實實可作爲品質良窳之重要指標。
4. 本公司工程量甚鉅，因採購法之規定，並無如日本船廠有所謂衛星廠商之規劃，因此中小型廠商多不抱持永續經營之心態看待所延攬的工程，從而不積極檢討以往所辦理工程發生之缺失，累積經驗並改正本身之品質系統，工程品質執行提升緩慢，因此發現之缺失一再發生。因此本公司工程部門有必要在工程結束後，就工程執行過程辦理結案檢討，包含契約工期之編列、預算編列、工程設計、承攬商對自主檢查表及停留點之設計、工安措施、監造措施等，修正原核定之施工計劃、監造計劃及品質計劃，俾得以間接輔導未來之承攬商在辦理本公司類似工程時按本公司之規定進行。

18 November 2008  
QA Department  
Machinery Division  
Kawasaki Heavy Industries, Ltd.

**MITSHBISHI Hull No. 2242 - Main Steam Turbine**  
**Meeting Documents for Shop Running Test**

**Contents**

1. No Load Running Test Schedule
2. No Load Running Test Record (Blank Sheet)
3. Photo of Trial Assembly of Emergency Steam Pipe for HP/LP Turbine  
Sole Running
4. Remaining Work Status at No Load Running Test
5. Factory Regulations

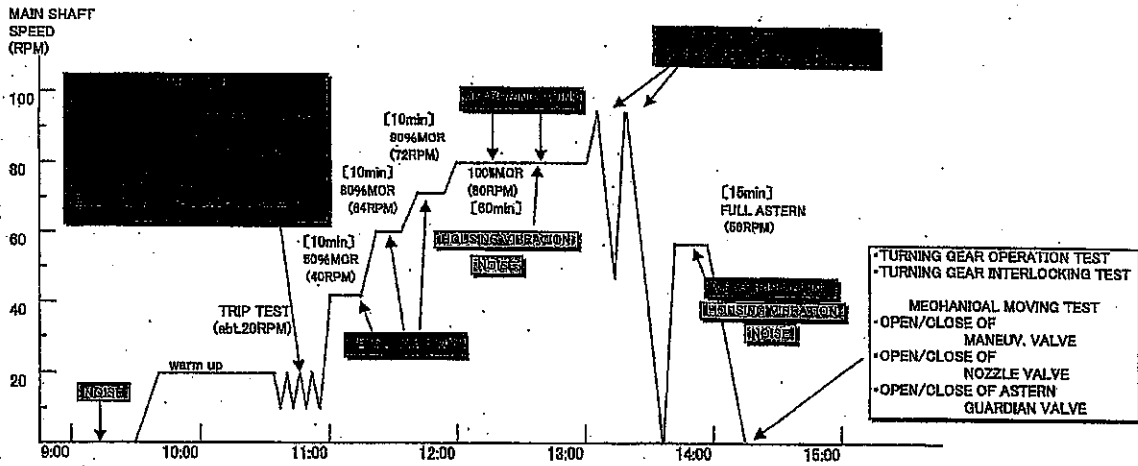


CLASSIFICATION :NK  
 SHIP OWNER :GPC/NYK  
 SHIPYARD :MHI  
 HULL NO. :MHI H.2242

TEST SCHEDULE

UA-400 TYPE MAIN PROPULSION TURBINE (3181386/31V5J66)

[REDACTED] OTHERS

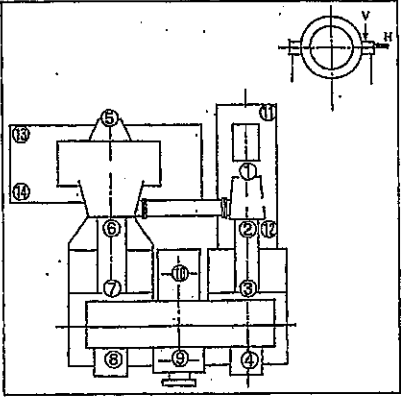


RECORD: [REDACTED] TABLE-2 [REDACTED] TABLE-3 [REDACTED] TABLE-4 [REDACTED] TABLE-1 OTHERS TABLE-5,6,7

MEASURING POINT: PRESSURE RECORD  
 TEMPERATURE RECORD  
 VIBRATION(MONITOR) RECORD  
 AXIAL DISPLACEMENT(MONITOR) RECORD



UA-400		Table - 2		RECORD OF FACTORS MEASUREMENT					DATE: _____ MEASURED BY: _____		
ROTATING DIRECTION				AHEAD					ASTERN		
TEST CORRESPOND TO				---	80% MCR rpm	80% MCR rpm	90% MCR rpm	100% MCR rpm	100% MCR rpm	FULL AST	
TIME AT RECORDING				Hour							
MAIN SHAFT SPEED				Min.							
				rpm							
STEAM PRESSURE	MAIN STEAM			MPaG							
	HP TURBINE AHEAD STEAM CHEST			MPaG							
	LP TURBINE ASTERN STEAM CHEST			MPaG							
	CONDENSER AT TOP			mmHg Vac.							
	GLAND LEAKING STEAM			kPaG							
STEAM TEMPERATURE	MAIN STEAM			°C							
	HP STEAM CHEST			°C							
	AST STEAM CHEST			°C							
	LPT INLET STEAM			°C							
	EXHAUST STEAM			°C							
BEARING MONITOR	HP ROTOR VIBRATION			µm							
	LP ROTOR VIBRATION			µm							
	MAIN RED. GEAR VIBRATION (HP SIDE)			mm/s							
	MAIN RED. GEAR VIBRATION (LP SIDE)			mm/s							
	HP ROTOR POSITION INDICATOR			mm							
LP ROTOR POSITION INDICATOR				mm							
LUBE OIL PRESSURE	MAIN LUBE OIL			kPaG							
	GEAR LUBE OIL			kPaG							
	CONTROL OIL			kPaG							
LUBE OIL TEMPERATURE	MAIN LUBE OIL			°C							
	GEAR LUBE OIL			°C							
BEARING TEMPERATURE	HP TURBINE	THRUST BEARING		°C							
		FWD. BEARING		°C							
		AFT. BEARING		°C							
	LP TURBINE	THRUST BEARING		°C							
		FWD. BEARING		°C							
		AFT. BEARING		°C							
	FIRST REDUCTION GEAR	PINION	HP SIDE	FWD. BEARING	°C						
			AFT. BEARING	°C							
		LP SIDE	FWD. BEARING	°C							
			AFT. BEARING	°C							
		WHEEL	HP SIDE	FWD. BEARING	°C						
			AFT. BEARING	°C							
	SECOND REDUCTION GEAR	PINION	HP SIDE	FWD. BEARING	°C						
			AFT. BEARING	°C							
		LP SIDE	FWD. BEARING	°C							
AFT. BEARING			°C								
WHEEL		FWD. BEARING	°C								
		AFT. BEARING	°C								
AMBIENT PRESSURE				hPa							
AMBIENT TEMPERATURE				°C							
COOLING SEA WATER TEMPERATURE				°C							

NO LOAD CONDITION		MOR	FULL AFTERN			DATE :
MEASURING TIME		80 rpm	56 rpm			MEASURED BY :
1	HP TURBINE FWD. BEARING	V A H				<p>1. Vibration direction V : Vertical (Up and Down) A : Axial (FWD. and AFT.) H : Horizontal (Right and Left)</p> <p>2. Measured component Vibration Velocity (Unit : mm/s)</p> <p>3. Criteria The vibration level shall be subjected to the limit required by shipyard in Purchasing Order Specification. (Limit: 7.1 mm/sec (R.M.S))</p> 
2	HP TURBINE AFT. BEARING	V A H				
3	HP 1ST RED. PINION AFT. BEARING	V A H				
4	HP 2ND RED. PINION AFT. BEARING	V A H				
5	LP TURBINE FWD. BEARING	V A H				
6	LP TURBINE AFT. BEARING	V A H				
7	LP 1ST RED. PINION AFT. BEARING	V A H				
8	LP 2ND RED. PINION AFT. BEARING	V A H				
9	MAIN GEAR AFT. BEARING	V A H				
10	MAIN GEAR FWD. BEARING	V A H				
11	BED PLATE FWD. SIDE	V A H				
12	BED PLATE AFT. SIDE	V A H				
13	MAIN CONDENSER FWD. SIDE	V A H				
14	MAIN CONDENSER AFT. SIDE	V A H				

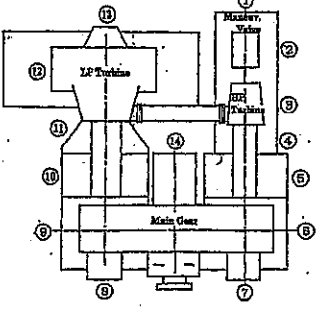
NO LOAD CONDITION		BACK G. NOISE	MOR	FULL AFTERN		DATE :
MEASURING TIME			80 rpm	56 rpm		MEASURED BY :
1	MANEUV. VALVE FWD. END					<p>1. Noise Level Meter Manufacture : Type :</p> <p>2. Unit: dB (A)</p> <p>3. Criteria The noise level shall be in accordance with IMO A468 (XII). Limit: 110dB(A)</p> <p>4. Measuring point to be followed as shown the drawing and each noise to be measured at 1 m distance from casing wall.</p> 
2	MANEUV. VALVE SIDE					
3	HP TURBINE SIDE					
4	HP FLEX. COUPLING SIDE					
5	HP 1ST RED. GEAR SIDE					
6	HP 2ND RED. GEAR SIDE					
7	ENGINE AFT. END (HP SIDE)					
8	ENGINE AFT. END (LP SIDE)					
9	LP 2ND RED. GEAR SIDE					
10	LP 1ST RED. GEAR SIDE					
11	LP FLEX. COUPLING SIDE					
12	LP TURBINE SIDE					
13	LP TURBINE FWD. END					
14	RED. GEAR FWD. END					

Table-5 RECORD OF TURNING GEAR OPERATION TEST RESULT

TEST ITEM	TEST RESULT
Turning for astern direction	
Turning for ahead direction	

Table-6 RECORD OF TURNING GEAR INTERLOCK TEST RESULT

TEST ITEM	TEST RESULT
Turning Gear Interlock	

Table-7 RECORD OF MECHANICAL MOVING TEST RESULT

TEST ITEM	TEST RESULT
Maneuvering Valve action (open/close)	
Astern Guardian Valve action (open/close)	
Nozzle Valve action (open/close)	

廠試測試記錄:

Table-1 RECORD OF EMERGENCY TRIP TEST RESULT

TEST ITEM	NORMAL CONDITION	TRIP SET (ALARM SET)	TEST RESULT	
Hand Trip	.....	.....	IN ORDER	
Lube Oil Pressure Low Trip	abt. 98.1 kPaG	49±4.9 kPaG (69±6.9 kPaG)	49 kPaG	
Control Oil Pressure Low Trip	abt. 892 kPaG	196±9.8 kPaG (245±9.8 kPaG)	200 kPaG	
Main Condenser Vacuum Low Trip	720 mmHgVac (96.0 kPaVac)	300±30 mmHg (600±60 mmHg)	300 mmHg	
Rotor Excessive Vibration Trip	HP Turbine	~ abt. 80 μm at 100% MCR rpm (at shop test)	180±5 μm (100±5 μm)	IN ORDER
	LP Turbine	~ abt. 44 μm at 100% MCR rpm (at shop test)	180±5 μm (150±5 μm)	IN ORDER
Rotor Excessive Axial Displacement Trip	HP Turbine	0.2 mm or less	1.0±0.05 mm (0.5±0.05 mm)	IN ORDER
	LP Turbine	0.2 mm or less	1.0±0.05 mm (0.5±0.05 mm)	IN ORDER
Main Red. Gear Excessive Vibration Trip	HP SIDE	~ abt. 2.0mm/s (R.M.S) (at shop test)	18±0.2 mm/s (7±0.2 mm/s)	IN ORDER
	LP SIDE	~ abt. 2.0mm/s (R.M.S) (at shop test)	18±0.2 mm/s (7±0.2 mm/s)	IN ORDER
Turbine Over-speed Trip (Observed by main shaft rev.)	LP SIDE	80 rpm	89.6~92.0 92.0 <sup>+0</sup> -2.4rpm 1st 91.0 rpm 2nd 91.0 rpm	

UA-400		Table - 2 RECORD OF FACTORS MEASUREMENT					DATE: Nov.-18 <sup>th</sup> -2008 MEASURED BY: Y. Manujama.						
ROTATING DIRECTION			AHEAD					ASTERN					
TEST CORRESPOND TO			---	50% MCR 40 rpm	80% MCR 64 rpm	90% MCR 72 rpm	100% MCR 80 rpm	100% MCR 80 rpm	FULL AST 1/2				
TIME AT RECORDING			Hour Min.	11:09	11:27	11:41	11:58	12:35	13:40				
MAIN SHAFT SPEED			rpm	405	647	724	803	806	567				
STEAM PRESSURE	MAIN STEAM		MPaG	3.05	3.05	3.00	3.00	3.00	2.95				
	HP TURBINE AHEAD STEAM CHEST		MPaG	-0.03	0.07	0.14	0.18	0.20	-0.07				
	LP TURBINE ASTERN STEAM CHEST		MPaG	-0.09	-0.09	-0.09	-0.09	-0.09	0.19				
	CONDENSER AT TOP		mmHg Vac.	725	730	725	725	725	725				
	GLAND PACKING STEAM		kPaG	.15	.15	.15	.16	.17	.21				
STEAM TEMPERATURE	MAIN STEAM		°C	230	240	250	260	275	260				
	HP STEAM CHEST		°C	160	170	190	210	220	---				
	AST STEAM CHEST		°C	---	---	---	---	---	210				
	LPT INLET STEAM		°C	80	70	75	80	85	---				
	EXHAUST STEAM		°C	45	35	30	35	35	80				
BEARING MONITOR	HP ROTOR VIBRATION		µm	3.9	2.0	4.6	4.6	4.7	8.4				
	LP ROTOR VIBRATION		µm	6.8	11.0	12.7	9.9	8.8	7.0				
	MAIN RED. GEAR VIBRATION (HP SIDE)		mm/s	0	0	0.10	0.10	0.10	0				
	MAIN RED. GEAR VIBRATION (LP SIDE)		mm/s	0	0	0.10	0.48	0.48	0				
	HP ROTOR POSITION INDICATOR		mm	0.04	-0.03	-0.06	-0.10	-0.10	0.07				
	LP ROTOR POSITION INDICATOR		mm	-0.12	-0.11	-0.11	-0.10	-0.10	-0.09				
LUBE OIL PRESSURE	MAIN LUBE OIL		kPaG	120	122	122	122	120	120				
	GEAR LUBE OIL		kPaG	140	140	140	140	130	135				
	CONTROL OIL		kPaG	310	310	310	310	310	305				
LUBE OIL TEMPERATURE	MAIN LUBE OIL		°C	40	40	40	40	40	40				
	GEAR LUBE OIL		°C	40	40	40	40	40	40				
BEARING TEMPERATURE	HP TURBINE	THRUST BEARING		°C	42	42	43	44	44	42			
		FWD. BEARING		°C	46	50	51	52	53	51			
		AFT. BEARING		°C	44	48	50	51	51	48			
		THRUST BEARING		°C	42	44	46	48	48	44			
		FWD. BEARING		°C	49	54	58	60	60	54			
		AFT. BEARING		°C	48	54	57	59	60	54			
	LP TURBINE	HP SIDE	FWD. BEARING		°C	44	53	57	60	60	49		
			AFT. BEARING		°C	44	48	50	53	53	47		
			LP SIDE	FWD. BEARING		°C	44	52	56	60	60	51	
				AFT. BEARING		°C	44	48	50	52	52	48	
		WHEEL	HP SIDE	FWD. BEARING		°C	42	44	45	46	46	44	
				AFT. BEARING		°C	42	44	44	45	46	44	
			LP SIDE	FWD. BEARING		°C	42	44	46	47	48	45	
				AFT. BEARING		°C	42	44	44	46	46	43	
		SECOND REDUCTION GEAR	PINION	HP SIDE	FWD. BEARING		°C	42	44	46	47	47	44
					AFT. BEARING		°C	42	45	47	48	49	45
				LP SIDE	FWD. BEARING		°C	43	46	48	50	50	46
					AFT. BEARING		°C	42	46	48	49	50	45
	WHEEL		FWD. BEARING		°C	38	38	39	40	40	40		
			AFT. BEARING		°C	36	37	38	39	39	39		
			AMBIENT PRESSURE		kPa	1012	1012	1012	1012	1012	1012		
			AMBIENT TEMPERATURE		°C	18	18	18	18.5	18	18		
	COOLING SEA WATER TEMPERATURE		°C	20	20	19.5	20	20	19				

NO LOAD CONDITION		MCR 80 rpm	FULL ASTERN 88 rpm		
MEASURING TIME		11:55	13:35		
1	HP TURBINE FWD. BEARING	V 0.2 A 0.1 H 0.1	0.1 0.1 0.1		
2	HP TURBINE AFT. BEARING	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		
3	HP 1ST RED. PINION AFT. BEARING	V 0.4 A 0.4 H 0.3	0.5 0.1 0.1		
4	HP 2ND RED. PINION AFT. BEARING	V 0.4 A 0.4 H 0.2	0.1 0.1 0.2		
5	LP TURBINE FWD. BEARING	V 0.1 A 0.3 H 0.3	0.1 0.1 0.1		
6	LP TURBINE AFT. BEARING	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		
7	LP 1ST RED. PINION AFT. BEARING	V 0.5 A 0.6 H 0.7	0.1 0.3 0.1		
8	LP 2ND RED. PINION AFT. BEARING	V 0.5 A 0.5 H 0.3	0.1 0.1 0.1		
9	MAIN GEAR AFT. BEARING	V 0.3 A 0.3 H 0.2	0.1 0.1 0.1		
10	MAIN GEAR FWD. BEARING	V 0.5 A 0.5 H 0.1	0.1 0.1 0.1		
11	RED PLATE FWD. SIDE	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		
12	RED PLATE AFT. SIDE	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		
13	MAIN CONDENSER FWD. SIDE	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		
14	MAIN CONDENSER AFT. SIDE	V 0.1 A 0.1 H 0.1	0.1 0.1 0.1		

1. Vibration direction  
V: Vertical (Up and Down)  
A: Axial (FWD. and AFT.)  
H: Horizontal (Right and Left)

2. Measured component  
Vibration Velocity (Unit: mm/s)

3. Criteria  
The vibration level shall be subjected to the limit required by shipyard in Purchasing Order Specification. (limit: 7.1 mm/sec (R.M.S))

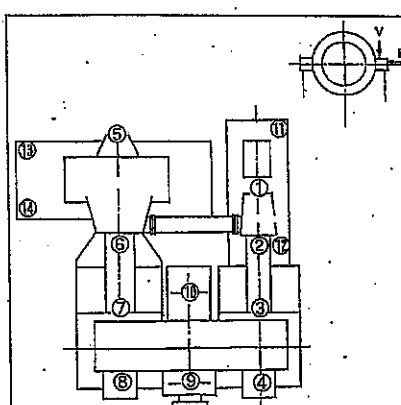


Fig. 1 VIBRATION MEASUREMENT POINT

NO LOAD CONDITION		BACK G. NOISE	MCR 80 rpm	FULL ASTERN 88 rpm	
MEASURING TIME		8:10	11:55	13:35	
1	MANEUV. VALVE FWD. END	65	92	92	
2	MANEUV. VALVE SIDE	67	99	98	
3	HP TURBINE SIDE	68	96	94	
4	HP FLEX. COUPLING SIDE	67	99	92	
5	HP 1ST RED. GEAR SIDE	64	91	88	
6	HP 2ND RED. GEAR SIDE	66	87	84	
7	ENGINE AFT. END (HP SIDE)	63	86	81	
8	ENGINE AFT. END (LP SIDE)	63	85	82	
9	LP 2ND RED. GEAR SIDE	63	84	83	
10	LP 1ST RED. GEAR SIDE	63	84	83	
11	LP FLEX. COUPLING SIDE	64	91	87	
12	LP TURBINE SIDE	65	85	84	
13	LP TURBINE FWD. END	66	92	91	
14	RED. GEAR FWD. END	64	94	88	

1. Noise Level Meter  
Manufacture: RION  
Type: S-1

2. Unit: dB (A)

3. Criteria  
The noise level shall be in accordance with IMO A468 (XII).  
(Limit: 110dB(A))

4. Measuring point to be followed as shown the drawing and each noise to be measured at 1m distance from casing wall.

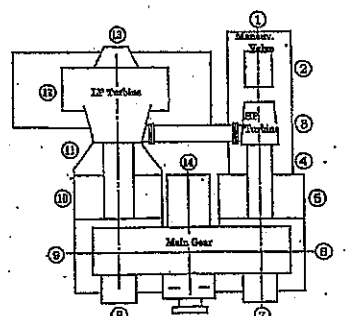


Fig. 2 NOISE MEASUREMENT POINT



Table-5 RECORD OF TURNING GEAR OPERATION TEST RESULT

TEST ITEM	TEST RESULT
Turning for astern direction	IN ORDER
Turning for ahead direction	IN ORDER

Table-6 RECORD OF TURNING GEAR INTERLOCK TEST RESULT

TEST ITEM	TEST RESULT
Turning Gear Interlock	IN ORDER

Table-7 RECORD OF MECHANICAL MOVING TEST RESULT

TEST ITEM	TEST RESULT
Maneuvering Valve action (open/close)	IN ORDER
Astern Guardian Valve action (open/close)	IN ORDER
Nozzle Valve action (open/close)	IN ORDER

廠試後會議船東要求事項

MHI HULL NO.2242 MAIN STEM TURBINE SHOP TEST

18, Nov, 2008

Hull No.2242

Written by: ship yard

No.	Comment by customer	Action and answer by KHI
1	H.Pタービンラビリンス部からの漏洩 40rpm迄止まらなかつた理由は?	
2	Conc oil Press Gauge (PI134)が Trip Test用に交換後、0.2点検値が (Test用 305kPa PI 295kPa)	
3	HP IP, LP IP & F.A 軸受の 音圧差が大きいが問題ありませんか	
4	HPタービン石のドレニコスト二弁に 銘板を取付けて下さい。(吊り下タイプ)	
5	R/G LO管が2曲り以上ある為、 内部確認が出来ない。	
6	同じく LPタービン A弁 軸受給油管 内部確認が出来ない。	
7	w/up コスト二弁は動作確認して 出荷をお願いします	
8	R/Gの隅々には切粉が残っている 掃除をお願いします。	
9	昇降はしにか不安定なものがある。 ・HP 1st P と LP 1st P の間の油圧は安定に2.2MPa ・HP 1st P の上部のオイルクーラー テスト前に安全確認を行ってください。	
10	据付ボルト穴の各寸法を提出下さい (すでに大工に依頼しています。)	

11 ④の要望事項を7/12-1/11まで

MHI HULL NO.2242 MAIN STEM TURBINE SHOP TEST

18, Nov, 2008

Hull No.2242

Written by: \_\_\_\_\_

No.	Comment by customer	Action and answer by KHI
1	Small leakage of steam from fore side of HP turbine rabyrinth side to be corrected. (NYKE/KI)	To be confirmed on board.
2	Lead wire of thermister, three or four places are needed supports to be fitted. (NYKE/KI)	Agreed.
3	Nozzle valve indicator is difficult to check to be improved. (NYKE/KI)	Agreed
4	Meeting memo which was submitted in SNo, 2241 would be cleared to be confirmed. (NYKE/KI)	All comments are cleared except comment No. 2 & 4.
5	Thrust Bearing for HP Turbine shall be checked at overhaul inspection (photo to be submitted)	Agreed.
6	Lub oil filter to be checked at overhaul inspection. (photo to be submitted)	Agreed
7		
8		
9		
10		

MHI HULL NO.2242 MAIN STEM TURBINE SHOP TEST

18, Nov, 2008

Hull No.2242

Written by : \_\_\_\_\_

No.	Comment by customer	Action and answer by KHI
1	Small leakage of steam from fore side of HP turbine rabyrinth side to be corrected. (NYKE/KI)	To be confirmed on board.
2	Lead wire of thermister, three or four places are needed supports to be fitted. (NYKE/KI)	Agreed.
3	Nozzle valve indicator is difficult to check to be improved. (NYKE/KI)	Agreed
4	Meeting memo which was submitted in SNo, 2241 would be cleared to be confirmed. (NYKE/KI)	All comments are cleared except comment No. 2 & 4.
5		
6		
7		
8		
9		
10		

MHI HULL No.2241 MAIN STEAM TURBINE -SHOP TEST

2008/7/31

Ship Owner's comment (NYK)

No.	Comment by customer	Action and answer by KHI
1	Each sensor (Vib. Monitor Displacement monitor, Over speed monitor...etc) should be applied the Name Plate.	Agreed.
2	Name Plate "No.2 Nozzle valve" is not necessary.	Agreed.
3	<del>CANCEL</del>	<del>CANCEL</del>
4	To be clarify the association between Hydraulic cylinder scale and CAM AXIS FEED BACK scale.	KHI shall provide the relative chart.
5	Please change the handle size of Astern Guardian valve.	KHI study.
6	Please mark with paint on grease nipple and clearly the position.	KHI shall mark on grease nipple with yellow paint. The position of grease nipple was described in the instruction.
7	What is the meter on Hydraulic Cylinder scale: ① Neutral zone for Maneuvering driving unit side ② Neutral zone for Hand operating side..	① 5 mm ② 9 mm

Ship Builder's comment (MHI)

No.	Comment by customer	Action and answer by KHI
1	Are you sure that the turning gear is full oil up?	Yes.
2	What purpose is the hole inside gear casing.	It's for drain.
3	To be submitted the calibration record.	Agreed.
4	Horizontal joint contact check of HP turbine casing should be done at overhauling inspection.	Agreed.
5	Please mark with red paint on turning gear lever and motor handle.	Agreed.
6	Name plate "Vacuum failure trip" of pressure switch should be changed to "vacuum low trip".	KHI will rectify.
7	Control oil pressure gauge (PI-134) indicate little lower than shop pressure gauge use for same line(trip pressure). Verify the accuracy of pressure gauges.	Agreed.
8	To be explained the reason why bearing temperature of Main gear (Aft.) is lower than Lube oil temperature.	It's normal condition. Explained and agreed.

9	Indication of Warm up position V/V(T-161) should be identified.	Agreed. Open : Black Shut : Red
10	To be added the support around warm up position line (T-158).	Agreed.
11	To be changed the root of HP No.2 nozzle w/v.	Leave as it is.
12	To be rectified the pipe arrangement for drain of bearing foundation (LPT Fwd.).	Agreed.
13	Indication of Warm up position No.2 nozzle V/V should be identified.	Same as No.9 comment.
14	Electrical component should be protected before shipping.	Agreed.
16	To be explained about supply and fitting of jack bolt.	Explained and agreed.
16	To be fixed the temporary cover on the bellows of Hydraulic cylinder.	Agreed.
17	To be painted all pipe completely.	Agreed.
18	To be submitted the analysis report for L.O. after shop test.	Agreed.
19	Please change the handle size of Astern Guardian valve.	Same as Owner's comment No.5.

20	Please fix the Inter rock plate of New warm up system.	To be fixed by Shipyard.
21	To be added the bracket for the temperature of LP turbine casing.	Agreed.
22	To be added the bracket for the local ten temperature and temperature sensor of Astern steam chest.	Leave as it is.
23	The gaskets for drain tube to Main condenser should be used full-face gasket or spiral wound gasket.	Agreed.

KHIQA / Miki Kiso

**MHI HULL No.2241 MAIN STEAM TURBINE - OPEN UP INSPECTION**

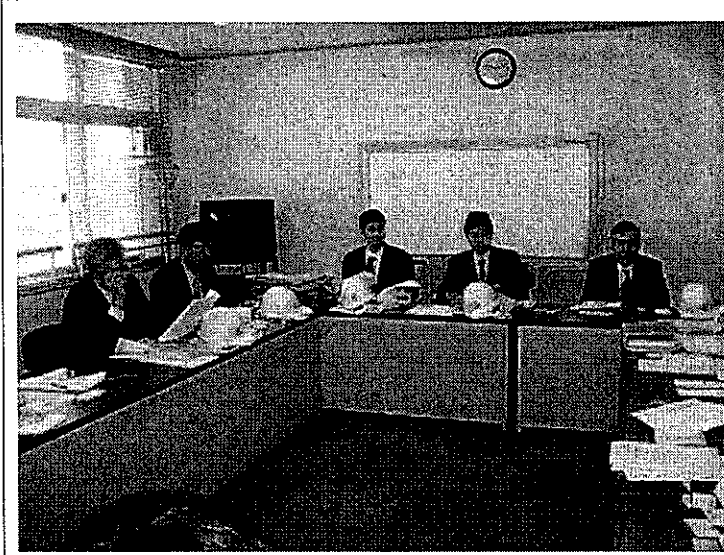
2008/6/4

*Ship Owner's comment (NYK) & Ship Builder's comment (MHI)*

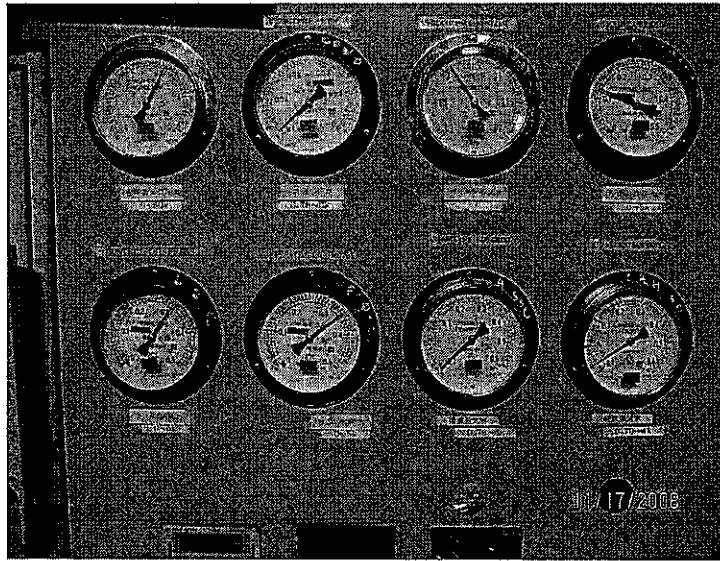
No.	Comment by customer	Action and answer by KHI
1	Following mark on gear tooth surface should be recorded by the photograph. ① LP 2 <sup>nd</sup> Pinion (Aft./Astern side) ② LP 1 <sup>st</sup> Pinion (Fore./Astern side) ③ HP 1 <sup>st</sup> Pinion (Aft./Ahead side)	Agreed.
2	Over speed device: To be mark the Nut and Rotor shaft.	Agreed.
3	The bolt of Peep hole for LP turbine should be fixed tongued washer.	Agreed.

KHIQA / Miki Kiso

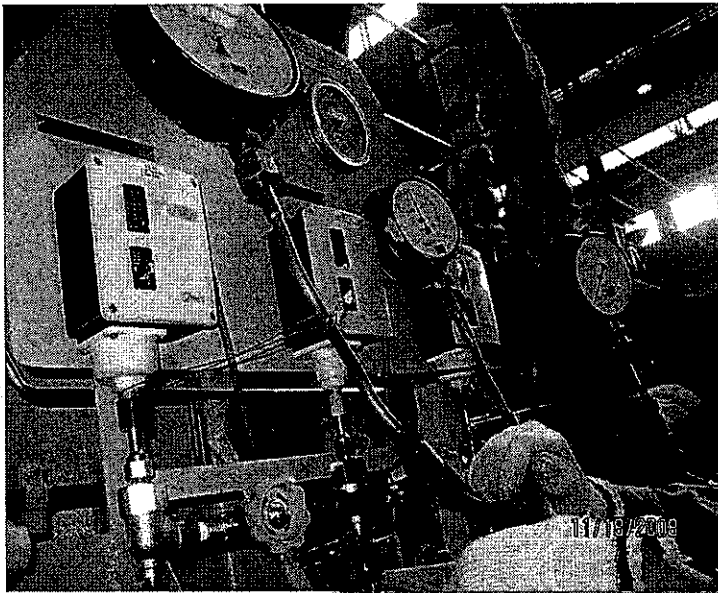
附件五：Main turbine 廠試檢驗相關照片



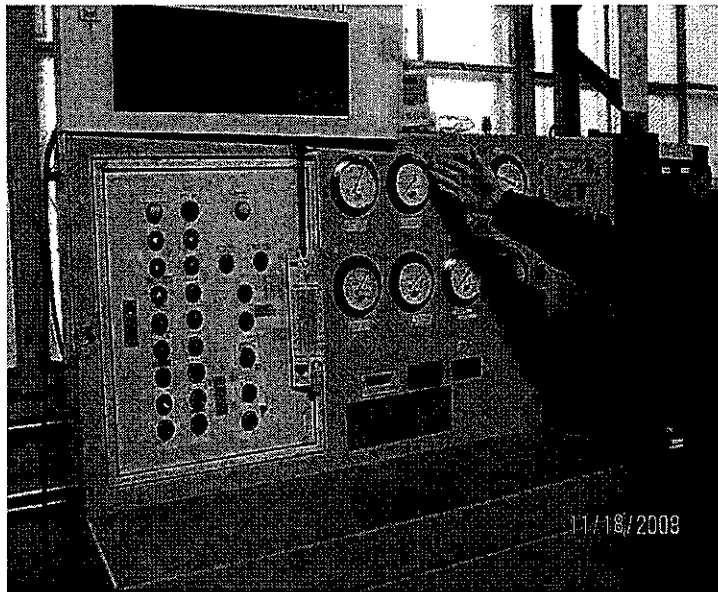
主推進蒸汽渦輪機廠試前會議



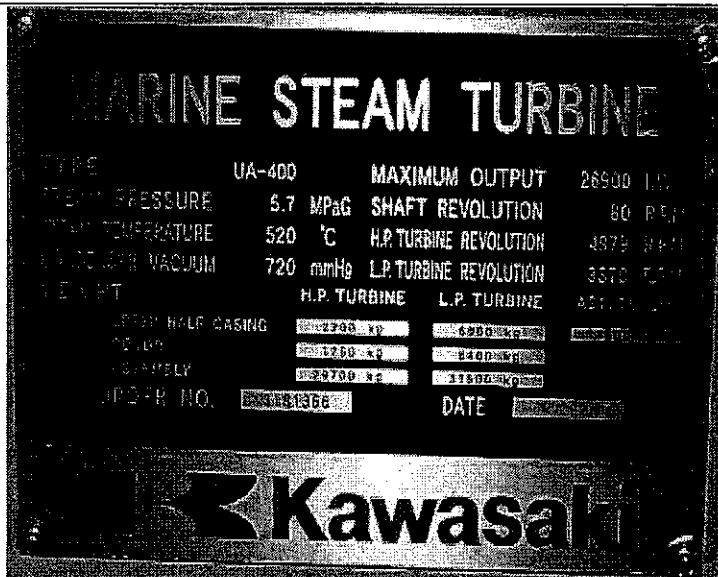
廠試現場計測之儀錶盤



安全裝置測試照片

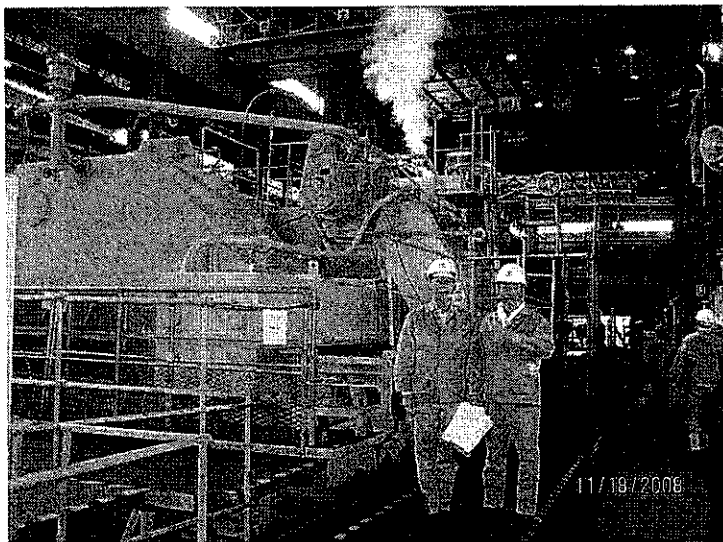


廠試現場計測之儀錶盤

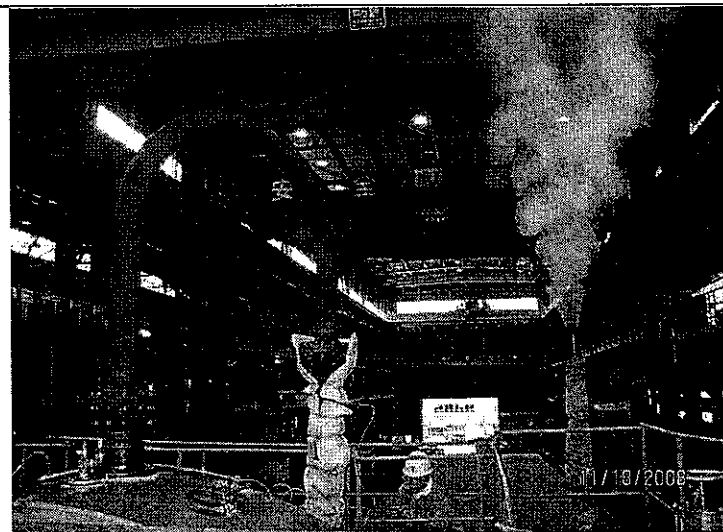


主推進蒸汽渦輪機之銘牌





廠試照片



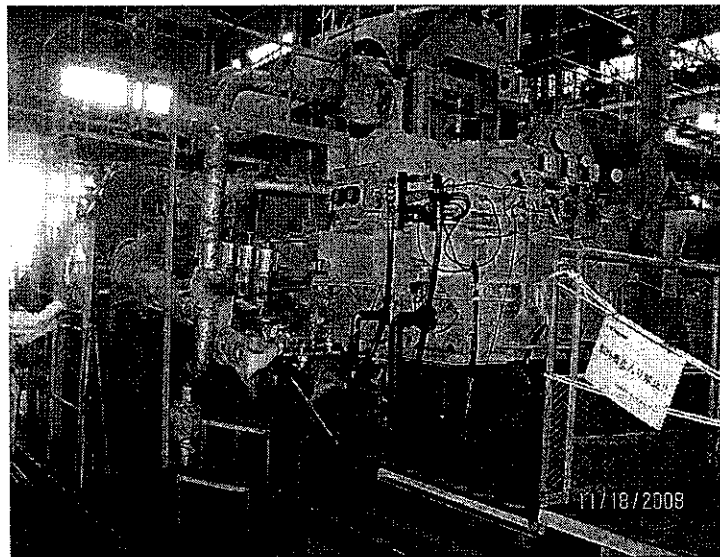
廠試時格蘭蒸汽排汽之照片



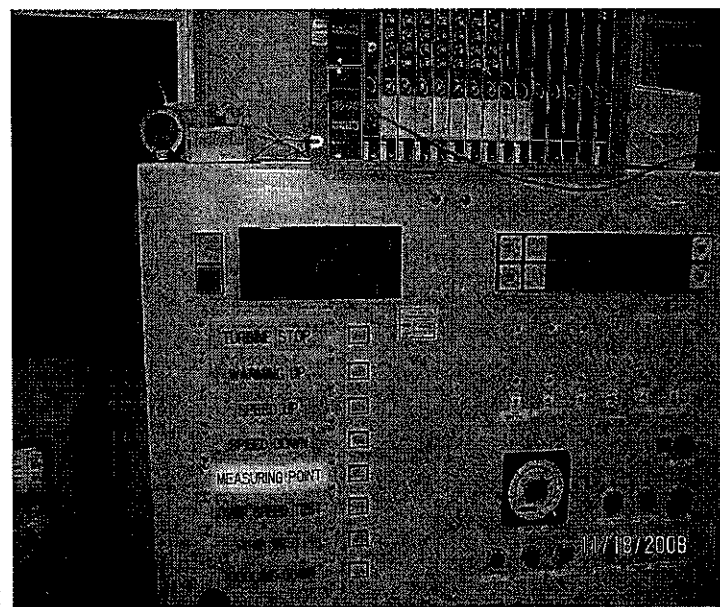
主蒸汽進口控制閥包括緊急操作桿照片



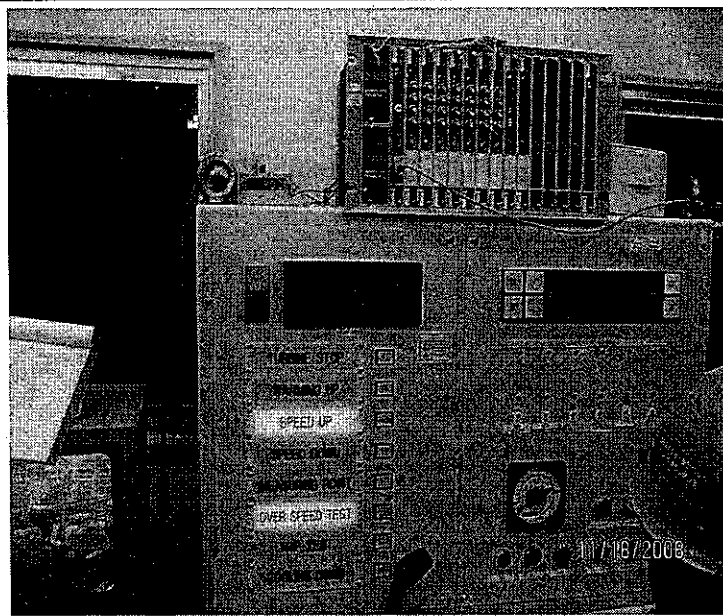
運轉中振動量測



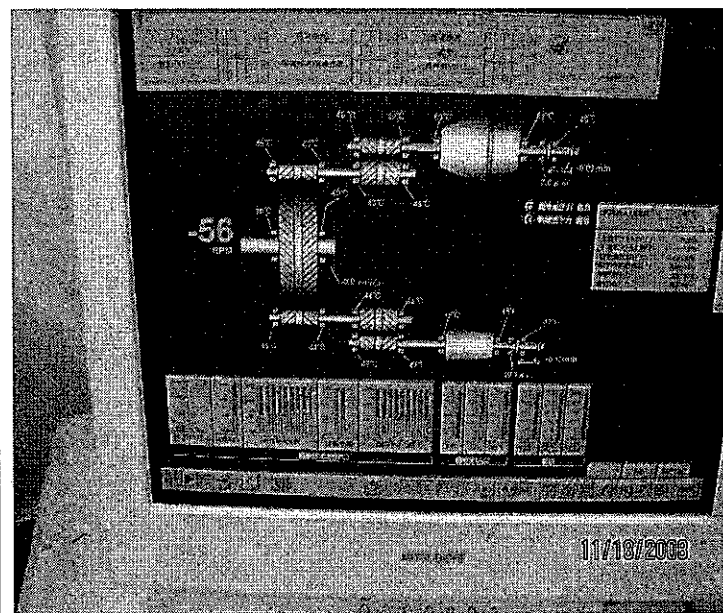
主推進蒸汽渦輪機廠試照片全景



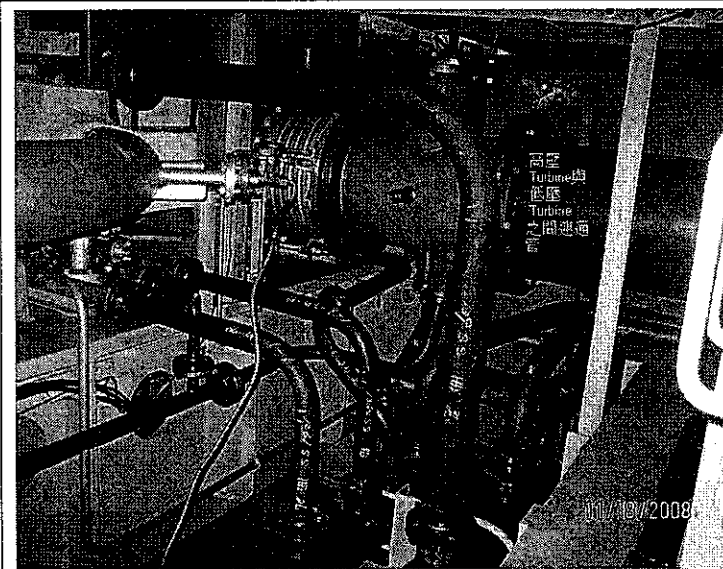
100%轉速到達開始量測所需數據



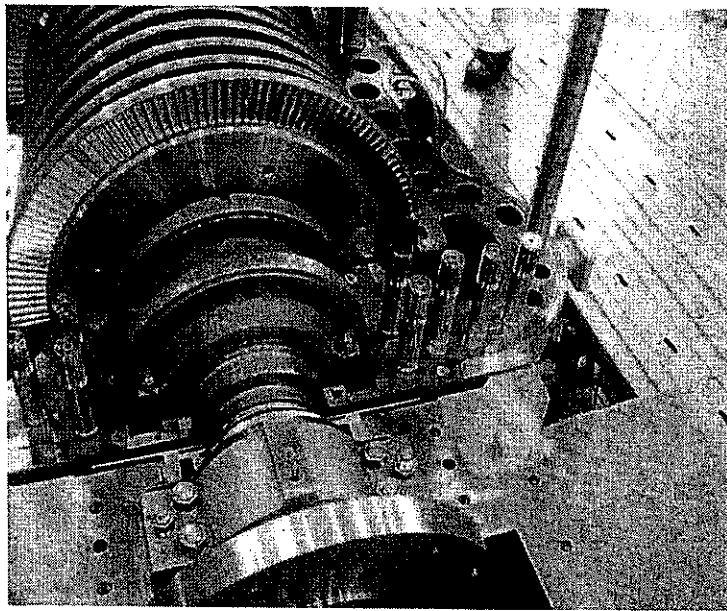
超速運轉中控制盤之照片



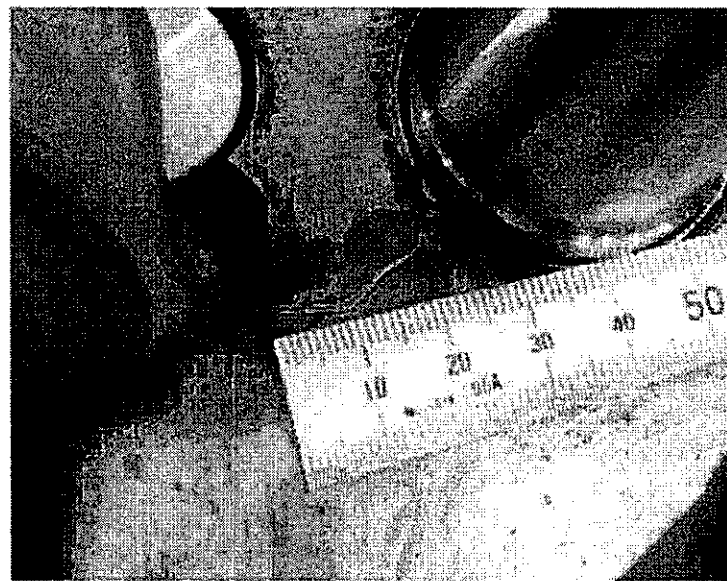
主推進 Turbine 機全速後  
退運轉溫度儀錶計



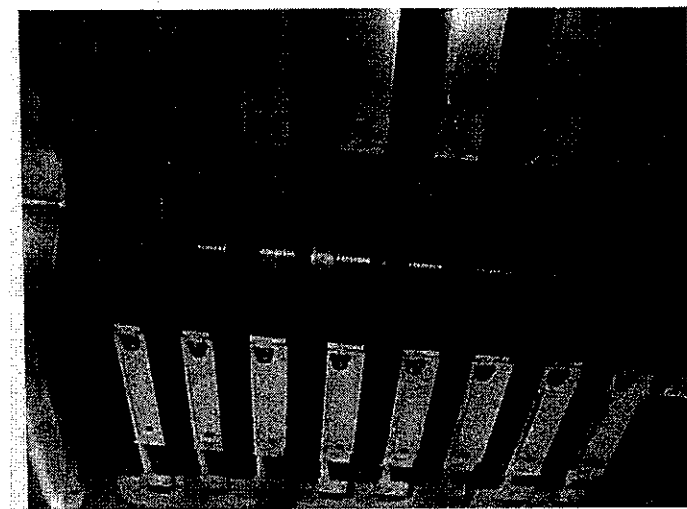
高,低壓蒸汽渦輪機之間  
連接管照片



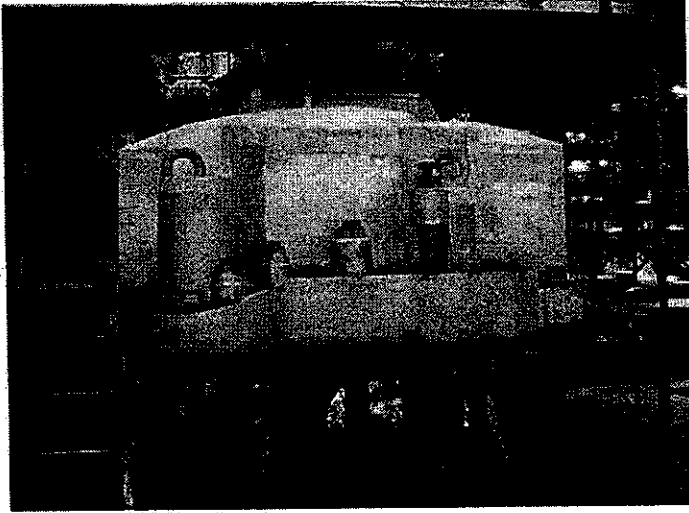
高壓 Turbine 外殼下半部  
紅色爲異物夾處



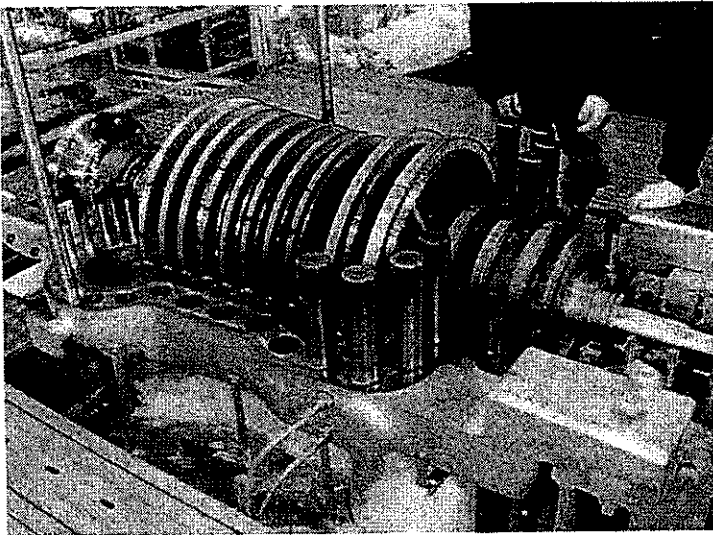
高壓 Turbine 外殼下半部  
異物夾處



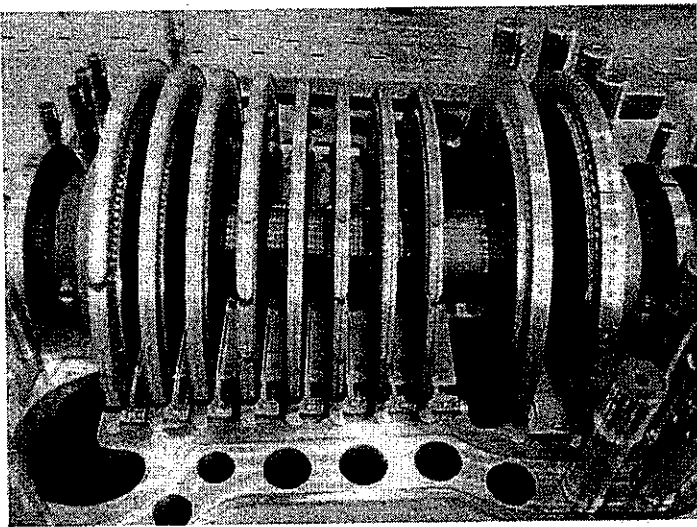
高壓透平機上部外殼內部



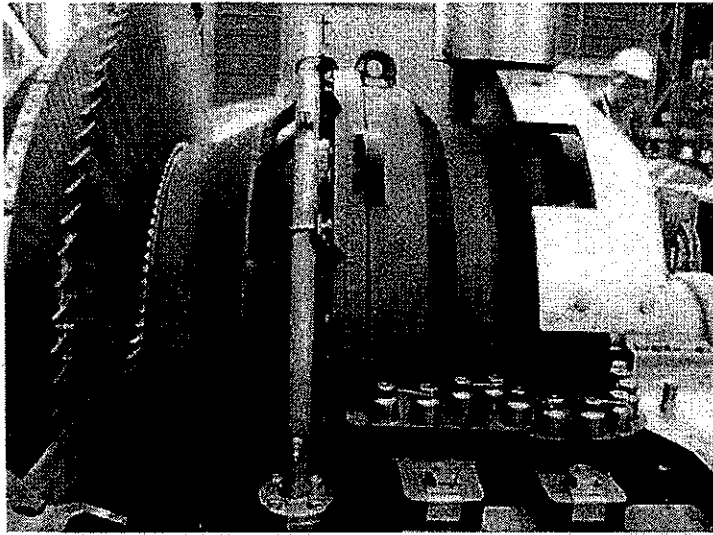
高壓透平機上部外殼



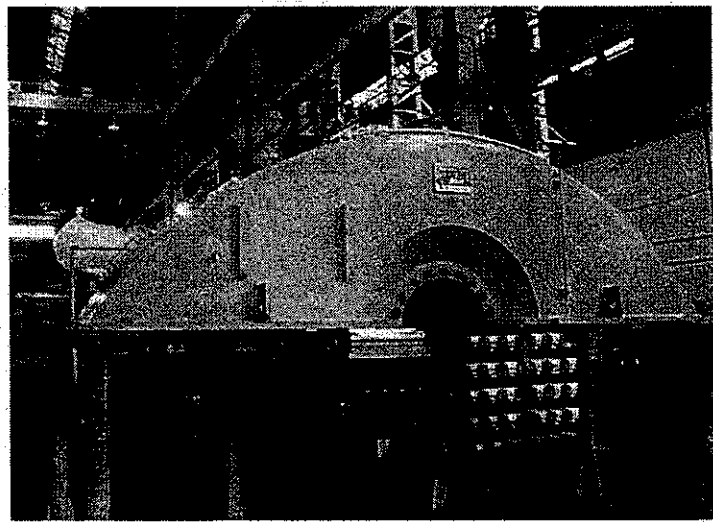
高壓透平機



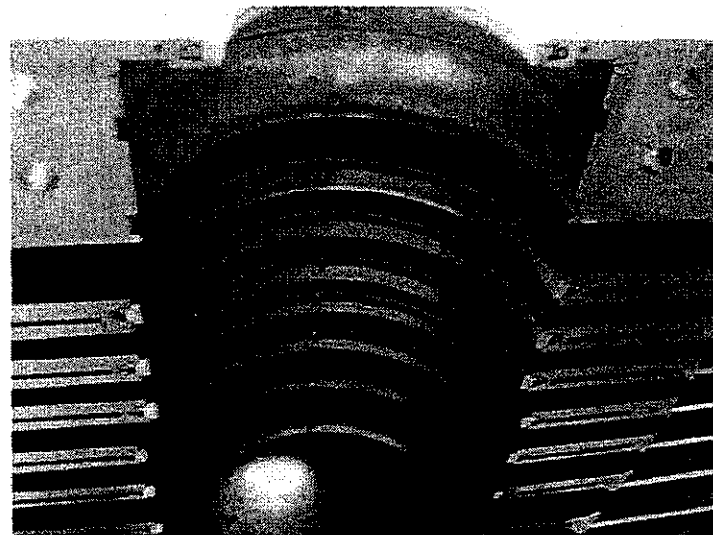
低壓透平機



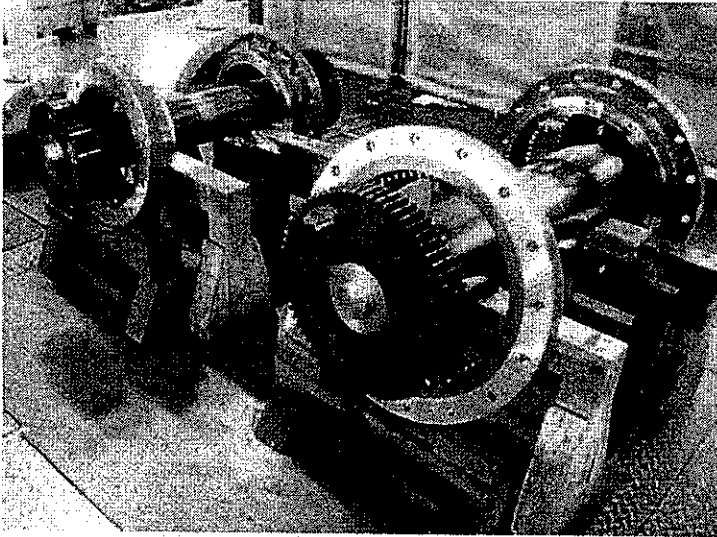
後退透平機



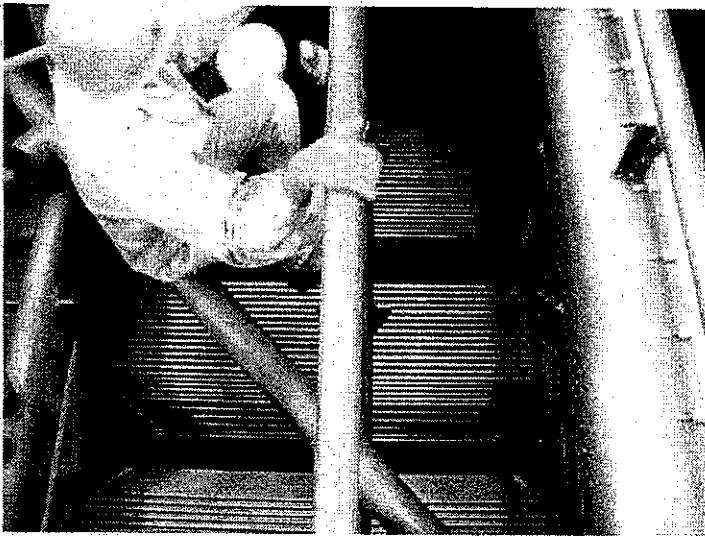
低壓透平機上殼



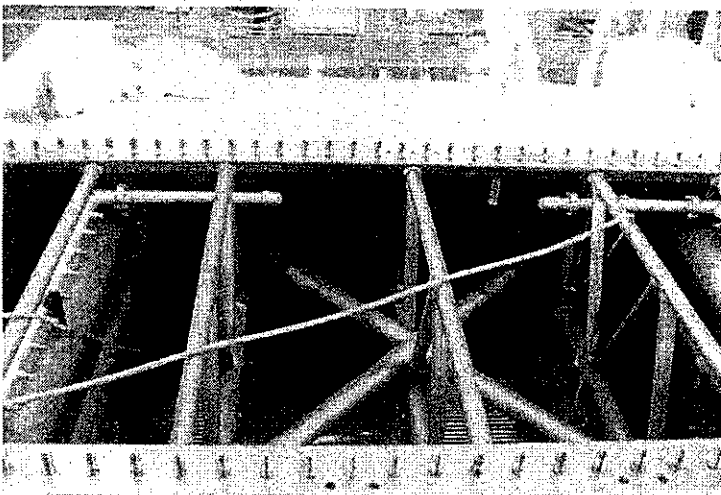
低壓透平機上殼內部



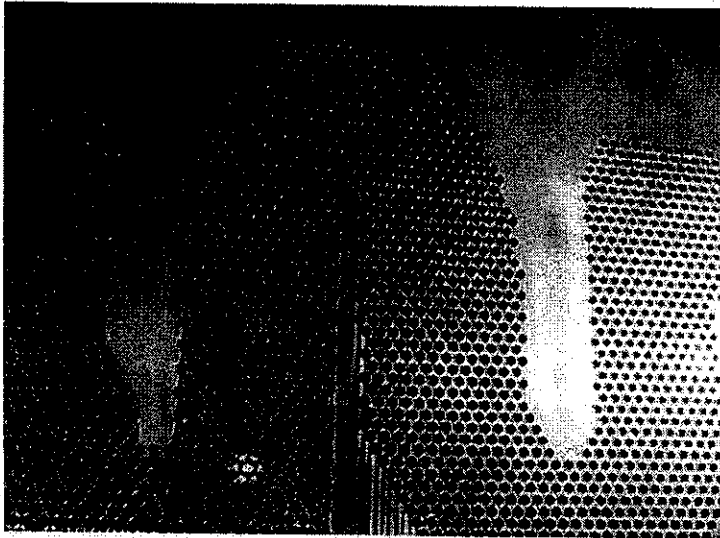
高壓及低壓透平機撓性  
接頭



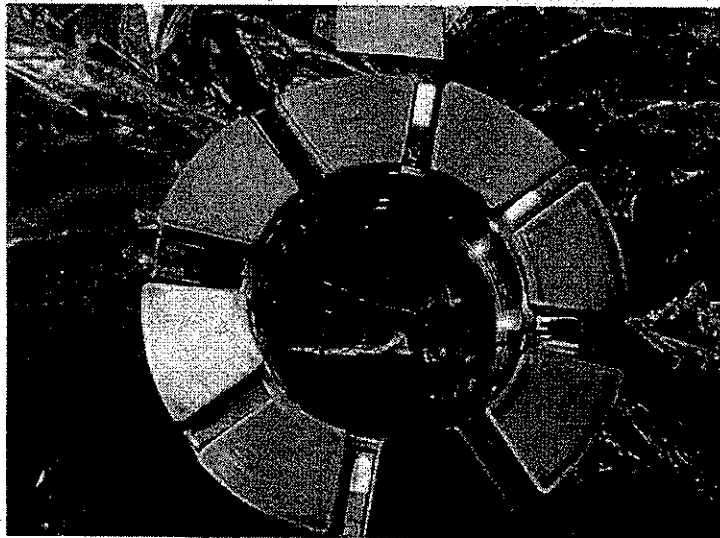
主冷凝器



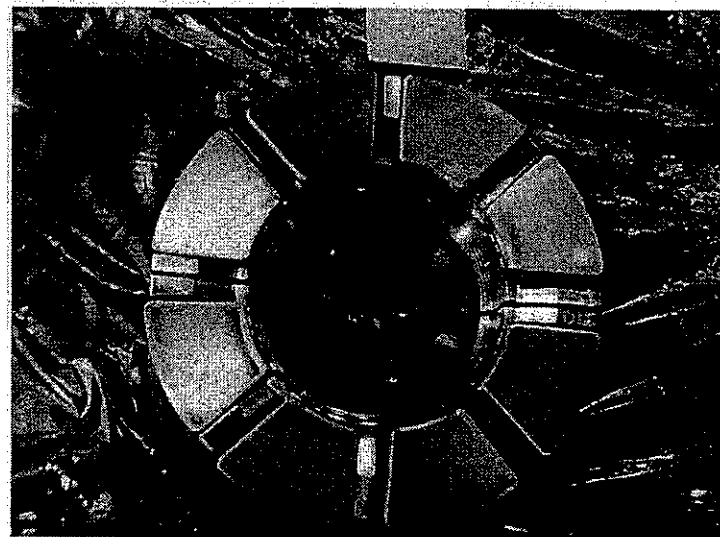
主冷凝器



主冷凝器冷卻管

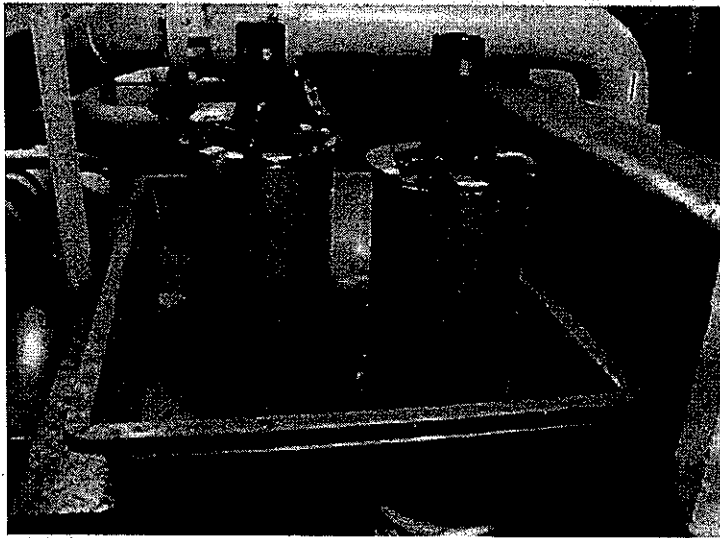


高壓透平機推力軸承擔  
(前側)

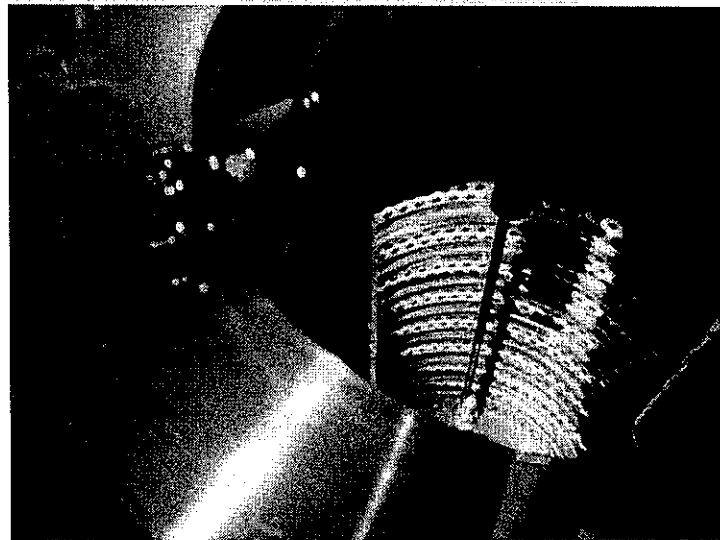


高壓透平機推力軸承擔  
(後側)



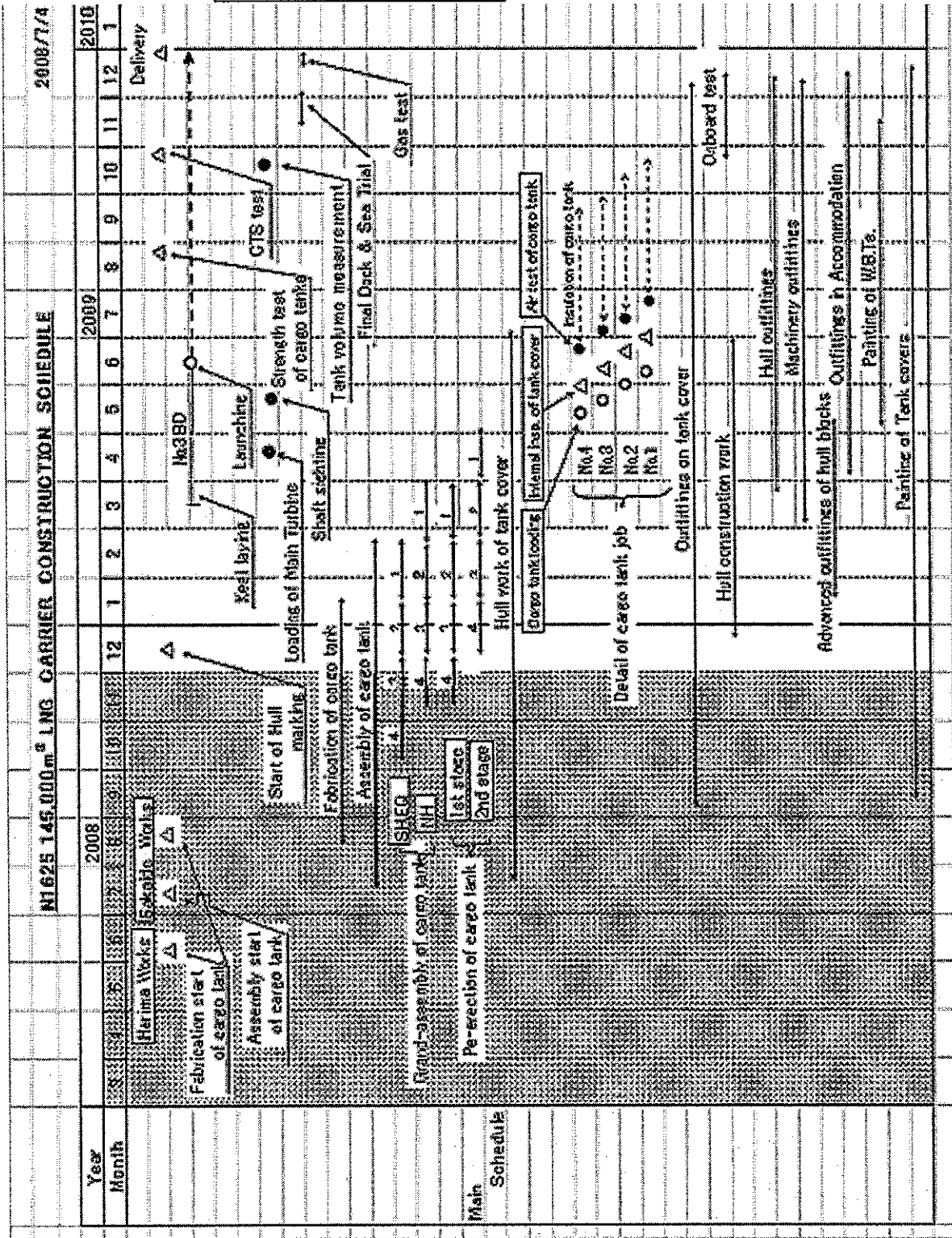


滑油過濾器



滑油過濾器內部

附件六：預定建造表



### 3. Construction Progress (S-Curve)

		2007												2008												2009												As of End of Nov, 2008																	
		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
KAWASAKI Hull No. 1625																																																							
PRODUCTION ACTIVITY	Weight %																																																						
HULL ASSEMBLY	23																																																						
HULL PRE-ERECTOR & ERECTION	16																																																						
PAINTING	15																																																						
HULL PART INSTALLATION	19																																																						
ENGINE PART INSTALLATION (Incl. electric work & piping fabrication)	12																																																						
CARGO TANK CONSTRUCTION	14																																																						
COMMISSIONING, TESTING AND TRIAL	1																																																						
TOTAL	100																																																						
PLANNED CUMULATIVE PROGRESS																																																							
ACTUAL CUMULATIVE PROGRESS																																																							
	Planned %																																																						
	Actual %																																																						
	Weight %																																																						
	Planned %																																																						
	Actual %																																																						

主要裝備廠試及到廠日期預定表

5. DELIVERY RECORD OF SUB-CONTRACTED APPURTENANCES AND MATERIALS (1/2)

KAWASAKI HULL

No.1625

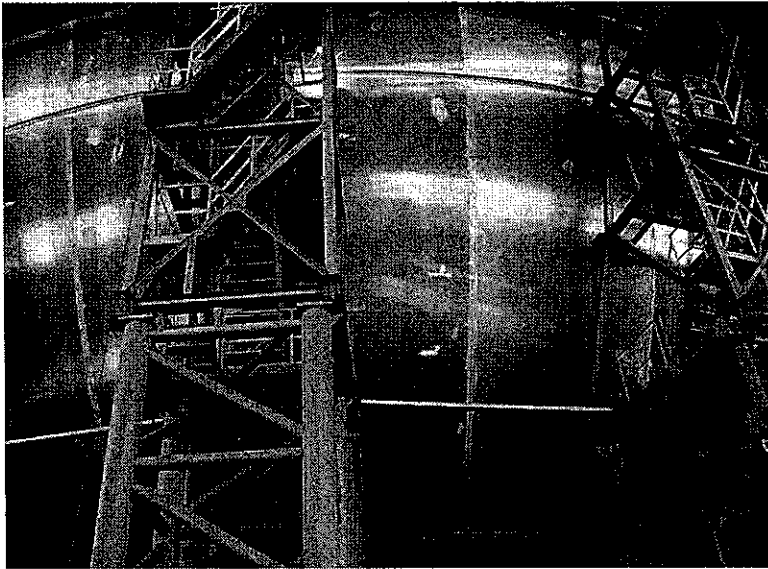
2008/11/18

No.	Item	Name of Supplier:	Expected Date of FA Test		Date of Delivery	Remark
			Test	Date		
H-06	WINDLASS	Kawasak. Precision	No Load running test	2009/4/B	2009/3/15	
H-06	MOORING WINCH	Kawasak. Precision	No Load running test	2009/4/B	2009/4/24	
H-13	HOSE HANDLING CRANE	Seigahara Seisakusho	Load & Operation test	2009/3/M	2009/3/25	
C-01	CARGO PUMP & SPRAY PUMP	Shinko Ind.	Performance	2009/8/M	2009/8/28	
C-02	HIGH DUTY (LOW DUTY) CARGO COMPRESSOR	CRYOSTAR	Performance & Cold Gas (N2)	2009/1/M	2009/4/10	
C-04	BUTTERFLY VALVE	Sasakura	Low Temp. Test	2008/2/B	2009/2/17	
C-05	SLUICE, GLOBE & NON-RETURN VALVE	Wada Valve	Low Temp. Test	2009/1/M	2009/1/30	
C-06	CARGO TANK SAFETY VALVE	Fusui Seisakusho	Operation Test	2009/8/M	2009/8/26	
C-10	CUSTODY TRANSFER SYSTEM	Kongsberg Maritime	Performance	2009/1/E	2009/3/24	(Main cabin)
C-16	N2 GENERATOR	Air Products	Performance	2009/1/E	2009/3/27	

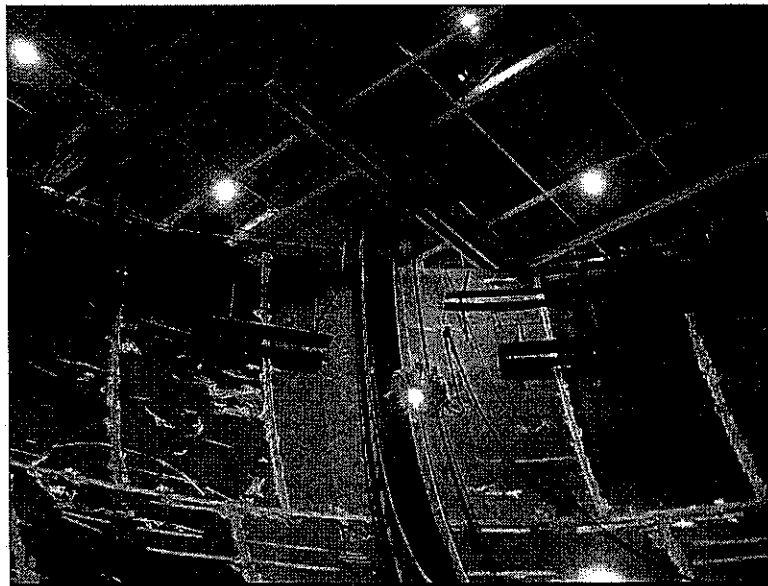
**5. DELIVERY RECORD OF SUB-CONTRACTED APPURTENANCES AND MATERIALS (2/2)**  
**KAWASAKI HULL**  
**No. 1625**

No.	Item	Name of Supplier	Expected Date of FA Test		Date of Delivery	Remark
			Test	Date		
E-01	TURBINE GENERATOR	Nishishiba Electric	Temperature, Characteristics, etc.	2009/1/M	2009/1/20	
E-01	DIESEL GENERATOR	Nishishiba Electric	Temperature, Characteristics, etc.	2009/1/M	2009/2/10	
E-10	ALARM AND MONITORING SYSTEM	JRCS Mfg.	Performance	2009/4/M	2009/5/8	(Machinery Cabinet)
M-01	MAIN TURBINE, CONDENSER AND REDUCTION GEAR	Kawasaki Heavy Industries	HP Rotor Dynamic Balancing LP Rotor Dynamic Balancing	2009/2/B	2009/4/14	
M-02	MAIN BOILER	Mitsubishi Heavy Industries	Shop Trial and Overhauling Hydraulic Finish Inspection	2009/2/B 2009/3/B	2009/4/17	
M-07	GENERATOR TURBINE	Shinko Ind.	Performance	2009/2/E	2009/4/8	
M-08	DIESEL GENERATOR ENGINE	Yanmar	Performance	2009/2/E	2009/4/7	

附件六：建造中相關照片



LNG TANK 外部製作中之情形

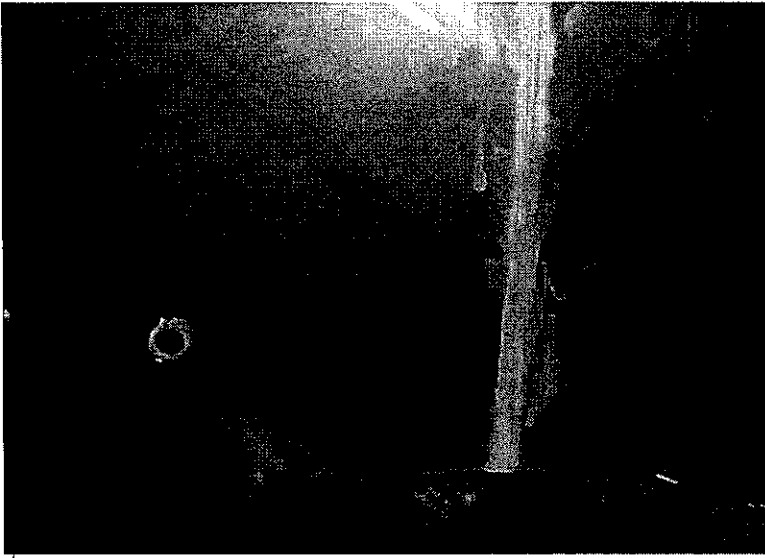


LNG TANK 內部製作中之情形

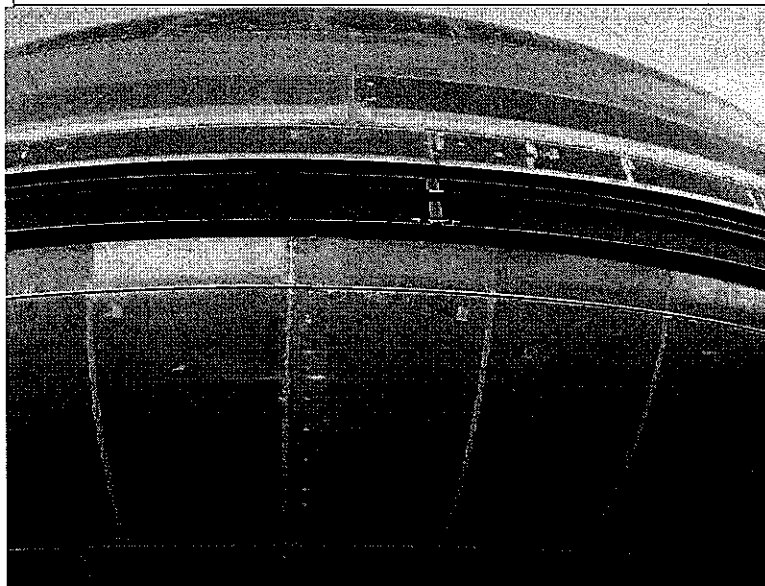


LNG TANK 內之管子塔

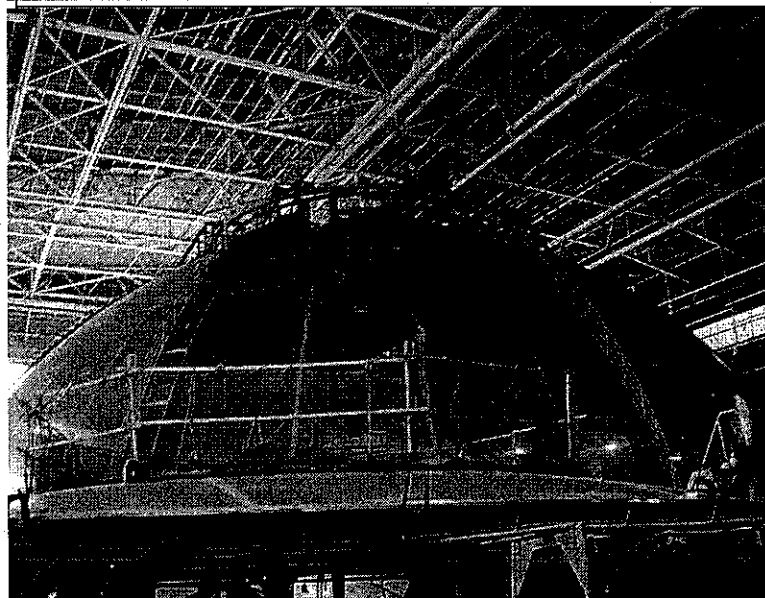
附件六：建造中相關照片



LNG TANK 底部安裝液貨  
PUMP 施工中

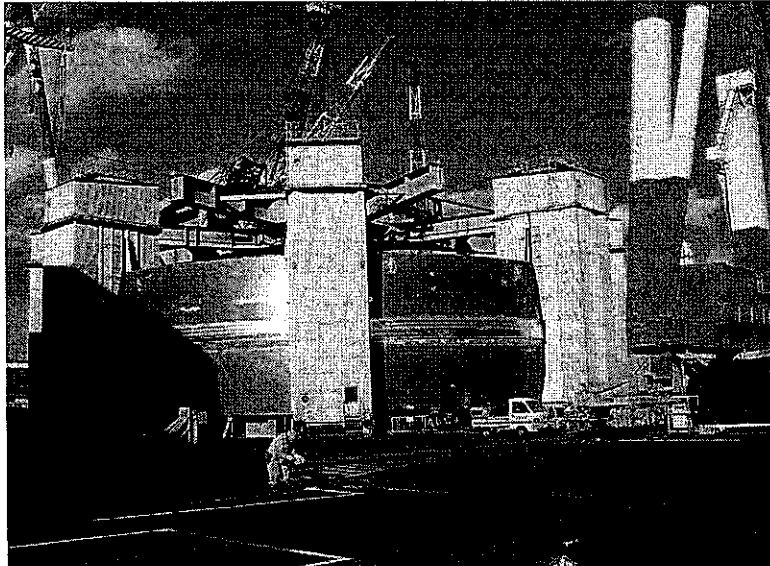


KHI 1625 第一個 LNG  
TANK 完成

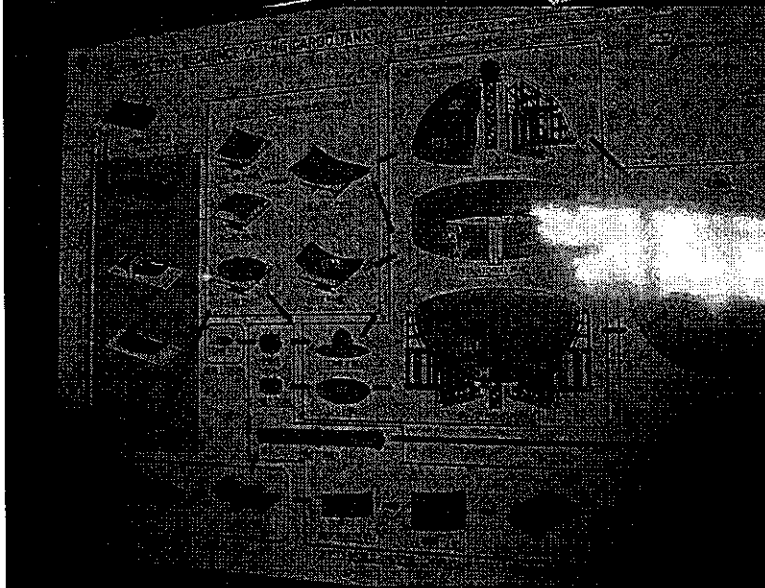


正製作中之 KHI 1625 第  
二個 LNG TANK

附件六：建造中相關照片



KHI 阪出造船廠品質與進度查核



LNG TANK 製作程序圖