出國報告（出國類別：洽公）

新購三期二級泵性能測試(SHINKO)

服務機關：中油公司永安液化天然氣廠
姓名職稱：吳進宣　工場長
蔡旭博　機械工程師
王富毅　機械技術員
派赴國家：日本
出國期間：98/06/03~98/06/09
報告日期：98/09/02

摘 要

中油公司永安液化天然氣廠之生產流程，從 LNG 船將 LNG 運抵本廠洩收至儲槽，以一級泵(primary pump)將 LNG 由儲槽輸送至再冷凝器，再藉由二級泵(secondary pump)將 LNG 壓力提升至約 90kg/cm2，經由管現運送至氣化器將 LNG 氣化成 NG，經由陸管及海管將 NG 分送至台灣所有之使用者。目前本廠二級泵共有 26 台，其中有 12 台爲日本 SHINKO 公司所生產之二級泵(型號：SMB150-12)。該廠牌二級泵目前爲本廠生產主力，每台每小時可供應 220M3 之液化天然氣供氣化，爲了能維持該設備之高妥善率，另新購買一台泵浦，以縮短設備之空窗期，提高二級泵妥善率。

中油於 97 年 6 月 23 日與 SHINKO 公司台灣獨家代理育青企業有限公司簽約購買新二級泵。契約要求需在原製造廠內進行性能測試，本公司有權參與驗證所購買之設備之性能，確認所購買之設備是否有達到契約中所要求之性能。

此次出國之主要之工作：一、現場確認所購買之二級泵之性能是否有達到本購買契約之規範。二、與 SHINKO 公司技術人員討論，在不更動現有之其他設備下，是否能提升二級泵之可行性。

本次至原設備製造廠進行性能測試結果，均符合本採購契約之規範，並且經討論後，原廠提出可沿用原 Shinko 公司所供應之二級泵含泵筒，僅需修改或更換部分內部零件，可將容量提升至 260 m^3/Hr建議。

目 次

壹、 目的

永安廠於 97 年時向 SHINKO 公司，購買契約規定需在原製造廠內進行性能測試，本公司有權參與驗證所購買之設備之性能，確認所購買之設備是否有達到契約中所要求之規定。

有關此次之測試項目有性能測試(performance teat)、NPSH 測試(NPSH test)、額定流量作持續運轉(continuous test)、泵浦作起動電流測量(start test)、噪音測試(noise test)、震動測量測(vibration measurement)等項目。

由於本廠爲生產線，需供應客戶所需天然氣，爲避免影響到正常供應，本廠無法針對測試項目做調整與配合，且無足夠之測量設備，所以原廠之性能測試資料攸關於本次所購買泵浦是否能驗收之關鍵。

貳、過程

一、 本次出國行程如下:

6月3日　搭乘國際線班機：高雄機場 -> 桃園機場 -> 日本關西機場
並經由新幹線抵達SHIKNO公司所在地廣島。

6月4日　與原廠人員進行現場測試程序之步驟及先前準備工作，並利用空擋時間討論有關二級泵性能提升可行性。

6月5日　進行現場測試及測試後拆解

6月6日　進行復裝檢查後，搭新幹線由廣島到大阪

6月7日　進行測試資料之整理

6月8日　參訪SHINKO之馬達製造工廠

6月9日　搭乘國際線班機：日本關西機場-> 桃園機場 -> 高雄機場
晚間返抵高雄機場

二、此次雙方參與性能測試及討論之人員

台灣中油股份有限公司：工場長/吳進宣、工程師/蔡旭博、技術員/王富毅

台灣代理育青公司：周明朝先生

SHINKO公司：技術本部泵浦部長/北龍成、技術本部基本設計部長/寺尾康博、品質管理本部品質管理部長/田中政秀、品質管理本部品質管理課長/谷本憲五、品質管理本部品質管理課長/森井勝博、營業本部營業一部主任/用松基敬、營業本部營業一部課長/田窪秀行

三、泵浦性能測試程序及測試報告：

(一)、性能測試程序：

1.測試標準：

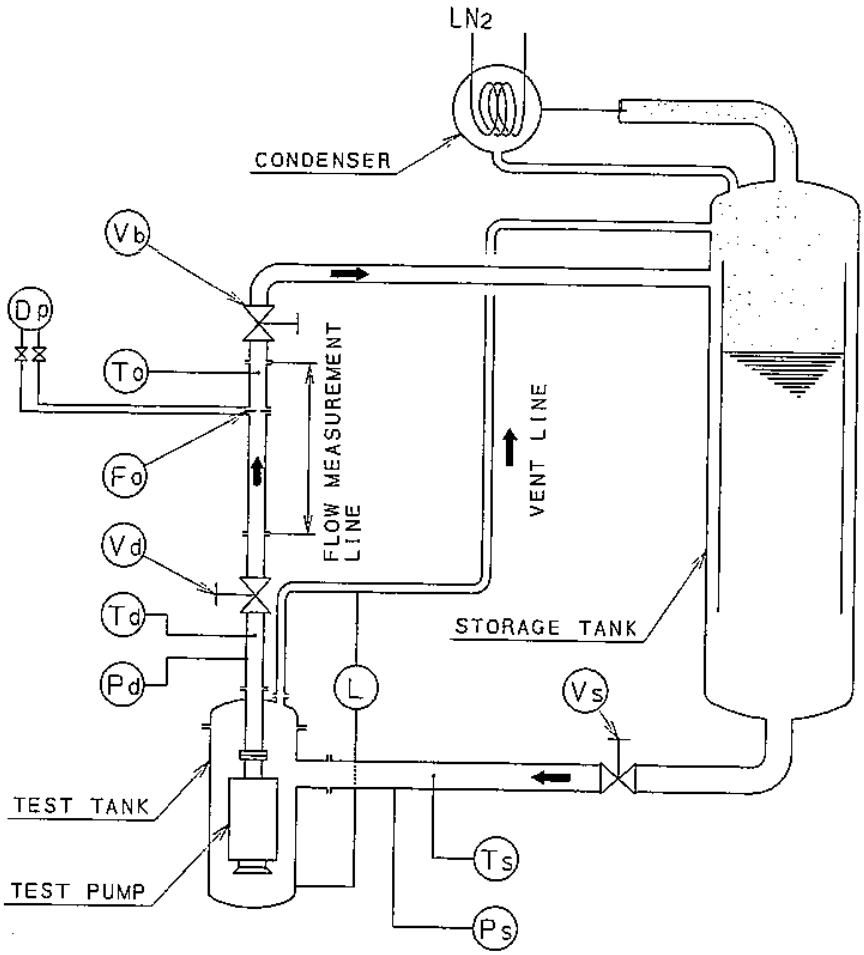
(1)JIS B8301-2000「Rotodynamic pump – hydraulic performance acceptance tests」

(2)JIS B8302-2002「Measurement methods of pump discharge」

(3)ANSI/HI 1.6-1994「American National Standard for Centrifugal Pump tests 」

2.測試液體：液化天然氣(溫度-165℃~-150℃)

3.測試設備：



4.絕緣測試：須大於 50MΩ

5.迴路電阻測試

6.測試電壓：60Hz ,6600V

以上爲測試之前準備。

7.啓動測試：計算啓動電流。

8.最低啓動電壓測試

9.性能測試：至少測試五點，本次測試點之要求如下：

測試點	測試流量(m^3/h)(額定流量 220 m^3/h)	
1	275	(125%)
2	220	(100%)
3	168	(76%)
4	117	(53%)
5	65	(30%)
6	0	(0%)
7	220	(100%)

10.振動測試：需低於下列測試值

設定值	警戒值	危險值
加速度(G)	5	7
速度(mm/sec)	7	18

11.NPSH 測試：

出口流量m^3/h	NPSH(m)
65	02
117	02
168	0.2
220	0.2
275	3.0

12.噪音測試：在不含背景噪音情況下距二級泵音源一公尺處噪音之量測值應低於 85dBA。

13.測試後檢點

(二)、泵浦性能測試報告

1. **性能測試報告：如附件一**

2. **測試後檢點：如附件二**

(三)、測試結果

檢視測試報告，每項測試均符合本採購契約之要求。

四、提升二級泵之可行性

沿用原 Shinko 公司所供應之二級泵含泵筒等，僅修改/更換部分內部零件，可將容量提升至 260 m3/Hr.,外部形狀/尺寸完全不變。

所需更換之零件如下：

零件名稱	零件編號	數量
Impeller	P/No.16	6
Impeller	P/No.17	6
Balance sleeve	P/No.26	1
Balance bush	P/No.45	1
Balance case	P/No.124	1
Throttle seat	P/No.168	1
Motor shaft	P/No.111	1
Rotor core	P/No.106	1
Stator core	P/No.105	1
Stator coil	P/No.107	1
cable	P/No.108	3

規格如下：

3/a 19

SPECIFICATION FOR SECOND STAGE LNG SEND OUT PUMP (REVAMPING PROJECT)

CUSTOMER	CHINESE PETROLEUM CORPORATION
LOCATION	YUNG-AN, KAOHSIUNG, TAIWAN
QUANTITY	12 SETS
ITEM NO.	Phase 3 upgrading
CPC INV. NO.	—
CODE, STANDARD	API 610, ANSI, JIS
WORK. NO.	-

SHINKO IND. LTD.

DRAW. NO.	SMB-R151202E	REV.	0

1. PUMP SPECIFICATION

1. MODEL	SMB150-12
2. CAPACITY	260 m^3/h
3. TOTAL HEAD	1890 m
4. SUCTION PRESSURE	4.50 kg/cm^2G
5. DISCHARGE PRESSURE	87.70 kg/cm^2G
6. DIFFERENTIAL PRESSURE	83.20 kg/cm^2G
7. LIQUID HANDLED	LNG
8. LIQUID TEMPERATURE	-157 ～ -133 ℃
9. LIQUID SPEC. GRAVITY	0.44(0.41 ～ 0.46)
10. NPSH A	2.6 m
11. NPSH R	0.2 m (Hight from suc. nozz. center)
12. SHAFT POWER	879 kW
13. EFFICIENCY	70 %
14. MAXIMUM FLOW	310 m^3/h
15. MINIMUM FLOW	75 m^3/h
16. DIREC. OF ROTATION	CLOCKWISE VIEWED FROM MOTOR
17. DISCHARGE NOZZLE	ANSI 900LB- 6B RF
18. VENT NOZZLE	ANSI 150LB- 4B RF
19. DESIGN PRESSURE OF BARREL COVER	14.5 kg/cm^2G
20. DESIGN PRESS. DISCH. SIDE	144 kg/cm^2G
21. DESIGN TEMPERATURE	-164 ℃

2. MOTOR SPECIFICATION

1. TYPE	VERTICAL SUBMERGED 3-PHASE INDUCTION
2. RATED OUTPUT	1000 kW
3. SYNCHRONOUS SPEED	3600 rpm
4. ELECTRIC POWER SOURCE	AC 6600 V, 60 Hz
5. RATED CURRENT	118 A
6. STARTING CURRENT	780 A
7. INSULATION CLASS	CLASS F
9. MIN. STARTING VOLTAGE	80 %
10. TIME RATING	CONTINUOUS
10. EFFICIENCY	90 %
11. STATOR COIL	FORMED WOUND COIL
12. COOLING LIQUID	LNG
13. SHAFT BEARING	BALL BEARING

3. MATERIAL OF MAIN PARTS

1. PUMP CASING	STAINLESS STEEL
2. VOLUTE	STAINLESS STEEL
3. IMPELLER	AL ALLOY CASTING
4. INDUCER	ALUMINIUM ALLOY
5. MOTOR FRAME	STAINLESS STEEL
6. PUMP SHAFT	STAINLESS STEEL
7. MOTOR SHAFT	9% NICKEL STEEL
8. BALL BEARING	STAINLESS STEEL
9. BARREL COVER	STAINLESS STEEL

4. ACCESSORIES FOR 1PUMP SET

1. TERMINAL HEADER	1 SET
2. JUNCTION BOX	1 SET
3. VIBRATION DETECTOR	4(*)
4. TERMINAL HEADER WITH JUNCTION BOX (FOR VIBRATION SENSOR)	1 SET
5. PRE-AMPLIFIER	4 SETS

(*) The sensors are compatible with Bently Nevada 3300 series dual accelerometer monitors.

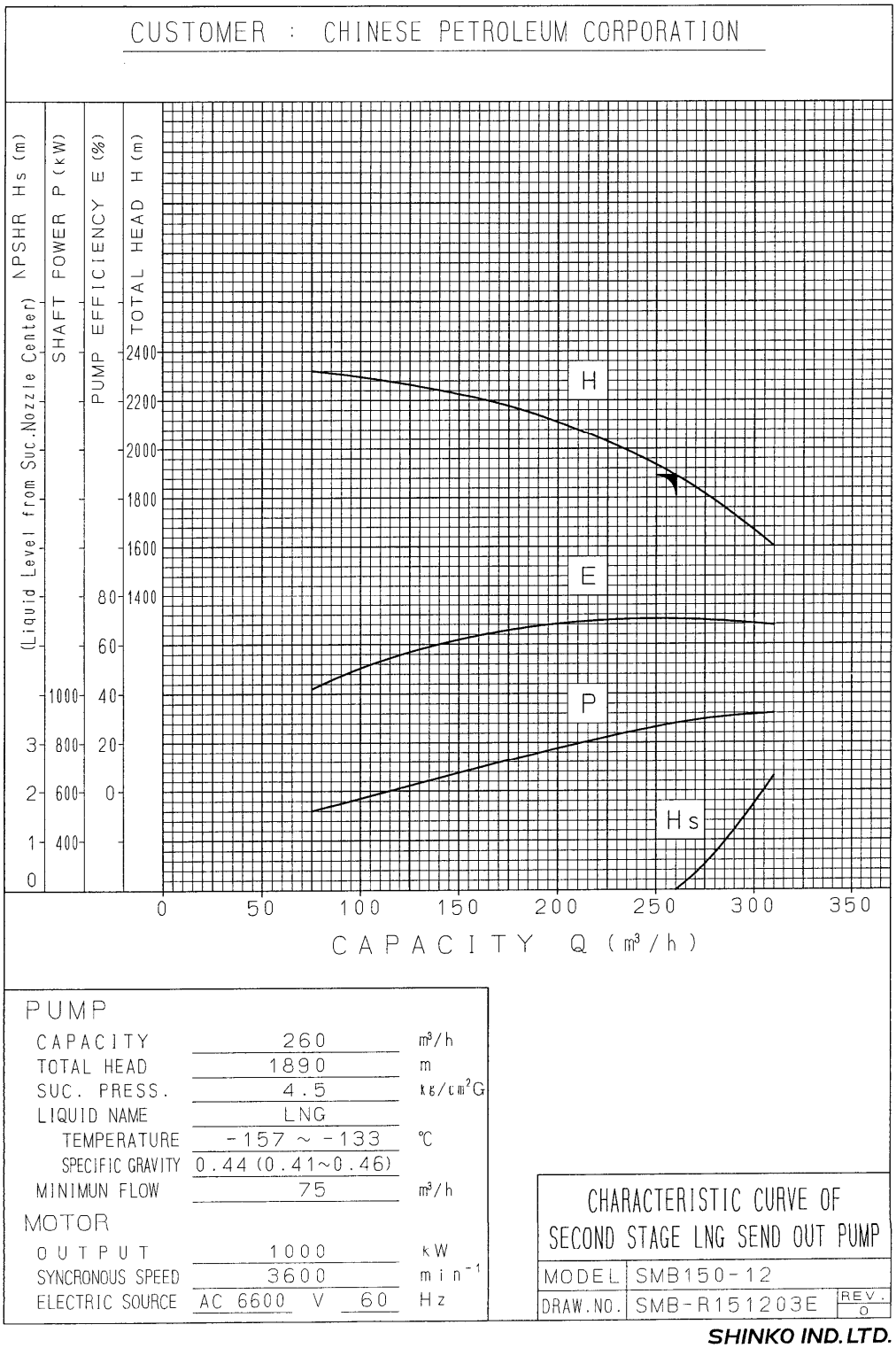
5. WEIGHT

1. PUMP	2400 kg
2. MOTOR	2000 kg
3. BARREL COVER	750 kg
4. JUNCTION BOX	200 kg
5. TOTAL	5350 kg

6. GUARANTEE

WE GUARANTEE TO REPAIR AND CHANGE PARTS FREE OF CHARGE WHEN PROBLEM WE'RE RESPONSIBLE FOR OCCURS WITHIN TWO YEARS AFTER DELIVERY.

性能曲線如下：


CUSTOMER : CHINESE PETROLEUM CORPORATION
NPSHR Hs (m) (Liquid Level from Suc.Nozzle Center)
SHAFT POWER P (kW)
PUMP EFFICIENCY E (%)
TOTAL HEAD H (m)
H
E
P
Hs
CAPACITY Q (m³/h)
PUMP
CAPACITY 260 m³/h
TOTAL HEAD 1890 m
SUC. PRESS. 4.5 kg/cm²G
LIQUID NAME LNG
TEMPERATURE -157 ~ -133 ℃
SPECIFIC GRAVITY 0.44 (0.41~0.46)
MINIMUN FLOW 75 m³/h
MOTOR
OUTPUT 1000 kW
SYNCRONOUS SPEED 3600 min⁻¹
ELECTRIC SOURCE AC 6600 V 60 Hz
CHARACTERISTIC CURVE OF
SECOND STAGE LNG SEND OUT PUMP
MODEL SMB150-12
DRAW.NO. SMB-R151203E
REV. 0
SHINKO IND.LTD.

五、參訪 SHINKO 之馬達製造工廠

馬達製造工廠爲西芝電機株式會社，其工廠位於兵庫縣姬路市，該公司除生產馬達外，尚有發電機、汽電共生系統等。產品應用於離島發電裝置、非常用自家發電裝置、大型船用電機、LNG 船用電機等項目，是非常具規模之公司。

肆、心得與建議

此次至 SHINKO 公司進行本公司所購買之泵浦性能測試，SHINKO 公司展現出對此次測試之重視，詳細解說每一個測試步驟與所使用之測試設備。測試期間每個測試數據均經雙方確認後，才進行下一組參數測量。表現出該公司之專業及嚴謹的態度，值得我們學習。

利用此次機會與該公司之技術人員討論並交換該種泵浦之維修，本廠對於軸之曲撓測量方式進行討論，取得該公司的測量方法。在參觀工廠時，發現有許多值得本廠學習之優點，如移動式起重機上標示移動方向，讓操作者與只會只有共同之方向指示；維修工具之收納方式等，值得本廠改進且減少工安意外之發生與維修工具之遺失。

泵浦性能提升部份，經與該公司人員討論本廠之需求後，提出可在原來之泵筒下，更換 11 項零件，而提升流量爲 260M^3/HR，提升幅度約爲 18%，待該公司所提供各項零件之價格後，再行評估是否值得進行性能提升。

附件一

P-300

TEST RECORDS OF RUNNING TEST

CONTENTS

Order No.	P0009005		
Item No.	P-130S		
Messrs.	CHINESE PETROLEUM CORPORATION	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
User	CHINESE PETROLEUM CORPORATION	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Serial No.	1020939

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SHINKO IND. LTD.

RESULT OF RUNNING TEST

Date	June 4,2009
Quality Control Department	
SECTION HEAD :	M. Tanaka
BRANCH HEAD :	M. Mori
DRAWN BY :	T. Takasumi

Our Order No.	P0009005				
Item No.	P-130S				
Date of test.	June 4,2009	Weather	Cloudy	Temp.	24℃
Customer	CHINESE PETROLEUM CORPORATION			Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
Location	YUNG-AN , KAOHSIUNG, TAIWAN			Model	SMB150-12
Plant	-			Serial No.	1020939

Specifi-cation of Pump	Capacity	- t/h	Liquid	LNG	Specifi-cation of Motor	Output	820 kW	Current	94 A
		220 m^3/h	Liquid Temp.	-133~ -157 ℃		Speed	3600 rpm	Maker	Nishishiba Electric
	Total Head	1890 m	Specific Gravity	0.44		Electric Power source	6600Vx60Hz	Serial No.	395216GM1

NO.	TEST ITEM	ACCEPTANCE STANDARDS	RESULT	JUDGEMENT
1	Total head at rated flow (220 m3/h)	1852.2~1927.8 m (1890±2%)	1900 m	**GOOD**
2	Total head at minimum flow (65 m3/h)	2123.2~2346.7 m (2235±5%)	2208 m	**GOOD**
3	Shaft power at rated flow (220 m3/h)	Less Than 740.4 kW (712×1.04%)	685 kW	**GOOD**
4	NPSH Test (about 275 m3/h)	Comfirm that cavitation is not occuring at **3.0**m liquid level height from suction center	2.96 m	**GOOD**
5	NPSH Test (about 220 m3/h)	Comfirm that cavitation is not occuring at **0.2**m liquid level height from suction center	0.15 m	**GOOD**
6	NPSH Test (about 168 m3/h)		0.15 m	**GOOD**
7	NPSH Test (about 117 m3/h)		0.17 m	**GOOD**
8	NPSH Test (about 65 m3/h)		0.15 m	**GOOD**
9	Vibration (Barrel flange rim)	Acceleration : < 5.0 G	Max. 0.40G	**GOOD**
10		Velocity : < 5.0 mm/sec. RMS	Max. 2.6mm/sec.	**GOOD**
11	Vibration (Internal sensor)	Acceleration : < 5.0 G	Max. 2.04G	**GOOD**
12		Unfiltered Velocity < 5.0 mm/sec. RMS	Max. 2.56mm/sec.	**GOOD**
13		Filtered Velocity < 3.4 mm/sec. RMS	Max. 2.43mm/sec.	**GOOD**
14	Starting Test (at the rated electric source)	Less Than 658 A (700% of rated current)	445.2 A	**GOOD**
15	Low voltage starting Test	Less Than 5280 V (6600V×0.80)	4824 V	**GOOD**
16	Winding temperature rise Test	Less Than 55℃	23.5 ℃	**GOOD**
17	Measurement of winding resistance	The each measured value to be within **±5%** of the average value.	Max. 0 %	**GOOD**
18	Measurement of winding resistance	More Than 50 MΩ (DC 1000V megger)	2000 MΩ OVER	**GOOD**

Witnessed by

CONVERTED TEST RECORD FOR

SHINKO IND. LTD.
HIROSHIMA JAPAN

SPARE SECOND STAGE LNG SEND OUT PUMP(P-130S)

Working No. P0009005

Customer CHINESE PETROLEUM CORPORATION

Date of Test 09/06/04

End User CHINESE PETROLEUM CORPORATION

Approved by. M. Tanaka

Project -

Tested by. T. Tatsumi

Pump

Model	SMB150-12	
Capacity (Vol)	220	[㎥/h]
(Mass)		[ton/h]
Total Head	1890	[m]
Kind of Liquid	LNG	
Liquid Temp	-133 ／ -157	[℃]
Specific Gravity	0.44 ／	
Machine No.	1020939	

Motor

Output	820	[kW]
Synchro.Speed	3600	[rpm]
Voltage	6600	[V]
Current	94	[A]
Frequency	60	[Hz]
Maker	Nishishiba Electric Co.,Ltd.	
Machine No.	395216GM1	

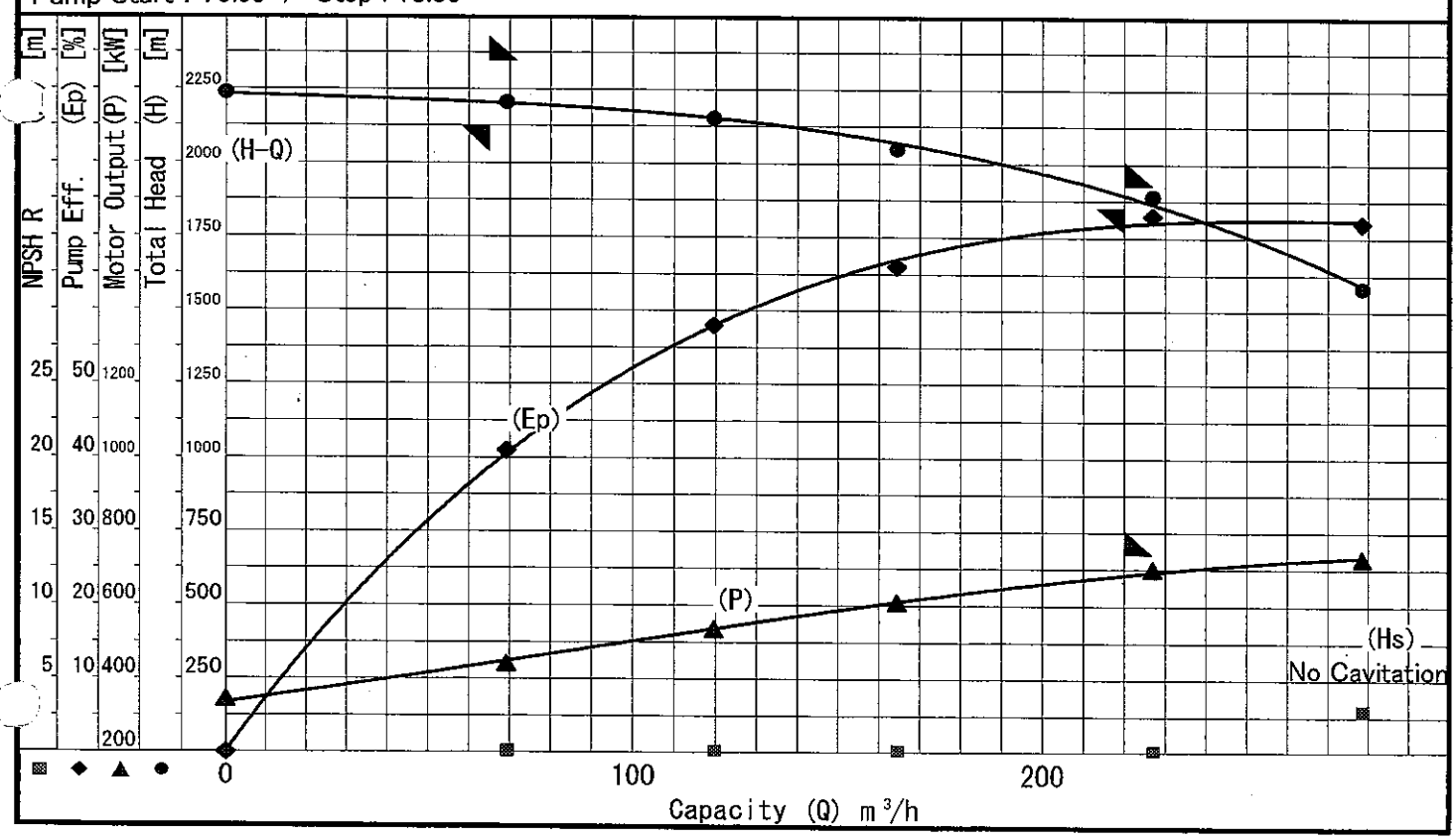
Measurement

Test Liquid: LNG

Mark◯ : Rated Capacity

TEST No	Time	Measured Data						Converted Data						Pump Eff.
		Capacity Qo [㎥/h]	Specific Gravity γs [-]	Total Head Ho [m]	Motor Output Po [kW]	NPSH Hst [m]	Freq Ft [Hz]	Capacity Q [㎥/h]	Specific Gravity γ [-]	Total Head H [m]	Motor Output P [kW]	NPSH Hs [m]	Freq F [Hz]	Ep [%]
1	11:04	278.4	0.46504	1580.5	771.3	2.96	60.00	278.4	0.4400	1580.5	729.7	2.96	60	72.3
②	11:19	226.9	0.46009	1890.4	731.9	0.15	60.00	226.9	0.4400	1890.4	700.0	0.15	60	73.4
3	11:30	164.5	0.45981	2050.1	635.3	0.15	60.00	164.5	0.4400	2050.1	607.9	0.15	60	66.5
4	11:45	119.6	0.46303	2152.4	563.4	0.17	60.00	119.6	0.4400	2152.4	535.4	0.17	60	57.6
5	12:23	69.2	0.46356	2204.9	464.9	0.15	60.00	69.2	0.4400	2204.9	441.3	0.15	60	41.4
6	12:32	0.0	0.46392	2235.1	363.0		60.00	0.0	0.4400	2235.1	344.3		60	0.0
7	12:38	223.6	0.45930	1896.3	734.9		60.00	223.6	0.4400	1896.3	704.1		60	72.2
8														
9														
10														

Pump Start : 10:58 / Stop : 13:00



TEST RECORD FOR

SHINKO IND. LTD.
HIROSHIMA JAPAN

SPARE SECOND STAGE LNG SEND OUT PUMP(P-130S)

Working No. P0009005

Customer CHINESE PETROLEUM CORPORATION

Date of Test 09/06/04

End User CHINESE PETROLEUM CORPORATION

Approved by. M. Tanaka

Project –

Tested by. T. Tatsumi

Pump

Model	SMB150-12	
Capacity (Vol)	220	[㎥/h]
(Mass)		[ton/h]
Total Head	1890	[m]
Kind of Liquid	LNG	
Liquid Temp	−133 ／ −157	[℃]
Specific Gravity	0.44 ／	
Machine No.	1020939	

Motor

Output	820	[kW]
Synchro.Speed	3600	[rpm]
Voltage	6600	[V]
Current	94	[A]
Frequency	60	[Hz]
Maker	Nishishiba Electric Co.,Ltd.	
Machine No.	395216GM1	

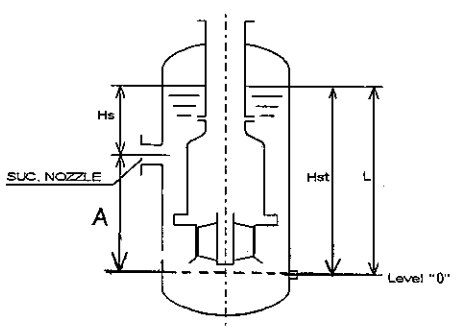
Measurement

Test Liquid:LNG

Mark○ : Rated Capacity

Test No	Time	Temp Ts [℃]	S.G. (Suc)		Capacity Qo [㎥/h]	Manometric Head Dis. Pd [MPa]	Suc. Ps [MPa]	Vel. Hv [m]	Total H [m]	NPSH T.tank L [m Aq]	NPSH R Hst [m]	Freq Ft [Hz]	Motor Vol. V [V]	Curr. I [A]	Input Pi [kW]	Eff. Em [%]	Output Po [kW]	Pump Eff. Ep [%]
		Td	(Dis)															
		To	(Orifice)															
1	11:04	−159.0	0.46504		278.4	7.24	0.057	5.55	1580.5	2.29	2.96	60.00	6607	87.0	844.6	91.3	771.3	72.3
		−153.9	0.46544															
		−150.6	0.45327															
②	11:19	−155.5	0.46009		226.9	8.62	0.093	3.69	1890.4	0.97	0.15	60.00	6605	82.7	803.1	91.1	731.9	73.4
		−149.8	0.46140															
		−146.6	0.44742															
3	11:30	−155.3	0.45981		164.5	9.32	0.083	1.94	2050.1	0.97	0.15	60.00	6625	72.1	701.4	90.6	635.3	66.5
		−148.6	0.46051															
		−144.8	0.44450															
4	11:45	−157.6	0.46303		119.6	9.78	0.064	1.03	2152.4	0.98	0.17	60.00	6749	63.9	626.1	90.0	563.4	57.6
		−148.5	0.46088															
		−144.2	0.44378															
5	12:23	−158.0	0.46356		69.2	9.96	0.076	0.34	2204.9	0.98	0.15	60.00	6812	54.1	524.0	88.7	464.9	41.4
		−145.8	0.45744															
		−142.0	0.44054															
6	12:32	−158.2	0.46392		0.0	10.07	0.072	0.00	2235.1			60.00	6830	44.8	419.9	86.4	363.0	0.0
		−144.9	0.45645															
		−141.1	0.43883															
7	12:38	−155.0	0.45930		223.6	8.66	0.097	3.58	1896.3			60.00	6785	81.1	806.3	91.1	734.9	72.2
		−150.0	0.46172															
		−146.6	0.44731															
8																		
9																		
10																		

1. Atmospheric Temperature 24 [℃]
2. Weather Cloudy
3. Diameter of flow orifice
   100 [mm]
4. Differential height of pressure measurement
   h = 2.11 [m]
5. Inside diameter of pressure measuring pipe.
   Discharge 97.1 [mm]
   Suction 497 [mm]
6. Calculation formula for NPSH R
   Hst = L / γ − A , A = 1.96 [m]



VIBRATION & NOISE MEASUREMENT RECORD

SHINKO IND. LTD.

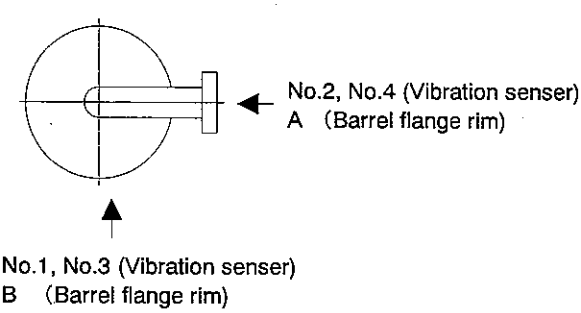
Date	Jun. 4, 2009
Quality Control Department	
SECTION HEAD :	M.Tanaka
BRANCH HEAD :	M.Morii
DRAWN BY :	T.Tatsumi

Our Order No.	P0009005				
Item No.	P-130S				
Date of test.	Jun. 4, 2009	Weather	Cloudy	Temp.	24℃
Customer	CHINESE PETROLEUM CORPORATION			Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
Location	YUNG-AN , KAOHSIUNG, TAIWAN			Model	SMB150-12
Plant	-			Serial No.	1020939

Specification of Pump	Capacity	- t/h	Liquid	LNG	Specification of Motor	Output	820 kW	Current	94 A
		220 m^3/h	Liquid Temp.	-133~ -157 ℃		Speed	3600 rpm	Maker	Nishishiba Electric
	Total Head	1890 m	Specific Gravity	0.44		Elec. Power source	6600Vx60Hz	Serial No.	395216GM1

Test No.	Time	LNG PERFORMANCE Capacity Q (m^3/h)	Total Head H (m)	Vibration Senser Location		Acc. (G) (10Hz~10KHz)	Velocity (mm/s .RMS) (10Hz~1KHz)	Velocity (mm/s .RMS) (Unfiltered)	Barrel flange rim Location	Acc. (G) (10Hz~1KHz)	Velocity (mm/s.RMS) (10Hz~1KHz)
1	11:04	278.4	1580.5	802U	No.1	0.38	1.80	1.71	A	0.40	0.9
					No.2	0.39	0.25	0.31			
				802L	No.3	0.89	1.36	1.31	B	0.23	1.6
					No.4	0.83	0.78	0.69			
②	11:19	226.9	1890.4	802U	No.1	0.47	2.42	2.38	A	0.12	1.5
					No.2	0.45	0.66	0.74			
				802L	No.3	1.95	1.75	1.75	B	0.13	2.5
					No.4	1.86	0.93	0.95			
3	11:30	164.5	2050.1	802U	No.1	0.45	2.43	2.56	A	0.18	1.4
					No.2	0.46	0.53	0.66			
				802L	No.3	1.72	1.54	1.56	B	0.15	2.5
					No.4	1.66	1.08	1.07			
4	11:45	119.6	2152.4	802U	No.1	0.51	2.07	2.22	A	0.25	0.9
					No.2	0.50	0.38	0.39			
				802L	No.3	2.04	1.37	1.40	B	0.20	2.6
					No.4	1.78	1.24	1.39			
5	12:23	69.2	2204.9	802U	No.1	0.46	2.20	2.38	A	0.24	1.3
					No.2	0.47	0.63	0.68			
				802L	No.3	1.77	1.45	1.66	B	0.25	2.5
					No.4	1.61	1.23	1.23			
7	12:38	223.6	1896.3	802U	No.1	0.45	2.21	2.07	A	0.10	1.6
					No.2	0.46	0.91	0.97			
				802L	No.3	1.78	1.53	1.51	B	0.13	2.2
					No.4	1.69	0.84	0.90			

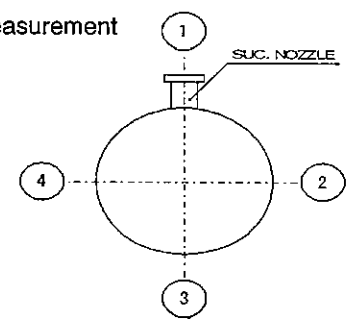
Note : 1. Electric -dynamic vibration senser (portable type) is used to measure above A, B.



NOISE (At Rated Capacity)

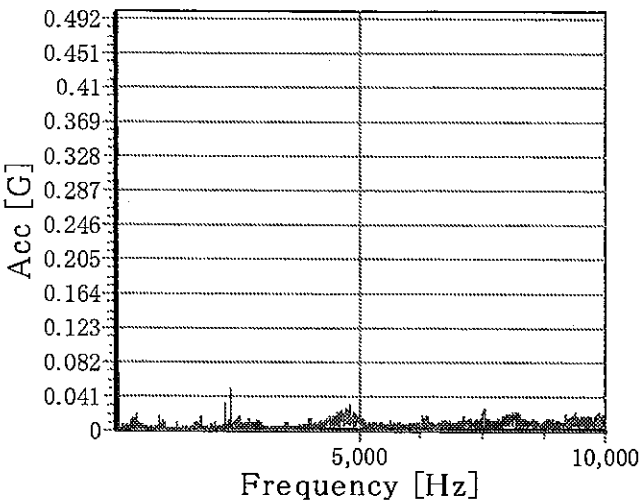
Background Noise	61	dB(A)
Position ①	84	dB(A)
Position ②	84	dB(A)
Position ③	84	dB(A)
Position ④	83	dB(A)

Position of Measurement

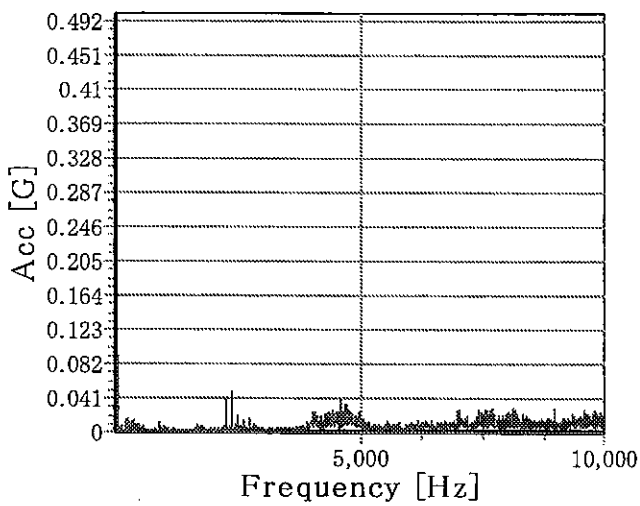


ACC.(G) 10Hz～10kHz 802U No.1

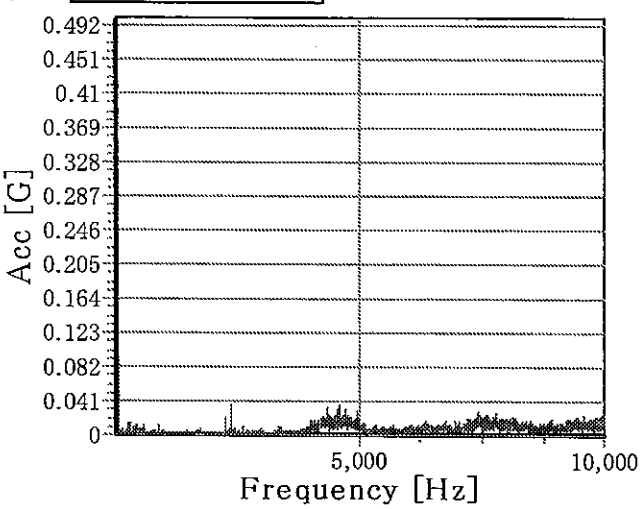
Test No. ① O.A.= 0.38



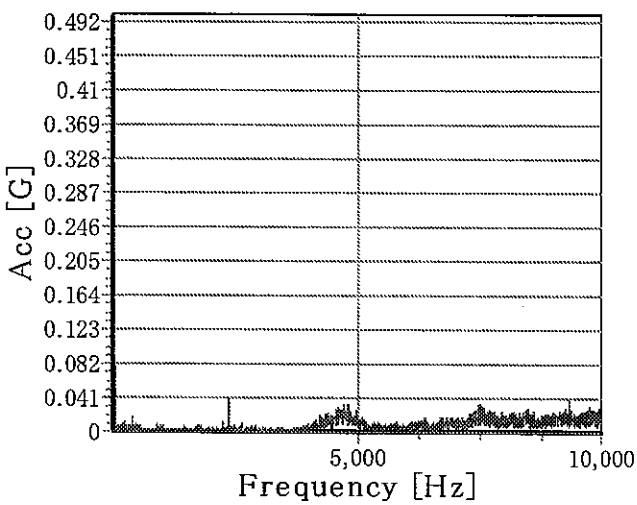
Test No. ② O.A.= 0.47



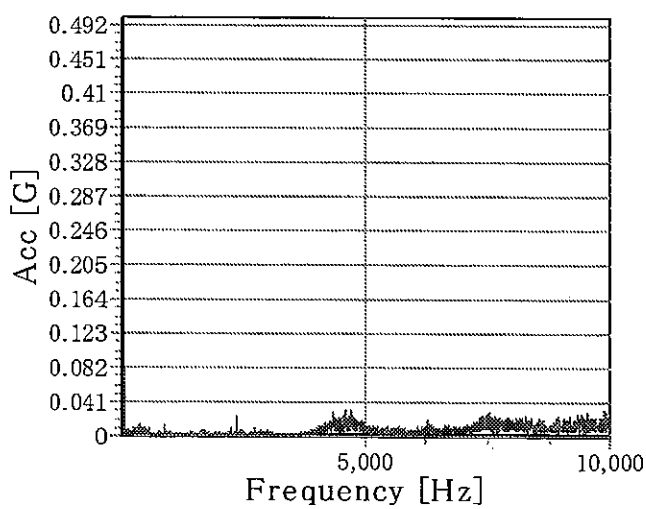
Test No. ③ O.A.= 0.45



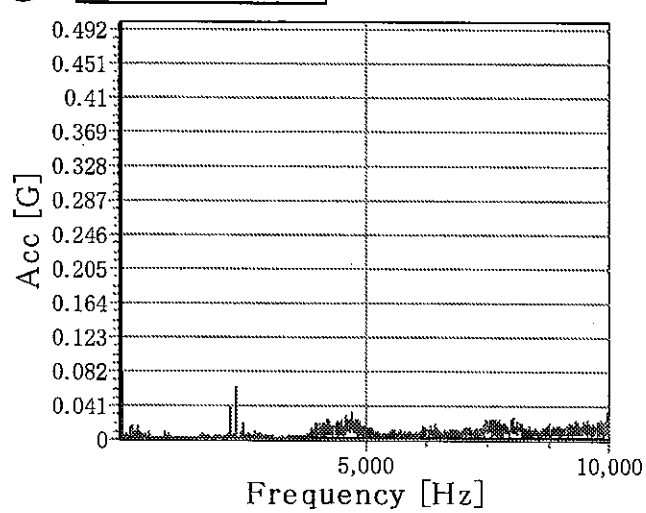
Test No. ④ O.A.= 0.51



Test No. ⑤ O.A.= 0.46

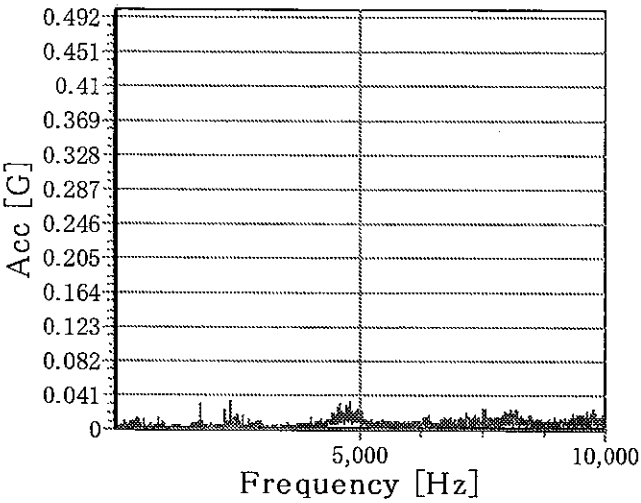


Test No. ⑦ O.A.= 0.45

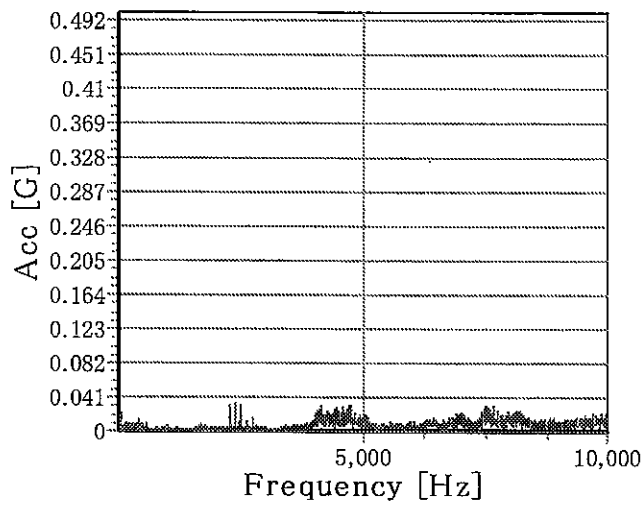


ACC.(G) 10Hz～10kHz 802U No.2

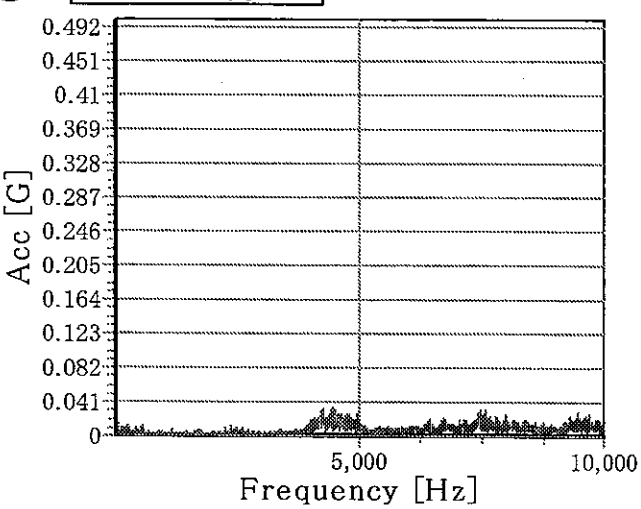
Test No. ① O.A.= 0.39



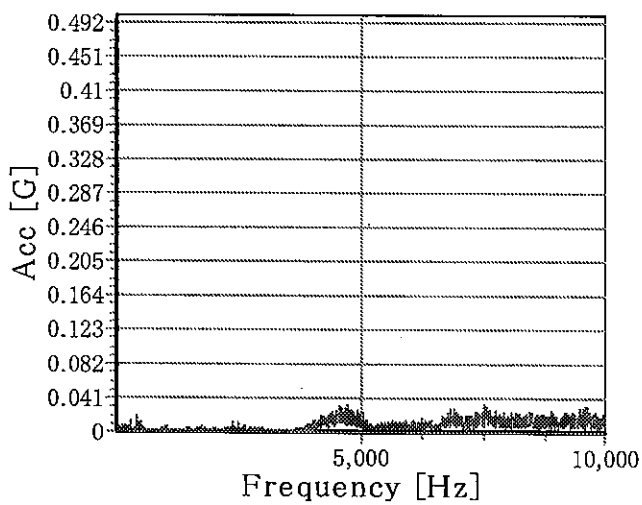
Test No. ② O.A.= 0.45



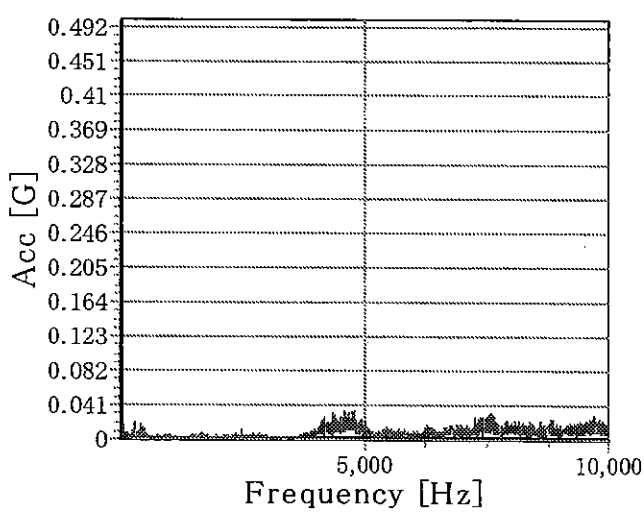
Test No. ③ O.A.= 0.46



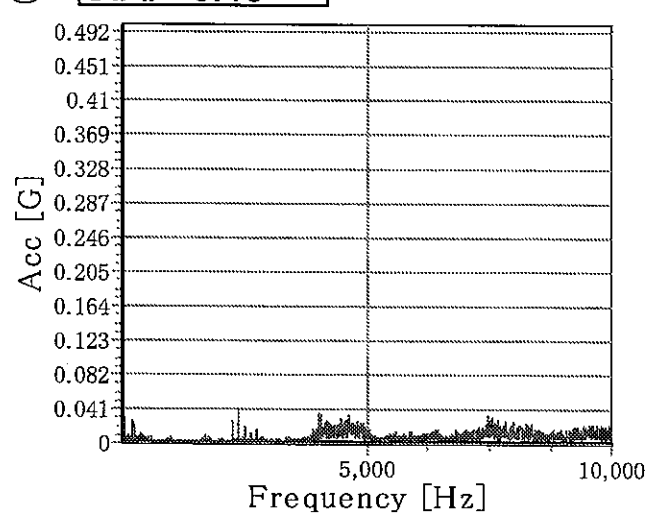
Test No. ④ O.A.= 0.50



Test No. ⑤ O.A.= 0.47

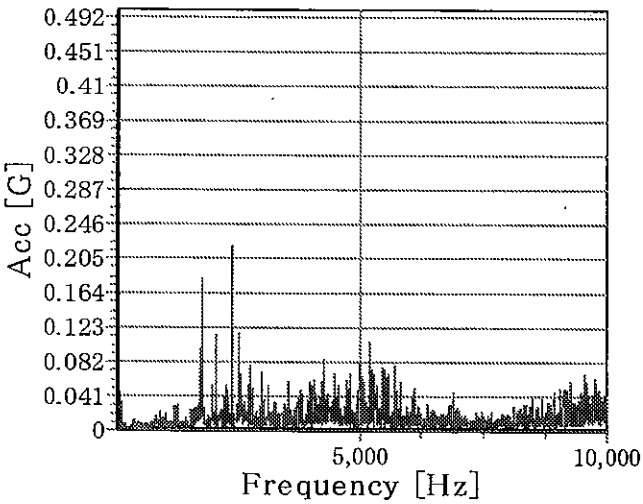


Test No. ⑦ O.A.= 0.46

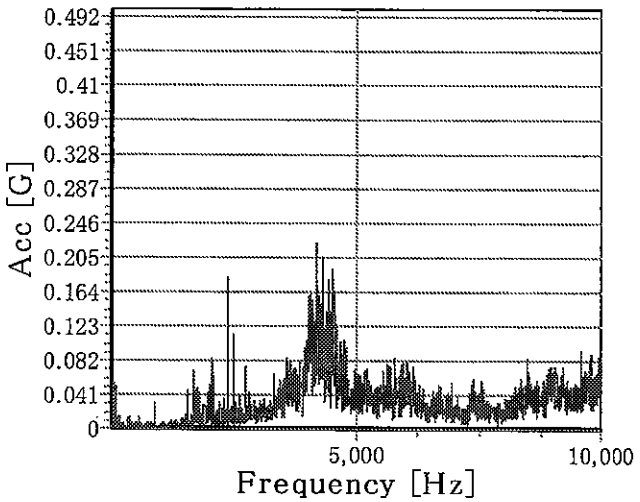


ACC.(G) 10Hz～10kHz 802L No.3

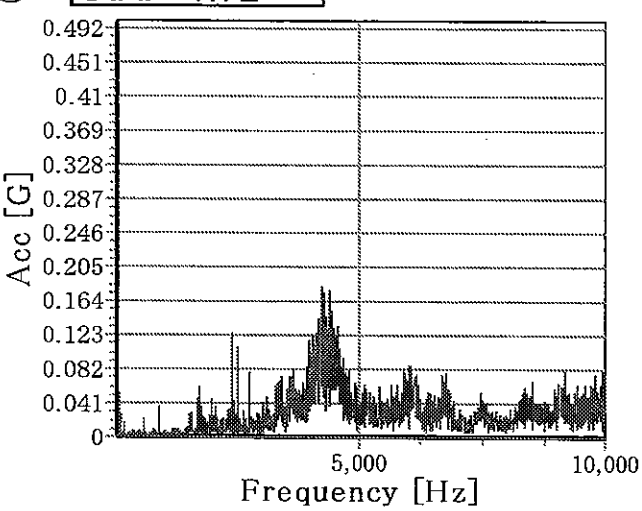
Test No. ① O.A.= 0.89



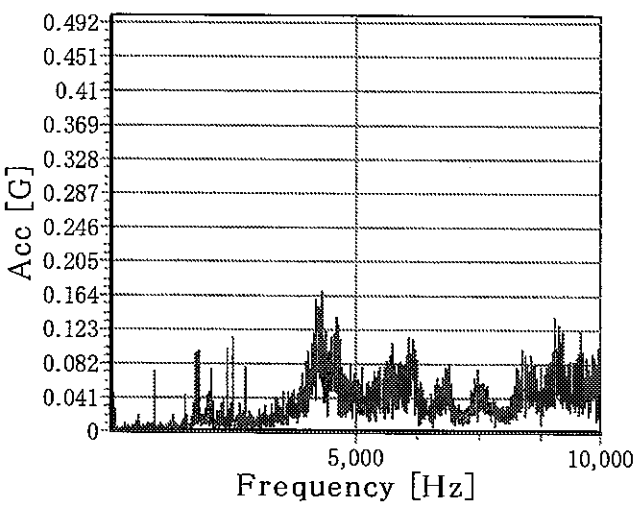
Test No. ② O.A.= 1.95



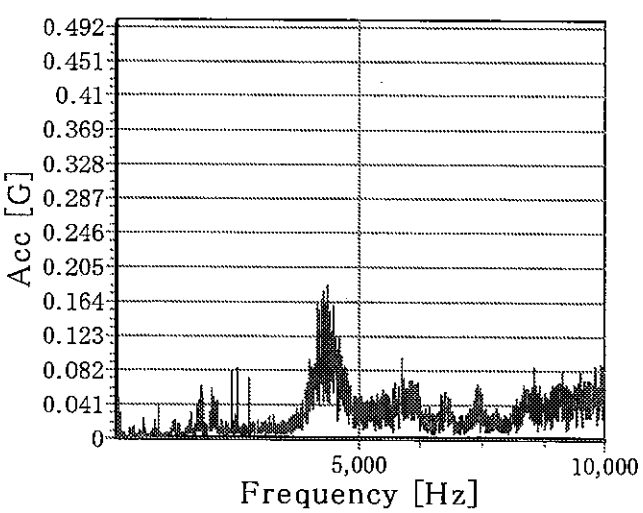
Test No. ③ O.A.= 1.72



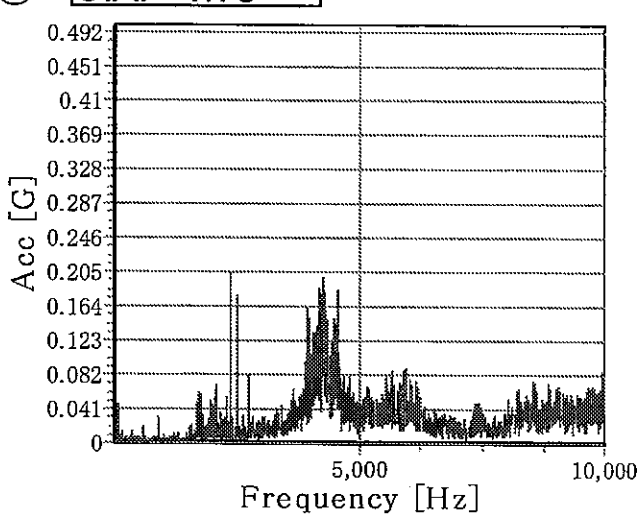
Test No. ④ O.A.= 2.04



Test No. ⑤ O.A.= 1.77

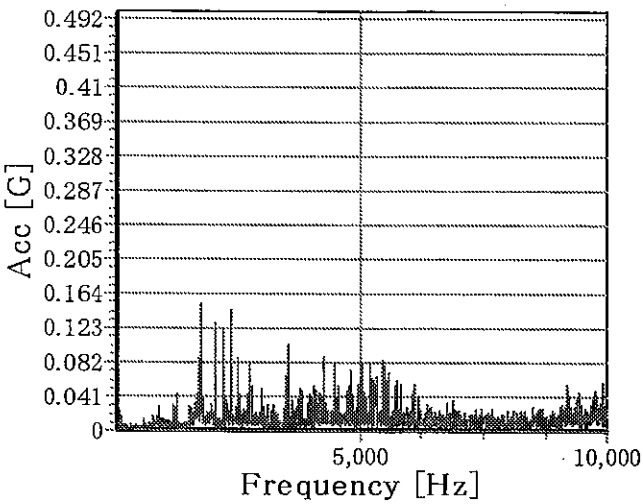


Test No. ⑦ O.A.= 1.78

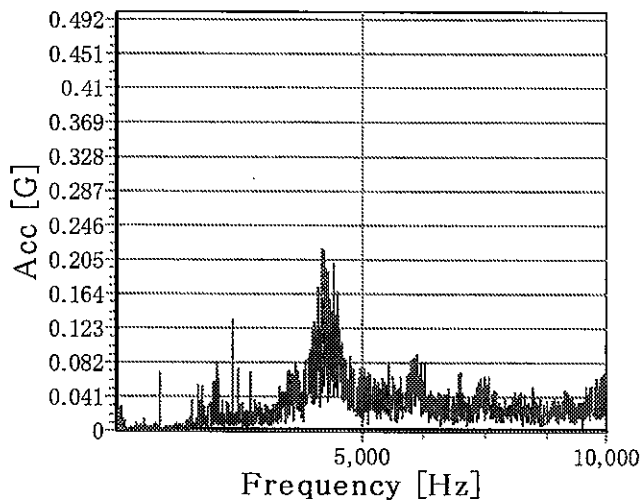


ACC.(G) 10Hz～10kHz 802L No.4

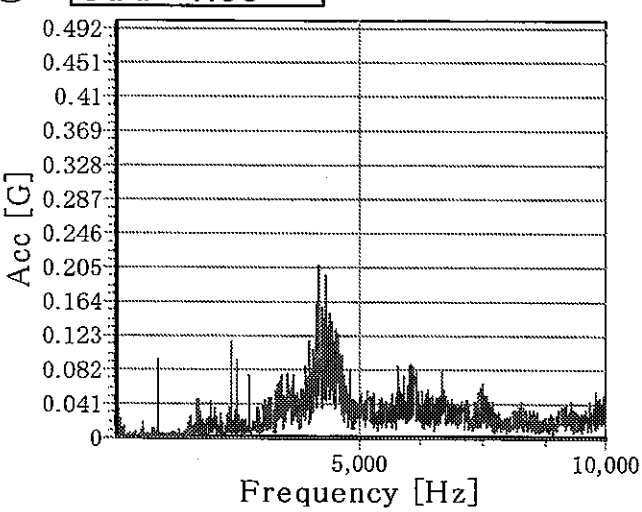
Test No. ① O.A.= 0.83



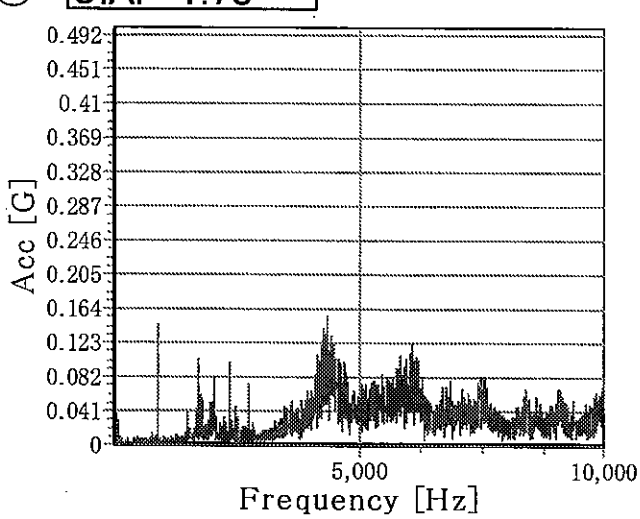
Test No. ② O.A.= 1.86



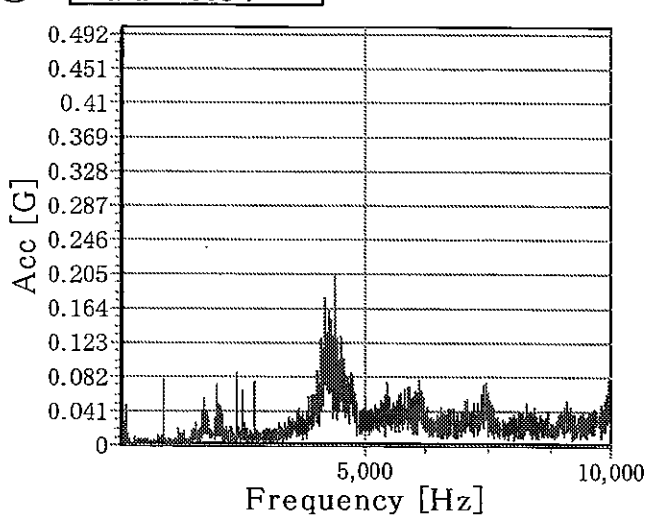
Test No. ③ O.A.= 1.66



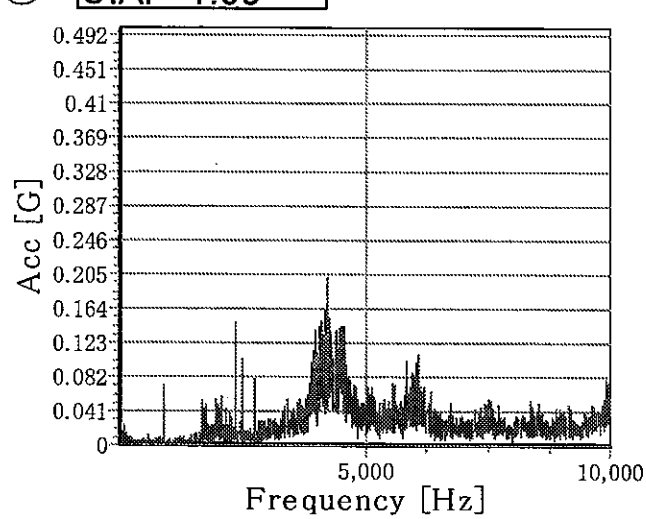
Test No. ④ O.A.= 1.78



Test No. ⑤ O.A.= 1.61

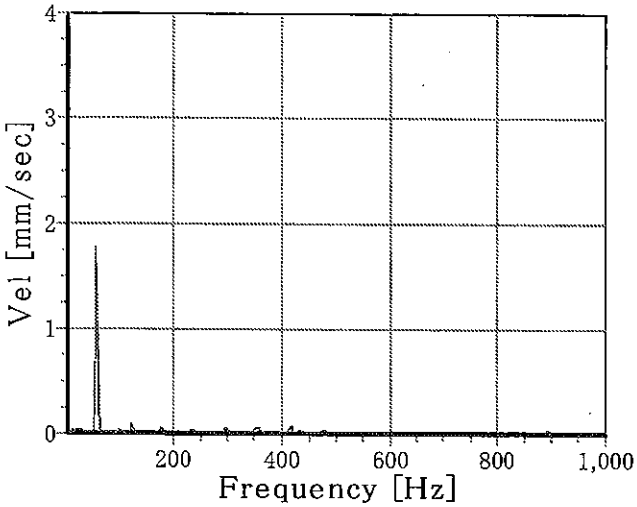


Test No. ⑦ O.A.= 1.69

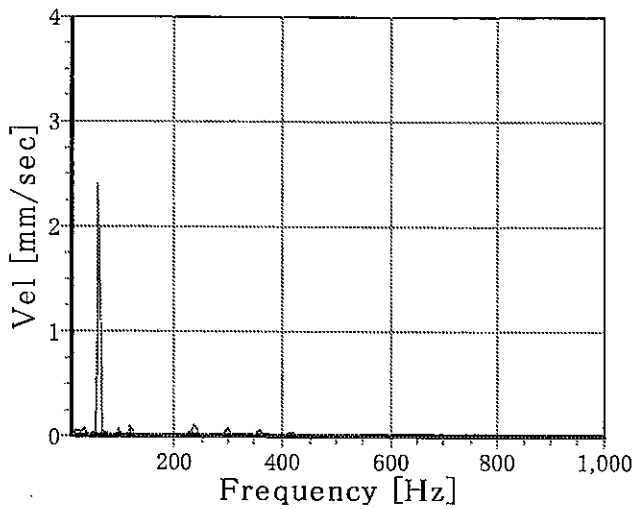


Velocity(mm/s) 10Hz～1kHz 802U No.1

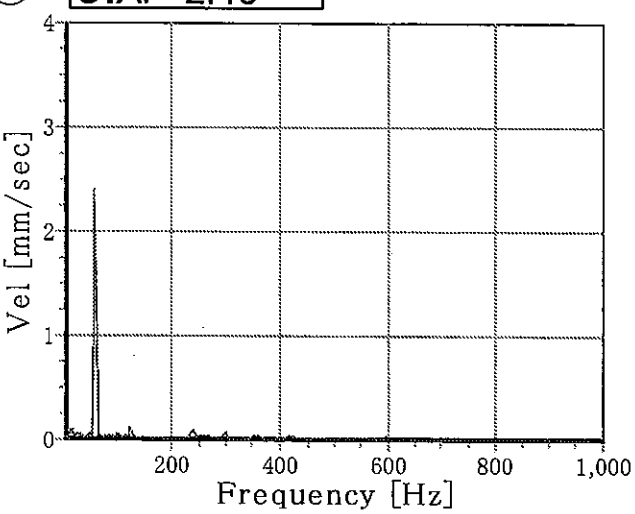
Test No. ① O.A.= 1.80



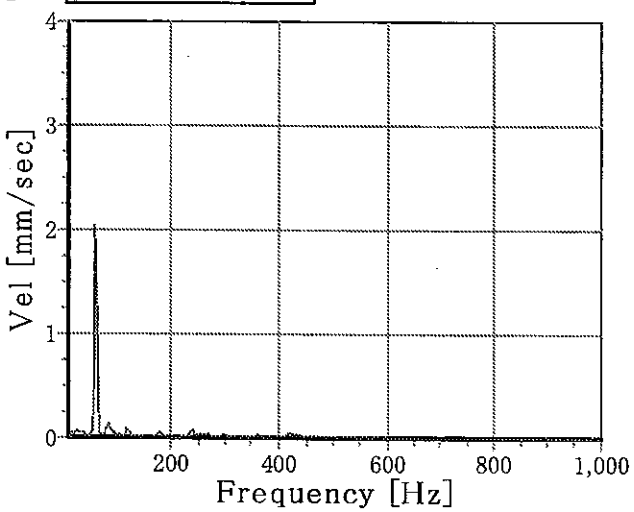
Test No. ② O.A.= 2.42



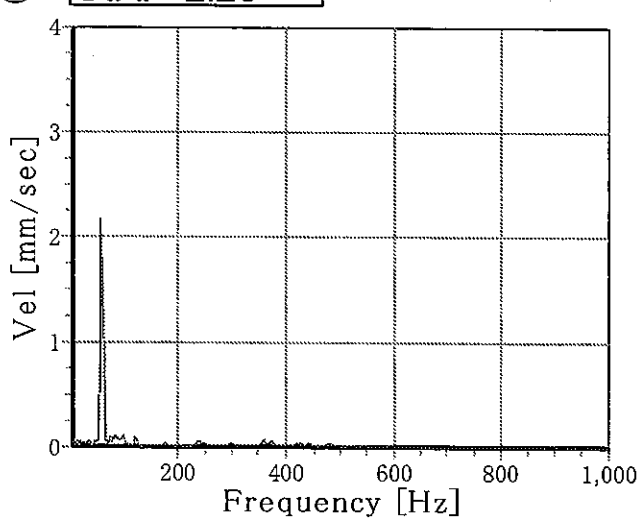
Test No. ③ O.A.= 2.43



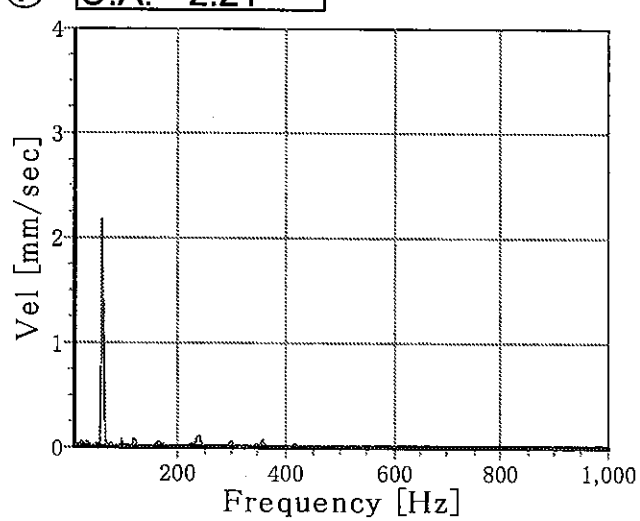
Test No. ④ O.A.= 2.07



Test No. ⑤ O.A.= 2.20

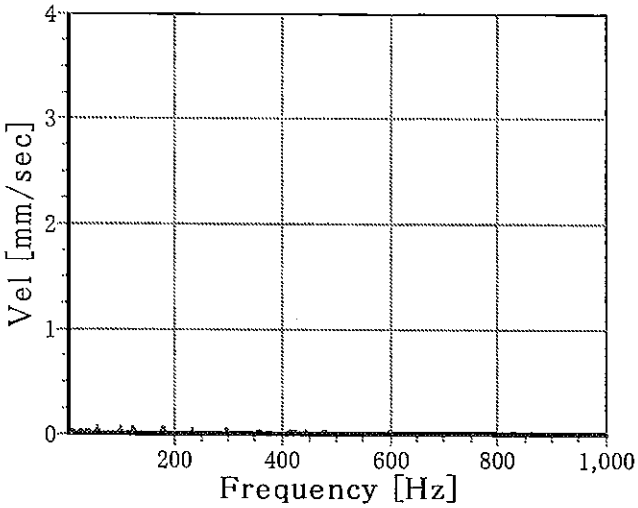


Test No. ⑦ O.A.= 2.21

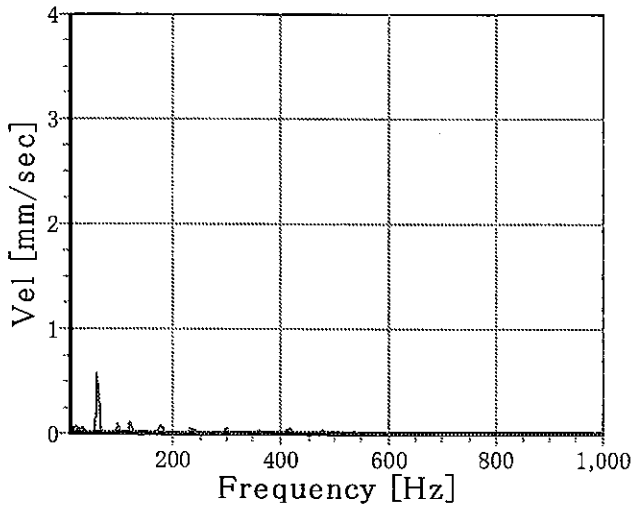


Velocity(mm/s) 10Hz～1kHz 802U No.2

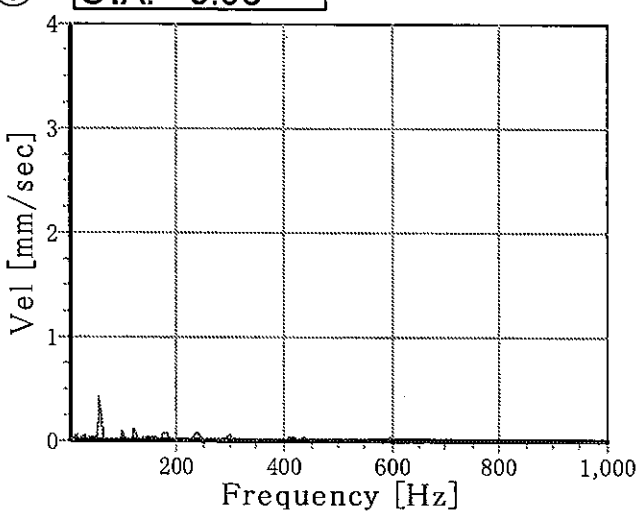
Test No. ① O.A.= 0.25



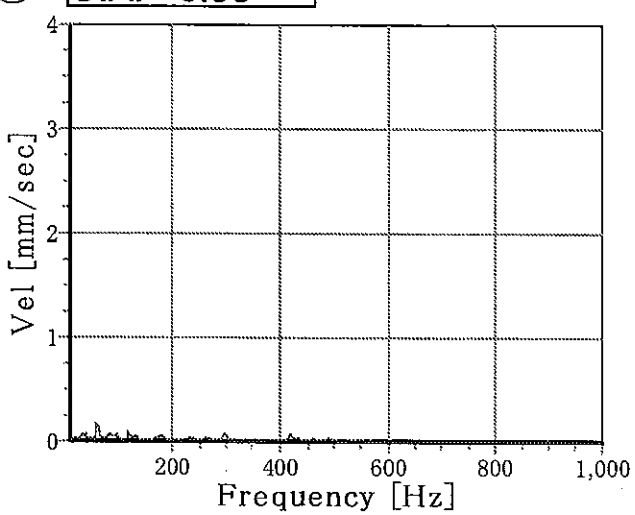
Test No. ② O.A.= 0.66



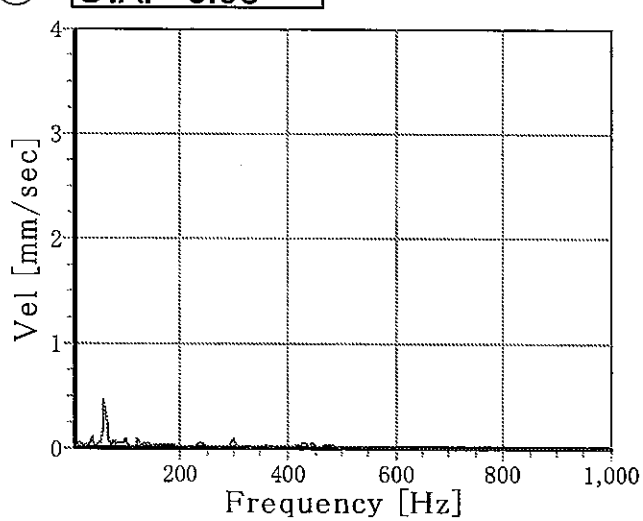
Test No. ③ O.A.= 0.53



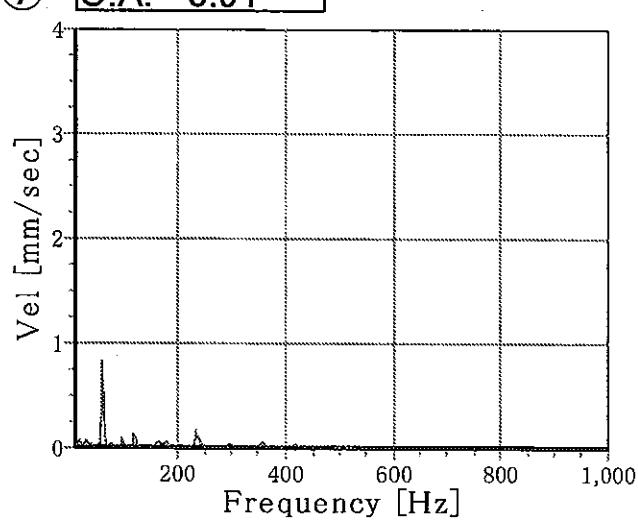
Test No. ④ O.A.= 0.38



Test No. ⑤ O.A.= 0.63

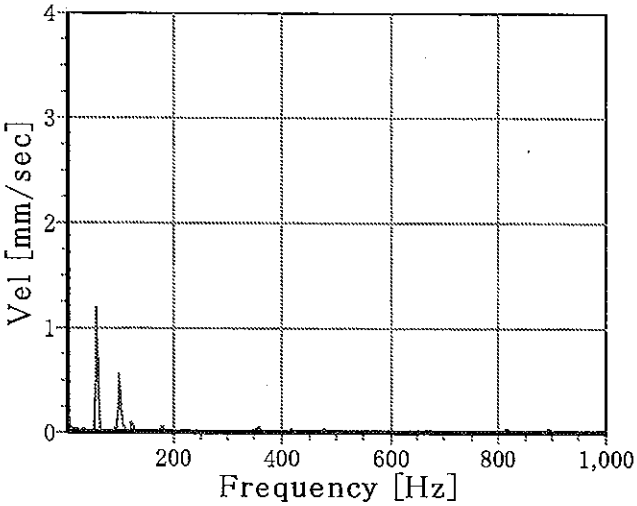


Test No. ⑦ O.A.= 0.91

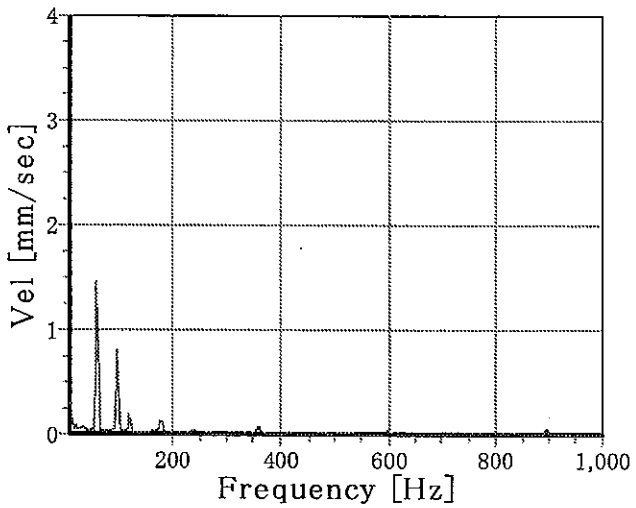


Velocity(mm/s) 10Hz～1kHz 802L No.3

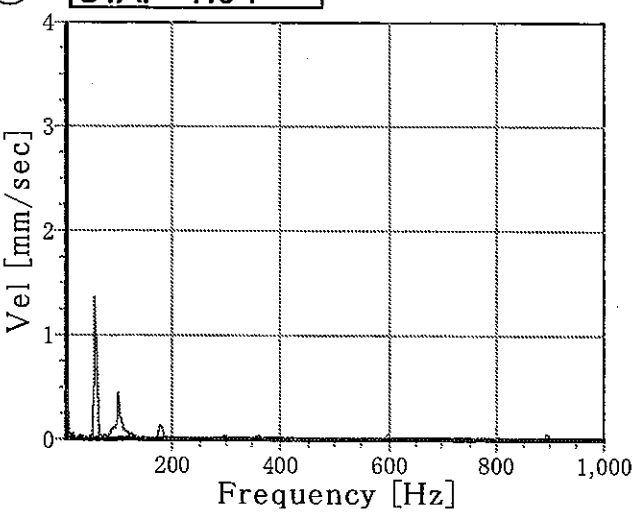
Test No. ① O.A.= 1.36



Test No. ② O.A.= 1.75



Test No. ③ O.A.= 1.54



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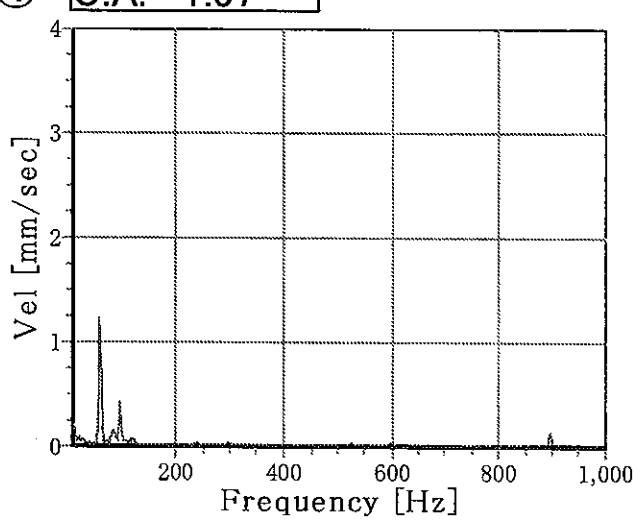

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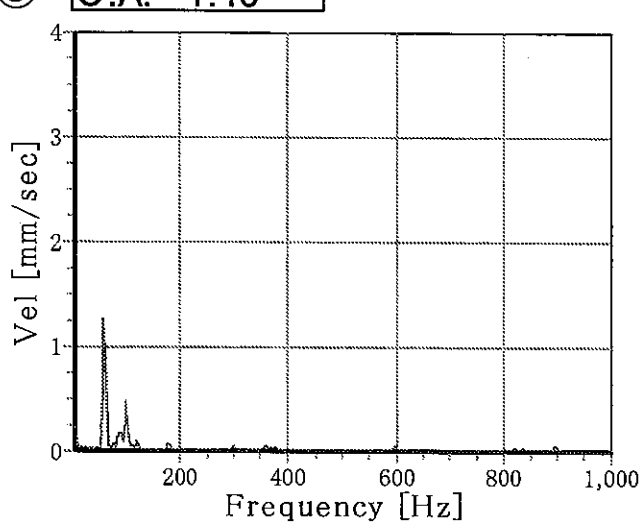

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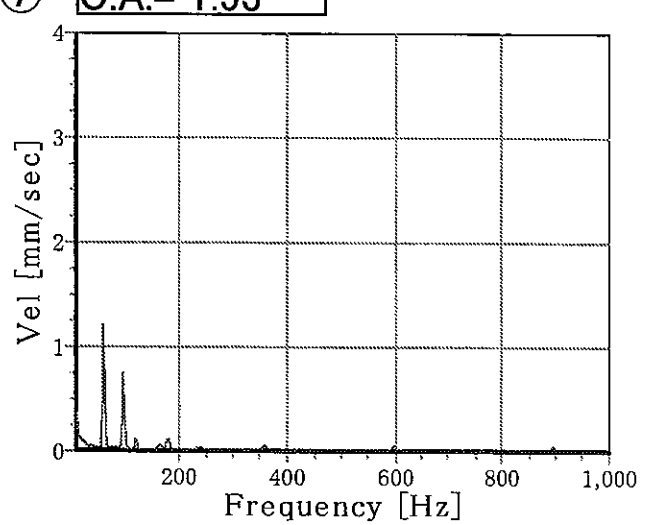
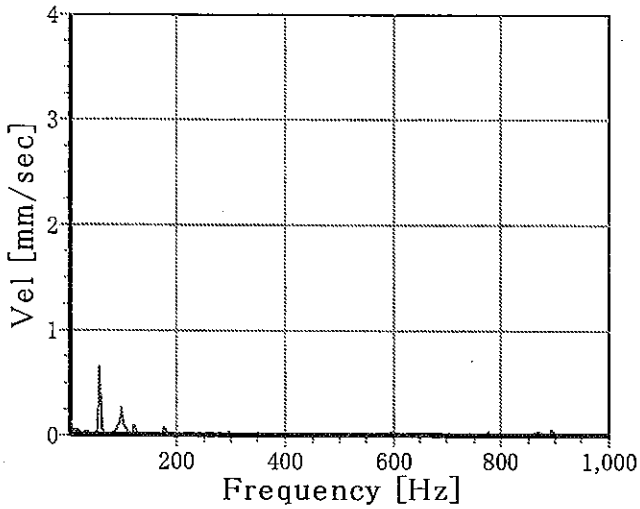
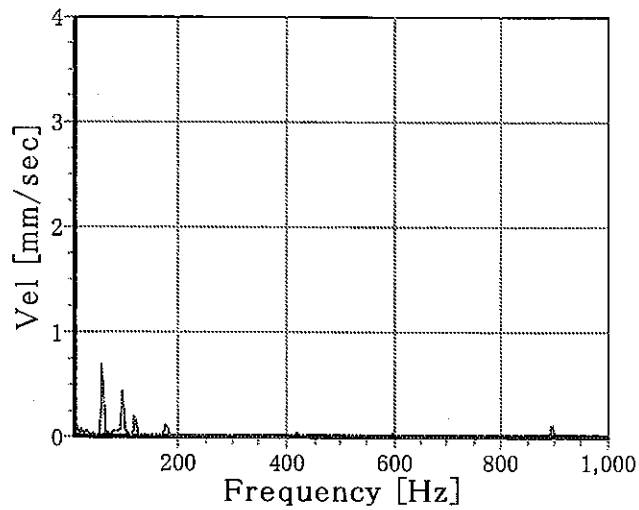


Velocity(mm/s) 10Hz～1kHz 802L No.4

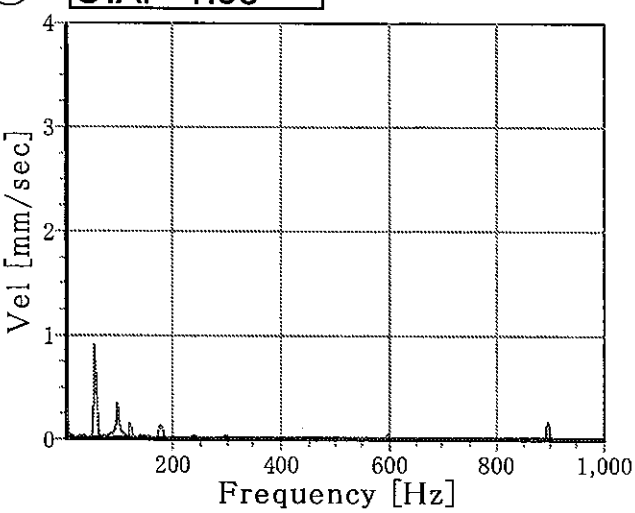
Test No. ① O.A.= 0.78



Test No. ② O.A.= 0.93



Test No. ③ O.A.= 1.08



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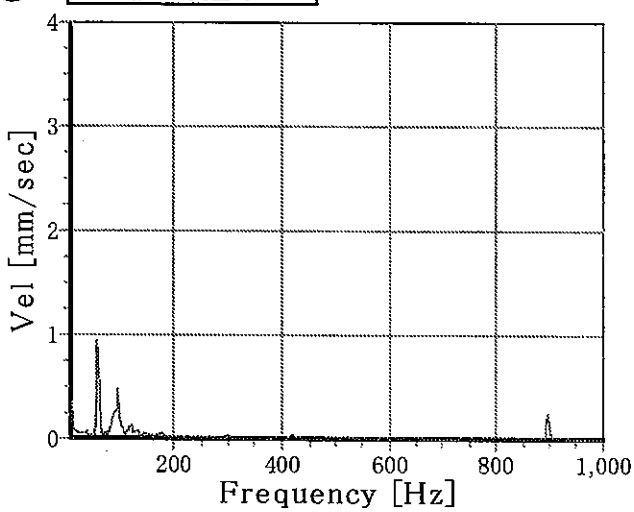

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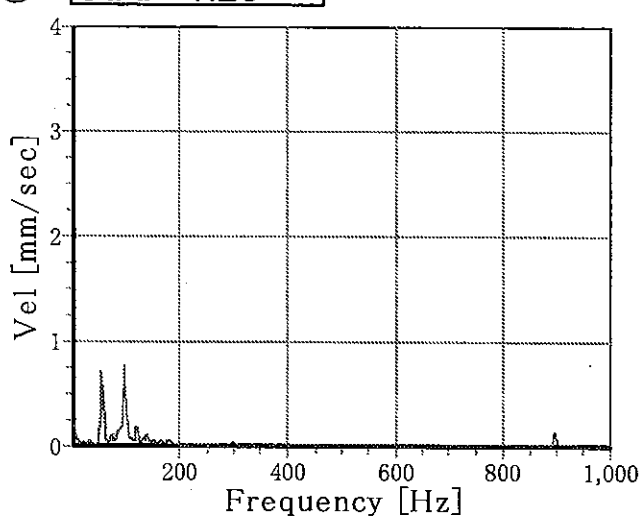
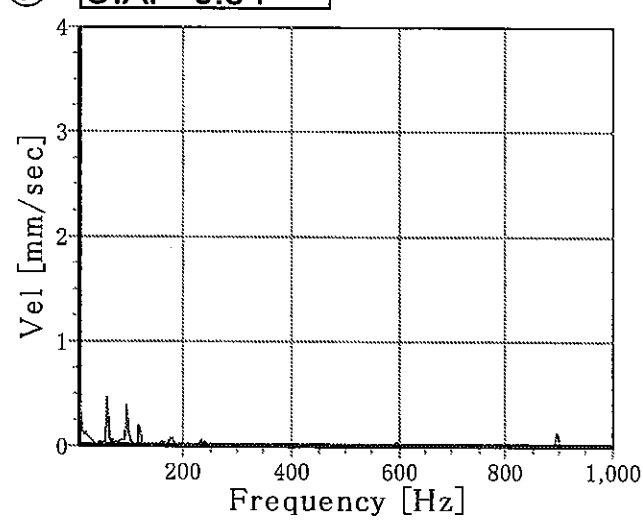
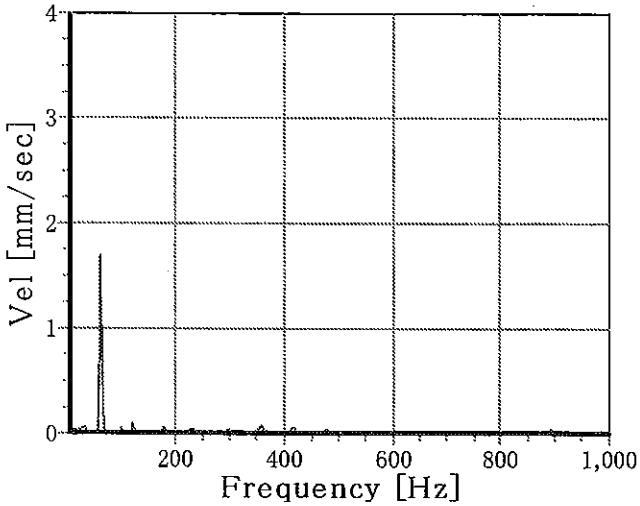


Test No. ⑦ O.A.= 0.84

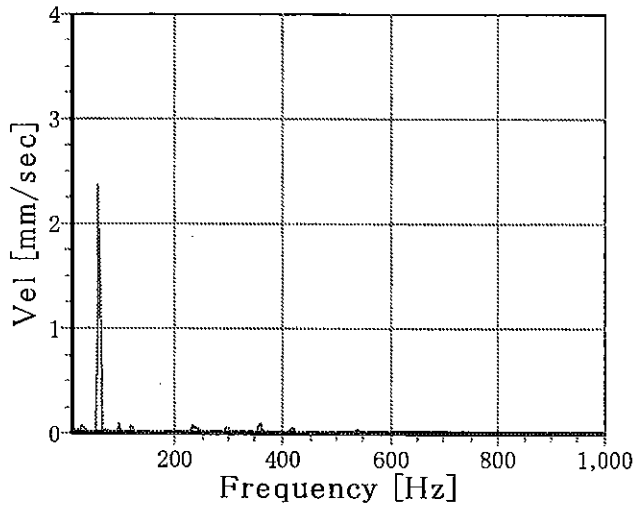


Velocity(mm/s) Unfiltered 802U No.1

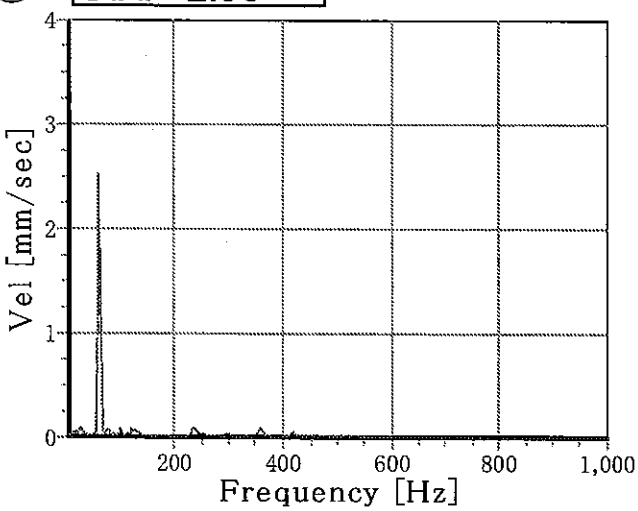
Test No. ① O.A.= 1.71



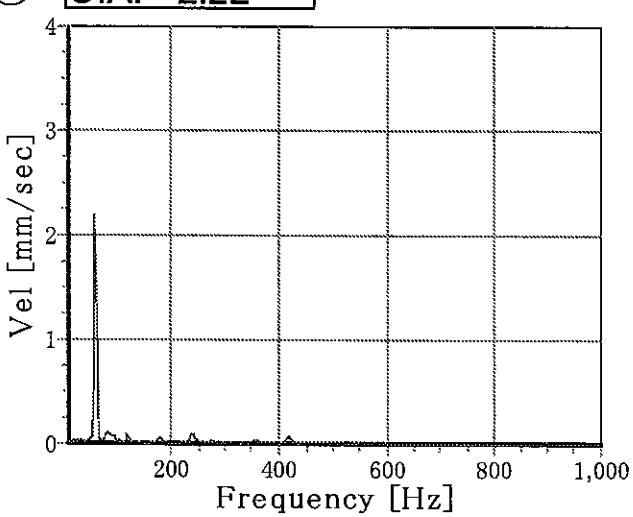
Test No. ② O.A.= 2.38



Test No. ③ O.A.= 2.56



Test No. ④ O.A.= 2.22



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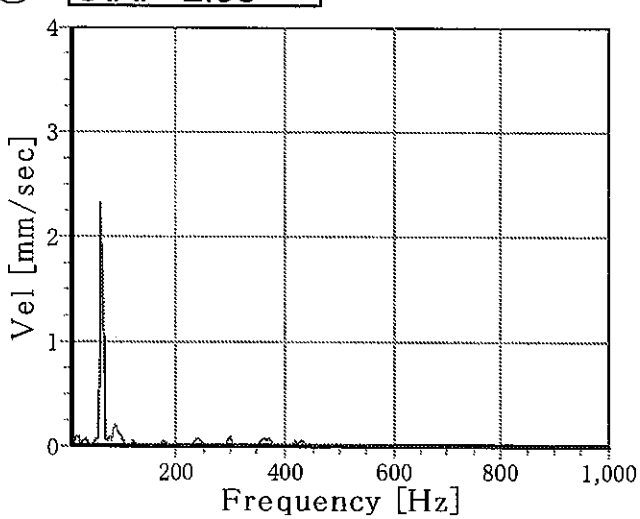
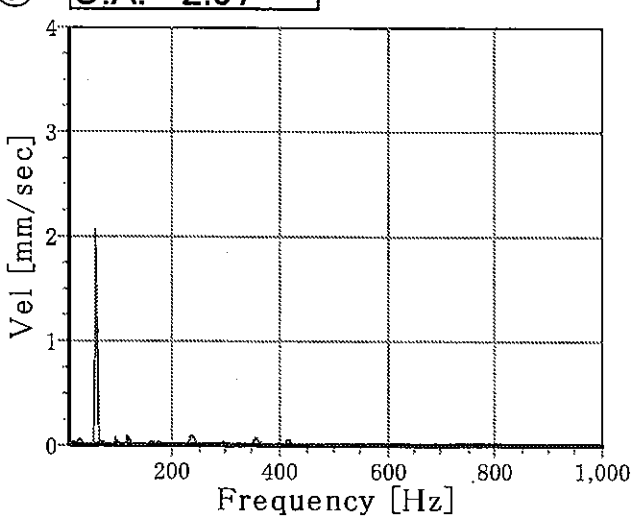
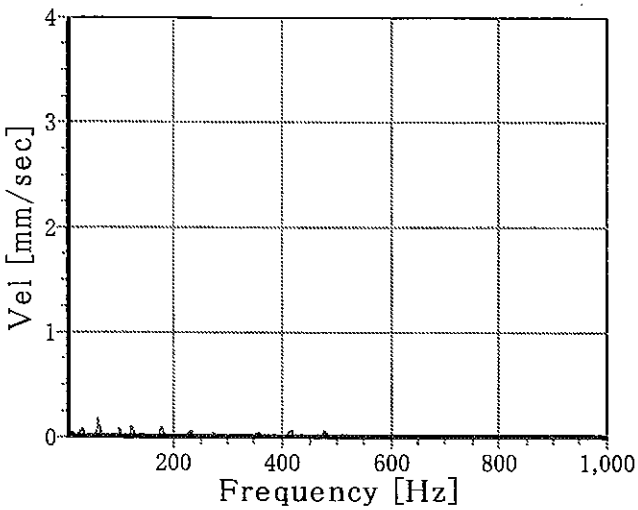


Test No. ⑦ O.A.= 2.07



Velocity(mm/s) Unfiltered 802U No.2

Test No. ① O.A.= 0.31



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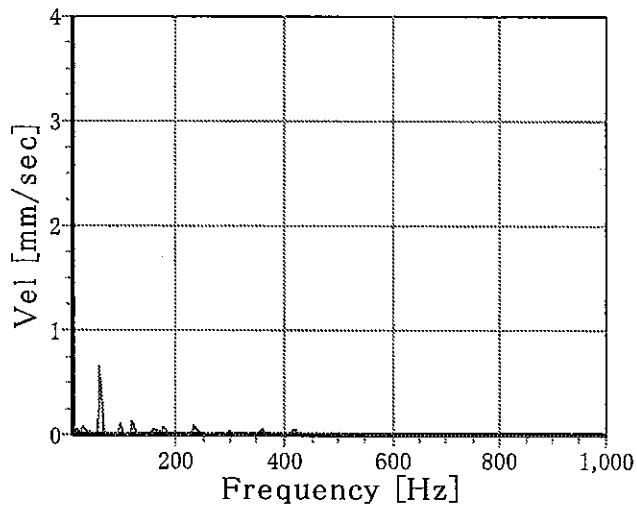
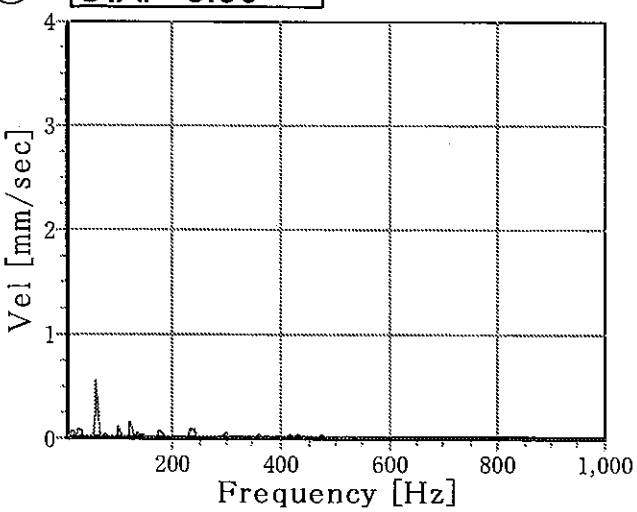


Test No. ③ O.A.= 0.66



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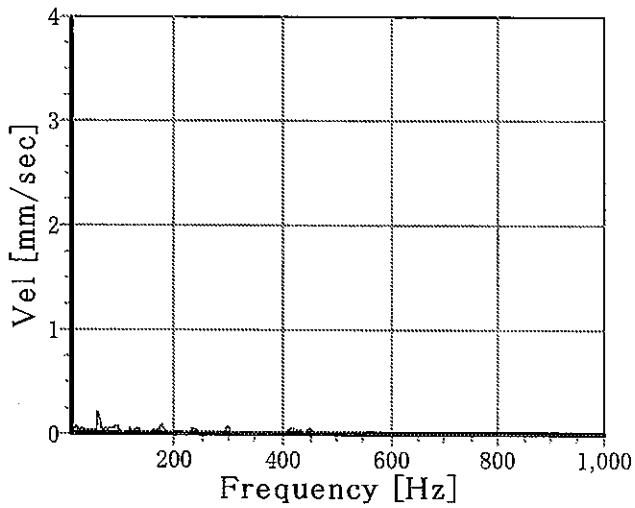
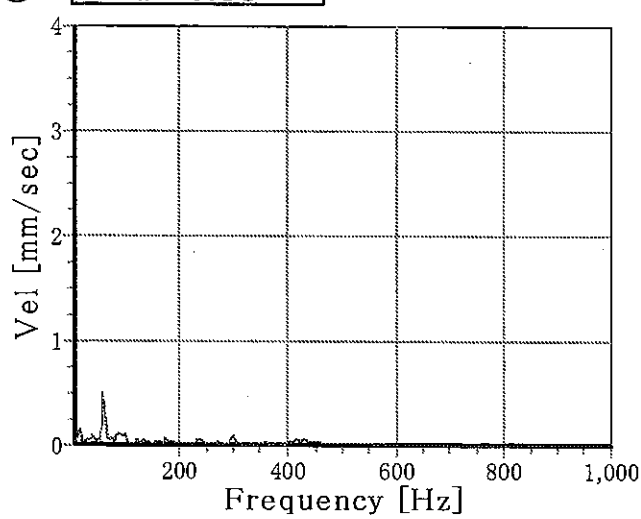
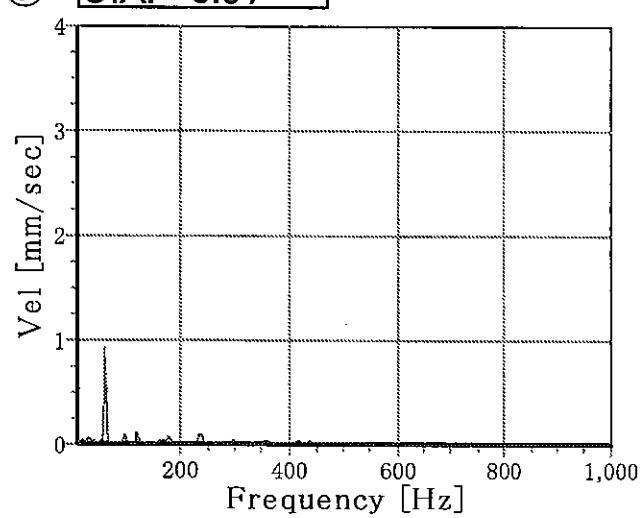


Test No. ⑤ O.A.= 0.68

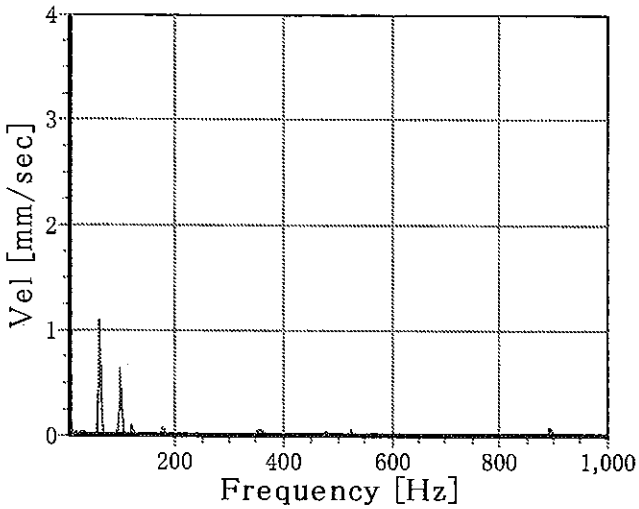


Test No. ⑦ O.A.= 0.97

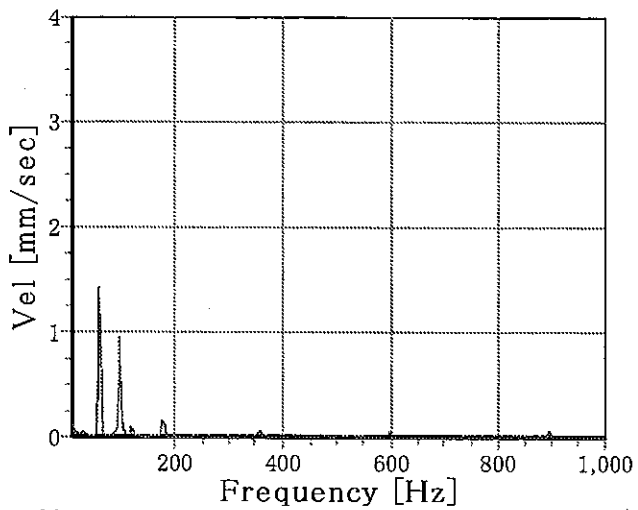


Velocity(mm/s) Unfiltered 802L No.3

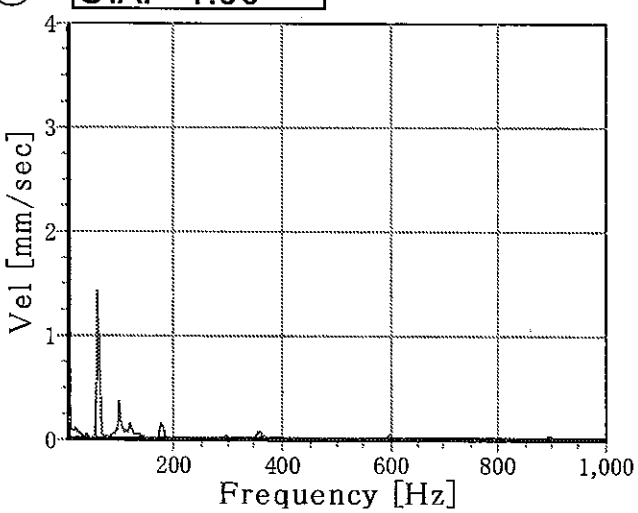
Test No. ① O.A.= 1.31



Test No. ② O.A.= 1.75



Test No. ③ O.A.= 1.56



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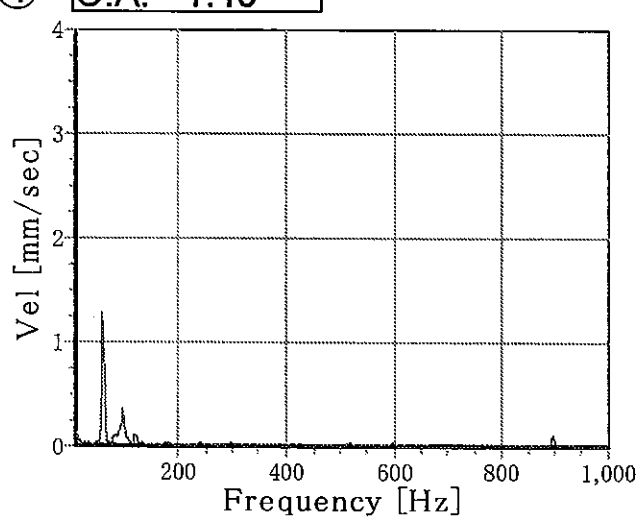

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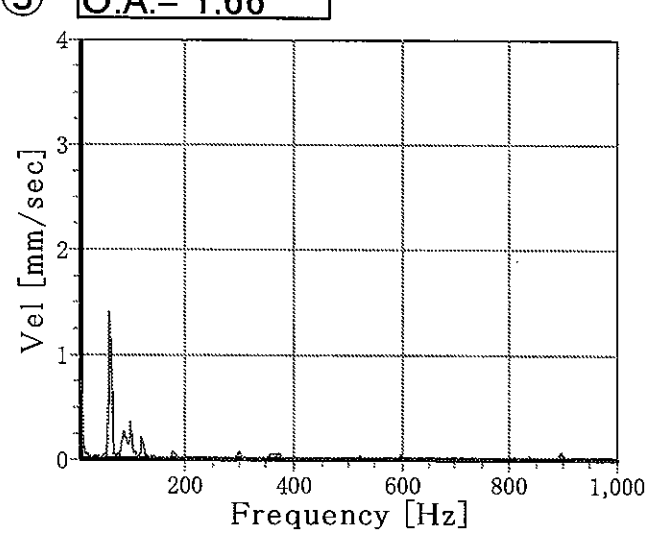

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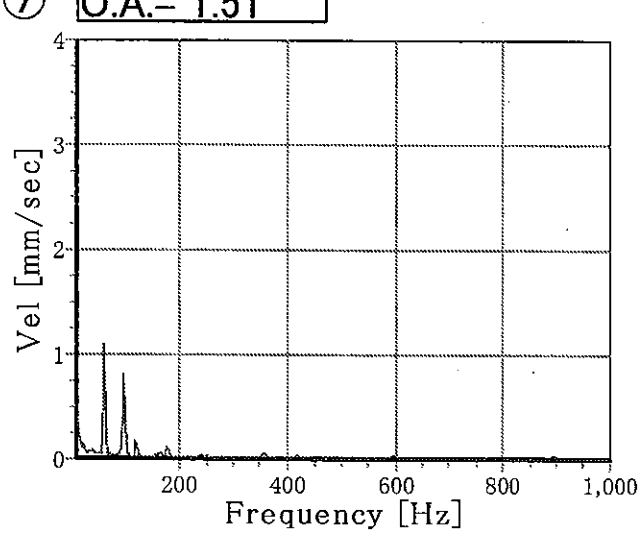
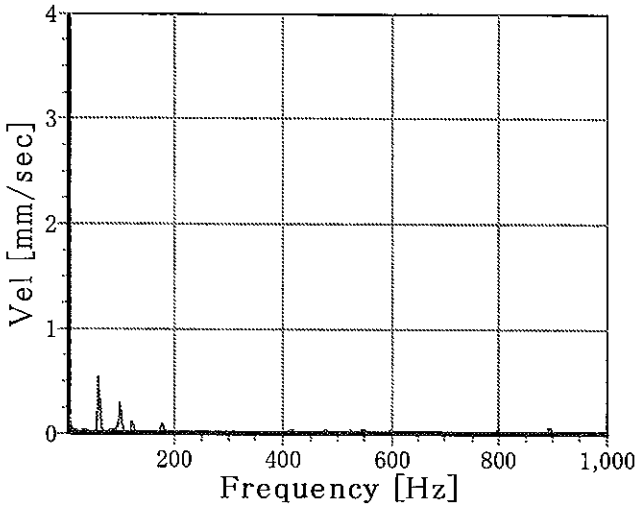


Velocity(mm/s) Unfiltered 802L No.4

Test No. ① O.A.= 0.69



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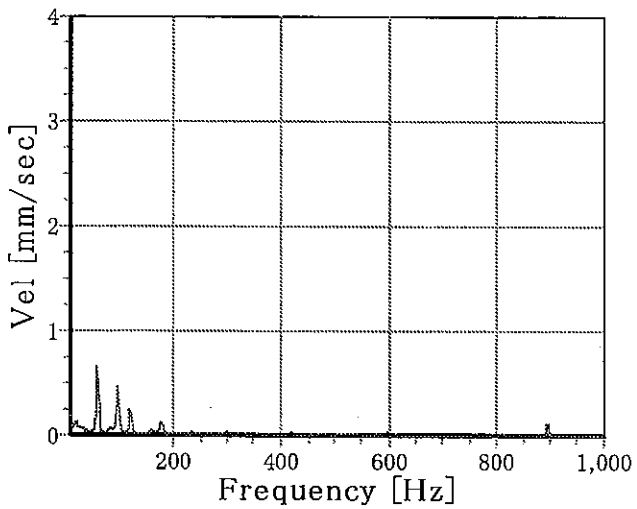

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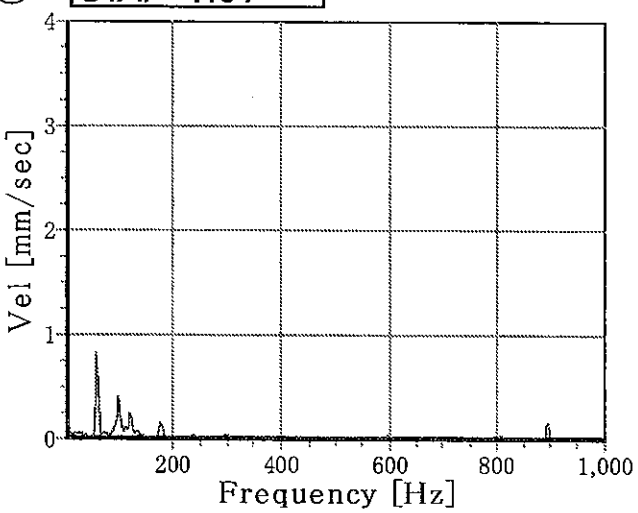
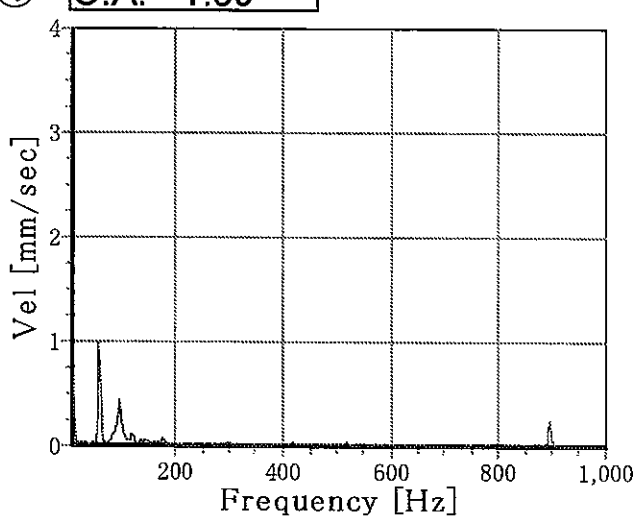
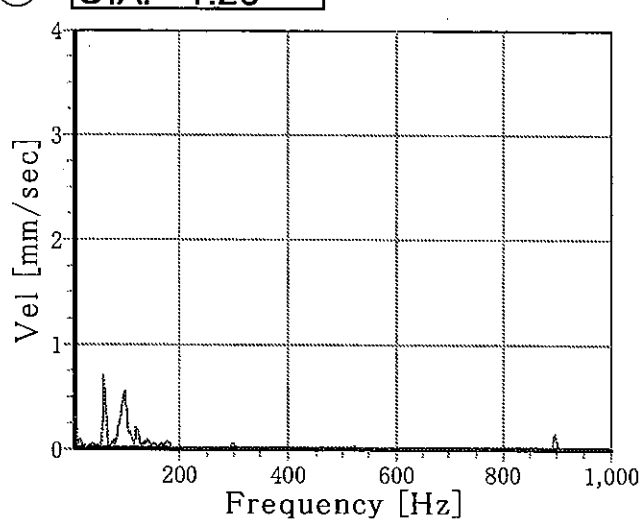


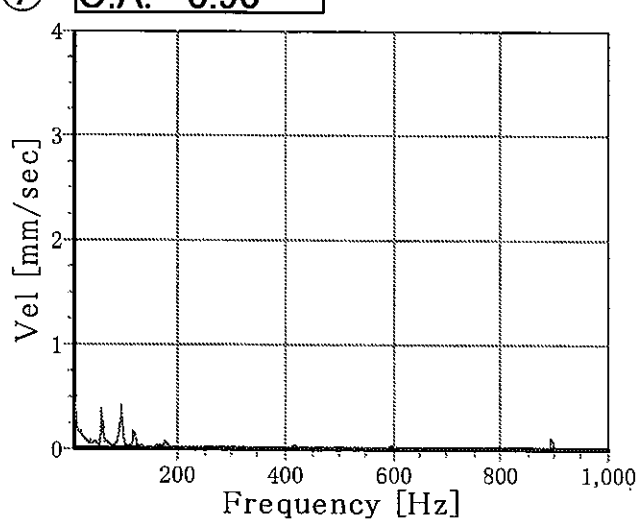
Test No. ④ O.A.= 1.39



Test No. ⑤ O.A.= 1.23



Test No. ⑦ O.A.= 0.90



TEST RECORD

CUSTOMER	CHINESE PETROLEUM CORPORATION
	SHINKO IND. LTD.
ARTICLE	820 kW THREE PHASE INDUCTION MOTOR
USE	SECOND STAGE LNG SEND OUT PUMP
TEST No.	395216GM1
RATING	820 kW – 6600 V – 94 A – 60 Hz – 3515 min^{-1} – class F – cont.
STANDARD	JEC–37–1979

1. Measurement of Insulation Resistance (by 1000V megger)

	Insulation Resistance	
Before running	2000	MΩ OVER
After running	2000	MΩ OVER

CRITERIA : More than 50 MΩ

2. Measurement of Winding Resistance (at LNG −158.5 ℃)

	Winding Resistance		Deviation	
U – V	0.476	Ω	0	%
V – W	0.476	Ω	0	%
W – U	0.476	Ω	0	%

CRITERIA : Individual measured value shall not have deviations of ± 5 % from the mean value.

3. Starting Test (Refer to oscillograph 1)

Starting Current (Is) 325.4 A
Starting Voltage (Vs) 4824 V

Calculation of Starting Current (Io)

$$Io = Is \times \frac{6600}{Vs} = 325.4\ A \times \frac{6600\ V}{4824\ V} = 445.2\ A$$

CRITERIA : Less than 658 A

4. Low Voltage Starting Test (Refer to oscillograph 1)

A terminal voltage confirms that a motor can start in less than the 80 % voltage in the performance examination.
(This examination is enforced at the same time with the initial examination.)

Result : 4824 V (73.1 %) It confirmed that it could start.

CRITERIA : It can start in less than 5280V (0.8 × 6600V).

Witnessed by

(Test enforced at SHINKO IND. LTD. Fuchu Works)

Issued by	QUALITY ASSURANCE SECTION	Date of tests	4 – JUNE – 2009
Approved by	Y. Fujii	Tested by	K. Sotani

NISHISHIBA ELECTRIC CO., LTD.

5. Winding Temperature Rise Test (LNG Liquid condition)

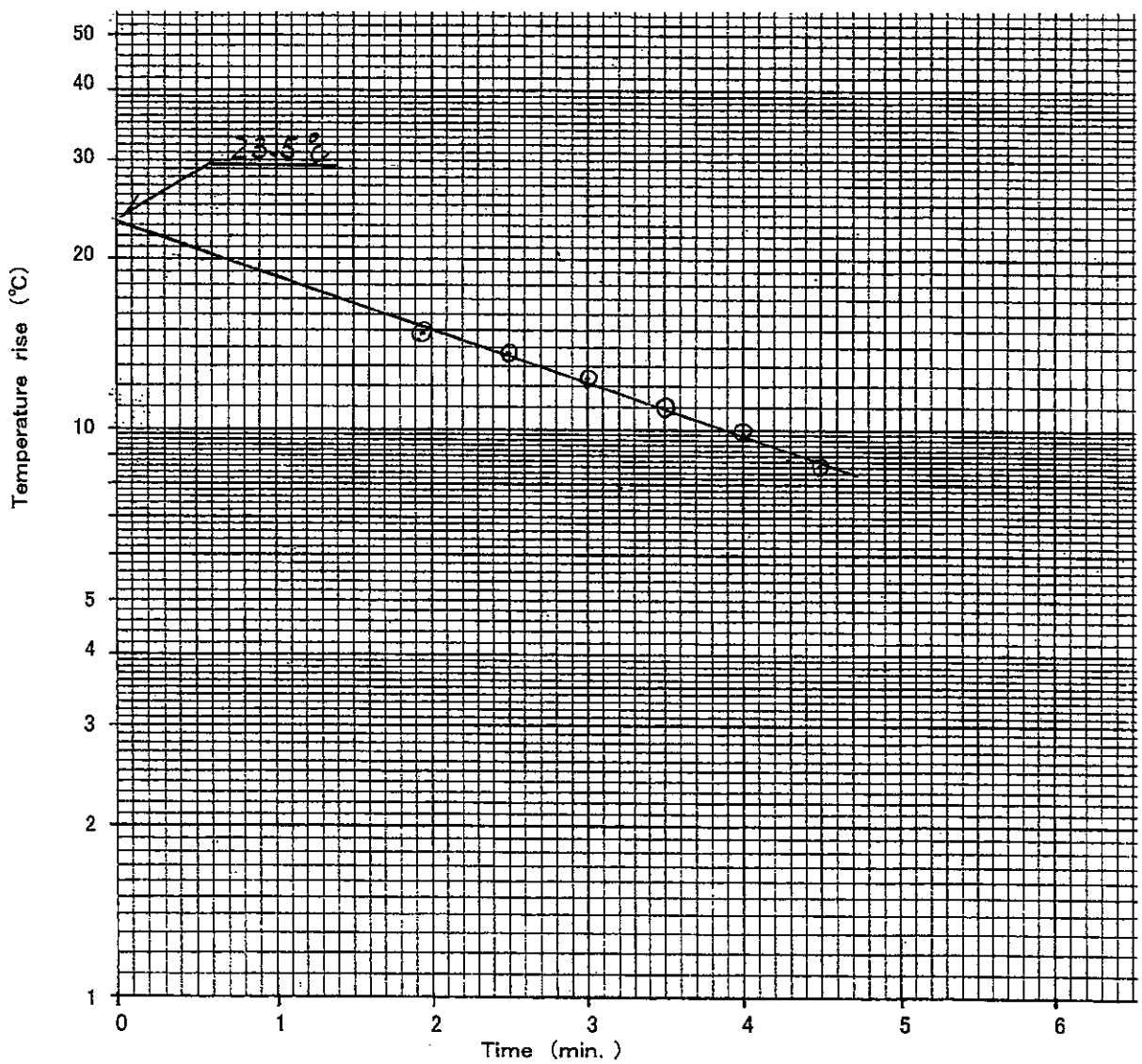
Operating condition

Voltage	6632 V
Current	82.0 A
InputPower	800.5 kW
Frequency	60.0 Hz
Operation time	2 Hr. 2 min.

Measured time min.	Measured time sec.	Winding resistance (R) Ω	Winding temp. (T) ℃	Liquid temp. (Ts) ℃	Temp. rise (ΔTt) ℃
1	55	0.592	-139.9	-154.7	14.8
2	30	0.585	-141.0	〃	13.7
3	0	0.577	-142.3	〃	12.4
3	30	0.568	-143.7	〃	11.0
4	0	0.561	-144.8	〃	9.9
4	30	0.554	-146.0	〃	8.7
		Base resistance (Ro)		0.476 Ω	
		Winding temp. (To)		-158.5 ℃	

Winding temp. (T) = [R × (235 + To) / Ro] − 235

Temp. Rise (ΔTt) = T − Ts

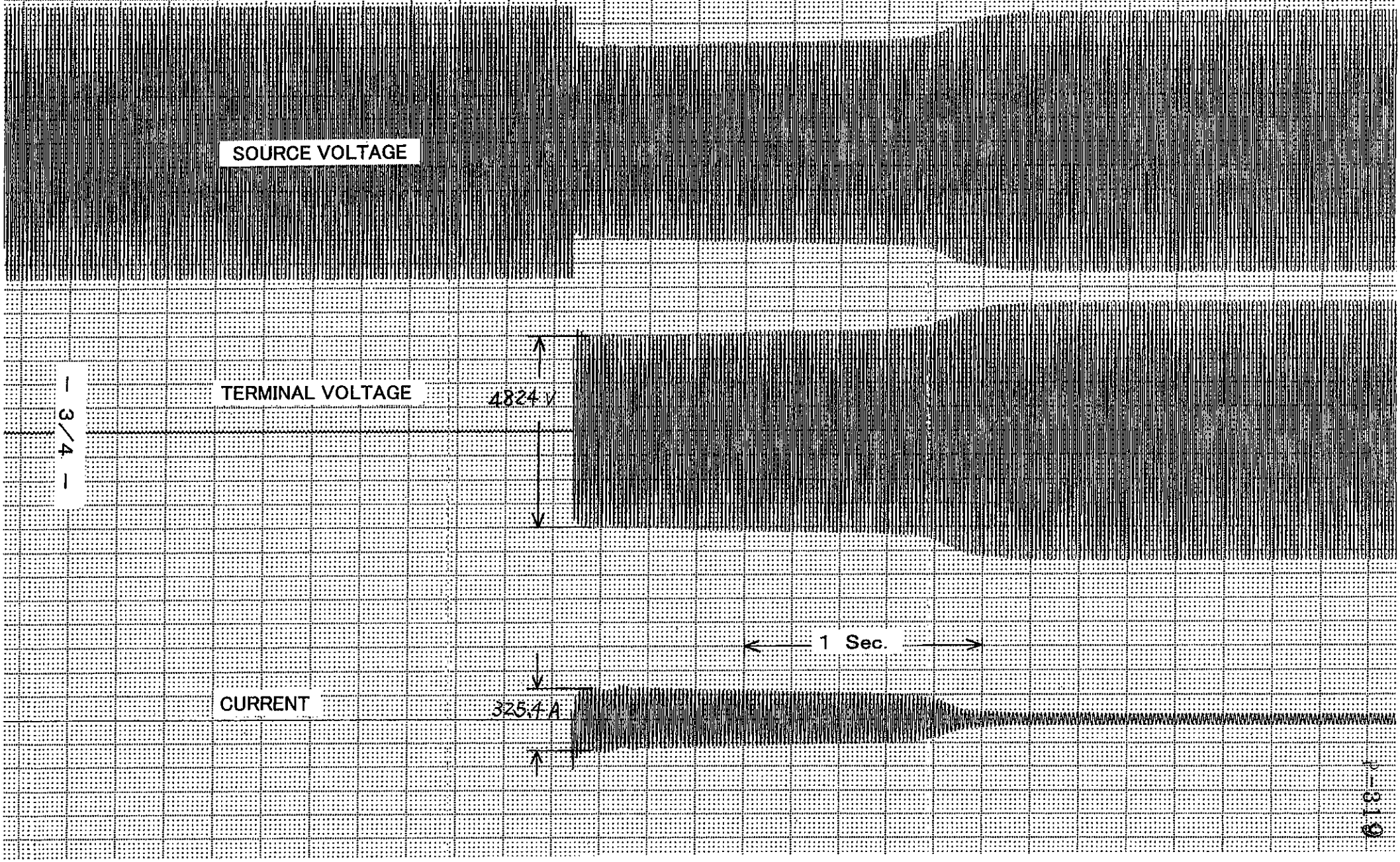


Temperature rise = 23.5 ℃

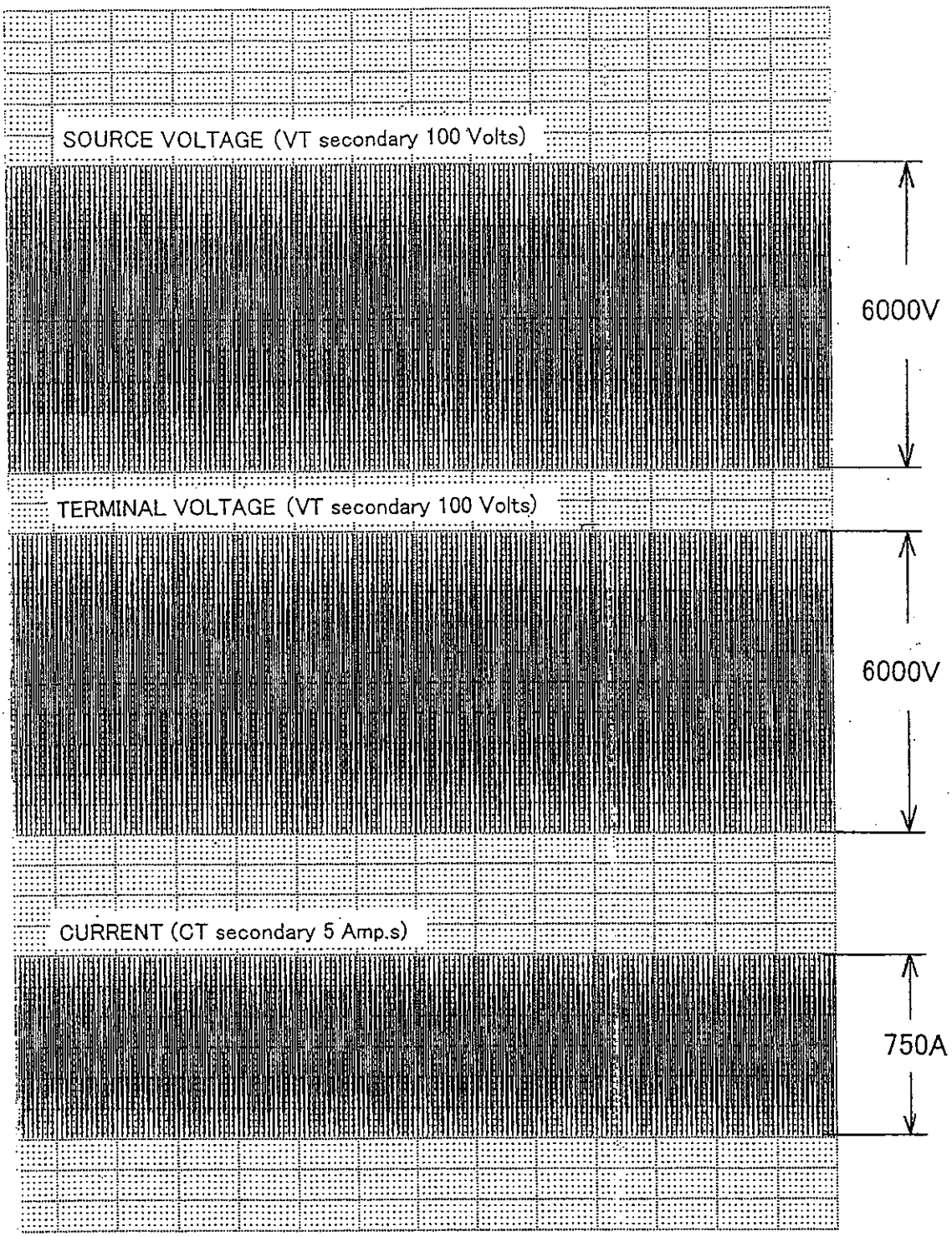
CRITERIA : Less than 55 ℃

MEASUREMENT OF STARTING CURRENT (Oscillograph 1)

T/R 395216GM1



Calibration



TEST RECORDS OF OVERHAUL & BEFORE SHIPMENT

CONTENTS

Order No.	P0009005		
Item No.	P-130S		
Messrs.	CHINESE PETROLEUM CORPORATION	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
User	CHINESE PETROLEUM CORPORATION	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Serial No.	1020939

OVERHAUL INSPECTION RECORD

P-401

Order No.	P0009005		
Item No.	P-130S		
Messrs.	CHINESE PETROLEUM CORPORATION	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
User	CHINESE PETROLEUM CORPORATION	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Machine No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw.No. SMB-Q151241 Rev.1)	Date of Inspection	Jun.5,2009

After completion of running test, overhaul shall be carried out for both pump side and motor side and following confirmation shall be done.

(1) There should be no imperfections such as crack, wounds and deformations on each part by visual inspection.

Result Good

(2) For the running clearances, it should be comfirmed that the calculated clearance value by measuring its inside and outside diameter to be within the tolerance.

Result Good

(3) The runout of the pump shaft (18) and motor shaft (111) shall be measured by the dial gauge and the difference between maximum and minimum reading should be below 0.05mm.

Result Good

(4) Insulation resistance measurement
The insulation resistance between winding and earth shall be measured by the DC 1000V megger.
The value of insulation resistance should be more than 50 MΩ.

Result Good

Witnessed	QUALITY CONTROL DEPT.	
	Approved by: M. Tanaka	Date: Jun. 5, 2009
	Checked by : W. Hoett	Date: Jun. 5, 2009
	Tested by : T. Tatsumi	Date: Jun. 5, 2009

SHINKO IND. LTD.

CLEARANCE INSPECTION RECORD(1)

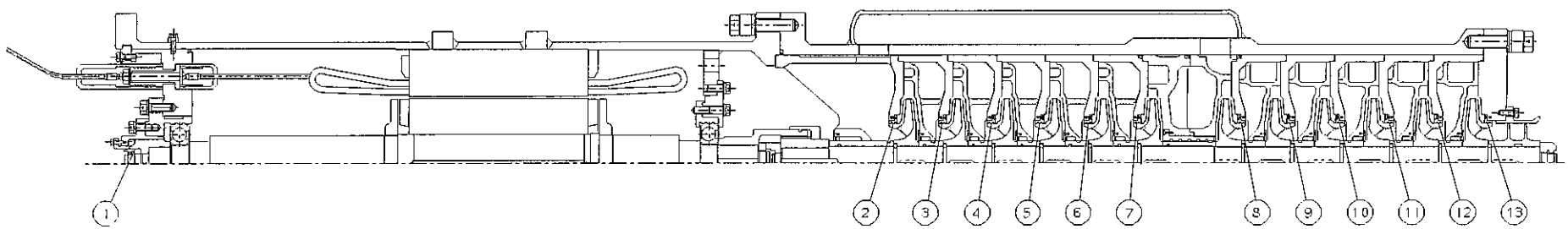
Order No.	P0009005
Messrs.	CHINESE PETROLEUM CORPORATION

☐Before Running test
■After Running test

User	CHINESE PETROLEUM CORPORATION	Item No.	P-130S	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP	Serial No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw. SMB-Q151241 Rev.1)	Date of Inspection	Jun. 5, 2009

Sketch



TEMP.:24℃
UNIT:mm

Measuring Point	1	2	3	4	5	6	7	8	9	10	11	12	13
	Balance Bush(45) & Blance Sleeve(26)	Mouth Ring(38) & Impeller(17)						Mouth Ring(38) & Impeller(16)					
Inside Diameters(Stationary Parts)	118.00	190.00	190.01	190.02	190.02	190.01	190.01	190.01	190.02	190.04	190.02	190.02	190.04
Outside Diameters(Rotating Parts)	117.62	189.71	189.70	189.71	189.71	189.70	189.70	189.71	189.72	189.71	189.72	189.71	189.70
Diametrical Clearance	0.38	0.29	0.31	0.31	0.31	0.31	0.31	0.30	0.30	0.33	0.30	0.31	0.34
Planned Diametrical Clearance	0.24～0.50	0.24～0.47						0.24～0.47					
Diametrical Clearance in Usable Limit	0.6	0.55						0.55					
Results	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good

Note:No.2 Clearance shall be measured by NISHISHIBA ELECTRIC CO.,LTD.

Witnessed

QUALITY CONTROL DEPT.

Approved by : M. Tanaka Date: Jun. 5, 2009
Checked by : M. Morii Date: Jun. 5, 2009
Tested by : T. Tatsumi Date: Jun. 5, 2009

S SHINKO IND. LTD.

P-402

CLEARANCE INSPECTION RECORD(2)

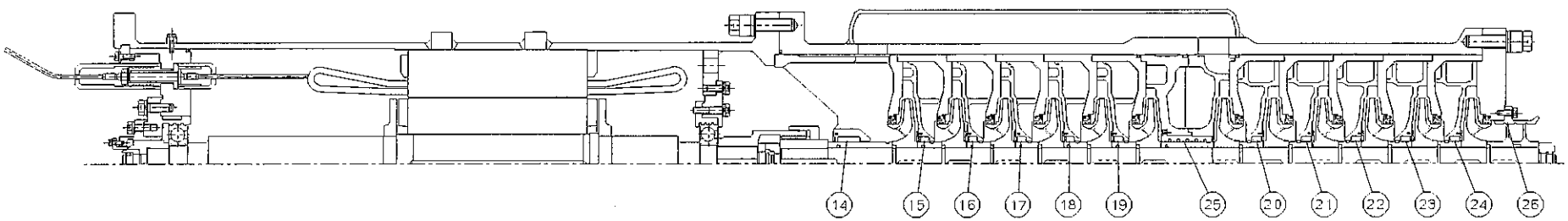
Order No.	P0009005
Messrs.	CHINESE PETROLEUM CORPORATION

☐Before Running test
■After Running test

User	CHINESE PETROLEUM CORPORATION	Item No.	P-130S	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP	Serial No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw. SMB-Q151241 Rev. 1)	Date of Inspection	Jun. 5, 2009

Sketch



TEMP. : 24℃
UNIT: mm

Measuring Point	14	15	16	17	18	19	20	21	22	23	24	25	26
	Sleeve Bearing(42) & Sleeve(24)	Sleeve Bearing(41) & Sleeve(23)					Sleeve Bearing(41) & Sleeve(22)					Stage Bush(44) & Stage Sleeve(25)	Bell Mouth(9) & Inducer(15)
Inside Diameters(Stationary Parts)	105.01	105.02	105.02	105.02	105.02	105.02	105.02	105.02	105.02	105.02	105.02	105.02	190.00
Outside Diameters(Rotating Parts)	104.96	104.96	104.96	104.96	104.95	104.95	104.95	104.97	104.96	104.96	104.97	104.72	188.50
Diametrical Clearance	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.05	0.06	0.06	0.05	0.30	1.50
Planned Diametrical Clearance	0.01～0.14	0.01～0.14					0.01～0.14					0.24～0.36	1.2～1.7
Diametrical Clearance in Usable Limit	0.17	0.17					0.17					0.45	2.2
Results	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good

Note: No. 2 Clearance shall be measured by NISHISHIBA ELECTRIC CO., LTD.

Witnessed

QUALITY CONTROL DEPT.

Approved by : M. Tanaka Date: Jun. 5, 2009
Checked by : M. Mori Date: Jun. 5, 2009
Tested by : T. Tatsumi Date: Jun. 5, 2009

SHINKO IND. LTD.

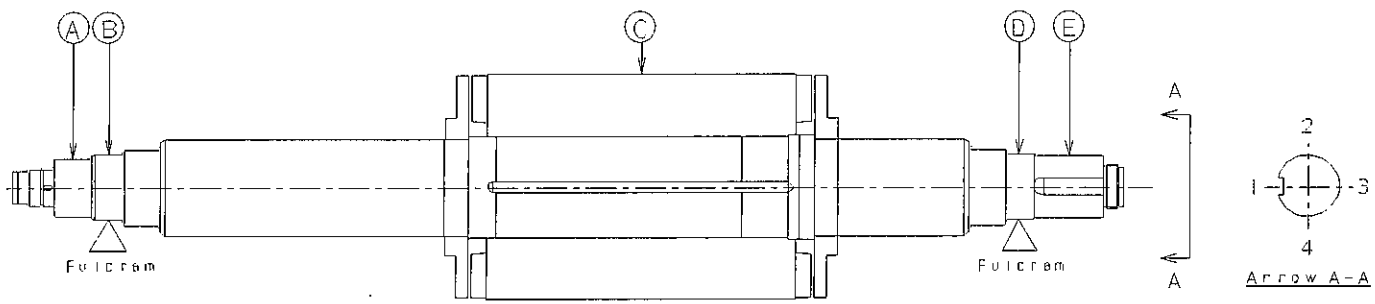
DIMENSION CHECK RECORD
(Motor shaft runout)

☐Before Running test
■After Running test

Order No.	P0009005				
Messrs.	CHINESE PETROLEUM CORPORATION				
User	CHINESE PETROLEUM CORPORATION	Item No.	P-130S	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP	Serial No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw.N SMB-Q151241 Rev.1)	Date of Inspection	Jun.5,2009

Sketch



TEMP.:24℃
UNIT:mm

Measuring Point	A	B	C	D	E
	Balance sleeve	Ball bearing	Rotor core	Ball bearing	Coupling
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.01	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00
Max.run-out	0.00	0.00	0.01	0.00	0.00
Allowance	0.05				
Result	Good				

Witnessed

QUALITY CONTROL DEPT.

Approved by :	M. Tanaka	Date:	Jun. 5, 2009
Checked by :	M. Morii	Date:	Jun. 5, 2009
Tested by :	T. Tatsumi	Date:	Jun. 5, 2009

S SHINKO IND. LTD.

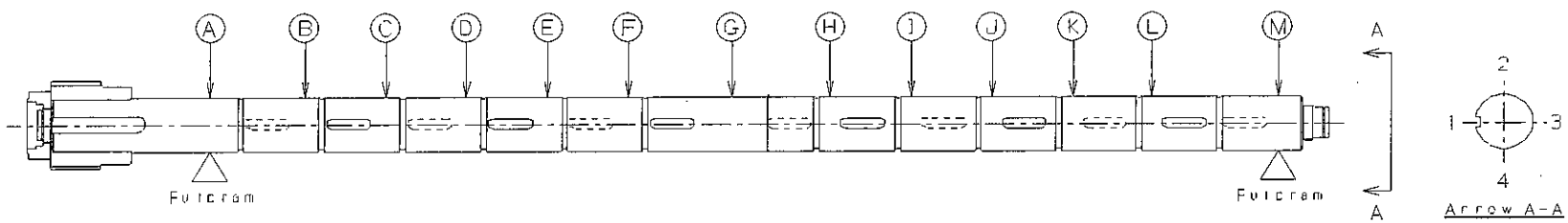
DIMENSION CHECK RECORD
(Pump shaft runout)

☐Before Running test
■After Running test

Order No.	P0009005				
Messrs.	CHINESE PETROLEUM CORPORATION				
User	CHINESE PETROLEUM CORPORATION	Item No.	P-130S	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP	Serial No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw.N SMB-Q151241 Rev.1)	Date of Inspection	Jun.5,2009

Sketch



Motor side

Suction side

TEMP.:24℃
UNIT:mm

Measuring Point	A	B	C	D	E	F	G	H	I	J	K	L	M
	Sleeve	7th stage sleeve	8th stage sleeve	9th stage sleeve	10th stage sleeve	11th stage sleeve	Stage sleeve	5th stage sleeve	4th stage sleeve	3rd stage sleeve	2nd stage sleeve	1st stage sleeve	Inducer
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max.run-out	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Allowance	0.05												
Result	Good												

Witnessed

QUALITY CONTROL DEPT.

Approved by : M. Tanaka Date: Jun. 5, 2009
Checked by : M. Morii Date: Jun. 5, 2009
Tested by : T. Tatsumi Date: Jun. 5, 2009

S SHINKO IND. LTD.

INSPECTION BEFORE SHIPMENT RECORD

P-406

Order No.	P0009005
Item No.	P-130S

Messrs.	CHINESE PETROLEUM CORPORATION	Pump Name	SPARE SECOND STAGE LNG SEND OUT PUMP
User	CHINESE PETROLEUM CORPORATION	Model	SMB150-12
Location	YUNG-AN, KAOHSIUNG, TAIWAN	Machine No.	1020939

Applicable Code and Acceptable Standards	■Shop Test Inspection Procedures (Draw.No. SMB-Q151241 Rev.1)	Date of Inspection	Jun.15,2009

Prior to shipment, following should be confirmed.

(1) Quantity check
The quantity shall be confirmed by the shipping list prior to shipment.

Result Good

(2) Appearance check
(a) There should be no wounds (marking line is also unacceptable) on the sealing surface of each flange.

(b) There should be no oil & fat and moisture on the surface.

(c) There should be no cutting chips, foreign matters on the surface.

Result Good

(3) Packing check
(a) There should be protecting cover on the nozzle of barrel cover.

(b) There should be vinyl sheet cover on the pump and motor.

(c) Packing and crating should be properly done.

Result Good

Witnessed	QUALITY CONTROL DEPT.
	Approved by: M. Tanaka Date: Jun. 15, 2009
	Checked by : M. Mori Date: Jun. 15, 2009
	Tested by : T. Tatsumi Date: Jun. 15, 2009

S SHINKO IND. LTD.